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JEB LITTLE CREEK
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FINAL SECOND COMPREHENSIVE FIVE YEAR REVIEW NAB LITTLE CREEK VIRGINIA BEACH VA (PUBLIC DOCUMENT)

03/01/2014

CH2M HILL

Final

Second Comprehensive Five-Year Review

Joint Expeditionary Base Little Creek
Virginia Beach, Virginia

Contract Task Order WE61

March 2014

Prepared for

Department of the Navy
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Mid-Atlantic

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Prepared by

CH2MHILL®

Virginia Beach, Virginia

Second Comprehensive Five-Year Review

Joint Expeditionary Base Little Creek

Virginia Beach, Virginia

March 2014

This report documents completion of the second Five-Year Review for the following sites with a Record of Decision (ROD) for taking action that leaves any hazardous substances, pollutants, or contaminants at the site: Site 7, Site 9, Site 10, Site 11, Site 11a, Site 12, and Site 13, at Joint Expeditionary Base (JEB) Little Creek in Virginia Beach, 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 Title 40 of the *Code of Federal Regulations* (CFR).

The Five-Year Review evaluated the implementation and performance of each site remedy in order to determine if the remedy is or will 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 findings of the 2014 Five-Year Review indicated that the remedies for Sites 7, 11a, 12, and 13 are protective of human health and the environment. Although currently protective, issues regarding the future protectiveness of the site remedies for Sites 9, 10, and 11 were identified. Due to discussions during the current five-year review period to cease groundwater sampling, data to evaluate groundwater quality since completion of the previous Five-Year Review are not available for Sites 9 and 10 landfills. Consensus regarding the sampling of groundwater should be reached and a groundwater sampling plan should be developed and implemented in conjunction with Five-Year Reviews at Sites 9 and 10 landfills as needed to demonstrate continued protectiveness of the remedy. An evaluation of 1,4-dioxane in groundwater will achieve long-term protectiveness of the Site 11 remedy.

Approved by:

F.E. Hughlett
Captain, United States Navy
Commander
Joint Expeditionary Base Little Creek-Fort Story

17 MAR 14
Date

Executive Summary

The Department of the Navy conducted this Five-Year Review for Joint Expeditionary Base (JEB) Little Creek in Virginia Beach, 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 Title 40 of the *Code of Federal Regulations* (CFR). The Report has been prepared in accordance with the United States Environmental Protection Agency (USEPA) *Comprehensive Five-Year Review Guidance* (2001) and Navy Policy on Five Year Reviews (CNO, 2011). It summarizes the evaluation of remedies and remedial actions that resulted in hazardous substances, pollutants, or contaminants remaining at sites above levels that allow for unlimited use and unrestricted exposure, and for which there is a Final Record of Decision (ROD) or Decision Document in place. This document presents the second Five-Year Review for JEB Little Creek, which has been conducted for remedial actions completed at the sites listed below (including the date of the remedial action triggering the five-year review) and shown in **Figure ES-1**:

- Site 7—Amphibious Base Landfill, September 2009
- Site 9—Driving Range Landfill, December 2003
- Site 10—Sewage Treatment Plant Landfill, December 2003
- Site 11—Former School of Music Plating Shop, July 2007
- Site 11a—Building 3033 Former Vehicle Repair Facility and Waste Oil Tank, September 2011
- Site 12—Former Exchange Laundry/Dry Cleaning Facility, September 2005
- Site 13—Former Public Works Center Pentachlorophenol (PCP) Dip Tank and Wash Rack, September 2007

The review was conducted for the period between March 20, 2009 and March 19, 2014. The First Five-Year Review report was signed by the Navy on March 19, 2009, which is the triggering action for this statutory review presented herein.

The objective of this Five-Year Review is to evaluate the implemented remedies to determine whether they remain 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 pre- and post-remedy implementation activities, analytical data and findings, and through interviews, site visits, and inspections. The community was notified of the review process through a public notice in *The Virginian-Pilot* published on April 24, 2013. This report identifies issues that may prevent a particular remedy from functioning as designed or from 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, as provided below.

As outlined in this Five-Year Review, the remedies for Sites 7, 11a, 12 and 13 are protective of human health and the environment. Although currently protective, issues regarding the future protectiveness of the remedies for Sites 9, 10, and 11 were identified. Based on the recommendation made during the first Five-Year Review (2009) to modify the long-term monitoring sampling and analysis plan, the development of the Tier II issue paper, *Consideration for Developing Long-Term Monitoring Plans for Unpermitted Navy Landfills in Virginia* (Virginia Navy Tier II, 2011), and ongoing discussions to cease groundwater sampling, data to evaluate groundwater quality since completion of the previous Five-Year Review are not available for Sites 9 and 10 landfills. Consensus regarding the sampling of groundwater should be reached and a groundwater sampling plan should be developed and implemented in conjunction with Five-Year Reviews at Sites 9 and 10 landfills as needed to demonstrate continued 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. At Site 11, 1,1,1-TCA has been identified as a site-specific COC. Site 11 groundwater samples have not been analyzed for 1,4-dioxane; therefore, its presence or absence in site groundwater is unknown at this time and an assessment of 1,4-dioxane in groundwater should be performed to evaluate long-term protectiveness of the Site 11 remedy. 1,1,1-TCA has not

been detected in groundwater samples collected from Sites 11a, 12, and 13; therefore, 1,4-dioxane is not expected to be present at these sites and no further investigation of this constituent is warranted for continued protectiveness of the remedy at these sites. A summary table of the sites, site descriptions, basis for action, site status, remedy components, recommendations and follow-up actions, protectiveness statements, and Five-Year Review statuses based on this Five-Year Review, is provided as follows.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Joint Expeditionary Base (JEB) Little Creek		
EPA ID: VA5170022482		
Region: 3	**State:** VA	**City/County:** Virginia Beach

SITE STATUS	
NPL Status: Final	
Multiple Sites? Yes	**Has the site achieved construction completion?** No

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 Mid-Atlantic
Author affiliation: United States Navy
Review period: March 20, 2009 – March 19, 2014
Date of site inspection: May 15, 2013
Type of review: Statutory
Review number: 2
Triggering action date: March 19, 2009
Due date *(five years after triggering action date)*: March 19, 2014

Five-Year Review Summary Form (continued)

Issues/Recommendations				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Navy	EPA	March 2015
Site(s): Site 7	**Issue Category: Operations and Maintenance**			
	Issue: Remedy capital costs are below the -30%/+50% range estimated in the ROD.			
	Recommendation: Evaluate changes to remedy costs and prepare the appropriate documentation, as needed.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	TBD	Navy	EPA	March 2015
Site(s): Site 9	**Issue Category: Monitoring**			
	Issue: Due to discussions during the current five-year review period to cease groundwater sampling, data to evaluate groundwater quality since completion of the previous Five-Year Review are not available for Sites 9 and 10 landfills.			
	Recommendation: Reach consensus regarding the sampling of groundwater and, as needed, develop and implement a groundwater sampling plan in conjunction with Five-Year Reviews to demonstrate continued protectiveness of the remedy.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Navy	EPA	September 2014
Site(s): Site 10	**Issue Category: Changed Site Conditions**			
	Issue: Ruts in soil cover, and dispersed surface debris including steel pipe, asphalt, and tires were observed during site inspections.			
	Recommendation: Repair existing ruts and remove surface debris from Site 10. Continue annual landfill inspections to monitor potential continued debris disposal and cover conditions. Conduct an investigation to determine the means by which debris has been disposed of within the area and make recommendations to prevent future disposal activities.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	TBD	Navy	EPA	March 2015
Site(s): Site 10	**Issue Category: Monitoring**			
	Issue: Due to discussions during the current five-year review period to cease groundwater sampling, data to evaluate groundwater quality since completion of the previous Five-Year Review are not available for Sites 9 and 10 landfills.			

	Recommendation: Reach consensus regarding the sampling of groundwater and, as needed, develop and implement a groundwater sampling plan in conjunction with Five-Year Reviews to demonstrate continued protectiveness of the remedy.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	TBD	Navy	EPA	March 2015
Site(s): Site 11	**Issue Category: Remedy Performance**			
	Issue: RSL established for 1,4-dioxane. Previous sampling did not include analysis of this constituent; therefore, the presence or absence of 1,4-dioxane in Site 11 groundwater is unknown..			
	Recommendation: Sampling for 1,4-dioxane to confirm its presence or absence in groundwater.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Navy	EPA	March 2015
Site(s): Site 11a	**Issue Category: Operations and Maintenance**			
	Issue: Remedy capital costs are below the -30%/+50% range estimated in the ROD.			
	Recommendation: Evaluate changes to remedy costs and prepare the appropriate documentation, as needed.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Navy	EPA	September 2014
Site(s): Site 12	**Issue Category: Monitoring**			
	Issue: No project action level in LTM UFP SAP to account for potential ecological exposures at the groundwater/surface water interface within the canal.			
	Recommendation: Revise existing surface water project action levels to account for potential ecological exposures at the groundwater/surface water interface.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Navy	EPA	March 2015
Site(s): Site 13	**Issue Category: Operations and Maintenance**			
	Issue: Remedy capital costs are above the -30%/+50% range estimated in the ROD.			
	Recommendation: Evaluate changes to remedy costs and prepare the appropriate documentation, as needed.			

Five-Year Review Summary Form (continued)

Site:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Site 7	Protective	N/A

Protectiveness Statement:
The remedy at Site 7 is in place, functioning as designed, and is protective of human health and the environment. The soil cover is in good condition and prevents direct contact with landfill contents. LUCs are in place and prevent unauthorized intrusive activities and unauthorized site use. Groundwater monitoring data indicate a release has not occurred from the landfill. There have been no changes in the physical conditions or use of the site that would affect the protectiveness of the remedy.

Site:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Sites 9 and 10	Short-term Protective	March 2015

Protectiveness Statement:
The remedies at Sites 9 and 10 are in place, functioning as designed, and are currently protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled through a combination of soil cover and LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. However, in order to determine if the remedies are protective in the long-term, a consensus on five-year review data requirements should be reached and, as needed, a groundwater sampling and analysis plan developed and implemented in conjunction with Five-Year Reviews to demonstrate continued protectiveness of the remedies.

Site:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Site 11	Short-term Protective	March 2015

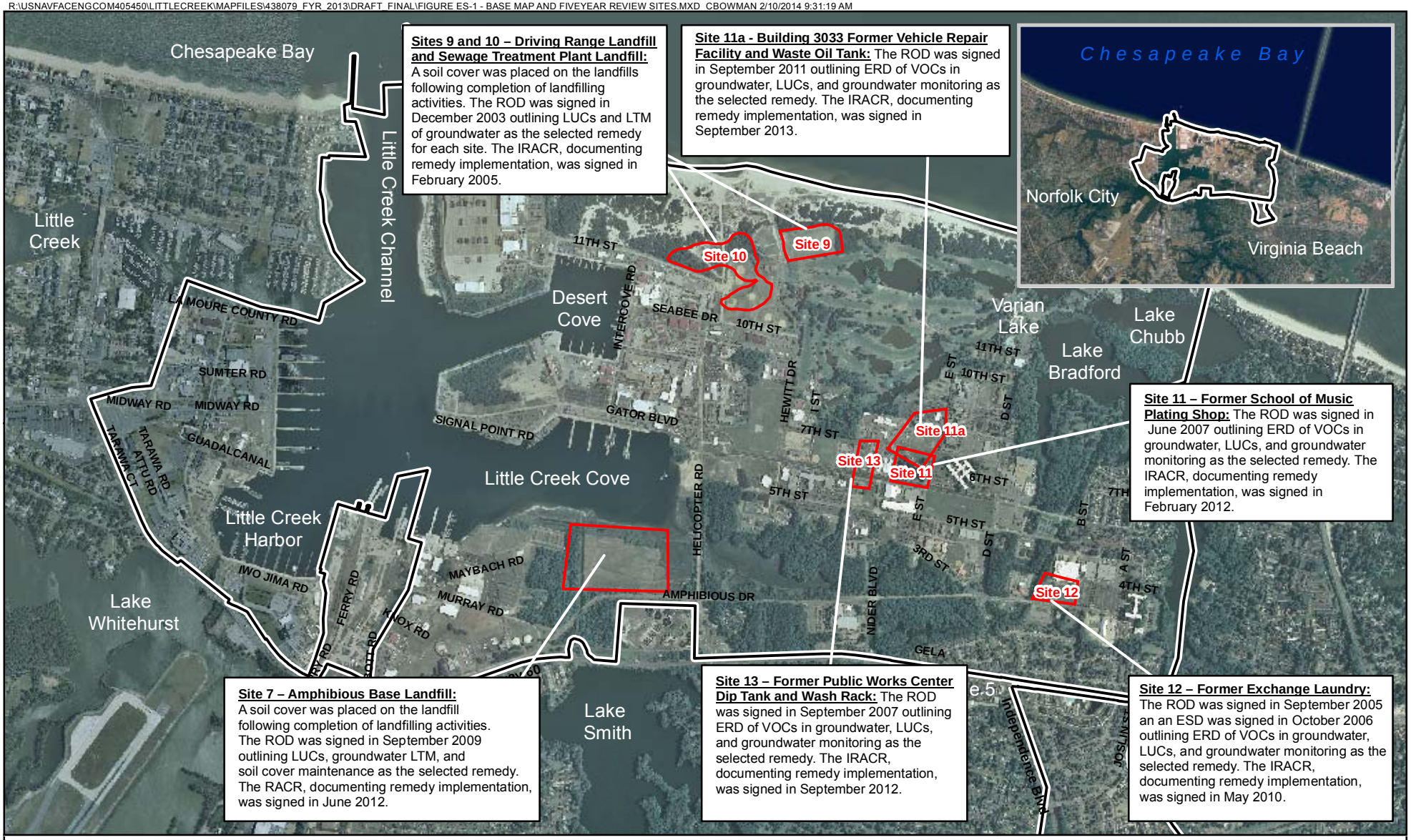
Protectiveness Statement:
The remedy at Site 11 is in place, functioning as designed, and is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled through LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. However, in order to evaluate long-term protectiveness of the remedy, a groundwater evaluation to determine the presence or absence of 1,4-dioxane in groundwater should be completed.

Site:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Site 11a	Protective	N/A

Protectiveness Statement:
The remedy at Site 11a is in place, functioning as designed, and is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled through LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Site:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Site 12	Protective	N/A
Protectiveness Statement: The remedy at Site 12 is in place, functioning as designed, and is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled through LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.		
Site:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Site 13	Protective	N/A
Protectiveness Statement: The remedy at Site 13 is in place, functioning as designed, and is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled through LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.		

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE ES-1 - BASE MAP AND FIVEYEAR REVIEW SITES.MXD CBOWMAN 2/10/2014 9:31:19 AM



Sites 9 and 10 – Driving Range Landfill and Sewage Treatment Plant Landfill: A soil cover was placed on the landfills following completion of landfilling activities. The ROD was signed in December 2003 outlining LUCs and LTM of groundwater as the selected remedy for each site. The IRACR, documenting remedy implementation, was signed in February 2005.

Site 11a - Building 3033 Former Vehicle Repair Facility and Waste Oil Tank: The ROD was signed in September 2011 outlining ERD of VOCs in groundwater, LUCs, and groundwater monitoring as the selected remedy. The IRACR, documenting remedy implementation, was signed in September 2013.

Site 11 – Former School of Music Plating Shop: The ROD was signed in June 2007 outlining ERD of VOCs in groundwater, LUCs, and groundwater monitoring as the selected remedy. The IRACR, documenting remedy implementation, was signed in February 2012.

Site 7 – Amphibious Base Landfill: A soil cover was placed on the landfill following completion of landfilling activities. The ROD was signed in September 2009 outlining LUCs, groundwater LTM, and soil cover maintenance as the selected remedy. The RACR, documenting remedy implementation, was signed in June 2012.

Site 13 – Former Public Works Center Dip Tank and Wash Rack: The ROD was signed in September 2007 outlining ERD of VOCs in groundwater, LUCs, and groundwater monitoring as the selected remedy. The IRACR, documenting remedy implementation, was signed in September 2012.

Site 12 – Former Exchange Laundry: The ROD was signed in September 2005 an an ESD was signed in October 2006 outlining ERD of VOCs in groundwater, LUCs, and groundwater monitoring as the selected remedy. The IRACR, documenting remedy implementation, was signed in May 2010.

Legend

- LUC Boundary
- Installation Boundary

ERD - Enhanced Reductive Dechlorination
ESD - Explanation of Significant Differences
FY - Fiscal Year
LTM - Long-Term Monitoring
LUC - Land Use Controls
ROD - Record of Decision
VOC - Volatile Organic Compound

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0 1,000 2,000 4,000 Feet

Figure ES-1
Base Map and Five-Year Review Sites
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

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9-2 Site 13 Conceptual Site Model
9-3 Site 13 Groundwater Contours—March 2013
9-4 Site 13 Extent of COC Groundwater Plume
9-5 Site 13 Remedy Design
9-6 Site 13 Long-term Monitoring Network
9-7 Site 13 PCE Isocontours
9-8 Site 13 TCE Isocontours
9-9 Site 13 cis-1,2-DCE Isocontours
9-10 Site 13 VC Isocontours
9-11 Site 13 PCP Isocontours

Acronyms and Abbreviations

µg/kg	microgram per kilogram
µg/L	microgram per liter
amsl	above mean sea level
AOC	Area of Concern
AR	Administrative Record
ARAR	applicable or relevant and appropriate requirement
Baker	Baker Environmental, Inc.
BERA	baseline ecological risk assessment
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CCR	Construction Completion Report
CD	cyclodextrin
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action—Navy
CNO	Chief of Naval Operations
COC	constituent of concern
COI	contaminant of interest
COPC	constituent of potential concern
CSM	conceptual site model
CTO	Contract Task Order
DCA	dichloroethane
DCE	dichloroethene
DD	Decision Document
DNAPL	dense non-aqueous-phase liquid
DO	dissolved oxygen
DPT	direct-push technology
Eco-SSL	ecological soil screening level
EE	engineering evaluation
ER	Environmental Restoration [Program]
ERA	ecological risk assessment
ERD	enhanced reductive dechlorination
ESD	Explanation of Significant Differences
ESQD	explosive safety quantity distance
FEAD	Facilities Engineering Acquisition Division
FFA	Federal Facilities Agreement
FS	feasibility study
ft	feet/foot
ft^3	square feet/foot
GIS	geographic information system
HHRA	human health risk assessment
HRSD	Hampton Roads Sanitation District
IAS	Initial Assessment Study
ID	identification

IRA	interim remedial action
IRACR	Interim Remedial Action Completion Report
IRP	Installation Restoration Program
ISCO	in situ chemical oxidation
JEB	Joint Expeditionary Base
kg	kilogram
LTM	long-term monitoring
LUC	land use control
MCL	maximum contaminant level
MDL	method detection limit
mg/kg	milligram per kilogram
mg/L	milligrams per liter
MWR	Morale, Welfare, and Recreation
NAB	Naval Amphibious Base
NACIP	Navy Assessment and Control of Installation Pollutants
NAPL	non-aqueous-phase liquid
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NERP	Navy Environmental Restoration Program
NTCRA	non-time-critical removal action
NFA	no further action
NPL	National Priorities List
ODC	other direct costs
OHM	OHM Remediation Services Corporation
O&M	operations and maintenance
ORC	oxygen-releasing compound
ORP	oxidation reduction potential
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCP	pentachlorophenol
PRAP	Proposed Remedial Action Plan
PVC	polyvinyl chloride
PWD	Public Works Department
RA	remedial action
RAB	Restoration Advisory Board
RACR	Remedial Action Completion Report
RAO	remedial action objective
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFA	RCRA Facility Assessment
RI	remedial investigation
ROD	Record of Decision
ROI	radius of influence

RRRS	Relative Risk Ranking System
RSL	regional screening level
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SERA	screening ecological risk assessment
SI	Supplemental Investigation
SRI	Supplemental Remedial Investigation
SVOC	semi-volatile organic compound
SWMU	solid waste management unit
TBC	to be considered
TCA	trichloroethane
TCDD	tetrachloro-p-dibenzo-dioxin
TCE	trichloroethene
TOC	total organic carbon
TOX	total organic halogens
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
UTL	upper tolerance limit
VC	vinyl chloride
VDEQ	Virginia Department of Environmental Quality
VFA	volatile fatty acids
VOC	volatile organic compound
WPNSTA	Naval Weapons Station
yd^3	cubic yards

SECTION 1

Introduction

1.1 Purpose

On October 1, 2009, Hampton Roads' first Joint Base was established. This new installation comprises the former Naval Amphibious Base (NAB) Little Creek and the former Army post Fort Story; the new name is Joint Expeditionary Base (JEB) Little Creek-Fort Story. With the forming of this new command, the Navy assumes responsibility for management of both properties and will now merge public meetings regarding the ongoing Environmental Restoration (ER) Program. However, separate records will be maintained to ensure the integrity of ongoing efforts at both properties. When required for public notices and distributions, the former bases are identified jointly as JEB Little Creek-Fort Story. For ER Program documents, the bases are referred to separately as JEB Little Creek and JEB Fort Story. The Five-Year Review for JEB Fort Story will be presented in a separate document.

This document presents the second comprehensive Five-Year Review performed under the Naval Facilities Engineering Command (NAVFAC), Atlantic Division, Comprehensive Long-term Environmental Action – Navy (CLEAN) Program, Contract No. N62470-11-D-8012, Contract Task Order WE61, as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121(c), as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan or NCP), Part 300.430(f)(4)(ii) of Title 40 of the *Code of Federal Regulations* (CFR). CH2M HILL has prepared this Five-Year Review report on behalf of the Department of the Navy (Navy) for JEB Little Creek, Virginia Beach, Virginia, in accordance with the United States Environmental Protection Agency (USEPA) *Comprehensive Five-Year Review Guidance* (USEPA, 2001) and Navy Policy on Five Year Reviews (CNO, 2011).

The purpose of this Five-Year Review is to evaluate the performance of implemented remedies at JEB Little Creek to assess whether the remedies remain protective of human health and the environment as stated in the respective Records of Decision (RODs). JEB Little Creek follows the Navy policy 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 (i.e., a comprehensive Five-Year Review). In accordance with the Navy policy, a Five-Year Review is required 5 years from the initiation of the first remedial action that leaves hazardous substances, pollutants, or contaminants at a site above levels that allow for unlimited use and unrestricted exposure. If a site contains multiple remedies, all are subject to a Five-Year Review when at least one remedy is initiated. On behalf of NAVFAC Mid-Atlantic, CH2M HILL has conducted this Five-Year Review of the remedial actions implemented at the following seven ER sites at JEB Little Creek:

- Site 7—Amphibious Base Landfill
- Site 9—Driving Range Landfill
- Site 10—Sewage Treatment Plant Landfill
- Site 11—Former School of Music Plating Shop
- Site 11a—Building 3033 Former Vehicle Repair Facility and Waste Oil Tank
- Site 12—Former Exchange Laundry/Dry Cleaning Facility
- Site 13—Former Public Works Center Pentachlorophenol (PCP) Dip Tank and Wash Rack

This Five-Year Review Report was prepared pursuant to CERCLA §121(c) and the NCP. CERCLA §121(c) 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 5 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] of this Title, 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 at 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 initiation of the selected remedial action.*

The triggering action of the statutory review process was the signature of the Sites 9 and 10 ROD in December 2003 by the Navy (Navy, 2003). This is the second Five-Year Review for JEB Little Creek. The first Five-Year Review for JEB Little Creek was signed on March 19, 2009, which is the triggering action for this second Five-Year Review. Navy policy (CNO, 2011) states that subsequent Five-Year Review reports shall be signed by the Navy no later than 5 years after the Navy signature date of the previous Five-Year Review report, consistent with Section 1.2.3 of the *Comprehensive Five-Year Review Guidance* (USEPA, 2001). This review was accomplished through reviews of various reports and documents pertaining to pre- and post-remedy implementation activities, analytical data, and findings, and through site visits, inspections, and interviews.

SECTION 2

Five-Year Review Process

JEB Little Creek is a federal facility at which CERCLA activities are funded and implemented by the Navy under the Navy Environmental Restoration Program (NERP). The Navy implements CERCLA at JEB Little Creek in partnership with USEPA and the Virginia Department of Environmental Quality (VDEQ). The JEB Little Creek Five-Year Review Team was led by Mr. Bryan Peed (NAVFAC Mid-Atlantic) and comprises representatives from USEPA Region 3 (Mr. Jeffrey Boylan) and VDEQ (Mr. Paul Herman). Assistance with the Five-Year Review process was provided by the Navy's CLEAN contractor, CH2M HILL. Remedy protectiveness for the seven sites at JEB Little Creek was evaluated through community involvement, document reviews, site inspections, interviews, and data review activities, as described in the following subsections.

2.1 Community Involvement

JEB Little Creek established a Restoration Advisory Board (RAB) for JEB Little Creek, comprised of community members as well as representatives of VDEQ and USEPA. The community was informed of the initiation of the second Five-Year Review at a RAB meeting on October 9, 2012. Prior to this meeting, a public notice was placed in the *Virginian-Pilot* informing the public of the RAB meeting. Additionally, a public notice (**Appendix A**) was placed in the *Virginian-Pilot* on April 24, 2013 to inform the community of the initiation of the second Five-Year Review, the sites to be included, information on where the RODs for the sites included in the Five-Year Review can be obtained, and how the community can contribute during the review process. No comments or questions were received from the public related to the Five-Year Review. When the Five-Year Review report has been finalized, a notice will be sent to the newspaper indicating the results and that the final report is available to the public.

Community relations activities are documented in the Administrative Record (AR). A complete list of the documents included in the AR file can be obtained from the JEB Little Creek Environmental Restoration web site (http://www.navfac.navy.mil/products_and_services/ev/products_and_services/env_restoration/administrative_records.html?fromDate=DD-MON-YYYY&toDate=DD-MON-YYYY&p_instln_id=LITTLE_CREEK_JEB&basic=&title=&sites=&author=&keywords=) or by contacting the Joint Expeditionary Base Little Creek-Fort Story Public Affairs Office at (757) 462-8425.

2.2 Document Review

The Five-Year Review included a review of site-specific documentation for each site. First, the ROD for each site was reviewed to identify the potential risks to human health and the environment, remedial action objectives (RAOs), selected remedies, and applicable or relevant and appropriate requirements (ARARs). Additional review of relevant documents, including operations and maintenance (O&M) records, monitoring data, and other pertinent documents and data, was also completed to assess remedy performance and continued protection of human health and the environment. **Appendix B** includes a list of the reviewed documents that are not included in the references section of this report.

2.3 Site Inspections

Site Inspections for the Five-Year Review were conducted on May 15, 2013 with representatives of the Navy, USEPA, VDEQ, and CH2M HILL, and consisted of inspections of all Five-Year Review sites to assess current conditions relevant to the protectiveness of the remedies. Completed Five-Year Review inspections checklists are located in **Appendix C** and summarized below. Regular land use control (LUC) inspections conducted at the sites are summarized in the respective site-specific sections of the document.

Site 7

Site fencing and signs are in good condition, the landfill soil cover is in place and functioning as intended, and there is adequate vegetative cover consisting of grass, trees, and shrubs. Tree and shrub growth on the soil cover was not observed and the grass was mowed. Tree growth was noted within the concrete matting used to stabilize

the western bank of the landfill, which may contribute to future exposure and potential erosion of landfill contents. It is recommended that tree growth be monitored and trees removed as needed to prevent damage to the stabilized bank. Monitoring wells appeared to be in good condition.

Site 9

The landfill soil cover is in place and functioning as intended, and adequate vegetative cover has been established. Tree and shrub growth on the soil cover was not observed and the grass was mowed. Site signs are in place; however, contact information on select signs is outdated. Monitoring wells appeared to be in good condition. Monitoring well LS09-MW03 was not located during the site inspection, and it is recommended that it be found and its condition assessed.

Site 10

Site fencing is in good condition. Adequate soil cover is present over the entire landfill; however, ruts in the soil cover resulting from mission activities were observed. It is recommended that the ruts be repaired to prevent future exposure to landfill contents. Additionally, surface debris, including steel pipe, asphalt, and tires, was observed. Surface debris was determined to not be associated with landfill activities; however, it is recommended that the debris be removed and continued annual landfill inspections be conducted to monitor for potential continued debris disposal. Site signs are in place; however, contact information on select signs is outdated. Monitoring wells appeared to be in good condition.

Site 11

No significant issues with Site 11 were observed during the site inspection. Site monitoring wells appeared to be in good condition and routine maintenance of monitoring wells is ongoing. No evidence of unauthorized intrusive activity was observed. Building 3602, located within the site boundary, is currently undergoing renovation.

Site 11a

No significant issues with Site 11a were observed during the site inspection. Site monitoring wells appeared to be in good condition and routine maintenance of monitoring wells is ongoing. One remaining injection well associated with remedy implementation needs to be abandoned. No evidence of unauthorized intrusive activity was observed.

Site 12

No significant issues with Site 12 were observed during the site inspection. Site monitoring wells appeared to be in good condition and routine maintenance of monitoring wells is ongoing. No evidence of unauthorized intrusive activity was observed.

Site 13

A sinkhole surrounding the concrete pad of injection well LS13-IW06 was observed. No groundwater was observed in the sinkhole. Repair of the sinkhole and concrete pad is recommended to prevent any potential future exposure to groundwater that may occur if expansion of the sinkhole were to result in exposure of the groundwater table. All other monitoring wells appeared to be in good condition and routine maintenance of monitoring wells is ongoing. No evidence of unauthorized intrusive activity was observed. Storage of empty, out of service refrigerators was observed within the site boundary.

2.4 Interviews

Interviews were conducted with the following parties as part of the Five-Year Review process (the date[s] of the interviews are shown in parentheses):

- Mr. Scott Mohr, NAVFAC Public Affairs Officer (June 27, 2013)
- Mr. Roger White, NAVFAC Environmental Protection Specialist (June 27, 2013)
- Mr. Dan Barnthouse, JEB Little Creek Morale, Welfare, and Recreation (MWR) Director (September 17, 2013)
- Ms. Nancy Rexroad, JEB Little Creek Lead Planner (September 19, 2013)

Mr. Mohr, Mr. White, Mr. Barnthouse and Ms. Rexroad were not aware of any community concerns regarding the sites or their administration, and they were not aware of any complaints, violations, or other incidents related to the sites. In summary, the information generated from the interviews (**Appendix D**) did not identify any concerns regarding the protectiveness of the various implemented remedies as documented in the site RODs.

SECTION 3

Background

3.1 Facility Description

JEB Little Creek covers approximately 2,215 acres in the northwest portion of Virginia Beach, Virginia, adjacent to the Chesapeake Bay (**Figure ES-1**). The area surrounding the base is low-lying and relatively flat, with several freshwater lakes (Chubb Lake, Lake Bradford, Little Creek Reservoir/Lake Smith, and Lake Whitehurst) located on or adjacent to the base. JEB Little Creek is situated around four saltwater bodies: Little Creek Harbor, Little Creek Cove, Desert Cove, and Little Creek Channel, which connects the coves and harbor with the Chesapeake Bay.

The former NAB Little Creek began operations as a permanent base in 1946. The base's mission was the training of landing craft personnel for operational assignments. JEB Little Creek has expanded in both area and complexity of its mission over the past 65 years. Base personnel provide logistic facilities and support services for local commands, organizations, home-ported ships, and other U.S. and allied units to meet amphibious warfare-training requirements of the U.S. armed forces. Past and present operations at JEB Little Creek include vehicle and boat maintenance, boat painting and sandblasting, construction and repair of buildings and piers, mixing and application of pesticides, electroplating of musical instruments, laundry and dry cleaning, medical and dental treatment, and the generation of steam for heat. In addition to industrial land use, JEB Little Creek is used for recreational, commercial, and residential purposes. Specifically, the southeast corner of the base has been developed for residential use.

3.2 Geology and Hydrogeology

JEB Little Creek is situated on the outer part of the Atlantic Coastal Plain, which is characterized by unconsolidated sediments several thousand feet in thickness (RGH, 1984). The uppermost geologic formations consist of alluvial, colluvial, and marsh deposits that are composed of silt, sand, and pebbles with some clay. The aquifers and confining/semi-confining units relevant to CERCLA investigations at JEB Little Creek are, from youngest to oldest, and from the ground surface in descending order: the Columbia aquifer, Yorktown confining unit, and the Yorktown aquifer. Groundwater flow directions for the aquifers are controlled by topography and surface water bodies, with the primary discharge direction being north toward the Chesapeake Bay.

3.3 Surrounding Land and Resource Uses

Land use surrounding the base is residential, commercial, and industrial (**Figure 3-1**). Columbia aquifer groundwater is not used as a potable water supply at or in the vicinity of JEB Little Creek because of its generally poor quality (naturally present iron and manganese is typically above secondary drinking water standards) and low well yield potential (generally less than 3 to 5 gallons per minute). Potable water is supplied to the base and surrounding community by the cities of Virginia Beach and Norfolk. Little Creek Reservoir/Lake Smith, located south of the base, serves as a secondary drinking water supply for parts of the City of Norfolk. The remaining surrounding water bodies are not used as potable water supplies, but are used for recreational activities such as boating, fishing, crabbing and swimming. A public health restriction on shellfish consumption and a fish consumption advisory are currently in place for Little Creek.

3.4 Regulatory and Environmental Investigation Summary

Comprehensive environmental restoration activities at JEB Little Creek began in 1984 under the Navy Assessment and Control of Installation Pollutants (NACIP) Program, renamed the Installation Restoration Program (IRP) in 1986 when it was changed to reflect the requirements of CERCLA as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The former NAB Little Creek (now referred to as JEB Little Creek) was identified as a Federal Facility on USEPA's National Priorities List (NPL) on May 10, 1999. A Federal Facility Agreement was finalized between the Navy, USEPA Region 3, and VDEQ in November 2003. Currently, there are

twelve sites defined under the Navy's IRP identified for CERCLA process activities (remedial investigation [RI], feasibility study [FS], and remedial action [RA]) at JEB Little Creek (**Table 3-1**).

The primary focus of this Five-Year Review report is on the seven sites undergoing RAs: Sites 7, 9, 10, 11, 11a12, and 13. These sites are discussed in further detail in Sections 4, 5, 6, 7, 8, and 9, respectively. In addition, RODs affirming the requirement for no further action (NFA) have been issued for four sites, as presented in **Table 3-1**.

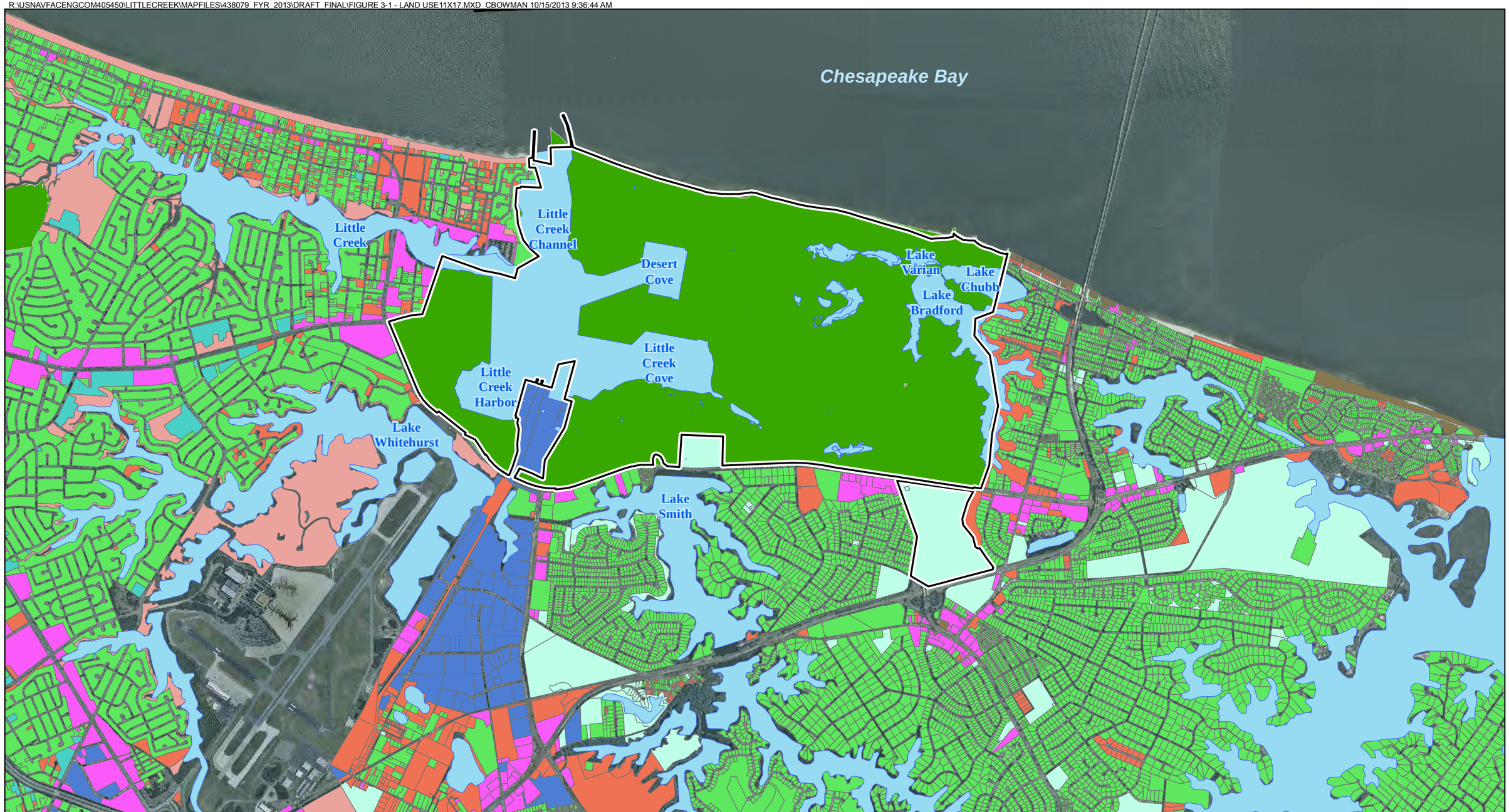
TABLE 3-1
Environmental Restoration Program Site Status Summary

Site Number	Site Identification	ROD Signed (Yes/No) and Status	
Site 7	Amphibious Base Landfill	Yes	ROD signed in September 2009
Site 8	Demolition Debris Landfill	Yes	NFA ROD signed in July 2008
Site 9	Driving Range Landfill	Yes	ROD signed in December 2003
Site 10	Sewage Treatment Plant Landfill	Yes	ROD signed in December 2003
Site 11	Former School of Music Plating Shop	Yes	ROD signed in July 2007
Site 11a	Building 3033 Former Vehicle Repair Facility and Waste Oil Tank	Yes	ROD signed in August 2011
Site 12	Former Exchange Laundry/Dry Cleaning Facility	Yes	ROD signed in September 2005; ESD signed in October 2006
Site 13	Former Public Works Center Dip Tank and Wash Rack	Yes	ROD signed in September 2007
SWMU 3	Pier 10 Sandblasting Yard	No	Currently in the RI/FS Stage
SWMU 7a	Small Boats Sandblast Yard	Yes	NFA ROD signed in June 2005
SWMU 7b	Small Boats Sandblast Yard (Desert Cove)	Yes	NFA ROD signed in September 2013
SWMU 8	West Annex Sandblasting Area	Yes	NFA ROD signed in June 2005

Notes:

- For additional information on the sites and other areas of interest at JEB Little Creek, refer to the *Site Management Plan, Fiscal Years 2014 through 2018, Joint Expeditionary Base Little Creek-Fort Story* (CH2M HILL, 2013a).
- SWMU - solid waste management unit

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 3-1 - LAND USE11X17.MXD_CBOWMAN 10/15/2013 9:36:44 AM



Legend

Land Use

- Unknown
- Residential
- Commercial
- Industrial
- Institutional
- Military
- Mixed Use
- Recreational
- Public/Semi Public
- Undeveloped
- Installation Area
- Surface Waterbody

N
W E
S

0 1,250 2,500 Feet

Figure 3-1
Land Use Map
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

CH2MHILL

SECTION 4

Site 7 – Amphibious Base Landfill

4.1 Site Chronology

Date	Event/Document	Document Administrative Record Number
December 1984	Initial Assessment Study	000130
October 1986	Round 1 Verification Step	000022
March 1989	Resource Conservation and Recovery Act (RCRA) Facility Assessment	000008
November 1991	Interim Remedial Investigation	000104
January 1992	Site Summary	001354
March 1993	Memorandum Discussing Sediment Samples at Site 7 and the Construction of Wetlands at the Site	000202
November 1994	RI/FS for Sites 7 and 9-13	000226, 000352, 000353
January 1996	Relative Risk Ranking System (RRRS) and Revised RRRS	000349
February 1997	FS Revision	000212
October 1997	Proposed Remedial Action Plan	000128
January 1998	Decision Document	000132
January 1998	Remedial Action – Soil Cover and Debris Removal initiated	--
November 1998	Final Long-term Monitoring Letter Report, Round 1	--
January 1999	Contractor Closeout Report	000404
April 1999	Long-term Monitoring Letter Report, Round 2	--
May 1999	Former NAB Little Creek on NPL	000439
October 1999	Long-term Monitoring Letter Report, Round 3	--
June 2000	Long-term Monitoring Letter Report, Round 4	--
June 2000	Screening Ecological Risk Assessment – IR Sites 5, 7, 8, 9, 10, 11, 12, 13, and 16, and SWMU 3	000417
June 2001	Long-term Monitoring Round 5 Letter Report	--
March 2002	Long-term Monitoring Round 6 Letter Report	--
August 2002	Long-term Monitoring Round 7 Letter Report	--
February 2003	Long-term Monitoring Round 8 Letter Report	--
June 2003	Long-term Monitoring Round 9 Letter Report	--
October 2003	Federal Facilities Agreement	000540
March 2004	Canal Sediment Delineation Results and Recommended Path Forward	--
November 2004	Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment	000650/000651
February 2005	Engineering Evaluation/Cost Analysis	000829

Date	Event/Document	Document Administrative Record Number
March 2005	Action Memorandum	000834
August 2005	Long-term Monitoring Report for Rounds 10 and 11	--
November 2005	Debris Delineation Results	000917
August 2006	Non-time-critical Removal Action (NTCRA) for removal of canal sediment initiated	--
January 2008	NTCRA Construction Completion Report	001359
January 2008	Phase I O&M Action initiated	--
March 2008	Phase II and III O&M Action initiated	--
April 2008	Phase I O&M Interim Closeout Report	--
August 2008	Focused Feasibility Study	001461
July 2009	Phase II and III O&M Construction Completion Report	--
September 2009	Record of Decision	000932
March 2012	Long-term Monitoring (LTM) Sampling and Analysis Plan	--
May 2012	Post-ROD LTM conducted	--
June 2012	Remedial Action Completion Report	001622
September 2012	O&M Action initiated	--
February 2013	Draft Long-term Monitoring Report	--

4.2 Background

4.2.1 Site Description and History

Site 7, the Amphibious Base Landfill, comprises approximately 38 acres in the south-central portion of JEB Little Creek (**Figure 4-1**). The Amphibious Base Landfill operated between 1962 and 1979. The Commonwealth of Virginia Department of Health issued a non-conforming permit on August 28, 1979, to allow disposal on an interim basis at Site 7, because conditions were not conducive for landfilling. In 1982, the permit was terminated and landfilling operations ceased. Initially, waste disposal operations at the site were conducted as a trench-type landfill with open burning of refuse in the trenches. The landfill later operated as an area landfill, with refuse spread over the ground and covered regularly. The estimated landfill waste volume is approximately 500,000 cubic yards (yd^3), originating from base housing and other residential activities at the installation. Waste oils and metals were also reportedly disposed of in the landfill starting in 1970. After closure, the landfill area continued to be used as a metal collection and transfer site, a temporary storage site for wastes, and a burn area for scrap wood and trees. Open burning halted in 1984. Waste storage activities at the site ceased in 1994.

4.2.2 Physical Characteristics

The site characteristics, including surface features, geology, and hydrology, are depicted on the conceptual site model (CSM) (**Figure 4-2**). Site 7 consists of the Amphibious Base Landfill and the discontinuous portion of the landfill referred to as the “Ear.” The area is bounded on the north by Little Creek Cove, on the east by Helicopter Road, on the south by Amphibious Drive and the Hampton Roads Sanitation District (HRSD) sewage treatment plant, and on the west by an undeveloped area and an ordnance magazine. A tidally-influenced canal running through the western portion of the site separates the landfill from the “Ear” and connects Lake Smith with Little Creek Cove. The “Ear” is forested, with dense vegetation in areas adjacent to the former access road. Currently there is no access to the primary landfill area from the “Ear.” A berm is situated along the eastern edge of the

drainage canal and diverts surface drainage from the landfill toward Little Creek Cove. A weir near the base boundary prevents tidal flow from the canal from reaching Lake Smith.

Currently, east of the drainage canal, there is an approximately 22-acre, vegetated, 24-inch-thick soil cover over the landfill contents. Site topography is generally level. Surface runoff from the landfill is directed toward a drainage swale located to the west discharging to the canal, and a drainage swale located to the north discharging to Little Creek Cove. Approximately 11 acres of tidally-influenced wetlands are present along the northern and eastern portions of the site. Currently, an unused helicopter landing pad is situated on the landfill cover. A chain-link fence running along the site's eastern and southern boundaries restricts access to the site. Two locked gates control vehicle access to the landfill across access roads entering the site's eastern side and western ear.

Shallow Columbia aquifer groundwater at the site ranges from 3 to 7 feet (ft) below ground surface (bgs) and generally flows north, discharging to Little Creek Cove (**Figure 4-3**). A tidal study conducted as part of the 1994 RI (FWES, 1994b) indicated that tidal influences may intermittently alter local groundwater flow directions from the generally northward orientation toward the western drainage canal and toward the eastern drainage canal. A clay confining unit (Yorktown confining unit), encountered across JEB Little Creek at a depth of approximately 19 to 24 ft bgs, separates the Columbia aquifer from the underlying Yorktown aquifer, impeding downward migration of Columbia aquifer groundwater to the Yorktown aquifer. Because of the proximity of the site to Little Creek Cove and the Chesapeake Bay, groundwater in the Yorktown aquifer beneath the site is also assumed to flow north.

The current, primary potential mechanism for contaminant transport from the site is leaching of contaminants from landfill waste and waste-contaminated subsurface soil through precipitation and infiltration to underlying groundwater, as groundwater migrates through Site 7 and discharges to Little Creek Cove. The potential for this transport mechanism to be complete has been reduced through the placement of a 24-inch soil cover.

4.2.3 Land and Resource Use

Site 7 is not currently used. Future land use such as industrial, recreational, and operational activities may occur, provided the activities are consistent with protection of human health and the environment. Groundwater at JEB Little Creek is not currently used as a potable water source, nor is it expected to be used as a future potable water source. Potable water is supplied to the base and surrounding community by the cities of Virginia Beach and Norfolk. Groundwater wells at the base golf course, approximately 3,960 feet northeast of Site 7, provide non-potable water from the Yorktown aquifer for irrigation of the golf course. LUCs are currently maintained within the area of restricted land and groundwater use at Site 7, and are inspected on an annual basis (**Figure 4-1**) (CH2M HILL, 2010a). The LUCs restrict land use and exposure to groundwater until site conditions allow for unlimited use and unrestricted exposure.

4.2.4 History of Contamination

Site 7 is an approximately 38-acre area used between 1962 and 1982 for the disposal of waste originating from base housing and other residential activities at the installation, as well as the disposal of waste oils and metals. Initially, waste disposal operations were conducted as a trench-type landfill with open burning of refuse in the trenches. The landfill later operated as an area landfill, with refuse spread over the ground and covered regularly.

Initial Response

The potential for site contamination from disposal practices was initially identified in the Initial Assessment Study (IAS) (RGH, 1984). Field investigations were conducted from 1986 to 1994 to characterize the nature and extent of contamination at the site. Investigation results indicated contamination from prior disposal practices at Site 7 has affected surface and subsurface soil, sediment, surface water and groundwater. The primary contaminants found in each medium were polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and metals. The landfill surface was generally covered in soil; however, in October 1994, 2 to 3 inches of topsoil was added to promote vegetative growth. A Decision Document (DD) was signed in January 1998 (CH2M HILL, 1998) outlining institutional controls (soil cover, site fencing, site signs, LUCs) with monitoring as the selected remedy. Remedy construction was completed in March 1998 (OHM, 1998). As part of remedy construction, visible debris was removed from the site and additional soil cover was added to the landfill area (OHM, 1998). Biannual

groundwater, surface water, and sediment long-term monitoring (LTM) was initiated in June 1998. Between June 1998 and February 2004, eleven rounds of LTM were conducted, and included the collection of groundwater, surface water, and sediment samples for analysis of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, PCBs, and metals. **Table 4-1** provides a summary of groundwater monitoring conducted at the site. Constituents were detected in all media; however, detected constituent concentrations were determined to not be indicative of a release from the landfill.

Site Risks

Human Health Risk

The initial RI and human health risk assessment (HHRA) were performed for Site 7 (along with five other sites) in November 1994 (FWES, 1994b), and served as the basis for the 1998 DD. In 2004, following the former NAB Little Creek's 1999 placement on the NPL and finalization of the Federal Facilities Agreement (FFA) in 2003, the site remedy selection decision process was re-evaluated and the 1994 RI/HHRA was revised 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. Data previously presented in the 1994 RI/HHRA were supplemented with the long-term monitoring data from Rounds 5 through 7 conducted in 2001 and 2002 (CH2M HILL, 2004a). The 2004 HHRA was later revised as part of the 2008 Focused FS to include groundwater data collected from the "Ear" to reflect overall groundwater conditions within the LUC boundary. The exposure media, pathways, and scenarios evaluated and constituents of concern (COCs) identified in the revised HHRA are summarized in **Table 4-2**. With the exception of waste in place, no potentially unacceptable risks from exposure to site soil, groundwater, surface water and sediment were identified.

Ecological Risk

An initial screening ecological risk assessment (SERA) was performed for Site 7 in June 2000 (CH2M HILL, 2000a). A baseline ecological risk assessment (BERA) (Steps 1 through 3) was completed in January 2001. Subsequent to the completion of the BERA, additional surface water, sediment, surface soil and groundwater samples were collected at Site 7. A revised BERA was completed in November 2004 to incorporate newly-collected data (CH2M HILL, 2004b). Potential ecological risks associated with surface soil, as well as sediment and surface water in Little Creek Cove and the vegetated wetlands, were considered low (acceptable), based on the frequency and magnitude of screening value exceedances. However, copper, lead, Aroclor-1260, and five pesticides were identified as constituents of potential concern (COPCs) in sediment in the central portion of the western drainage canal. Based on these results, a non-time-critical removal action (NTCRA) was conducted in 2007 to remove contaminated sediments in this portion of the canal. Following the removal of 1 foot of sediment, the canal was backfilled with 1 foot of clean fill to its original depth, and the eastern bank of the landfill was stabilized using concrete matting and vegetation to prevent landfill contents from eroding into the canal. The NTCRA was documented in the NTCRA Construction Completion Report (JV I, 2008c). Following completion of the NTCRA, no potentially unacceptable ecological risks remained at the site.

4.2.5 Basis for Taking Remedial Action

Based on the results of previous investigations, remedial action is warranted to protect public health, welfare, and the environment from actual or threatened exposure to waste remaining in place at Site 7.

4.3 Remedial Actions

4.3.1 Remedy Selection

The ROD for Site 7 was signed in September 2009 (Navy, 2009d). The ROD summarized the risks to human health and ecological receptors, established RAOs, and defined the selected remedy. The remedy at Site 7, soil cover, LUCs, and groundwater LTM, was selected to meet the following RAO:

- Prevent human and ecological receptor exposure to landfill contents through a containment presumptive remedy (2-foot soil cover and groundwater monitoring) and LUCs

No unacceptable risks to human health were identified from exposure to soil, groundwater, sediment, or surface water at or beyond the boundaries of the landfill and ecological risks identified were mitigated as a result of excavation and backfill of the canal during completion of the NTCRA. The only unacceptable risk at Site 7 is from direct exposure to landfill contents remaining on site; therefore, quantitative cleanup goals were not established. Unacceptable risks, RAOs, remedy components, performance standards and expected outcomes for evaluating the overall performance of the remedy are summarized in **Table 4-3**.

The following LUC objectives for Site 7 were selected in the ROD:

- Prohibit digging into or disturbance of the existing soil cover and landfill contents
- Prohibit the use of the site for residential, child care, elementary or secondary school, or playground facilities

These LUC objectives, in addition to the following objective, have been implemented with the actions detailed in the LUC remedial design (RD) for Site 7 (CH2M HILL, 2010a):

- Maintain the integrity of any current or future monitoring system such as monitoring wells

LUCs will be maintained until site conditions allow for unlimited use and unrestricted exposure.

TABLE 4-3
Site 7 Remedial Action Summary and Expected Outcomes

Risk		COCs	RAO	Remedy Components	Metric/Cleanup Level	Expected Outcome
Human Health	**Ecological**					
Waste/Soil						
Waste in-place/ Exposure to landfill contents		Not applicable	Prevent human and ecological receptor exposure to landfill contents through a containment presumptive remedy (2-foot soil cover and groundwater monitoring) and LUCs	Soil cover O&M	Maintain integrity of the soil cover through annual inspection and regular maintenance.	Industrial land use
				LUCs	Maintain LUCs through registration of a survey plat with the City of Virginia Beach and documentation of LUC restrictions in the Navy's geographic information system (GIS) database.	
				Groundwater monitoring	Conduct groundwater monitoring to determine if a release from the landfill has occurred.	

4.3.2 Remedy Implementation

The Site 7 Remedial Action Completion Report (RACR) was signed in July 2012 and documents that the remedy is in place and functioning as intended (Navy, 2012a). Remedy implementation was completed as described in the following subsections.

Soil Cover Operations and Maintenance

The Navy retains the responsibility for overseeing the administrative and substantive requirements of O&M for the Site 7 soil cover. O&M plans for soil cover maintenance are developed as needed. Currently, inspection activities are conducted annually. The LUC inspection requirements are documented in the LUC RD (Navy, 2010).

The primary O&M activities for Site 7 consist of:

- Inspection for signs of settling, subsidence, displacement and erosion
- Drainage system inspection for signs of standing water, erosion, and obstructions
- Inspection of the groundwater monitoring system for signs of damage and tampering

- Inspection of signs for damage, fading, and viewing obstructions
- Roadway inspection for signs of erosion, rutting, physical damage and obstructions

All inspections are conducted by the Navy. The Navy directly subcontracts regular maintenance (such as mowing) and non-routine maintenance (such as cap repair) with third-party subcontractors.

Between January and July 2008, three phases of O&M were conducted to extend the soil cover over portions of the landfill identified during debris delineation activities as lacking adequate cover (JVI, 2008d and JVIII, 2009). Approximately 85 tons of concrete and vegetation debris and 10 tons of scrap metal were removed from the site and an 18-inch layer of clean fill (17,346 yd^3) and 6-inch layer of topsoil (4,934 yd^3) were placed over the landfill and seeded. Biodegradable coconut fiber logs and concrete matting were placed along the northern boundary to provide slope stabilization and control erosion and surface runoff until a vegetative cover could be established. Surface debris was also removed from the Site 7 "Ear."

In September 2012, an approximately 500-foot-long, rock-lined drainage swale was installed on the northwest edge of the soil cover to provide proper drainage from the landfill (**Appendix E**). Additionally, an approximately 27-cubic-foot (ft^3) sinkhole observed in July 2011 on the southeast edge of the landfill was filled with material removed to create the drainage swale, and re-vegetated. In May 2013, the existing rip-rap drainage swale on the western edge of the landfill was repaired, to address ponding of surface runoff prior to discharge into the canal.

4.3.2.1 Land Use Controls

LUCs are in place to prevent exposure to landfill contents. The LUC RD for Site 7 was finalized in December 2010. Signs were placed around the perimeter of Site 7 to notify individuals of buried debris, prevent unauthorized digging, and provide a point of contact for further implementation. A survey plat was filed with the City of Virginia Beach in the Commonwealth of Virginia on May 21, 2012, to provide public notice of the environmental conditions and limitations on the use of the property and to record the LUC boundary (Navy, 2012). As outlined in the LUC RD, annual site inspections were initiated in July 2011 and have been conducted to monitor unauthorized activities and land use changes. Checklists and data reports are completed during inspections and issued to USEPA and VDEQ. No land use infractions have been observed to date.

4.3.2.2 Groundwater Long-term Monitoring

In accordance with the LTM Uniform Federal Policy (UFP) Sampling and Analysis Plan (SAP), post-ROD groundwater LTM was initiated in May 2012 to monitor the quality of the groundwater at Site 7 and identify whether a release from the landfill may have occurred that might adversely affect human health and the environment. Groundwater samples were collected from five existing monitoring wells and samples were analyzed for VOCs, SVOCs, pesticides, PCBs, total and dissolved inorganic constituents, cyanide, and dioxins and furans (**Table 4-1**). Data were screened against May 2012 adjusted tap water regional screening levels (RSLs), maximum contaminant levels (MCLs), and background upper tolerance limits (UTLs). Although some exceedances of screening criteria were identified, May 2012 post-ROD groundwater monitoring results are consistent with data collected during pre-ROD groundwater sampling and concentrations and are not indicative of a site release and offsite migration of groundwater contaminants. Because a site release and offsite migration of contaminants was not identified, data were not screened against ecological screening values for protection of Little Creek Cove.

4.3.3 Summary of the Estimated Remedy Costs

Table 4-4 presents capital costs and annual O&M and LTM costs for Site 7. Total remedy costs to date are below the +50%/-30% range estimated in the ROD. Reduced costs recognized during years 1 through 3 are the result of a delay in groundwater LTM initiation until Year 4 due to discussion of analytical requirements. Changes to estimated remedy costs should be further evaluated and the appropriate documentation prepared.

TABLE 4-4
Site 7 Estimated Project Costs

Year	Timeframe	Projected Cost from ROD	Estimated Actual Cost	Notes
			Capital Cost*	
0	2009	$31,860	$10,600	Soil cover in place prior to ROD. Includes development and filing of survey plat.
			Management and Monitoring Cost*	
1	2010	$67,789	$29,500	Includes labor, other direct costs (ODCs), and subcontractor costs associated with LUC inspections and reporting
2	2011	$67,789	$29,500	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting
3	2012	$67,789	$47,100	Includes groundwater LTM UFP-SAP development Includes labor, ODCs, and subcontractor costs associated with soil cover O&M, including installation of drainage swale and cover repair
4**	2013	$67,789	$59,762	Includes labor, ODCs, and subcontractor costs associated with LTM sampling and reporting
	Total	$303,016	$176,462	
	+50%	$454,524		
	-30%	$212,111		

*Costs reflect those expended under contract to CH2M HILL. Completion of annual LUC inspections assumed by Navy in 2012. Landfill mowing conducted by separate Navy subcontractor.
**Represents costs expended between January and June 2013.

4.4 Progress Since Last Five-Year Review

The ROD was signed in September 2009 and this is the first Five-Year Review for Site 7.

4.5 Technical Assessment

This section presents the answers to the three questions defined for the Technical Assessment for Site 7 based primarily on information presented in Section 4.3. Opportunities for maintenance and optimization of the remedy are presented in **Table 4-5**.

4.5.1 Question A: Is the remedy functioning as intended by the ROD?

Remedial Action Performance: Based on the review of documents, LTM results, ARARs, risk assumptions, and site inspection reports, the Site 7 remedy is functioning as intended by the ROD.

Soil Cover O&M: Two feet of soil cover have been established over the landfill. Regular site inspections and O&M actions have made sure that the integrity of the soil cover is maintained. As a result of inspections, a sinkhole was noted and repaired and site drainage swales were installed atop the cover to promote runoff and control erosion. Vegetation has been established on the soil cover and regularly maintained to prevent soil cover erosion. With the exception of some tree growth along the concrete bank, regular mowing has prevented large plant growth in the soil cover.

Implementation of LUCs: LUCs have been implemented through the Final LUC RD. LUCs and annual site inspections have made sure that the soil cover integrity is maintained, unauthorized site use is prohibited, and

exposure to landfill contents is prevented. Landfill signs restricting site use have remained intact, and site fencing and locks prevent access.

LTM Activities: Post-ROD groundwater LTM was initiated in May 2012. Data do not indicate a release to groundwater from the landfill or offsite migration of groundwater contaminants.

Early Indicators of Potential Issues: No indicators of potential issues have been identified.

Opportunities for Optimization: As part of the post-ROD LTM report, a review of the site CSM and pre- and post-ROD groundwater LTM data was conducted in accordance with the guidelines presented in the Tier II issue paper, *Consideration for Developing Long-Term Monitoring Plans for Unpermitted Navy Landfills in Virginia* (Virginia Navy Tier II, 2011). A comparison of data to risk-based screening criteria and facility background values, as well as a statistical evaluation of data trends and prediction intervals, concluded that a release to groundwater from the landfill has not occurred and is not likely to occur in the future. Therefore, based on the types of waste buried, the amount of data available, and data evaluation results, it was concluded that sufficient post-closure care has been conducted at Site 7, and therefore, cessation of groundwater LTM was recommended. It is recommended that future groundwater sampling be conducted in conjunction with Five-Year Reviews to assess continued protectiveness of the remedy, as needed.

4.5.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

Changes in Standards and TBCs: No changes in standards or items to be considered (TBCs) that adversely affect the protectiveness of the remedy were identified during this Five-Year Review.

Changes in Exposure Pathways: Current and anticipated future land use is industrial and is expected to remain the same. The exposure assumptions used to develop the HHRA and BERA are reasonable given that the current land use has not changed over time at Site 7. There is no indication that hydrologic or hydrogeologic conditions have changed in a way that adversely affects the protectiveness of the remedy.

Changes in Toxicity and Other Contaminant Characteristics: With the exception of exposure to waste in-place, no risk was identified at Site 7. Changes in toxicity and tap water RSL values have been made since completion of the revised HHRA in 2004 (see **Table 4-6** summarizing changes in toxicity factors). However, these changes would not substantially change the results and conclusions of the HHRA; furthermore, LUCs are in place that prevent exposure to groundwater, so these changes would not adversely affect the current protectiveness of the selected remedy. VOCs, SVOCs, pesticides, PCBs, metals, and dioxins/furans were sampled for during May 2012 LTM. Data were compared against the May 2012 tap water RSLs, as discussed in Section 4.3.2.3. With the exception of vanadium, no changes to the tap water RSLs occurred between May 2012 and May 2013. The maximum detected concentration of vanadium detected during the May 2012 sampling event (3.8 J µg/L) is below the May 2013 tap water RSL (6.3 µg/L). Pesticides and PCBs were not detected and VOCs, SVOCs, and dioxins/furans that were detected were below the MCLs and tap water RSLs; therefore, changes to toxicity values for these constituent groups would not affect the protectiveness of the remedy. The changes in toxicity values associated with metals would not affect protectiveness because, with the exception of arsenic detected in May 2012, the metals concentrations were below the MCLs. Total and dissolved arsenic was detected above the MCL in one monitoring well (LS07-MW03) located upgradient of the landfill and are therefore, not reflective of impacts from historic landfilling activities. Additionally, because LUCs are in place prohibiting unrestricted use of the groundwater, these toxicity value changes do not affect the current protectiveness of the remedy. Based on site history, explosives constituents are not expected to be present at Site 7.

There have been some changes in ecological screening values since the BERA was issued (November 2004) for some of the chemicals detected in soil, groundwater, surface water and sediment at Site 7 (see **Table 4-7** summarizing changes in screening values). However, these changes would not substantially change the results and conclusions of the BERA. The existing soil cover prevents significant direct ecological exposure to the landfill contents.

Changes in Risk Assessment Methodologies: Although there have been some procedural changes to how human health risk assessments are conducted, none of these changes adversely affect the protectiveness of the remedy for Site 7. There have been no major procedural changes in how ecological risk assessments (ERAs) are conducted. A BERA was completed in November 2004.

4.5.3 Question C: Has any other information come to light that could question the protectiveness of the remedy?

No other information is available that could call into question the protectiveness of the remedy.

TABLE 4-5
Remedy Maintenance and Optimization Activities for Site 7

Maintenance/Optimization Opportunity	Recommendations	Party Responsible
Tree growth observed in concrete matting on western bank of landfill.	Remove existing tree growth. Include mowing of concrete matting in future landfill maintenance to prevent additional tree growth.	Navy
Conduct future groundwater sampling in conjunction with Five-Year Reviews, as needed, to ensure continued protectiveness of the remedy.	A groundwater sampling plan should be developed and groundwater sampling in conjunction with Five-Year Reviews should be conducted at Site 7 as needed to demonstrate continued protectiveness of the remedy.	Navy

4.6 Issues, Recommendations, and Follow-up Actions

Table 4-8 outlines the issues identified during this Five-Year Review and presents recommendations and follow-up actions for Site 7. Because this is the first Five-Year Review for Site 7, there are no carryover issues from the earlier Five-Year Review.

TABLE 4-8
Issues, Recommendations, and Follow-Up Actions for Site 7

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date*	Affects Protectiveness	
				Current	Future
Ongoing Site Evaluation and Remedy Optimization Activities to Ensure Continued Protectiveness					
Remedy capital costs are below the -30%/+50% range estimated in the ROD.	Evaluate changes to remedy costs and prepare the appropriate documentation, as needed.	Navy	March 2015	N	N

4.7 Protectiveness Statement

The remedy at Site 7 is in place, functioning as designed, and is protective of human health and the environment. The soil cover is in good condition and prevents direct contact with landfill contents. LUCs are in place and prevent unauthorized intrusive activities and unauthorized site use. Groundwater monitoring data indicate a release has not occurred from the landfill. There have been no changes in the physical conditions or use of the site that would affect the protectiveness of the remedy.

4.8 Next Review

The next Five-Year Review for Site 7 is scheduled for 2019.

TABLE 4-1

Site 7 Pre- and Post-ROD Groundwater LTM Sampling Summary

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, VA

Monitoring Well	Pre-ROD Round 1 - June 1998							Pre-ROD Round 2 - November 1998						Pre-ROD Round 3 - June 1999						Pre-ROD Round 4 - January 2000						Pre-ROD Round 5 - February 2001					
	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Wet Chemistry*	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals
LS07-MW01	x	x		x	x	x	x	x	x		x	x	x	x	x	X	X	x	x	x	x	X	X	x	x	x	x		x	x	x
LS07-MW03	x	x		x	x	x	x	x	x		x	x	x	x	x	X	X	x	x	x	x	X	X	x	x	x	x		x	x	x
LS07-MW07	x	x		x	x	x	x	x	x		x	x	x	x	x	X	X	x	x	x	x	X	X	x	x	x	x		x	x	x
LS07-MW08	x	x		x	x	x	x	x	x		x	x	x	x	x	X	X	x	x	x	x	X	X	x	x	x	x		x	x	x
LS07-MW09	x	x		x	x	x	x	x	x		x	x	x	x	x	X	X	x	x	x	x	X	X	x	x	x	x		x	x	x

Monitoring Well	Pre-ROD Round 6 -September 2001						Pre-ROD Round 7 - March 2002						Pre-ROD Round 8 - November 2002						Pre-ROD Round 9 - March 2003						Pre-ROD Round 10 - September 2003						Pre-ROD Round 11 - February 2004					
	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals
LS07-MW01	x	x		x	x	x	x	x		x	x	x	x				x		x				x		x				x		x				x	
LS07-MW03	x	x		x	x	x	x	x		x	x	x	x				x		x				x		x				x		x				x	
LS07-MW07	x	x		x	x	x	x	x		x	x	x	x				x		x				x		x				x		x				x	
LS07-MW08	x	x		x	x	x	x	x		x	x	x	x				x		x				x		x				x		x				x	
LS07-MW09	x	x		x	x	x	x	x		x	x	x	x				x		x				x		x				x		x				x	

Monitoring Well	Post-ROD Round 1 - May 2012						
	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Dioxins/Furans
LS07-MW01	x	x	x	x	x	x	x
LS07-MW03	x	x	x	x	x	x	x
LS07-MW07	x	x	x	x	x	x	x
LS07-MW08	x	x	x	x	x	x	x
LS07-MW09	x	x	x	x	x	x	x

Notes:

* Wet chemistry includes alkalinity, bicarbonate, chloride, and sulfate

VOCs - volatile organic compounds

SVOCs - semivolatile organic compounds

PCBs - polychlorinated biphenyls

TABLE 4-2
Summary of Historical HHRA and Resulting Chemicals of Concern
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach Virginia

Site No	Site Description	HHRA	Exposure Scenarios Evaluated						COCs
			Time Frame	Receptors	Exposure Routes				
					Soil	GW	Sediment	SW	
Site 7	Amphibious Base Landfill	RI/HHRA (2004); Focused FS (2008).	Current	Maintenance Worker	Ing/derm/inh				
			Current/Future	Trespasser/Visitor	Ing/derm/inh		Ing/derm	Ing/derm	
				Site Worker				Ing/derm	
			Future	Industrial Worker		Ing/derm/inh			
				Residents (adult/child)	Ing/derm/inh	Ing/derm/inh			
				Construction Worker	Ing/derm/inh	Ing/derm/inh			
Site 9	Driving Range Landfill	Revised RI/HHRA/FS (2001)	Current/Future	Site Worker	Ing/derm/inh		not evaluated	not evaluated	
				Recreational (adult/child)	Ing/derm/inh				
			Future	Industrial Worker		Ing			
				Residents (adult/child)		Ing/derm			GW - Sb
				Construction Worker		derm/inh			
Site 10	Sewage Treatment Plant Landfill	Revised RI/HHRA/FS (2001)	Current/Future	Site Worker	Ing/derm/inh		not evaluated	not evaluated	
				Recreational (adult/child)	Ing/derm/inh				
			Future	Industrial Worker		Ing			GW - Mn
				Residents (adult/child)		Ing/derm			GW - Cd, Mn, Tl, and Zn
				Construction Worker		derm/inh			
Site 11	Former School of Music Plating Shop	SRI/HHRA (2004); SRI Addendum/Revised HHRA (2006)	Current/Future	Industrial Worker	Ing/derm/inh		not evaluated	not evaluated	
				Trespasser/Visitor	Ing/derm/inh				
			Future	Industrial Worker	Ing/derm/inh	Ing			GW - various VOCs (1)
				Residents (adult/child)	Ing/derm/inh	Ing/derm/inh†			GW - various VOCs (1)
				Construction Worker	Ing/derm/inh	derm/inh			GW - various VOCs (1)
		VI Assessment (2005)	Current/Future	Site Worker		Inh			
Site 11a	Building 3033 Former Vehicle Repair Facility and Waste Oil Tank	RI/HHRA (2010);	Current	Resident (adult)	Ing/derm		not evaluated	not evaluated	
			Future	Residents (adult/child)	Ing/derm/inh	Ing/derm/inh†			GW - PCE, TCE
				Construction Worker	Ing/derm/inh	derm/inh			GW - PCE, TCE
				Industrial Worker	Ing/derm/inh				
				Trespasser/Visitor	Ing/derm/inh				
		VI Assessment/ RI Addendum (2011)	Current/Future	Residents		Inh			
				Industrial Worker		Inh			
Site 12	Former Exchange Laundry/ Dry Cleaning Facility	SRI/HHRA (2000)	Current/Future	Industrial Worker	Ing/derm/inh				
				Trespasser/Visitor	Ing/derm/inh		Ing/derm	Ing/derm	
			Future	Residents (adult/child)	Ing/derm/inh	Ing/derm/inh†			GW - PCE, TCE, 1,1-/1,2-DCE, VC
				Construction Worker	Ing/derm/inh				
Site 13	Former Public Works Center Dip Tank and Wash Rack	SRI/HHRA (2002)	Current/Future	Industrial Worker	Ing/derm/inh	Ing	not evaluated	not evaluated	GW - PCE, TCE, VC
			Future	Residents (adult/child)	Ing/derm/inh	Ing/derm/inh†			GW - PCE, TCE, VC, PCP
				Construction Worker	Ing/derm/inh	derm/inh			GW - PCE, PCP
		VI Assessment (2007)	Current/Future	Site Worker		inh			

Notes
† evaluated for adult residents only
Highlights indicate the exposure media and pathways posing unacceptable risks
1) The following VOCs were identified as COCs at Site 11:
1,1,1-TCA, 1,1,2-TCA, 1,1-DCA, 1,2-DCA, 1,1-DCE, cis-1,2-/trans-1,2-DCE, 1,2-DCP, carbon tetrachloride, chloroform, methylene chloride, TCE, V(

Acronyms:
GW - Groundwater; SW - Surface Water
COC - Chemical of Concern
SRI - Supplemental Remedial Investigation
RI - Remedial Investigation
FS - Feasibility Study
HHRA - Human Health Risk Assessment
VI - Vapor Intrusion
VOC - volatile organic compound

Sb - Antimony
Cd - Cadmium
Mn - Manganese
Tl - Thallium
Zn - Zinc

TCA - Trichloroethane
DCA - Dichloroethane
DCE - Dichloroethene
DCP - Dichloropropane
PCE - Tetrachloroethene
TCE - Trichloroethene
VC - Vinyl chloride
PCP - Pentachlorophenol

Ing - Ingestion
derm - dermal contact
inh - inhalation

TABLE 4-6

Comparison Between Prior Toxicity Values (2008) and 2013 Toxicity Values Under EPA Hierarchy (2003)

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

		Ingestion Exposure								Inhalation Exposure [a]								Tap Water RSL			
		RfDo				SFo				RfC				IUR				(TR =10-6; HQ = 0.1)			
		(mg/kg-day)				(mg/kg-day)$^{-1}$				(mg/m^3)				(ug/m^3)$^{-1}$				ug/L			
Chem Group	**Analyte**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**
VOC	1,1,1-Trichloroethane	2	I	2	I	--		--		5	I	5	I	--		--		910	nc	750	nc
VOC	1,1,2,2-Tetrachloroethane	0.004	P	0.02	I	0.2	I	0.2	I	--		--		0.000058	I	0.000058	C	0.067	ca	0.066	ca
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113	30	I	30	I	--		--		30	H	30	H	--		--		5900	nc	5300	nc
VOC	1,1,2-Trichloroethane	0.004	I	0.004	I	0.057	I	0.057	I	--		0.0002	X	0.000016	I	0.000016	I	0.24	ca	0.041	nc
VOC	1,1-Dichloroethane	0.2	P	0.2	P	0.0057	C	0.0057	C	--		--		0.0000016	C	0.0000016	C	2.4	ca	2.4	ca
VOC	1,1-Dichloroethene	0.05	I	0.05	I	--		--		0.2	I	0.2	I	--		--		34	nc	26	nc
VOC	1,2,3-Trichlorobenzene	n/a		0.0008	X	n/a		--		n/a		--		n/a		--		n/a		0.52	nc
VOC	1,2,4-Trichlorobenzene	0.01	I	0.01	I	0.0036	C	0.029	P	0.004	P	0.002	P	--		--		0.82	nc	0.39	nc
VOC	1,2-Dibromo-3-chloropropane	0.0002	P	0.0002	P	0.8	P	0.8	P	0.0002	I	0.0002	I	0.006	P	0.006	P	0.00032	ca	0.00032	ca
VOC	1,2-Dibromoethane	0.009	I	0.009	I	2	I	2	I	0.009	I	0.009	I	0.0006	I	0.0006	I	0.0065	ca	0.0065	ca
VOC	1,2-Dichlorobenzene	0.09	I	0.09	I	--		--		0.2	H	0.2	H	--		--		37	nc	28	nc
VOC	1,2-Dichloroethane	0.02	P	0.006	X	0.091	I	0.091	I	2.4	A	0.007	P	0.000026	I	0.000026	I	0.15	ca	0.15	ca
VOC	1,2-Dichloropropane	--		0.09	A	0.036	C	0.036	C	0.004	I	0.004	I	0.00001	C	0.00001	C	0.39	ca	0.38	ca
VOC	1,3-Dichlorobenzene	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
VOC	1,4-Dichlorobenzene	--		0.07	A	0.0054	C	0.0054	C	0.8	I	0.8	I	0.000011	C	0.000011	C	0.43	ca	0.42	ca
VOC	1,4-Dioxane	--		0.03	I	0.011	I	0.1	I	3.6	A	0.11	A	--		0.0000077	C	6.1	ca	0.67	ca
VOC	2-Butanone	0.6	I	0.6	I	--		--		5	I	5	I	--		--		710	nc	490	nc
VOC	2-Hexanone	n/a		0.005	I	n/a		--		n/a		0.03	I	n/a		--		n/a		3.4	nc
VOC	4-Methyl-2-pentanone	0.08	H	0.08	H	--		--		3	I	3	I	--		--		200	nc	100	nc
VOC	Acetone	0.9	I	0.9	I	--		--		31	A	31	A	--		--		2200	nc	1200	nc
VOC	Benzene	0.004	I	0.004	I	0.055	I	0.055	I	0.03	I	0.03	I	0.0000078	I	0.0000078	I	0.41	ca	0.39	ca
VOC	Bromochloromethane	n/a		--		n/a		--		n/a		0.04	X	n/a		--		n/a		8.3	nc
VOC	Bromodichloromethane	0.02	I	0.02	I	0.062	I	0.062	I	--		--		--		0.000037	C	1.1	ca	0.12	ca
VOC	Bromoform	0.02	I	0.02	I	0.0079	I	0.0079	I	--		--		0.0000011	I	0.0000011	I	8.5	ca	7.9	ca
VOC	Bromomethane	0.0014	I	0.0014	I	--		--		0.005	I	0.005	I	--		--		0.87	nc	0.7	nc
VOC	Carbon disulfide	0.1	I	0.1	I	--		--		0.7	I	0.7	I	--		--		100	nc	72	nc
VOC	Carbon tetrachloride	0.0007	I	0.004	I	0.13	I	0.07	I	0.19	A	0.1	I	0.000015	I	0.000006	I	0.2	ca	0.39	ca
VOC	Chlorobenzene	0.02	I	0.02	I	--		--		0.05	P	0.05	P	--		--		9.1	nc	7.2	nc
VOC	Chloroethane	--		--		--		--		10	I	10	I	--		--		2100	nc	2100	nc
VOC	Chloroform	0.01	I	0.01	I	0.031	C	0.031	C	0.098	A	0.098	A	0.000023	I	0.000023	I	0.19	ca	0.19	ca
VOC	Chloromethane	--		--		0.013	H	--		0.09	I	0.09	I	0.0000018	H	--		1.8	ca	19	nc
VOC	cis-1,2-Dichloroethene	0.01	P	0.002	I	--		--		--		--		--		--		37	nc	2.8	nc
VOC	cis-1,3-Dichloropropene	0.03	I	0.03	I	0.1	I	0.1	I	0.02	I	0.02	I	0.000004	I	0.000004	I	0.43	ca	0.41	ca
VOC	Cyclohexane	--		--		--		--		6	I	6	I	--		--		1300	nc	1300	nc
VOC	Dibromochloromethane	0.02	I	0.02	I	0.084	I	0.084	I	--		--		--		0.000027	C	0.8	ca	0.15	ca
VOC	Dichlorodifluoromethane (Freon-12)	0.2	I	0.2	I	--		--		0.2	H	0.1	X	--		--		39	nc	19	nc
VOC	Ethylbenzene	0.1	I	0.1	I	0.011	C	0.011	C	1	I	1	I	0.0000025	C	0.0000025	C	1.5	ca	1.3	ca
VOC	Isopropylbenzene	0.1	I	0.1	I	--		--		0.4	I	0.4	I	--		--		68	nc	39	nc
VOC	m- and p-Xylene	--		0.2	(4)	--		--		0.7	C	0.1	(4)	--		--		150	nc	19	nc
VOC	Methyl acetate	1	H	1	X	--		--		--		--		--		--		3700	nc	1600	nc
VOC	Methylcyclohexane	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
VOC	Methylene chloride	0.06	I	0.006	I	0.0075	I	0.002	I	1.1	A	0.6	I	4.7E-07	I	1E-08	I	4.8	ca	8.4	nc
VOC	Methyl-tert-butyl ether (MTBE)	--		--		0.0018	C	0.0018	C	3	I	3	I	2.6E-07	C	2.6E-07	C	12	ca	12	ca
VOC	o-Xylene	2	H	0.2	(4)	--		--		0.7	C	0.1	(4)	--		--		140	nc	19	nc
VOC	Styrene	0.2	I	0.2	I	--		--		1	I	1	I	--		--		160	nc	110	nc
VOC	Tetrachloroethene	0.01	I	0.006	I	0.54	C	0.0021	I	0.27	A	0.04	I	0.0000059	C	2.6E-07	I	0.11	ca	3.5	nc
VOC	Toluene	0.08	I	0.08	I	--		--		5	I	5	I	--		--		230	nc	86	nc
VOC	trans-1,2-Dichloroethene	0.02	I	0.02	I	--		--		0.06	P	0.06	P	--		--		11	nc	8.6	nc
VOC	trans-1,3-Dichloropropene	0.03	I	0.03	I	0.1	I	0.1	I	0.02	I	0.02	I	0.000004	I	0.000004	I	0.43	ca	0.41	ca
VOC	Trichloroethene	--		0.0005	I	0.013	C	0.046	I	--		0.002	I	0.000002	C	0.0000041	I	1.7	ca	0.26	nc
VOC	Trichlorofluoromethane(Freon-11)	0.3	I	0.3	I	--		--		0.7	H	0.7	H	--		--		130	nc	110	nc
VOC	Vinyl chloride	0.003	I	0.003	I	0.72	I	0.72	I	0.1	I	0.1	I	0.0000044	I	0.0000044	I	0.016	ca	0.015	ca
Explo	1,3,5-Trinitrobenzene (1,3,5-TNB)	0.03	I	0.03	I	--		--		--		--		--		--		110	nc	46	nc
Explo	1,3-Dinitrobenzene (1,3-DNB)	0.0001	I	0.0001	I	--		--		--		--		--		--		0.37	nc	0.15	nc
Explo	2,4,6-Trinitrotoluene (2,4,6-TNT)	0.0005	I	0.0005	I	0.03	I	0.03	I	--		--		--		--		1.8	nc	0.76	nc
Explo	2,4-Dinitrotoluene (2,4-DNT)	0.002	I	0.002	I	--		0.31	C	--		--		--		0.000089	C	7.3	nc	0.2	ca

TABLE 4-6

Comparison Between Prior Toxicity Values (2008) and 2013 Toxicity Values Under EPA Hierarchy (2003)

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

		Ingestion Exposure								Inhalation Exposure [a]								Tap Water RSL			
		RfDo				SFo				RfC				IUR				(TR =10-6; HQ = 0.1)			
		(mg/kg-day)				(mg/kg-day)$^{-1}$				(mg/m^3)				(ug/m^3)$^{-1}$				ug/L			
Chem Group	**Analyte**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**
Explo	2,6-Dinitrotoluene (2,6-DNT)	0.001	P	0.0003	X	--		1.5	P	--		--		--		--		3.7	nc	0.042	ca
Explo	2-Amino-4,6-dinitrotoluene (2-Am-DNT)	0.002	(3)	0.002	(3)	--		--		--		--		--		--		7.3	nc	3	nc
Explo	2-Nitrotoluene (2-NT)	0.0009	P	0.0009	P	0.22	P	0.22	P	--		--		--		--		0.31	ca	0.27	ca
Explo	3-Nitrotoluene (3-NT)	0.02	P	0.0001	X	--		--		--		--		--		--		73	nc	0.13	nc
Explo	4-Amino-2,6-dinitrotoluene (4-Am-DNT)	0.002	(3)	0.002	(3)	--		--		--		--		--		--		7.3	nc	3	nc
Explo	4-Nitrotoluene (4-NT)	0.004	P	0.004	P	0.016	P	0.016	P	--		--		--		--		4.2	ca	3.7	ca
Explo	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.003	I	0.003	I	0.11	I	0.11	I	--		--		--		--		0.61	ca	0.61	ca
Explo	Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0.004	P	0.004	P	--		--		--		--		--		--		15	nc	6.1	nc
Explo	Nitrobenzene (NB)	0.0005	I	0.002	I	--		--		0.002	H	0.009	I	--		0.00004	I	0.34	nc	0.12	ca
Explo	Nitroglycerin	0.0001	P	0.0001	P	0.017	P	0.017	P	--		--		--		--		0.37	nc	0.15	nc
Explo	Nitroguanadine	0.1	I	0.1	I	--		--		--		--		--		--		370	nc	160	nc
Explo	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.05	I	0.05	I	--		--		--		--		--		--		180	nc	78	nc
Explo	Perchlorate	0.0007	I	0.0007	I	--		--		--		--		--		--		2.6	nc	1.1	nc
Explo	PETN	n/a		0.002	P	n/a		0.004	X	n/a		--		n/a		--		n/a		3	nc
Metal	Aluminum	1	P	1	P	--		--		0.005	P	0.005	P	--		--		3700	nc	1600	nc
Metal	Antimony	0.0004	I	0.0004	I	--		--		--		--		--		--		1.5	nc	0.6	nc
Metal	Arsenic	0.0003	I	0.0003	I	1.5	I	1.5	I	0.00003	C	0.000015	C	0.0043	I	0.0043	I	0.045	ca	0.045	ca
Metal	Barium	0.2	I	0.2	I	--		--		0.0005	H	0.0005	H	--		--		730	nc	290	nc
Metal	Beryllium	0.002	I	0.002	I	--		--		0.00002	I	0.00002	I	0.0024	I	0.0024	I	7.3	nc	1.6	nc
Metal	Cadmium	0.0005	I	0.0005	I	--		--		--		0.00001	A	0.0018	I	0.0018	I	1.8	nc	0.69	nc
Metal	Calcium	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
Metal	Chromium	--		--		--		--		--		--		0.012	I	--		--		--	
Metal	Chromium(III)	1.5	I	1.5	I	--		--		--		--		--		--		5500	nc	1600	nc
Metal	Chromium(VI)	0.003	I	0.003	I	--		0.5	J	0.000008	I	0.0001	I	0.084	I	0.084	S	11	nc	0.031	ca
Metal	Cobalt	0.0003	P	0.0003	P	--		--		0.000006	P	0.000006	P	0.009	P	0.009	P	1.1	nc	0.47	nc
Metal	Copper	0.04	H	0.04	H	--		--		--		--		--		--		150	nc	62	nc
Metal	Cyanide	0.02	I	0.0006	I	--		--		--		0.0008	(6)	--		--		73	nc	0.14	nc
Metal	Iron	0.7	P	0.7	P	--		--		--		--		--		--		2600	nc	1100	nc
Metal	Lead	--		--		--		--		--		--		--		--		--		--	
Metal	Magnesium	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
Metal	Manganese	0.024	I	0.024	S	--		--		0.00005	I	0.00005	I	--		--		88	nc	32	nc
Metal	Mercury	0.0003	I	0.0003	I	--		--		--		0.0003	S	--		--		1.1	nc	0.43	nc
Metal	Nickel	0.02	I	0.02	I	--		--		--		0.00009	A	--		0.00026	C	73	nc	30	nc
Metal	Potassium	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
Metal	Selenium	0.005	I	0.005	I	--		--		--		0.02	C	--		--		18	nc	7.8	nc
Metal	Silver	0.005	I	0.005	I	--		--		--		--		--		--		18	nc	7.1	nc
Metal	Sodium	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
Metal	Thallium	0.000065	(5)	0.00001	X	--		--		--		--		--		--		0.24	nc	0.016	nc
Metal	Vanadium	0.005	(2)	0.005	(2)	--		--		--		0.0001	A	--		--		18	nc	6.3	nc
Metal	Zinc	0.3	I	0.3	I	--		--		--		--		--		--		1100	nc	470	nc
PCB	Aroclor-1016	0.00007	I	0.00007	I	0.07	I	0.07	(1)	--		--		0.00002	I	0.00002	(1)	0.26	nc	0.11	nc
PCB	Aroclor-1221	--		--		2	I	2	(1)	--		--		0.00057	I	0.00057	(1)	0.0068	ca	0.004	ca
PCB	Aroclor-1232	--		--		2	I	2	(1)	--		--		0.00057	I	0.00057	(1)	0.0068	ca	0.004	ca
PCB	Aroclor-1242	--		--		2	I	2	(1)	--		--		0.00057	I	0.00057	(1)	0.034	ca	0.034	ca
PCB	Aroclor-1248	--		--		2	I	2	(1)	--		--		0.00057	I	0.00057	(1)	0.034	ca	0.034	ca
PCB	Aroclor-1254	0.00002	I	0.00002	I	2	I	2	(1)	--		--		0.00057	I	0.00057	(1)	0.034	ca	0.031	nc
PCB	Aroclor-1260	--		--		2	I	2	(1)	--		--		0.00057	I	0.00057	(1)	0.034	ca	0.034	ca
Pest	4,4'-DDD	--		--		0.24	I	0.24	I	--		--		--		0.000069	C	0.28	ca	0.027	ca
Pest	4,4'-DDE	--		--		0.34	I	0.34	I	--		--		--		0.000097	C	0.2	ca	0.2	ca
Pest	4,4'-DDT	0.0005	I	0.0005	I	0.34	I	0.34	I	--		--		0.000097	I	0.000097	I	0.2	ca	0.2	ca
Pest	Aldrin	0.00003	I	0.00003	I	17	I	17	I	--		--		0.0049	I	0.0049	I	0.004	ca	0.004	ca
Pest	alpha-BHC	--		0.008	A	6.3	I	6.3	I	--		--		0.0018	I	0.0018	I	0.011	ca	0.0062	ca
Pest	alpha-Chlordane	0.0005	I	0.0005	I	0.35	I	0.35	I	0.0007	I	0.0007	I	0.0001	I	0.0001	I	0.19	ca	0.19	ca
Pest	beta-BHC	--		--		1.8	I	1.8	I	--		--		0.00053	I	0.00053	I	0.037	ca	0.022	ca
Pest	delta-BHC	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
Pest	Dieldrin	0.00005	I	0.00005	I	16	I	16	I	--		--		0.0046	I	0.0046	I	0.0042	ca	0.0015	ca

TABLE 4-6

Comparison Between Prior Toxicity Values (2008) and 2013 Toxicity Values Under EPA Hierarchy (2003)

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

		Ingestion Exposure								Inhalation Exposure [a]								Tap Water RSL			
		RfDo				SFo				RfC				IUR				(TR =10-6; HQ = 0.1)			
		(mg/kg-day)				(mg/kg-day)$^{-1}$				(mg/m^3)				(ug/m^3)$^{-1}$				ug/L			
Chem Group	**Analyte**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**
Pest	Endosulfan I	0.006	I	0.006	I	--		--		--		--		--		--		22	nc	7.8	nc
Pest	Endosulfan II	0.006	I	0.006	I	--		--		--		--		--		--		22	nc	7.8	nc
Pest	Endosulfan sulfate	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
Pest	Endrin	0.0003	I	0.0003	I	--		--		--		--		--		--		1.1	nc	0.17	nc
Pest	Endrin aldehyde	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
Pest	Endrin ketone	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
Pest	gamma-BHC (Lindane)	0.0003	I	0.0003	I	1.1	C	1.1	C	--		--		0.00031	C	0.00031	C	0.061	ca	0.036	ca
Pest	gamma-Chlordane	0.0005	I	0.0005	I	0.35	I	0.35	I	0.0007	I	0.0007	I	0.0001	I	0.0001	I	0.19	ca	0.19	ca
Pest	Heptachlor	0.0005	I	0.0005	I	4.5	I	4.5	I	--		--		0.0013	I	0.0013	I	0.015	ca	0.0018	ca
Pest	Heptachlor epoxide	0.000013	I	0.000013	I	9.1	I	9.1	I	--		--		0.0026	I	0.0026	I	0.0074	ca	0.0033	ca
Pest	Methoxychlor	0.005	I	0.005	I	--		--		--		--		--		--		18	nc	2.7	nc
Pest	Toxaphene	--		--		1.1	I	1.1	I	--		--		0.00032	I	0.00032	I	0.061	ca	0.013	ca
SVOC	1,1-Biphenyl	0.05	I	0.05	I	--		0.008	X	--		0.0004	X	--		--		180	nc	0.083	nc
SVOC	1,2,4,5-Tetrachlorobenzene	0.0003	I	0.0003	I	--		--		--		--		--		--		1.1	nc	0.12	nc
SVOC	2,2'-Oxybis(1-chloropropane)	0.04	I	0.04	I	0.07	H	0.07	H	--		--		0.00001	H	0.00001	H	0.32	ca	0.31	ca
SVOC	2,3,4,6-Tetrachlorophenol	0.03	I	0.03	I	--		--		--		--		--		--		110	nc	17	nc
SVOC	2,4,5-Trichlorophenol	0.1	I	0.1	I	--		--		--		--		--		--		370	nc	89	nc
SVOC	2,4,6-Trichlorophenol	0.001	P	0.001	P	0.011	I	0.011	I	--		--		0.0000031	I	0.0000031	I	3.7	nc	0.9	nc
SVOC	2,4-Dichlorophenol	0.003	I	0.003	I	--		--		--		--		--		--		11	nc	3.5	nc
SVOC	2,4-Dimethylphenol	0.02	I	0.02	I	--		--		--		--		--		--		73	nc	27	nc
SVOC	2,4-Dinitrophenol	0.002	I	0.002	I	--		--		--		--		--		--		7.3	nc	3	nc
SVOC	2,4-Dinitrotoluene	0.002	I	0.002	I	--		0.31	C	--		--		--		0.000089	C	7.3	nc	0.2	ca
SVOC	2,6-Dinitrotoluene	0.001	P	0.0003	X	--		1.5	P	--		--		--		--		3.7	nc	0.042	ca
SVOC	2-Chloronaphthalene	0.08	I	0.08	I	--		--		--		--		--		--		290	nc	55	nc
SVOC	2-Chlorophenol	0.005	I	0.005	I	--		--		--		--		--		--		18	nc	7.1	nc
SVOC	2-Methylnaphthalene	0.004	I	0.004	I	--		--		--		--		--		--		15	nc	2.7	nc
SVOC	2-Methylphenol	0.05	I	0.05	I	--		--		--		0.6	C	--		--		180	nc	72	nc
SVOC	2-Nitroaniline	n/a		0.01	X	n/a		--		n/a		0.00005	X	n/a		--		n/a		15	nc
SVOC	2-Nitrophenol	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
SVOC	3,3'-Dichlorobenzidine	--		--		0.45	I	0.45	I	--		--		--		0.00034	C	0.15	ca	0.11	ca
SVOC	3-Nitroaniline	0.0003	P	n/a		0.021	P	n/a		0.001	P	n/a		--		n/a		1.1	nc	n/a	
SVOC	4,6-Dinitro-2-methylphenol	0.0001	P	0.00008	X	--		--		--		--		--		--		0.37	nc	0.12	nc
SVOC	4-Bromophenyl-phenylether	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
SVOC	4-Chloro-3-methylphenol	n/a		0.1	A	n/a		--		n/a		--		n/a		--		n/a		110	nc
SVOC	4-Chloroaniline	0.004	I	0.004	I	0.054	P	0.2	P	--		--		--		--		1.2	ca	0.32	ca
SVOC	4-Chlorophenyl-phenylether	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
SVOC	4-Methylphenol	0.005	H	0.1	A	--		--		--		0.6	C	--		--		18	nc	140	nc
SVOC	4-Nitroaniline	0.003	P	0.004	P	0.021	P	0.02	P	0.004	P	0.006	P	--		--		3.2	ca	3.3	ca
SVOC	4-Nitrophenol	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
SVOC	Acenaphthene	0.06	I	0.06	I	--		--		--		--		--		--		220	nc	40	nc
SVOC	Acenaphthylene	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
SVOC	Acetophenone	0.1	I	0.1	I	--		--		--		--		--		--		370	nc	150	nc
SVOC	Anthracene	0.3	I	0.3	I	--		--		--		--		--		--		1100	nc	130	nc
SVOC	Atrazine	0.035	I	0.035	I	0.23	C	0.23	C	--		--		--		--		0.29	ca	0.26	ca
SVOC	Benzaldehyde	0.1	I	0.1	I	--		--		--		--		--		--		370	nc	150	nc
SVOC	Benzo(a)anthracene	--		--		0.73	E	0.73	E	--		--		0.00011	C	0.00011	C	0.029	ca	0.029	ca
SVOC	Benzo(a)pyrene	--		--		7.3	I	7.3	I	--		--		0.0011	C	0.0011	C	0.0029	ca	0.0029	ca
SVOC	Benzo(b)fluoranthene	--		--		0.73	E	0.73	E	--		--		0.00011	C	0.00011	C	0.029	ca	0.029	ca
SVOC	Benzo(g,h,i)perylene	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
SVOC	Benzo(k)fluoranthene	--		--		0.073	E	0.073	E	--		--		0.00011	C	0.00011	C	0.29	ca	0.29	ca
SVOC	bis(2-Chloroethoxy)methane	0.003	P	0.003	P	--		--		--		--		--		--		11	nc	4.6	nc
SVOC	bis(2-Chloroethyl)ether	--		--		1.1	I	1.1	I	--		--		0.00033	I	0.00033	I	0.012	ca	0.012	ca
SVOC	bis(2-Ethylhexyl)phthalate	0.02	I	0.02	I	0.014	I	0.014	I	--		--		--		0.0000024	C	4.8	ca	4.8	ca
SVOC	Butylbenzylphthalate	0.2	I	0.2	I	0.0019	P	0.0019	P	--		--		--		--		35	ca	14	ca
SVOC	Caprolactam	0.5	I	0.5	I	--		--		--		--		--		--		1800	nc	770	nc
SVOC	Carbazole	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	

TABLE 4-6

Comparison Between Prior Toxicity Values (2008) and 2013 Toxicity Values Under EPA Hierarchy (2003)

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JEB Little Creek

Virginia Beach Virginia

		Ingestion Exposure								Inhalation Exposure [a]								Tap Water RSL			
		RfDo				SFo				RfC				IUR				(TR =10-6; HQ = 0.1)			
		(mg/kg-day)				(mg/kg-day)$^{-1}$				(mg/m^3)				(ug/m^3)$^{-1}$				ug/L			
Chem Group	**Analyte**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**
SVOC	Chrysene	--		--		0.0073	E	0.0073	E	--		--		0.000011	C	0.000011	C	2.9	ca	2.9	ca
SVOC	Dibenz(a,h)anthracene	--		--		7.3	E	7.3	E	--		--		0.0012	C	0.0012	C	0.0029	ca	0.0029	ca
SVOC	Dibenzofuran	n/a		0.001	X	n/a		--		n/a		--		n/a		--		n/a		0.58	nc
SVOC	Diethylphthalate	0.8	I	0.8	I	--		--		--		--		--		--		2900	nc	1100	nc
SVOC	Dimethyl phthalate	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
SVOC	Di-n-butylphthalate	0.1	I	0.1	I	--		--		--		--		--		--		370	nc	67	nc
SVOC	Di-n-octylphthalate	n/a		0.01	P	n/a		--		n/a		--		n/a		--		n/a		16	nc
SVOC	Fluoranthene	0.04	I	0.04	I	--		--		--		--		--		--		150	nc	63	nc
SVOC	Fluorene	0.04	I	0.04	I	--		--		--		--		--		--		150	nc	22	nc
SVOC	Hexachlorobenzene	0.0008	I	0.0008	I	1.6	I	1.6	I	--		--		0.00046	I	0.00046	I	0.042	ca	0.042	ca
SVOC	Hexachlorobutadiene	0.001	P	0.001	P	0.078	I	0.078	I	--		--		0.000022	I	0.000022	I	0.86	ca	0.26	ca
SVOC	Hexachlorocyclopentadiene	0.006	I	0.006	I	--		--		0.0002	I	0.0002	I	--		--		22	nc	2.2	nc
SVOC	Hexachloroethane	0.001	I	0.0007	I	0.014	I	0.04	I	--		0.03	I	0.000004	I	0.000011	C	3.7	nc	0.51	nc
SVOC	Indeno(1,2,3-cd)pyrene	--		--		0.73	E	0.73	E	--		--		0.00011	C	0.00011	C	0.029	ca	0.029	ca
SVOC	Isophorone	0.2	I	0.2	I	0.00095	I	0.00095	I	2	C	2	C	--		--		71	ca	67	ca
SVOC	Naphthalene	0.02	I	0.02	I	--		--		0.003	I	0.003	I	0.000034	C	0.000034	C	0.14	ca	0.14	ca
SVOC	Nitrobenzene	0.0005	I	0.002	I	--		--		0.002	H	0.009	I	--		0.00004	I	0.34	nc	0.12	ca
SVOC	n-Nitroso-di-n-propylamine	--		--		7	I	7	I	--		--		--		0.002	C	0.0096	ca	0.0093	ca
SVOC	n-Nitrosodiphenylamine	--		--		0.0049	I	0.0049	I	--		--		--		0.0000026	C	14	ca	10	ca
SVOC	Pentachlorophenol	0.03	I	0.005	I	0.12	I	0.4	I	--		--		--		0.0000051	C	0.56	ca	0.035	ca
SVOC	Phenanthrene	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
SVOC	Phenol	0.3	I	0.3	I	--		--		0.2	C	0.2	C	--		--		1100	nc	450	nc
SVOC	Pyrene	0.03	I	0.03	I	--		--		--		--		--		--		110	nc	8.7	nc
Dioxins/Furans	2,3,7,8-TCDD	1E-09	A	7E-10	I	130000	C	130000	C	--		4E-08	C	38	C	38	C	5.2E-07	ca	5.2E-07	ca

Notes:

[a] Note: Inhalation values listed for non-volatile compounds (e.g., metals) are only applicable to dust inhalation and would not be appropriate for groundwater

Red shading indicates current value (2013) is more stringent than the corresponding 2008 value (increase in cancer potency, decrease in noncancer reference values, or decrease in RSL

Green shading indicates current value (2013) is less stringent than the corresponding 2008 value (decrease in cancer potency, increase in noncancer reference values, or increase in RSL

Yellow shading indicates current value (2013) exists while there was no corresponding 2008 value

Orange shading indicates no current value (2013) exists while there was a 2008 value

Surrogate Toxicity Values and RSL:

Toxicity values and tap water RSLs for 1,3-Dichloropropene are used for cis-1,3-Dichloropropene and trans-1,3-Dichloropropene

Toxicity values and tap water RSLs for Antimony (metallic) are used for Antimony.

Toxicity values and tap water RSLs for Chlordane are used for alpha-Chlordane and gamma-Chlordane

Toxicity values and tap water RSLs for Endosulfan are used for Endosulfan I and Endosulfan II

Toxicity values and tap water RSLs for Mercuric Chloride (and other Mercury salts) are used for Mercury

Toxicity values and tap water RSLs for Nickel Soluble Salts are used for Nickel

Toxicity values and tap water RSLs for Thallium (Soluble Salts) are used for Thallium

Acronyms:

RfDo - Oral Reference Dose
SFo - Oral Slope Factor
mg/kg-day - milligrams per kilogram per day
ug/L - microgram per liter
VOC - volatile organic compound
Pest - pesticides

RfC - Inhalation Reference Concentration
IUR - Inhalation Unit Risk
mg/m^3 - milligrams per cubic meter
n/a - not available
SVOC - semi-volatile organic compound
Explo - explosive

Ref - Reference
RSL - Regional Screening Level
ug/m^3 - micrograms per cubic meter
-- chemical is listed on the table but no value is provided.
PCB - polychlorinated biphenyls

References:

2013 RSLs - May 2013 EPA Regional Screening Levels Table.

2008 RSLs - September 2008 EPA Regional Screening Levels Table.

Tap Water RSLs presented are based on Cancer Target Risk (TR) of 1C^{-6} and non-cancer hazard quotient (HQ) of 0.1.

TABLE 4-6

Comparison Between Prior Toxicity Values (2008) and 2013 Toxicity Values Under EPA Hierarchy (2003)

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

		Ingestion Exposure								Inhalation Exposure [a]								Tap Water RSL			
		RfDo				SFo				RfC				IUR				(TR =10-6; HQ = 0.1)			
		(mg/kg-day)				$(mg/kg\text{-}day)^{-1}$				(mg/m^3)				$(ug/m^3)^{-1}$				ug/L			
Chem Group	**Analyte**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**	**2008**	**Ref**	**2013**	**Ref**

A = Agency for Toxic Substances and Disease Registry
C = California EPA
E = Environmental Criteria and Assessment Office
J = New Jersey Department of Environmental Protection
H = Health Effects Assessment Summary Tables
I = Integrated Risk Information System
P = EPA's Provisional Peer Reviewed Toxicity Values
X = EPA's Provisional Peer Reviewed Toxicity Values Appendix

1) Aroclor 1016 is considered "lowest risk" and assigned appropriate toxicity values. All other Aroclors are assigned the high risk toxicity values
2) The oral RfD toxicity value for Vanadium was derived from the IRIS oral RfD for Vanadium Pentoxide by factoring out the molecular weight (MW) of the oxide ion
3) The IRIS oral RfD of 2E-03 mg/kg-day for 2,4-Dinitrotoluene is used as a surrogate for 2-Amino-4,6-Dinitrotoluene and 4-Amino-2,6-Dinitrotoluene
4) The IRIS oral RfD of 2E-01 mg/kg-day for xylene, mixture is used as a surrogate for the 3 xylene congeners
5) The oral RfD toxicity value for Thallium (Soluble Salts) was derived from the IRIS oral RfD for Thallium sulfate by factoring out the molecular weight (MW) of Thallium salt
6) The IRIS inhalation RfC of 8E-04 mg/m^3 for Hydrogen cyanide is used as a surrogate for Cyanide.

Table 4-7

Comparison Between Prior Ecological Screening Values (2004) and 2013 Ecological Screening Values - Site 7

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Surface Water						
Inorganics						
Aluminum	87.0	USEPA 1999b	87.0	USEPA 2009	Unchanged	
Antimony	500	USEPA 1995	500	USEPA 2006b	Unchanged	
Arsenic	36.0	USEPA 2002	36.0	USEPA 2009	Unchanged	
Barium	1,000	USEPA 1995 (with UF of 10)	200	Buchman 2008	Unchanged	Maximum HQ <1
Beryllium	1,500	USEPA 1995	100	Buchman 2008	Unchanged	Maximum HQ <1
Cadmium	8.85	USEPA 2002	8.85	USEPA 2009	Unchanged	
Chromium	50.4	USEPA 2002	50.4	USEPA 2009	Unchanged	
Cobalt	23.0	Suter and Tsao 1996	23.0	Suter and Tsao 1996	Unchanged	
Copper	3.70	USEPA 2002	3.73	USEPA 2009	Unchanged	
Cyanide	1.00	USEPA 1995	1.00	USEPA 2009	Unchanged	
Iron	1,000	USEPA 2002	1,000	USEPA 2009	Unchanged	
Lead	8.50	USEPA 2002	8.52	USEPA 2009	Unchanged	
Manganese	10.0	USEPA 1995	100	Buchman 2008	Unchanged	
Mercury	1.10	USEPA 2002	1.11	USEPA 2009	Unchanged	
Nickel	8.30	USEPA 2002	8.28	USEPA 2009	Unchanged	
Selenium	71.1	USEPA 2002	71.1	USEPA 2009	Unchanged	
Silver	0.92	Buchman 1999	0.23	USEPA 2001	Unchanged	Dissolved silver
Thallium	213	USEPA 1995 (with UF of 10)	21.3	USEPA 2001	Unchanged	Mean HQ <1
Vanadium	10,000	USEPA 1995	50.0	Buchman 2008	Unchanged	Maximum HQ <1
Zinc	86.0	USEPA 2002	85.6	USEPA 2009	Unchanged	
Dissolved Metals						
Aluminum	87.0	USEPA 1999b	87.0	USEPA 2009	Unchanged	
Antimony	500	USEPA 1995	500	USEPA 2006b	Unchanged	
Arsenic	36.0	USEPA 2002	36.0	USEPA 2009	Unchanged	
Barium	1,000	USEPA 1995 (with UF of 10)	200	Buchman 2008	Unchanged	Maximum HQ <1
Beryllium	1,500	USEPA 1995	100	Buchman 2008	Unchanged	Maximum HQ <1
Cadmium	8.80	USEPA 2002	8.80	USEPA 2009	Unchanged	

Table 4-7

Comparison Between Prior Ecological Screening Values (2004) and 2013 Ecological Screening Values - Site 7

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Chromium	50.0	USEPA 2002	50.0	USEPA 2009	Unchanged	
Cobalt	23.0	Suter and Tsao 1996	23.0	Suter and Tsao 1996	Unchanged	
Copper	3.10	USEPA 2002	3.10	USEPA 2009	Unchanged	
Iron	1,000	USEPA 2002	1,000	USEPA 2009	Unchanged	
Lead	8.10	USEPA 2002	8.10	USEPA 2009	Unchanged	
Manganese	10.0	USEPA 1995	100	Buchman 2008	Unchanged	
Mercury	0.94	USEPA 2002	0.94	USEPA 2009	Unchanged	
Nickel	8.20	USEPA 2002	8.20	USEPA 2009	Unchanged	
Selenium	71.0	USEPA 2002	71.0	USEPA 2009	Unchanged	
Silver	0.92	Buchman 1999	0.23	USEPA 2001	Unchanged	Frequency of Detection; Magnitude of Maximum HQ
Thallium	213	USEPA 1995 (with UF of 10)	21.3	USEPA 2001	Unchanged	Mean HQ <1
Vanadium	10,000	USEPA 1995	50.0	Buchman 2008	Unchanged	Maximum HQ <1
Zinc	81.0	USEPA 2002	81.0	USEPA 2009	Unchanged	
Pesticide/Polychlorinated Biphenyls						
4,4'-DDD	0.025	USEPA 1999a	0.025	USEPA 2001	Unchanged	
4,4'-DDE	1.40	USEPA 1995 (with UF of 10)	0.14	USEPA 2001	Unchanged	Not detected
4,4'-DDT	0.001	USEPA 1995	0.0065	USEPA 2006b	Unchanged	
Aldrin	0.13	USEPA 1995 (with UF of 10)	0.13	USEPA 2001	Unchanged	
alpha-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	USEPA 2006b	Unchanged	
alpha-Chlordane	0.004	USEPA 1995	0.004	USEPA 2009	Unchanged	
Aroclor-1016	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1221	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1232	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1242	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1248	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1254	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1260	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	

Table 4-7

Comparison Between Prior Ecological Screening Values (2004) and 2013 Ecological Screening Values - Site 7

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Virginia Beach Virginia

Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
beta-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	alpha-BHC	Unchanged	
delta-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	alpha-BHC	Unchanged	
Dieldrin	0.11	USEPA 1996	0.11	USEPA 1996	Unchanged	
Endosulfan I	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endosulfan II	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endosulfan sulfate	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endrin	0.01	USEPA 1996	0.01	USEPA 1996	Unchanged	
Endrin aldehyde	0.01	USEPA 1996	0.01	Endrin	Unchanged	
Endrin ketone	0.01	USEPA 1996	0.01	Endrin	Unchanged	
gamma-BHC (Lindane)	0.016	USEPA 1995 (with UF of 10)	0.016	USEPA 2001	Unchanged	
gamma-Chlordane	0.004	USEPA 1995	0.004	USEPA 2009	Unchanged	
Heptachlor	0.0036	USEPA 1995	0.0036	USEPA 2009	Unchanged	
Heptachlor epoxide	0.0036	USEPA 1995	0.0036	USEPA 2009	Unchanged	
Methoxychlor	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Toxaphene	0.21	USEPA 1996	0.21	USEPA 1996	Unchanged	
Semivolatile Organic Compounds						
2,4,5-Trichlorophenol	11.0	USEPA 1995	12.0	USEPA 2006b	Unchanged	
2,4,6-Trichlorophenol	NSV	--	61.0	USEPA 2006b	Unchanged	Maximum HQ <1
2,4-Dichlorophenol	NSV	--	NSV	--	Unchanged	
2,4-Dimethylphenol	110	Federal Register 59:3762 (1994)	100	Buchman 2008	Unchanged	Maximum HQ <1
2,4-Dinitrophenol	485	USEPA 1995 (with UF of 10)	48.5	USEPA 2001	Unchanged	Maximum HQ <1
2,4-Dinitrotoluene	370	USEPA 1995	480	Nipper et al. 2001	Unchanged	
2,6-Dinitrotoluene	NSV	--	1,000	Nipper et al. 2001	Unchanged	Maximum HQ <1
2-Chloronaphthalene	0.75	USEPA 1995 (with UF of 10)	0.40	Buchman 2008	Unchanged	Not detected
2-Chlorophenol	NSV	--	265	USEPA 2006b	Unchanged	Maximum HQ <1
2-Methylnaphthalene	30.0	USEPA 1995 (with UF of 10)	330	Buchman 2008	Unchanged	
2-Methylphenol	NSV	--	1,020	USEPA 2006b	Unchanged	Maximum HQ <1
2-Nitroaniline	NSV	--	NSV	--	Unchanged	
2-Nitrophenol	485	USEPA 1994	2,940	USEPA 2006b	Unchanged	

Table 4-7

Comparison Between Prior Ecological Screening Values (2004) and 2013 Ecological Screening Values - Site 7

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Virginia Beach Virginia

Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
3,3'-Dichlorobenzidine	NSV	--	73.0	USEPA 2006b	Unchanged	
3-Nitroaniline	NSV	--	NSV	--	Unchanged	
4,6-Dinitro-2-methylphenol	NSV	--	NSV	--	Unchanged	
4-Bromophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Chloro-3-methylphenol	NSV	--	NSV	--	Unchanged	
4-Chloroaniline	129	Buchman 1999	129	Buchman 2008	Unchanged	
4-Chlorophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Methylphenol	13.0	Suter and Tsao 1996 (for 2-methylphenol)	543	USEPA 2006b	Unchanged	
4-Nitroaniline	NSV	--	NSV	--	Unchanged	
4-Nitrophenol	485	USEPA 1995 (with UF of 10)	71.7	USEPA 2001	Unchanged	Maximum HQ <1
Acenaphthene	710	USEPA 1995	40.0	USEPA 1996	Unchanged	Maximum HQ <1
Acenaphthylene	30.0	USEPA 1995 (with UF of 10)	4,840	Buchman 2008	Unchanged	
Anthracene	30.0	USEPA 1995 (with UF of 10)	0.18	USEPA 2006b	Unchanged	Not detected
Benzo(a)anthracene	8.13	USEPA 1995	0.027	Suter and Tsao 1996	Unchanged	Not detected
Benzo(a)pyrene	0.021	USEPA 1995 (with UF of 10)	0.014	Suter and Tsao 1996	Unchanged	Not detected
Benzo(b)fluoranthene	30.0	USEPA 1995 (with UF of 10)	9.07	Buchman 2008	Unchanged	Not detected
Benzo(g,h,i)perylene	30.0	USEPA 1995 (with UF of 10)	7.64	Buchman 2008	Unchanged	Not detected
Benzo(k)fluoranthene	30.0	USEPA 1995 (with UF of 10)	9.07	Benzo(b)fluoranthene value	Unchanged	Not detected
Bis(2-chloro-1-methylethyl) ether	NSV	--	NSV	--	Unchanged	
bis(2-Chloroethoxy)methane	6,400	USEPA 1995	6,400	Buchman 2008	Unchanged	
bis(2-Chloroethyl)ether	NSV	--	NSV	--	Unchanged	
bis(2-Ethylhexyl)phthalate	360	USEPA 1995	360	Buchman 2008	Unchanged	
Butylbenzylphthalate	29.4	USEPA 1999a	29.4	USEPA 2001	Unchanged	
Carbazole	NSV	--	NSV	--	Unchanged	
Chrysene	30.0	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Dibenz(a,h)anthracene	30.0	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Dibenzofuran	NSV	--	65.0	USEPA 2006b	Unchanged	
Diethylphthalate	75.9	USEPA 1999a	75.9	USEPA 2001	Unchanged	

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Dimethyl phthalate	580	USEPA 1999a	580	USEPA 2001	Unchanged	
Di-n-butylphthalate	3.40	USEPA 1995	3.40	USEPA 2001	Unchanged	
Di-n-octylphthalate	3.40	USEPA 1995	3.40	Buchman 2008	Unchanged	
Fluoranthene	16.0	USEPA 1995	11.0	USEPA 1996	Unchanged	Maximum HQ <1
Fluorene	30.0	USEPA 1995 (with UF of 10)	3.90	USEPA 1996	Unchanged	Not detected
Hexachlorobenzene	129	USEPA 1995	3.68	Buchman 2008	Unchanged	Not detected
Hexachlorobutadiene	3.20	USEPA 1995 (with UF of 10)	0.32	USEPA 2001	Unchanged	Not detected
Hexachlorocyclopentadiene	0.70	USEPA 1995 (with UF of 10)	0.07	USEPA 2001	Unchanged	Not detected
Hexachloroethane	94.0	USEPA 1995 (with UF of 10)	9.40	USEPA 2001	Unchanged	Not detected
Indeno(1,2,3-cd)pyrene	30.0	USEPA 1995 (with UF of 10)	4.31	Buchman 2008	Unchanged	Not detected
Isophorone	1,290	USEPA 1995 (with UF of 10)	129	USEPA 2001	Unchanged	Maximum HQ <1
Naphthalene	230	USEPA 1995 (with UF of 10)	23.5	USEPA 2001	Unchanged	Maximum HQ <1
Nitrobenzene	668	USEPA 1995 (with UF of 10)	66.8	USEPA 2001	Unchanged	Maximum HQ <1
n-Nitroso-di-n-propylamine	NSV	--	120	USEPA 2006b	Unchanged	
n-Nitrosodiphenylamine	330,000	USEPA 1995 (with UF of 10)	33,000	USEPA 2001	Unchanged	Maximum HQ <1
Pentachlorophenol	7.90	USEPA 1995	7.90	USEPA 2009	Unchanged	
Phenanthrene	4.60	USEPA 1995	8.30	USEPA 1996	Unchanged	
Phenol	580	USEPA 1995 (with UF of 10)	58.0	USEPA 2001	Unchanged	Maximum HQ <1
Pyrene	30.0	USEPA 1995 (with UF of 10)	0.24	USEPA 2006b	Unchanged	Not detected
Volatile Organic Compounds						
1,1,1-Trichloroethane	3,120	USEPA 1995 (with UF of 10)	312	USEPA 2001	Unchanged	Maximum HQ <1
1,1,2,2-Tetrachloroethane	623	USEPA 1995 (with UF of 10)	90.2	USEPA 2001	Unchanged	Maximum HQ <1
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-1	6,400	USEPA 1995 (for trichlorofluoromethane)	NSV	--	Unchanged	ESVs for other VOCs
1,1,2-Trichloroethane	3,120	USEPA 1995 (with UF of 10)	550	USEPA 2006b	Unchanged	Maximum HQ <1
1,1-Dichloroethane	3,200	USEPA 1995 (with UF of 100)	47.0	Suter and Tsao 1996	Unchanged	Maximum HQ <1
1,1-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	2,240	USEPA 2001	Unchanged	Maximum HQ <1
1,2,4-Trichlorobenzene	129	USEPA 1995	5.40	USEPA 2006b	Unchanged	Not detected
1,2-Dibromo-3-chloropropane	NSV	--	NSV	--	Unchanged	
1,2-Dibromoethane	NSV	--	NSV	--	Unchanged	

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
1,2-Dichlorobenzene	129	USEPA 1995	42.0	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dichloroethane	1,130	USEPA 1995 (with UF of 100)	1,130	USEPA 2001	Unchanged	
1,2-Dichloroethene (total)	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dichloropropane	3,040	USEPA 1995	2,400	USEPA 2001	Unchanged	Maximum HQ <1
1,3-Dichlorobenzene	129	USEPA 1994	28.5	USEPA 2001	Unchanged	Maximum HQ <1
1,4-Dichlorobenzene	129	USEPA 1995	19.9	USEPA 2001	Unchanged	Maximum HQ <1
2-Butanone	14,000	Suter and Tsao 1996	14,000	Suter and Tsao 1996	Unchanged	
2-Hexanone	NSV	--	NSV	--	Unchanged	
4-Methyl-2-pentanone	NSV	--	123,000	USEPA 2006b	Unchanged	Maximum HQ <1
Acetone	1,500	Suter and Tsao 1996	564,000	USEPA 2006b	Unchanged	
Benzene	700	USEPA 1995	110	USEPA 2006b	Unchanged	Maximum HQ <1
Bromodichloromethane	6,400	USEPA 1995	NSV	--	Unchanged	ESVs for other VOCs
Bromoform	640	USEPA 1999a	640	USEPA 2001	Unchanged	
Bromomethane	120	USEPA 1999a	120	USEPA 2001	Unchanged	
Carbon disulfide	2.00	USEPA 1995	0.92	Suter and Tsao 1996	Unchanged	Frequency of Detection; Magnitude of Maximum HQ
Carbon tetrachloride	5,000	USEPA 1995 (with UF of 10)	1,500	USEPA 2001	Unchanged	Maximum HQ <1
Chlorobenzene	129	USEPA 1995	25.0	USEPA 2006b	Unchanged	Maximum HQ <1
Chloroethane	NSV	--	NSV	--	Unchanged	
Chloroform	815	USEPA 1999a	815	USEPA 2001	Unchanged	
Chloromethane	2,700	USEPA 1999a	2,700	USEPA 2001	Unchanged	
cis-1,2-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
cis-1,3-Dichloropropene	79.0	USEPA 1995 (with UF of 10)	7.90	USEPA 2001	Unchanged	Not detected
Cumene	NSV	--	NSV	--	Unchanged	
Cyclohexane	NSV	--	NSV	--	Unchanged	
Dibromochloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Dichlorodifluoromethane(Freon-12)	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Ethylbenzene	43.0	USEPA 1995 (with UF of 10)	25.0	USEPA 2006b	Unchanged	Maximum HQ <1

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
m- and p-Xylene	135	USEPA 1995	19.0	USEPA 2006b	Unchanged	Not detected
Methyl acetate	NSV	--	NSV	--	Unchanged	
Methylcyclohexane	NSV	--	NSV	--	Unchanged	
Methylene chloride	6,400	USEPA 1995	2,560	USEPA 2001	Unchanged	Maximum HQ <1
Methyl-tert-butyl ether (MTBE)	51,000	Wong et al. 2001	5,000	Buchman 2008	Unchanged	Maximum HQ <1
o-Xylene	135	USEPA 1995	19.0	USEPA 2006b	Unchanged	Maximum HQ <1
Styrene	NSV	--	910	USEPA 2006b	Unchanged	
Tetrachloroethene	450	USEPA 1995	45.0	USEPA 2001	Unchanged	Maximum HQ <1
Toluene	37.0	USEPA 1999a	215	USEPA 2006b	Unchanged	
trans-1,2-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
trans-1,3-Dichloropropene	79.0	USEPA 1995 (with UF of 10)	7.90	USEPA 2001	Unchanged	Not detected
Trichloroethene	200	USEPA 1995 (with UF of 10)	1,940	USEPA 2006b	Unchanged	
Trichlorofluoromethane(Freon-11)	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Vinyl chloride	22,400	USEPA 1995 (with UF of 10)	930	USEPA 2006b	Unchanged	Maximum HQ <1
Xylene, total	135	USEPA 1995	19.0	USEPA 2006b	Unchanged	Maximum HQ <1
Sediment						
Inorganics						
Aluminum	18,000	Buchman 1999	18,000	Buchman 2008	Unchanged	
Antimony	150	USEPA 1995	2.00	Long and Morgan 1990	Unchanged	Mean HQ <1
Arsenic	8.20	USEPA 1995	8.20	Long et al. 1995	Unchanged	
Barium	48.0	Buchman 1999	48.0	Buchman 2008	Unchanged	
Beryllium	NSV	--	NSV	--	Unchanged	
Cadmium	1.20	USEPA 1995	1.20	Long et al. 1995	Unchanged	
Chromium	81.0	USEPA 1995	81.0	Long et al. 1995	Unchanged	
Cobalt	10.0	Buchman 1999	10.0	Buchman 2008	Unchanged	
Copper	34.0	USEPA 1995	34.0	Long et al. 1995	Unchanged	
Cyanide	NSV	--	NSV	--	Unchanged	
Iron	220,000	Buchman 1999	220,000	Buchman 2008	Unchanged	
Lead	46.7	USEPA 1995	46.7	Long et al. 1995	Unchanged	

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Manganese	260	Buchman 1999	260	Buchman 2008	Unchanged	
Mercury	0.15	USEPA 1995	0.15	Long et al. 1995	Unchanged	
Nickel	20.9	USEPA 1995	20.9	Long et al. 1995	Unchanged	
Selenium	1.00	Buchman 1999	1.00	Buchman 2008	Unchanged	
Silver	1.00	USEPA 1995	1.00	Long et al. 1995	Unchanged	
Thallium	NSV	--	NSV	--	Unchanged	
Vanadium	57.0	Buchman 1999	57.0	Buchman 2008	Unchanged	
Zinc	150	USEPA 1995	150	Long et al. 1995	Unchanged	
Pesticide/Polychlorinated Biphenyls						
4,4'-DDD	16.0	USEPA 1995	1.22	MacDonald 1994	Unchanged	Equilibrium-partitioning
4,4'-DDE	2.20	USEPA 1995	2.20	Long et al. 1995	Unchanged	
4,4'-DDT	1.58	USEPA 1995	1.19	MacDonald 1994	Unchanged	Was a COC
Aldrin	9.50	Buchman 1999	9.50	Buchman 2008	Unchanged	
alpha-BHC	6.00	Ontario Ministry of the Environment 1993	1,360	USEPA 2006b	Unchanged	
alpha-Chlordane	7.00	Ontario Ministry of the Environment 1993	2.26	MacDonald 1994	Unchanged	Equilibrium-partitioning
Aroclor-1016	22.7	USEPA 1995	48.0	MacDonald et al. 2000	Unchanged	
Aroclor-1221	22.7	USEPA 1995	48.0	MacDonald et al. 2000	Unchanged	
Aroclor-1232	22.7	USEPA 1995	48.0	MacDonald et al. 2000	Unchanged	
Aroclor-1242	22.7	USEPA 1995	48.0	MacDonald et al. 2000	Unchanged	
Aroclor-1248	22.7	USEPA 1995	48.0	MacDonald et al. 2000	Unchanged	
Aroclor-1254	22.7	USEPA 1995	63.3	CCME 2002	Unchanged	
Aroclor-1260	22.7	USEPA 1995	48.0	MacDonald et al. 2000	Unchanged	
beta-BHC	5.00	Ontario Ministry of the Environment 1993	1,360	alpha-BHC	Unchanged	
delta-BHC	5.00	beta-BHC value	1,360	alpha-BHC	Unchanged	
Dieldrin	0.72	Buchman 1999	0.72	MacDonald 1994	Unchanged	
Endosulfan I	10.0	Chandler and Scott 1991	0.51	USEPA 2008	Unchanged	Frequency of Detection; Magnitude of Mean HQ
Endosulfan II	10.0	Chandler and Scott 1991	2.40	USEPA 2008	Unchanged	Not detected
Endosulfan sulfate	10.0	Chandler and Scott 1991	0.36	USEPA 2006b	Unchanged	Not detected

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Endrin	3.00	Ontario Ministry of the Environment 1993	2.67	USEPA 2006b	Unchanged	Was a COC
Endrin aldehyde	3.00	Endrin value	3.50	USEPA 1996	Unchanged	
Endrin ketone	3.00	Endrin value	3.50	USEPA 1996	Unchanged	
gamma-BHC (Lindane)	3.00	Ontario Ministry of the Environment 1993	0.32	MacDonald 1994	Unchanged	Not detected
gamma-Chlordane	7.00	Ontario Ministry of the Environment 1993	2.26	MacDonald 1994	Unchanged	Equilibrium-partitioning
Heptachlor	5.00	Heptachlor epoxide value	0.30	Buchman 2008	Unchanged	Not detected
Heptachlor epoxide	5.00	Ontario Ministry of the Environment 1993	NSV	--	Unchanged	Not detected
Methoxychlor	NSV	--	29.6	USEPA 2006b	Unchanged	Not detected
Toxaphene	NSV	--	540	USEPA 2008	Unchanged	Not detected
Semivolatile Organic Compounds						
1,1-Biphenyl	260	Barrick et al. 1988	NSV	--	Unchanged	ESVs for other SVOCs
2,4,5-Trichlorophenol	NSV	--	819	USEPA 2006b	Unchanged	Not detected
2,4,6-Trichlorophenol	NSV	--	2,647	USEPA 2006b	Unchanged	Not detected
2,4-Dichlorophenol	NSV	--	NSV	--	Unchanged	
2,4-Dimethylphenol	29.0	USEPA 1995	29.0	Washington State 1995	Unchanged	
2,4-Dinitrophenol	NSV	--	NSV	--	Unchanged	
2,4-Dinitrotoluene	NSV	--	3,184	NAVFAC 2007	Unchanged	Not detected
2,6-Dinitrotoluene	NSV	--	549	Nipper et al. 2002	Unchanged	Not detected
2-Chloronaphthalene	NSV	--	NSV	--	Unchanged	
2-Chlorophenol	NSV	--	344	USEPA 2006b	Unchanged	Not detected
2-Methylnaphthalene	70.0	USEPA 1995	70.0	Long et al. 1995	Unchanged	
2-Methylphenol	63.0	USEPA 1995	63.0	Washington State 1995	Unchanged	
2-Nitroaniline	NSV	--	NSV	--	Unchanged	
2-Nitrophenol	NSV	--	NSV	--	Unchanged	
3,3'-Dichlorobenzidine	NSV	--	2,060	USEPA 2006b	Unchanged	Not detected
3-Nitroaniline	NSV	--	NSV	--	Unchanged	
4,6-Dinitro-2-methylphenol	NSV	--	NSV	--	Unchanged	
4-Bromophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Chloro-3-methylphenol	NSV	--	NSV	--	Unchanged	

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
4-Chloroaniline	NSV	--	NSV	--	Unchanged	
4-Chlorophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Methylphenol	670	USEPA 1995	670	Washington State 1995	Unchanged	
4-Nitroaniline	NSV	--	NSV	--	Unchanged	
4-Nitrophenol	NSV	--	NSV	--	Unchanged	
Acenaphthene	16.0	USEPA 1995	16.0	Long et al. 1995	Unchanged	
Acenaphthylene	44.0	USEPA 1995	44.0	Long et al. 1995	Unchanged	
Acetophenone	NSV	--	NSV	--	Unchanged	
Anthracene	85.3	USEPA 1995	85.3	Long et al. 1995	Unchanged	
Atrazine	NSV	--	NSV	--	Unchanged	
Benzaldehyde	NSV	--	NSV	--	Unchanged	
Benzo(a)anthracene	261	USEPA 1995	261	Long et al. 1995	Unchanged	
Benzo(a)pyrene	430	USEPA 1995	430	Long et al. 1995	Unchanged	
Benzo(b)fluoranthene	3,200	USEPA 1995	1,800	Buchman 2008	Unchanged	Maximum HQ <1
Benzo(g,h,i)perylene	670	USEPA 1995	670	Buchman 2008	Unchanged	
Benzo(k)fluoranthene	1,800	Buchman 1999	1,800	Buchman 2008	Unchanged	
Bis(2-chloro-1-methylethyl) ether	NSV	--	NSV	--	Unchanged	
bis(2-Chloroethoxy)methane	NSV	--	NSV	--	Unchanged	
bis(2-Chloroethyl)ether	NSV	--	NSV	--	Unchanged	
bis(2-Ethylhexyl)phthalate	1,300	USEPA 1995	182	MacDonald 1994	Unchanged	Equilibrium-partitioning
Butylbenzylphthalate	63.0	USEPA 1995	63.0	Buchman 2008	Unchanged	
Caprolactam	NSV	--	NSV	--	Unchanged	
Carbazole	1,800	Cubbage et al. 1997	1,800	Cubbage et al. 1997	Unchanged	
Chrysene	384	USEPA 1995	384	Long et al. 1995	Unchanged	
Dibenz(a,h)anthracene	63.4	USEPA 1995	63.4	Long et al. 1995	Unchanged	
Dibenzofuran	540	USEPA 1995	110	Buchman 2008	Unchanged	Equilibrium-partitioning
Diethylphthalate	200	USEPA 1995	218	USEPA 2006b	Unchanged	
Dimethyl phthalate	71.0	USEPA 1995	530	Washington State 1995	Unchanged	
Di-n-butylphthalate	1,400	USEPA 1995	58.0	Buchman 2008	Unchanged	Equilibrium-partitioning

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Di-n-octylphthalate	6,200	USEPA 1995	61.0	Buchman 2008	Unchanged	Equilibrium-partitioning
Fluoranthene	600	USEPA 1995	600	Long et al. 1995	Unchanged	
Fluorene	19.0	USEPA 1995	19.0	Long et al. 1995	Unchanged	
Hexachlorobenzene	22.0	USEPA 1995	3.80	Washington State 1995	Unchanged	Not detected
Hexachlorobutadiene	11.0	USEPA 1995	39.0	Washington State 1995	Unchanged	
Hexachlorocyclopentadiene	NSV	--	139	USEPA 2006b	Unchanged	Not detected
Hexachloroethane	NSV	--	73.0	Buchman 2008	Unchanged	Not detected
Indeno(1,2,3-cd)pyrene	600	USEPA 1995	600	Buchman 2008	Unchanged	
Isophorone	NSV	--	NSV	--	Unchanged	
Naphthalene	160	USEPA 1995	160	Long et al. 1995	Unchanged	
Nitrobenzene	NSV	--	21.0	Buchman 2008	Unchanged	Not detected
n-Nitroso-di-n-propylamine	NSV	--	NSV	--	Unchanged	
n-Nitrosodiphenylamine	28.0	USEPA 1995	28.0	Buchman 2008	Unchanged	
PAH (total)	4,022	Buchman 1999	4,022	Long et al. 1995	Unchanged	
Pentachlorophenol	360	USEPA 1995	360	Washington State 1995	Unchanged	
Phenanthrene	240	USEPA 1995	240	Long et al. 1995	Unchanged	
Phenol	420	USEPA 1995	420	Washington State 1995	Unchanged	
Pyrene	665	USEPA 1995	665	Long et al. 1995	Unchanged	
Volatile Organic Compounds						
1,1,1-Trichloroethane	31.0	USEPA 1995	856	USEPA 2006b	Unchanged	
1,1,2,2-Tetrachloroethane	NSV	--	202	USEPA 2006b	Unchanged	Maximum HQ <1
1,1,2-Trichloroethane	31.0	USEPA 1995	570	USEPA 2006b	Unchanged	
1,1-Dichloroethane	NSV	--	NSV	--	Unchanged	
1,1-Dichloroethene	NSV	--	2,782	USEPA 2006b	Unchanged	Maximum HQ <1
1,2,4-Trichlorobenzene	40.0	USEPA 1995	473	USEPA 2006b	Unchanged	
1,2-Dichlorobenzene	35.0	USEPA 1995	989	USEPA 2006b	Unchanged	
1,2-Dichloroethane	NSV	--	NSV	--	Unchanged	
1,2-Dichloroethene (total)	NSV	--	NSV	--	Unchanged	
1,2-Dichloropropane	NSV	--	NSV	--	Unchanged	

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1,3-Dichlorobenzene	NSV	--	842	USEPA 2006b	Unchanged	Not detected
1,4-Dichlorobenzene	110	USEPA 1995	110	Buchman 2008	Unchanged	
2-Butanone	NSV	--	NSV	--	Unchanged	
2-Hexanone	NSV	--	NSV	--	Unchanged	
4-Methyl-2-pentanone	NSV	--	NSV	--	Unchanged	
Acetone	NSV	--	NSV	--	Unchanged	
Benzene	NSV	--	137	USEPA 2006b	Unchanged	Maximum HQ <1
Bromodichloromethane	NSV	--	NSV	--	Unchanged	
Bromoform	NSV	--	1,308	USEPA 2006b	Unchanged	Maximum HQ <1
Bromomethane	NSV	--	NSV	--	Unchanged	
Carbon disulfide	NSV	--	NSV	--	Unchanged	
Carbon tetrachloride	NSV	--	7,244	USEPA 2006b	Unchanged	Maximum HQ <1
Chlorobenzene	NSV	--	162	USEPA 2006b	Unchanged	Maximum HQ <1
Chloroethane	NSV	--	NSV	--	Unchanged	
Chloroform	NSV	--	NSV	--	Unchanged	
Chloromethane	NSV	--	NSV	--	Unchanged	
cis-1,3-Dichloropropene	NSV	--	7.31	USEPA 2006b	Unchanged	Not detected
Dibromochloromethane	NSV	--	NSV	--	Unchanged	
Ethylbenzene	10.0	USEPA 1995	305	USEPA 2006b	Unchanged	
Methylene chloride	NSV	--	NSV	--	Unchanged	
Styrene	NSV	--	7,069	USEPA 2006b	Unchanged	Maximum HQ <1
Tetrachloroethene	57.0	USEPA 1995	57.0	Buchman 2008	Unchanged	
Toluene	NSV	--	1,086	USEPA 2006b	Unchanged	Maximum HQ <1
trans-1,3-Dichloropropene	NSV	--	7.31	USEPA 2006b	Unchanged	Not detected
Trichloroethene	41.0	Buchman 1999	41.0	Buchman 2008	Unchanged	
Vinyl chloride	NSV	--	NSV	--	Unchanged	
Xylene, total	40.0	USEPA 1995	NSV	--	Unchanged	Not detected

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Surface Soil						
Inorganics						
Aluminum	50.0	Efroymson et al. 1997a	pH < 5.5	USEPA 2003a	Unchanged	Background
Antimony	5.00	Efroymson et al. 1997a	78.0	USEPA 2005a	Unchanged	
Arsenic	60.0	Efroymson et al. 1997b	18.0	USEPA 2005b	Unchanged	Maximum HQ <1
Barium	500	Efroymson et al. 1997a	330	USEPA 2005c	Unchanged	Maximum HQ <1
Beryllium	10.0	Efroymson et al. 1997a	40.0	USEPA 2005d	Unchanged	
Cadmium	4.00	Efroymson et al. 1997a	32.0	USEPA 2005e	Unchanged	
Chromium	0.40	Efroymson et al. 1997b	64.0	CCME 2007	Unchanged	
Cobalt	100	USEPA 1995	13.0	USEPA 2005f	Unchanged	Maximum HQ <1
Copper	50.0	Efroymson et al. 1997b	70.0	USEPA 2007a	Unchanged	
Cyanide	27.5	MHSPE 1994	15.8	MHSPE 2000	Unchanged	Maximum HQ <1
Iron	200	Efroymson et al. 1997b	5 < pH > 8	USEPA 2003b	Unchanged	Background
Lead	50.0	Efroymson et al. 1997a	120	USEPA 2005g	Unchanged	
Manganese	500	Efroymson et al. 1997a	220	USEPA 2007b	Unchanged	Mean HQ <1
Mercury	0.10	Efroymson et al. 1997b	0.10	Efroymson et al. 1997b	Unchanged	
Nickel	30.0	Efroymson et al. 1997a	38.0	USEPA 2007c	Unchanged	
Selenium	1.80	USEPA 1995	0.52	USEPA 2007d	Unchanged	Mean HQ <1
Silver	2.00	Efroymson et al. 1997a	560	USEPA 2006a	Unchanged	
Thallium	1.00	Efroymson et al. 1997a	1.00	Efroymson et al. 1997a	Unchanged	
Vanadium	2.00	Efroymson et al. 1997a	130	CCME 2007	Unchanged	
Zinc	50.0	Efroymson et al. 1997a	120	USEPA 2007e	Unchanged	
Pesticide/Polychlorinated Biphenyls						
4,4'-DDD	100	USEPA 1995	583	MHSPE 2000; 2001	Unchanged	
4,4'-DDE	100	USEPA 1995	114	MHSPE 2000; 2001	Unchanged	
4,4'-DDT	100	USEPA 1995	100	MHSPE 2000; 2001	Unchanged	
Aldrin	100	USEPA 1995	3.63	MHSPE 2000; 2001	Unchanged	Not detected
alpha-BHC	100,000	USEPA 1995	226	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
alpha-Chlordane	100	USEPA 1995	11.0	MHSPE 2000	Unchanged	Mean HQ <1

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Aroclor-1016	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1221	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1232	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1242	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1248	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1254	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1260	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
beta-BHC	100,000	USEPA 1995	342	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
delta-BHC	100,000	USEPA 1995	226	alpha-BHC	Unchanged	Maximum HQ <1
Dieldrin	100	USEPA 1995	10.5	MHSPE 2000; 2001	Unchanged	Not detected
Endosulfan I	NSV	--	6.32	MHSPE 2000	Unchanged	Not detected
Endosulfan II	NSV	--	6.32	MHSPE 2000	Unchanged	Not detected
Endosulfan sulfate	NSV	--	6.32	Endosulfan	Unchanged	Not detected
Endrin	100	USEPA 1995	1.95	MHSPE 2000; 2001	Unchanged	Not detected
Endrin aldehyde	100	USEPA 1995	1.95	Endrin	Unchanged	Not detected
Endrin ketone	100	USEPA 1995	1.95	Endrin	Unchanged	Not detected
gamma-BHC (Lindane)	100	USEPA 1995	7.75	MHSPE 2000; 2001	Unchanged	Not detected
gamma-Chlordane	100	USEPA 1995	11.0	MHSPE 2000	Unchanged	Mean HQ <1
Heptachlor	100	Heptachlor epoxide value	52.9	MHSPE 2000	Unchanged	Maximum HQ <1
Heptachlor epoxide	100	USEPA 1995	52.9	Heptachlor	Unchanged	Maximum HQ <1
Methoxychlor	100	USEPA 1995	500	Beyer 1990	Unchanged	
Toxaphene	NSV	--	500	Beyer 1990	Unchanged	Not detected
Semivolatile Organic Compounds						
1,1-Biphenyl	6,800	Efroymson et al. 1997a	13,600	Efroymson et al. 1997a	Unchanged	
2,4,5-Trichlorophenol	430	Efroymson et al. 1997a	1,350	Efroymson et al. 1997a	Unchanged	
2,4,6-Trichlorophenol	580	Efroymson et al. 1997b	580	Efroymson et al. 1997b	Unchanged	
2,4-Dichlorophenol	13,400	Efroymson et al. 1997b	500	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
2,4-Dimethylphenol	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
2,4-Dinitrophenol	20,000	Efroymson et al. 1997a	20,000	Efroymson et al. 1997a	Unchanged	

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2,4-Dinitrotoluene	NSV	--	11,000	NRCC 2006	Unchanged	Maximum HQ <1
2,6-Dinitrotoluene	NSV	--	8,500	NRCC 2006	Unchanged	Maximum HQ <1
2-Chloronaphthalene	1,033	MHSPE 1994	LMW PAH	--	Unchanged	Maximum HQ <1
2-Chlorophenol	100	USEPA 1995	500	Beyer 1990; CCME 2007	Unchanged	
2-Methylnaphthalene	NSV	--	LMW PAH	--	Unchanged	Maximum HQ <1
2-Methylphenol	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
2-Nitroaniline	NSV	--	NSV	--	Unchanged	
2-Nitrophenol	NSV	--	1,000	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
3,3'-Dichlorobenzidine	NSV	--	NSV	--	Unchanged	
3-Nitroaniline	NSV	--	NSV	--	Unchanged	
4,6-Dinitro-2-methylphenol	NSV	--	1,000	Beyer 1990; CCME 2007	Unchanged	Not detected
4-Bromophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Chloro-3-methylphenol	NSV	--	500	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
4-Chloroaniline	NSV	--	500	MHSPE 2000	Unchanged	Maximum HQ <1
4-Chlorophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Methylphenol	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
4-Nitroaniline	NSV	--	NSV	--	Unchanged	
4-Nitrophenol	380	Efroymson et al. 1997b	380	Efroymson et al. 1997b	Unchanged	
Acenaphthene	2,500	Efroymson et al. 1997a	LMW PAH	--	Unchanged	Maximum HQ <1
Acenaphthylene	100	USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Acetophenone	NSV	--	NSV	--	Unchanged	
Anthracene	100	USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Atrazine	NSV	--	11.9	MHSPE 2000; 2001	Unchanged	Not detected
Benzaldehyde	NSV	--	NSV	--	Unchanged	
Benzo(a)anthracene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(a)pyrene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(b)fluoranthene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(g,h,i)perylene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(k)fluoranthene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1

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Bis(2-chloro-1-methylethyl) ether	NSV	--	NSV	--	Unchanged	
bis(2-Chloroethoxy)methane	NSV	--	NSV	--	Unchanged	
bis(2-Chloroethyl)ether	NSV	--	NSV	--	Unchanged	
bis(2-Ethylhexyl)phthalate	10,000	IPCS 1992	30,000	CCME 2007	Unchanged	
Butylbenzylphthalate	NSV	--	30,000	CCME 2007	Unchanged	Maximum HQ <1
Caprolactam	NSV	--	NSV	--	Unchanged	
Carbazole	NSV	--	NSV	--	Unchanged	
Chrysene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Dibenz(a,h)anthracene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Dibenzofuran	NSV	--	NSV	--	Unchanged	
Diethylphthalate	13,400	Efroymson et al. 1997a	26,800	Efroymson et al. 1997a	Unchanged	
Dimethyl phthalate	10,640	Efroymson et al. 1997b	10,640	Efroymson et al. 1997b	Unchanged	
Di-n-butylphthalate	200,000	Efroymson et al. 1997a	40,000	Efroymson et al. 1997a	Unchanged	Maximum HQ <1
Di-n-octylphthalate	NSV	--	30,000	CCME 2007	Unchanged	Maximum HQ <1
Fluoranthene	100	USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Fluorene	1,700	Efroymson et al. 1997b	LMW PAH	--	Unchanged	Maximum HQ <1
Hexachlorobenzene	NSV	--	1,000	Beyer 1990	Unchanged	Maximum HQ <1
Hexachlorobutadiene	NSV	--	NSV	--	Unchanged	
Hexachlorocyclopentadiene	1,000	Efroymson et al. 1997a	2,000	Efroymson et al. 1997a	Unchanged	
Hexachloroethane	NSV	--	NSV	--	Unchanged	
Indeno(1,2,3-cd)pyrene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Isophorone	NSV	--	NSV	--	Unchanged	
Naphthalene	100	USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Nitrobenzene	2,260	Efroymson et al. 1997b	2,260	Efroymson et al. 1997b	Unchanged	
n-Nitroso-di-n-propylamine	NSV	--	NSV	--	Unchanged	
n-Nitrosodiphenylamine	1,090	Efroymson et al. 1997b	1,090	Efroymson et al. 1997b	Unchanged	
PAH (total)	4,100	MHSPE 1994	18,000	USEPA 2007f	Unchanged	Lower of HMW and LMW PAH ESVs
Pentachlorophenol	3,000	Efroymson et al. 1997a	5,000	USEPA 2007g	Unchanged	

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Phenanthrene	100	USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Phenol	1,880	Efroymson et al. 1997b	1,880	Efroymson et al. 1997b	Unchanged	
Pyrene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Volatile Organic Compounds						
1,1,1-Trichloroethane	300	USEPA 1995	1,025	MHSPE 2000	Unchanged	
1,1,2,2-Tetrachloroethane	300	USEPA 1995	5,000	Beyer 1990; CCME 2007	Unchanged	
1,1,2-Trichloroethane	300	USEPA 1995	2,000	MHSPE 2000	Unchanged	
1,1-Dichloroethane	300	USEPA 1995	548	MHSPE 2000	Unchanged	
1,1-Dichloroethene	NSV	--	173	MHSPE 2000	Unchanged	Maximum HQ <1
1,2,4-Trichlorobenzene	1,270	Efroymson et al. 1997b	1,270	Efroymson et al. 1997b	Unchanged	
1,2-Dichlorobenzene	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
1,2-Dichloroethane	401	MHSPE 1994	2,190	MHSPE 2000; 2001	Unchanged	
1,2-Dichloroethene (total)	300	USEPA 1995	447	MHSPE 2000	Unchanged	
1,2-Dichloropropane	38,800	Efroymson et al. 1997b	38,800	Efroymson et al. 1997b	Unchanged	
1,3-Dichlorobenzene	NSV	--	1,000	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
1,4-Dichlorobenzene	1,280	Efroymson et al. 1997b	1,280	Efroymson et al. 1997b	Unchanged	
2-Butanone	NSV	--	NSV	--	Unchanged	
2-Hexanone	NSV	--	NSV	--	Unchanged	
4-Methyl-2-pentanone	10,000	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Acetone	NSV	--	NSV	--	Unchanged	
Benzene	105	MHSPE 1994	1,140	MHSPE 2000; 2001	Unchanged	
Bromodichloromethane	45,000	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Bromoform	114,700	USEPA 1995 (with UF of 10)	300	CCME 2007	Unchanged	Maximum HQ <1
Bromomethane	NSV	--	NSV	--	Unchanged	
Carbon disulfide	NSV	--	NSV	--	Unchanged	
Carbon tetrachloride	1,000,000	Efroymson et al. 1997b	3,400	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Chlorobenzene	2,400	Efroymson et al. 1997b	2,400	Efroymson et al. 1997b	Unchanged	
Chloroethane	NSV	--	5,000	CCME 2007	Unchanged	Maximum HQ <1
Chloroform	1,000	MHSPE 1994	1,844	MHSPE 2000; 2001	Unchanged	

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Chloromethane	NSV	--	5,000	CCME 2007	Unchanged	Maximum HQ <1
cis-1,3-Dichloropropene	300	USEPA 1995	5,000	Beyer 1990; CCME 2007	Unchanged	
Dibromochloromethane	NSV	--	NSV	--	Unchanged	
Ethylbenzene	5,005	MHSPE 1994	1,815	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Methylene chloride	1,001	MHSPE 1994	1,250	MHSPE 2000; 2001	Unchanged	
Styrene	10,010	MHSPE 1994	64,000	Efroymson et al. 1997a	Unchanged	
Tetrachloroethene	401	MHSPE 1994	179	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Toluene	13,005	MHSPE 1994	40,000	Efroymson et al. 1997a	Unchanged	
trans-1,3-Dichloropropene	300	USEPA 1995	5,000	Beyer 1990; CCME 2007	Unchanged	
Trichloroethene	6,000	MHSPE 1994	500	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Vinyl chloride	300	USEPA 1995	412	MHSPE 2000; 2001	Unchanged	
Xylene, total	2,505	MHSPE 1994	1,300	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Groundwater						
Inorganics						
Aluminum	87.0	USEPA 1999b	87.0	USEPA 2009	Unchanged	
Antimony	500	USEPA 1995	500	USEPA 2006b	Unchanged	
Arsenic	36.0	USEPA 2002	36.0	USEPA 2009	Unchanged	
Barium	1,000	USEPA 1995 (with UF of 10)	200	Buchman 2008	Unchanged	Maximum HQ <1
Beryllium	1,500	USEPA 1995	100	Buchman 2008	Unchanged	Maximum HQ <1
Cadmium	8.85	USEPA 2002	8.85	USEPA 2009	Unchanged	
Chromium	50.4	USEPA 2002	50.4	USEPA 2009	Unchanged	
Cobalt	23.0	Suter and Tsao 1996	23.0	Suter and Tsao 1996	Unchanged	
Copper	3.70	USEPA 2002	3.73	USEPA 2009	Unchanged	
Cyanide	1.00	USEPA 1995	1.00	USEPA 2009	Unchanged	
Iron	1,000	USEPA 2002	1,000	USEPA 2009	Unchanged	
Lead	8.50	USEPA 2002	8.52	USEPA 2009	Unchanged	
Manganese	10.0	USEPA 1995	100	Buchman 2008	Unchanged	
Mercury	1.10	USEPA 2002	1.11	USEPA 2009	Unchanged	
Nickel	8.30	USEPA 2002	8.28	USEPA 2009	Unchanged	

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Selenium	71.1	USEPA 2002	71.1	USEPA 2009	Unchanged	
Silver	0.92	Buchman 1999	0.23	USEPA 2001	Unchanged	Dissolved silver
Thallium	213	USEPA 1995 (with UF of 10)	21.3	USEPA 2001	Unchanged	Mean HQ <1
Vanadium	10,000	USEPA 1995	50.0	Buchman 2008	Unchanged	Maximum HQ <1
Zinc	86.0	USEPA 2002	85.6	USEPA 2009	Unchanged	
Dissolved Metals						
Aluminum	87.0	USEPA 1999b	87.0	USEPA 2009	Unchanged	
Antimony	500	USEPA 1995	500	USEPA 2006b	Unchanged	
Arsenic	36.0	USEPA 2002	36.0	USEPA 2009	Unchanged	
Barium	1,000	USEPA 1995 (with UF of 10)	200	Buchman 2008	Unchanged	Maximum HQ <1
Beryllium	1,500	USEPA 1995	100	Buchman 2008	Unchanged	Maximum HQ <1
Cadmium	8.80	USEPA 2002	8.80	USEPA 2009	Unchanged	
Chromium	50.0	USEPA 2002	50.0	USEPA 2009	Unchanged	
Cobalt	23.0	Suter and Tsao 1996	23.0	Suter and Tsao 1996	Unchanged	
Copper	3.10	USEPA 2002	3.10	USEPA 2009	Unchanged	
Iron	1,000	USEPA 2002	1,000	USEPA 2009	Unchanged	
Lead	8.10	USEPA 2002	8.10	USEPA 2009	Unchanged	
Manganese	10.0	USEPA 1995	100	Buchman 2008	Unchanged	
Mercury	0.94	USEPA 2002	0.94	USEPA 2009	Unchanged	
Nickel	8.20	USEPA 2002	8.20	USEPA 2009	Unchanged	
Selenium	71.0	USEPA 2002	71.0	USEPA 2009	Unchanged	
Silver	0.92	Buchman 1999	0.23	USEPA 2001	Unchanged	Not detected
Thallium	213	USEPA 1995 (with UF of 10)	21.3	USEPA 2001	Unchanged	Mean HQ <1
Vanadium	10,000	USEPA 1995	50.0	Buchman 2008	Unchanged	Maximum HQ <1
Zinc	81.0	USEPA 2002	81.0	USEPA 2009	Unchanged	

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Pesticide/Polychlorinated Biphenyls						
4,4'-DDD	0.025	USEPA 1999a	0.025	USEPA 2001	Unchanged	
4,4'-DDE	1.40	USEPA 1995 (with UF of 10)	0.14	USEPA 2001	Unchanged	Maximum HQ <1
4,4'-DDT	0.001	USEPA 1995	0.0065	USEPA 2006b	Unchanged	
Aldrin	0.13	USEPA 1995 (with UF of 10)	0.13	USEPA 2001	Unchanged	
alpha-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	USEPA 2006b	Unchanged	
alpha-Chlordane	0.004	USEPA 1995	0.004	USEPA 2009	Unchanged	
Aroclor-1016	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1221	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1232	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1242	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1248	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1254	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1260	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
beta-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	alpha-BHC	Unchanged	
delta-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	alpha-BHC	Unchanged	
Dieldrin	0.11	USEPA 1996	0.11	USEPA 1996	Unchanged	
Endosulfan I	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endosulfan II	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endosulfan sulfate	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endrin	0.01	USEPA 1996	0.01	USEPA 1996	Unchanged	
Endrin aldehyde	0.01	USEPA 1996	0.01	Endrin	Unchanged	
Endrin ketone	0.01	USEPA 1996	0.01	Endrin	Unchanged	
gamma-BHC (Lindane)	0.016	USEPA 1995 (with UF of 10)	0.016	USEPA 2001	Unchanged	
gamma-Chlordane	0.004	USEPA 1995	0.004	USEPA 2009	Unchanged	
Heptachlor	0.0036	USEPA 1995	0.0036	USEPA 2009	Unchanged	
Heptachlor epoxide	0.0036	USEPA 1995	0.0036	USEPA 2009	Unchanged	
Methoxychlor	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Toxaphene	0.21	USEPA 1996	0.21	USEPA 1996	Unchanged	

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Semivolatile Organic Compounds						
1,1-Biphenyl	NSV	--	NSV	--	Unchanged	
2,4,5-Trichlorophenol	11.0	USEPA 1995	12.0	USEPA 2006b	Unchanged	
2,4,6-Trichlorophenol	NSV	--	61.0	USEPA 2006b	Unchanged	Maximum HQ <1
2,4-Dichlorophenol	NSV	--	NSV	--	Unchanged	
2,4-Dimethylphenol	110	Federal Register 59:3762 (1994)	100	Buchman 2008	Unchanged	Maximum HQ <1
2,4-Dinitrophenol	485	USEPA 1995 (with UF of 10)	48.5	USEPA 2001	Unchanged	Maximum HQ <1
2,4-Dinitrotoluene	370	USEPA 1995	480	Nipper et al. 2001	Unchanged	
2,6-Dinitrotoluene	NSV	--	1,000	Nipper et al. 2001	Unchanged	Maximum HQ <1
2-Chloronaphthalene	0.75	USEPA 1995 (with UF of 10)	0.40	Buchman 2008	Unchanged	Not detected
2-Chlorophenol	NSV	--	265	USEPA 2006b	Unchanged	Maximum HQ <1
2-Methylnaphthalene	30.0	USEPA 1995 (with UF of 10)	330	Buchman 2008	Unchanged	
2-Methylphenol	NSV	--	1,020	USEPA 2006b	Unchanged	Maximum HQ <1
2-Nitroaniline	NSV	--	NSV	--	Unchanged	
2-Nitrophenol	485	USEPA 1994	2,940	USEPA 2006b	Unchanged	
3,3'-Dichlorobenzidine	NSV	--	73.0	USEPA 2006b	Unchanged	Maximum HQ <1
3-Nitroaniline	NSV	--	NSV	--	Unchanged	
4,6-Dinitro-2-methylphenol	NSV	--	NSV	--	Unchanged	
4-Bromophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Chloro-3-methylphenol	NSV	--	NSV	--	Unchanged	
4-Chloroaniline	129	Buchman 1999	129	Buchman 2008	Unchanged	
4-Chlorophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Methylphenol	13.0	Suter and Tsao 1996 (for 2-methylphenol)	543	USEPA 2006b	Unchanged	
4-Nitroaniline	NSV	--	NSV	--	Unchanged	
4-Nitrophenol	485	USEPA 1995 (with UF of 10)	71.7	USEPA 2001	Unchanged	Maximum HQ <1
Acenaphthene	710	USEPA 1995	40.0	USEPA 1996	Unchanged	Maximum HQ <1
Acenaphthylene	30.0	USEPA 1995 (with UF of 10)	4,840	Buchman 2008	Unchanged	
Acetophenone	NSV	--	NSV	--	Unchanged	
Anthracene	30.0	USEPA 1995 (with UF of 10)	0.18	USEPA 2006b	Unchanged	Not detected

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Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Atrazine	NSV	--	10.0	Buchman 2008	Unchanged	
Benzaldehyde	NSV	--	NSV	--	Unchanged	
Benzo(a)anthracene	8.13	USEPA 1995	0.027	Suter and Tsao 1996	Unchanged	Not detected
Benzo(a)pyrene	0.021	USEPA 1995 (with UF of 10)	0.014	Suter and Tsao 1996	Unchanged	Not detected
Benzo(b)fluoranthene	30.0	USEPA 1995 (with UF of 10)	9.07	Buchman 2008	Unchanged	Not detected
Benzo(g,h,i)perylene	30.0	USEPA 1995 (with UF of 10)	7.64	Buchman 2008	Unchanged	Not detected
Benzo(k)fluoranthene	30.0	USEPA 1995 (with UF of 10)	9.07	Benzo(b)fluoranthene value	Unchanged	Not detected
Bis(2-chloro-1-methylethyl) ether	NSV	--	NSV	--	Unchanged	
bis(2-Chloroethoxy)methane	6,400	USEPA 1995	6,400	Buchman 2008	Unchanged	
bis(2-Chloroethyl)ether	NSV	--	NSV	--	Unchanged	
bis(2-Ethylhexyl)phthalate	360	USEPA 1995	360	Buchman 2008	Unchanged	
Butylbenzylphthalate	29.4	USEPA 1999a	29.4	USEPA 2001	Unchanged	
Caprolactam	NSV	--	NSV	--	Unchanged	
Carbazole	NSV	--	NSV	--	Unchanged	
Chrysene	30.0	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Dibenz(a,h)anthracene	30.0	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Dibenzofuran	NSV	--	65.0	USEPA 2006b	Unchanged	Maximum HQ <1
Diethylphthalate	75.9	USEPA 1999a	75.9	USEPA 2001	Unchanged	
Dimethyl phthalate	580	USEPA 1999a	580	USEPA 2001	Unchanged	
Di-n-butylphthalate	3.40	USEPA 1995	3.40	USEPA 2001	Unchanged	
Di-n-octylphthalate	3.40	USEPA 1995	3.40	Buchman 2008	Unchanged	
Fluoranthene	16.0	USEPA 1995	11.0	USEPA 1996	Unchanged	Not detected
Fluorene	30.0	USEPA 1995 (with UF of 10)	3.90	USEPA 1996	Unchanged	Not detected
Hexachlorobenzene	129	USEPA 1995	3.68	Buchman 2008	Unchanged	Frequency of Detection
Hexachlorobutadiene	3.20	USEPA 1995 (with UF of 10)	0.32	USEPA 2001	Unchanged	Frequency of Detection
Hexachlorocyclopentadiene	0.70	USEPA 1995 (with UF of 10)	0.07	USEPA 2001	Unchanged	Not detected
Hexachloroethane	94.0	USEPA 1995 (with UF of 10)	9.40	USEPA 2001	Unchanged	Maximum HQ <1
Indeno(1,2,3-cd)pyrene	30.0	USEPA 1995 (with UF of 10)	4.31	Buchman 2008	Unchanged	Not detected

Table 4-7

Comparison Between Prior Ecological Screening Values (2004) and 2013 Ecological Screening Values - Site 7

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Isophorone	1,290	USEPA 1995 (with UF of 10)	129	USEPA 2001	Unchanged	Maximum HQ <1
Naphthalene	230	USEPA 1995 (with UF of 10)	23.5	USEPA 2001	Unchanged	Maximum HQ <1
Nitrobenzene	668	USEPA 1995 (with UF of 10)	66.8	USEPA 2001	Unchanged	Maximum HQ <1
n-Nitroso-di-n-propylamine	NSV	--	120	USEPA 2006b	Unchanged	Maximum HQ <1
n-Nitrosodiphenylamine	330,000	USEPA 1995 (with UF of 10)	33,000	USEPA 2001	Unchanged	Maximum HQ <1
Pentachlorophenol	7.90	USEPA 1995	7.90	USEPA 2009	Unchanged	
Phenanthrene	4.60	USEPA 1995	8.30	USEPA 1996	Unchanged	
Phenol	580	USEPA 1995 (with UF of 10)	58.0	USEPA 2001	Unchanged	Maximum HQ <1
Pyrene	30.0	USEPA 1995 (with UF of 10)	0.24	USEPA 2006b	Unchanged	Not detected
Volatile Organic Compounds						
1,1,1,2-Tetrachloroethane	623	USEPA 1995 (with UF of 10)	90.2	1,1,2,2-Tetrachloroethane	Unchanged	Maximum HQ <1
1,1,1-Trichloroethane	3,120	USEPA 1995 (with UF of 10)	312	USEPA 2001	Unchanged	Maximum HQ <1
1,1,2,2-Tetrachloroethane	623	USEPA 1995 (with UF of 10)	90.2	USEPA 2001	Unchanged	Maximum HQ <1
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-1	6,400	USEPA 1995 (for trichlorofluoromethane)	NSV	--	Unchanged	Not detected
1,1,2-Trichloroethane	3,120	USEPA 1995 (with UF of 10)	550	USEPA 2006b	Unchanged	Maximum HQ <1
1,1-Dichloroethane	3,200	USEPA 1995 (with UF of 100)	47.0	Suter and Tsao 1996	Unchanged	Maximum HQ <1
1,1-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	2,240	USEPA 2001	Unchanged	Maximum HQ <1
1,2,3-Trichloropropane	NSV	--	NSV	--	Unchanged	
1,2,4-Trichlorobenzene	129	USEPA 1995	5.40	USEPA 2006b	Unchanged	Not detected
1,2-Dibromo-3-chloropropane	NSV	--	NSV	--	Unchanged	
1,2-Dibromoethane	NSV	--	NSV	--	Unchanged	
1,2-Dichlorobenzene	129	USEPA 1995	42.0	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dichloroethane	1,130	USEPA 1995 (with UF of 100)	1,130	USEPA 2001	Unchanged	
1,2-Dichloroethene (total)	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dichloropropane	3,040	USEPA 1995	2,400	USEPA 2001	Unchanged	Maximum HQ <1
1,3-Dichlorobenzene	129	USEPA 1994	28.5	USEPA 2001	Unchanged	Maximum HQ <1
1,4-Dichlorobenzene	129	USEPA 1995	19.9	USEPA 2001	Unchanged	Maximum HQ <1
2-Butanone	14,000	Suter and Tsao 1996	14,000	Suter and Tsao 1996	Unchanged	
2-Hexanone	NSV	--	NSV	--	Unchanged	

Table 4-7

Comparison Between Prior Ecological Screening Values (2004) and 2013 Ecological Screening Values - Site 7

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
4-Methyl-2-pentanone	NSV	--	123,000	USEPA 2006b	Unchanged	Maximum HQ <1
Acetone	1,500	Suter and Tsao 1996	564,000	USEPA 2006b	Unchanged	
Acrylonitrile	NSV	--	NSV	--	Unchanged	
Benzene	700	USEPA 1995	110	USEPA 2006b	Unchanged	Maximum HQ <1
Bromochloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Bromodichloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Bromoform	640	USEPA 1999a	640	USEPA 2001	Unchanged	
Bromomethane	120	USEPA 1999a	120	USEPA 2001	Unchanged	
Carbon disulfide	2.00	USEPA 1995	0.92	Suter and Tsao 1996	Unchanged	Mean HQ <1 (with dilution)
Carbon tetrachloride	5,000	USEPA 1995 (with UF of 10)	1,500	USEPA 2001	Unchanged	Maximum HQ <1
Chlorobenzene	129	USEPA 1995	25.0	USEPA 2006b	Unchanged	Maximum HQ <1
Chloroethane	NSV	--	NSV	--	Unchanged	
Chloroform	815	USEPA 1999a	815	USEPA 2001	Unchanged	
Chloromethane	2,700	USEPA 1999a	2,700	USEPA 2001	Unchanged	
cis-1,2-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
cis-1,3-Dichloropropene	79.0	USEPA 1995 (with UF of 10)	7.90	USEPA 2001	Unchanged	Not detected
Cumene	NSV	--	NSV	--	Unchanged	
Cyclohexane	NSV	--	NSV	--	Unchanged	
Dibromochloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Dibromomethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Dichlorodifluoromethane(Freon-12)	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Ethylbenzene	43.0	USEPA 1995 (with UF of 10)	25.0	USEPA 2006b	Unchanged	Maximum HQ <1
Iodomethane	NSV	--	NSV	--	Unchanged	
m- and p-Xylene	135	USEPA 1995	19.0	USEPA 2006b	Unchanged	Not detected
Methyl acetate	NSV	--	NSV	--	Unchanged	
Methylcyclohexane	NSV	--	NSV	--	Unchanged	
Methylene chloride	6,400	USEPA 1995	2,560	USEPA 2001	Unchanged	Maximum HQ <1
Methyl-tert-butyl ether (MTBE)	51,000	Wong et al. 2001	5,000	Buchman 2008	Unchanged	Maximum HQ <1
m-Xylene	135	USEPA 1995	19.0	USEPA 2006b	Unchanged	Maximum HQ <1

Table 4-7

Comparison Between Prior Ecological Screening Values (2004) and 2013 Ecological Screening Values - Site 7

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2004 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
o-Xylene	135	USEPA 1995	19.0	USEPA 2006b	Unchanged	Maximum HQ <1
Styrene	NSV	--	910	USEPA 2006b	Unchanged	Maximum HQ <1
Tetrachloroethene	450	USEPA 1995	45.0	USEPA 2001	Unchanged	Maximum HQ <1
Toluene	37.0	USEPA 1999a	215	USEPA 2006b	Unchanged	
trans-1,2-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
trans-1,3-Dichloropropene	79.0	USEPA 1995 (with UF of 10)	7.90	USEPA 2001	Unchanged	Not detected
trans-1,4-Dichloro-2-butene	NSV	--	NSV	--	Unchanged	
Trichloroethene	200	USEPA 1995 (with UF of 10)	1,940	USEPA 2006b	Unchanged	
Trichlorofluoromethane(Freon-11)	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Vinyl acetate	NSV	--	16.0	Suter and Tsao 1996	Unchanged	Not detected
Vinyl chloride	22,400	USEPA 1995 (with UF of 10)	930	USEPA 2006b	Unchanged	Maximum HQ <1
Xylene, total	135	USEPA 1995	19.0	USEPA 2006b	Unchanged	Maximum HQ <1

NSV - No Screening Value

1 - If 2013 ESV is lower than or absent (NSV) relative to 2004, or if new

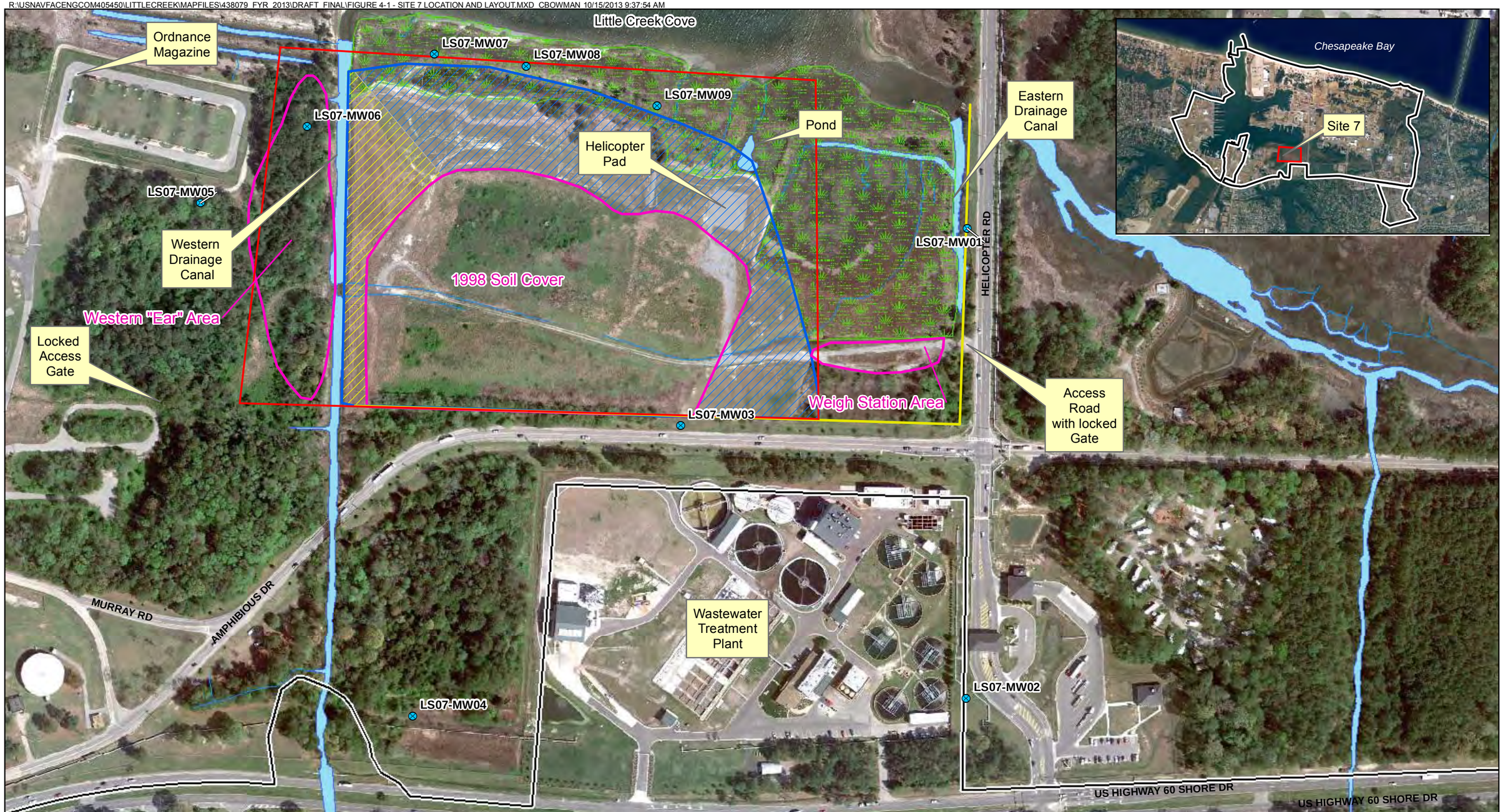
Red shading indicates current value (2013) is more stringent than the corresponding 2004 value.

Green shading indicates current value (2013) is less stringent than the corresponding 2004 value.

Yellow shading indicates current value (2013) exists while there was no corresponding 2004 value.

Orange shading indicates no current value (2013) exists while there was a 2004 value.

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 4-1 - SITE 7 LOCATION AND LAYOUT.MXD CBOWMAN 10/15/2013 9:37:54 AM



Legend

- Monitoring Well
- Fence Line
- LUC Boundary
- Drainage
- Landfill Boundary
- 2008 Soil Cover Maintenance
- 2007 Soil Cover Maintenance
- Wetland
- Installation Boundary

N
W E
S

0 125 250 500 Feet

Imagery Source: Google

Figure 4-1
Site 7 Layout
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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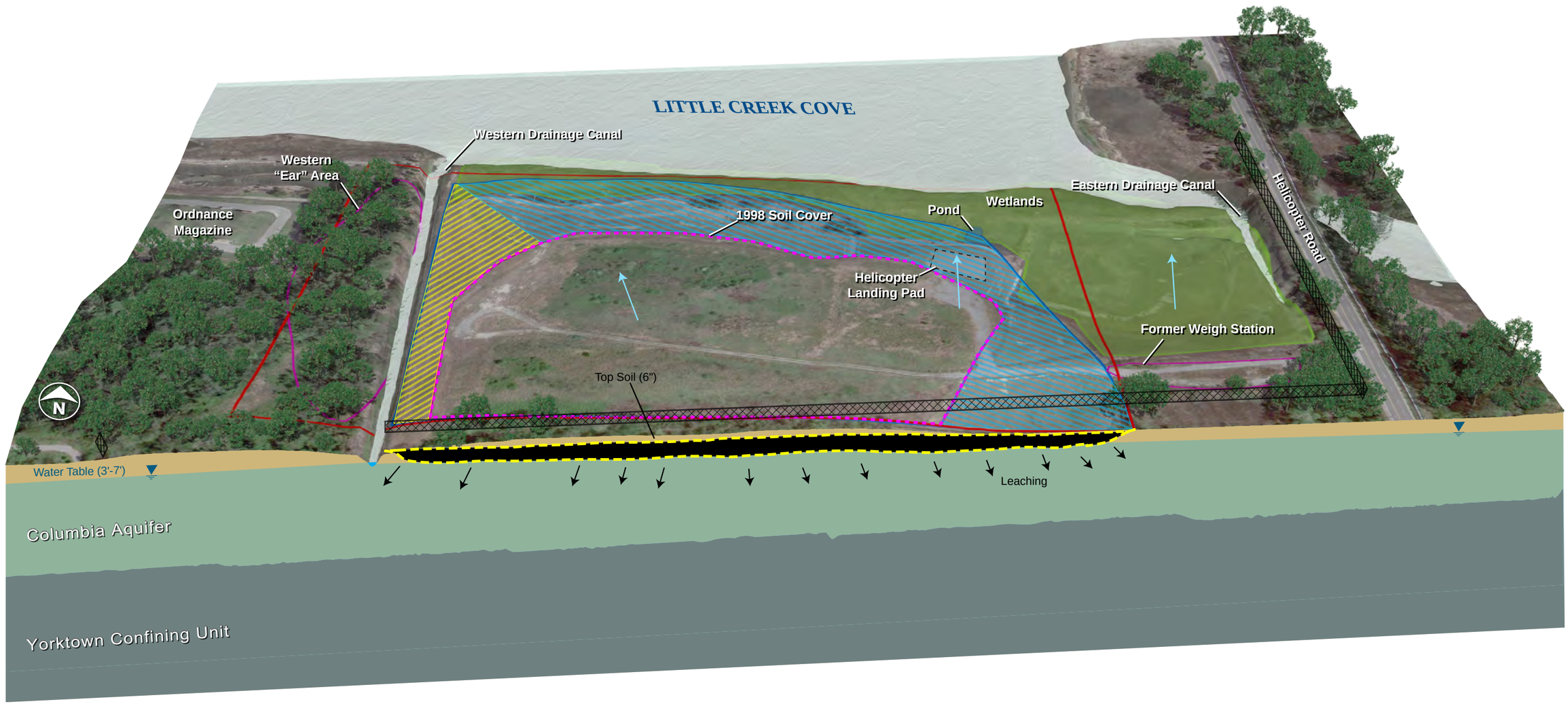
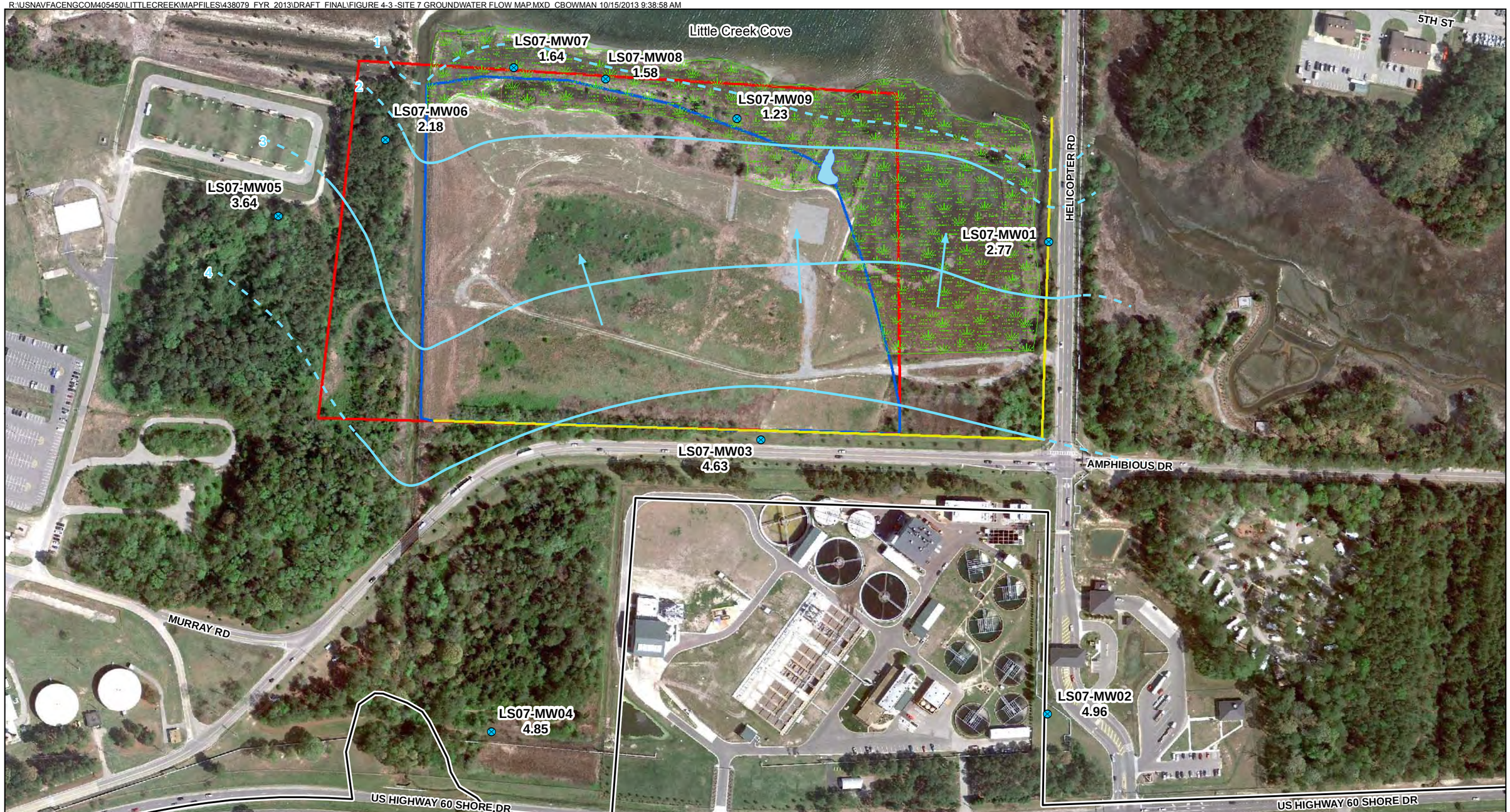


LEGEND

- Groundwater Flow Direction
- Water Table (~3'-7')
- Wetlands
- LUC Boundary
- Landfill Boundary
- Landfill Contents
- Fence
- 2007 Soil Cover Maintenance
- 2008 Soil Cover Maintenance
- 1998 Soil Cover

FIGURE 4-**2**
Site 7 Conceptual Site Model
Second Comprehensive Five-year Review
Joint Expeditionary Base (JEB) Little Creek
Virginia Beach, Virginia

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 4-3 -SITE 7 GROUNDWATER FLOW MAP.MXD CBOWMAN 10/15/2013 9:38:58 AM



Legend

- Monitoring Well
- Fence Line
- Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour Inferred
- Installation Boundary
- Wetland
- Landfill Boundary
- LUC Boundary

N
W E
S

0 125 250 500 Feet

Imagery Source: Google

Figure 4-3
Site 7 Groundwater Contours - May 2012
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

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SECTION 5

Site 9 – Driving Range Landfill, Site 10 – Sewage Treatment Plant Landfill

5.1 Site Chronology

Date	Event/ Document	Document Administrative Record Number
December 1984	IAS	000130
October 1986	RVS	000022
March 1989	RFA	000008
November1991	IRI	000104
November 1994	RI/FS for Sites 7 and 9–13	000226, 000352, 000353
May 1996	Semiannual Groundwater Monitoring Initiated at Sites 9 and 10	--
November 1996	Project Plans for Groundwater Monitoring at Sites 5, 9, 10, and 11	000118
January 1997	Groundwater Monitoring Letter Report – Round 1	--
January 1997	Proposed Remedial Action Plan	000121
June 1997	DD	000217
July 1998	Groundwater Monitoring Letter Report – Rounds 2 & 3	--
July 1998	Groundwater Monitoring Letter Report – Round 4	--
November 1998	Groundwater Monitoring Letter Report – Round 5	--
May 1999	Former NAB Little Creek on NPL	000439
October 1999	Groundwater Monitoring Letter Report – Round 7	--
January 2000	Semiannual Groundwater Monitoring program revised to Annual Groundwater Monitoring Program	--
February 2000	Soil Cover Survey	--
May 2000	Groundwater Monitoring Summary Report for Rounds 1 - 6	--
June 2000	Groundwater Monitoring Letter Report – Round 8	--
June 2000	Screening Ecological Risk Assessment	000417
November 2000	Groundwater Monitoring Letter Report – Round 9	--
February 2001	Revised RI/HHRA/FS	000425
March 2001	BERA	000424
March 2001	Proposed Remedial Action Plan (PRAP)	000436
August 2002	Groundwater Monitoring Letter Report – Round 10	--
November 2002	Groundwater Monitoring Letter Report – Round 11	--
October 2003	FFA	000540
November 2003	Groundwater Monitoring Letter Report – Round 12	--
December 2003	ROD	000571

Date	Event/ Document	Document Administrative Record Number
March 2004	LUC RD	--
September 2004	Long-Term Monitoring Report for Round 12 and Data Trend Analysis for Rounds 1 through 12	--
September 2004	Project Plans for the Post-ROD LTM Program	--
September 2004	Initiated Quarterly Inspections and Annual LTM	--
February 2005	Interim Remedial Action Completion Report (IRACR)	000940
August 2005	Fiscal Year 2005 Long-Term Monitoring Report, Sites 9 and 10	--
January 2007	Fiscal Year 2006 Long-Term Monitoring Report, Sites 9 and 10	--
March 2008	Fiscal Year 2007 Long-Term Monitoring Report, Sites 9 and 10	--
January 2009	Fiscal Year 2008 Long-Term Monitoring Report, Sites 9 and 10	--
March 2009	Five-Year Review	001534
September 2009	O&M Action initiated	--
April 2010	Construction Completion Report (CCR)	--
February 2013	Draft LTM Exit Rationale Technical Memorandum	--
May 2013	LUC RD Revision 1	--

5.2 Background

5.2.1 Site 9 Description and History

Site 9, the Driving Range Landfill, comprises approximately 6 acres in the northeast portion of the installation, northwest of the golf course, directly east of the Sewage Treatment Plant Landfill (Site 10) and Hewitt Drive, and approximately 500 ft south of the Chesapeake Bay shoreline (**Figure 5-1**). The Driving Range Landfill was used for the disposal of solid waste from 1950 through 1956, and was not closed under a regulatory authority program. Landfilling methods entailed excavating trenches and backfilling them with waste. Trench depths were likely limited by the water table. The estimated land disposal volume was 40,000 yd^3 of waste. An incinerator, located on Hewitt Drive opposite the western perimeter of Site 9, was active during the landfill operating period and reportedly burned combustible materials generated by the facility. The landfill reportedly received ash and bypassed materials from the incinerator, PCBs, pesticides, used motor oil, paints, solvents, acids, bases, asbestos, and solid waste from the base (RGH, 1984).

Following termination of landfill operations, a soil cover was placed over the landfill and the installation converted the area into the Eagle Haven Golf Course driving range. In association with the 1953 Pistol Range, closed under the MMRP, a berm was constructed using clean fill along the east side of Hewitt Drive. Sewage sludge was placed along the southern site boundary to enhance growth of the grass. The thickness of the soil cover across most of Site 9 is between 2 and 5 feet.

5.2.2 Site 10 Description and History

Site 10, the Sewage Treatment Plant Landfill, comprises approximately 18 acres in the northeast portion of the installation, west of Site 9—Driving Range Landfill, and approximately 500 ft south of the Chesapeake Bay shoreline (**Figure 5-1**). The Sewage Treatment Plant Landfill operated from 1941 until 1968. Landfilling operations began in the southern portion of the site, which included an extension of Desert Cove, and then moved northward to the associated marsh lowlands. Between 1941 and 1952, the Sewage Treatment Plant Landfill was the only operational landfill on the base, and received household and industrial wastes (i.e., containing PCBs, pesticides,

paints, solvents, , acids, and bases) and demolition debris until the Driving Range Landfill (Site 9) was opened in 1952 (RGH, 1984). Between 1952 and 1968, sewage sludge from the onsite wastewater treatment plant was disposed in the northwestern portion of the landfill. The estimated disposal volume was 46,500 yd^3 of waste.

Following termination of landfill operations, a soil cover was placed over the landfill and the installation converted part of the area for use as a baseball field and military combat exercises. The thickness of the soil cover across most of Site 10 is between 2 and 6 feet.

5.2.3 Physical Characteristics

The site characteristics, including surface features, geology, and hydrogeology, are depicted on the CSM (**Figure 5-2**). Prior to landfilling activities, the area of Sites 9 and 10 was a marsh environment adjoining the eastern arm of Little Creek Cove. The northern perimeters of the landfills are bounded by a network of sand dunes that parallel the Chesapeake Bay shoreline. Currently there is between 2 and 6 feet of vegetated soil cover over the landfill contents. Site topography ranges from approximately 6 to 15 feet above mean sea level (amsl). Generally, stormwater in the area is lost through infiltration or evaporation; however, some runoff drains to the offsite golf course lakes located southeast of the driving range, to the Chesapeake Bay to the north, and to Desert Cove to the southwest. There are no surface water bodies located within the sites. Access to both sites is generally unrestricted for those with access to JEB Little Creek.

Depths to the shallow Columbia aquifer groundwater at the sites ranges from 4.45 to 11.72 ft bgs, and groundwater generally flows radially from topographic highs at the sites toward surrounding surface water bodies (**Figure 5-3**). A clay confining unit (Yorktown confining unit), encountered across JEB Little Creek at a depth of approximately 19 to 24 ft bgs, separates the Columbia aquifer from the underlying Yorktown aquifer, impeding downward migration of Columbia aquifer groundwater to the Yorktown aquifer. Because of the proximity of the sites to the Chesapeake Bay, groundwater in the Yorktown aquifer beneath the sites is assumed to flow north and discharge into the Chesapeake Bay.

The current, primary potential mechanism for contaminant transport from the sites is leaching of contaminants from landfill waste and waste-contaminated subsurface soil through precipitation and infiltration to groundwater as groundwater migrates through the sites and discharges to surrounding surface water bodies. The potential for this transport mechanism to be complete has been reduced through the placement of a minimum 24-inch soil cover. Additionally, based on the observed historical groundwater concentrations and expected mixing and attenuation of groundwater as it discharges to surrounding surface water bodies, aquatic organisms are not expected to be adversely affected by the landfills.

5.2.4 Land and Resource Use

Site 9 is currently used as the Eagle Haven Golf Course driving range and is managed by JEB Little Creek MWR. The southeastern portion of Site 10 is currently used as recreational baseball fields and is also managed by Little Creek MWR. The vegetated dune area located in the northeastern portion of Site 10 is currently used for military combat exercises. Current and future land uses of the sites are not expected to change. The land surrounding the sites is used for industrial and recreational purposes.

Groundwater at JEB Little Creek is not currently used as a potable water source, nor is it expected to be used as a future potable water source. Potable water is supplied to the base and surrounding community by the cities of Virginia Beach and Norfolk. Groundwater supply wells at the base golf course, located approximately 2,400 feet southeast of Site 9 and approximately 2,800 feet southeast of Site 10, provide non-potable water from the Yorktown aquifer to irrigate the golf course.

LUCs are currently maintained within areas of restricted land and groundwater use at Sites 9 and 10 and are inspected on an annual (Site 9) and biannual (Site 10) basis (see **Figure 5-1**). The LUCs restrict land use and prohibit the use of Columbia aquifer groundwater until site conditions allow for unlimited use and unrestricted exposure.

5.2.5 History of Contamination

Site 9 is an approximately 6-acre area used between 1950 through 1956 for the disposal of ash and bypassed materials from the incinerator, PCBs, pesticides, used motor oil, paints, solvents, acids, bases, asbestos, and solid waste from the base. Site 10 is an approximately 18-acre area used between 1941 until 1968 for the disposal of household and industrial wastes (i.e., contaminated with PCBs, pesticides, paints, solvents, acids, and bases), demolition debris, and sewage sludge.

Initial Response

Following the termination of landfilling activities, the Driving Range Landfill was covered and converted into the golf course driving range, and the Sewage Treatment Plant Landfill was covered to facilitate base improvement (bulkheading of Desert Cove) and was later converted for use as recreational baseball fields and mission combat exercise areas. The potential for site contamination from disposal practices at Sites 9 and 10 was initially identified in the IAS (RGH, 1984). Field investigations were conducted from 1985 to 1993 to characterize the nature and extent of contamination at the sites. Investigation results indicated that contamination from prior disposal practices at Sites 9 and 10 has affected surface and subsurface soil and groundwater. The primary contaminants were PCBs (Site 9 only) and metals. Although no discernible plumes of groundwater contamination were identified, biannual groundwater monitoring was initiated in 1996 to monitor the potential migration of contaminants in groundwater (FWES, 1997). A DD for Sites 9 and 10 was finalized in June 1997 (Baker, 1997) outlining institutional controls (site signs, LUCs) with LTM as the selected remedy. Between 1996 and 2003, 12 rounds of LTM were conducted at Sites 9 and 10 (**Tables 5-1 and 5-2**). Data were not indicative of releases from the landfills and offsite migration of contaminants. A soil cover survey was conducted in February 2000 and indicated adequate (minimum of 24-inches) cover material was present at Sites 9 and 10.

Site Risks

Human Health Risk

A Phase I Baseline Risk Assessment was conducted as part of the 1994 RI (FWES, 1994b) and served as the basis for the 1997 DD. In 2001, following the former NAB Little Creek's placement on the NPL in 1999, the site remedy selection decision process was re-evaluated and the 1994 RI/HHRA was revised to further define the nature and extent of soil and groundwater contamination and assess potential risks to human health and the environment (CH2M HILL, 2001a). Soil and groundwater data previously presented in the 1994 RI/HHRA were supplemented with the groundwater LTM data from Rounds 1 through 6 conducted between 1996 and 2000. The exposure media, pathways, and scenarios evaluated and COCs identified in the revised HHRA are summarized in **Table 4-2**. Potentially unacceptable risks were identified at Sites 9 and 10 from exposure to waste in place and future potable use of groundwater. Site COCs identified were:

- **Site 9:** antimony
- **Site 10:** cadmium, manganese, thallium and zinc

Ecological Risk

A SERA was conducted in 2000 followed by a BERA in 2001. Several metals were detected in surface soil and groundwater above ecological screening values. Detected concentrations of these metals in surface soil were similar to background UTLs and associated risks were considered low to negligible. No direct exposure pathway for ecological receptor exposure to groundwater is present. Metals detected in groundwater are expected to have no adverse effects on aquatic organisms in the Chesapeake Bay (the primary receiving water body for groundwater flow from the sites) as a result of the dilution and attenuation that occurs during migration and discharge. The BERA concluded that no unacceptable ecological risks were present at Sites 9 and 10.

5.2.6 Basis for Taking Remedial Action

Based on the results of previous investigations, remedial action is warranted to protect public health, welfare, and the environment from actual or threatened exposure to waste remaining in place and in groundwater at Sites 9 and 10.

5.3 Remedial Actions

5.3.1 Remedy Selection

The ROD for Sites 9 and 10 was signed in December 2003 (Navy, 2003). The ROD summarized the risks to human health and ecological receptors, established RAOs, and defined the selected remedy. The remedy for Sites 9 and 10, LUCs and LTM of groundwater, was selected to meet the following RAOs:

- Prevent or minimize direct contact of human and ecological receptors with landfill contents
- Prevent unacceptable risks to potential receptors for groundwater
- Control surface water runoff and erosion

Cleanup levels for site-specific COCs were established as their respective MCLs. Unacceptable risks, RAOs, remedy components, performance standards and expected outcomes for evaluating the overall performance of the remedy are summarized in **Table 5-3.**

The following LUC objectives for Sites 9 and 10 were selected in the ROD:

- Prohibit digging into or disturbing the existing soil covers or contents of the landfills
- Prohibit residential development on the sites
- Prohibit the use of the shallow aquifer groundwater beneath the sites other than for environmental monitoring and testing

LUC objectives have been implemented with the actions detailed in the LUC RD for Sites 9 and 10 (Navy, 2004). The LUCs will be maintained until site conditions allow for unlimited use and unrestricted exposure.

TABLE 5-3
Sites 9 and 10 Remedial Action Summary and Expected Outcomes

Risk		COC	RAO	Remedy Component	Metric/Cleanup Level	Expected Outcome
Human Health	**Ecological**					
Waste/Soil						
Waste-in-place/ Exposure to landfill contents		Not applicable	Prevent or minimize direct contact of human and ecological receptors to landfill contents	LUCs	Maintain LUCs through registration of a survey plat with the City of Virginia Beach and documentation of LUC restrictions in the Navy's GIS database.	Industrial/recreational land use
			Control surface water runoff and erosion	Soil Cover O&M	Maintain integrity of the soil cover through annual inspection and regular maintenance.	
Groundwater						
Future adult/child resident and industrial worker ingestion of, dermal contact with, and/or inhalation of (while showering) shallow aquifer groundwater	No exposure pathway.	Site 9 - Antimony Site 10 - Cadmium, manganese thallium and zinc	Prevent unacceptable risk to potential receptors from the groundwater	Groundwater monitoring	Conduct groundwater LTM to determine if a release from the landfill has occurred.	Industrial/recreational land use
					Monitor natural attenuation of COCs in groundwater to cleanup levels (MCLs).	

5.3.2 Remedy Implementation

The Sites 9 and 10 IRACR was signed in April 2005 and documents that the remedy is in place and functioning as intended (CH2M HILL, 2005a). Remedy implementation was completed as described in the following subsections.

Soil Cover Operations and Maintenance

The Navy retains the responsibility for overseeing the administrative and substantive requirements of O&M for the Sites 9 and 10 soil covers. O&M plans for soil cover maintenance are developed as needed. Currently,

inspection activities are conducted annually at Site 9 and biannually at Site 10. The LUC inspection requirements are documented in the LUC RD (Navy, 2004).

The primary O&M activities for Sites 9 and 10 consist of:

- Inspection for signs of settling, subsidence, displacement and erosion
- Drainage system inspection for signs of standing water, erosion, and obstructions
- Inspection of the groundwater monitoring system for signs of damage and tampering
- Inspection of signs for damage, fading, and viewing obstructions
- Roadway inspection for signs of erosion, rutting, physical damage and obstructions

All inspections are conducted by the Navy. The Navy directly subcontracts regular maintenance (such as mowing) and non-routine maintenance (such as cover repair) with third-party subcontractors.

Land Use Controls

LUCs are in place to prevent exposure to landfill contents and groundwater. The LUC RD for Sites 9 and 10 was finalized in June 2004. Signs were placed around the perimeter of Sites 9 and 10 to notify individuals of buried debris, prevent unauthorized digging, and provide a point of contact for further implementation. Survey plats were filed with the Virginia Beach Circuit Court in the Commonwealth of Virginia on August 9, 2004 for Site 9 and August 6, 2004 for Site 10, to provide public notice of the environmental conditions and limitations on the use of the property and record the LUC boundary (CH2M HILL, 2005a). As outlined in the LUC RD, site inspections were initiated in October 2004 and have been conducted to monitor unauthorized activities and land use changes on a quarterly basis, until the frequency was reduced from quarterly at both sites to annually at Site 9 and biannually at Site 10 in 2012. Checklists and data reports are completed during inspections and issued to USEPA and VDEQ.

Groundwater Long-term Monitoring

Project Plans for post-ROD LTM were finalized in September 2004 and annual groundwater LTM was initiated in October 2004 (CH2M HILL, 2004c). Annual groundwater monitoring included the collection of groundwater samples from six shallow monitoring wells at Site 9 and six shallow monitoring wells at Site 10. As outlined in the Project Plans, groundwater samples collected during each LTM event were analyzed for site COCs (Site 9: antimony; Site 10: cadmium, manganese, thallium and zinc). In advance of the first Five-Year Review, to be sure additional landfill releases had not occurred, groundwater samples collected during the October 2006 LTM sampling event were also analyzed for VOCs, SVOCs, pesticides/PCBs, and total and dissolved metals. Additionally, to evaluate groundwater quality, groundwater samples collected in October 2007 were analyzed for site COCs as well as groundwater quality indicator parameters (specific conductance, pH, total organic halogens [TOX], and total organic carbon [TOC]) (CH2M HILL, 2007b). Groundwater LTM has not been conducted since October 2007, prior to completion of the initial Five-Year Review for JEB Little Creek. **Tables 5-1** and **5-2** provide a summary of groundwater monitoring conducted at the sites.

5.4 Progress Since Last Five-Year Review

5.4.1 Follow-up Actions Since Last Five-Year Review

The previous Five-Year Review report included the following protectiveness statement for Sites 9 and 10:

> *The selected remedy is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are controlled through quarterly ER site inspections and annual groundwater LTM. As detailed in Section 3.7, modifications to the groundwater LTM plan are suggested to evaluate potential future releases and offsite migration of contaminants. Risk management decisions, analytical parameters, and site-specific monitoring well networks will be defined during development of future LTM plans. Additionally, corrective action is warranted to repair the bare and the low-lying areas observed at Sites 9 and 10.*

Although the Five-Year Review concluded that the remedy is functioning as intended and is protective of human health and the environment, issues and recommendations for follow-up actions were identified. **Table 5-4** presents the status of these recommendations and follow-up actions.

TABLE 5-4
Sites 9 and 10 Follow-up Actions from First Five-Year Review (2009)

Issue from Five-Year Review Report, March 2009						Status – September 2013	
				Affects Protectiveness (Y/N)			
Issue	**Recommendations and Follow-up Actions**	**Party Responsible**	**Milestone Date**	**Current**	**Future**	**Action Taken**	**Date of Action**
Bare areas have been noted on the Site 9 driving range during quarterly ER site inspections.	The Navy will evaluate the most cost-effective method to repair the bare areas.	Navy USEPA VDEQ	May 2009	N	Y	An irrigation system was installed, the soil cover was re-graded, and new vegetation was planted. O&M activities are documented in a CCR (JV III, 2010).	Complete - April 2010
During the September 2008 site inspection, a low spot, likely the result of vehicle traffic, was present at Site 10. Additionally, an empty 55-gallon drum was observed along the combat exercise range fence line.	Backfill the low-lying area with clean fill and remove the drum from the site.	Navy USEPA VDEQ	March 2009	N	Y	Low-lying bare areas were re-graded and new vegetation was planted. O&M activities are documented in a CCR (JV III, 2010). A fence was installed to restrict vehicle access and prevent future bare areas. The drum was determined to be a trash receptacle used by MWR.	Complete - April 2010
Site monitoring wells are not clearly labeled outside the casing.	Apply permanent identification to all well casings.	Navy USEPA VDEQ	January 2013	N	N	Basewide well repairs conducted in October 2010. Each well was affixed with an outer casing clearly identifying it as an observation or monitoring well. Weather-resistant stickers with well IDs were affixed to all casings.	Complete - October and November 2010
Annual groundwater monitoring sampling and analysis plan is not adequate to fully evaluate potential degradation in groundwater quality, indicative of a release and offsite migration from the landfill.	Modify the sampling and analysis plans for fiscal years 2009 through 2013.	Navy USEPA VDEQ	Sept. 2009	N	Y	Scoping sessions for development of the revised Sites 9 and 10 LTM sampling plan were conducted between the Navy, USEPA, and VDEQ on May 12, 2009 and July 23, 2009. Following issuance of the Tier II issue paper, *Consideration for Developing Long-Term Monitoring Plans for Unpermitted Navy Landfills in Virginia* (Virginia Navy Tier II, 2011), an additional scoping session was held on March 30, 2011 during which the rationale for the cessation of LTM, in line with the Tier II issue paper, at Sites 9 and 10 were discussed. A draft technical memorandum documenting lines of evidence for the cessation of annual groundwater LTM at Sites 9 and 10 was submitted in February 2012 (CH2M HILL, 2012a). Based on the types of waste buried, the amount of data available, and data evaluation results, it was concluded that sufficient post-closure care has been conducted at Sites 9 and 10, and cessation of annual groundwater LTM is recommended.	Complete – February 2013

5.4.2 Results of Implemented Actions

This section summarizes the remedial activities conducted since completion of the last Five-Year Review in 2009. To assess the performance of the remedial action, data and information were reviewed with respect to each of the performance metrics outlined in **Table 5-3**.

Site Inspections

During this Five-Year Review period, quarterly site inspections were conducted at Sites 9 and 10 between 2009 and 2012. A consensus agreement revising the inspection frequencies at Sites 9 and 10 was signed in May 15, 2013 that reduced the required frequency from quarterly at both sites to annually at Site 9 and biannually at Site 10. The change is documented in the LUC RD Revision 1 (Navy, 2013b).

With the exception of general well repairs, no significant issues were identified at Site 9. Tire ruts in the soil cover were repeatedly noted through quarterly inspections at Site 10, and were repaired in 2009; however, since the repairs, additional tire ruts have been noted and are recommended to be repaired. General well maintenance at Sites 9 and 10 wells, including replacing or repairing missing or broken bollards, well locks, and well caps, was noted. Additionally, monitoring well LS09-MW03 was not able to be located at Site 9 during the September 2013 site inspection. The contact information on the signs at the sites was found to be outdated during several of the inspections, including the most recent inspection conducted for the Five-Year Review. It is recommended that the contact information on the signs be updated. In addition, miscellaneous debris, including wood and polyvinyl chloride (PVC) pipe at Site 9 and concrete, wood, and metal debris at Site 10, were repeatedly noted during the inspections; however, the debris was not protruding from the soil cover and is therefore not considered associated with previous landfilling activities. The wood and PVC piping at Site 9 was removed following completion of the January 2011 site inspections. The miscellaneous debris at Site 10 is not affecting the protectiveness of the remedy; however, it is recommended that the debris be removed, continued annual landfill inspections be conducted to monitor for potential continued debris disposal, the means by which debris has been disposed of within the area be investigated, and recommendations made to prevent future disposal activities.

With the exception of the ruts recently identified in the soil cover at Site 10, LUCs and annual site inspections have made sure that the soil cover integrity is maintained and exposure to landfill contents is prevented, and LUCs are currently in place and functioning at both Sites 9 and 10. Landfill signs restricting intrusive activities at the site have remained intact.

Soil Cover O&M

The first Five-Year Review identified the need for corrective action to repair bare and the low-lying areas observed at both Sites 9 and 10. In accordance with the O&M plan developed for this action (JV I, 2010a), beginning in September 2009, Site 9 was re-graded, an irrigation system was installed at the driving range, and the area was re-vegetated. The low-lying areas at Site 10 were re-graded and new vegetation planted. To prevent additional vehicle traffic and degradation of the soil cover at Site 10, a fence was installed to limit the soil cover area to foot traffic only. O&M activities are documented in the CCR, finalized in April 2010 (JV I, 2010a).

Long-term Monitoring

Per the recommendation from the previous Five-Year Review, scoping sessions for development of a revised Sites 9 and 10 LTM sampling plan were conducted between the Navy, USEPA, and VDEQ on May 12, 2009 and July 23, 2009. Following issuance of the Tier II issue paper, *Consideration for Developing Long-Term Monitoring Plans for Unpermitted Navy Landfills in Virginia* (Virginia Navy Tier II, 2011), an additional scoping session was held on March 30, 2011 during which the rationale for the cessation of LTM at Sites 9 and 10, in line with the Tier II issue paper, were discussed. A revised draft technical memorandum documenting lines of evidence for the cessation of LTM at Sites 9 and 10 was submitted in November 2013 (CH2M HILL, 2013b) and included a review of the site CSMs and previously collected pre- and post-ROD groundwater LTM data. A comparison of data to risk-based screening criteria and facility background values, as well as a statistical evaluation of data trends and prediction intervals, concluded that releases to groundwater from the landfills have not occurred and are not likely to occur in the future. Based on the types of waste buried, the amount of data available, and data

evaluation results, it was concluded that sufficient post-closure care has been conducted at Sites 9 and 10, and cessation of annual groundwater LTM was recommended.

5.4.3 Summary of the Estimated Remedy Costs

Tables 5-5 and **5-6** present capital and annual O&M and LTM costs for Sites 9 and 10, respectively. Although costs expended each year vary, total remedy costs to date are within the +50%/-30% range estimated in the ROD.

TABLE 5-5
Site 9 Estimated Project Costs

Year	Timeframe	Projected Cost from ROD	Estimated Actual Cost	Notes
			Capital Cost	
0	2004	$0	$0	Soil cover in place prior to ROD.
			Management and Monitoring Cost*	
1	2005	$32,450	$11,330	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with October 2004 LTM and reporting
2	2006	$32,450	$7,470	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with October 2005 LTM and reporting Includes labor, ODCs, and subcontractor costs associated with well repair and abandonment event.
3	2007	$32,450	$9,070	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with October 2006 LTM and reporting
4	2008	$32,450	$11,930	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with October 2007 LTM and reporting
5	2009	$32,450	$251,160	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with irrigation system installation and soil cover repairs
6	2010	$17,583	$19,480	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with well repair and abandonment event.
7	2011	$17,583	$19,320	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting.
8	2012	$17,583	--	
9**	2013	$17,583	--	
	Total	**$232,582**	**$329,760**	
	+50%	$348,873		
	-30%	$162,807		

*Costs reflect those expended under contract to CH2M HILL. Completion of annual LUC inspections assumed by Navy in 2012. Landfill mowing conducted by separate subcontractor.

**Represents costs expended between January and June 2013.

TABLE 5-6
Site 10 Estimated Project Costs

Year	Timeframe	Projected Cost from ROD	Estimated Actual Cost	Notes
			Capital Cost	
0	2004	$0	$0	Soil cover in place prior to ROD.
			Management and Monitoring Cost*	
1	2005	$34,550	$40,430	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with October 2004 LTM and reporting Includes labor, ODCs, and subcontractor costs associated with the Site 10 Excavation HHRA.
2	2006	$34,550	$20,830	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with October 2005 LTM and reporting Includes labor, ODCs, and subcontractor costs associated with well repair and abandonment event.
3	2007	$34,550	$20,840	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with October 2006 LTM and reporting
4	2008	$34,550	$25,950	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with October 2007 LTM and reporting
5	2009	$34,550	$24,860	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Include costs associated with repair of low-lying bare areas performed in conjunction with the Site 9 irrigation system installation and soil cover repairs
6	2010	$19,683	$24,560	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting Includes labor, ODCs, and subcontractor costs associated with well repair and abandonment event.
7	2011	$19,683	$19,320	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting
8	2012	$19,683	--	
9**	2013	$19,683	--	
	Total	**$251,482**	**$176,790**	
	+50%	$377,223		
	-30%	$176,037		

*Costs reflect those expended under contract to CH2M HILL. Completion of annual LUC inspections assumed by Navy in 2012. Landfill mowing conducted by separate subcontractor.
**Represents costs expended between January and June 2013.

5.5 Technical Assessment

This section presents the answers to the three questions defined for the Technical Assessment for Sites 9 and 10 based primarily on information presented in Section 5.4. Opportunities for maintenance and optimization of the remedy are presented in **Table 5-7**.

5.5.1 Question A: Is the remedy functioning as intended by the decision document?

Remedial Action Performance: Based on the review of documents, ARARs, risk assumptions, and site inspection reports, the Sites 9 and 10 remedies are functioning as intended by the ROD.

Soil Cover O&M: Two feet of soil cover have been established over the landfills. Regular site inspections have made sure the integrity of the soil covers is maintained. As a result of inspections, tire ruts in the soil cover at Site 10 were repaired in 2009; however, additional tire ruts were noted, in a different area of the cover, during the 2012 site inspection. Vegetation has been established on the soil covers and regularly maintained to prevent soil cover erosion at both sites, and regular mowing has prevented large plant growth in the soil cover.

Implementation of LUCs: LUCs have been implemented through the Final LUC RD. LUCs and regular site inspections have made sure that the soil cover integrity is maintained, unauthorized site use is prohibited, and exposure to landfill contents and groundwater is prevented. Landfill signs restricting site use have remained intact, although contact information needs to be updated.

LTM Activities: A draft technical memorandum documenting lines of evidence for the cessation of annual LTM at Sites 9 and 10 was submitted in February 2012 (CH2M HILL, 2012a). However, the Technical Memorandum recommends continued sampling in conjunction with Five-Year Reviews to evaluate overall remedy protectiveness, as needed. Five-Year Review sampling requirements are currently being discussed. As a result, groundwater sampling has not been conducted since October 2007, prior to completion of the initial Five-Year Review for JEB Little Creek. Based on a comparison of previously collected annual LTM data to risk-based screening criteria and facility background values, as well as a statistical evaluation of data trends and prediction intervals, it was concluded that releases to groundwater from the landfills have not occurred and are not likely to occur in the future. Therefore the absence of data during the current five-year review period does not impact short-term protectiveness. Additionally, groundwater is not currently used as a potable water supply and LUCs are currently in place to prevent the withdrawal of groundwater except for environmental monitoring. As warranted, monitoring well LS09-MW03 at Site 9 should be located for use during future groundwater sampling or abandonment.

Early Indicators of Potential Issues: No indicators of potential issues have been identified.

Opportunities for Optimization: A review of the site CSMs and previously collected pre- and post-ROD groundwater LTM data was conducted in accordance with the guidelines presented in the Tier II issue paper, *Consideration for Developing Long-Term Monitoring Plans for Unpermitted Navy Landfills in Virginia* (Virginia Navy Tier II, 2011). A comparison of data to risk-based screening criteria and facility background values, as well as a statistical evaluation of data trends and prediction intervals, concluded that a release to groundwater from the landfill has not occurred and is not likely to occur in the future. Therefore, based on the types of waste buried, the amount of data available, and data evaluation results, it was concluded that sufficient post-closure care has been conducted at Sites 9 and 10, and cessation of annual groundwater LTM was recommended.

5.5.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy 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: Current and anticipated future land use is industrial/recreational and is expected to remain the same. The exposure assumptions used to develop the HHRA and ERA are reasonable given the current land use has not changed over time at Sites 9 and 10. 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: Changes in toxicity and tap water RSL values have been made since the last Five-Year Review in 2009 (see **Table 4-5** summarizing changes in toxicity factors). However, these changes would not substantially change the results of the risk assessment; furthermore, LUCs are in place that prevent exposure to groundwater. Therefore, these changes would not adversely affect the current protectiveness of the selected remedy. Because no new data have been collected at Sites 9 and 10 since the last Five-Year Review, a review of the most recent data available for VOCs, SVOCs, pesticides, PCBs, and total and dissolved metals (with exception of site-specific COCs), collected in October 2006, was conducted. Additionally, dioxins/furans data collected at Site 9 in June 2000 and July 2003 were also reviewed. Based on site history, dioxins/furans are not expected to be present at Site 10. Additionally, explosives constituents are not expected to be present at Sites 9 and 10. VOCs, SVOCs, pesticides, total and dissolved metals, and dioxins/furans were detected in Site 9 groundwater. VOCs and total/dissolved metals were detected in Site 10 groundwater. For those detected VOCs, SVOCs, and pesticides with changes in tap water RSLs since the last Five-Year Review, all are below their respective May 2013 screening level. MCLs are not established for the VOCs and pesticides detected. SVOCs detected are below the MCLs. No tap water RSLs or MCLs have been established for the dioxins/furans detected at Site 9; however, the 2,3,7,8-tetrachloro-p-dibenzo-dioxin (TCDD) equivalents were calculated for the data. Concentrations above the 2,3,7,8-TCDD equivalent MCL were detected in samples collected from monitoring wells located within the landfill boundary. However, these changes would not substantially change the results of the risk assessment; furthermore, 2,3,7,8-TCDD is the most toxic form of dioxin and was not detected at Site 9 and LUCs are in place prohibiting unrestricted use of the groundwater. Therefore, these toxicity value changes do not affect the protectiveness of the remedy. For the most part, the changes in toxicity values associated with metals would not affect protectiveness because, with the exceptions of antimony and cadmium at Site 9, the metals concentrations with tap water RSL changes were below the MCLs. Concentrations above the MCLs were detected in samples collected from monitoring wells located within the landfill boundary. However, these changes would not substantially change the results of the risk assessment; furthermore, LUCs are in place prohibiting unrestricted use of the groundwater; therefore, these toxicity value changes do not affect the protectiveness of the remedy. The cleanup goals for Sites 9 and 10 were established as the MCLs and no changes to these levels have been made.

There have been some changes in ecological screening values since the BERA was issued (March 2001) for some of the chemicals detected in soil and groundwater at Sites 9 and 10 (see **Table 5-8** summarizing changes in screening values). However, these changes would not substantially change the results of the risk assessment and thereby affect the protectiveness of the remedy.

Changes in Risk Assessment Methodologies: Although there have been some procedural changes to how human health risk assessments are conducted, none of these changes adversely affect the protectiveness of the selected remedies for Sites 9 and 10. There have been no major procedural changes in how the ERAs are conducted since the BERA was completed in March 2001.

5.5.3 Question C: Has any other information come to light that could question the protectiveness of the remedy?

No other information is available that could call into question the protectiveness of the remedies.

TABLE 5-7
Remedy Maintenance and Optimization Activities for Sites 9 and 10

Maintenance/Optimization Opportunity	Recommendations	Party Responsible
Site signs are in place; however, contact information on select signs is outdated.	Update the contact information on the select signs.	Navy
Monitoring well LS09-MW03 was not located during the site inspection.	Locate monitoring well LS09-MW03 and assess the condition of the well.	Navy

5.6 Issues, Recommendations, and Follow-Up Actions

Table 5-9 outlines the issues identified during this Five-Year Review and presents recommendations and follow-up actions for Sites 9 and 10.

TABLE 5-9
Issues, Recommendations, and Follow-Up Actions for Sites 9 and 10

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date*	Affects Protectiveness	
				Current	Future
Issues Identified for Follow-Up Action During Current Five-Year Review					
Due to discussions during the current five-year review period to cease groundwater sampling, data to evaluate groundwater quality since completion of the previous Five-Year Review are not available for Sites 9 and 10 landfills.	Reach consensus regarding the sampling of groundwater and, as needed, develop and implement a groundwater sampling plan in conjunction with Five-Year Reviews to demonstrate continued protectiveness of the remedy.	Navy	September 2014	N	To be determined (TBD)
Ruts in the soil cover and debris, including steel pipe, asphalt, and tires were observed during the site inspection at Site 10.	Repair existing ruts and remove surface debris from Site 10. Continue annual landfill inspections to monitor potential continued debris disposal and cover conditions. Conduct an investigation to determine the means by which debris has been disposed of within the area and make recommendations to prevent future disposal activities.	Navy	September 2014	N	N

*Achievement of milestone dates are dependent on Navy funding.

5.7 Protectiveness Statement

The remedies at Sites 9 and 10 are in place, functioning as designed, and are currently protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled through a combination of soil cover and LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. However, in order to determine if the remedies are protective in the long-term, a consensus on five-year review data requirements should be reached and, as needed, a groundwater sampling and analysis plan developed and implemented in conjunction with Five-Year Reviews to demonstrate continued protectiveness of the remedy.

5.8 Next Review

The next Five-Year Review for Sites 9 and 10 is scheduled for 2019.

TABLE 5-1

Site 9 Pre- and Post-ROD Groundwater LTM Sampling Summary

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, VA

Monitoring Well	Pre-ROD Round 1 - May 1996							Pre-ROD Round 2 - December 1996							Pre-ROD Round 3 - May 1997							Pre-ROD Round 4 - December 1997							Pre-ROD Round 5 - June 1998							Pre-ROD Round 6 - November 1998						
	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals
LS09-MW02	X					X	X						X	X	X					X	X	X					X	X	X	X		X		X	X	X	X		X		X	X
LS09-MW03																																				X	X		X		X	X
LS09-MW04	X					X	X						X	X	X					X	X	X					X	X	X	X		X		X	X	X	X		X		X	X
LS09-MW05	X					X	X						X	X	X					X	X	X					X	X	X	X		X		X	X	X	X		X		X	X
LS09-MW06	X					X	X						X	X	X					X	X	X					X	X	X	X		X		X	X	X	X		X		X	X
LS09-MW07																																										
LS09-MW08																																										
LS09-UST1	X					X	X						X	X	X					X	X	X					X	X	X	X		X		X	X	X	X		X		X	X
LS09-UST3	X					X	X						X	X	X					X	X	X					X	X	X	X		X		X	X	X	X		X		X	X

Monitoring Well	Pre-ROD Round 7 - June 1999							Pre-ROD Round 8 - January 2000							Pre-ROD Round 9 - June 2000							Pre-ROD Round 10 - September 2001							Pre-ROD Round 11 - July 2002							Pre-ROD Round 12 - July 2003						
	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Dioxin/Furan	Tot. Metals	Dis. Metals
LS09-MW02	X		X	X		X	X	X		X	X		X	X		X	X	X		X	X																					
LS09-MW03																																										
LS09-MW04	X		X	X		X	X	X		X	X		X	X		X	X	X	X	X	X		X	X	X		X	X		X	X	X		X	X		X	X	X	X	X	X
LS09-MW05	X		X	X		X	X	X		X	X		X	X		X	X	X		X	X		X	X	X		X	X		X	X	X		X	X		X	X	X		X	X
LS09-MW06	X		X	X		X	X	X		X	X		X	X		X	X	X	X	X	X		X	X	X		X	X		X	X	X		X	X		X	X	X		X	X
LS09-MW07																							X	X	X		X	X		X	X	X		X	X		X	X	X		X	X
LS09-MW08																														X	X	X		X	X		X	X	X		X	X
LS09-UST1	X		X	X		X	X	X		X	X		X	X		X	X	X		X	X																					
LS09-UST3	X		X	X		X	X	X		X	X		X	X		X	X	X		X	X		X	X	X		X	X		X	X	X		X	X		X	X	X		X	X

Monitoring Well	Post-ROD Round 1 - October 2004								Post-ROD Round 2 - October 2005								Post-ROD Round 3 - October 2006								Post-ROD Round 4 - October 2007							
	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Water quality*	Select Metals**	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Water quality*	Select Metals**	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Water quality*	Select Metals**	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Water quality*	Select Metals**
LS09-MW02																																
LS09-MW03																																
LS09-MW04								X								X	X	X	X	X	X	X									X	X
LS09-MW05								X								X	X	X	X	X	X	X									X	X
LS09-MW06								X								X	X	X	X	X	X	X									X	X
LS09-MW07								X								X	X	X	X	X	X	X									X	X
LS09-MW08								X								X	X	X	X	X	X	X									X	X
LS09-UST1																																
LS09-UST3								X								X	X	X	X	X	X	X									X	X

Notes:

* Water quality parameters include pH, specific conductivity, total organic carbon (TOC), and total organic halogens (TOX)

** Select metals include total and dissolved antimony, cadmium, manganese, thallium, and zinc in 2004 and antimony only in 2005 and 2007

VOCs - volatile organic compounds

SVOCs - semivolatile organic compounds

PCBs - polychlorinated biphenyls

TABLE 5-2

Site 10 Pre- and Post-ROD Groundwater LTM Sampling Summary

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, VA

Monitoring Well	Pre-ROD Round 1 - May 1996						Pre-ROD Round 2 - December 1996						Pre-ROD Round 3 - May 1997						Pre-ROD Round 4 - December 1997						Pre-ROD Round 5 - June 1998						Pre-ROD Round 6 - November 1998					
	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals
LS10-MW01	X				X	X					X	X	X				X	X	X				X	X	X	X		X	X	X	X	X		X	X	X
LS10-MW02	X				X	X					X	X	X				X	X	X				X	X	X	X		X	X	X	X	X		X	X	X
LS10-MW03											X	X	X				X	X	X				X	X	X	X		X	X	X						
LS10-MW04	X				X	X					X	X	X				X	X	X				X	X	X	X		X	X	X	X	X		X	X	X
LS10-MW05	X				X	X					X	X	X				X	X	X				X	X	X	X		X	X	X	X	X		X	X	X
LS10-MW06	X				X	X					X	X	X				X	X	X				X	X	X	X		X	X	X	X	X		X	X	X
LS10-MW07	X				X	X					X	X	X				X	X	X				X	X	X	X		X	X	X	X	X		X	X	X
LS10-MW08	X				X	X					X	X	X				X	X	X				X	X	X	X		X	X	X	X	X		X	X	X
LS10-MW09																																				

Monitoring Well	Pre-ROD Round 7 - June 1999						Pre-ROD Round 8 - January 2000						Pre-ROD Round 9 - June 2000						Pre-ROD Round 10 - September 2001						Pre-ROD Round 11 - July 2002						Pre-ROD Round 12 - July 2003					
	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals
LS10-MW01	X		X	X	X	X	X		X	X	X	X		X	X	X	X	X																		
LS10-MW02	X		X	X	X	X	X		X	X	X	X		X	X	X	X	X								X	X	X	X	X		X	X	X	X	X
LS10-MW03	X		X	X	X	X	X		X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X	X	X	X
LS10-MW04	X		X	X	X	X	X		X	X	X	X																								
LS10-MW05	X		X	X	X	X	X		X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X	X	X	X
LS10-MW06	X		X	X	X	X	X		X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X	X	X	X
LS10-MW07	X		X	X	X	X	X		X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X	X	X	X
LS10-MW08	X		X	X	X	X	X		X	X	X	X																								
LS10-MW09																				X	X	X	X	X		X	X	X	X	X		X	X	X	X	X

Monitoring Well	Post-ROD Round 1 - October 2004								Post-ROD Round 2 - October 2005								Post-ROD Round 3 - October 2006								Post-ROD Round 4 - October 2007							
	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Water quality*	Select Metals**	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Water quality*	Select Metals**	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Water quality*	Select Metals**	VOCs	SVOCs	Pesticides	PCBs	Tot. Metals	Dis. Metals	Water quality*	Select Metals**
LS10-MW01																																
LS10-MW02								X								X	X	X	X	X	X	X									X	X
LS10-MW03								X								X	X	X	X	X	X	X									X	X
LS10-MW04																																
LS10-MW05								X								X	X	X	X	X	X	X									X	X
LS10-MW06								X								X	X	X	X	X	X	X									X	X
LS10-MW07								X								X	X	X	X	X	X	X									X	X
LS10-MW08																																
LS10-MW09								X								X	X	X	X	X	X	X									X	X

Notes:

* Water quality parameters include pH, specific conductivity, total organic carbon (TOC), and total organic halogens (TOX)

** Select metals include total and dissolved antimony, cadmium, manganese, thallium, and zinc in 2004 and antimony only in 2005 and 2007

VOCs - volatile organic compounds

SVOCs - semivolatile organic compounds

PCBs - polychlorinated biphenyls

Table 5-8

Comparison Between Prior Ecological Screening Values (2001) and 2013 Ecological Screening Values - Sites 9 and 10

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Site 9 Surface Soil						
Inorganics						
Aluminum	50.0	Efroymson et al. 1997a	pH < 5.5	USEPA 2003a	Unchanged	Background
Chromium	0.40	Efroymson et al. 1997b	64.0	CCME 2007	Unchanged	
Cyanide	0.06	Eisler 1991	15.8	MHSPE 2000	Unchanged	
Iron	200	Efroymson et al. 1997b	5 < pH > 8	USEPA 2003b	Unchanged	Background
Lead	50.0	Efroymson et al. 1997a	120	USEPA 2005g	Unchanged	
Mercury	0.10	Efroymson et al. 1997b	0.10	Efroymson et al. 1997b	Unchanged	
Vanadium	2.00	Efroymson et al. 1997a	130	CCME 2007	Unchanged	
Zinc	50.0	Efroymson et al. 1997a	120	USEPA 2007e	Unchanged	
Pesticides/PCBs						
Endosulfan I	NSV	--	6.32	MHSPE 2000	Unchanged	Maximum HQ <1
Endosulfan II	NSV	--	6.32	MHSPE 2000	Unchanged	Maximum HQ <1
Endosulfan sulfate	NSV	--	6.32	Endosulfan	Unchanged	Maximum HQ <1
Heptachlor	NSV	--	52.9	MHSPE 2000	Unchanged	Maximum HQ <1
Toxaphene	NSV	--	500	Beyer 1990	Unchanged	Maximum HQ <1
Semivolatile Organic Compounds						
1,2-Dichlorobenzene	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
1,3-Dichlorobenzene	NSV	--	1,000	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
2,2'-Oxybis(1-chloropropane)	NSV	--	NSV	--	Unchanged	
2,4,5-Trichlorophenol	430	Efroymson et al. 1997a	1,350	Efroymson et al. 1997a	Unchanged	
2,4-Dimethylphenol	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
2,4-Dinitrotoluene	NSV	--	11,000	NRCC 2006	Unchanged	Maximum HQ <1
2,6-Dinitrotoluene	NSV	--	8,500	NRCC 2006	Unchanged	Maximum HQ <1
2-Chlorophenol	100	USEPA 1995	500	Beyer 1990; CCME 2007	Unchanged	
2-Methylnaphthalene	NSV	--	LMW PAH	--	Unchanged	Maximum HQ <1
2-Methylphenol	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
2-Nitroaniline	NSV	--	NSV	--	Unchanged	
2-Nitrophenol	NSV	--	1,000	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
3,3'-Dichlorobenzidine	NSV	--	NSV	--	Unchanged	
3-Nitroaniline	NSV	--	NSV	--	Unchanged	
4,6-Dinitro-2-methylphenol	NSV	--	1,000	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
4-Bromophenyl-phenylether	NSV	--	NSV	--	Unchanged	

Table 5-8

Comparison Between Prior Ecological Screening Values (2001) and 2013 Ecological Screening Values - Sites 9 and 10

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
4-Chloro-3-methylphenol	NSV	--	500	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
4-Chloroaniline	NSV	--	500	MHSPE 2000	Unchanged	Maximum HQ <1
4-Chlorophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Methylphenol	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
4-Nitroaniline	NSV	--	NSV	--	Unchanged	
4-Nitrophenol	380	Efroymson et al. 1997b	380	Efroymson et al. 1997b	Unchanged	
Acenaphthylene	100	USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Anthracene	100	MHSPE 1994; USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Benzo(a)anthracene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(a)pyrene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(g,h,i)perylene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(k)fluoranthene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
bis(2-Chloroethoxy)methane	NSV	--	NSV	--	Unchanged	
bis(2-Chloroethyl)ether	NSV	--	NSV	--	Unchanged	
bis(2-Ethylhexyl)phthalate	NSV	--	30,000	CCME 2007	Unchanged	Maximum HQ <1
Butylbenzylphthalate	NSV	--	30,000	CCME 2007	Unchanged	Maximum HQ <1
Carbazole	NSV	--	NSV	--	Unchanged	
Dibenz(a,h)anthracene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Dibenzofuran	NSV	--	NSV	--	Unchanged	
Di-n-octylphthalate	NSV	--	30,000	CCME 2007	Unchanged	Maximum HQ <1
Hexachlorobenzene	NSV	--	1,000	Beyer 1990	Unchanged	Maximum HQ <1
Hexachlorobutadiene	NSV	--	NSV	--	Unchanged	
Hexachloroethane	NSV	--	NSV	--	Unchanged	
Indeno(1,2,3-cd)pyrene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Isophorone	NSV	--	NSV	--	Unchanged	
Naphthalene	100	MHSPE 1994; USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
n-Nitroso-di-n-propylamine	NSV	--	NSV	--	Unchanged	
PAH (HMW)	--	--	18,000	USEPA 2007f	Unchanged	Maximum HQ <1
PAH (LMW)	--	--	29,000	USEPA 2007f	Unchanged	Maximum HQ <1
Phenanthrene	100	MHSPE 1994; USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Volatile Organic Compounds						
1,1-Dichloroethene	NSV	--	173	MHSPE 2000	Unchanged	Maximum HQ <1
2-Butanone	NSV	--	NSV	--	Unchanged	

Table 5-8

Comparison Between Prior Ecological Screening Values (2001) and 2013 Ecological Screening Values - Sites 9 and 10

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
2-Hexanone	NSV	--	NSV	--	Unchanged	
Acetone	NSV	--	NSV	--	Unchanged	
Bromomethane	NSV	--	NSV	--	Unchanged	
Carbon disulfide	NSV	--	NSV	--	Unchanged	
Chloroethane	NSV	--	5,000	CCME 2007	Unchanged	Maximum HQ <1
Chloromethane	NSV	--	5,000	CCME 2007	Unchanged	Maximum HQ <1
Dibromochloromethane	NSV	--	NSV	--	Unchanged	
Site 9 Groundwater						
Inorganics						
Aluminum	NSV	--	NSV	--	Unchanged	
Antimony	500	USEPA 1995	500	USEPA 2006b	Unchanged	
Arsenic	36.0	USEPA 1999b	36.0	USEPA 2009	Unchanged	
Barium	1,000	USEPA 1995 (with UF of 10)	200	Buchman 2008	Unchanged	Mean HQ <1
Beryllium	1,500	USEPA 1995	100	Buchman 2008	Unchanged	Maximum HQ <1
Cadmium	9.40	USEPA 1999b	8.85	USEPA 2009	Unchanged	Maximum HQ <1
Chromium	50.4	USEPA 1999b	50.4	USEPA 2009	Unchanged	
Cobalt	NSV	--	NSV	--	Unchanged	
Copper	3.70	USEPA 1999b	3.73	USEPA 2009	Unchanged	
Cyanide	1.00	USEPA 1995	1.00	USEPA 2009	Unchanged	
Iron	NSV	--	NSV	--	Unchanged	
Lead	8.50	USEPA 1999b	8.52	USEPA 2009	Unchanged	
Manganese	10.0	USEPA 1995	100	Buchman 2008	Unchanged	
Mercury	1.10	USEPA 1999b	1.11	USEPA 2009	Unchanged	
Nickel	8.30	USEPA 1995	8.28	USEPA 2009	Unchanged	
Selenium	71.0	USEPA 1999b	71.1	USEPA 2009	Unchanged	
Silver	0.23	USEPA 1999a	0.23	USEPA 2001	Unchanged	
Thallium	213	USEPA 1995 (with UF of 10)	21.3	USEPA 2001	Unchanged	Maximum HQ <1
Vanadium	10,000	USEPA 1995	50.0	Buchman 2008	Unchanged	Maximum HQ <1
Zinc	86.0	USEPA 1999b	85.6	USEPA 2009	Unchanged	
Pesticides/PCBs						
4,4'-DDD	0.025	USEPA 1999a	0.025	USEPA 2001	Unchanged	
4,4'-DDE	1.40	USEPA 1995 (with UF of 10)	0.14	USEPA 2001	Unchanged	Maximum HQ <1
4,4'-DDT	0.001	USEPA 1995	0.0065	USEPA 2006b	Unchanged	

Table 5-8

Comparison Between Prior Ecological Screening Values (2001) and 2013 Ecological Screening Values - Sites 9 and 10

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Aldrin	0.13	USEPA 1995 (with UF of 10)	0.13	USEPA 2001	Unchanged	
alpha-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	USEPA 2006b	Unchanged	
alpha-Chlordane	0.004	USEPA 1995	0.004	USEPA 2009	Unchanged	
Aroclor-1016	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1221	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1232	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1242	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1248	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1254	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1260	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
beta-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	alpha-BHC	Unchanged	
delta-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	alpha-BHC	Unchanged	
Dieldrin	0.0019	USEPA 1995	0.11	USEPA 1996	Unchanged	
Endosulfan I	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endosulfan II	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endosulfan sulfate	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endrin	0.0023	USEPA 1995	0.01	USEPA 1996	Unchanged	
Endrin aldehyde	0.0023	USEPA 1995	0.01	Endrin	Unchanged	
Endrin ketone	0.0023	USEPA 1995	0.01	Endrin	Unchanged	
gamma-BHC (Lindane)	0.016	USEPA 1995 (with UF of 10)	0.016	USEPA 2001	Unchanged	
gamma-Chlordane	0.004	USEPA 1995	0.004	USEPA 2009	Unchanged	
Heptachlor	0.0036	USEPA 1995	0.0036	USEPA 2009	Unchanged	
Heptachlor epoxide	0.0036	USEPA 1995	0.0036	USEPA 2009	Unchanged	
Methoxychlor	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Toxaphene	0.21	USEPA 1996	0.21	USEPA 1996	Unchanged	
Semivolatile Organic Compounds						
1,2,4-Trichlorobenzene	129	USEPA 1995	5.40	USEPA 2006b	Unchanged	Not detected
1,2-Dichlorobenzene	129	USEPA 1995	42.0	USEPA 2006b	Unchanged	Maximum HQ <1
1,3-Dichlorobenzene	28.5	USEPA 1999a	28.5	USEPA 2001	Unchanged	
1,4-Dichlorobenzene	129	USEPA 1995	19.9	USEPA 2001	Unchanged	Maximum HQ <1
2,2'-Oxybis(1-chloropropane)	NSV	--	NSV	--	Unchanged	
2,4,5-Trichlorophenol	11.0	USEPA 1995	12.0	USEPA 2006b	Unchanged	
2,4,6-Trichlorophenol	NSV	--	61.0	USEPA 2006b	Unchanged	Maximum HQ <1

Table 5-8

Comparison Between Prior Ecological Screening Values (2001) and 2013 Ecological Screening Values - Sites 9 and 10

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
2,4-Dichlorophenol	NSV	--	NSV	--	Unchanged	
2,4-Dimethylphenol	110	Federal Register 59:3762 (1994)	100	Buchman 2008	Unchanged	Maximum HQ <1
2,4-Dinitrophenol	485	USEPA 1995 (with UF of 10)	48.5	USEPA 2001	Unchanged	Maximum HQ <1
2,4-Dinitrotoluene	370	USEPA 1995	480	Nipper et al. 2001	Unchanged	
2,6-Dinitrotoluene	NSV	--	1,000	Nipper et al. 2001	Unchanged	Maximum HQ <1
2-Chloronaphthalene	0.75	USEPA 1995 (with UF of 10)	0.40	Buchman 2008	Unchanged	Not detected
2-Chlorophenol	NSV	--	265	USEPA 2006b	Unchanged	Maximum HQ <1
2-Methylnaphthalene	30.0	USEPA 1995 (with UF of 10)	330	Buchman 2008	Unchanged	
2-Methylphenol	NSV	--	1,020	USEPA 2006b	Unchanged	Maximum HQ <1
2-Nitroaniline	NSV	--	NSV	--	Unchanged	
2-Nitrophenol	485	USEPA 1994	2,940	USEPA 2006b	Unchanged	
3,3'-Dichlorobenzidine	NSV	--	73.0	USEPA 2006b	Unchanged	Maximum HQ <1
3-Nitroaniline	NSV	--	NSV	--	Unchanged	
4,6-Dinitro-2-methylphenol	NSV	--	NSV	--	Unchanged	
4-Bromophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Chloro-3-methylphenol	NSV	--	NSV	--	Unchanged	
4-Chloroaniline	129	Buchman 1999	129	Buchman 2008	Unchanged	
4-Chlorophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Methylphenol	NSV	--	NSV	--	Unchanged	
4-Nitroaniline	NSV	--	NSV	--	Unchanged	
4-Nitrophenol	485	USEPA 1995 (with UF of 10)	71.7	USEPA 2001	Unchanged	Maximum HQ <1
Acenaphthene	710	USEPA 1995	40.0	USEPA 1996	Unchanged	Maximum HQ <1
Acenaphthylene	30.0	USEPA 1995 (with UF of 10)	4,840	Buchman 2008	Unchanged	
Anthracene	30.0	USEPA 1995 (with UF of 10)	0.18	USEPA 2006b	Unchanged	Not detected
Benzo(a)anthracene	8.13	USEPA 1995	0.027	Suter and Tsao 1996	Unchanged	Not detected
Benzo(a)pyrene	0.021	USEPA 1995 (with UF of 10)	0.014	Suter and Tsao 1996	Unchanged	Not detected
Benzo(b)fluoranthene	30.0	USEPA 1995 (with UF of 10)	9.07	Buchman 2008	Unchanged	Not detected
Benzo(g,h,i)perylene	30.0	USEPA 1995 (with UF of 10)	7.64	Buchman 2008	Unchanged	Not detected
Benzo(k)fluoranthene	30.0	USEPA 1995 (with UF of 10)	9.07	Benzo(b)fluoranthene value	Unchanged	Not detected
bis(2-Chloroethoxy)methane	6,400	USEPA 1995	6,400	Buchman 2008	Unchanged	
bis(2-Chloroethyl)ether	NSV	--	NSV	--	Unchanged	
bis(2-Ethylhexyl)phthalate	360	USEPA 1995	360	Buchman 2008	Unchanged	

Table 5-8

Comparison Between Prior Ecological Screening Values (2001) and 2013 Ecological Screening Values - Sites 9 and 10

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Butylbenzylphthalate	29.4	USEPA 1999a	29.4	USEPA 2001	Unchanged	
Carbazole	NSV	--	NSV	--	Unchanged	
Chrysene	30.0	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Dibenz(a,h)anthracene	30.0	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Dibenzofuran	NSV	--	65.0	USEPA 2006b	Unchanged	Maximum HQ <1
Diethylphthalate	75.9	USEPA 1999a	75.9	USEPA 2001	Unchanged	
Dimethyl phthalate	580	USEPA 1999a	580	USEPA 2001	Unchanged	
Di-n-butylphthalate	3.40	USEPA 1995	3.40	USEPA 2001	Unchanged	
Di-n-octylphthalate	3.40	USEPA 1995	3.40	Buchman 2008	Unchanged	
Fluoranthene	16.0	USEPA 1995	11.0	USEPA 1996	Unchanged	Maximum HQ <1
Fluorene	30.0	USEPA 1995 (with UF of 10)	3.90	USEPA 1996	Unchanged	Not detected
Hexachlorobenzene	129	USEPA 1995	3.68	Buchman 2008	Unchanged	Not detected
Hexachlorobutadiene	3.20	USEPA 1995 (with UF of 10)	0.32	USEPA 2001	Unchanged	Not detected
Hexachlorocyclopentadiene	0.70	USEPA 1995 (with UF of 10)	0.07	USEPA 2001	Unchanged	Not detected
Hexachloroethane	94.0	USEPA 1995 (with UF of 10)	9.40	USEPA 2001	Unchanged	Not detected
Indeno(1,2,3-cd)pyrene	30.0	USEPA 1995 (with UF of 10)	4.31	Buchman 2008	Unchanged	Not detected
Isophorone	1,290	USEPA 1995 (with UF of 10)	129	USEPA 2001	Unchanged	Maximum HQ <1
Naphthalene	230	USEPA 1995 (with UF of 10)	23.5	USEPA 2001	Unchanged	Maximum HQ <1
Nitrobenzene	668	USEPA 1995 (with UF of 10)	66.8	USEPA 2001	Unchanged	Maximum HQ <1
n-Nitroso-di-n-propylamine	NSV	--	120	USEPA 2006b	Unchanged	Maximum HQ <1
n-Nitrosodiphenylamine	330,000	USEPA 1995 (with UF of 10)	33,000	USEPA 2001	Unchanged	Maximum HQ <1
Pentachlorophenol	7.90	USEPA 1995	7.90	USEPA 2009	Unchanged	
Phenanthrene	4.60	USEPA 1995	8.30	USEPA 1996	Unchanged	
Phenol	580	USEPA 1995 (with UF of 10)	58.0	USEPA 2001	Unchanged	Maximum HQ <1
Pyrene	30.0	USEPA 1995 (with UF of 10)	0.24	USEPA 2006b	Unchanged	Not detected
Volatile Organic Compounds						
1,1,1-Trichloroethane	3,120	USEPA 1995 (with UF of 10)	312	USEPA 2001	Unchanged	Maximum HQ <1
1,1,2,2-Tetrachloroethane	623	USEPA 1995 (with UF of 10)	90.2	USEPA 2001	Unchanged	Maximum HQ <1
1,1,2-Trichloroethane	3,120	USEPA 1995 (with UF of 10)	550	USEPA 2006b	Unchanged	Maximum HQ <1
1,1-Dichloroethane	3,200	USEPA 1995 (with UF of 100)	47.0	Suter and Tsao 1996	Unchanged	Maximum HQ <1
1,1-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	2,240	USEPA 2001	Unchanged	Maximum HQ <1
1,2,4-Trichlorobenzene	129	USEPA 1995	5.40	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dibromo-3-chloropropane	NSV	--	NSV	--	Unchanged	

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Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
1,2-Dibromoethane	NSV	--	NSV	--	Unchanged	
1,2-Dichlorobenzene	129	USEPA 1995	42.0	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dichloroethane	1,130	USEPA 1995 (with UF of 100)	1,130	USEPA 2001	Unchanged	
1,2-Dichloroethene (total)	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dichloropropane	3,040	USEPA 1995	2,400	USEPA 2001	Unchanged	Maximum HQ <1
1,3-Dichlorobenzene	28.5	USEPA 1999a	28.5	USEPA 2001	Unchanged	
1,4-Dichlorobenzene	129	USEPA 1995	19.9	USEPA 2001	Unchanged	Maximum HQ <1
2-Butanone	NSV	--	NSV	--	Unchanged	
2-Hexanone	NSV	--	NSV	--	Unchanged	
4-Methyl-2-pentanone	NSV	--	123,000	USEPA 2006b	Unchanged	Maximum HQ <1
Acetone	NSV	--	564,000	USEPA 2006b	Unchanged	Maximum HQ <1
Benzene	700	USEPA 1995	110	USEPA 2006b	Unchanged	Maximum HQ <1
Bromochloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Bromodichloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Bromoform	640	USEPA 1999a	640	USEPA 2001	Unchanged	
Bromomethane	120	USEPA 1999a	120	USEPA 2001	Unchanged	
Carbon disulfide	2.00	USEPA 1995	0.92	Suter and Tsao 1996	Unchanged	Not detected
Carbon tetrachloride	5,000	USEPA 1995 (with UF of 10)	1,500	USEPA 2001	Unchanged	Maximum HQ <1
Chlorobenzene	105	USEPA 1999a	25.0	USEPA 2006b	Unchanged	Maximum HQ <1
Chloroethane	NSV	--	NSV	--	Unchanged	
Chloroform	815	USEPA 1999a	815	USEPA 2001	Unchanged	
Chloromethane	2,700	USEPA 1999a	2,700	USEPA 2001	Unchanged	
cis-1,2-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
cis-1,3-Dichloropropene	79.0	USEPA 1995 (with UF of 10)	7.90	USEPA 2001	Unchanged	Not detected
Dibromochloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Ethylbenzene	43.0	USEPA 1995 (with UF of 10)	25.0	USEPA 2006b	Unchanged	Maximum HQ <1
Methylene chloride	6,400	USEPA 1995	2,560	USEPA 2001	Unchanged	Maximum HQ <1
Styrene	NSV	--	910	USEPA 2006b	Unchanged	Maximum HQ <1
Tetrachloroethene	450	USEPA 1995	45.0	USEPA 2001	Unchanged	Maximum HQ <1
Toluene	37.0	USEPA 1999a	215	USEPA 2006b	Unchanged	
trans-1,2-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
trans-1,3-Dichloropropene	79.0	USEPA 1995 (with UF of 10)	7.90	USEPA 2001	Unchanged	Not detected
Trichloroethene	200	USEPA 1995 (with UF of 10)	1,940	USEPA 2006b	Unchanged	

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Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Vinyl chloride	22,400	USEPA 1995 (with UF of 10)	930	USEPA 2006b	Unchanged	Maximum HQ <1
Xylene, total	135	USEPA 1995	19.0	USEPA 2006b	Unchanged	Maximum HQ <1
Site 10 Surface Soil						
Inorganics						
Aluminum	50.0	Efroymson et al. 1997a	pH < 5.5	USEPA 2003a	Unchanged	Background
Antimony	5.00	Efroymson et al. 1997a	78.0	USEPA 2005a	Unchanged	
Arsenic	60.0	Efroymson et al. 1997b	18.0	USEPA 2005b	Unchanged	Maximum HQ <1
Barium	500	Efroymson et al. 1997a	330	USEPA 2005c	Unchanged	Maximum HQ <1
Beryllium	10.0	Efroymson et al. 1997a	40.0	USEPA 2005d	Unchanged	
Cadmium	4.00	Efroymson et al. 1997a	32.0	USEPA 2005e	Unchanged	
Chromium	0.40	Efroymson et al. 1997b	64.0	CCME 2007	Unchanged	
Cobalt	100	USEPA 1995	13.0	USEPA 2005f	Unchanged	Maximum HQ <1
Copper	50.0	Efroymson et al. 1997b	70.0	USEPA 2007a	Unchanged	
Cyanide	0.06	Eisler 1991	15.8	MHSPE 2000	Unchanged	
Iron	200	Efroymson et al. 1997b	5 < pH > 8	USEPA 2003b	Unchanged	Background
Lead	50.0	Efroymson et al. 1997a	120	USEPA 2005g	Unchanged	
Manganese	500	Efroymson et al. 1997a	220	USEPA 2007b	Unchanged	Maximum HQ <1
Mercury	0.10	Efroymson et al. 1997b	0.10	Efroymson et al. 1997b	Unchanged	
Nickel	30.0	Efroymson et al. 1997a	38.0	USEPA 2007c	Unchanged	
Selenium	1.80	USEPA 1995	0.52	USEPA 2007d	Unchanged	Maximum HQ <1
Silver	2.00	Efroymson et al. 1997a	560	USEPA 2006a	Unchanged	
Thallium	1.00	Efroymson et al. 1997a	1.00	Efroymson et al. 1997a	Unchanged	
Vanadium	2.00	Efroymson et al. 1997a	130	CCME 2007	Unchanged	
Zinc	50.0	Efroymson et al. 1997a	120	USEPA 2007e	Unchanged	
Pesticides/PBCs						
4,4'-DDD	100	USEPA 1995	583	MHSPE 2000; 2001	Unchanged	
4,4'-DDE	100	USEPA 1995	114	MHSPE 2000; 2001	Unchanged	
4,4'-DDT	100	USEPA 1995	100	MHSPE 2000; 2001	Unchanged	
Aldrin	100	USEPA 1995	3.63	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
alpha-BHC	100,000	USEPA 1995	226	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
alpha-Chlordane	100	USEPA 1995	11.0	MHSPE 2000	Unchanged	Mean HQ <1
Aroclor-1016	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1221	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	

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Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Aroclor-1232	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1242	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1248	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1254	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
Aroclor-1260	100	USEPA 1995	8,000	Efroymson et al. 1997a	Unchanged	
beta-BHC	100,000	USEPA 1995	342	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
delta-BHC	100,000	USEPA 1995	226	alpha-BHC	Unchanged	Maximum HQ <1
Dieldrin	100	USEPA 1995	10.5	MHSPE 2000; 2001	Unchanged	Mean HQ <1
Endosulfan I	NSV	--	6.32	MHSPE 2000	Unchanged	Maximum HQ <1
Endosulfan II	NSV	--	6.32	MHSPE 2000	Unchanged	Maximum HQ <1
Endosulfan sulfate	NSV	--	6.32	Endosulfan	Unchanged	Maximum HQ <1
Endrin	100	USEPA 1995	1.95	MHSPE 2000; 2001	Unchanged	Not detected
Endrin aldehyde	100	USEPA 1995	1.95	Endrin	Unchanged	Not detected
Endrin ketone	100	USEPA 1995	1.95	Endrin	Unchanged	Not detected
gamma-BHC (Lindane)	100	USEPA 1995	7.75	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
gamma-Chlordane	100	USEPA 1995	11.0	MHSPE 2000	Unchanged	Maximum HQ <1
Heptachlor	NSV	--	52.9	MHSPE 2000	Unchanged	Maximum HQ <1
Heptachlor epoxide	100	USEPA 1995	52.9	Heptachlor	Unchanged	Maximum HQ <1
Methoxychlor	100	USEPA 1995	500	Beyer 1990	Unchanged	
Toxaphene	NSV		500	Beyer 1990	Unchanged	Maximum HQ <1
Semivolatile Organic Compounds						
1,2,4-Trichlorobenzene	1,270	Efroymson et al. 1997b	1,270	Efroymson et al. 1997b	Unchanged	
1,2-Dichlorobenzene	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
1,3-Dichlorobenzene	NSV	--	1,000	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
1,4-Dichlorobenzene	1,280	Efroymson et al. 1997b	1,280	Efroymson et al. 1997b	Unchanged	
2,2'-Oxybis(1-chloropropane)	NSV	--	NSV	--	Unchanged	
2,4,5-Trichlorophenol	430	Efroymson et al. 1997a	1,350	Efroymson et al. 1997a	Unchanged	
2,4,6-Trichlorophenol	580	Efroymson et al. 1997b	580	Efroymson et al. 1997b	Unchanged	
2,4-Dichlorophenol	13,400	Efroymson et al. 1997b	500	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
2,4-Dimethylphenol	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
2,4-Dinitrophenol	20,000	Efroymson et al. 1997a	20,000	Efroymson et al. 1997a	Unchanged	
2,4-Dinitrotoluene	NSV	--	11,000	NRCC 2006	Unchanged	Maximum HQ <1
2,6-Dinitrotoluene	NSV	--	8,500	NRCC 2006	Unchanged	Maximum HQ <1

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Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
2-Chloronaphthalene	1,033	MHSPE 1994	LMW PAH	--	Unchanged	Maximum HQ <1
2-Chlorophenol	100	USEPA 1995	500	Beyer 1990; CCME 2007	Unchanged	
2-Methylnaphthalene	NSV	--	LMW PAH	--	Unchanged	Maximum HQ <1
2-Methylphenol	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
2-Nitroaniline	NSV	--	NSV	--	Unchanged	
2-Nitrophenol	NSV	--	1,000	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
3,3'-Dichlorobenzidine	NSV	--	NSV	--	Unchanged	
3-Nitroaniline	NSV	--	NSV	--	Unchanged	
4,6-Dinitro-2-methylphenol	NSV	--	1,000	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
4-Bromophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Chloro-3-methylphenol	NSV	--	500	Beyer 1990; CCME 2007	Unchanged	Maximum HQ <1
4-Chloroaniline	NSV	--	500	MHSPE 2000	Unchanged	Maximum HQ <1
4-Chlorophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Methylphenol	100	USEPA 1995	1,000	Beyer 1990; CCME 2007	Unchanged	
4-Nitroaniline	NSV	--	NSV	--	Unchanged	
4-Nitrophenol	380	Efroymson et al. 1997b	380	Efroymson et al. 1997b	Unchanged	
Acenaphthene	2,500	Efroymson et al. 1997a	LMW PAH	--	Unchanged	Maximum HQ <1
Acenaphthylene	100	USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Anthracene	100	MHSPE 1994; USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Benzo(a)anthracene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(a)pyrene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(b)fluoranthene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(g,h,i)perylene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Benzo(k)fluoranthene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
bis(2-Chloroethoxy)methane	NSV	--	NSV	--	Unchanged	
bis(2-Chloroethyl)ether	NSV	--	NSV	--	Unchanged	
bis(2-Ethylhexyl)phthalate	NSV	--	30,000	CCME 2007	Unchanged	Maximum HQ <1
Butylbenzylphthalate	NSV	--	30,000	CCME 2007	Unchanged	Maximum HQ <1
Carbazole	NSV	--	NSV	--	Unchanged	
Chrysene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Dibenz(a,h)anthracene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Dibenzofuran	NSV	--	NSV	--	Unchanged	
Diethylphthalate	13,400	Efroymson et al. 1997a	26,800	Efroymson et al. 1997a	Unchanged	

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Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Dimethyl phthalate	10,640	Efroymson et al. 1997b	10,640	Efroymson et al. 1997b	Unchanged	
Di-n-butylphthalate	200,000	Efroymson et al. 1997a	40,000	Efroymson et al. 1997a	Unchanged	Maximum HQ <1
Di-n-octylphthalate	NSV	--	30,000	CCME 2007	Unchanged	Maximum HQ <1
Fluoranthene	100	MHSPE 1994; USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Fluorene	1,700	Efroymson et al. 1997b	LMW PAH	--	Unchanged	Maximum HQ <1
Hexachlorobenzene	NSV	--	1,000	Beyer 1990	Unchanged	Maximum HQ <1
Hexachlorobutadiene	NSV	--	NSV	--	Unchanged	
Hexachlorocyclopentadiene	1,000	Efroymson et al. 1997a	2,000	Efroymson et al. 1997a	Unchanged	
Hexachloroethane	NSV	--	NSV	--	Unchanged	
Indeno(1,2,3-cd)pyrene	100	MHSPE 1994; USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Isophorone	NSV	--	NSV	--	Unchanged	
Naphthalene	100	MHSPE 1994; USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Nitrobenzene	2,260	Efroymson et al. 1997b	2,260	Efroymson et al. 1997b	Unchanged	
n-Nitroso-di-n-propylamine	NSV	--	NSV	--	Unchanged	
n-Nitrosodiphenylamine	1,090	Efroymson et al. 1997b	1,090	Efroymson et al. 1997b	Unchanged	
PAH (HMW)	--	--	18,000	USEPA 2007f	Unchanged	Maximum HQ <1
PAH (LMW)	--	--	29,000	USEPA 2007f	Unchanged	Maximum HQ <1
Pentachlorophenol	3,000	Efroymson et al. 1997a	5,000	USEPA 2007g	Unchanged	
Phenanthrene	100	MHSPE 1994; USEPA 1995	LMW PAH	--	Unchanged	Maximum HQ <1
Phenol	1,880	Efroymson et al. 1997b	1,880	Efroymson et al. 1997b	Unchanged	
Pyrene	100	USEPA 1995	HMW PAH	--	Unchanged	Maximum HQ <1
Volatile Organic Compounds						
1,1,1-Trichloroethane	300	USEPA 1995	1,025	MHSPE 2000	Unchanged	
1,1,2,2-Tetrachloroethane	300	USEPA 1995	5,000	Beyer 1990; CCME 2007	Unchanged	
1,1,2-Trichloroethane	300	USEPA 1995	2,000	MHSPE 2000	Unchanged	
1,1-Dichloroethane	300	USEPA 1995	548	MHSPE 2000	Unchanged	
1,1-Dichloroethene	NSV	--	173	MHSPE 2000	Unchanged	
1,2-Dichloroethane	401	MHSPE 1994	2,190	MHSPE 2000; 2001	Unchanged	
1,2-Dichloroethene (total)	300	USEPA 1995	447	MHSPE 2000	Unchanged	
1,2-Dichloropropane	38,800	Efroymson et al. 1997b	38,800	Efroymson et al. 1997b	Unchanged	
2-Butanone	NSV	--	NSV	--	Unchanged	
2-Hexanone	NSV	--	NSV	--	Unchanged	
4-Methyl-2-pentanone	10,000	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected

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Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Acetone	NSV	--	NSV	--	Unchanged	
Benzene	105	MHSPE 1994	1,140	MHSPE 2000; 2001	Unchanged	
Bromodichloromethane	45,000	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Bromoform	114,700	USEPA 1995 (with UF of 10)	300	CCME 2007	Unchanged	Maximum HQ <1
Bromomethane	NSV	--	NSV	--	Unchanged	
Carbon disulfide	NSV	--	NSV	--	Unchanged	
Carbon tetrachloride	1,000,000	Efroymson et al. 1997b	3,400	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Chlorobenzene	2,400	Efroymson et al. 1997b	2,400	Efroymson et al. 1997b	Unchanged	
Chloroethane	NSV	--	5,000	CCME 2007	Unchanged	Maximum HQ <1
Chloroform	1,000	MHSPE 1994	1,844	MHSPE 2000; 2001	Unchanged	
Chloromethane	NSV	--	5,000	CCME 2007	Unchanged	Maximum HQ <1
cis-1,3-Dichloropropene	300	USEPA 1995	5,000	Beyer 1990; CCME 2007	Unchanged	
Dibromochloromethane	NSV	--	NSV	--	Unchanged	
Ethylbenzene	5,005	MHSPE 1994	1,815	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Methylene chloride	1,001	MHSPE 1994	1,250	MHSPE 2000; 2001	Unchanged	
Styrene	10,010	MHSPE 1994	64,000	Efroymson et al. 1997a	Unchanged	
Tetrachloroethene	401	MHSPE 1994	179	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Toluene	13,005	MHSPE 1994	40,000	Efroymson et al. 1997a	Unchanged	
trans-1,3-Dichloropropene	300	USEPA 1995	5,000	Beyer 1990; CCME 2007	Unchanged	
Trichloroethene	6,000	MHSPE 1994	500	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Vinyl chloride	300	USEPA 1995	412	MHSPE 2000; 2001	Unchanged	
Xylene, total	2,505	MHSPE 1994	1,300	MHSPE 2000; 2001	Unchanged	Maximum HQ <1
Site 10 Groundwater						
Inorganics						
Aluminum	NSV	--	NSV	--	Unchanged	
Antimony	500	USEPA 1995	500	USEPA 2006b	Unchanged	
Arsenic	36.0	USEPA 1999b	36.0	USEPA 2009	Unchanged	
Barium	1,000	USEPA 1995 (with UF of 10)	200	Buchman 2008	Unchanged	Mean HQ <1
Beryllium	1,500	USEPA 1995	100	Buchman 2008	Unchanged	Maximum HQ <1
Cadmium	9.40	USEPA 1999b	8.85	USEPA 2009	Unchanged	Mean HQ <1
Chromium	50.4	USEPA 1999b	50.4	USEPA 2009	Unchanged	
Cobalt	NSV	--	NSV	--	Unchanged	
Copper	3.70	USEPA 1999b	3.73	USEPA 2009	Unchanged	

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Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Cyanide	1.00	USEPA 1995	1.00	USEPA 2009	Unchanged	
Iron	NSV	--	NSV	--	Unchanged	
Lead	8.50	USEPA 1999b	8.52	USEPA 2009	Unchanged	
Manganese	10.0	USEPA 1995	100	Buchman 2008	Unchanged	
Mercury	1.10	USEPA 1999b	1.11	USEPA 2009	Unchanged	
Nickel	8.30	USEPA 1995	8.28	USEPA 2009	Unchanged	
Selenium	71.0	USEPA 1999b	71.1	USEPA 2009	Unchanged	
Silver	0.23	USEPA 1999a	0.23	USEPA 2001	Unchanged	
Thallium	213	USEPA 1995 (with UF of 10)	21.3	USEPA 2001	Unchanged	Maximum HQ <1
Vanadium	10,000	USEPA 1995	50.0	Buchman 2008	Unchanged	Maximum HQ <1
Zinc	86.0	USEPA 1999b	85.6	USEPA 2009	Unchanged	
Pesticides/PCBs						
4,4'-DDD	0.025	USEPA 1999a	0.025	USEPA 2001	Unchanged	
4,4'-DDE	1.40	USEPA 1995 (with UF of 10)	0.14	USEPA 2001	Unchanged	Maximum HQ <1
4,4'-DDT	0.001	USEPA 1995	0.0065	USEPA 2006b	Unchanged	
Aldrin	0.13	USEPA 1995 (with UF of 10)	0.13	USEPA 2001	Unchanged	
alpha-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	USEPA 2006b	Unchanged	
alpha-Chlordane	0.004	USEPA 1995	0.004	USEPA 2009	Unchanged	
Aroclor-1016	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1221	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1232	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1242	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1248	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1254	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Aroclor-1260	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
beta-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	alpha-BHC	Unchanged	
delta-BHC	0.034	USEPA 1995 (with UF of 10)	25.0	alpha-BHC	Unchanged	
Dieldrin	0.0019	USEPA 1995	0.11	USEPA 1996	Unchanged	
Endosulfan I	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endosulfan II	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endosulfan sulfate	0.0087	USEPA 1995	0.0087	USEPA 2009	Unchanged	
Endrin	0.0023	USEPA 1995	0.01	USEPA 1996	Unchanged	
Endrin aldehyde	0.0023	USEPA 1995	0.01	Endrin	Unchanged	

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Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Endrin ketone	0.0023	USEPA 1995	0.01	Endrin	Unchanged	
gamma-BHC (Lindane)	0.016	USEPA 1995 (with UF of 10)	0.016	USEPA 2001	Unchanged	
gamma-Chlordane	0.004	USEPA 1995	0.004	USEPA 2009	Unchanged	
Heptachlor	0.0036	USEPA 1995	0.0036	USEPA 2009	Unchanged	
Heptachlor epoxide	0.0036	USEPA 1995	0.0036	USEPA 2009	Unchanged	
Methoxychlor	0.03	USEPA 1995	0.03	USEPA 2009	Unchanged	
Toxaphene	0.21	USEPA 1996	0.21	USEPA 1996	Unchanged	
Semivolatile Organic Compounds						
1,2,4-Trichlorobenzene	129	USEPA 1995	5.40	USEPA 2006b	Unchanged	Not detected
1,2-Dichlorobenzene	129	USEPA 1995	42.0	USEPA 2006b	Unchanged	Maximum HQ <1
1,3-Dichlorobenzene	28.5	USEPA 1999a	28.5	USEPA 2001	Unchanged	
1,4-Dichlorobenzene	129	USEPA 1995	19.9	USEPA 2001	Unchanged	Maximum HQ <1
2,2'-Oxybis(1-chloropropane)	NSV	--	NSV	--	Unchanged	
2,4,5-Trichlorophenol	11.0	USEPA 1995	12.0	USEPA 2006b	Unchanged	
2,4,6-Trichlorophenol	NSV	--	61.0	USEPA 2006b	Unchanged	Maximum HQ <1
2,4-Dichlorophenol	NSV	--	NSV	--	Unchanged	
2,4-Dimethylphenol	110	Federal Register 59:3762 (1994)	100	Buchman 2008	Unchanged	Maximum HQ <1
2,4-Dinitrophenol	485	USEPA 1995 (with UF of 10)	48.5	USEPA 2001	Unchanged	Maximum HQ <1
2,4-Dinitrotoluene	370	USEPA 1995	480	Nipper et al. 2001	Unchanged	
2,6-Dinitrotoluene	NSV	--	1,000	Nipper et al. 2001	Unchanged	Maximum HQ <1
2-Chloronaphthalene	0.75	USEPA 1995 (with UF of 10)	0.40	Buchman 2008	Unchanged	Not detected
2-Chlorophenol	NSV	--	265	USEPA 2006b	Unchanged	Maximum HQ <1
2-Methylnaphthalene	30.0	USEPA 1995 (with UF of 10)	330	Buchman 2008	Unchanged	
2-Methylphenol	NSV	--	1,020	USEPA 2006b	Unchanged	Maximum HQ <1
2-Nitroaniline	NSV	--	NSV	--	Unchanged	
2-Nitrophenol	485	USEPA 1994	2,940	USEPA 2006b	Unchanged	
3,3'-Dichlorobenzidine	NSV	--	73.0	USEPA 2006b	Unchanged	Maximum HQ <1
3-Nitroaniline	NSV	--	NSV	--	Unchanged	
4,6-Dinitro-2-methylphenol	NSV	--	NSV	--	Unchanged	
4-Bromophenyl-phenylether	NSV	--	NSV	--	Unchanged	
4-Chloro-3-methylphenol	NSV	--	NSV	--	Unchanged	
4-Chloroaniline	129	Buchman 1999	129	Buchman 2008	Unchanged	
4-Chlorophenyl-phenylether	NSV	--	NSV	--	Unchanged	

Table 5-8

Comparison Between Prior Ecological Screening Values (2001) and 2013 Ecological Screening Values - Sites 9 and 10

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
4-Methylphenol	NSV	--	NSV	--	Unchanged	
4-Nitroaniline	NSV	--	NSV	--	Unchanged	
4-Nitrophenol	485	USEPA 1995 (with UF of 10)	71.7	USEPA 2001	Unchanged	Maximum HQ <1
Acenaphthene	710	USEPA 1995	40.0	USEPA 1996	Unchanged	Maximum HQ <1
Acenaphthylene	30.0	USEPA 1995 (with UF of 10)	4,840	Buchman 2008	Unchanged	
Anthracene	30.0	USEPA 1995 (with UF of 10)	0.18	USEPA 2006b	Unchanged	Not detected
Benzo(a)anthracene	8.13	USEPA 1995	0.027	Suter and Tsao 1996	Unchanged	Not detected
Benzo(a)pyrene	0.021	USEPA 1995 (with UF of 10)	0.014	Suter and Tsao 1996	Unchanged	Not detected
Benzo(b)fluoranthene	30.0	USEPA 1995 (with UF of 10)	9.07	Buchman 2008	Unchanged	Not detected
Benzo(g,h,i)perylene	30.0	USEPA 1995 (with UF of 10)	7.64	Buchman 2008	Unchanged	Not detected
Benzo(k)fluoranthene	30.0	USEPA 1995 (with UF of 10)	9.07	Benzo(b)fluoranthene value	Unchanged	Not detected
bis(2-Chloroethoxy)methane	6,400	USEPA 1995	6,400	Buchman 2008	Unchanged	
bis(2-Chloroethyl)ether	NSV	--	NSV	--	Unchanged	
bis(2-Ethylhexyl)phthalate	360	USEPA 1995	360	Buchman 2008	Unchanged	
Butylbenzylphthalate	29.4	USEPA 1999a	29.4	USEPA 2001	Unchanged	
Carbazole	NSV	--	NSV	--	Unchanged	
Chrysene	30.0	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Dibenz(a,h)anthracene	30.0	USEPA 1995 (with UF of 10)	NSV	--	Unchanged	Not detected
Dibenzofuran	NSV	--	65.0	USEPA 2006b	Unchanged	Maximum HQ <1
Diethylphthalate	75.9	USEPA 1999a	75.9	USEPA 2001	Unchanged	
Dimethyl phthalate	580	USEPA 1999a	580	USEPA 2001	Unchanged	
Di-n-butylphthalate	3.40	USEPA 1995	3.40	USEPA 2001	Unchanged	
Di-n-octylphthalate	3.40	USEPA 1995	3.40	Buchman 2008	Unchanged	
Fluoranthene	16.0	USEPA 1995	11.0	USEPA 1996	Unchanged	Maximum HQ <1
Fluorene	30.0	USEPA 1995 (with UF of 10)	3.90	USEPA 1996	Unchanged	Not detected
Hexachlorobenzene	129	USEPA 1995	3.68	Buchman 2008	Unchanged	Not detected
Hexachlorobutadiene	3.20	USEPA 1995 (with UF of 10)	0.32	USEPA 2001	Unchanged	Not detected
Hexachlorocyclopentadiene	0.70	USEPA 1995 (with UF of 10)	0.07	USEPA 2001	Unchanged	Not detected
Hexachloroethane	94.0	USEPA 1995 (with UF of 10)	9.40	USEPA 2001	Unchanged	Not detected
Indeno(1,2,3-cd)pyrene	30.0	USEPA 1995 (with UF of 10)	4.31	Buchman 2008	Unchanged	Not detected
Isophorone	1,290	USEPA 1995 (with UF of 10)	129	USEPA 2001	Unchanged	Maximum HQ <1
Naphthalene	230	USEPA 1995 (with UF of 10)	23.5	USEPA 2001	Unchanged	Maximum HQ <1

Table 5-8

Comparison Between Prior Ecological Screening Values (2001) and 2013 Ecological Screening Values - Sites 9 and 10

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Nitrobenzene	668	USEPA 1995 (with UF of 10)	66.8	USEPA 2001	Unchanged	Maximum HQ <1
n-Nitroso-di-n-propylamine	NSV	--	120	USEPA 2006b	Unchanged	Maximum HQ <1
n-Nitrosodiphenylamine	330,000	USEPA 1995 (with UF of 10)	33,000	USEPA 2001	Unchanged	Maximum HQ <1
Pentachlorophenol	7.90	USEPA 1995	7.90	USEPA 2009	Unchanged	
Phenanthrene	4.60	USEPA 1995	8.30	USEPA 1996	Unchanged	
Phenol	580	USEPA 1995 (with UF of 10)	58.0	USEPA 2001	Unchanged	Maximum HQ <1
Pyrene	30.0	USEPA 1995 (with UF of 10)	0.24	USEPA 2006b	Unchanged	Not detected
Volatile Organic Compounds						
1,1,1-Trichloroethane	3,120	USEPA 1995 (with UF of 10)	312	USEPA 2001	Unchanged	Maximum HQ <1
1,1,2,2-Tetrachloroethane	623	USEPA 1995 (with UF of 10)	90.2	USEPA 2001	Unchanged	Maximum HQ <1
1,1,2-Trichloroethane	3,120	USEPA 1995 (with UF of 10)	550	USEPA 2006b	Unchanged	Maximum HQ <1
1,1-Dichloroethane	3,200	USEPA 1995 (with UF of 100)	47.0	Suter and Tsao 1996	Unchanged	Maximum HQ <1
1,1-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	2,240	USEPA 2001	Unchanged	Maximum HQ <1
1,2,4-Trichlorobenzene	129	USEPA 1995	5.40	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dibromo-3-chloropropane	NSV	--	NSV	--	Unchanged	
1,2-Dibromoethane	NSV	--	NSV	--	Unchanged	
1,2-Dichlorobenzene	129	USEPA 1995	42.0	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dichloroethane	1,130	USEPA 1995 (with UF of 100)	1,130	USEPA 2001	Unchanged	
1,2-Dichloroethene (total)	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
1,2-Dichloropropane	3,040	USEPA 1995	2,400	USEPA 2001	Unchanged	Maximum HQ <1
1,3-Dichlorobenzene	28.5	USEPA 1999a	28.5	USEPA 2001	Unchanged	
1,4-Dichlorobenzene	129	USEPA 1995	19.9	USEPA 2001	Unchanged	Maximum HQ <1
2-Butanone	NSV	--	NSV	--	Unchanged	
2-Hexanone	NSV	--	NSV	--	Unchanged	
4-Methyl-2-pentanone	NSV	--	123,000	USEPA 2006b	Unchanged	Maximum HQ <1
Acetone	NSV	--	564,000	USEPA 2006b	Unchanged	Maximum HQ <1
Benzene	700	USEPA 1995	110	USEPA 2006b	Unchanged	Maximum HQ <1
Bromochloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Bromodichloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Bromoform	640	USEPA 1999a	640	USEPA 2001	Unchanged	
Bromomethane	120	USEPA 1999a	120	USEPA 2001	Unchanged	
Carbon disulfide	2.00	USEPA 1995	0.92	Suter and Tsao 1996	Unchanged	Not detected
Carbon tetrachloride	5,000	USEPA 1995 (with UF of 10)	1,500	USEPA 2001	Unchanged	Maximum HQ <1

Table 5-8

Comparison Between Prior Ecological Screening Values (2001) and 2013 Ecological Screening Values - Sites 9 and 10

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach Virginia

Chemical	2001 ESV	Reference	2013 ESV	Reference	Risk Conclusion	Rationale[1]
Chlorobenzene	105	USEPA 1999a	25.0	USEPA 2006b	Unchanged	Maximum HQ <1
Chloroethane	NSV	--	NSV	--	Unchanged	
Chloroform	815	USEPA 1999a	815	USEPA 2001	Unchanged	
Chloromethane	2,700	USEPA 1999a	2,700	USEPA 2001	Unchanged	
cis-1,2-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
cis-1,3-Dichloropropene	79.0	USEPA 1995 (with UF of 10)	7.90	USEPA 2001	Unchanged	Not detected
Dibromochloromethane	6,400	USEPA 1995	NSV	--	Unchanged	Not detected
Ethylbenzene	43.0	USEPA 1995 (with UF of 10)	25.0	USEPA 2006b	Unchanged	Maximum HQ <1
Methylene chloride	6,400	USEPA 1995	2,560	USEPA 2001	Unchanged	Maximum HQ <1
Styrene	NSV	--	910	USEPA 2006b	Unchanged	Maximum HQ <1
Tetrachloroethene	450	USEPA 1995	45.0	USEPA 2001	Unchanged	Maximum HQ <1
Toluene	37.0	USEPA 1999a	215	USEPA 2006b	Unchanged	
trans-1,2-Dichloroethene	22,400	USEPA 1995 (with UF of 10)	680	USEPA 2006b	Unchanged	Maximum HQ <1
trans-1,3-Dichloropropene	79.0	USEPA 1995 (with UF of 10)	7.90	USEPA 2001	Unchanged	Not detected
Trichloroethene	200	USEPA 1995 (with UF of 10)	1,940	USEPA 2006b	Unchanged	
Vinyl chloride	22,400	USEPA 1995 (with UF of 10)	930	USEPA 2006b	Unchanged	Maximum HQ <1
Xylene, total	135	USEPA 1995	19.0	USEPA 2006b	Unchanged	Maximum HQ <1

NSV - No Screening Value

1 - If 2013 ESV is lower than or absent (NSV) relative to 2001, or if new

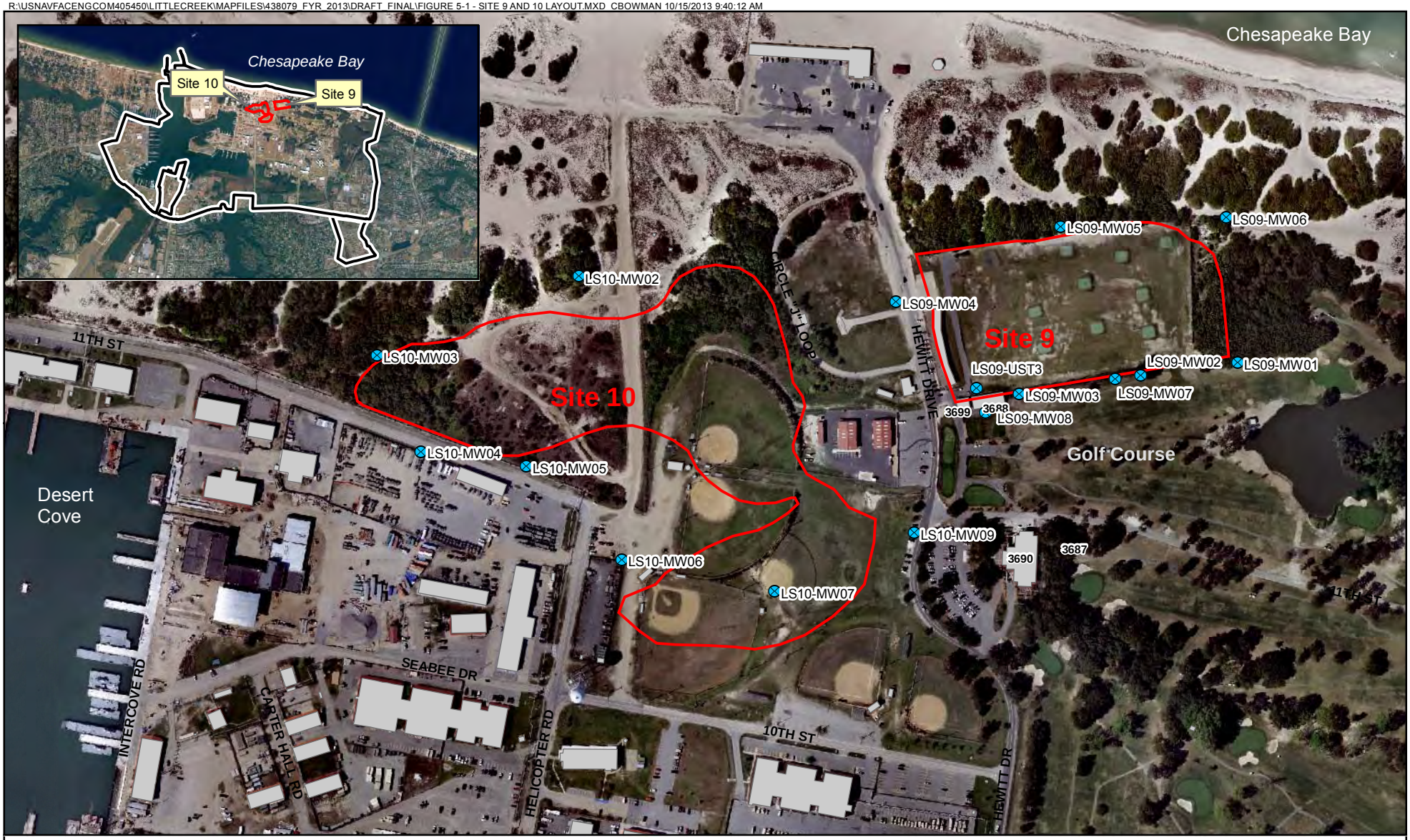
Red shading indicates current value (2013) is more stringent than the corresponding 2001 value.

Green shading indicates current value (2013) is less stringent than the corresponding 2001 value

Yellow shading indicates current value (2013) exists while there was no corresponding 2001 value.

Orange shading indicates no current value (2013) exists while there was a 2001 value.

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 5-1 - SITE 9 AND 10 LAYOUT.MXD CBOWMAN 10/15/2013 9:40:12 AM



Legend

- Monitoring Well
- Land Use Control Boundary
- Buildings

N
W E
S

0 200 400
Feet

Figure 5-1
Sites 9 and 10 Layout
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

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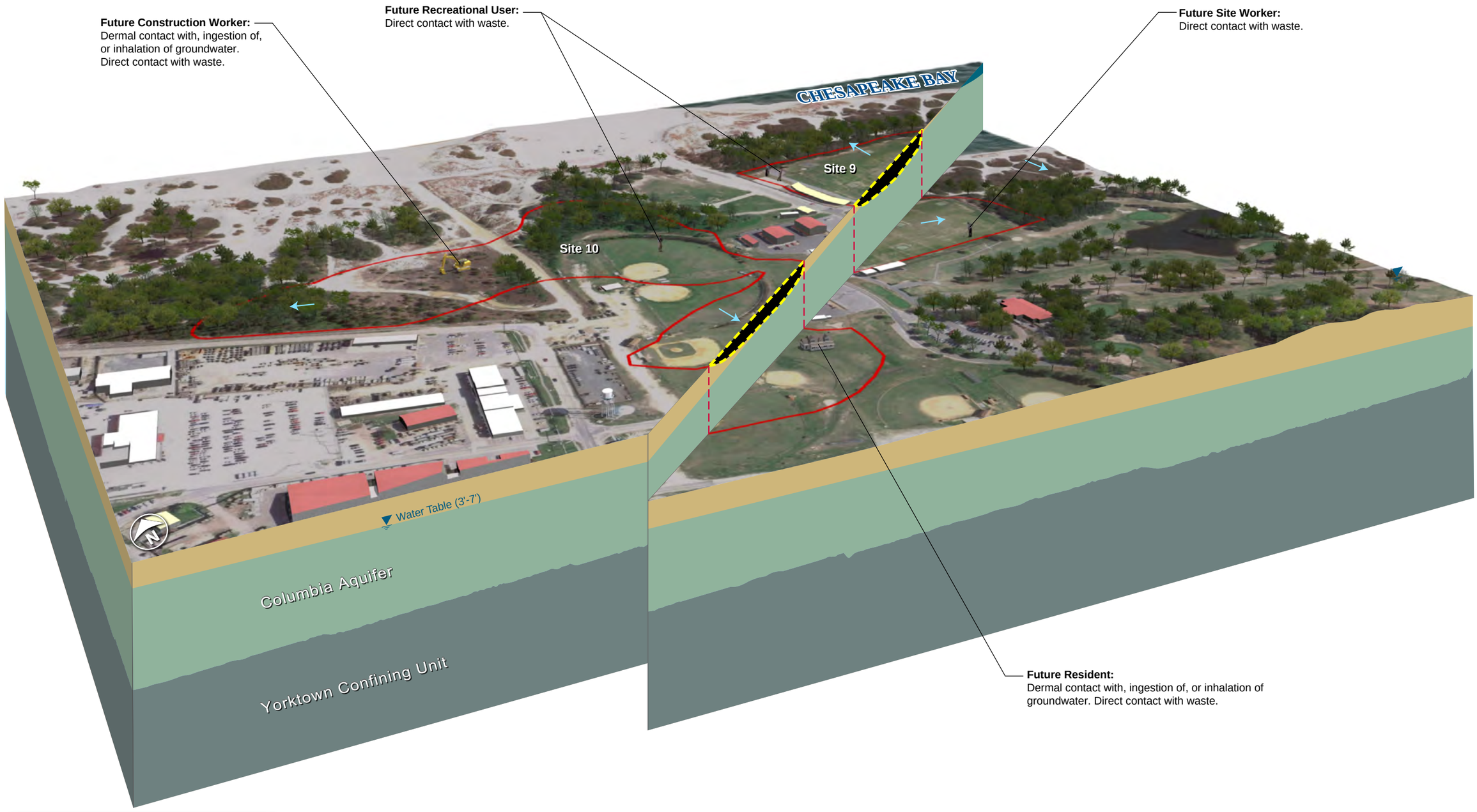


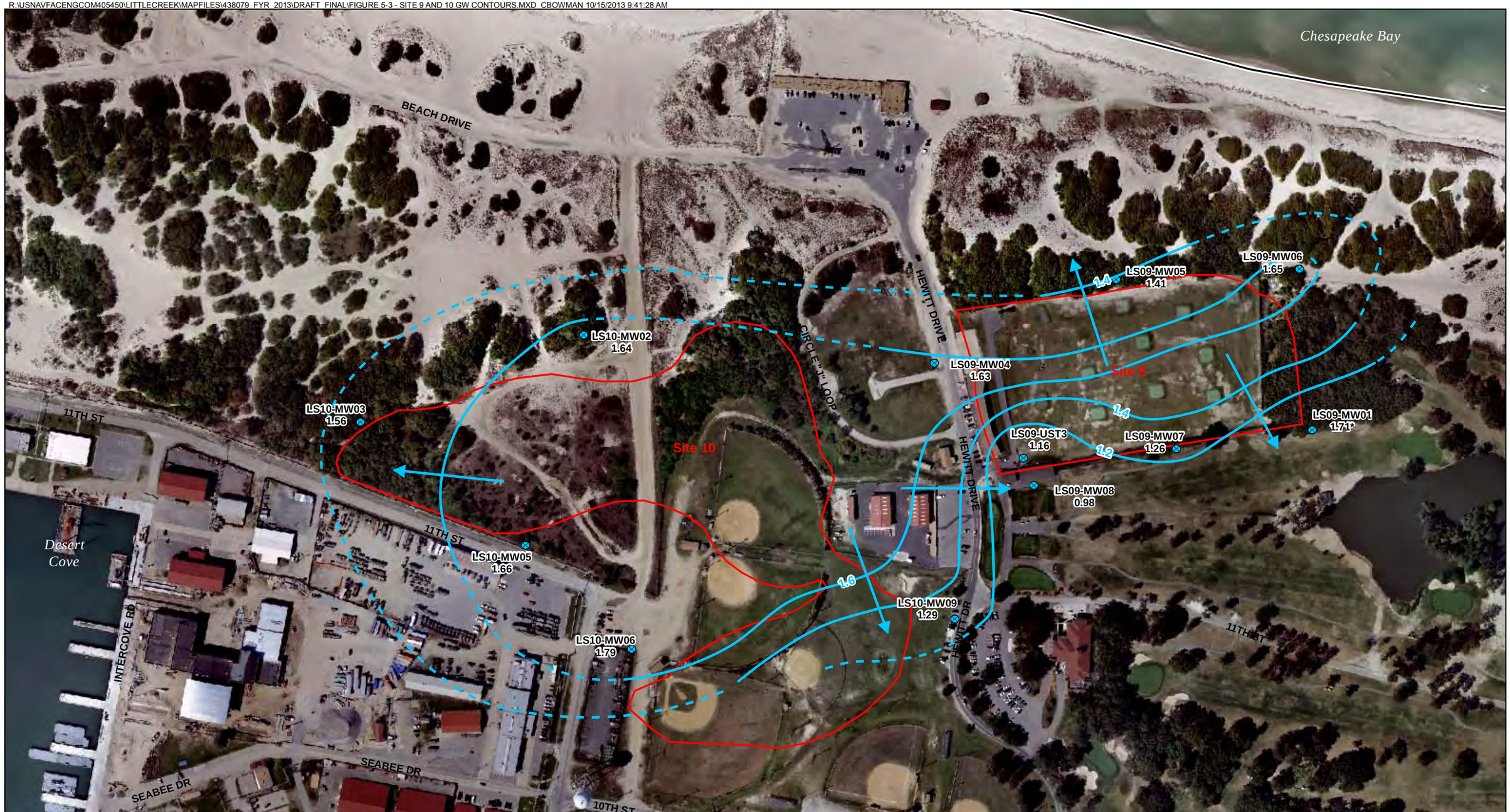
LEGEND

- Groundwater Flow Direction
- Water Table
- Site Boundary
- Landfill Contents

FIGURE 5-2
Sites 9 and 10 Conceptual Site Model
Second Comprehensive Five-year Review
Groundwater Sampling UFP SAP
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 5-3 - SITE 9 AND 10 GW CONTOURS.MXD CBOWMAN 10/15/2013 9:41:28 AM



Legend

- Monitoring Well
- Groundwater Elevation Contour (Contour Interval 0.2 ft)
- Inferred Groundwater Elevation Contour
- Groundwater Flow Direction
- Installation Boundary
- LUC Boundary

N
W E
S

0 125 250
Feet

Figure 5-3
Sites 9 and 10 Groundwater Contours - October 2007
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

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SECTION 6

Site 11 – Former School of Music Plating Shop

6.1 Site Chronology

Date	Event/Document	Document Administrative Record Number
December 1984	IAS	000130
October 1986	RVS	000022
March 1989	RFA	000008
August 1993	EE/CA	001018
November 1994	RI/FS for Sites 7 and 9-13	000226, 000352, 000353
November 1994	DD for Removal of Neutralization Tank, Piping, and Surrounding Soil	000125
October 1995	Removal Action Work Plan	000289
May 1996	Interim Remedial Action (IRA) Closeout Report; post-removal groundwater monitoring initiated	000119
April 1998	Supplemental RI initiated	000215
May 1999	Former NAB Little Creek on NPL	000439
June 2000	SERA	000417
June 2002	Cyclodextrin (CD) solution pilot test	--
October 2003	FFA	000540
June 2004	Supplemental Remedial Investigation (SRI)/HHRA	000656
September 2005	Vapor Intrusion Investigation	000920
March 2006	SRI Addendum/Revised HHRA	001028
June 2006	FS	001030
October 2006	Pentachlorophenol Technical Memorandum	--
October 2006	Proposed Plan	--
July 2007	ROD	001221
December 2008	Remedial Action Work Plan (RAWP)	--
March 2009	Five-Year Review	001534
March 2009	LUC RD	--
July 2009	Annual LUC inspections initiated	--
May 2009	Enhanced Reductive Dechlorination (ERD) Injections Complete	--
May 2010	LUC RD Revision 1	--
June 2010	Remedial Action Construction Completion Report	--
June 2011	Enhanced Reductive Dechlorination Annual Groundwater Monitoring Summary	--
February 2012	IRACR	--
March 2012	Draft Final Post-ROD LTM UFP-SAP, Revision 1, Groundwater LTM initiated	--
May 2012	Vapor Intrusion LTM initiated	--
May 2013	LUC RD Revision 2	--

6.2 Background

6.2.1 Site Description and History

Site 11, the Former School of Music Plating Shop, is located in the eastern portion of the base, near the intersection of Seventh and E Streets (**Figures ES-1** and **6-1**). Activities at the Former School of Music Plating Shop have resulted in a chlorinated solvent plume underlying the School of Music (Building 3602), southwest of the former plating shop.

The former plating shop operated between 1964 and 1974, after which plating operations were transferred to a separate facility. During operation, small quantities of plating baths, acids, and lacquer strippers were disposed of in the plating shop sink, which drained into an in-ground, concrete neutralization tank and its associated piping, and eventually into the storm sewer system (RGH, 1984). It was reported that approximately 10 gallons of plating baths, acids, and lacquer stripper were disposed into the neutralization tank through the shop sinks each year of its operation (RGH, 1984). During its period of operation, the plating shop reportedly used silver cyanide, copper cyanide, chromic acid (brite dip), nickel plating baths, and various acids. In addition, lacquer strippers and lacquer were also used. There are no records of chlorinated solvents being used at this site; however, degreasing solvents such as trichloroethene (TCE) and 1,1,1-trichloroethane (TCA) historically have been associated with operations at similar facilities. The neutralization tank, piping, and surrounding soil were excavated in 1996.

6.2.2 Physical Characteristics

The site characteristics, including surface features, geology, and hydrogeology, are depicted on the site CSM (**Figure 6-2**). The ground surface in the vicinity of Site 11 is generally level, approximately 10 ft amsl, and includes the School of Music (Building 3602) and storage buildings (Building 3650 and Building 3651, formerly the plating shop), a landscaped lawn, an asphalt parking lot, and a concrete drive behind Building 3602. The majority of precipitation is lost through infiltration or evaporation; however, some stormwater runoff is collected by man-made stormwater drainage ditches and discharged to the stormwater sewer system. There are no surface water bodies within the boundary of Site 11. Site 11 is located approximately 1,500 ft south of the golf course ponds and approximately 3,750 ft south of the Chesapeake Bay. Access to the site is unrestricted to those with access to JEB Little Creek.

Shallow Columbia aquifer groundwater at Site 11 is encountered at depths from 5 to 7 ft bgs. The Columbia aquifer extends to a depth of approximately 24 ft bgs, where the Yorktown confining unit separates the Columbia aquifer from the underlying Yorktown aquifer. Prior to implementation of the remedial action, including repair of a leaking sanitary sewer line behind Building 3602, groundwater flow was directed to the south/southwest. Following repair of the sanitary sewer line, groundwater flow is now directed predominantly west/southwest (**Figure 6-3**). The groundwater gradient underlying Site 11 is relatively flat and varies by less than 1 foot across the site. The average shallow groundwater flow velocity is estimated to be 2 feet per year.

The current, primary mechanism for contaminant transport is through dissolved plume migration downgradient with groundwater flow (advection) and dissolution of VOCs to groundwater from dense non-aqueous-phase liquid (DNAPL)at the top of the Yorktown confining unit. The mechanisms responsible for the fate of chemicals are natural degradation through various pathways (which plays a significant role in the length of time the chemicals will exist in the subsurface) and volatilization of chemicals from groundwater into the gas phase (which results in a decrease of contaminant mass from the saturated zone).

6.2.3 Land and Resource Use

Currently, Site 11 consists of the School of Music and its associated parking lot. Building 3651 is used for storing miscellaneous items, and the grass field located north of the School of Music is used for marching band practice and drill sessions. Enlisted quarters, industrial activities, and administrative offices surround the site.

Groundwater at JEB Little Creek is not currently used as a potable water source, nor is it expected to be used as a future potable water source. Potable water is supplied to the base and surrounding community by the cities of

Virginia Beach and Norfolk. Groundwater supply wells at the base golf course, located approximately 1,500 feet north of Site 11, provide non-potable water from the Yorktown aquifer for irrigation of the golf course.

LUCs are currently maintained within an area of restricted land and groundwater use at Site 11 and are inspected on an annual basis (Navy, 2009a; 2010; 2013b). The LUCs restrict land use and prevent exposure to shallow groundwater until site conditions allow for unlimited use and unrestricted exposure.

6.2.4 History of Contamination

Chlorinated VOCs were historically released to groundwater from the former plating shop neutralization tank. Groundwater contamination includes a residual source area adjacent to the former neutralization tank and a down-gradient plume consisting predominantly of dissolved-phase contaminants (**Figure 6-4**). Groundwater contamination is highly stratified, with the interval just above the clay (approximately 21 to 23 ft bgs) containing the greatest concentrations of contaminants. Shallower groundwater contains much lower VOC concentrations. Investigations have not confirmed the presence of DNAPL; however, the maximum detected concentration of TCE in groundwater indicates that DNAPL may be present based on the rule of thumb that concentrations in excess of 1 percent of a compound's aqueous solubility suggest the presence of DNAPL. No VOCs have been detected in samples collected from the underlying Yorktown aquifer.

Initial Response

Site 11 was initially identified in the IAS (RGH, 1984). Based on the results of field investigations conducted from 1986 to 1994, a DD for removal of potential sources of soil and groundwater contamination was finalized in November 1994 (FWES, 1994a). The neutralization tank, piping, and surrounding soil were removed in 1996 (ITC, 1996). Soil surrounding the piping and neutralization tank, and to 2 feet below the tank, was excavated and disposed of offsite. Confirmation sampling was conducted and the analytical data indicated concentrations of VOCs in remaining soil were below risk-based screening levels. Following excavation, the area was backfilled with clean fill.

A pilot study was conducted in 2002 to evaluate the treatment of VOCs in groundwater through the injection and extraction of a cyclodextrin (CD) solution. Approximately 32.5 kilograms (kg) of TCE and 1,1,1-TCA and 3 kg of 1,1-DCE were removed as a result of the pilot study (Boving et al., 2003). Additionally, groundwater samples collected following the pilot study indicated degradation of parent VOC (TCE) had occurred (CH2M HILL, 2003a). Although the CD treatment system was able to cause the dissolution of residual DNAPL and extract contaminants, this approach was not evaluated in the FS as a potential final remedy for the site because of both the impact of the treatment system on site use, and the associated substantial O&M requirements to maintain system performance.

6.2.4.1 Site Risks

Human Health Risk

An HHRA was conducted as part of the 2004 SRI to evaluate the risks to human health from exposure to soil and groundwater (CH2M HILL, 2004d). In 2005, potential risk associated with vapor intrusion of VOCs into the School of Music was evaluated (CH2M HILL, 2005b). Additionally, a revised HHRA was completed in 2006 to re-evaluate the potential human health risks associated with VOCs in groundwater following completion of the CD pilot study (CH2M HILL, 2006a). The exposure media, pathways, and scenarios evaluated and COCs identified in the revised HHRA are summarized in **Table 4-2**.

No potentially unacceptable risks or hazards associated with exposure to site soil were identified. It was concluded that exposure to shallow groundwater may pose potentially unacceptable hazards and risks for future construction workers, industrial workers, and adult/child residents. Risks and hazards were primarily associated with exposure to VOCs in groundwater. No potentially unacceptable risks were identified from exposure to indoor air under existing site conditions.

Ecological Risk

A SERA (Steps 1 and 2 of the ERA process) was completed in 2000 to evaluate potential exposure pathways for ecological receptors (CH2M HILL, 2000a). The assessment concluded there are no unacceptable ecological risks to terrestrial receptors at Site 11 because no complete exposure pathways to surface soil exist at the site and the source area (subsurface neutralization tank and piping) was removed in 1996. There is no complete pathway for ecological receptor exposure to groundwater and no aquatic habitats exist on or near the site.

6.2.5 Basis for Taking Remedial Action

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 shallow groundwater at Site 11. Site COCs and their respective cleanup levels identified in the ROD for Site 11 are summarized in **Table 6-1**.

TABLE 6-1
Cleanup Levels for Site 11 Chemicals of Concern

Chemical of Concern	Cleanup Level* (µg/L)
1,1,1-TCA	200
1,1,2-TCA	5
1,1-dichloroethane (1,1-DCA)	2,900**
1,1-dichloroethene (1,1-DCE)	7
1,2-DCA	5
1,2-Dichloropropane	5
Carbon tetrachloride	5
Chloroform	9.6**
Methylene chloride	5
Trichloroethene	5
Vinyl chloride	2
cis-1,2-DCE	70
trans-1,2-DCE	100

Notes:
*Clean-up levels are Maximum Contaminant Levels (MCLs).
** No MCL exists. Risk-based cleanup level was calculated.
µg/L - micrograms per liter

6.3 Remedial Actions

6.3.1 Remedy Selection

The ROD for Site 11 was signed in July 2007 (Navy, 2007a). The ROD summarized the risks to human health and ecological receptors, established RAOs, and defined the selected remedy. The selected remedy for Site 11 was defined as groundwater treatment through ERD and LUCs to meet the following RAOs:

- Prevent exposure to Site 11 groundwater until concentrations of VOCs have been reduced to levels that allow for unlimited use and unrestricted exposure.
- Reduce concentrations of VOCs in Site 11 groundwater to cleanup levels to the maximum extent practicable within a reasonable amount of time.

Cleanup levels for Site 11 were established as the federal MCLs. Where MCLs were not available, cleanup levels were established as a risk-based calculated value. Cleanup levels were calculated using the same exposure assumptions used in the HHRA and equations from the *Risk Assessment Guidance for Superfund Volume 1, Part B* (USEPA, 1991) to a cancer risk of 10^{-5} and hazard quotient of 1. Unacceptable risks, RAOs, remedy components, performance standards, and expected outcomes for evaluating the overall performance of the remedy are summarized in **Table 6-2.**

TABLE 6-2
Site 11 Remedial Action Summary and Expected Outcomes

Risk		COCs	RAOs	Remedy Components	Metric/Cleanup Level	Expected Outcome	
Human Health	**Ecological**						
Groundwater							
Future adult/child resident and industrial worker ingestion of, dermal contact with, and inhalation of groundwater (while showering); future construction worker dermal contact with and inhalation of groundwater in an open excavation	No complete and significant exposure pathways	1,1,1-TCA 1,1,2-TCA 1,1-DCA 1,1-DCE 1,2-DCA 1,2-Dichloropropane Carbon tetrachloride Chloroform Methylene chloride Trichloroethene Vinyl chloride cis-1,2-DCE trans-1,2-DCE	Reduce concentrations of VOCs in Site 11 groundwater to cleanup levels to the maximum extent practicable within a reasonable amount of time	ERD	Monitor groundwater COC concentrations and geochemical conditions to confirm achievement of substrate radius of influence (ROI) and conditions conducive for ERD.	Achieve unlimited use and unrestricted exposure	Removal of LUCs
				Performance monitoring			
				Groundwater monitoring	Monitor shallow groundwater COC concentrations and geochemical conditions to confirm continued effectiveness of the remedy and COC degradation until concentrations are at or below cleanup levels.		
			Prevent exposure to Site 11 groundwater until concentrations of VOCs have been reduced to levels that allow for unlimited use and unrestricted exposure		Monitor to evaluate the potential for vapor intrusion risk until concentrations of COCs in groundwater are at or below cleanup levels.		
				LUCs	Periodic inspection of the site to confirm adherence to LUCs until groundwater COCs are at or below cleanup levels.	Removal of LUCs	

The following LUC objectives for Site 11 were selected in the ROD:

- Prohibit the withdrawal of groundwater except for environmental monitoring and testing
- Prohibit the use of the site for residential, child care, elementary or secondary school, or playground facilities
- Maintain the integrity of any current or future remedial or monitoring system

LUC objectives have been implemented with the actions detailed in the LUC RD (CH2M HILL, 2009f). The LUCs will be maintained until the concentrations of VOCs in the groundwater have been reduced to levels that allow for unlimited use and unrestricted exposure.

6.3.2 Remedy Implementation

The Site 11 IRACR was signed in February 2012 and documents that the remedy is in place and functioning as designed. Remedy implementation was completed as described in the following subsections.

Remedial System Installation

In advance of remedy implementation, leaking sanitary sewer lines in the vicinity of Site 11 were repaired in October 2007. The final RA Work Plan was submitted in December 2008 (JVI, 2008b) and remedial action began in January 2009 with the installation of five new monitoring wells and 26 injection wells (**Figure 6-5**). Following installation, baseline groundwater samples were collected to establish remedy conditions. Injection of emulsified vegetable oil product was performed in April/May 2009. Remedy construction was documented in the RA CCR (JVI, 2010b). Following substrate injection, performance monitoring was conducted at a frequency of 1-, 3-, 6-, 9-, and 12-months post-injection. Performance monitoring results indicated the remedy was successful in achieving the geochemical conditions required to facilitate ERD (CH2M HILL, 2011a).

Land Use Controls

LUCs are in place to prevent exposure to groundwater (**Figure 6-1**). The LUC RD for Site 11 was finalized in March 2009 (CH2M, 2009f). A survey plat for Site 11 was filed with the City of Virginia Beach on June 2, 2011 to provide public notice of the Site 11 environmental conditions and limitations on the use of the property and to record the LUC boundary (Navy, 2012b). As outlined in the LUC RD, annual inspections are conducted to monitor unauthorized activities and land use changes. Checklists and data reports are completed during inspections and issued to USEPA and VDEQ.

Long-term Monitoring

Groundwater and vapor intrusion LTM at Site 11 was initiated in March 2012 in accordance with the Draft Final LTM UFP-SAP, Revision 1 (Site 11 SAP) (CH2M HILL, 2012b). Groundwater monitoring is conducted semiannually to assess the continued effectiveness of the remedy in achieving the RAOs. Groundwater samples are collected from a minimum of 13 monitoring wells and up to 20 monitoring wells (**Figure 6-6)** and analyzed for site COCs, total and dissolved arsenic, as well as wet chemistry parameters TOC, volatile fatty acids (VFAs), nitrate, nitrite, sulfate, sulfide, methane, ethane, and ethene. Vapor intrusion LTM is conducted to monitor potential building occupant exposure to VOCs via indoor air and includes collection of indoor air, sub-slab, and outdoor air samples from primary buildings of interest located within 100 feet of the plume (**Figure 6-6**) for analysis of site contaminants of interest (COIs).

6.4 Progress Since Last Five-Year Review

6.4.1 Follow-up Actions Since Last Five-Year Review

The previous Five-Year Review report included the following protectiveness statement for Site 11:

> *The remedy has not been implemented at Site 11; however, it is expected to be protective of human health and environment. In the interim, exposure pathways that could result in unacceptable risk are controlled through quarterly ER site inspections. Remedy construction began in January 2009 and is expected to be completed in March 2009. Full implementation of the LUCs and the groundwater LTM plan will be documented in the IRACR. Based upon a review of the Site 12 remedy performance (Section 5), there is no evidence at this*

time to expect the Site 11 remedy will not be successful. Further evaluation of the vapor intrusion pathway is recommended following resolution of risk evaluation methodology.

Although the remedy had not yet been implemented at the time of the last Five-Year Review, issues and recommendations for follow-up actions were identified. **Table 6-3** presents the status of these recommendations and follow-up actions.

TABLE 6-3
Site 11 Progress Action Items from 2009 Five-Year Review

Issue	Recommendations and Follow-up Actions	Party Responsible	Mile-stone Date	Affects Protectiveness		Status – March 2013	
				Current	Future	Action Taken and Outcome	Date of Action
Changes to the methodology for evaluating the potential for vapor intrusion risk.	Following resolution of risk evaluation methodology, re-evaluation of the potential for vapor intrusion risk at Site 11 is recommended.	Navy	Oct. 2009	N	Y	Evaluation of potential risks associated with vapor intrusion was incorporated into the Site 11 SAP. Baseline vapor intrusion LTM, including building inspections and indoor air sampling, was completed in May and December 2012. No potential risks were identified. Results will be included in an LTM report to be completed following the September 2013 LTM event. Evaluation of vapor intrusion will continue as part of LTM and sampling will be conducted, at a minimum, once every 5 years.	Complete - March 2012
LUC RD is not fully implemented.	Implement LUCs in accordance with the LUC RD and document in the IRACR for the site.	Navy	July 2010	N	Y	The Initial LUC RD was finalized in March 2009. Consensus agreements for LUC RD revisions were signed on May 19, 2010 and May 15, 2013 to more clearly identify the risks and receptors the LUCs were intended to address.	Complete - March 2009
Site monitoring wells are not clearly labeled outside the casing.	Apply permanent identification to all well casings.	Navy	Sept. 2013	N	N	Basewide well repairs conducted in October 2010. Each well was affixed with an outer casing clearly identifying it as an observation or monitoring well. Weather-resistant stickers with well IDs were affixed to all casings.	Complete - October 2010

6.4.2 Results of Implemented Actions

This section summarizes the remedial activities conducted since completion of the last Five-Year Review in 2009. To assess the performance of the remedial action, data and information were reviewed with respect to each of the performance metrics outlined in **Table 6-2**.

Some of the data and information presented to assist in this Five-Year Review have previously been presented through reports and Partnering Team presentations. The intention of this data review and analysis is to provide sound interpretations based on data previously provided, as well as additional data collected but not previously provided. To facilitate review of this document, groundwater and vapor intrusion data not previously documented in a report are presented in **Appendix F**; however, this report is not intended to fully present and document all data gathered. Data not previously documented in a report will be subsequently formally documented. Trend graphs for select monitoring wells are presented in **Appendix G**.

Remedial System Construction

Prior to completion of the previous Five-Year Review, remedy implementation at Site 11 had begun but was not complete. Since the previous Five-Year Review, approximately 2,346 gallons of injectate solution (emulsified oil substrate [slow release substrate], sodium bicarbonate, and water) were applied to each of the injection wells to enhance the naturally occurring, microbially-mediated, anaerobic degradation of COCs (JVI, 2010b). Groundwater samples were collected from designated monitoring wells at 1, 3, 6, 9, and 12 months following injection to evaluate the adequacy of the injection system and the overall effectiveness of the treatment. The final round of post-injection monitoring was conducted in May 2010. Sample locations are depicted on **Figure 6-6** and results are discussed below.

Performance Monitoring Results Summary

To evaluate the adequacy of the injection system, field and geochemical data were reviewed to be sure suitable anaerobic conditions were achieved, pH was maintained, and TOC levels were indicative of adequate substrate distribution. Performance monitoring results indicated that the remedy implementation was successful in the source zone and downgradient plume (CH2M HILL, 2011a). Oxidation reduction potential (ORP) and dissolved oxygen (DO) concentrations decreased after substrate injections, suggesting adequate reducing conditions were achieved. Additionally, increases in the TOC concentrations indicate successful substrate delivery in the target treatment areas.

The assessment of overall effectiveness of the ERD remediation is based on changes in plume configuration, plume containment, and the concentrations of COCs remaining in groundwater at the site. After 1 year, the post-injection areal extent of the groundwater plume was observed to be similar to that of the pre-injection areal extent; however, the overall total COC concentrations decreased within the aquifer. Additionally, biotransformation of parent compounds (such as TCE) to less chlorinated daughter products was also observed, providing strong lines of evidence for reductive dechlorination. Performance monitoring results indicated that additional substrate injections were not immediately needed and recommended transitioning from performance monitoring to LTM. To address the lack of substantial degradation of chlorinated ethanes in the vicinity of LS11-MW38D, it was recommended to consider bioaugmentation in the future with a microbial consortium capable of degrading chlorinated ethanes in environments with elevated, mixed (i.e., both chloroethane and chloroethene) VOC concentrations (CH2M HILL, 2011a).

Remedial System O&M

No remedial system O&M has been required in this Five-Year Review period.

Long-term Monitoring

Groundwater and vapor intrusion LTM is currently performed in accordance with the Draft Final LTM UFP SAP, Revision 1 (Site 11 SAP) (CH2M HILL, 2012b) as discussed in Section 6.3.2.

Groundwater

Groundwater monitoring was initiated in March 2012 and has subsequently been conducted in September 2012 and March 2013. Groundwater LTM data through the March 2013 Five-Year Review groundwater monitoring event are provided in **Appendix F** and data trends for select monitoring wells are provided in **Appendix G**. Pre-injection (January 2009) and Five-Year Review (March 2013) groundwater plumes for TCE, cis-1,2-DCE, 1,1-DCE, and vinyl chloride (VC) are depicted in **Figures 6-7** through **6-10**.

As shown in **Figure 6-4**, the overall lateral extent of the Columbia aquifer plume has slightly increased in size; however, as explained in the following sentence, an overall decrease in total COCs of 28 percent has been recognized since remedy implementation. The percentage change in total COCs since remedy implementation was calculated as the sum of COC concentrations in each LTM monitoring well during FYR sampling divided by the sum of COC concentrations in each monitoring well during pre-injection baseline sampling. The increase in lateral extent is likely the result in shifting groundwater flow direction following repair of the sanitary sewer line and advection of dissolved phase contaminants in a more westerly direction. COCs were not detected above method detection limits in samples collected from upgradient, down-gradient and cross-gradient perimeter wells LS11-

MW11D, LS11-MW12D, LS11-MW13D, and LS11-MW17D. Although COC concentrations were detected in down-gradient perimeter wells LS11-MW14D and LS11-MW15D, COC concentrations were not observed in exceedance of cleanup levels. In samples collected from western perimeter monitoring well LS11-MW07D, concentrations of COCs have been detected in exceedance of cleanup levels since the March 2012 groundwater sampling event. COCs were not previously detected in this well. Detected concentrations may be the result of shifting groundwater flow directions. Installation of an additional down-gradient perimeter monitoring well should be considered as part of remedy optimization to monitor the western migration of COCs.

Site-specific COCs 1,1,2-TCA, 1,2-DCA, 1,2-dichloropropane and carbon tetrachloride have not been above method detection limits or have been detected below cleanup levels since baseline LTM. Concentrations of the remaining COCs remain above cleanup levels. As shown in **Figures 6-7** through **6-10** and the trend graphs in **Appendix G**, overall concentrations of most COCs have decreased by several orders of magnitude since remedy implementation. Following substrate injection, TCE concentrations in samples collected from source area well LS11-MW38D were reduced by approximately 84 percent from 120,000 in February 2009 to 19,300 micrograms per liter (μg/L) in March 2013. However, TCE concentrations in LS11-MW38D have been observed to be increasing since baseline LTM collected in March 2012. Increases in TCE daughter products cis-1,2-DCE and VC provide strong lines of evidence that ERD is ongoing within the most affected portion of the groundwater plume at Site 11. However, these increases, coupled with the slower degradation of chlorinated ethanes (1,1,1-TCA and 1,1-DCA), contribute to the lower overall decrease of total COCs at Site 11.

In the downgradient portion of the plume, parent compound TCE concentrations have decreased, with the largest decrease observed in monitoring well LS11-MW10D at approximately 34 percent, from 290 in September 2008 to 190 μg/L during the March 2013 Five-Year Review event. Daughter products have generally stayed consistent or have decreased in samples collected from the downgradient monitoring wells.

Although TOC concentrations in the source area in the vicinity of LS11-MW38D are above desired conditions to facilitate ERD (> 20 milligrams per liter [mg/L]), concentrations are below pre-injection baseline and likely reflective of conditions established as a result of the CD pilot study and not substrate added as part of the remedial action. CD is comprised of organic carbon structures in a ring formation and because of its chemical components, when present, will add to the overall TOC concentrations detected in groundwater samples. However, unlike the slow release substrate applied at this site, CD is not as easily fermentable, and therefore does not serve as an appropriate food and energy source for the biodegradation of the chlorinated VOCs. Therefore, additional substrate injections in the source area should be considered as part of remedy operations and maintenance. Additionally, TOC concentrations were low (< 20 mg/L) or non-detect in the southern portion of the plume; therefore, additional injection of substrate along the downgradient edge should also be considered as part of remedy operations and maintenance.

Based on the continued lack of substantial degradation of chlorinated ethanes observed in the vicinity of MW38D (only a 37 percent reduction of 1,1,1-TCA from 62,000 in February 2009 to 39,000 μg/L in March 2013 and 34 percent reduction of 1,1-DCA from 14,000 in February 2009 to 9,280 μg/L in March 2013 in samples collected from MW38D), bioaugmentation with a microbial consortium capable of degrading chlorinated ethanes in environments with elevated mixed concentrations (i.e., both chloroethane and chloroethene) should be considered as part of remedy optimization.

Vapor Intrusion

Vapor intrusion monitoring was initiated with Round 1 baseline monitoring in May 2012 followed by Round 2 baseline monitoring in December 2012. As a part of baseline monitoring, building surveys were conducted at all buildings located within 100 feet of the groundwater plume (Buildings 3165, 3560, 3602, and 3651) to identify buildings with potential exposure pathways for vapor intrusion (regular building occupancy, cracks in the subslab, floor drains, etc.). Based on the results of the initial building survey, primary buildings of interest were identified and included the three occupied Buildings 3165, 3560, and 3602. Indoor air samples were collected from within each of the primary buildings of interest during each baseline event and analyzed for site COIs.

Indoor air sample locations are shown in **Figure 6-6**. Vapor intrusion data are provided in Table E-2 of **Appendix F**. In accordance with the decision matrix contained with the Site 11 LTM UFP SAP, because concentrations of COIs were below screening levels during Round 1, only indoor air samples were collected during Round 2. With the exception of chloromethane, methylene chloride, and propylene, COIs were not detected in indoor air. Concentrations of chloromethane, methylene chloride, and propylene were all below the established screening levels. Based on the results of the baseline vapor intrusion monitoring, no potentially unacceptable risks requiring mitigation were identified. Vapor intrusion monitoring will continue as part of ongoing LTM through regular building inspections and, at a minimum, indoor air sampling once every 5 years. In addition, indoor air sampling may be conducted after substrate re-injection or any remedy modifications.

Land Use Controls

A consensus agreement was signed on May 19, 2010, documenting the addition of the following LUC objective to the LUC RD for Site 11:

- Prevent dermal contact with groundwater by construction workers.

Additionally, to protect against any potential human health risk related to vapor intrusion resulting from changes in land use, a consensus agreement was signed in May 15, 2013, adding the following LUC objective to the LUC RD for Site 11:

- Prohibit changes from current building use or construction of new buildings without further evaluation of potential vapor intrusion risks and/or implementation of necessary mitigation measures.

Site Inspection

During this Five-Year Review period, annual site inspections were conducted at Site 11 between 2009 and 2012. Results of the 2013 inspection are discussed in Section 2.3 and provided in **Appendix C**. With the exception of general well repairs, no significant issues, unauthorized intrusive activities, or changes in land use were identified. General well maintenance was conducted as needed. During the September 2013 inspection it was observed that Building 3602 is currently undergoing renovation.

Summary of the Estimated Remedy Costs

Table 6-4 presents capital and annual O&M and LTM costs for Site 11. Additional capital costs incurred from those projected in the ROD are a result of inclusion of the sanitary sewer repair. Annual management costs are lower than those projected in the ROD because additional substrate injections have not been conducted. Although costs expended each year vary, total remedy costs to date are within the +50%/-30% range estimated in the ROD.

TABLE 6-4
Site 11 Estimated Project Costs

Year	Timeframe	Projected Cost from ROD	Estimated Actual Cost	Notes
			Capital Cost*	
0	2008-2010	$499,000	$878,700	Includes labor, ODCs, and subcontractor costs for project planning, sanitary sewer repair, field mobilization/demobilization, well Installation, substrate injections, performance monitoring, and reporting.
			Management and Monitoring Cost**	
1	2011	$167,367	$56,300	Includes labor, ODCs, and subcontractor costs associated with LUC inspections and reporting. Includes labor, ODCs, and subcontractor costs associated with preparation of the pre-draft and draft Site 11 LTM UFP SAP.
2	2012	$167,367	$39,700	Includes labor, ODCs, and subcontractor costs associated with finalization of the Site 11 LTM UFP SAP. Includes labor, ODCs, and subcontractor costs associated with baseline and semiannual groundwater LTM sampling. Includes labor, ODCs, and subcontractor costs associated with baseline (2 rounds) vapor intrusion LTM sampling.
3***	2013	$167,367	$17,000	Includes labor, ODCs, and subcontractor costs associated with Five-Year Review groundwater LTM sampling.
	Total	**$1,001,101**	**$991,700**	
	+50%	$1,501,652		
	-30%	$700,771		

* Costs reflect those expended under contract to AGVIQ/CH2M HILL.
**Costs reflect those expended under contract to CH2M HILL. Completion of annual LUC inspections assumed by Navy in 2012.
***Represents costs expended between January and June 2013.

6.5 Technical Assessment

This section presents the answers to the three questions defined for the Technical Assessment for Site 11 based primarily on information presented in Section 6.4. Opportunities for maintenance and optimization of the remedy are presented in **Table 6-5**.

6.5.1 Question A: Is the remedy functioning as intended by the ROD?

Remedial Action Performance: Based on the review of documents, ARARs, risk assumptions, and site inspection reports, the Site 11 remedy is functioning as intended by the ROD. Remedy construction was completed in May 2009. Performance monitoring was conducted at a frequency of 1, 3, 6, 9, and 12 months following injection of the ERD substrate. As documented in the June 2011 ERD Summary Report, the remedy was successfully implemented and effective in achieving geochemical conditions to facilitate ERD. Concentrations of COCs have decreased, but remain above cleanup levels. Based on a review of LTM data, additional substrate injection and bioaugmentation should be considered during remedy optimization for continued effectiveness in accordance with the decisions matrixes included in the Site 11 LTM UFP SAP.

Implementation of LUCs: LUCs have been implemented through the Final LUC RD and subsequent revisions. LUCs and site inspections have ensured that unauthorized site use is prohibited and exposure to groundwater is prevented.

LTM Activities: Groundwater and vapor intrusion LTM was initiated in March 2012 to assess continued effectiveness in achieving the RAOs. COC concentrations remain above cleanup levels. As a result of rebound of

TCE and low TOC, re-injection of the source area and down-gradient plume should be considered. No potentially unacceptable risks from vapor intrusion were identified. LTM will continue as outlined in the LTM UFP SAP.

Early Indicators of Potential Issues: No indicators of potential issues have been identified.

Opportunities for Optimization: No remedy optimization has been conducted to date. Optimization through addition, removal, or reassignment of LTM monitoring wells, as well as site re-injection, is built into the decision matrices in the Site 11 LTM UFP SAP. Based on LTM data collected to date, no changes to the existing monitoring well network are recommended at this time; however, installation of an additional downgradient perimeter monitoring well should be considered in the future to monitor the western migration of COCs. Re-injection of substrate in the source area and downgradient plume coupled with bioaugmentation for degradation of chlorinated ethanes should also be considered.

6.5.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy 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. Current and anticipated future land use is industrial and is expected to remain the same. The exposure assumptions used to develop the HHRA and ERA are reasonable given that the current land use has not changed over time at Site 11. Physical conditions of Site 11 that would affect exposure pathways have not changed since the last Five-Year Review. Changes in groundwater flow directions following repair of the leaking sanitary sewer line have been observed. As a result, concentrations of site COCs above cleanup levels have been detected in perimeter monitoring well LS11-MW07D. It is recommended that further evaluation of groundwater flow be conducted and revisions made to the LTM program as needed. No new contaminants, sources, or routes of exposure were identified as part of this Five-Year Review.

Changes in Toxicity and Other Contaminant Characteristics. 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 has been detected at Site 11. Groundwater samples have not been analyzed for 1,4-dioxane at Site 11; therefore, its presence or absence in site groundwater is unknown at this time. Although the presence of 1,4-dioxane is unknown at Site 11, groundwater is not currently used as a potable water supply and LUCs are in place to prevent exposure to groundwater; therefore, the remedy remains protective in the short term. To achieve long-term protectiveness, it is recommended that the presence of this constituent be investigated at Site 11.

With the exception of 1,1-DCA and chloroform, the groundwater cleanup levels are established as the MCLs. No changes to the MCLs have occurred since the last Five-Year Review. Changes to toxicity values associated with 1,1-DCA and chloroform have occurred; therefore, cleanup levels were recalculated. Based on the results of the calculations, new cleanup levels for chloroform (from 9.6 μg/L to 9.5 μg/L) and 1,1-DCA (from 2,900 μg/L to 120 μg/L) have been established. Changes in cleanup levels do not adversely affect the protectiveness of the remedy.

Additional changes in toxicity and tap water RSL values have been made since the last Five-Year Review (**Table 4-5**). Select VOCs and arsenic are sampled as part of ongoing groundwater LTM. There have been no changes in toxicity associated with VOCs that would affect the protectiveness of the remedy because either the VOC is already listed as a site COC, it was not previously detected, or it was not previously detected above the MCL. SVOCs, PCBs, pesticides and metals (except for arsenic) have not been analyzed in groundwater since ROD signature. Based on site history, SVOCs, PCBs, and pesticides, as well as dioxins/furans, are not expected to be present at Site 11. For the most part, the changes in toxicity values associated with metals would not affect the protectiveness of the remedy because historically, metals concentrations detected were below the MCLs. Arsenic data collected as part of ongoing groundwater LTM indicate arsenic concentrations are below the MCL. LUCs prevent exposure to groundwater; therefore, changes to the toxicity values would not adversely affect the current 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 11. There have been no major procedural changes in how the ERAs are conducted since the last Five-Year Review.

As part of the last Five-Year Review, it was recommended that vapor intrusion be re-evaluated as a result of changes in USEPA guidance on vapor intrusion risk assessment methodology. As discussed in Section 6.4.2, vapor intrusion monitoring has been included in the LTM program to evaluate current and potential future risk from vapor intrusion until site conditions allow for unlimited use and unrestricted exposure. Results of baseline vapor intrusion monitoring, including the collection of indoor air samples in May and December 2012, indicate there are no current potentially unacceptable risks requiring mitigation. Continued evaluation of the vapor intrusion pathway will be conducted as part of ongoing LTM.

6.5.3 Question C: Has any other information come to light that could question the protectiveness of the remedy?

No new information has come to light that would question the protectiveness of the remedy.

TABLE 6-5
Remedy Maintenance and Optimization Activities for Site 11

Maintenance/Optimization Opportunity	Recommendations	Party Responsible
TOC concentrations in groundwater below pre-injection baseline in source area and below desired conditions to facilitate ERD in southern portion of plume. Limited degradation of chlorinated ethanes.	Recommend additional substrate injection with bioaugmentation consisting of a microbial consortium capable of degrading chlorinated ethanes in environments with elevated mixed concentrations (i.e., both chloroethane and chloroethene) as part of remedy O&M to ensure continued effectiveness.	Navy
Detection of COCs above cleanup levels in western perimeter monitoring well.	Recommend continued monitoring of western migration of plume and potential installation of additional monitoring wells.	Navy

6.6 Issues, Recommendations, and Follow-up Actions

Table 6-6 outlines the issues identified during this Five-Year Review and presents recommendations and follow-up actions for Site 11.

6.7 Protectiveness Statement

The remedy at Site 11 is in place, functioning as designed, and is currently protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled through LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. However, in order to evaluate the long-term protectiveness of the remedy, a groundwater evaluation to determine the presence or absence of 1,4-dioxane should be completed.

TABLE 6-6
Issues, Recommendations, and Follow-up Actions for Site 11

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date*	Affects Protectiveness	
				Current	Future
Issues Identified for Follow-Up Action During Current Five-Year Review					
RSL established for 1,4-dioxane. Previous sampling did not include analysis of this constituent; therefore, the presence or absence of 1,4-dioxane in Site 11 groundwater is unknown.	Sampling for 1,4-dioxane to confirm the presence or absence in groundwater.	Navy	September 2015	N	TBD

*Achievement of milestone dates are dependent on Navy funding.

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 6-1 - SITE 11 LOCATION AND LAYOUT.MXD CBOWMAN 10/15/2013 9:41:51 AM

Legend

- LUC Boundary
- Water Line
- Sanitary Sewer
- Sanitary Sewer Line Repaired
- Storm Water
- Heat Cool Line
- Electrical Cable Line

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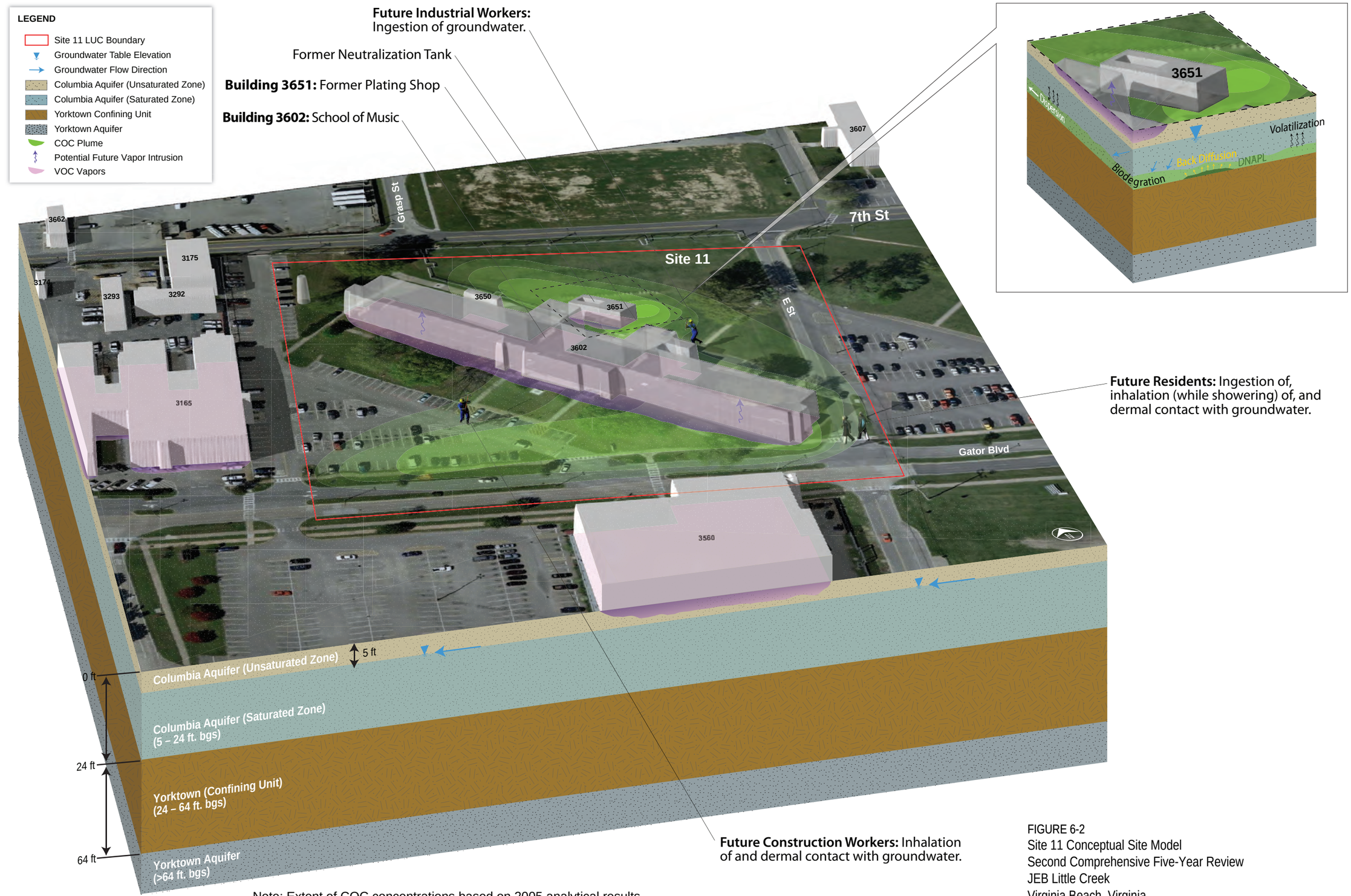
Feet

Figure 6-1
Site 11 Location and Layout
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

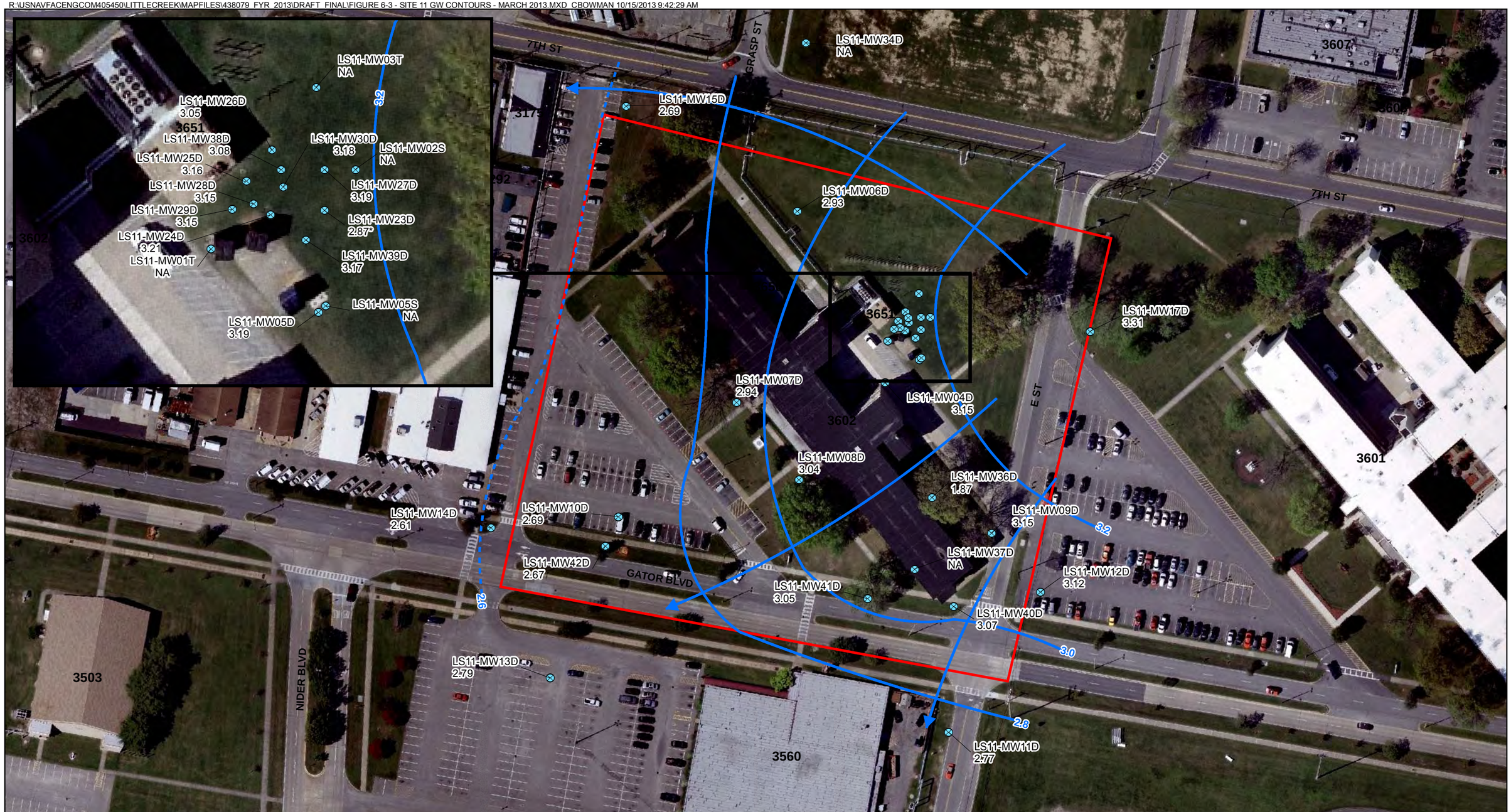


Note: Extent of COC concentrations based on 2005 analytical results

FIGURE 6-2
Site 11 Conceptual Site Model
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 6-3 - SITE 11 GW CONTOURS - MARCH 2013.MXD CBOWMAN 10/15/2013 9:42:29 AM



Legend

- Annual Monitoring Well
- Groundwater Contour (dahsed where inferred)
- Groundwater Flow Arrow
- LUC Boundary

Notes:
All elevations in feet mean sea level
*Groundwater elevation not used to generate countours

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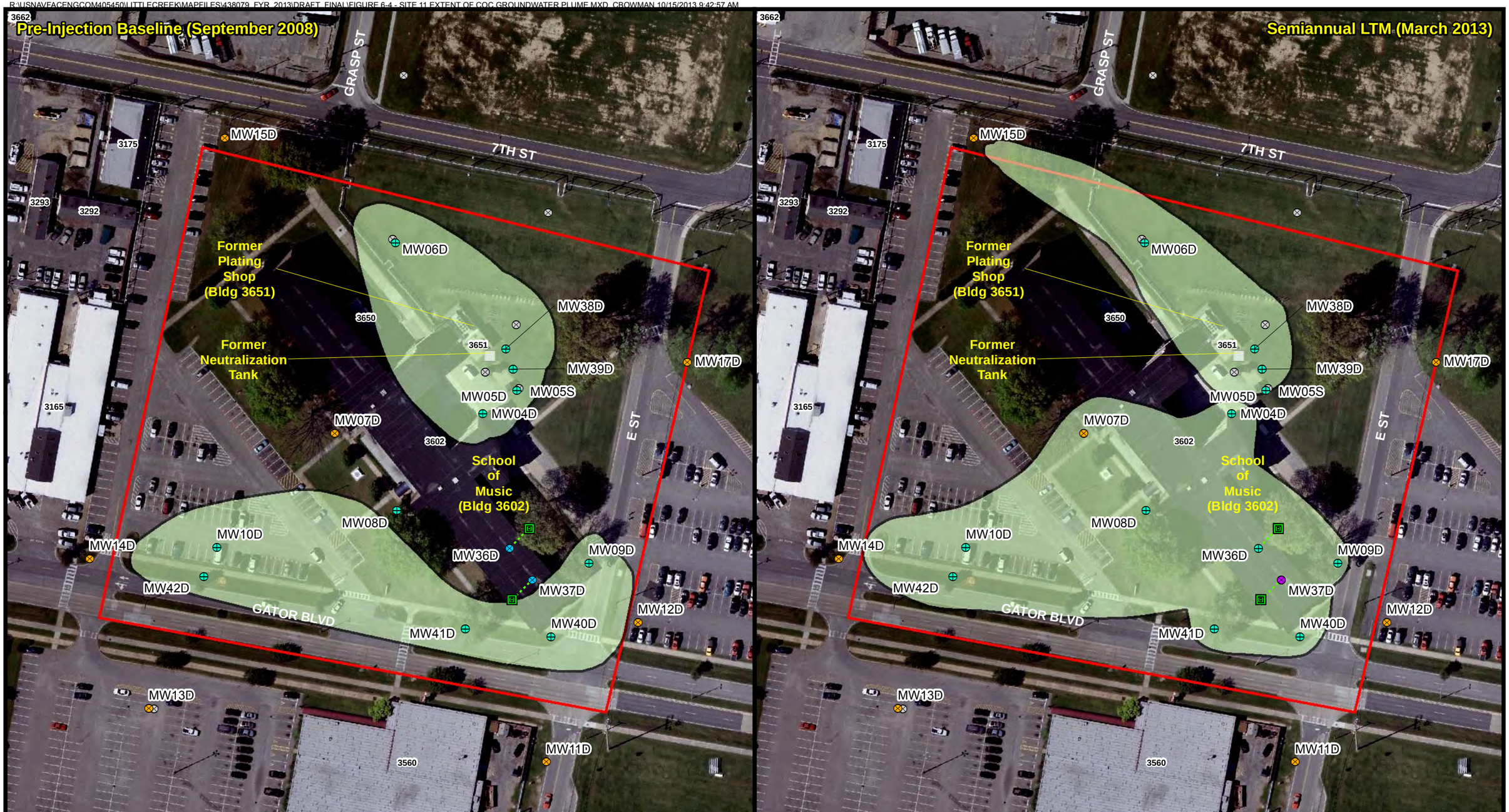
Figure 6-3
Site 11 Groundwater Contours - March 2013
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 6-4 - SITE 11 EXTENT OF COC GROUNDWATER PLUME.MXD, CROWMAN 10/15/2013 9:42:57 AM



Legend

- Monitoring Well (Removed during steam line repair)
- Flushmount Access to Existing 45° Directional Monitoring Well
- Monitoring Well
- Existing wells not included in monitoring well network
- Perimeter Well
- Performance Well
- LUC Boundary
- Extent of COC Groundwater Plume

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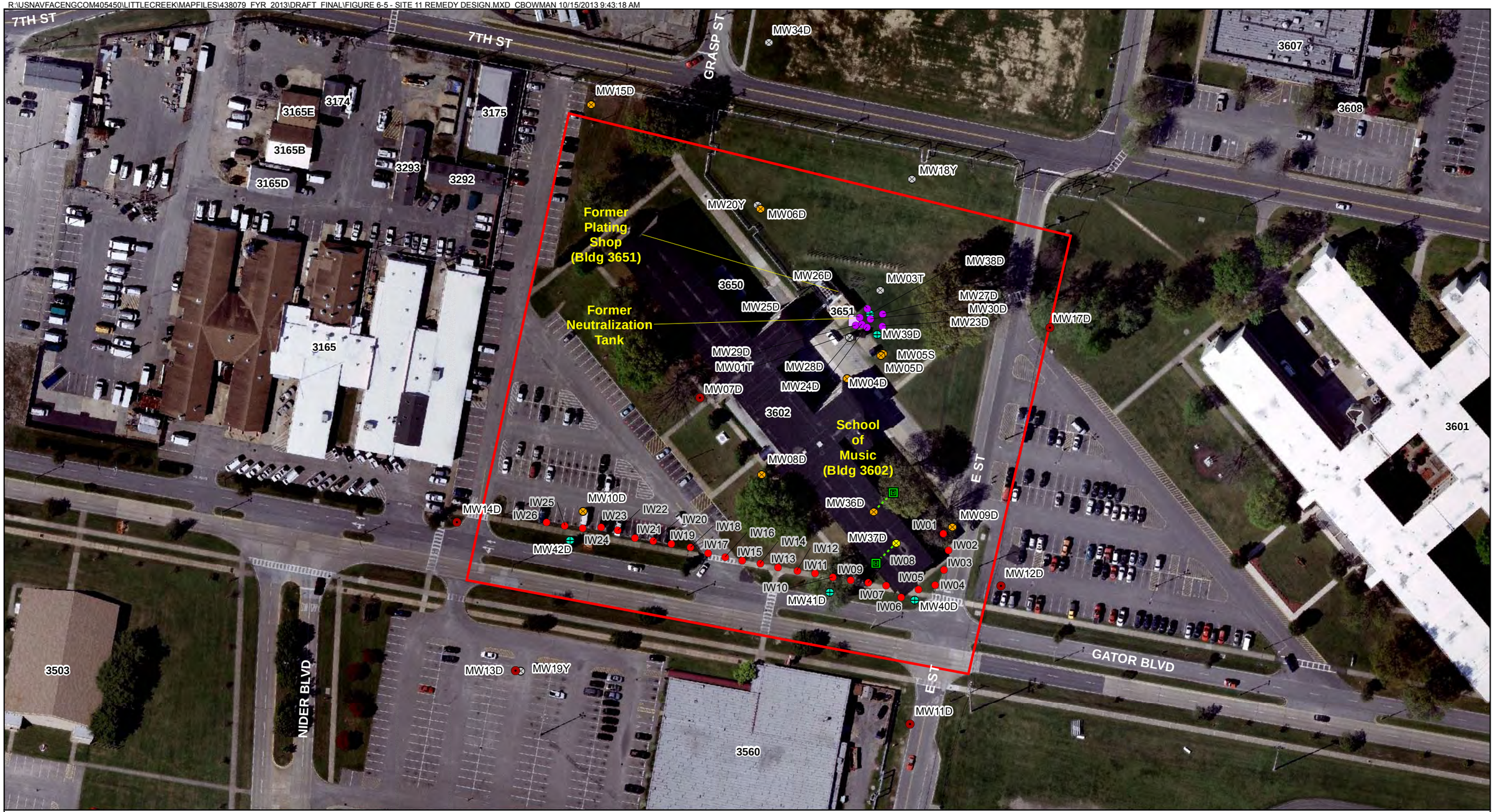
Figure 6-4
Site 11 Extent of COC Groundwater Plume
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 6-5 - SITE 11 REMEDY DESIGN.MXD CBOWMAN 10/15/2013 9:43:18 AM



Legend

- Existing Monitoring Well not Employed for the Remedial Action
- Flushmount Access to Existing 45° Directional Monitoring Well
- Annual Monitoring Well
- Perimeter Monitoring Well
- Performance Monitoring Well (1, 3, 6, and 9 months)
- Monitoring Well used for injection
- Injection Well
- Monitoring Well (Removed during steam line repair)

LUC Boundary

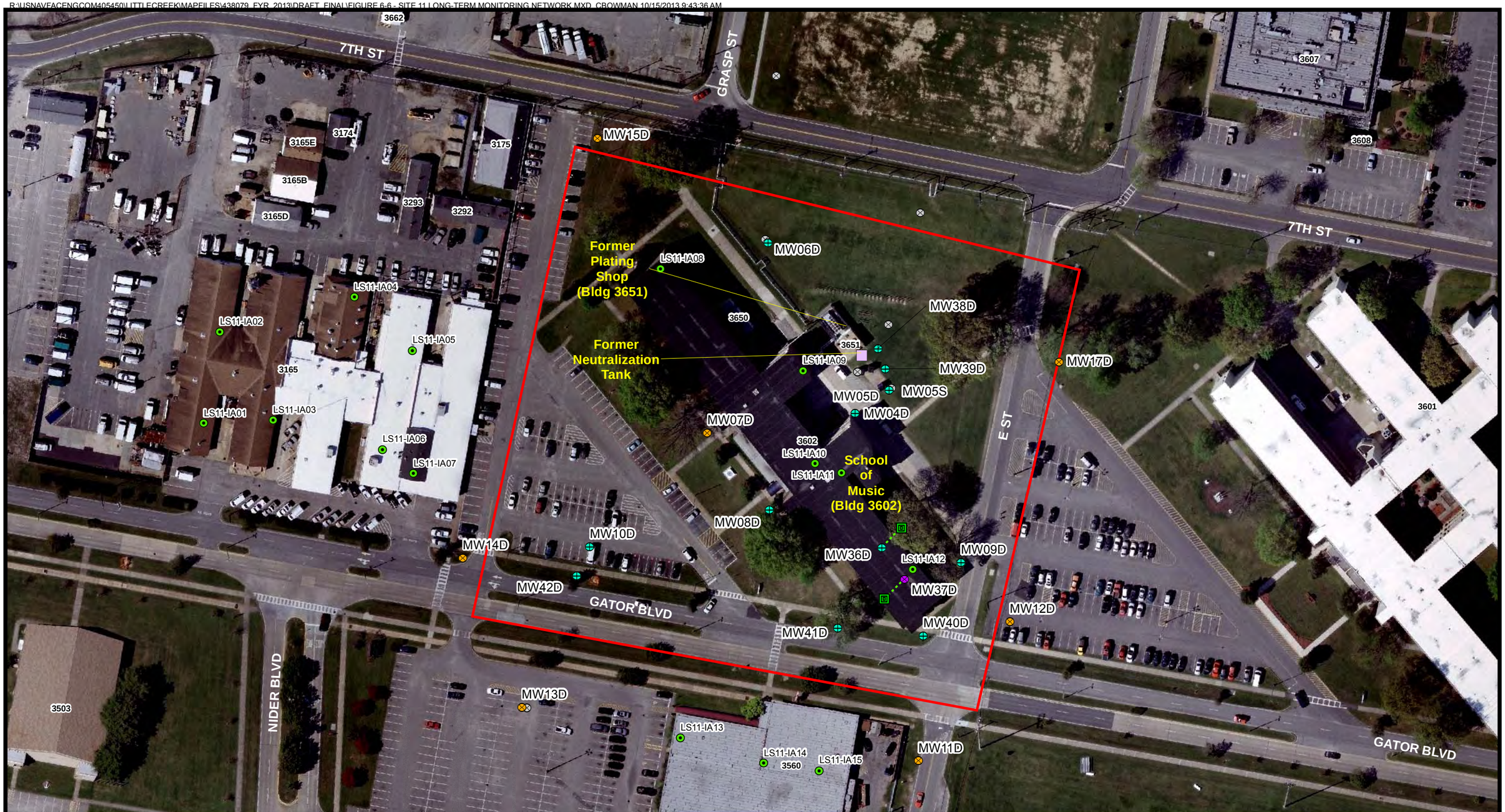
N W E S

0 50 100 Feet

Figure 6-5
Site 11 Remedy Design
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 6-6 - SITE 11 LONG-TERM MONITORING NETWORK.MXD CBOWMAN 10/15/2013 9:43:36 AM



Legend

- Monitoring Well (Removed during steam line repair)
- Vapor Intrusion Sample Location
- Flushmount Access to Existing 45° Directional Monitoring Well
- Performance Well
- Perimeter Well
- Existing wells not included in monitoring well network
- LUC Boundary

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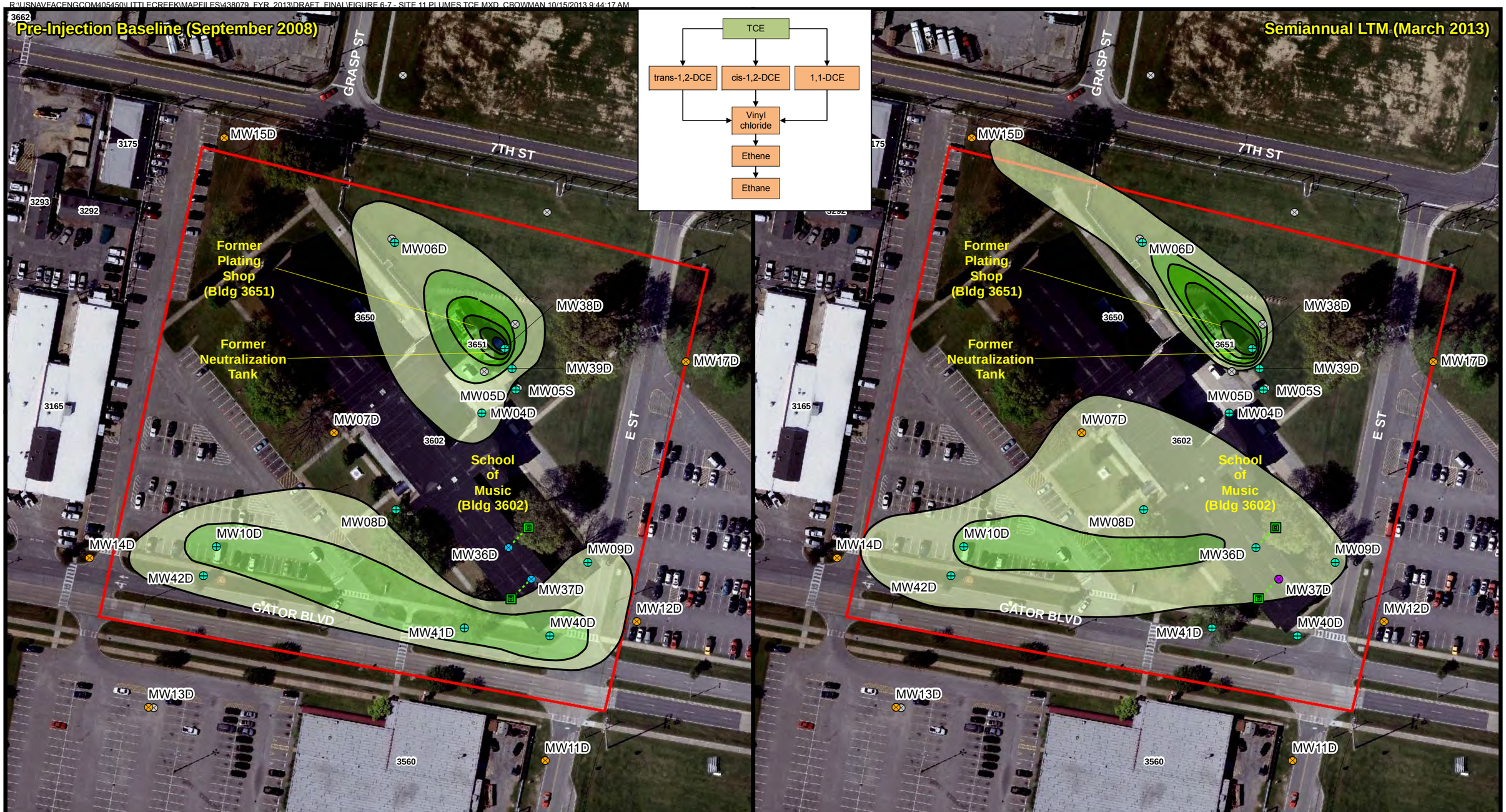
Figure 6-6
Long-term Monitoring Network
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 6-7 - SITE 11 PLUMES TCE.MXD CBOWMAN 10/15/2013 9:44:17 AM



Legend

- Monitoring Well (Removed during steam line repair)
- Flushmount Access to Existing 45° Directional Monitoring Well
- Monitoring Well
- Existing wells not included in monitoring well network
- Perimeter Well
- Performance Well
- LUC Boundary

Isoconcentrations

- 5-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- 10000-50000 µg/L
- > 50000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 6-7
Site 11 TCE Isoconcentrations
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

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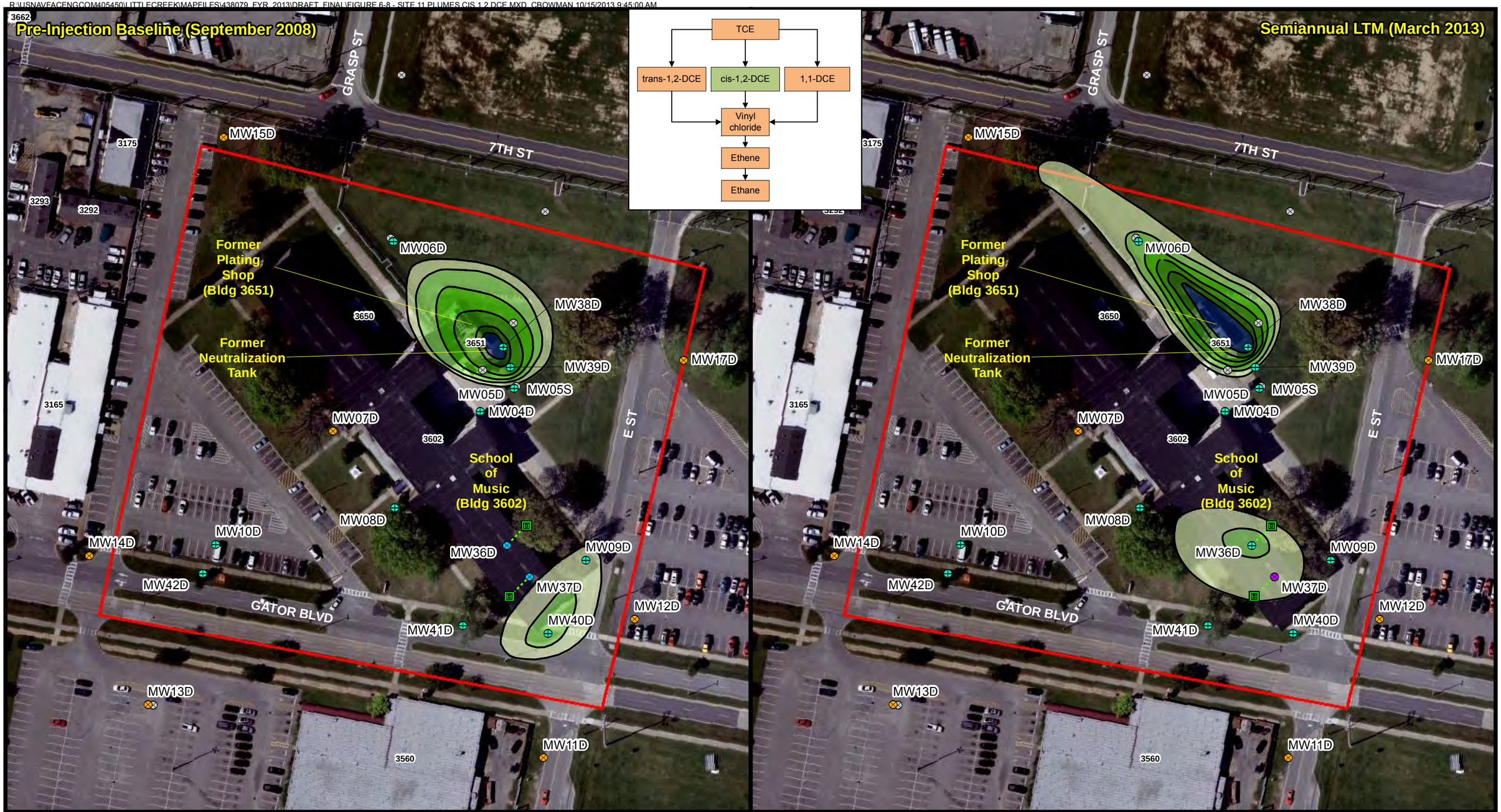
R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 6-8 - SITE 11 PLUMES CIS 1 2 DCE.MXD CBOWMAN 10/15/2013 9:45:00 AM



Legend

- Monitoring Well (Removed during steam line repair)
- Flushmount Access to Existing 45° Directional Monitoring Well
- Monitoring Well
- Existing wells not included in monitoring well network
- Perimeter Well
- Performance Well
- LUC Boundary

Isoconcentrations

- 70-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- 10000-50000 µg/L
- >50000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 6-8
Site 11 cis-1,2-DCE Isoconcentrations
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

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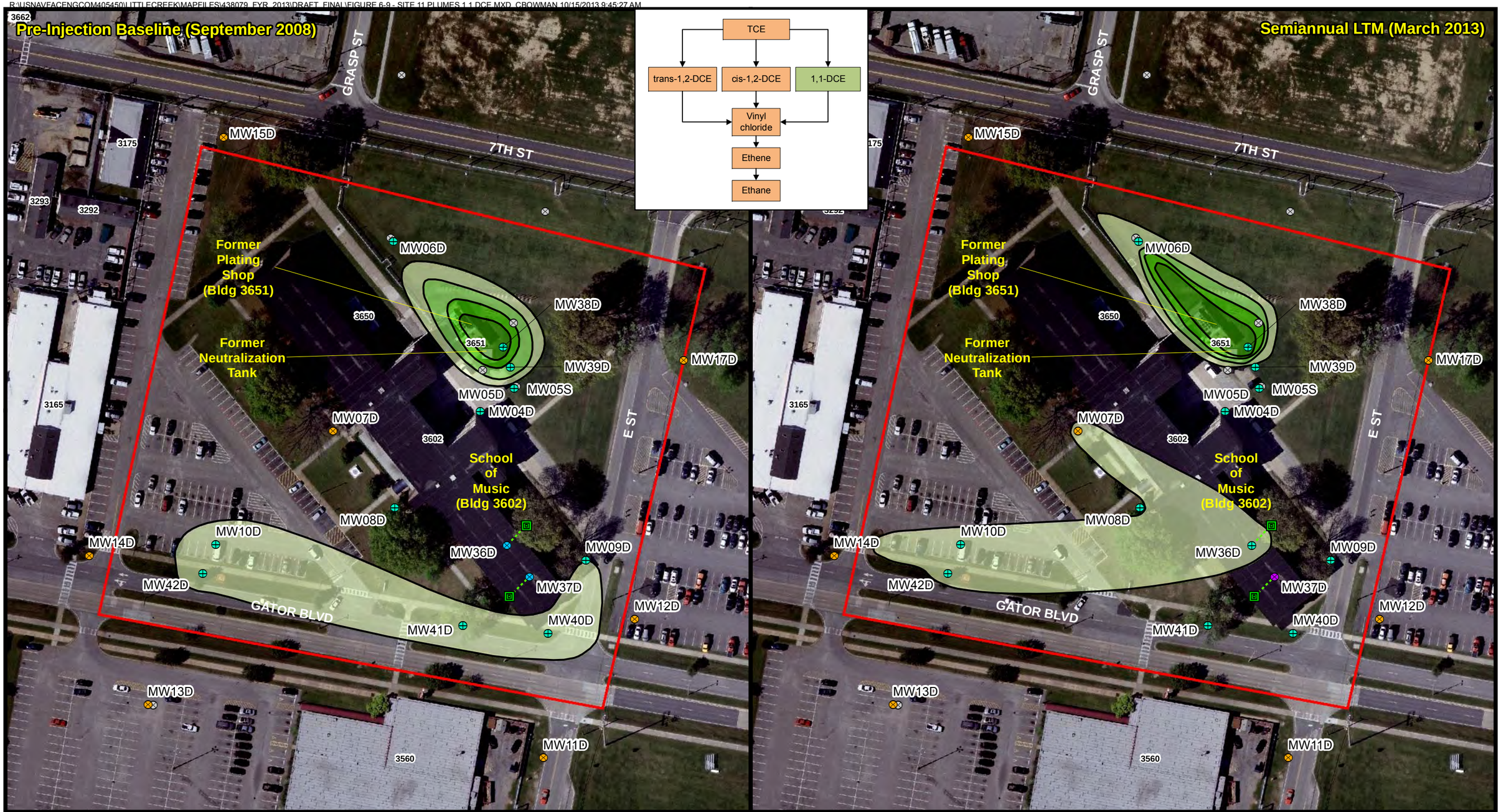
R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 6-9 - SITE 11 PLUMES 1.1 DCE.MXD CBOWMAN 10/15/2013 9:45:27 AM



Legend

- Monitoring Well (Removed during steam line repair)
- Flushmount Access to Existing 45° Directional Monitoring Well
- Monitoring Well
- Existing wells not included in monitoring well network
- Perimeter Well
- Performance Well
- LUC Boundary

Isoconcentrations

- 7-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- > 10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 6-9
Site 11 1,1-DCE Isoconcentrations
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

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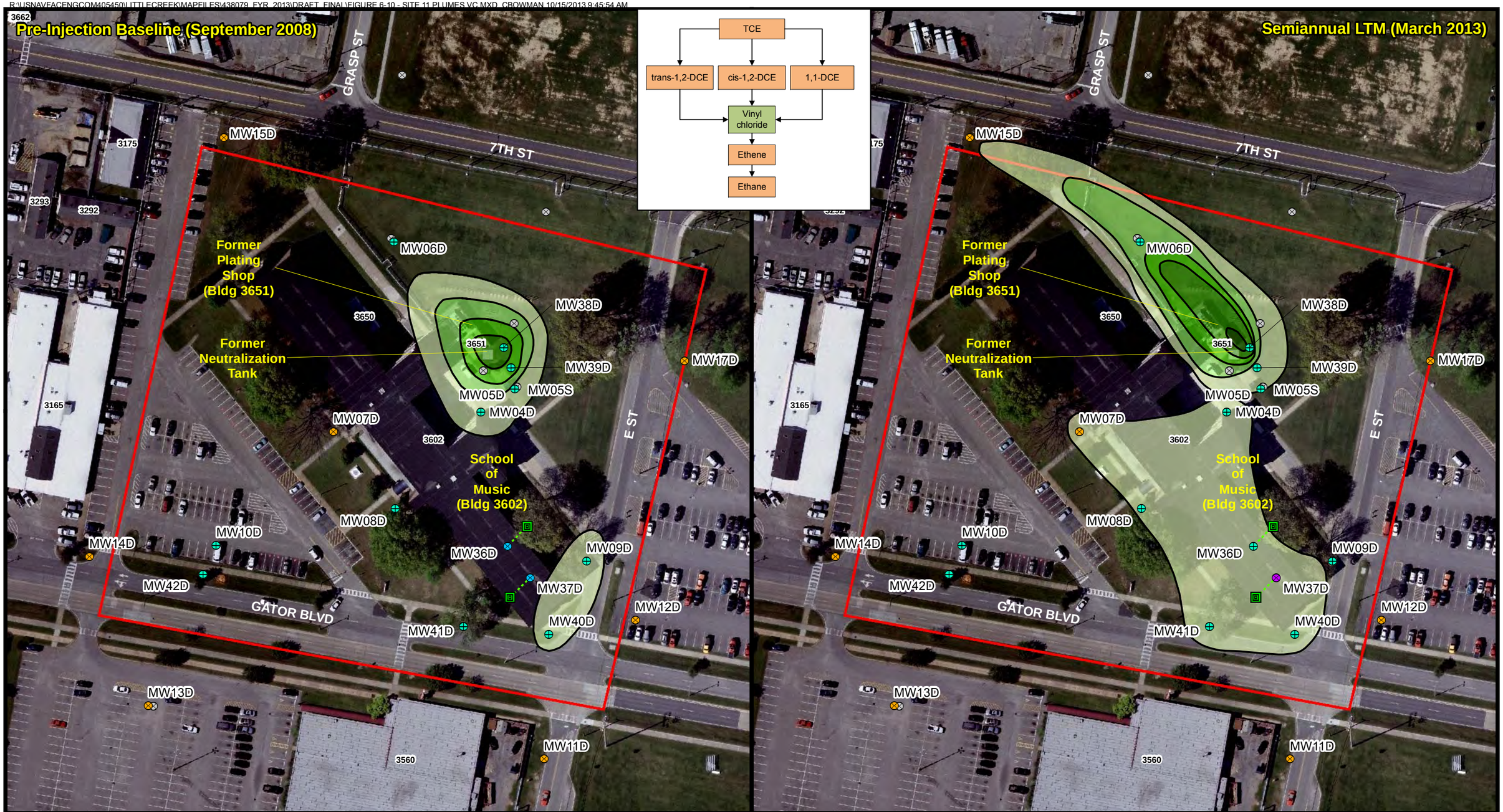
R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 6-10 - SITE 11 PLUMES VC.MXD CROWMAN 10/15/2013 9:45:54 AM



Legend

- Monitoring Well (Removed during steam line repair)
- Flushmount Access to Existing 45° Directional Monitoring Well
- Monitoring Well
- Existing wells not included in monitoring well network
- Perimeter Well
- Performance Well
- LUC Boundary

Isoconcentrations

- 2-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- > 10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 6-10
Site 11 Vinyl Chloride Isoconcentrations
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, VA

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SECTION 7

Site 11a – Building 3033 Former Vehicle Repair Facility and Waste Oil Tank

7.1 Site Chronology

Date	Event/Document	Document Administrative Record Number
August 2001	Site 11 Groundwater Investigation	--
June 2003	Site 11a Supplemental Investigation (SI)	000519
October 2003	FFA	000540
July 2006	Treatability Study	000990
July 2010	RI	001168
February 2011	RI Addendum	001177
June 2011	FS	001131
August 2011	Proposed Plan	001138
August 2011	ROD	001149
October 2012	100% Submittal Basis of Design	--
October 2012	Remedial Action Work Plan and Sampling and Analysis Plan	001629
November 2012	ERD Injections Complete	--
March 2013	Remedial Action Construction Completion Report	--
April 2013	LUC RD	--
May 2013	Annual LUC inspections initiated	--
September 2013	IRACR	--

7.2 Background

7.2.1 Site Description and History

Site 11a, the Building 3033 Former Vehicle Repair Facility and Waste Oil Tank, is located in the central portion of JEB Little Creek, near the intersection of Seventh and E Streets (**Figure ES-1** and **Figure 7-1)**. Currently, the site consists of Buildings 3606 (single-residency barracks) and 3606A (Quarter Deck) with unpaved areas that have been landscaped with shrubs, bushes, grass, and several large trees surrounding the buildings. Two former buildings, Buildings 3033 and 3034, were historically located at Site 11a. Former Building 3033 was used as a 12-bay vehicle repair facility. Historical records indicate the presence of an underground waste oil tank associated with the vehicle repair activities. The tank was previously identified as Solid Waste Management Unit 60 and closed under CERCLA with no further action following a desktop audit. The contents of the tank were not documented and there is no record of solvent disposal in the tank. The tank was reportedly excavated and removed in 1988 under the VDEQ Underground Storage Tank (UST) Program. Former Building 3034 was used as a garden supply center. No releases associated with this building have been documented.

Site 11a was identified in 1998 when VOCs were detected in groundwater from a Site 11 upgradient monitoring well (LS11-MW16D) during the Site 11 Supplemental RI (CH2M HILL, 2010b). Groundwater samples were collected in 1999 in the Site 11a vicinity as part of Site 11 investigations to identify a potential upgradient source of VOCs.

Consequently, the VOC groundwater contamination upgradient of Site 11 became identified in the FFA in 2003 as Site 11a, an Appendix B Preliminary Screening Area, and was proposed for investigation under CERCLA. Investigation results indicate site activities have resulted in a chlorinated solvent plume underlying the barracks parking lot and grassy field.

7.2.2 Physical Characteristics

The site characteristics, including surface features, geology, and hydrogeology, are depicted on the site CSM (**Figure 7-2**). The Site 11a topography is generally level, approximately 10 ft amsl, and includes Buildings 3606 (single-residency barracks) and 3606A (Quarter Deck) with unpaved areas that have been landscaped with shrubs, bushes, grass, and several large trees surrounding the buildings. There are no natural drainage features evident and no surface water bodies on or near the site. The majority of precipitation is lost through infiltration or evaporation; however, some stormwater runoff is captured through stormwater drop inlets at the site that convey surface runoff to outfalls that discharge to the stormwater sewer system. Site 11a is located approximately 800 feet south of the golf course ponds and approximately 2,900 feet south of the Chesapeake Bay. Access to the site is unrestricted for those with access to JEB Little Creek.

Shallow Columbia aquifer groundwater at Site 11a is encountered at depths from 5 to 10 feet bgs. The Columbia aquifer extends to a depth of between 20 to 30 ft bgs where the Yorktown confining unit separates the Columbia aquifer from the underlying Yorktown aquifer. The primary groundwater flow direction fluctuates based on weather events, but is predominantly to the west-southwest (**Figure 7-3**). The groundwater gradient underlying Site 11a is relatively flat and varies by less than 1 foot across the site. The average shallow groundwater flow velocity is estimated to be 2.4 feet per year.

The current, primary mechanism for contaminant transport is through dissolved plume migration downgradient with groundwater flow (advection). A secondary, less-prominent transport mechanism for the COCs is dispersion from the source area as a result of the low groundwater gradient. The mechanisms responsible for the fate of chemicals are natural degradation through various pathways (which plays a significant role in the length of time the chemicals will exist in the subsurface) and volatilization of chemicals from groundwater into the gas phase (which results in a decrease of contaminant mass from the saturated zone).

7.2.3 Land and Resource Use

Currently, surface features at Site 11a consist of Buildings 3606 and 3606A, their surrounding asphalt parking areas, and an open-mown grass field (**Figure 7-1**). Building 3606 is a five-story barracks building used as single- or double-occupancy lodging for active duty personnel. Building 3606A is a one-story building used primarily for administrative and recreational activities associated with the barracks. The open field south of Building 3606 is used primarily as a recreational area for building occupants.

Groundwater at JEB Little Creek is not currently used as a potable water source, nor is it expected to be used as a future potable water source. Potable water is supplied to the base and surrounding community by the cities of Virginia Beach and Norfolk. Groundwater supply wells at the base golf course, located approximately 800 feet north-northwest of Site 11a, provide non-potable water from the Yorktown aquifer to irrigate the golf course.

The LUCs are currently maintained within the area of restricted land and groundwater use at Site 11a and are inspected on an annual basis (Navy, 2013b). The LUCs restrict land use and prevent exposure to shallow groundwater until site conditions allow for unlimited use and unrestricted exposure.

7.2.4 History of Contamination

Although no record of a release associated with former Buildings 3033 and 3034 has been identified, investigation results indicate chlorinated VOCs were historically released to groundwater. Groundwater contamination includes a small source area near the footprint of the former Building 3033 and the suspected location of the former waste oil UST, with dissolved-phase contaminants extending south-southwest following the primary direction of groundwater flow and extending north beneath Building 3606 (**Figure 7-4**). TCE is the most horizontally extensive VOC, while tetrachloroethene (PCE) is concentrated in the source area and the area just south of the source. Groundwater contamination is predominately present in the bottom 5-foot interval just above the clay confining

unit (approximately 23 to 28 ft bgs). Data do not indicate the presence of DNAPL at the site. No VOCs have been detected in samples collected from the underlying Yorktown aquifer.

Initial Response

Site 11a was initially identified in the FFA, following the detection of elevated concentrations of TCE upgradient of Site 11. A treatability study was conducted in 2005 to evaluate the in situ chemical oxidation (ISCO) of VOCs in groundwater through injection of ferrous sulfate, hydrochloric acid, and sodium persulfate to condition the aquifer, followed by injection of hydrogen peroxide (Fenton's Reagent). Three rounds of post-injection sampling were conducted in April 2005, June 2005, and November 2005. The results of the treatability study indicated that ISCO was ineffective in consistently reducing VOC concentrations across the treatment area, likely because of insufficient distribution of reagent in the aquifer (CH2M HILL, 2006c).

Site Risks

Human Health Risk

An HHRA was conducted as part of the 2010 RI and 2011 RI Addendum to evaluate the potential human health risks associated with exposure to soil and groundwater (CH2M HILL, 2010b; CH2M HILL, 2011b). The exposure media, pathways, and scenarios evaluated and COCs identified are summarized in **Table 4-2**. No potentially unacceptable risks or hazards associated with exposure to site soil were identified. It was concluded that exposure to shallow groundwater may pose unacceptable hazards and risks for future construction workers and adult/child residents. Risks and hazards were primarily associated with exposure to VOCs in groundwater. No potentially unacceptable current or future risks were identified from exposure to indoor air under existing site conditions.

Ecological Risk

A SERA (Step 1 of the ERA process) was completed as part of the 2010 RI to evaluate potential risks to ecological receptors from direct exposure to surface soil (CH2M HILL, 2010b). There is no complete pathway for ecological receptor exposure to groundwater (see Section 6.2.4) and no aquatic habitats exist on or near the site. The Site 11a SERA concluded potential ecological risks (above background levels) are negligible based on the lack of complete and significant terrestrial exposure pathways.

7.2.5 Basis for Taking Remedial Action

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 shallow groundwater at Site 11a. Site COCs and their respective cleanup levels identified in the ROD for Site 11a are summarized in **Table 7-1**.

TABLE 7-1
Cleanup Levels for Site 11a Chemicals of Concern

Chemical of Concern	Cleanup Level* (µg/L)
PCE	5
TCE	5

Notes:
*Cleanup levels are MCLs.

Although not identified as site-specific COCs requiring action, the degradation of PCE and TCE may result in temporary increases to the concentrations of daughter products cis-1,2-DCE and VC above their respective MCLs. Because RAOs cannot be met if these constituents are above their MCLs, cis-1,2-DCE and VC will be monitored during remedy implementation to be sure concentrations remain below their respective MCLs. The daughter product MCLs are as follows:

- cis-1,2-DCE: 70 µg/L
- VC: 2 µg/L

7.3 Remedial Actions

7.3.1 Remedy Selection

The ROD for Site 11a was signed in September 2011 (CH2M HILL, 2011b). The ROD summarized the risks to human health and ecological receptors, established RAOs, and defined the selected remedy. The selected remedy for Site 11a was defined as groundwater treatment through ERD, groundwater monitoring, and LUCs to meet the following RAOs:

- Reduce concentrations of COCs in the source area and the down-gradient plume to cleanup levels (MCLs) through treatment to the maximum extent practicable within a reasonable amount of time.
- Prevent exposure to Site 11a groundwater and groundwater emissions in indoor air until concentrations of COCs have been reduced to levels that allow for unlimited use and unrestricted exposure.

Cleanup levels for Site 11a were established as the federal MCLs. Unacceptable risks, RAOs, remedy components, performance standards and expected outcomes for evaluating the overall performance of the remedy are summarized in **Table 7-2.**

The following LUC objectives for Site 11a were selected in the ROD:

- Prohibit activities that would result in contact with shallow groundwater except for environmental monitoring
- Prohibit the withdrawal of shallow groundwater except for environmental monitoring
- Prohibit construction of new buildings at the site without making sure vapor intrusion mitigation measures are included in building design
- Prohibit the use of the site for child care, elementary or secondary school, or playground facilities
- Maintain the integrity of any current or future remedial or monitoring system

LUC objectives have been implemented with the actions detailed in the LUC RD (Navy, 2013b). LUCs will be maintained until the concentrations of VOCs in the groundwater have been reduced to levels that allow for unlimited use and unrestricted exposure.

7.3.2 Remedy Implementation

The Site 11a IRACR was signed in September 2013 and documents that the remedy is in place and functioning as designed. Remedy implementation was completed as described in the following subsections.

Remedial System Installation

Remedy implementation began in April 2012 in accordance with the 90% remedial design (CH2M HILL, 2011f) and final RA work plan (Osage, 2012) with the installation of five new monitoring wells and baseline groundwater sampling. Based on the results of baseline sampling, the 100% remedial design (CH2M HILL, 2012c) was issued and a revised final work plan (Osage, 2012) submitted. In November 2012, approximately 1,234 gallons of solution (emulsified vegetable oil, sodium bicarbonate, and potable water) were injected into 46 temporary injection points (**Figure 7-5**) via direct-push technology. Remedy construction was documented in the RA CCR (Osage, 2013). Following substrate injection, performance monitoring was conducted at a frequency of 1, 3, and 6 months post-injection. Sample locations are depicted on **Figure 7-5** and results are summarized below.

TABLE 7-2
Site 11a Expected Outcomes

Risk		COCs	RAOS	Remedy Components	Metric/Cleanup Level	Expected Outcome	
Human Health	**Ecological**						
Groundwater							
Future adult/child resident ingestion of, dermal contact with, and inhalation of groundwater (while showering); future construction worker dermal contact with and inhalation of groundwater in an open excavation	No complete and significant exposure pathways	PCE TCE	Reduce concentrations of COCs in the source area and the down-gradient plume to remediation goals (MCLs) through treatment to the maximum extent practicable within a reasonable amount of time	ERD	Monitor groundwater COC concentrations to confirm achievement of substrate ROI and conditions conducive for ERD.	Elimination of source area (total COCs < 500 µg/L) and prevention of down-gradient migration of plume	Removal of LUCs
				Performance monitoring			
				Groundwater monitoring	Monitor shallow groundwater COC concentrations to confirm the natural degradation process until concentrations are at or below cleanup levels (MCLs)	Achieve unlimited use and unrestricted exposure	
			Prevent exposure to Site 11a groundwater and groundwater emissions until concentrations of COCs have been reduced to levels that allow for unlimited use and unrestricted exposure	LUCs	Periodic inspection of the site to confirm adherence to LUCs until shallow groundwater COCs are at or below their respective cleanup levels (MCLs)	Removal of LUCs	
				Groundwater monitoring	Monitor shallow groundwater COC concentrations to evaluate the potential for vapor intrusion until concentrations are at or below cleanup levels (MCLs)		

Performance Monitoring Results Summary

To evaluate the adequacy of the injection system, field and geochemical data were reviewed to be sure suitable anaerobic conditions were achieved, pH was maintained, and TOC levels were indicative of adequate substrate distribution. Performance monitoring results indicated that the remedy implementation was successful (Osage, 2013). ORP and DO concentrations decreased from baseline conditions after substrate injections, suggesting adequate reducing conditions were achieved. Although significant increases in TOC have not been observed at 6 months post-injection, increased travel time for the substrate to achieve the desired radius of influence may be a result of use of direct-push technology.

The assessment of overall effectiveness of the ERD remediation is based on changes in plume configuration, plume containment, and the concentrations of COCs remaining in groundwater at the site. After 6 months, the post-injection areal extent of the groundwater plume was observed to be similar to that of the pre-injection areal extent; however, decreases in parent compound PCE (**Figure 7-6**) within the source area coupled by temporary increases in daughter product TCE (**Figure 7-7**) have been observed. One of the expected outcomes for Site 11a groundwater is the elimination of the source area, with success determined by total COC concentration falling below 500 µg/L. The total COC concentration at 6 months post-injection in the source area was only slightly above (at 577.5 µg/L) the 500 µg/L source area removal expected outcome.

Land Use Controls

LUCs are in place to prevent exposure to groundwater (**Figure 7-1**). The LUC RD for Site 11a was finalized in April 2013 (Navy, 2013). A survey plat for Site 11a was filed with the City of Virginia Beach on July 8, 2013 to provide public notice of the Site 11a environmental conditions and limitations on the use of the property and to record the LUC boundary (Navy, 2013). As outlined in the LUC RD, annual inspections are conducted to monitor unauthorized activities and land use changes. Checklists and data reports are completed during inspections and issued to USEPA and VDEQ.

Long-term Monitoring

The long-term monitoring plan for Site 11a is currently being developed. Groundwater and vapor intrusion LTM are anticipated to begin in March 2014.

Site Inspections

During this Five-Year Review period, annual site inspections were conducted at Site 11a in 2011 and 2012. Results of the 2013 inspection are discussed in Section 2.3 and provided in **Appendix C**. With the exception of general well repairs, no significant issues, unauthorized intrusive activities, or changes in land use were identified. General well maintenance was conducted as needed. One remaining injection well associated with remedy implementation needs to be abandoned.

Summary of the Estimated Remedy Costs

Capital costs for implementation of the Site 11a remedial action were approximately $201,500, below the estimated -30%/+50% range ($280,840/$601,800) documented in the ROD. Management and monitoring costs have not yet been recognized. Changes to estimated remedy costs should be evaluated and the appropriate documentation prepared.

7.4 Progress Since Last Five-Year Review

The ROD was signed in September 2011 (CH2M HILL, 2011b) and this is the first Five-Year Review for Site 11a.

7.5 Technical Assessment

This section presents the answers to the three questions defined for the Technical Assessment for Site 11a based primarily on information presented in Section 7.3. Opportunities for maintenance and optimization of the remedy are presented in **Table 7-3**. The 6-month post-injection monitoring was completed in May 2013; however, ERD Groundwater Monitoring Summary Report which summarizes the data and provides conclusion and

recommendations based on the performance monitoring is not yet available, and consequently the data and trend graphs are not included in the appendices.

7.5.1 Question A: Is the remedy functioning as intended by the ROD?

Remedial Action Performance: Based on the review of documents, ARARs, risk assumptions, and site inspection reports, the Site 11a remedy is functioning as intended by the ROD. Remedy construction was completed in November 2012. Performance monitoring was conducted at a frequency of 1, 3, and 6 months following injection of the ERD substrate. As documented in the IRACR, the remedy was successfully implemented and effective in achieving geochemical conditions to facilitate ERD. Concentrations of COCs have decreased, but remain above MCLs.

Implementation of LUCs: LUCs have been implemented through the Final LUC RD. LUCs and site inspections have made sure that unauthorized site use is prohibited and exposure to groundwater is prevented.

LTM Activities: The LTM plan for Site 11a is currently being developed. Groundwater and vapor intrusion LTM are anticipated to begin in March 2014.

Early Indicators of Potential Issues: No indicators of potential issues have been identified.

Opportunities for Optimization: No opportunities for optimization have been recognized to date. Continued optimization of the remedy, including monitoring well network revision and additional substrate injection, will be incorporated into the decision matrixes included in the LTM plan to be developed.

7.5.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy 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. Current and anticipated future land use is industrial and is expected to remain the same. The exposure assumptions used to develop the HHRA and ERA are reasonable given that the current land use has not changed over time at Site 11a. Physical conditions of Site 11a that would affect exposure pathways have not changed. No new contaminants, sources, or routes of exposure were identified as part of this Five-Year Review.

Changes in Toxicity and Other Contaminant Characteristics. Changes in toxicity and tap water RSL values have been made since completion of the HHRA in 2010. However, these changes would not substantially change the results of the risk assessment; furthermore, LUCs prevent exposure to groundwater. Therefore, changes to the toxicity values would not adversely affect the current protectiveness of the remedy.

Since completion of the HHRA, 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. Although 1,4-dioxane has not been included in the sample analyte list for previous sampling, 1,1,1-TCA has not been detected in samples collected from Site 11a. Therefore, 1,4-dioxane is not expected to be present at the site and no further investigation of this constituent is warranted for long-term protectiveness of the remedy.

There have been no changes in toxicity associated with other VOCs that would affect the protectiveness of the remedy because either the VOC is already listed as a site COC, it was not previously detected, or it was not previously detected above the MCL. For the most part, the changes in toxicity values associated with metals would not affect the protectiveness of the remedy because historically, metals concentrations detected were below the MCL. Based on site history, SVOCs, PCBs, and pesticides, as well as dioxins/furans and explosives constituents, are not expected to be present at Site 11a. The cleanup goals for the site were established as the MCLs and no changes to these levels have been made.

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 11a. There have been no major procedural changes in how the ERAs are conducted since the last Five-Year Review.

7.5.3 Question C: Has any other information come to light that could question the protectiveness of the remedy?

No new information has come to light that would question the protectiveness of the remedy.

TABLE 7-3
Remedy Maintenance and Optimization Activities for Site 11a

Maintenance/Optimization Opportunity	Recommendations	Party Responsible
One remaining injection well associated with remedy implementation needs to be abandoned.	Abandon injection well.	Navy USEPA VDEQ

7.6 Issues, Recommendations, and Follow-up Actions

Table 7-4 outlines the issues identified during this Five-Year Review and presents recommendations and follow-up actions for Site 11a.

TABLE 7-4
Issues, Recommendations, and Follow-up Actions for Site 11a

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date*	Affects Protectiveness	
				Current	Future
Issues Identified for Follow-Up Action During Current Five-Year Review					
Remedy capital costs are below the -30%/+50% range estimated in the ROD.	Evaluate changes to remedy costs and prepare the appropriate documentation, as needed.	Navy	March 2015	N	N

*Achievement of milestone dates are dependent on Navy funding.

7.7 Protectiveness Statement

The remedy at Site 11a is in place, functioning as designed, and is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled through LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 7-1 - SITE 11A LOCATION AND LAYOUT.MXD CBOWMAN 10/15/2013 9:46:18 AM

Legend

- Approximate Location of Former Underground Waste Oil Tank
- LUC Boundary
- Demolished Building
- Electrical Cable Line
- Heat Cool Line
- Natural Gas Line
- Storm Sewer Line
- Wastewater Line
- Water Line

N
W E
S

0 50 100
Feet

Figure 7-1
Site 11a Location and Layout
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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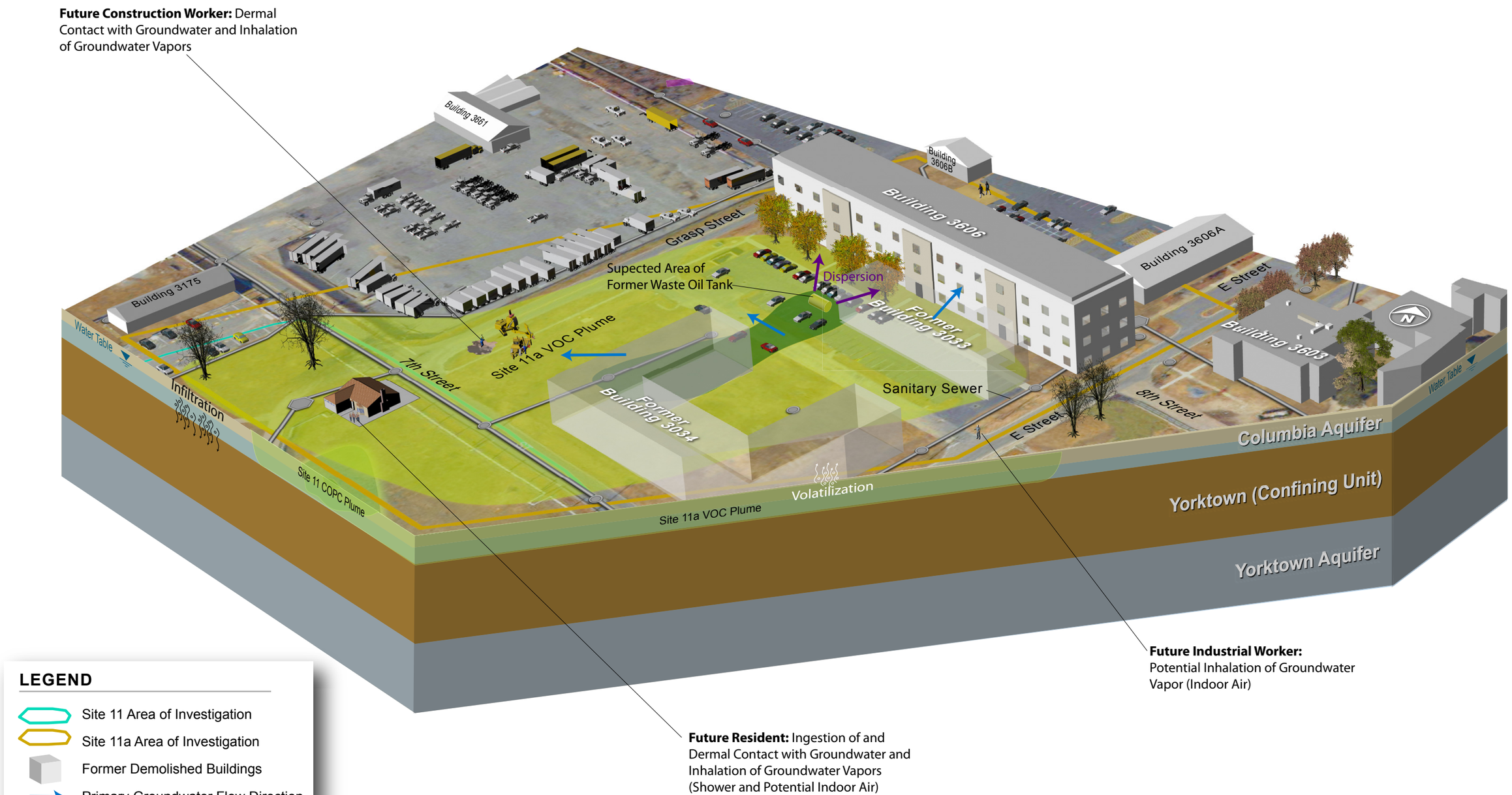

Note: Extent of COC concentrations based on 2007 analytical results

FIGURE 7-2
Site 11a Conceptual Site Model
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 7-3 - SITE 11A GW CONTOURS - MARCH 2013.MXD CBOWMAN 10/15/2013 9:47:38 AM

Legend

- Groundwater Monitoring Wells
- Groundwater Contour (dashed where inferred)
- Approximate Groundwater Flow Direction
- Installation Boundary
- LUC Boundary

Notes:
Depth to groundwater measurements recorded on May 15, 2013
Groundwater elevation measurements in feet above mean seal level

N
W E
S

0 30 60
Feet

Figure 7-3
Site 11a Groundwater Contours - May 2013
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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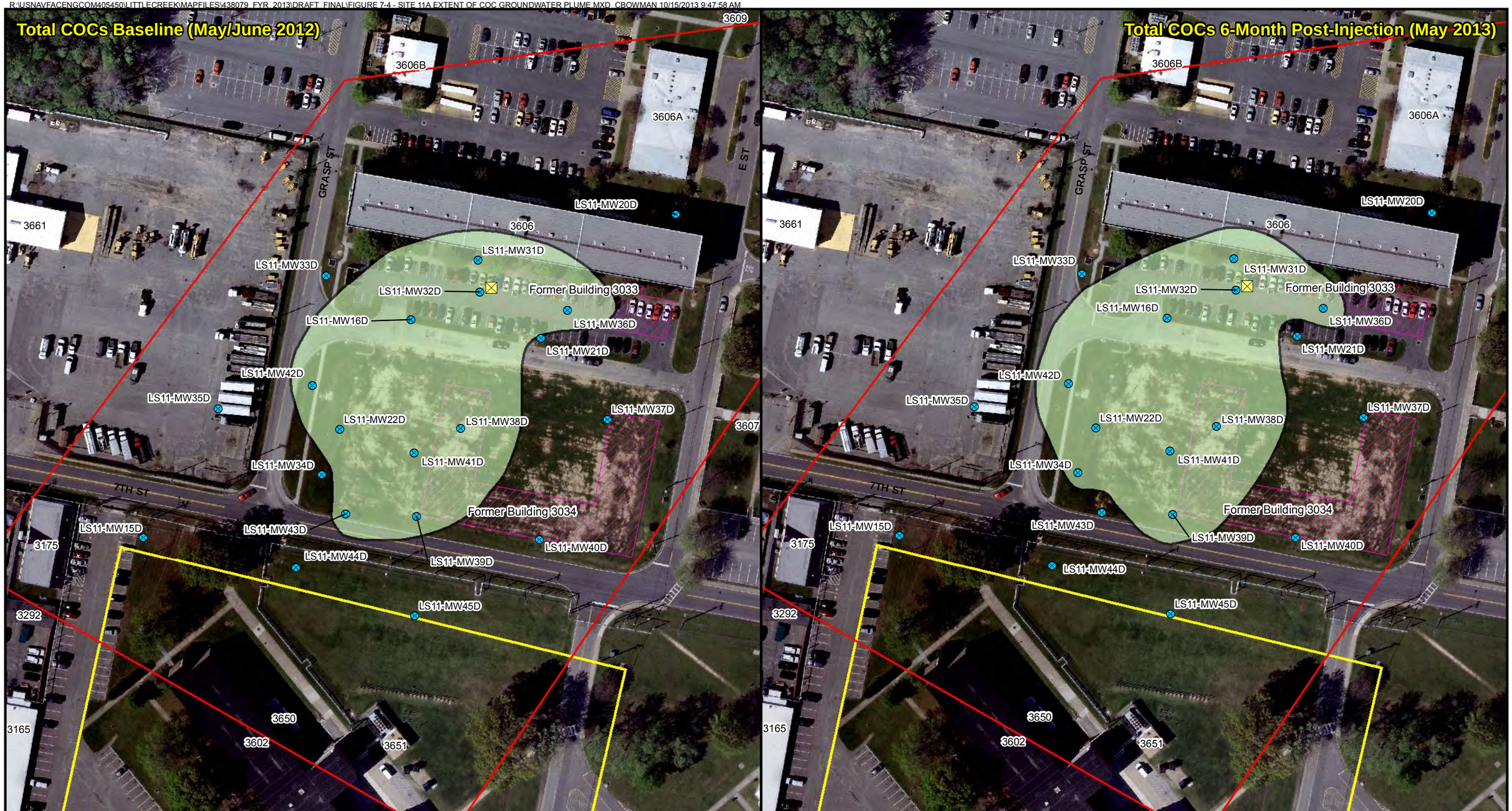
R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 7-4 - SITE 11A EXTENT OF COC GROUNDWATER PLUME.MXD CBOWMAN 10/15/2013 9:47:58 AM



Legend

- Monitoring Well
- Approximate Location of Former Underground Waste Oil Tank
- Site 11 LUC Boundary
- Site 11a LUC Boundary
- Demolished Building
- Extent of COC Groundwater Plume

N
W E
S

0 50 100
Feet

Figure 7-4
Site 11a Extent of COC Groundwater Plume.
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 7-5 - SITE 11A REMEDY DESIGN.MXD CBOWMAN 10/15/2013 9:48:22 AM

Legend

- Injection Location
- Monitoring Well
- New Monitoring Well
- Approximate Location of Former Underground Waste Oil Tank
- LUC Boundary
- Demolished Building

N
W E
S

0 50 100
Feet

Figure 7-5
Site 11a Remedy Design
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 7-6 - SITE 11A PCE ISOCONCENTRATIONS.MXD CBOWMAN 10/15/2013 9:48:48 AM

Legend

- Injection Location
- Monitoring Well
- New Monitoring Well
- Approximate Location of Former Underground Waste Oil Tank
- Site 11 LUC Boundary
- Site 11a LUC Boundary
- Demolished Building
- Isoconcentration Line
- Isoconcentration (inferred)

Isoconcentrations

- 5-100 µg/L
- 100-500 µg/L

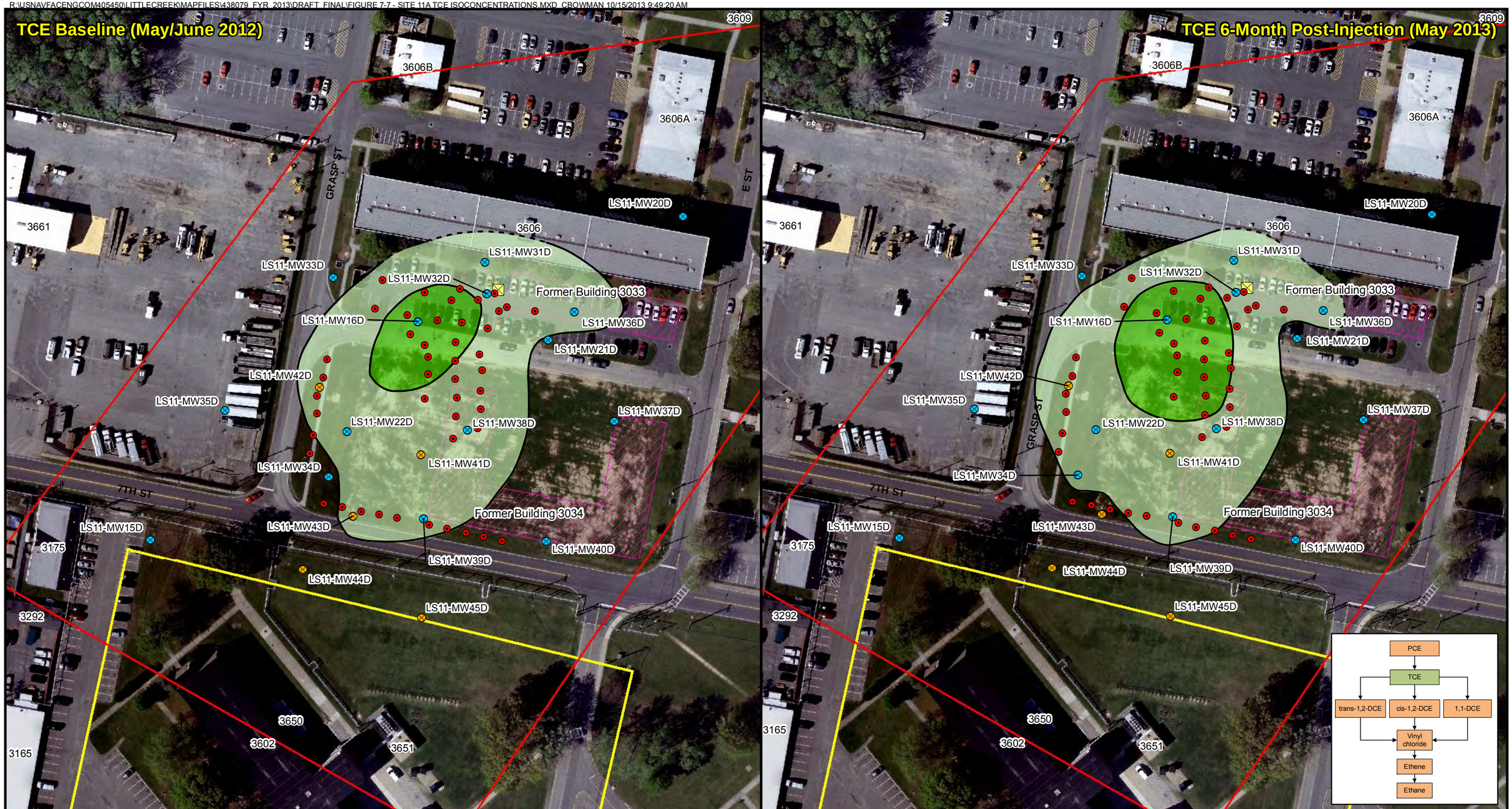
N W E S

0 50 100 Feet

Figure 7-6
Site 11a PCE Isoconcentrations
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 7-7 - SITE 11A TCE ISOCONCENTRATIONS.MXD CBOWMAN 10/15/2013 9:49:20 AM



Legend

- Injection Location
- Monitoring Well
- New Monitoring Well
- Approximate Location of Former Underground Waste Oil Tank
- Site 11 LUC Boundary
- Site 11a LUC Boundary
- Demolished Building
- Isoconcentration Line
- Isoconcentration (inferred)

Isoconcentrations

- 5-100 µg/L
- 100-500 µg/L

N W E S

0 50 100 Feet

Figure 7-7
Site 11a TCE Isoconcentrations
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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SECTION 8

Site 12 – Former Exchange Laundry/Dry Cleaning Facility

8.1 Site Chronology

Date	Event/Document	Document Administrative Record Number
December 1984	IAS	000130
October 1986	RVS	000022
March 1989	RFA	000008
August 1990	Environmental Assessment Phase I	Not available
April 1991	Environmental Assessment Phase II	000009
November 1991	IRI	000104
June 1992	Site Closeout Report	--
November 1994	RI/FS for Sites 7 and 9-13	000226, 000352, 000353
May 1999	Former NAB Little Creek on NPL	000439
June 2000	SERA	000417
October 2000	SRI	000422
March 2003	BERA	001368
October 2003	FFA	000540
March 2004	FS	--
September 2004	Revised FS	000783
September 2004	Revised FS Addendum	0011444
June 2005	Proposed Plan	0000866
September 2005	ROD	0000927
September 2005	Periodic site inspections initiated	
August 2006	Explanation of Significant Differences (ESD)	0001032
February 2007	RAWP	--
April 2007	ERD Injections Complete	--
October 2008	Remedial Action Construction Completion Report	--
October 2008	ERD Annual Groundwater Monitoring Summary	--
February 2009	LUC RD	--
March 2009	Five Year Review	001534
March 2009	Second ERD Injections Complete	--
July 2009	Annual LUC inspections initiated	--
May 2010	LUC RD Revision 1	--
May 2010	IRACR	--
January 2011	Draft Final, Post-ROD LTM UFP-SAP	--
March 2011	Groundwater LTM initiated	--
September 2011	Third ERD Injections Complete	--
May 2013	LUC RD Revision 2	--

8.2 Background

8.2.1 Site Description and History

Site 12, the Former Exchange Laundry/Dry Cleaning Facility, is located in the eastern portion of the base, near the intersection of Amphibious Drive and B Streets (**Figures ES-1** and **8-1**). Use of the Former Exchange Laundry/Dry Cleaning Facility has resulted in a chlorinated solvent plume underlying the existing commissary parking lot.

The Former Exchange Laundry/Dry Cleaning Facility (former Building 3323) operated from 1973 until 1987, when it was demolished for the construction of the existing commissary (Building 3445). During operation, an estimated 1,320 gallons of waste, including PCE, soap, sizing, and dyes associated with dry cleaning activities, were disposed in a stormwater catch basin located to the northeast (RGH, 1984). Of this total, 200 gallons were estimated to be PCE sludge. The catch basin and associated storm sewer line were removed in 1992 for construction of the existing commissary.

8.2.2 Physical Characteristics

The site characteristics, including surface features, geology, and hydrogeology, are depicted on the site CSM (**Figure 8-2**). The ground surface in the vicinity of Site 12 is generally level, approximately 11 ft amsl, and includes the commissary (Building 3445), its associated parking lot, a self-serve car wash (Building 3528), and a drainage canal running north to south (**Figure 8-1**). The drainage canal is a relatively steep-banked, linear drainage canal with a thick growth of vegetation at the top of the bank. The drainage canal connects Lake Bradford to Little Creek Cove. The water level in the canal is controlled by a weir at Little Creek Cove that prevents the tides in the cove from backing up into Lake Bradford. During most of the year, except during heavy rains, the canal is stagnant with no perceptible flow. With the exception of the drainage canal, there are no additional surface water bodies within the boundary of Site 12. The majority of precipitation is lost through infiltration or evaporation; however, some stormwater runoff is collected by the stormwater sewer system and is subsequently discharged into the drainage canal. Site 12 is located approximately 3,600 feet southeast of the golf course ponds and approximately 5,000 feet south of the Chesapeake Bay. Access to the site is unrestricted.

Columbia aquifer groundwater is encountered at depths from 6 to 8 ft bgs. The Columbia aquifer extends to a depth of between 13 to 18 ft bgs where the Yorktown confining unit separates the Columbia aquifer from the underlying Yorktown aquifer. The primary groundwater flow direction fluctuates based on weather events but is predominantly to the west toward the canal (**Figure 8-3**). The groundwater gradient underlying Site 12 is relatively flat and varies by less than 1 foot across the site. The average shallow groundwater flow velocity is estimated to range from 0.61 to approximately 4.4 ft/day.

The current, primary mechanism for contaminant transport is through dissolved plume migration downgradient with groundwater flow (advection). A secondary, less-prominent transport mechanism for the COCs is dispersion from the source area as a result of the low groundwater gradient. The mechanisms responsible for the fate of chemicals are natural degradation through various pathways (which plays a significant role in the length of time the chemicals will exist in the subsurface) and volatilization of chemicals from groundwater into the gas phase (which results in a decrease of contaminant mass from the saturated zone).

8.2.3 Land and Resource Use

Currently, Site 12 consists of the base commissary, its associated parking lot, and a self-service car wash. Enlisted quarters, industrial activities, and administrative offices surround the site.

Groundwater at JEB Little Creek is not currently used as a potable water source, nor is it expected to be used as a future potable water source. Potable water is supplied to the base and surrounding community by the cities of Virginia Beach and Norfolk. Groundwater supply wells at the base golf course, located approximately 3,600 feet southeast of Site 12, provide non-potable water from the Yorktown aquifer to irrigate the golf course.

LUCs are currently maintained within an area of restricted land and groundwater use at Site 12 and are inspected on an annual basis (Navy, 2009b; Navy, 2010; Navy, 2013b) (**Figure 8-1**). The LUCs restrict land use and prevent exposure to shallow groundwater until site conditions allow for unlimited use and unrestricted exposure.

8.2.4 History of Contamination

Chlorinated VOC wastes generated by the Former Exchange Laundry/Dry Cleaning Facility were historically released to the surface or near surface through the storm sewer and percolated downward to groundwater. Groundwater contamination includes two residual source areas located north and west of the former laundry/dry cleaning facility. Chlorinated VOCs in groundwater extend from the source areas west toward the canal and slightly east (**Figure 8-4**). The vertical extent of VOCs in groundwater is about 20 feet to the clay confining unit, with higher contaminant concentrations near the top and bottom of the aquifer separated by lower concentrations in the intermediate aquifer depths. Concentrations of VOCs were historically higher near the bottom of the aquifer in the source areas. Data do not indicate the presence of DNAPL at the site. Chlorinated VOCs have not been detected in canal surface water or sediment. Additionally, groundwater sampling conducted to the west of the canal does not indicate VOCs are migrating under the canal. No VOCs have been detected in samples collected from the underlying Yorktown aquifer.

Initial Response

Site 12 was initially identified in the IAS (RGH, 1984). Prior to signature of the ROD, no actions had been conducted at the site.

8.2.4.1 Site Risks

Human Health Risk

An HHRA was conducted as part of the 2000 SRI to evaluate the risks to human health from exposure to soil, groundwater, surface water and sediment (CH2M HILL, 2000b). The exposure media, pathways, and scenarios evaluated and COCs identified in the revised HHRA are summarized in **Table 4-1**.

No potentially unacceptable risks or hazards associated with exposure to site soil, sediment, and surface water were identified. It was concluded that exposure to shallow groundwater may pose potentially unacceptable hazards and risks for future adult/child residents. Risks and hazards were primarily associated with exposure to VOCs in groundwater. As part of a site characterization study, soil gas samples were collected for analysis of VOCs to evaluate potential vapor intrusion pathways prior to the construction of the Commissary in 1995 (ATEC, 1993). Per recommendation of the study, a passive subsurface venting system was installed under the commissary floor to prevent the possibility of vapor migration into the new building. Therefore, an evaluation of vapor intrusion risk has not been conducted at Site 12.

Ecological Risk

A SERA (Steps 1 and 2 of the ERA process) was completed in 2000 using data collected as part of the 1994 RI/FS and 2000 SRI to evaluate potential exposure pathways for ecological receptors (CH2M HILL, 2000a). The assessment concluded there are no unacceptable risks to terrestrial receptors at Site 12 because no complete and significant exposure pathways exist at the site; however, potentially unacceptable risks to aquatic receptors exposed to sediment and surface water in the drainage canal were identified. As a result of the leaking sanitary sewer line intercepting groundwater prior to discharge to the canal, the assessment concluded there was no complete exposure pathway to groundwater discharging to surface water.

Following dredging of the drainage canal by the City of Virginia Beach in 1999 to improve stormwater capacity, additional sediment and surface water sampling was conducted for completion of a BERA (CH2M HILL, 2003c). The BERA focused solely on the assessment of potential risks associated with sediment and surface water in the drainage canal. The assessment concluded that potential ecological risks were low because of the limited habitat in the canal. Additionally, no potentially unacceptable risk associated with food web exposure was identified.

8.2.5 Basis for Taking Remedial Action

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 shallow groundwater at Site 12. Site COCs and their respective cleanup levels identified in the ROD for Site 12 are summarized in **Table 8-1**.

TABLE 8-1
Cleanup Levels for Site 12 Chemicals of Concern

Chemical of Concern	Cleanup Level* (µg/L)
PCE	5
TCE	5
1,1-DCE	7
cis-1,2-DCE	70
trans-1,2-DCE	100
VC	2

Notes:
*Cleanup levels are MCLs.

8.3 Remedial Actions

8.3.1 Remedy Selection

The ROD for Site 12 was signed in September 2005 (CH2M HILL, 2005c). The ROD summarized the risks to human health and ecological receptors, established RAOs, and defined the selected remedy. The selected remedy for Site 12 outlined in the ROD was ISCO, ERD, LTM and LUCs. In October 2006, an ESD was signed removing the ISCO portion of the remedy as a result of the likelihood for metals mobilization in groundwater. Therefore, the selected remedy for Site 12 was defined as groundwater treatment through ERD, groundwater monitoring, and LUCs to meet the following RAOs:

- Prevent unacceptable risk to human health and the environment from exposure to chlorinated VOCs in groundwater.
- Reduce chlorinated VOC concentrations to their MCLs by applying best available technologies.

Cleanup levels for Site 12 were established as the federal MCLs. Unacceptable risks, RAOs, remedy components, performance standards and expected outcomes for evaluating the overall performance of the remedy are summarized in **Table 8-2.**

The following LUC objectives for Site 12 were selected in the ROD:

- Prohibit the withdrawal of groundwater except for environmental monitoring and testing
- Prohibit the use of the site for residential, child care, elementary or secondary school, or playground facilities
- Maintain the integrity of any current or future remedial or monitoring system

LUC objectives have been implemented with the actions detailed in the LUC RD (Navy, 2009b). LUCs will be maintained until concentrations of VOCs in groundwater have been reduced to levels that allow unlimited use and unrestricted exposure.

TABLE 8-2
Site 12 Remedial Action Summary and Expected Outcomes

Risk		COCs	RAOs	Remedy Components	Metric/Cleanup Level	Expected Outcome	
Human Health	**Ecological**						
Groundwater							
Future adult/child resident ingestion of and dermal contact with groundwater; future construction worker dermal contact with and inhalation of groundwater in an open excavation	No complete and significant exposure pathways	PCE TCE 1,1-DCE cis-1,2-DCE trans-1,2-DCE VC	Reduce chlorinated VOC concentrations to the MCLs by applying best available technologies	ERD	Monitor groundwater COC concentrations and geochemical conditions to confirm achievement of substrate ROI and conditions conducive for ERD.	Achieve unlimited use and unrestricted exposure	Removal of LUCs
				Performance Monitoring			
				Groundwater monitoring	Monitor shallow groundwater COC concentrations and geochemical conditions to confirm continued effectiveness of the remedy and COC degradation until concentrations are at or below their respective cleanup levels.		
			Prevent unacceptable risk to human health and the environment from exposure to chlorinated VOCs in groundwater	LUCs	Periodic inspection of the site to confirm adherence to LUCs until groundwater COCs are at or below their respective cleanup levels.	Removal of LUCs	

8.3.2 Remedy Implementation

The Site 12 IRACR was signed in May 2010 and documents that the remedy is in place and functioning as designed (CH2M HILL, 2010c). Remedy implementation was completed as described in the following subsections.

Remedial System Installation

The final RA Work Plan was submitted in February 2007 (JV I, 2007a) and remedial action began in March 2007 with the installation of 17 new monitoring wells and 54 injection wells (**Figure 8-5**). Following installation, baseline groundwater samples were collected from newly-installed monitoring wells to establish pre-treatment conditions. Based on the results of baseline sampling, additional groundwater sampling was conducted in April 2007 via direct-push technology to delineate the western and southwestern edge of the plume. In March/April 2007, approximately 4,700 gallons of injectate solution (emulsified oil substrate, sodium bicarbonate, vitamin B-12, and potable water) were applied to each of the injection wells to enhance the naturally-occurring, microbially-mediated, anaerobic degradation of COCs. Remedy construction was documented in the RA CCR (JV I, 2008a). Groundwater samples were collected from designated monitoring wells at 1, 3, 6, 9, and 12 months following injection to evaluate the adequacy of the injection system. The final round of post-injection monitoring was conducted in May 2008. Performance monitoring results indicated the remedy was successful in achieving the geochemical conditions required to facilitate ERD (CH2M HILL, 2009a).

Land Use Controls

LUCs are in place to prevent exposure to groundwater (**Figure 8-1**). The LUC RD for Site 12 was finalized in February 2009 (Navy, 2009b). A survey plat for Site 12 was filed with the City of Virginia Beach on March 25, 2010 to provide public notice of the Site 12 environmental conditions and limitations on the use of the property and to record the LUC boundary (Navy, 2009b). As outlined in the LUC RD, periodic inspections are conducted to monitor unauthorized activities and land use changes. Checklists and data reports are completed during inspections and issued to USEPA and VDEQ.

Long-term Monitoring

Groundwater LTM at Site 12 was initiated in March 2012 in accordance with the Draft Final LTM UFP-SAP (Site 12 SAP) (CH2M HILL, 2011d). Groundwater LTM is performed to assess the continued effectiveness of the remedy in achieving the RAOs (CH2M HILL, 2012b). Groundwater sampling is conducted semiannually from a minimum of 18 monitoring wells and up to 24 monitoring wells (**Figure 8-6**). Additionally, quarterly sampling is conducted at one monitoring well. Groundwater samples are analyzed for site COCs, total and dissolved arsenic, as well as wet chemistry parameters TOC, VFAs, nitrate, nitrite, sulfate, sulfide, methane, ethane, and ethene.

8.4 Progress Since Last Five-Year Review

8.4.1 Follow-up Actions Since Last Five-Year Review

The previous Five-Year Review report included the following protectiveness statement for Site 12:

> *The groundwater portion of the remedy for Site 12 has been implemented, is currently functioning as designed, and is expected to be protective of human health and the environment. In order for the remedy to be protective in the long-term, an IRACR must be in place to document the implementation of the LUCs and the groundwater LTM plan. In the interim, exposure pathways that could result in unacceptable risk are controlled through quarterly ER site inspections. The remedy is successfully reducing concentrations of VOCs in groundwater; however, since VOC concentrations remain above their respective MCLs in some areas, additional action is warranted at Site 12. Additional injection of substrate to prolong the effectiveness of the remedy was conducted in January/February 2009. Continued monitoring of plume configuration and migration will be conducted through post-remedial action groundwater monitoring to ensure long-term effectiveness of the remedy.*

Although the remedy was determined to be functioning as designed at the time of the last Five-Year Review, issues and recommendations for follow-up actions were identified. **Table 8-3** presents the status of these recommendations and follow-up actions.

TABLE 8-3
Site 12 Progress Action Items from 2008 Five-Year Review

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date	Affects Protectiveness		Status – March 2013	
				Current	Future	Action Taken and Outcome	Date of Action
LUC RD is not fully implemented.	Implement LUCs in accordance with the LUC RD and document in the IRACR for the site.	Navy	March 2009	N	Y	Initial LUC RD finalized in March 2009. Consensus agreements for LUC RD revisions were signed on May 19, 2010, and May 15, 2013 to more clearly identify the risks and receptors the LUCs were intended to address. The IRACR for Site 12 was signed in May 2010.	Complete – May 2010
Site monitoring wells are not clearly labeled outside the casing.	Apply permanent identification labels to all well casings.	Navy	Sept. 2013	N	N	Basewide well repairs conducted in October 2010. Each well was affixed with an outer casing clearly identifying it as an observation or monitoring well. Weather-resistant stickers with well IDs were affixed to all casings.	Complete - October 2010

8.4.2 Results of Implemented Actions

This section summarizes the remedial activities conducted since completion of the last Five-Year Review in 2009. To assess the performance of the remedial action, data and information were reviewed with respect to each of the performance metrics outlined in **Table 8-2**.

Some of the data and information presented to assist in this Five-Year Review have previously been presented through reports and Partnering Team presentations. The intention of this data review and analysis is to provide sound interpretations based on data previously provided, as well as additional data collected but not previously provided. To facilitate review of this document, groundwater data not previously documented in a report are presented in **Appendix F**; however, this report is not intended to fully present and document all data gathered. Data not previously documented in a report will be subsequently formally documented. Trend graphs for contaminant concentrations in select monitoring wells are presented in **Appendix G**.

Remedial System O&M

Following remedy implementation, concentrations of COCs had decreased but remained above MCLs; therefore, an additional substrate injection was recommended to keep aquifer conditions amenable for reductive dechlorination. A second injection was completed in March 2009, followed by one post-injection groundwater sampling event in June 2009. Based on the results of the March 2011 baseline LTM, a third injection was completed in August/ September 2011. Post-injection monitoring was conducted as semiannual LTM at 1, 6, and 12 months.

Long-term Monitoring

Groundwater LTM is currently performed in accordance with the Draft Final LTM UFP SAP (Site 12 SAP) (CH2M HILL, 2011d).

Groundwater

Groundwater monitoring was initiated in March 2011 and has subsequently been conducted in June 2011, September 2011, December 2011, March 2012, June 2012, September 2012, December 2012, and March 2013. Groundwater LTM data through the March 2013 Five-Year Review groundwater monitoring event are provided in **Appendix F** and data trends for select monitoring wells are provided in **Appendix G**. Pre-injection (2005 to 2007) and Five-Year Review (March 2013) groundwater plumes for PCE, TCE, cis-1,2-DCE, and VC in shallow and deep Columbia aquifer groundwater are provided in **Figures 8-7** through **8-14**.

As shown on **Figure 8-4**, the overall lateral extent of the plume has decreased since remedy implementation. An overall decrease in total COCs of 84 percent has been recognized; however, concentrations remain above cleanup levels in both the shallow and deep portions of the Columbia aquifer. With the exception of LS12-MW01D and LS12-MW07T, COCs have not been detected above the MCLs in perimeter monitoring wells. Although detected in LS12-MW01D and LS12-MW07T above cleanup levels, concentrations of COCs above cleanup levels remain within the LUC boundary. Concentrations of TCE in upgradient perimeter monitoring well LS12-MW01D are slightly above MCLs; however, concentrations are consistent with those detected during pre-injection baseline sampling. Increasing concentrations of TCE, cis-1,2-DCE, and VC, with concentrations of TCE and VC above their respective MCLs, have been observed in LS12-MW07T. Additionally, increasing concentrations of total and dissolved arsenic above the MCL have also been observed. As a result of these observed increases and cleanup level exceedances, it is recommended that LS12-MW07T be reassigned as a plume monitoring well, and existing monitoring well LS12-MW09T be added to the LTM network as a perimeter well to monitor the downgradient migration of COCs.

Shallow Columbia Aquifer

As shown on **Figures 8-7** through **8-14** and trend graphs provided in **Appendix G,** concentrations of PCE, TCE, cis-1,2-DCE and VC have decreased by several orders of magnitude, with an approximate 78 percent reduction in total COCs, in the shallow portion of the Columbia aquifer since remedy implementation. Significant decreases in parent product PCE (maximum concentration of 12,000 µg/L in March 2007 to maximum concentration of 35.5 µg/L in March 2013) and first order daughter product TCE (maximum concentration of 720 J µg/L in May 2005 to maximum concentration of 39.2 J µg/L in March 2013) have occurred, while periodic increases and less significant decreases in daughter products cis-1,2-DCE and VC have been recognized. Although overall decreases

in COCs since the pre-injection baseline have been recognized, some rebound of PCE and TCE in source area monitoring well LS12-MW33S, coupled with stalling of daughter product breakdown in various source area and plume monitoring wells, have been observed.

Concentrations of COCs have been below cleanup levels for at least three consecutive LTM events, including the Five-Year Review event, in plume monitoring wells LS12-MW27S and LS12-MW28S. Because perimeter monitoring well LS12-MW04S has remained below cleanup levels, it is recommended that this monitoring well be removed from the network and plume monitoring wells LS12-MW27S and LS12-MW28S be reassigned as perimeter wells to monitor the southwestern edge of the shallow Columbia aquifer plume.

March 2013 groundwater sampling results indicate that TOC concentrations are below the desired 20 mg/L in all but two samples collected from LS12-MW07T, LS12-MW30S, and LS12-MW32S, where TOC is only slightly above 20 mg/L. Additionally, although some generation of VFAs was observed 6 months following the third round of substrate injections, little to no VFAs continue to be generated. Geochemical parameters such as pH, DO, and ORP indicate that the reducing conditions necessary to facilitate ERD have been maintained. However, based on the low TOC and lack of VFA generation, coupled with the rebound of PCE and TCE and stalling of daughter product degradation, an additional round of substrate injections should be considered.

Deep Columbia Aquifer

As shown on **Figures 8-11** through **8-14**, and trend graphs provided in **Appendix G,** concentrations of PCE, TCE, cis-1,2-DCE and VC in the deep portion of the Columbia aquifer have decreased by several orders of magnitude, with an approximately 90 percent reduction in total COCs, since remedy implementation. Significant decreases in parent product PCE (maximum concentration of 18,000 µg/L in March 2007 to maximum concentration of 628 µg/L in March 2013) and first order daughter product TCE (maximum concentration of 680 µg/L in March 2007 to maximum concentration of 53.1 µg/L in March 2013) have occurred, while periodic increases and less significant decreases in daughter products cis-1,2-DCE and VC have been recognized. Although overall decreases in COCs since the pre-injection baseline have been recognized, stalling and increases of daughter product degradation in various source area and plume monitoring wells have been observed.

Concentrations of COCs have been below cleanup levels for at least three consecutive LTM events, including the Five-Year Review event, in plume monitoring well LS12-MW27D. Coupled with shallow Columbia aquifer monitoring wells LS12-MW27S and LS12-MW28S, it is recommended that LS12-MW27D be reassigned as a perimeter well to monitor the southwestern edge of the deep Columbia aquifer plume.

Concentrations of COCs in downgradient contingency monitor well LS12-MW36D, which is adjacent to the canal, have fluctuated across events, with concentrations of PCE and VC above the cleanup levels during the March 2013 Five-Year Review event. Although concentrations exceed the MCLs, they are below established surface water and volatilization criteria. Additionally, concentrations of COCs in samples collected from across the canal from perimeter monitoring well LS12-MW23D have not been detected above MCLs, indicating COCs are not migrating underneath the canal. Although COCs are not adversely affecting the canal or migrating beneath the canal, because COCs are above cleanup level, re-injection at the deep downgradient injection line should be considered.

March 2013 groundwater sampling results indicate that TOC concentrations remain elevated (greater than 100 mg/L) in samples collected from LS12-MW32D and LS12-MW34D, but that TOC concentrations were below or only slightly above 20 mg/L in the remaining wells. Additionally, although some generation of VFAs was observed 6 months following the third round of substrate injections, little to no VFAs continue to be generated. Geochemical parameters such as pH, DO, and ORP indicate that the reducing conditions necessary to facilitate ERD have been maintained. However, based on the low TOC and lack of VFA generation, coupled with the stalling of daughter product degradation, an additional round of substrate injections should be considered.

Land Use Controls

In response to construction of a handicap-accessible ramp at the southwestern corner of the commissary in April 2010, assessment of risk associated with construction worker exposure to groundwater was evaluated. Potentially unacceptable risks were identified from dermal exposure to VOCs in groundwater. Because the existing remedy is

protective of the more-conservative, residential exposure scenario, no changes to RAOs or cleanup levels were warranted. However, a consensus agreement was signed on May 19, 2010 documenting the addition of the following LUC objective to the LUC RD for Site 12:

- Prevent dermal contact with groundwater by construction workers

To protect against any potential human health risk related to vapor intrusion resulting from changes in land use, a consensus agreement was signed in May 15, 2013, adding the following LUC objective to the LUC RD for Site 12:

- Prohibit changes from current building use or construction of new buildings without further evaluation of potential vapor intrusion risks and/or implementation of necessary mitigation measures

8.4.2.1 Site Inspection

During this Five-Year Review period, annual site inspections were conducted at Site 12 between 2009 and 2012. Results of the 2013 inspection are discussed in Section 2.3 and provided in **Appendix C**. With the exception of general well repairs, no significant issues, unauthorized intrusive activities, or changes in land use were identified during site inspections. However, in April 2010, construction of a handicap-accessible ramp at the southwestern corner of the commissary was observed during a site visit. The existing concrete sidewalk and approximately 1 foot of soil surrounding injection well LS12-I06 were removed. Groundwater was not encountered during construction activities. General well maintenance was conducted as needed.

8.4.3 Summary of the Estimated Remedy Costs

Table 8-4 presents capital and annual O&M and LTM costs for Site 12. Although costs expended each year vary, total remedy costs to date are within the +50%/-30% range estimated in the ROD.

TABLE 8-4
Site 12 Estimated Project Costs

Year	Timeframe	Projected Cost from ROD	Estimated Actual Cost	Notes
				Capital Cost*
0	2007 - 2009	$1,195,000	$1,183,500	Includes costs labor, ODCs, and subcontractor costs for project planning, field mobilization/demobilization, well installation, baseline and direct-push technology (DPT) sampling, two rounds of substrate injections, performance monitoring, and reporting.
				Management and Monitoring Cost**
1	2009	$22,000	$15,000	Includes cost of developing pre-draft LTM UFP SAP. Includes labor and ODCs associated with LUC inspections and reporting.
2	2010	22,000	$25,000	Includes cost of developing draft and draft final LTM UFP SAP. Includes labor and ODCs associated with LUC inspections and reporting.
3	2011	$22,000	$107,500	Includes labor, ODCs, and subcontractor costs associated with baseline, quarterly (2), and semiannual LTM sampling. Includes labor and ODCs associated with LUC inspections and reporting. Includes labor, ODCs, and subcontractor costs associated with completion of Round 3 O&M injections and reporting.
4	2012	$22,000	$39,000	Includes labor, ODCs, and subcontractor costs associated with annual, quarterly (2), and semiannual LTM sampling.
5***	2013	$22,000	$33,500	Includes labor, ODCs, and subcontractor costs associated with 5-year review and quarterly (1) LTM sampling.
	Total	**$1,305,000**	**$1,403,500**	
	+50%	$1,957,500		
	-30%	$913,500		

* Costs reflect those expended under contract to AGVIQ/CH2M HILL.
**Costs reflect those expended under contract to CH2M HILL. Completion of annual LUC inspections assumed by Navy in 2012.
***Represents costs expended between January and June 2013.

8.5 Technical Assessment

This section presents the answers to the three questions defined for the Technical Assessment for Site 12 based primarily on information presented in Section 8.4. Opportunities for maintenance and optimization of the remedy are presented in **Table 8-5**.

8.5.1 Question A: Is the remedy functioning as intended by the ROD?

Remedial Action Performance: Based on the review of documents, ARARs, risk assumptions, and site inspection reports, the Site 12 remedy is functioning as intended by the ROD. Remedy construction was completed in April 2007. Performance monitoring was conducted at a frequency of 1, 3, 6, 9, and 12 months following injection of ERD substrate. Post-injection data indicated the remedy was successfully implemented and effective in achieving geochemical conditions to facilitate ERD. Two additional rounds of injections (March 2009 and August/September 2011) have been conducted to maintain remedy effectiveness. Concentrations of COCs have decreased, but remain above MCLs.

Implementation of LUCs: LUCs have been implemented through the Final LUC RD and subsequent revisions. LUCs and site inspections have made sure that unauthorized site use is prohibited and exposure to groundwater is prevented.

LTM Activities: Groundwater LTM was initiated in March 2011 to assess continued effectiveness in achieving the RAOs. Concentrations of COCs have continued to decrease since remedy implementation, but remain above MCLs. As a result of MCL exceedances in perimeter monitoring well LS12-MW07T, it is recommended that LS12-MW07T be reassigned as a site plume well, and existing monitoring well LS12-MW09T be added to the LTM network as the new perimeter well to monitor migration of COCs west toward the canal. Additionally, as a result of stalling and rebound in PCE concentrations and increasing COC concentrations at the leading edge of the plume, re-injection of the source areas and down-gradient plume should be considered.

Early Indicators of Potential Issues: No indicators of potential issues have been identified.

Opportunities for Optimization: Continued optimization through addition, removal, or reassignment of LTM monitoring wells, as well as site re-injection, is built into the decision matrices in the Site 12 LTM UFP SAP. Based on baseline LTM results, a third round of injections was conducted in August/September 2011 to enhance the effectiveness of the remedial system. Based on the LTM data collected to date and in line with the decision matrices, optimization of the LTM network through removal of LS12-MW04S, reassignment of LSMW07T, LS12-MW27S, LS12-MW27D, and LS12-MW28S, and addition of LS12-MW09T as discussed in Section 8.4.2 was initiated during the September 2013 groundwater sampling event. Based upon decision matrixes established in the LTM UFP SAP, additional injection as part of continued optimization will be considered following completion of each round of groundwater LTM and conducted as necessary.

8.5.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy 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. Current and anticipated future land use is industrial and is expected to remain the same. The exposure assumptions used to develop the HHRA and ERA are reasonable given that the current land use has not changed over time at Site 12. With the exception of potential groundwater discharge to the canal, physical conditions at Site 12 that would affect exposure pathways have not changed since the last Five-Year Review. As a result of the sanitary sewer line historically leaking and intercepting groundwater prior to discharge to the canal, the SERA conducted for Site 12 concluded that there was no complete exposure pathway to groundwater discharging to the canal. Following repair of the leaking sanitary sewer line, groundwater flow direction has changed to be west towards the canal. To assess the potential risks associated with this change in groundwater flow direction, groundwater samples are collected quarterly as part of ongoing LTM for analysis of site COCs from downgradient well LS12-MW36D, located adjacent to the canal, and compared to surface water

project action levels. These project action levels are based on protection against human exposure and do not currently consider potential ecological exposures associated with the groundwater/surface water interface. **Table 8-6** provides a comparison of LTM data collected from downgradient monitoring well LS12-MW36D to freshwater ecological screening values and Region 3 BTAG values. Concentrations of COCs have been below ecological screening values and Region 3 BTAG values in this well throughout the LTM program. It is recommended that groundwater sampling at LW12-MW36D continue quarterly in accordance with the LTM UFP SAP; however, it is recommended that the surface water project action levels be updated to account for the evaluation of potential groundwater discharges to, and subsequent ecological exposures in, the canal. No new contaminants or sources were identified as part of this Five-Year Review.

Changes in Toxicity and Other Contaminant Characteristics. 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. Although 1,4-dioxane has not been included in the sample analyte list for previous sampling, 1,1,1-TCA has not been detected in groundwater samples collected from Site 12 and PCE has been identified as the VOC historically released. Therefore, 1,4-dioxane is not expected to be present at the site and no further investigation of this constituent is warranted for continued protectiveness of the remedy.

Additional changes in toxicity and tap water RSL values have been made since the last Five-Year Review (**Table 4-5**). Select VOCs and arsenic are sampled as part of ongoing groundwater LTM. There have been no changes in toxicity associated with VOCs that would affect the protectiveness of the remedy because either the VOC is already listed as a site COC, it was not previously detected, or it was not previously detected above the MCL. SVOCs, PCBs, pesticides and metals (except arsenic) have not been analyzed in groundwater since ROD signature. Based on site history, SVOCs, PCBs, and pesticides, as well as dioxins/furans and explosives constituents, are not expected to be present at Site 12. For the most part, the changes in toxicity values associated with metals would not affect the protectiveness of the remedy because historically, metals concentrations detected were below the MCL or background. Arsenic data collected as part of ongoing groundwater LTM indicate increases in concentrations to above the MCL in perimeter monitoring well LS12-MW07T; however, concentrations above the MCL are not migrating beyond the LUC boundary. LUCs prevent exposure to groundwater; therefore, changes to the toxicity values would not adversely affect the current protectiveness of the remedy.

The cleanup levels for the site were established as the MCLs and no changes to these levels have been made since the last Five-Year Review.

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 12. There have been no major procedural changes in how the ERAs are conducted since the last 5-year review.

8.5.3 Question C: Has any other information come to light that could question the protectiveness of the remedy?

No new information has come to light that would question the protectiveness of the remedy.

TABLE 8-5
Remedy Maintenance and Optimization Activities for Site 12

Maintenance/Optimization Opportunity	Recommendations	Party Responsible
Concentrations of COCs above cleanup levels and increasing concentrations of total and dissolved arsenic above the MCL detected in perimeter monitoring well LS12-MW07T.	Recommend reassignment of LS12-MW07T to a plume monitoring well, and inclusion of existing monitoring well LS12-MW09T in the LTM network as a perimeter well to monitor the downgradient migration of COCs and arsenic.	Navy
Concentrations of COCs below cleanup levels for at least three consecutive LTM events, including the Five-Year Review event, in plume monitoring wells LS12-MW27S and LS12-MW28S, and downgradient perimeter well LS12-MW04S.	Recommend removal of perimeter well LS12-MW04S from the LTM network and reassignment of plume monitoring wells LS12-MW27S and LS12-MW28S as perimeter wells to monitor the southwestern edge of the shallow Columbia aquifer plume.	Navy
TOC concentrations in groundwater below desired conditions to facilitate ERD and lack of VFA generation. Stalling and rebound in PCE concentrations and increasing COC concentrations at the leading edge of the plume.	Recommend re-injection of substrate to ensure continued effectiveness.	Navy

8.6 Issues, Recommendations, and Follow-up Actions

Table 8-7 outlines the issues identified during this Five-Year Review and presents recommendations and follow-up actions for Site 12.

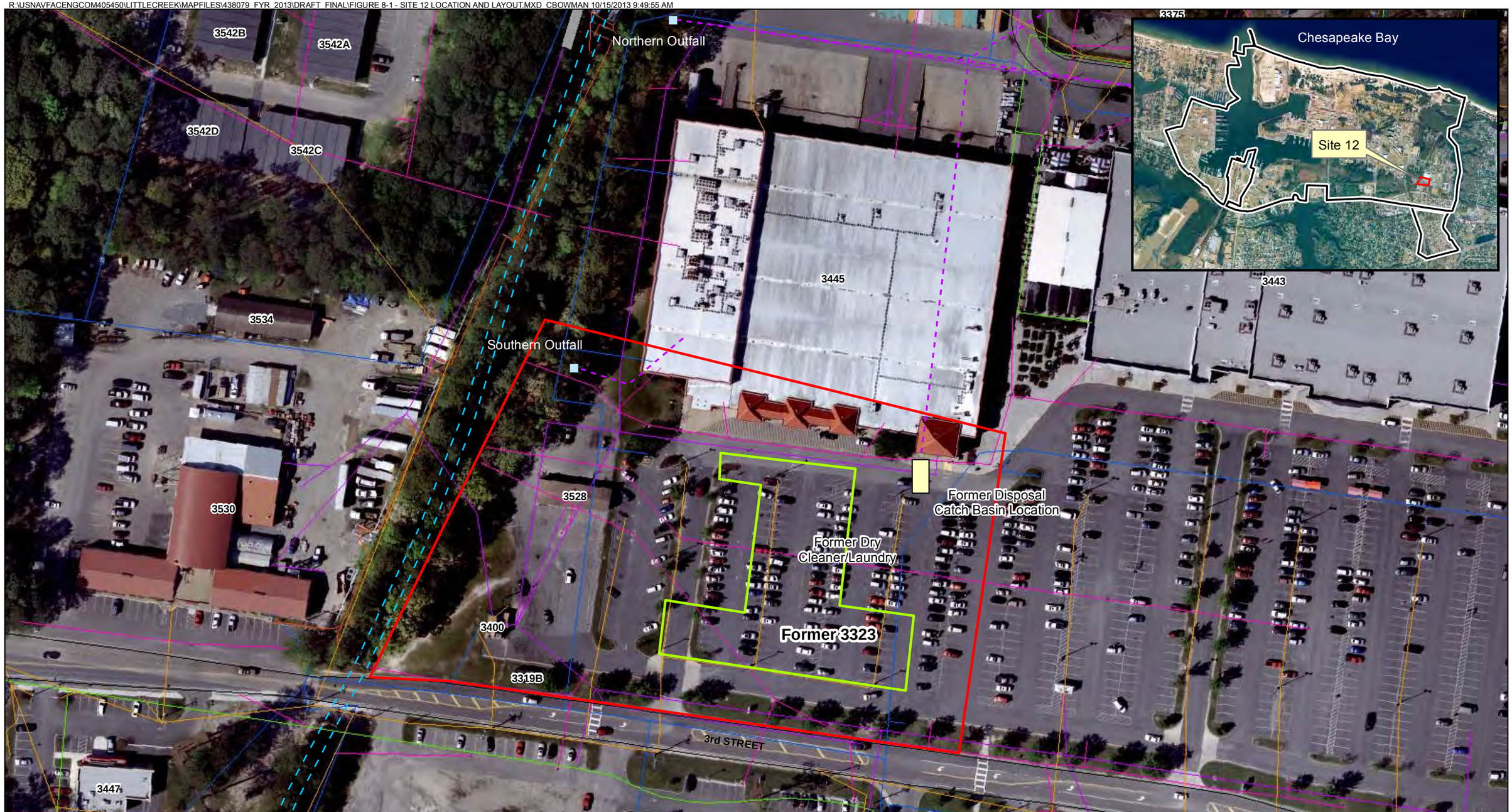
8.7 Protectiveness Statement

The remedy at Site 12 is in place, functioning as designed, and is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled through LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

TABLE 8-7
Issues, Recommendations, and Follow-up Actions for Site 12

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date*	Affects Protectiveness	
				Current	Future
Issues Identified for Follow-Up Action During Current Five-Year Review					
No project action level in LTM UFP SAP to account for potential ecological exposures at the groundwater/surface water interface.	Revise existing surface water project action levels to account for potential ecological exposures at the groundwater/surface water interface within the canal.	Navy	September 2014	N	N

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-1 - SITE 12 LOCATION AND LAYOUT.MXD CBOWMAN 10/15/2013 9:49:55 AM



Legend

- Outfall Location
- Former Storm Water Line
- Canal
- LUC Boundary
- Former Disposal Catch Basin Location
- Former Dry Cleaner/Laundry
- Electrical Cable Line
- Heat Cool Line
- Natural Gas Line
- Storm Sewer Line
- Wastewater Line
- Water Line

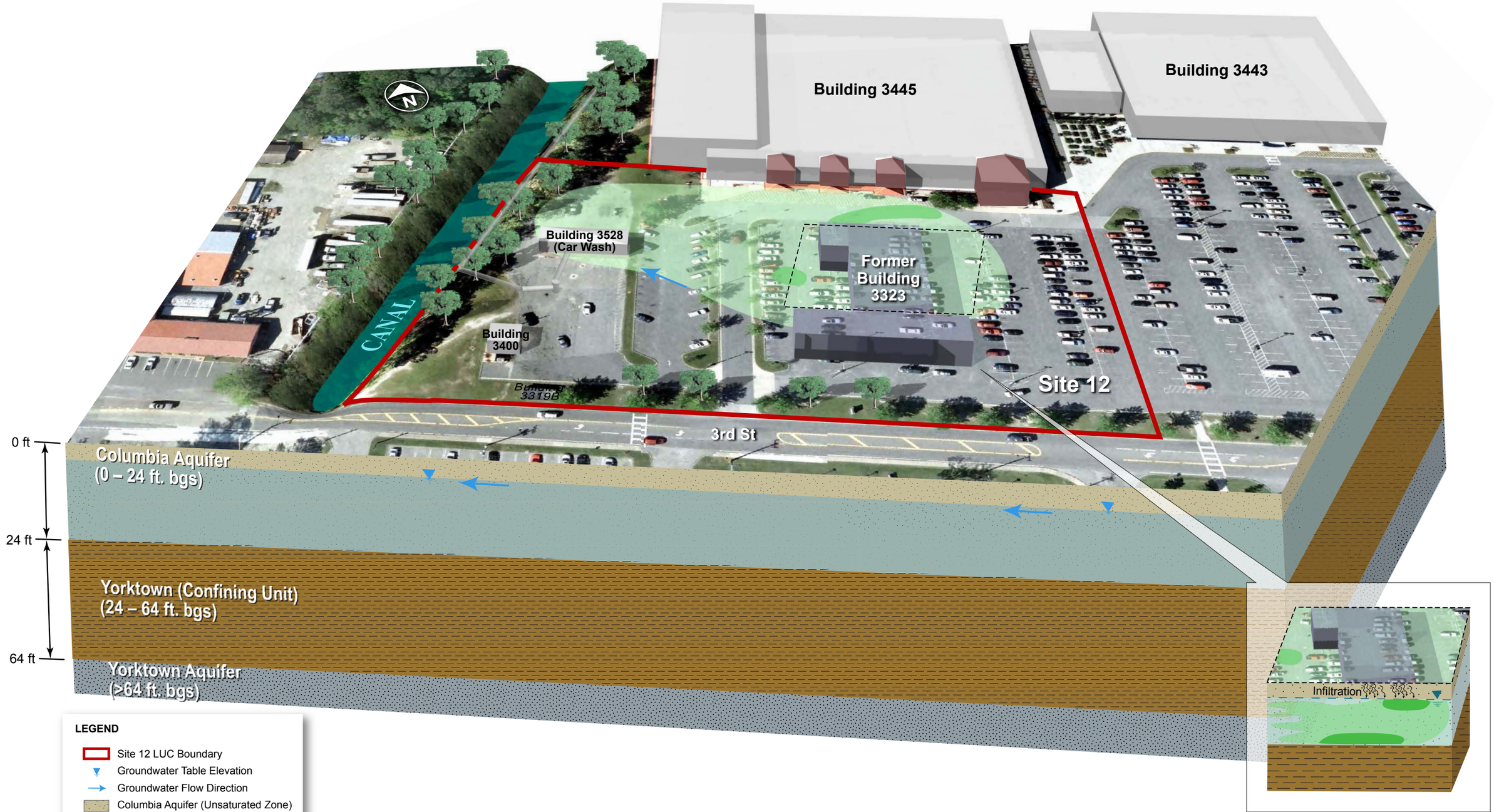
N W E S

0 50 100 200 Feet

Figure 8-1
Site 12 Location and Layout
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

Note: Storm Sewer was removed during construction of the commissary (1987 - 1992).

CH2MHILL



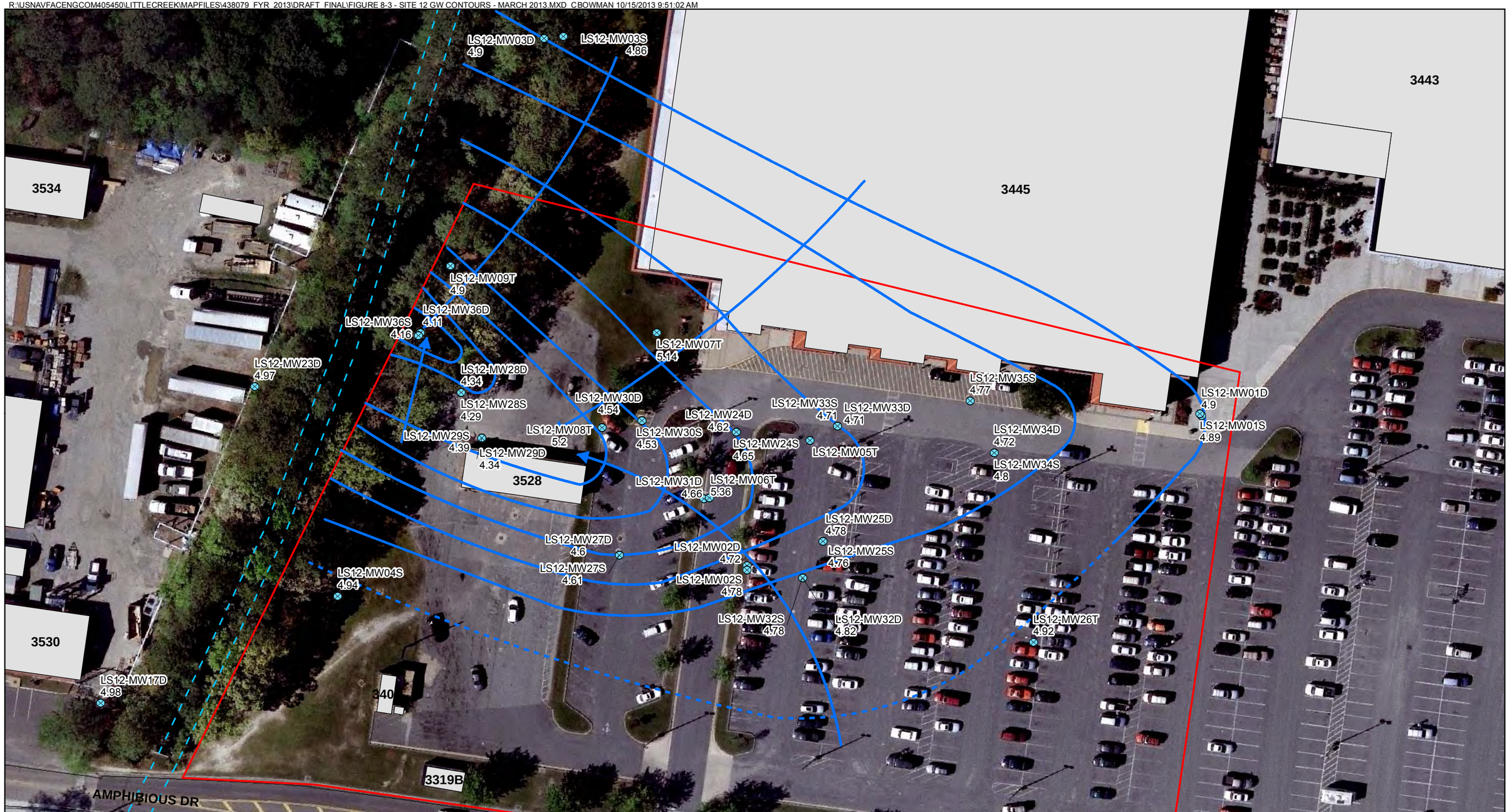
Note: Extent of COC concentrations based on 2005-2007 analytical results

FIGURE 8-2
Site 12 Conceptual Site Model
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

ES082009019MKE LittleCreekSite12_3-D_CSM_v9.ai 10-18-13 jls/ct

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-3 - SITE 12 GW CONTOURS - MARCH 2013.MXD CBOWMAN 10/15/2013 9:51:02 AM



Legend

- Monitoring Well
- Freshwater Canal
- Groundwater Contour (dahsed where inferred)
- Groundwater Flow Arrow
- LUC Boundary
- Buildings

N
W E
S

0 30 60
Feet

Figure 8-3
Site 12 Groundwater Contours - March 2013
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-4 - SITE 12 EXTENT OF COC GROUNDWATER PLUME.MXD CBOWMAN 10/15/2013 9:59:05 AM

Legend

- Monitoring Well
- Source Wells
- Contingent Sample Location
- Plume Wells
- Perimeter Wells
- Performance Monitoring Well
- Annual Monitoring Well
- Injection Well
- Monitoring Well - Not Sampled
- Canal
- Land Use Control Boundary
- Former Dry Cleaner/Laundry
- Extent of COC Groundwater Plume

N
W E
S

0 50 100
Feet

Figure 8-4
Site 12 Extent of COC Groundwater Plume
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-5 - SITE 12 REMEDY DESIGN.MXD CBOWMAN 10/15/2013 10:00:01 AM

Legend

- Outfall Location
- Injection Well
- Existing wells not included in monitoring well network
- Source Area Monitoring Wells
- Contingency Monitoring Wells
- Plume Area Monitoring Wells
- Perimeter Monitoring Wells
- Canal
- LUC Boundary
- Former Disposal Catch Basin Location
- Former Dry Cleaner/Laundry

N
W E
S

0 50 100 200 Feet

Note: Storm Sewer was removed during construction of the commissary (1987 - 1992).

Figure 8-5
Site 12 Remedy Design
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-6 - SITE 12 LONG-TERM MONITORING NETWORK.MXD CBOWMAN 10/15/2013 10:00:43 AM

Legend

- Outfall Location
- Perimeter Monitoring Wells
- Existing wells not included in monitoring well network
- Plume Area Monitoring Wells
- Source Area Monitoring Wells
- Contingency Monitoring Wells
- Canal
- LUC Boundary
- Former Disposal Catch Basin Location
- Former Dry Cleaner/Laundry

N
W E
S

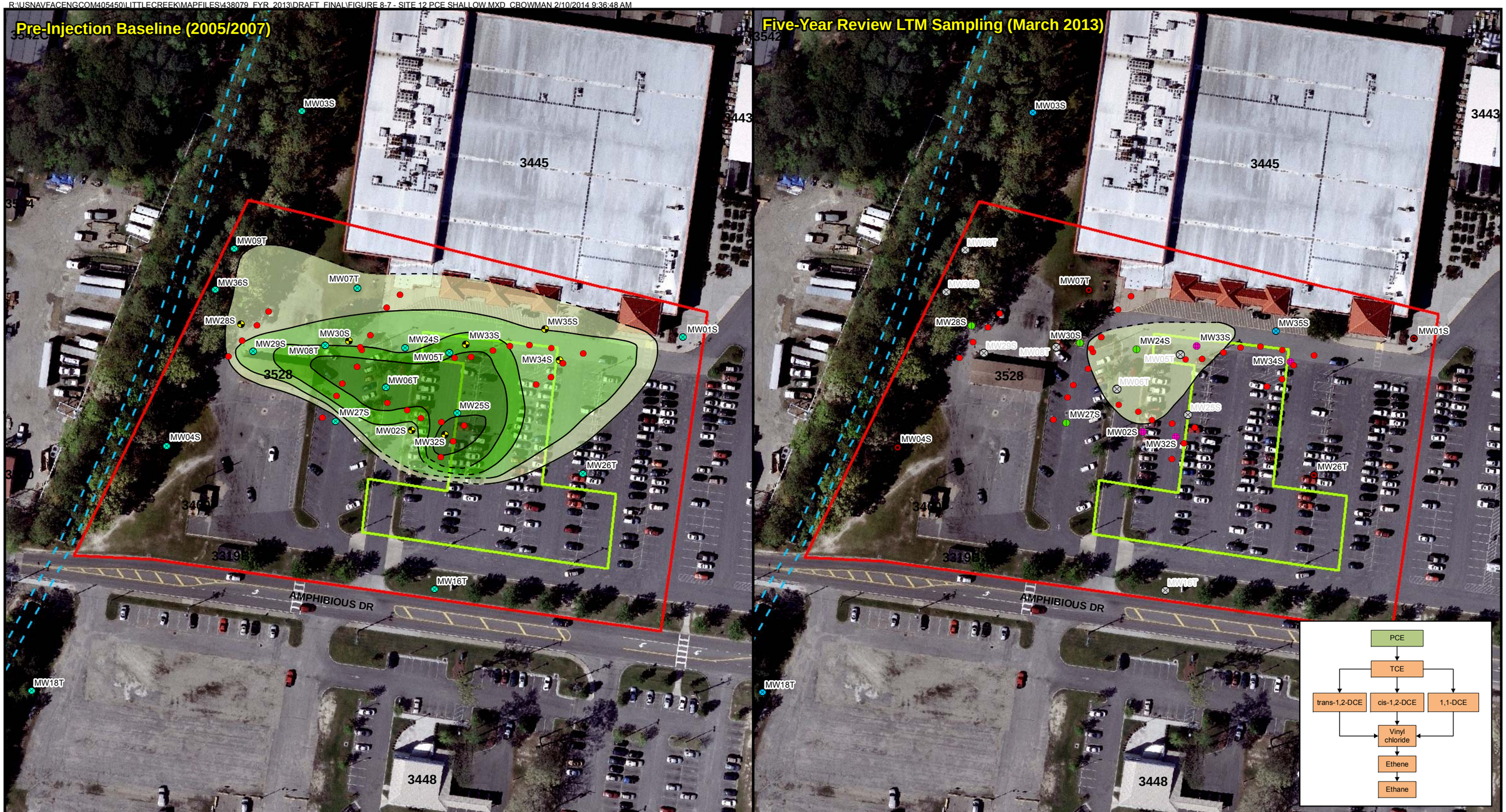
0 50 100 200
Feet

Figure 8-6
Site 12 Long-term Monitoring Network
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

Note: Storm Sewer was removed during construction of the commissary (1987 - 1992).

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-7 - SITE 12 PCE SHALLOW.MXD CBOWMAN 2/10/2014 9:36:48 AM



Legend

- Monitoring Well
- Source Well
- Plume Well
- Perimeter Well
- Injection Well
- Performance Monitoring Well
- Annual Monitoring Well
- Monitoring Well - Not Sampled
- Canal
- Land Use Control Boundary
- Former Dry Cleaner/Laundry

Shallow Isoconcentrations

- 5-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- > 10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

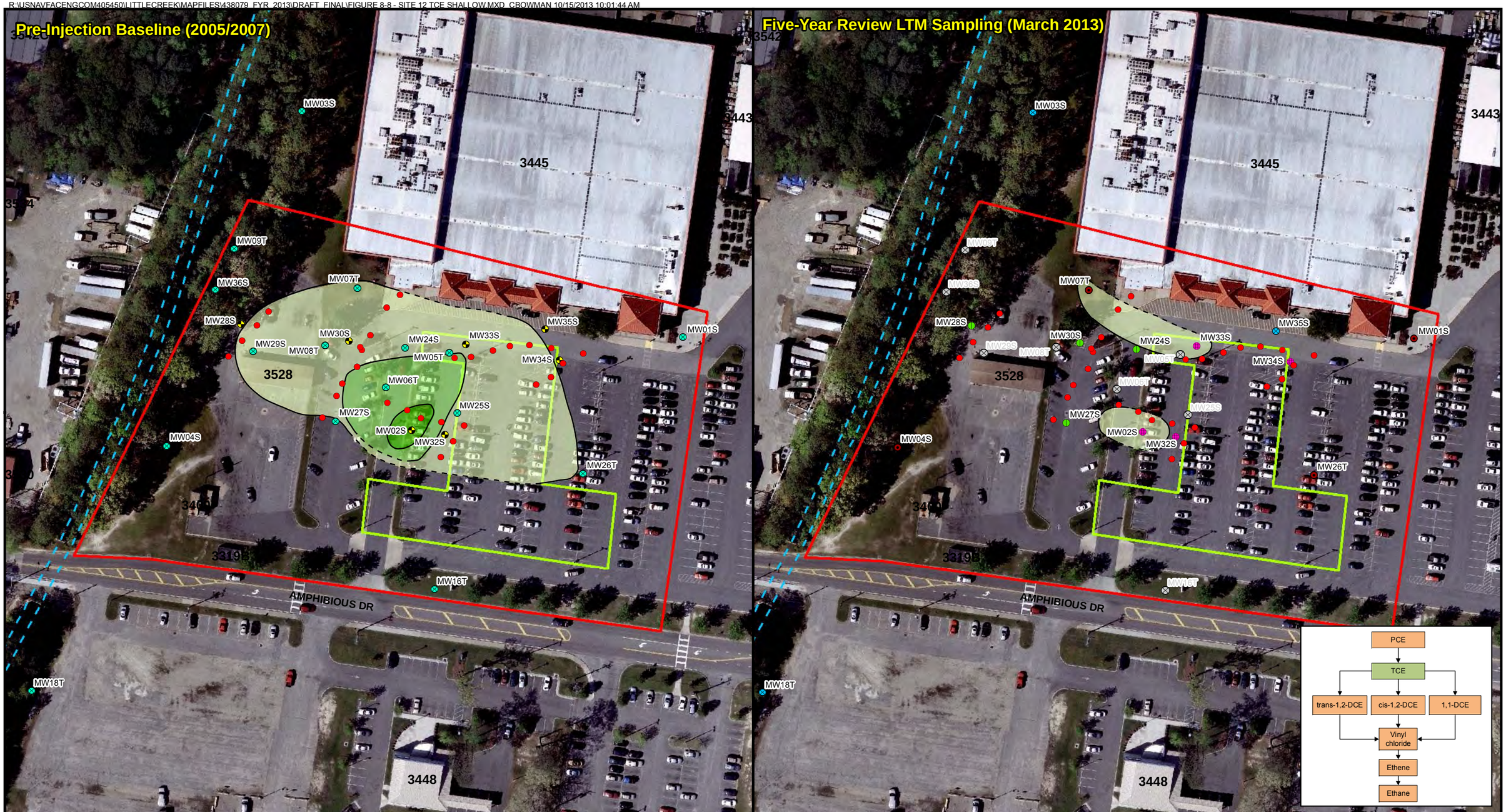
N W E S

0 50 100 Feet

Figure 8-7
Site 12 PCE Isocontours - Shallow Columbia Aquifer
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-8 - SITE 12 TCE SHALLOW.MXD CBOWMAN 10/15/2013 10:01:44 AM



Legend

- Monitoring Well
- Source Well
- Plume Well
- Perimeter Well
- Injection Well
- Performance Monitoring Well
- Annual Monitoring Well
- Monitoring Well - Not Sampled
- Canal
- Land Use Control Boundary
- Former Dry Cleaner/Laundry

Shallow Isoconcentrations

- 5-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 8-8
Site 12 TCE Isocontours - Shallow Columbia Aquifer
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-9 - SITE 12 CIS 1 2 DCE SHALLOW.MXD CBOWMAN 10/15/2013 10:02:18 AM

Legend

- Monitoring Well
- Source Well
- Plume Well
- Perimeter Well
- Injection Well
- Performance Monitoring Well
- Annual Monitoring Well
- Monitoring Well - Not Sampled
- Canal
- Land Use Control Boundary
- Former Dry Cleaner/Laundry

Shallow Isoconcentrations

- 70-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- > 10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

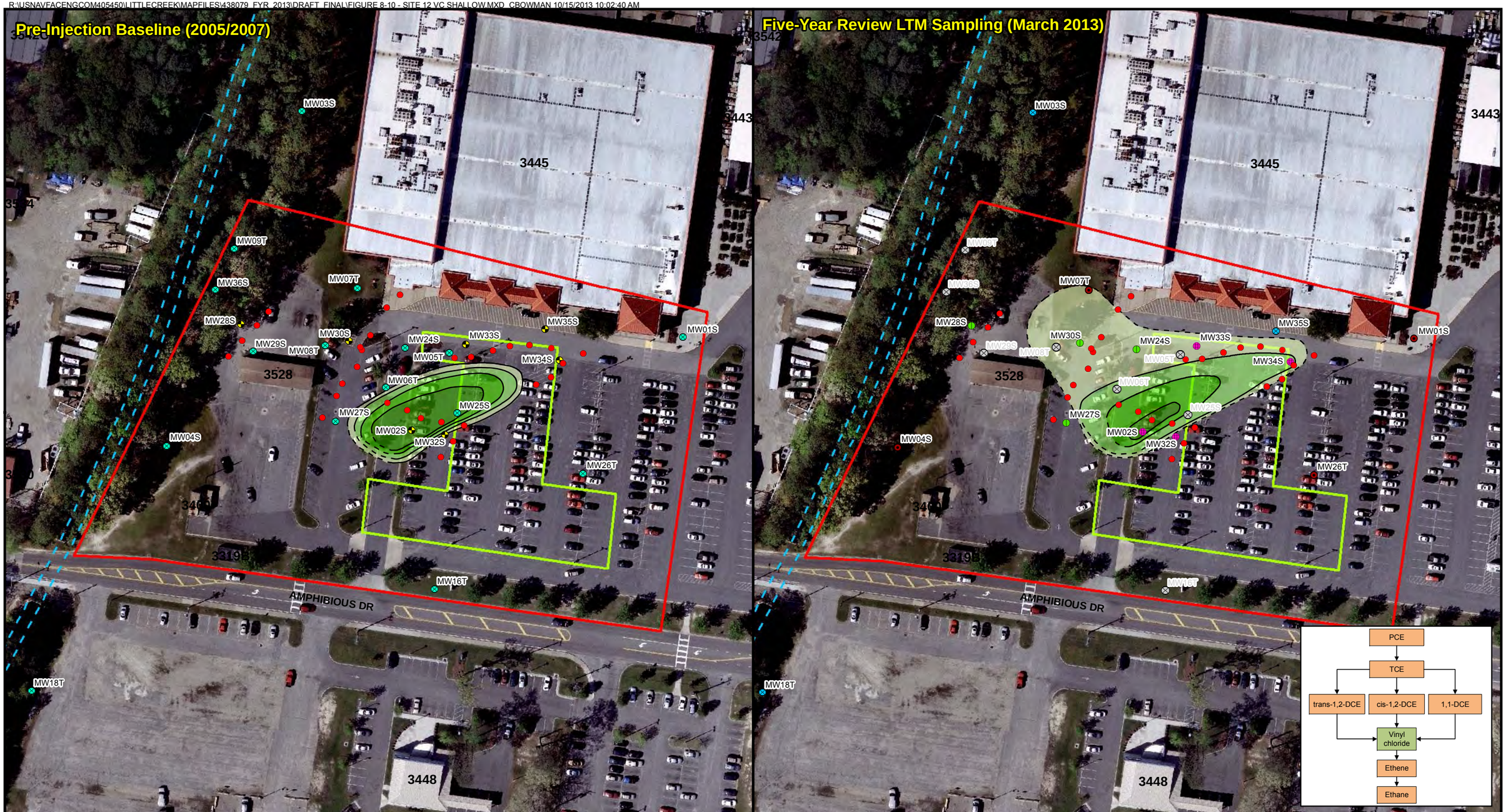
N W E S

0 50 100 Feet

Figure 8-9
Site 12 cis-1,2-DCE Isocontours - Shallow Columbia Aquifer
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-10 - SITE 12 VC SHALLOW.MXD CBOWMAN 10/15/2013 10:02:40 AM



Legend

- Monitoring Well
- Source Well
- Plume Well
- Perimeter Well
- Injection Well
- Performance Monitoring Well
- Annual Monitoring Well
- Monitoring Well - Not Sampled
- Canal
- Land Use Control Boundary
- Former Dry Cleaner/Laundry

Shallow Isoconcentrations

- 2-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 8-10
Site 12 Vinyl Chloride Isocontours - Shallow Columbia Aquifer
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-11 - SITE 12 PCE DEEP.MXD CBOWMAN 10/15/2013 11:30:42 AM

Legend

- Monitoring Well
- Source Wells
- Contingent Sample Location
- Plume Wells
- Perimeter Wells
- Injection Well
- Performance Monitoring Well
- Annual Monitoring Well
- Monitoring Well - Not Sampled
- Canal
- Land Use Control Boundary
- Former Dry Cleaner/Laundry

Deep Isoconcentrations

- 5-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- >10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 8-11
Site 12 PCE Isocontours - Deep Columbia Aquifer
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-12 - SITE 12 TCE DEEP.MXD CBOWMAN 10/15/2013 11:31:21 AM

Legend

- Monitoring Well
- Source Wells
- Contingent Sample Location
- Plume Wells
- Perimeter Wells
- Injection Well
- Performance Monitoring Well
- Annual Monitoring Well
- Monitoring Well - Not Sampled
- Canal
- Land Use Control Boundary
- Former Dry Cleaner/Laundry

Deep Isoconcentrations

- 5-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- > 10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 8-12
Site 12 TCE Isocontours - Deep Columbia Aquifer
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-13 - SITE 12 CIS 1,2 DCE DEEP.MXD CBOWMAN 10/15/2013 11:31:56 AM

Legend

- Monitoring Well
- Source Wells
- Contingent Sample Location
- Plume Wells
- Perimeter Wells
- Injection Well
- Performance Monitoring Well
- Annual Monitoring Well
- Monitoring Well - Not Sampled
- Canal
- Land Use Control Boundary
- Former Dry Cleaner/Laundry

Deep Isoconcentrations

- 70-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- > 10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 8-13
Site 12 cis-1,2-DCE Isocontours - Deep Columbia Aquifer
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 8-14 - SITE 12 VC DEEP.MXD CBOWMAN 10/15/2013 11:32:22 AM

Legend

- Monitoring Well
- Source Wells
- Contingent Sample Location
- Plume Wells
- Perimeter Wells
- Injection Well
- Performance Monitoring Well
- Annual Monitoring Well
- Monitoring Well - Not Sampled
- Canal
- Land Use Control Boundary
- Former Dry Cleaner/Laundry

Deep Isoconcentrations

- 2-100 µg/L
- 100-500 µg/L
- 500-1000 µg/L
- 1000-10000 µg/L
- > 10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 8-14
Site 12 Vinyl Chloride Isocontours - Deep Columbia Aquifer
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

SECTION 9

Site 13 – Former Public Works Center Dip Tank and Wash Rack

9.1 Site Chronology

Date	Event/Document	Document Administrative Record Number
1982	Dip tank and associated drying racks dismantled	
December 1984	IAS	000130
October 1986	RVS	000022
March 1989	RFA	000008
November 1991	IRI	000104
November 1994	RI/FS for Sites 7 and 9-13	000226, 000352, 000353
March 1999	EE/CA	000332
March 1999	IRA initiated	--
May 1999	Former NAB Little Creek on NPL	000439
July 1999	Removal Action Closeout Report	000457
June 2000	SERA	000417
August 2000	Oxygen-releasing Compound (ORC) Pilot Study initiated	--
October 2001	BERA	000475
May 2002	SRI/HHRA	000465
March 2003	ORC Groundwater Remediation Report	000472
October 2003	FFA	000540
June 2004	FS	000573
September 2004	ERD and ISCO Treatability Study initiated	--
August 2006	Treatability Study Report	000989
June 2007	Vapor Intrusion Investigation Technical Memorandum	001214
July 2007	Proposed Plan	001280
September 2007	ROD	001268
March 2009	Five Year Review	001534
March 2009	LUC RD	--
July 2009	Annual LUC inspections initiated	--
March 2010	RAWP	--
May 2010	LUC RD Revision 1	--
May 2010	ERD Injections Complete	--
April 2011	RA CCR	--
December 2011	ERD Groundwater Monitoring Summary	--
June 2012	Draft Final Post-ROD LTM UFP SAP, Revision 2	--
September 2012	Groundwater LTM initiated	--
September 2012	IRACR	--
May 2013	LUC RD Revision 2	--

9.2 Background

9.2.1 Site Description and History

Site 13, the Former Public Works Center Dip Tank and Wash Rack, is located in the eastern portion of the base within the facility Public Works Department (PWD) compound, near the intersection of 7th and F Streets in the eastern portion of JEB Little Creek, approximately one block west of Site 11 (**Figure ES-1** and **9-1**).

During operation, the site consisted of a former 1,500-gallon, in-ground dip tank that was used to treat wood with a mixture of PCP, diesel, and kerosene, associated washing/drying racks, and an open area formerly used by the PWD to store supplies and equipment. From the early 1960s to 1974, wood was treated in the dip tank solution, allowed to dry at onsite racks, and subsequently distributed for use on the base. The dip tank and associated drying racks were dismantled and removed in 1982. Contaminated soil was excavated as part of an IRA in 1999. The area was then paved with asphalt and converted to a PWD storage area. The wash rack, installed in 1945, was used to clean vehicles and equipment with steam and biodegradable chemicals. The wash rack consists of a concrete pad surrounded by a concrete curb, with a centrally located drain leading to an oil-water separator. An unpaved storage area located adjacent to the wash rack was used to store various materials and equipment.

9.2.2 Physical Characteristics

The site characteristics, including surface features, geology, and hydrogeology, are depicted on the site CSM (**Figure 9-2**). The ground surface in the vicinity of Site 13 is generally level, approximately 10 ft amsl, and includes areas of exposed gravel and/or grass-covered ground surface between buildings, as well as a concrete and asphalt parking lot used by PWD. A grass drainage ditch located along 7th Street conveys runoff from the site to the southeast through the facility stormwater system. There are no surface water bodies within the boundary of Site 13. Site 13 is located approximately 1,500 feet south of the golf course ponds and approximately 3,750 feet south of the Chesapeake Bay. Access to the site is unrestricted for those with access to JEB Little Creek.

Shallow Columbia aquifer groundwater at Site 13 is encountered at depths from 4 to 7 ft bgs. The Columbia aquifer extends to a depth of approximately 22 ft bgs where the Yorktown confining unit separates the Columbia aquifer from the underlying Yorktown aquifer. Groundwater flow at the site is primarily south/southwest (**Figure 9-3**). The groundwater gradient underlying Site 13 is relatively flat and varies by less than 1 foot across the site. The average groundwater velocity is estimated to be 8 feet per year.

The current, primary mechanism for contaminant transport is through dissolved plume migration downgradient with groundwater flow (advection). The mechanisms responsible for the fate of chemicals are natural degradation through various pathways (which plays a significant role in the length of time the chemicals will exist in the subsurface) and volatilization of chemicals from groundwater into the gas phase (which results in a decrease of contaminant mass from the saturated zone).

9.2.3 Land and Resource Use

Currently, Site 13 continues to be used by the PWD for base maintenance activities and consists of several buildings (Buildings 3165, 3165B, 3165D, 3165E, and 3174), the former wash rack, and the PWD parking lot. Enlisted quarters, industrial activities, and administrative offices surround the site.

Groundwater at JEB Little Creek is not currently used as a potable water source, nor is it expected to be used as a future potable water source. Potable water is supplied to the base and surrounding community by the cities of Virginia Beach and Norfolk. Groundwater supply wells at the base golf course, located approximately 1,500 feet north of Site 13, withdraw provide non-potable water from the Yorktown aquifer to irrigate the golf course.

LUCs are currently maintained within an area of restricted land and groundwater use at Site 13 and are inspected on an annual basis (Navy, 2010; Navy, 2013b). The LUCs restrict land use and prevent exposure to shallow groundwater until site conditions allow for unlimited use and unrestricted exposure.

9.2.4 History of Contamination

Use of the former dip tank and wash rack has resulted in a chlorinated organic compound plume (VOCs and PCP) underlying the PWD parking lot. Direct releases of PCP may have occurred from the former dip tank to subsurface soil and groundwater. The source of chlorinated VOCs was not specifically identified, but appears to have been within the PWD at a location west or southwest of the dip tank (**Figure 9-4**). Chlorinated VOC and PCP concentrations are highest in the upper portion of the Columbia aquifer (approximately 3 to 12 ft bgs), with VOCs highest in the central parking area and PCP highest adjacent to the former dip tank. Detected concentrations of PCP in shallow groundwater indicate non-aqueous-phase liquid (NAPL) PCP may have been concentrated in soil above the water table or in the top few feet of the aquifer, and was unable to migrate down through the water column. Detected concentrations of VOC compounds do not indicate the presence of DNAPL at Site 13.

Initial Response

Site 13 was initially identified in the IAS (RGH, 1984). Based on the results of field investigations conducted from 1986 to 1994, an IRA was completed in March/April 1999. During the IRA, approximately 442 tons (276 yd^3) of PCP-contaminated soil, defined as containing PCP greater than 16,000 µg/kg, was excavated and disposed of offsite. Post-excavation confirmation sampling was conducted and the area backfilled with clean fill material (OHM, 1999b).

In March 2000, an ORC Pilot Study was performed at the site to test the compound's effectiveness in reducing PCP concentrations in groundwater. Approximately 1,400 pounds of solution was injected into the shallow groundwater in the vicinity of the previously-conducted removal action. Following injections, six rounds of post-injection monitoring were conducted for a period of 60 weeks (through January 2002). Results indicated a significant decrease (average of 90%) in PCP concentrations over the duration of the pilot study (CH2M HILL, 2003a).

In November 2004, a treatability study was conducted to evaluate the effectiveness of ISCO and ERD in reducing concentrations of PCP and VOCs in groundwater. Approximately 4,300 gallons of hydrogen peroxide followed by 4,300 gallons of iron catalyst were injected in the northern portion of the plume, and approximately 6,600 gallons of emulsified oil substrate followed by approximately 3 gallons of vitamin B-12 were injected into the southern portion of the plume. Following injections, six rounds of post-injection monitoring were conducted through January 2006. Results indicated that both ISCO and ERD were effective in reducing concentrations; however, it was concluded that ERD was the most favorable alternative for continued treatment of PCP and VOCs (JV I, 2006).

Site Risks

Human Health Risk

An HHRA was conducted as part of the 2002 SRI to evaluate the risks to human health from exposure to soil and groundwater (CH2M HILL, 2002). In 2006, potential risk associated with vapor intrusion of VOCs was evaluated (CH2M HILL, 2007a). The exposure media, pathways, and scenarios evaluated and COCs identified in the revised HHRA are summarized in **Table 4-2**.

No potentially unacceptable risks or hazards associated with exposure to site soil were identified. It was concluded that exposure to shallow groundwater may pose potentially unacceptable risks and hazards for future construction workers, industrial workers, and adult/child residents. Risks and hazards were primarily associated with PCP and VOCs in groundwater. No potentially unacceptable risks were identified from exposure to indoor air under existing site conditions.

Ecological Risk

A SERA (Steps 1 and 2 of the ERA process) was completed in 2000 (CH2M HILL, 2000a) and a BERA, through Step 3a, was completed in 2001 (CH2M HILL, 2001d) to evaluate potential exposure pathways for ecological receptors. The assessments concluded that there were no unacceptable ecological risks for terrestrial receptors at Site 13 because of the lack of complete and significant exposure pathways. There is no complete pathway for ecological exposure to groundwater, no complete and significant transport pathway for groundwater or storm water discharge to surface water bodies, and no aquatic habitats exist on the site.

9.2.5 Basis for Taking Remedial Action

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 PCP and VOCs in shallow groundwater at Site 13. Site COCs and their respective cleanup levels identified in the ROD for Site 13 are summarized in **Table 9-1**.

TABLE 9-1
Cleanup Levels for Site 13 Chemicals of Concern

Chemical of Concern	Cleanup Level* (µg/L)
PCE	5
TCE	5
VC	2
PCP	1

Notes:
*Cleanup levels are MCLs.

9.3 Remedial Actions

9.3.1 Remedy Selection

The ROD for Site 13 was signed in September 2007 (Navy, 2007b). The ROD summarized the risks to human health and ecological receptors, established RAOs, and defined the selected remedy. The selected remedy for Site 13 was defined as groundwater treatment through ERD and LUCs to meet the following RAOs:

- Prevent exposure to Site 13 groundwater until concentrations of PCP and VOCs have been reduced to levels that allow for unlimited use and unrestricted exposure.
- Reduce concentrations of PCP and VOCs in Site 13 groundwater to cleanup levels through treatment to the maximum extent practicable within a reasonable amount of time.

Cleanup levels for Site 13 were established as the federal MCLs. Unacceptable risks, RAOs, remedy components, performance standards, and expected outcomes for evaluating the overall performance of the remedy are summarized in **Table 9-2.**

The following LUC objectives for Site 13 were selected in the ROD:

- Prohibit the withdrawal of groundwater except for environmental monitoring and testing
- Prohibit the use of the site for residential, child care, elementary or secondary school, or playground facilities
- Maintain the integrity of any current or future remedial or monitoring system

LUC objectives have been implemented with the actions detailed in the LUC RD (CH2M HILL, 2009f). The LUCs will be maintained until the concentrations of PCP and VOCs in the groundwater have been reduced to levels that allow for unlimited use and unrestricted exposure.

TABLE 9-2
Site 13 Remedial Action Summary and Expected Outcomes

Risk		COCs	RAOs	Remedy Components	Metric/Cleanup Level	Expected Outcome	
Human Health	**Ecological**						
Groundwater							
Future adult/child resident ingestion of and dermal contact with groundwater; future construction worker dermal contact with and inhalation of groundwater in an open excavation	No complete and significant exposure pathways to groundwater	PCE TCE VC PCP	Reduce concentrations of PCP and VOCs in Site 13 groundwater to the cleanup levels through treatment to the maximum extent practicable within a reasonable amount of time.	ERD	Monitor groundwater COC concentrations and geochemical conditions to confirm achievement of substrate ROI and conditions conducive for ERD.	Achieve unlimited use and unrestricted exposure	Removal of LUCs
				Performance monitoring			
				Groundwater monitoring	Monitor shallow groundwater COC concentrations and geochemical conditions to confirm continued effectiveness of the remedy and COC degradation until concentrations are at or below cleanup levels.		
			Prevent exposure to Site 13 groundwater until concentrations of PCP and VOCs have been reduced to levels that allow for unlimited use and unrestricted exposure	Groundwater monitoring	Monitor to evaluate the potential for vapor intrusion risk until concentrations of COCs in groundwater are at or below cleanup levels.		
				LUCs	Periodic inspection of the site to confirm adherence to LUCs until groundwater COCs are at or below their respective cleanup levels.	Removal of LUCs	

9.3.2 Remedy Implementation

The Site 13 IRACR was signed in September 2012 and documents that the remedy is in place and functioning as designed. Remedy implementation was completed as described in the following subsections.

Remedial System Installation

The draft RA Work Plan was submitted in September 2008 (CH2M HILL, 2009b) and remedial action began in December 2008 with baseline groundwater sampling from existing monitoring wells to establish pre-treatment conditions. Based on the results of baseline sampling, the remedial design was revised and the final RA Work Plan was submitted in March 2010 (JV III, 2010). Beginning in March 2010, remedial action continued with the installation of 5 new monitoring wells and 27 injection wells (**Figure 9-5**). Following installation, baseline groundwater samples were collected from the newly-installed monitoring wells. Emulsified vegetable oil product was injected in May 2010. Remedy construction was documented in the RA CCR (JV III, 2011). Following substrate injection, performance monitoring was conducted at a frequency of 1, 3, 6, 9, and 12 months post-injection. Performance monitoring results indicated the remedy was successful in achieving the geochemical conditions required to facilitate ERD.

Land Use Controls

LUCs are in place to prevent exposure to groundwater (**Figure 9-1**). The LUC RD for Site 13 was finalized in March 2009 (CH2M HILL, 2009g). A survey plat for Site 13 was filed with the City of Virginia Beach on September 20, 2011 to provide public notice of the Site 13 environmental conditions and limitations on the use of the property and to record the LUC boundary (Navy, 2009c). As outlined in the LUC RD, annual inspections are conducted to monitor unauthorized activities and land use changes. Checklists and data reports are completed during inspections and issued to USEPA and VDEQ.

Long-term Monitoring

Groundwater LTM at Site 13 was initiated in September 2012 in accordance with the Draft Final LTM UFP SAP, Revision 2 (Site 13 SAP) (CH2M HILL, 2012d). Groundwater monitoring is conducted semiannually to assess the effectiveness of the remedy in achieving RAOs. Groundwater samples are collected from a minimum of 24 monitoring wells and up to 31 monitoring wells (**Figure 9-6)** and analyzed for site COCs, total and dissolved arsenic, as well as wet chemistry parameters TOC, VFAs, nitrate, nitrite, sulfate, sulfide, methane, ethane, and ethene. Based upon decision matrixes established in the LTM UFP SAP, additional injection as part of continued optimization will be considered following completion of each round of groundwater LTM and conducted as necessary. Vapor intrusion LTM is not currently conducted at Site 13 because those buildings located within 100 feet of the Site 13 plume either do not present complete exposure pathways, or they are currently sampled as part of the Site 11 vapor intrusion LTM. If building uses/conditions change or are dropped for the Site 11 LTM program, vapor intrusion monitoring as part of the Site 13 LTM will be initiated.

9.4 Progress Since Last Five-Year Review

9.4.1 Follow-up Actions Since Last Five-Year Review

The previous Five-Year Review report included the following protectiveness statement for Site 13:

> *The remedy has not been implemented at Site 13; however, it is expected to be protective of human health and the environment. In the interim, exposure pathways that could result in unacceptable risk are controlled through quarterly ER site inspections. Remedy construction is expected to begin in April 2009. Full implementation of the LUCs and the groundwater LTM plan will be documented in the IRACR. Based upon a review of the Site 12 remedy performance (Section 5), there is no evidence at this time to expect the Site 13 remedy will not be successful. Further evaluation of the vapor intrusion pathway is recommended following resolution of risk evaluation methodology.*

Although the remedy had not yet been implemented at the time of the last 5-Year Review, issues and recommendations for follow-up actions were identified. **Table 9-3** presents the status of these recommendations and follow-up actions.

TABLE 9-3
Site 13 Progress Action Items from 2008 Five-Year Review

Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date	Affects Protectiveness		Status – March 2013	
				Current	Future	Action Taken and Outcome	Date of Action
Changes to the methodology for evaluating the potential for vapor intrusion risk.	Following resolution of the risk evaluation methodology, re-evaluation of the potential for vapor intrusion risk at Site 13 is recommended.	Navy	October 2009	N	Y	Evaluation of potential risks associated with vapor intrusion was incorporated into the Site 11 and Site 13 LTM programs. Because those buildings located within 100 feet of the Site 13 plume either do not present complete exposure pathways or are currently sampled as part of Site 11 vapor intrusion LTM, sampling specifically associated with Site 13 is not currently conducted. If building uses/conditions change or buildings are dropped from the Site 11 LTM program, vapor intrusion monitoring as part of Site 13 LTM will be initiated. Baseline VI LTM was completed at Site 11 in May and December 2012. No potential risks were identified. Results are to be included in LTM report. Additional sampling will be conducted as needed.	Complete - March 2012
LUC RD is not fully implemented.	Implement LUCs in accordance with the LUC RD and document in the IRACR for the Site.	Navy	Sept. 2010	N	Y	The initial LUC RD was finalized in March 2009. Consensus agreements for LUC revisions were signed on May 19, 2010 and May 15, 2013 to more clearly identify the risks and receptors the LUCs were intended to address.	Complete- March 2009
Site monitoring wells are not clearly labeled outside the casing.	Apply permanent identification labels to all well casings.	Navy	Sept. 2013	N	N	Basewide well repairs conducted in October 2010. Each well was affixed with an outer casing clearly identifying it as an observation or monitoring well. Weather-resistant stickers with well IDs were affixed to all casings.	Complete - October 2010

*Achievement of milestone dates are dependent on Navy funding.

9.4.2 Results of Implemented Actions

This section summarizes the remedial activities conducted since completion of the last Five-Year Review in 2009. To assess the performance of the remedial action, data and information were reviewed with respect to each of the performance metrics outlined in **Table 9-2**.

Some of the data and information presented to assist in this Five-Year Review have previously been presented through reports and Partnering Team presentations. The intention of this data review and analysis is to provide sound interpretations based on data previously provided, as well as additional data collected but not previously provided. To facilitate review of this document, groundwater monitoring data not previously documented in a report are presented in **Appendix F**; however, this report is not intended to fully present and document all data gathered. Data not previously documented in a report will be subsequently formally documented. Trend graphs for contaminant concentrations in select monitoring wells are presented in **Appendix G**.

Remedial System Construction

Prior to completion of the previous Five-Year Review, remedy implementation at Site 13 had begun but was not complete. Since the previous Five-Year Review, 5 new monitoring wells and 27 injection wells were installed. Approximately 4,700 gallons of injectate solution (LactOil®, sodium bicarbonate, and water) were applied to each of the injection wells to enhance the naturally-occurring, microbially-mediated anaerobic degradation of COCs (JV III, 2011). Monitoring and injection well development water was used in the source area near the former dip tank and wash rack, and potable water was used in the downgradient plume. Groundwater samples were collected from designated monitoring wells 1, 3, 6, 9, and 12 months following injection to evaluate the adequacy of the injection system and the overall effectiveness of the treatment. The final round of post-injection monitoring was conducted in May 2011. Sample locations are depicted in **Figure 9-5** and results are discussed below.

Performance Monitoring Results Summary

To evaluate the adequacy of the injection system, field and geochemical data were reviewed to be sure suitable anaerobic conditions were achieved, pH was maintained, and TOC levels were indicative of adequate substrate distribution. Performance monitoring results indicated that the remedy implementation was successful in the source zone and downgradient plume (CH2M HILL, 2011e). ORP and DO concentrations decreased after substrate injections, suggesting reducing conditions were achieved. Additionally, increases in TOC concentrations indicate successful substrate delivery in the target treatment areas.

The assessment of overall effectiveness of the ERD remediation is based on changes in plume configuration, plume containment, and the concentrations of COCs remaining in groundwater at the site. After 1 year, COC concentrations detected in groundwater generally decreased, but with notable increases in PCP and VOC concentrations in the northern portion of the plume. Increased concentrations may be the result of leaching from soil as a result of remedy implementation. Biotransformation of parent compounds (such as PCE) to less chlorinated daughter products and innocuous end products (methane, ethane, and ethene) was observed, indicating that reductive dechlorination is proceeding as intended.

Remedial System O&M

No remedial system O&M has been required in this Five-Year Review period.

Long-Term Monitoring

Groundwater LTM is currently performed in accordance with the Draft Final LTM UFP SAP, Revision 2, (Site 13 SAP) (CH2M HILL, 2012d). Vapor intrusion sampling for Site 13 is conducted as part of Site 11 LTM and discussed in Section 9.3.2.

Groundwater

Groundwater monitoring was initiated in September 2012 and has subsequently been conducted in March 2013. Groundwater LTM data through the March 2013 Five-Year Review groundwater monitoring event are provided in **Appendix F** and data trends for select monitoring wells are provided in **Appendix G**. Pre-injection (December

2008) and Five-Year Review (March 2013) groundwater plume maps for PCE, TCE, cis-1,2-DCE, VC, and PCP are provided in **Figures 9-7** through **9-11**.

As shown on **Figure 9-4**, the overall lateral extent of the Columbia aquifer plume has generally remained the same with some change in shape. Overall, a 14 percent increase in total COCs was observed from pre-injection baseline to initial LTM; however, an overall 19 percent reduction in total COCs has been observed from pre-injection baseline to the March 2013 sampling event. The increase is primarily the result of increased COC concentrations in source area monitoring well LS13-MW28D, where VOCs were not detected above cleanup levels and PCP was only slightly above the cleanup level during pre-injection baseline sampling (**Figures 9-7 through 9-11**). Increased concentrations are likely the result of leaching of residual contamination from soil. Although concentrations increased from pre-injection baseline at LS13-MW28D, LTM data indicate ongoing decreases in parent compounds PCE and TCE coupled with periodic increases in daughter products cis-1,2-DCE and VC.

With the exception of the area surrounding LS13-MW28D, VOCs have been reduced to below cleanup levels. Removal or reassignment of monitoring wells will be considered following collection of three rounds of LTM data. Concentrations of PCP have generally decreased (maximum concentration of 160 J µg/L in December 2008 to maximum concentration of 67 µg/L in March 2013) across the site but remain above cleanup levels. All COCs, including total and dissolved arsenic, have either not been detected or were detected at concentrations below cleanup levels in samples collected from perimeter monitoring wells and contingency monitoring well LS13-MW20T.

The March 2013 Five-Year Review event groundwater sampling results indicate that TOC concentrations have decreased to below the desired 20 mg/L in all but one sample, collected from LS13-MW12D, where TOC is only slightly above 20 mg/L. Additionally, little to no VFAs are being generated. Geochemical parameters such as pH, DO, and ORP indicate that the reducing conditions necessary to facilitate ERD have been maintained. However, based on the low TOC and lack of VFA generation, coupled with the increase in PCP and VOCs in the source area, an additional round of substrate injections should be considered.

9.4.3 Land Use Controls

A Consensus Agreement was signed on May 19, 2010, documenting the addition of the following LUC objective to the LUC RD for Site 13:

- Prevent dermal contact with groundwater by construction workers.

Additionally, to protect against any potential human health risk related to vapor intrusion resulting from changes in land use, a consensus agreement was signed in May 15, 2013, adding the following LUC objective to the LUC RD for Site 13:

- Prohibit changes from current building use or construction of new buildings without further evaluation of potential vapor intrusion risks and/or implementation of necessary mitigation measures.

Site Inspection

During this Five-Year Review period, annual site inspections were conducted at Site 13 between 2009 and 2012. Results of the 2013 inspection are discussed in Section 2.3 and provided in **Appendix C**. With the exception of general well repairs, no significant issues, unauthorized intrusive activities, or changes in land use were identified. General well maintenance was conducted as needed. A sinkhole surrounding the concrete pad of injection well LS13-IW06 was observed during the September 2013 site inspection. No groundwater was observed within the sinkhole.

Summary of the Estimated Remedy Costs

Table 9-4 presents capital and annual O&M and LTM costs for Site 13. Total remedy costs are slightly outside of the +50%/-30% range estimated in the ROD. Additional capital costs from those projected in the ROD are generally the result of the installation of permanent injection wells rather than the use of temporary injection points as documented in the ROD. Changes to estimated remedy costs should be evaluated and the appropriate documentation prepared.

TABLE 9-4
Site 13 Estimated Project Costs

Year	Timeframe	Projected Cost from ROD	Estimated Actual Cost	Notes
			Capital Cost*	
0	2008-2011	$378,987	$564,000	Includes labor, ODCs, and subcontractor costs for project planning, field mobilization/demobilization, well installation, baseline sampling, substrate injections, performance monitoring, and reporting.
			Management and Monitoring Cost**	
1	2012	$32,180	$61,659	Includes labor, ODCs, and subcontractor costs associated with UFP SAP preparation. Includes labor, ODCs, and subcontractor costs associated with baseline LTM sampling.
2***	2013	$32,180	$34,826	Includes labor, ODCs, and subcontractor costs associated with Five-Year Review LTM sampling.
	Total	**$411,167**	**$660,485**	
	+50%	$616,751		
	-30%	$287,817		

* Costs reflect those expended under contract to AGVIQ/CH2M HILL.

**Costs reflect those expended under contract to CH2M HILL.
***Represents costs expended between January and June 2013.

9.5 Technical Assessment

This section presents the answers to the three questions defined for the Technical Assessment for Site 11 based primarily on information presented in Section 9.4. Opportunities for maintenance and optimization of the remedy are presented in **Table 9-5**.

9.5.1 Question A: Is the remedy functioning as intended by the ROD?

Remedial Action Performance: Based on the review of documents, ARARs, risk assumptions, and site inspection reports, the Site 13 remedy is functioning as intended by the ROD. Remedy construction was completed in May 2010. Performance monitoring was conducted at a frequency of 1, 3, 6, 9, and 12 months following injection of the ERD substrate. As documented in the December 2011 ERD Summary Report, the remedy was successfully implemented and effective in achieving geochemical conditions to facilitate ERD. Concentrations of COCs have decreased but remain above cleanup levels. Based on a review of LTM data, additional substrate injection should be considered for continued effectiveness in accordance with the decisions matrixes included in the Site 13 LTM UFP SAP.

Implementation of LUCs: LUCs have been implemented through the Final LUC RD. LUCs and site inspections have ensured that unauthorized site use is prohibited and exposure to groundwater is prevented. A sinkhole surrounding the concrete pad of injection well LS13-IW06 was observed during the September 2013 site inspection. No groundwater was observed within the sinkhole, however, it is recommended that the concrete pad be repaired to prevent any potential future exposure to groundwater that may occur if expansion of the sinkhole were to result in exposure of the groundwater table.

LTM Activities: Groundwater LTM was initiated in September 2012 to assess continued effectiveness in achieving the RAOs. COC concentrations remain above cleanup levels. In general COC concentrations are decreasing, with the exception of increases observed in the source area.

Early Indicators of Potential Issues: No indicators of potential issues have been identified.

Opportunities for Optimization: Continued optimization through addition, removal, or reassignment of LTM monitoring wells, as well as site re-injection, is built into the decision matrices in the Site 13 LTM UFP SAP. No other opportunities for optimization have been recognized to date.

9.5.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy 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. Current and anticipated future land use is industrial and is expected to remain the same. The exposure assumptions used to develop the HHRA and ERA are reasonable given that the current land use has not changed at Site 13 over time. Physical conditions of Site 13 that would affect exposure pathways have not changed since the last 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. 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. Although 1,4-dioxane has not been included in the sample analyte list for previous sampling, 1,1,1-TCA has not been detected in groundwater samples collected from Site 13 and PCE has been identified as the VOC historically released. Therefore, 1,4-dioxane is not expected to be present at the site and no further investigation of this constituent is warranted for continued protectiveness of the remedy.

Additional changes in toxicity and tap water RSL values have been made since the last Five-Year Review (**Table 4-5**). PCP, select VOCs, and arsenic are sampled as part of ongoing groundwater LTM. There have been no changes in toxicity associated with SVOCs and VOCs that would affect the protectiveness of the remedy because either the SVOC or VOC is already listed as a site COC, it was not previously detected, or it was not previously detected above the MCL. PCBs, pesticides, and metals (except arsenic) have not been analyzed in groundwater since ROD signature. Based on site history, PCBs, and pesticides, as well as dioxins/furans and explosives constituents, are not expected to be present at Site 13. For the most part, the changes in toxicity values associated with metals would not affect the protectiveness of the remedy because historically, metals concentrations detected were below MCLs or background concentrations. Arsenic data collected as part of ongoing groundwater LTM indicate concentrations potentially migrating offsite are below the MCL. LUCs prevent exposure to groundwater; therefore, changes to the toxicity values would not adversely affect the current protectiveness of the remedy.

The cleanup levels for the site were established as the MCLs and no changes to these levels have been made since the last Five-Year Review.

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 13. There have been no major procedural changes in how the ERAs are conducted since the last Five-Year Review.

9.5.3 Question C: Has any other information come to light that could question the protectiveness of the remedy?

No new information has come to light that would question the protectiveness of the remedy.

TABLE 9-5
Remedy Maintenance and Optimization Activities for Site 13

Maintenance/Optimization Opportunity	Recommendations	Party Responsible
TOC concentrations in groundwater below desired conditions to facilitate ERD, lack of VFA generation, and increasing concentrations of COCs.	Recommend re-injection of substrate to ensure continued effectiveness.	Navy
Sinkhole surrounding the concrete pad of injection well LS13-IW06. No groundwater observed in existing sinkhole.	Recommend repair of sinkhole to prevent potential future exposure to groundwater that may occur if expansion of the sinkhole were to result in exposure of the groundwater table.	Navy

9.6 Issues, Recommendations, and Follow-up Actions

Table 9-6 outlines the issues identified during this Five-Year Review and presents recommendations and follow-up actions for Site 13.

TABLE 9-6
Issues, Recommendations, and Follow-up Actions for Site 13

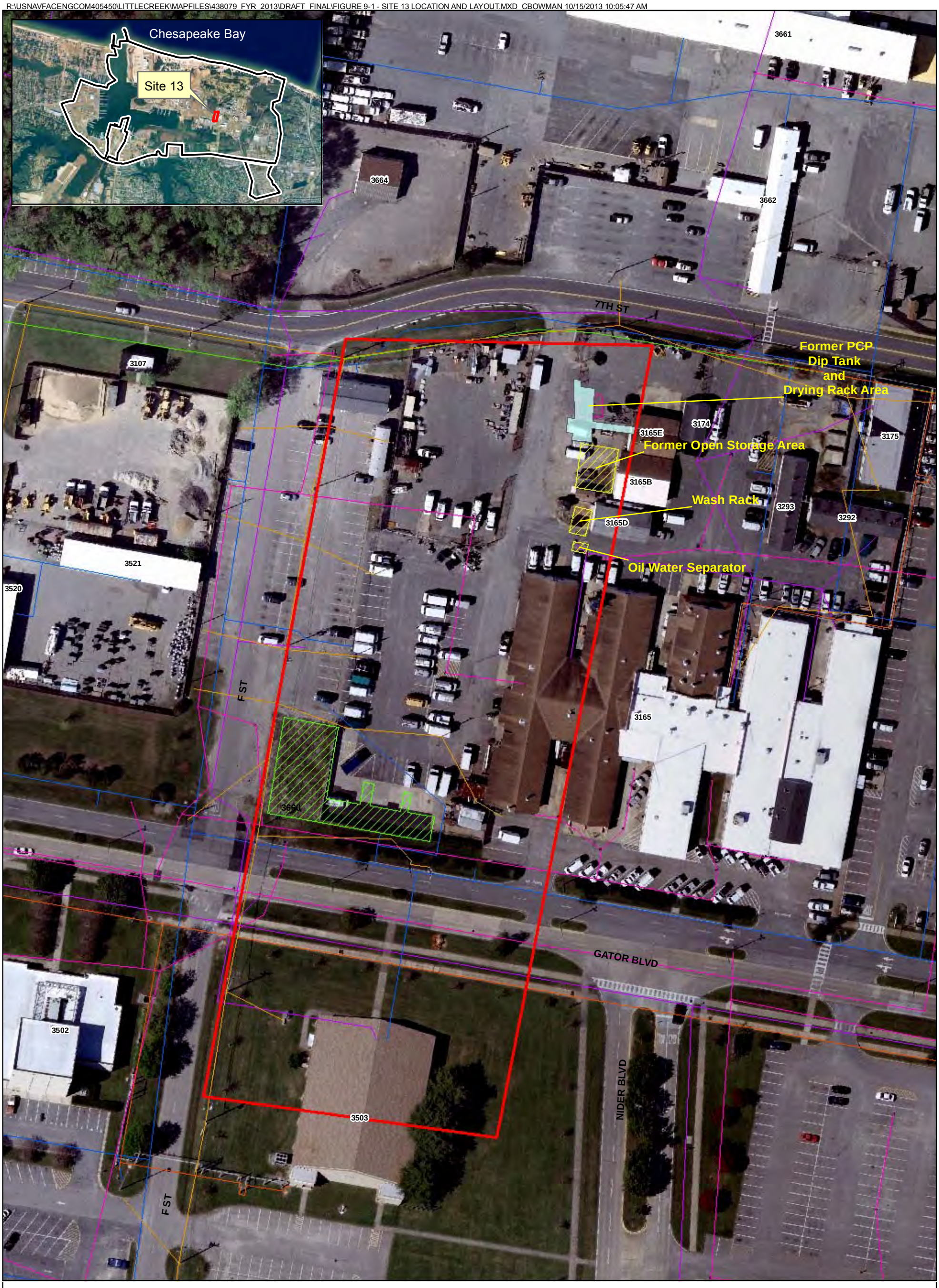
Issue	Recommendations and Follow-up Actions	Party Responsible	Milestone Date*	Affects Protectiveness	
				Current	Future
Issues Identified for Follow-Up Action During Current Five-Year Review					
Remedy costs to date are above the -30%/+50% range estimated in the ROD.	Evaluate changes to remedy costs and prepare the appropriate documentation, as needed.	Navy	March 2015	N	N

*Achievement of milestone dates are dependent on Navy funding.

9.7 Protectiveness Statement

The remedy at Site 13 is in place, functioning as designed, and is protective of human health and the environment. Exposure pathways that could result in an unacceptable risk are being controlled through LUCs. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-1 - SITE 13 LOCATION AND LAYOUT.MXD CBOWMAN 10/15/2013 10:05:47 AM



Legend

- 1999 Soil Removal Area
- LUC Boundary
- Former Building
- Former PCP Dip Tank and Dry Rack Area
- Site 13 Features
- Water Line
- Wastewater Line
- Storm Sewer Line
- Natural Gas Line
- Heat Cool Line
- Electrical Cable Line

N
W E
S

0 40 80 160
Feet

Figure 9-1
Site 13 Location and Layout
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

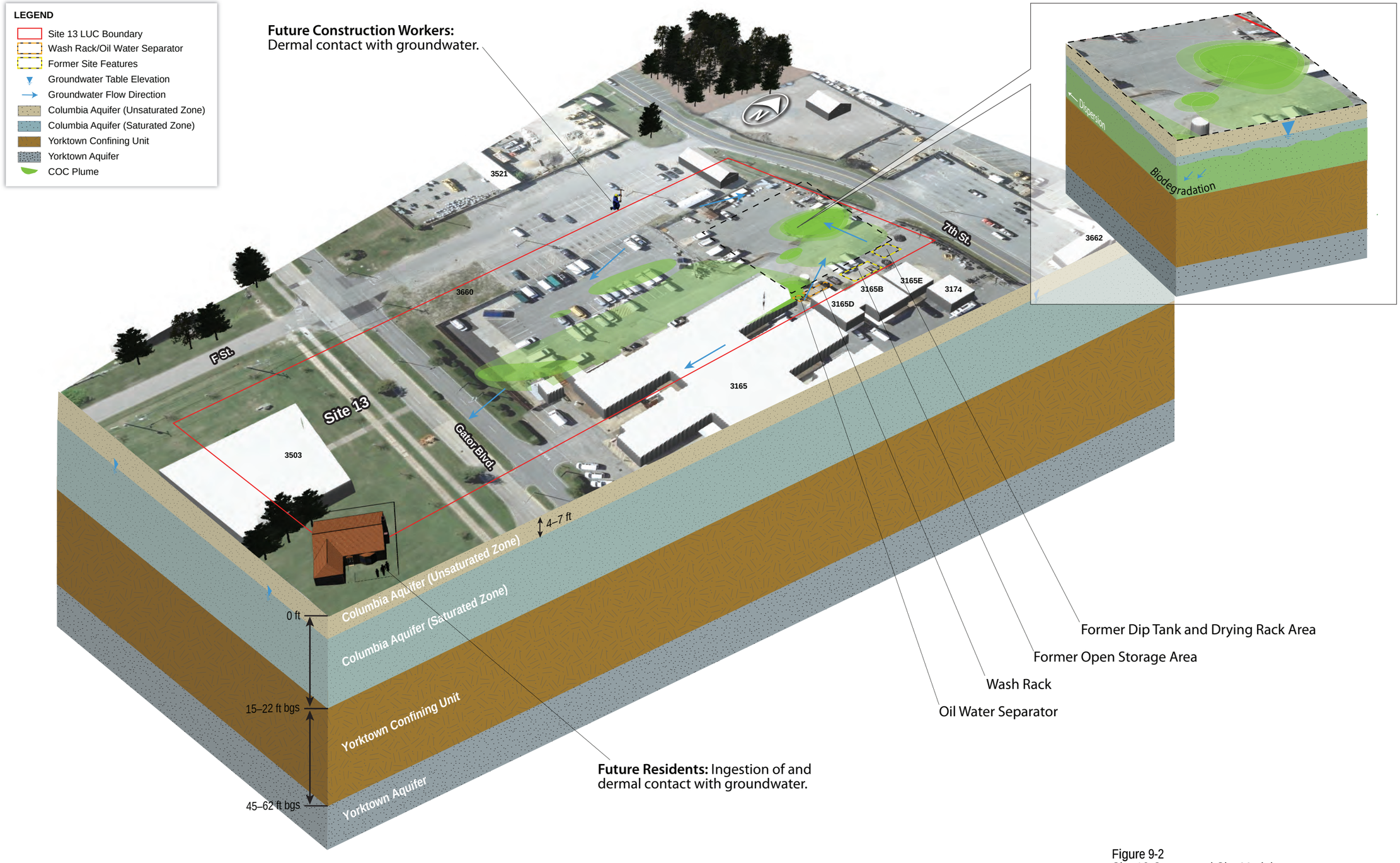


Figure 9-2
Site 13 Conceptual Site Model
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

Note: Extent of COC concentrations based on 2008-2010 analytical results

ES113011052854SAC Little_Creek_Site13_v5.ai 1.17.12 tdaus/jls

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-3 - SITE 13 GW CONTOURS - MARCH 2013.MXD CBOWMAN 10/15/2013 10:06:10 AM

Legend

- Monitoring Well
- Groundwater Contour (dahsed where inferred)
- Groundwater Flow Arrow
- Former PCP Dip Tank and Dry Rack Area
- Site 13 Features
- LUC Boundary
- Former Building

Note:
Injection well and Monitoring well IDs are truncated on this figure: Actual well IDs start with "LS13-".
All elevations in feet mean sea level.
*Groundwater elevation not used to generate contours.

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S

0 30 60
Feet

Figure 9-3
Site 13 Groundwater Contours - March 2013
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-4 - SITE 13 EXTENT OF COC GROUNDWATER PLUME.MXD CBOWMAN 10/15/2013 10:07:11 AM

Legend

- Existing wells not included in monitoring well network
- Injection Well (10-ft. ROI typical)
- Plume Area Monitoring Wells
- Source Area Monitoring Wells
- Perimeter Monitoring Wells
- Contingency Monitoring Wells
- Monitoring Well - Not Sampled
- Former Building 3660
- LUC Boundary
- Extent of COC Groundwater Plume

N W E S

0 50 100 Feet

Figure 9-4
Site 13 Extent of COC Groundwater Plume
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-5 - SITE 13 REMEDY DESIGN.MXD CBOWMAN 10/15/2013 10:08:25 AM

Legend

- Existing wells not included in monitoring well network
- Injection Well (10-ft. ROI typical)
- Plume Area Monitoring Wells
- Source Area Monitoring Wells
- Perimeter Monitoring Wells
- Contingency Monitoring Wells
- LUC Boundary
- Former Building
- Former PCP Dip Tank and Dry Rack Area
- Site 13 Features

N
W E
S

0 40 80 160 Feet

Figure 9-5
Site 13 Remedy Design
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-6 - SITE 13 LONG-TERM MONITORING NETWORK.MXD CBOWMAN 10/15/2013 10:08:54 AM

Legend

- Existing wells not included in monitoring well network
- Plume Area Monitoring Wells
- Source Area Monitoring Wells
- Perimeter Monitoring Wells
- Contingency Monitoring Wells
- LUC Boundary
- Former Building
- Former PCP Dip Tank and Dry Rack Area
- Site 13 Features

N
W E
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0 40 80 160
Feet

Figure 9-6
Site 13 Long-term Monitoring Network
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-7 - SITE 13 PCE PLUMES.MXD CBOWMAN 10/15/2013 10:09:30 AM

Legend

- Existing wells not included in monitoring well network
- Injection Well (10-ft. ROI typical)
- Plume Area Monitoring Wells
- Source Area Monitoring Wells
- Perimeter Monitoring Wells
- Contingency Monitoring Wells
- Monitoring Well - Not Sampled
- Former Building 3660
- LUC Boundary

Isoconcentrations

- > 5 - 100 µg/L
- 100 - 500 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 9-7
Site 13 PCE Isocontours
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-8 - SITE 13 TCE PLUMES.MXD, CROWMAN 10/15/2013 10:09:56 AM

Legend

- Existing wells not included in monitoring well network
- Injection Well (10-ft. ROI typical)
- Plume Area Monitoring Wells
- Source Area Monitoring Wells
- Perimeter Monitoring Wells
- Contingency Monitoring Wells
- Monitoring Well - Not Sampled
- Former Building 3660
- LUC Boundary

Isoconcentrations

- > 5 - 100 µg/L
- 100 - 500 µg/L
- 500 - 1000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 9-8
Site 13 TCE Isocontours
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-9 - SITE 13 CIS 1 2 DCE PLUMES.MXD CBOWMAN 2/10/2014 9:34:33 AM

Legend

- Existing wells not included in monitoring well network
- Injection Well (10-ft. ROI typical)
- Plume Area Monitoring Wells
- Source Area Monitoring Wells
- Perimeter Monitoring Wells
- Contingency Monitoring Wells
- Monitoring Well - Not Sampled
- Former Building 3660
- LUC Boundary

Isoconcentrations

- > 2 -100 µg/L
- 100 - 500 µg/L
- 500 - 1000 µg/L
- 1000 - 10000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 9-9
Site 13 cis-1,2-DCE Isocontours
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-10 - SITE 13 VC PLUMES.MXD CROWMAN 10/15/2013 10:11:02 AM

Legend

- Existing wells not included in monitoring well network
- Injection Well (10-ft. ROI typical)
- Plume Area Monitoring Wells
- Source Area Monitoring Wells
- Perimeter Monitoring Wells
- Contingency Monitoring Wells
- Monitoring Well - Not Sampled
- Former Building 3660
- LUC Boundary

Isoconcentrations

- > 2 - 100 µg/L
- > 100 - 500 µg/L
- > 500 - 1000 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 9-10
Site 13 VC Isocontours
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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R:\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_2013\DRAFT_FINAL\FIGURE 9-11 - SITE 13 PCP PLUMES.MXD CBOWMAN 10/15/2013 10:11:34 AM

Legend

- Existing wells not included in monitoring well network
- Injection Well (10-ft. ROI typical)
- Plume Area Monitoring Wells
- Source Area Monitoring Wells
- Perimeter Monitoring Wells
- Contingency Monitoring Wells
- Monitoring Well - Not Sampled
- Former Building 3660
- LUC Boundary

Isoconcentrations

- > 1 - 100 µg/L
- 100 - 500 µg/L
- Isoconcentration
- Isoconcentration (Inferred)

N W E S

0 50 100 Feet

Figure 9-11
Site 13 PCP Isocontours
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

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SECTION 10

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Appendix A
Public Notices

Public Notices

NAVFAC
Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

PUBLIC NOTICE
Record of Decision Five-Year Review
Joint Expeditionary Base Little Creek
Virginia Beach, Virginia

The Department of the Navy and the US Environmental Protection Agency (EPA), Region III, are beginning the second Five-Year Review of existing Record of Decision (ROD) documents and ongoing remedial (environmental cleanup) actions at Joint Expeditionary Base (JEB) Little Creek, located in Virginia Beach, Virginia. A ROD is a public document explaining the selected remedial action for implementation at a site. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, and the National Contingency Plan [40 Code of Federal Regulations Part 300.430(f)(4)(ii)], remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure must be reviewed every five years. The Five-Year Review period for JEB Little Creek began when the Navy signed the first ROD for the Base. The purpose of the Five-Year Review is to ensure these environmental cleanup actions continue to adequately protect human health and the environment. The Navy will submit draft findings of the Five-Year Review to EPA and the Virginia Department of Environmental Quality in September 2013. The final Five-Year Review report will be made available to the public in March 2014.

RODs and remedial actions to be reviewed:

Site 7 - Amphibious Base Landfill: A soil cover was placed on the landfill following completion of landfilling activities. The soil cover was enhanced under a Decision Document signed in January 1998. A ROD was signed in September 2009 selecting maintenance of the existing soil cover, land use controls, and long-term monitoring of groundwater as the remedy for the site. Remedy implementation was completed in Fiscal Year (FY) 2012.

Sites 9 and 10 - Driving Range Landfill and Sewage Treatment Plant Landfill: A soil cover was placed on the landfills following completion of landfilling activities. The ROD was signed in December 2003 selecting land use controls and long-term monitoring of groundwater as the remedy for each site. Remedy implementation was completed in FY 2005.

Site 11 - Former School of Music Plating Shop: The ROD was signed in July 2007 selecting enhanced reductive dechlorination (ERD) of volatile organic compounds (VOCs) in groundwater, land use controls, and groundwater monitoring as the remedy for the site. Remedy implementation was completed in FY 2012. Land use controls are in place to prohibit the use of groundwater.

Site 11a - Building 3033 Former Waste Oil Tank: The ROD was signed in September 2011 selecting ERD of VOCs in groundwater, land use controls, and groundwater monitoring as the remedy for the site. Remedy implementation is ongoing and is expected to be completed in FY 2013. Land use controls will be put in place to prohibit the use of groundwater.

Site 12 - Former Exchange Laundry: The ROD was signed in September 2005 and an Explanation of Significant Differences was signed in October 2006 selecting ERD of VOCs in groundwater, land use controls, and groundwater monitoring as the remedy for the site. Remedy implementation was completed in FY 2010. Land use controls are in place to prohibit the use of groundwater.

Site 13 - Former Public Works Center Dip Tank and Wash Rack: The ROD was signed in September 2007 selecting ERD of VOCs and pentachlorophenol in groundwater, land use controls, and groundwater monitoring as the remedy for the site. Remedy implementation was completed in FY 2012. Land use controls are in place to prohibit the use of groundwater.

The remedy for each site was selected based on findings contained in documents that are part of the Administrative Record for JEB Little Creek, which can be accessed at the following location:
https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_ww_pp/navfac_hq_pp/navfac_env_pp/env_restoration_installations/lant/midlant/jeblcfs/welcome.

The Administrative Record provides background information on all of the sites included in the Five Year Review, as well as remedial investigations conducted at each site. If you have questions or information regarding the effectiveness of the selected remedies, please contact the JEB Little Creek-Fort Story Public Affairs Office:

Public Affairs Office
Joint Expeditionary Base Little Creek-Fort Story
2600 Tarawa Ct., Suite 100
Virginia Beach, Virginia 23459-3297
Phone: (757) 462-8425

VP April 24, 2013 23550850

Appendix B
Reference Documents

APPENDIX B

Documents Reviewed

In addition to the documents listed below, review of documents maintained on the JEBLC Partnering Team (Navy, EPA Region III, and the Virginia Department of Environmental Quality) website was also performed including groundwater monitoring data, groundwater contour maps, discharge monitoring reports, and landfill inspection reports.

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Appendix C
Site Inspection Checklists

I. SITE INFORMATION	
Site Name: Site 7 - Amphibious Base Landfill	**Date of Inspection:** May 15, 2013
Location and Region: JEB Little Creek, NAVFAC Mid-Atlantic	**EPA ID:** VA5170022482
Agency, office, or company leading the five-year review: NAVFAC Mid-Atlantic with USEPA and VDEQ	**Weather/ temperature:** Sunny, 85°, windy

Remedy Includes: (Check all that apply):

- Landfill cover/containment ☑
- Access controls ☐
- Institutional controls ☑
- Groundwater pump and treatment ☐
- Surface water collection and treatment ☐
- Monitored natural attenuation ☐
- Groundwater containment ☐
- Vertical barrier walls ☐

Attachments: Site map

Local regulatory authorities and response agencies (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) F

Agency	USEPA Region 3			
Contact	Jeffrey Boylan	RPM	5/15/2013	215-814-2094
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

Agency	VDEQ			
Contact	Paul Herman, P.E.	RPM	5/15/2013	804-698-4464
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

II. INTERVIEWS - NOT APPLICABLE

III. ON-SITE DOCUMENTS & RECORD VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily Available ☐	Up to date ☐	N/A ☑
	As-built drawings	Readily Available ☐	Up to date ☐	N/A ☑
	Maintenance logs	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: O&M work plans developed as needed. As-built drawings contained in CCR documents. Inspection reports provided to USEPA and VDEQ as outlined in LUC RDs and subsequent LUC RD revisions.			
2.	**Site Specific Health and Safety Plan**	Readily Available ☐	Up to date ☐	N/A ☑
	Contingency/emergency response plan	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: Health and safety plans developed as needed for O&M			
3.	**O&M and OSHA Training Records**	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: As needed per Navy contracts			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily Available ☐	Up to date ☐	N/A ☑
	Effluent discharge	Readily Available ☐	Up to date ☐	N/A ☑
	Waste disposal, POTW	Readily Available ☐	Up to date ☐	N/A ☑
	Other permits_____	Readily Available ☐	Up to date ☐	N/A ☑

5.	**Gas Generation Records**	Readily Available ☐	Up to date ☐	N/A ☑
6.	**Settlement Monument Records**	Readily Available ☐	Up to date ☐	N/A ☑
7.	**Groundwater Monitoring Records**	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: Groundwater monitoring not conducted since last five-year review			
8.	**Leachate Extraction Records**	Readily Available ☐	Up to date ☐	N/A ☑
9.	**Discharge Compliance Records**			
	Air	Readily Available ☐	Up to date ☐	N/A ☑
	Water (effluent)	Readily Available ☐	Up to date ☐	N/A ☑
10.	**Daily Access/Security Logs**	Readily Available ☐	Up to date ☐	N/A ☑

IV.O&M COST

1 **O&M Organization**

State in-house ☐ Contractor for State ☐
PRP in-house ☐ Contractor for PRP ☐
Federal Facility in-house ☑ Contractor for Federal Facility ☐
Other :

2 **O&M Cost Records**

See Section 4.4 of main document.

3 **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: See Section 4.4 of main document.

V. ACCESS AND INSTITUTIONAL CONTROLS

A. Fencing

1. **Fencing damaged** N/A ☑

Location shown on site map ☐
Gates secured ☑

Remarks : Fencing in good condition and locked.

B. Other Access Restrictions

1. **Signs and other security measures** N/A ☐

Locations shown on site map ☑

Remarks : Signs in good condition and located as shown on map.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Conditions imply ICs not properly implemented
Yes ☐ No ☑ N/A ☐
Conditions imply ICs not being fully enforced
Yes ☐ No ☑ N/A ☐
Type of monitoring (e.g., self-reporting, drive by) : Visual inspection of cover, results reported to USEPA and VDEQ
Frequency : Annual
Responsible party/agency : NAVFAC Mid-LANT
Contact : Bryan Peed (Name) RPM (Title) 757-341-0480 (Phone No.)

Reporting is up to date
Yes ☑ No ☐ N/A ☐
Reports are verified by the lead agency
Yes ☑ No ☐ N/A ☐
Specific requirements in deed or decision documents have been met
Yes ☑ No ☐ N/A ☐
Violations have been reported
Yes ☐ No ☐ N/A ☑
Other problems or suggestions: Report attached ☐
See comments in Section XI.

2 **Adequacy** N/A ☐
ICs are adequate ☑
ICs are inadequate ☐

D. General

1 **Vandalism/trespassing**
Location shown on site map ☐
No vandalism evident ☑

2 **Land use changes on site** N/A ☑

3 **Land use changes off site** N/A ☑
Remarks : None observed

VI. GENERAL SITE CONDITIONS

A. Roads Applicable ☐ N/A ☑

1 **Roads damaged** N/A ☑
Location shown on site map ☐
Roads adequate ☐

B. Other Site Conditions

1 Remarks : Adequate vegetative cover established. Tree growth noted on bank and should be monitored.
Site drainage repaired and functioning as designed, no standing water observed.

VII. LANDFILL COVERS

A. Landfill Surface

1 **Settlement**
Location shown on site map ☐
Settlement not evident ☑

2 **Cracks**
Location shown on site map ☐
Cracking not evident ☑

3 **Erosion**
Location shown on site map ☐
Erosion not evident ☑

4 **Holes**
Location shown on site map ☐
Holes not evident ☑
Areal extent : _____ Depth : _____
Remarks :

5 **Vegetative Cover**
Grass ☑
Cover properly established ☑
No signs of stress ☑
Trees/Shrubs (indicate size and locations on a diagram) ☑
Remarks : Tree/shrub growth noted on western bank.

6 **Alternative Cover** (armored rock, concrete, etc.) N/A ☐

7 **Bulges**
Location shown on site map ☐
Bulges not evident ☑

8 **Wet Areas/Water Damage**
Wet areas/water damage not evident ☑
Wet areas ☐ Location shown on site map ☐ Areal extent : _____
Ponding ☐ Location shown on site map ☐ Areal extent : _____
Seeps ☐ Location shown on site map ☐ Areal extent : _____
Soft sub grade ☐ Location shown on site map ☐ Areal extent : _____
Remarks :

9 **Slope Instability**
No evidence of slope instability ☑
Slides ☐ Location shown on site map ☐
Areal extent : _____
Remarks :

B. Benches (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		Applicable ☐	N/A ☑
C. Letdown Channels (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)		Applicable ☑	N/A ☐
D. Cover Penetrations		Applicable ☐	N/A ☑
1	**Gas Vents**		N/A ☑
2	**Gas Monitoring Probes**		N/A ☑
3	**Monitoring Wells** (within surface area of landfill) Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ Remarks : All monitoring wells that were inspected were in acceptable condition.		
4	**Leachate Extraction Wells**		N/A ☑
5	**Settlement Monuments**		N/A ☑
E. Gas Collection & Treatment		Applicable ☐	N/A ☑
F. Cover Drainage Layer		Applicable ☑	N/A ☐
G. Detention/Sedimentation Ponds		Applicable ☐	N/A ☑
H. Retaining Walls		Applicable ☑	N/A ☐
I. Perimeter Ditches/Off-Site Discharge		Applicable ☐	N/A ☑
	VIII. VERTICAL BARRIER WALLS	Applicable ☐	N/A ☑
	IX.GROUNDWATER/SURFACE WATER REMEDIES		
A. Groundwater Extraction Wells/Pumps/Pipelines		Applicable ☐	N/A ☑
B. Surface Water Collection Structures, Pumps, and Pipelines		Applicable ☐	N/A ☑
C. Treatment System		Applicable ☐	N/A ☑
D. Monitoring Data			
1	Monitoring Data Is routinely submitted on time ☑	Is of acceptable quality ☑	
2	Monitoring data suggests: Release from landfill has not occurred ☑		
E. Monitored Natural Attenuation		Applicable ☐	N/A ☑
	X. OTHER REMEDIES	Applicable ☐	N/A ☑
	XI. OVERALL OBSERVATIONS		
A.	**Implementation of the Remedy**		
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Remedy designed to prevent direct exposure to landfill contents. Soil cover in place and functioning as intended. Groundwater monitoring conducted to evaluate potential release and offsite migration of contaminants.		
B. Adequacy of O&M			
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Visual inspections conducted to identify deficiencies in soil cover. O&M actions conducted during five-year review period to address standing water and landfill depression observed.		

C. Early indicators of Potential Remedy Problems
Describe issues and observations such as unexpected changes in the cost of scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be comprised in the future. None noted.
D. Opportunities for Optimization
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Optimization of monitoring frequency in ongoing.

I. SITE INFORMATION

Site Name: Site 9 - Driving Range Landfill	**Date of Inspection:** May 15, 2013
Location and Region: JEB Little Creek, NAVFAC Mid-Atlantic	**EPA ID:** VA5170022482
Agency, office, or company leading the five-year review: NAVFAC Mid-Atlantic with USEPA and VDEQ	**Weather/ temperature:** Sunny, 85°, windy

Remedy Includes: (Check all that apply):

- Landfill cover/containment ☑
- Access controls ☐
- Institutional controls ☑
- Groundwater pump and treatment ☐
- Surface water collection and treatment ☐
- Monitored natural attenuation ☐
- Groundwater containment ☐
- Vertical barrier walls ☐

Attachments: Site map

Local regulatory authorities and response agencies (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) F

Agency	USEPA Region 3			
Contact	Jeffrey Boylan	RPM	5/15/2013	215-814-2094
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

Agency	VDEQ			
Contact	Paul Herman, P.E.	RPM	5/15/2013	804-698-4464
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

II. INTERVIEWS - NOT APPLICABLE

III. ON-SITE DOCUMENTS & RECORD VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily Available ☐	Up to date ☐	N/A ☑
	As-built drawings	Readily Available ☐	Up to date ☐	N/A ☑
	Maintenance logs	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: O&M work plans developed as needed. As-built drawings contained in CCR documents. Inspection reports provided to USEPA and VDEQ as outlined in LUC RDs and subsequent LUC RD revisions.			
2.	**Site Specific Health and Safety Plan**	Readily Available ☐	Up to date ☐	N/A ☑
	Contingency/emergency response plan	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: Health and safety plans developed as needed for O&M			
3.	**O&M and OSHA Training Records**	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: As needed per Navy contracts			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily Available ☐	Up to date ☐	N/A ☑
	Effluent discharge	Readily Available ☐	Up to date ☐	N/A ☑
	Waste disposal, POTW	Readily Available ☐	Up to date ☐	N/A ☑
	Other permits	Readily Available ☐	Up to date ☐	N/A ☑

5.	**Gas Generation Records**	Readily Available ☐	Up to date ☐	N/A ☑
6.	**Settlement Monument Records**	Readily Available ☐	Up to date ☐	N/A ☑
7.	**Groundwater Monitoring Records**	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: Groundwater monitoring not conducted since last five-year review			
8.	**Leachate Extraction Records**	Readily Available ☐	Up to date ☐	N/A ☑
9.	**Discharge Compliance Records**			
	Air	Readily Available ☐	Up to date ☐	N/A ☑
	Water (effluent)	Readily Available ☐	Up to date ☐	N/A ☑
10.	**Daily Access/Security Logs**	Readily Available ☐	Up to date ☐	N/A ☑

IV.O&M COST

1 **O&M Organization**

State in-house ☐ Contractor for State ☐
PRP in-house ☐ Contractor for PRP ☐
Federal Facility in-house ☑ Contractor for Federal Facility ☐
Other :

2 **O&M Cost Records**

See Section 5.4 of main document.

3 **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: See Section 5.4 of main document.

V. ACCESS AND INSTITUTIONAL CONTROLS

A. Fencing

1. **Fencing damaged** N/A ☑

Location shown on site map ☐
Gates secured ☐

Remarks : Fencing associated with mission activities in place, access to landfill is unrestricted.

B. Other Access Restrictions

1. **Signs and other security measures** N/A ☐

Locations shown on site map ☑

Remarks : Signs in place as shown on map; contact information needs updating on select signs.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Conditions imply ICs not properly implemented
Yes ☐ No ☑ N/A ☐

Conditions imply ICs not being fully enforced
Yes ☐ No ☑ N/A ☐

Type of monitoring (e.g., self-reporting, drive by) : Visual inspection of cover, results reported to USEPA and VDEQ

Frequency : Annual

Responsible party/agency : NAVFAC Mid-LANT

Contact : Bryan Peed (Name) RPM (Title) 757-341-0480 (Phone No.)

Reporting is up to date
Yes ☑ No ☐ N/A ☐

Reports are verified by the lead agency
Yes ☑ No ☐ N/A ☐

Specific requirements in deed or decision documents have been met
Yes ☑ No ☐ N/A ☐

Violations have been reported
Yes ☐ No ☐ N/A ☑

Other problems or suggestions: Report attached ☐

See comments in Section XI.

2 **Adequacy** N/A ☐
ICs are adequate ☑
ICs are inadequate ☐

D. General

1 **Vandalism/trespassing**
Location shown on site map ☐
No vandalism evident ☑

2 **Land use changes on site** N/A ☑

3 **Land use changes off site** N/A ☑
Remarks : None observed

VI. GENERAL SITE CONDITIONS

A. Roads Applicable ☐ N/A ☑

1 **Roads damaged** N/A ☑
Location shown on site map ☐
Roads adequate ☐

B. Other Site Conditions

1 Remarks : Adequate vegetative cover established. No stressed vegetation or ponding water observed.
Unable to locate monitoring well LS09-MW03.

VII. LANDFILL COVERS

A. Landfill Surface

1 **Settlement**
Location shown on site map ☐
Settlement not evident ☑

2 **Cracks**
Location shown on site map ☐
Cracking not evident ☑

3 **Erosion**
Location shown on site map ☐
Erosion not evident ☑

4 **Holes**
Location shown on site map ☐
Holes not evident ☑
Areal extent : _____ Depth : _____
Remarks :

5 **Vegetative Cover**
Grass ☑
Cover properly established ☑
No signs of stress ☑
Trees/Shrubs (indicate size and locations on a diagram) ☐
Remarks :

6 **Alternative Cover** (armored rock, concrete, etc.) N/A ☑

7 **Bulges**
Location shown on site map ☐
Bulges not evident ☑

8 **Wet Areas/Water Damage**
Wet areas/water damage not evident ☑
Wet areas ☐ Location shown on site map ☐ Areal extent : _____
Ponding ☐ Location shown on site map ☐ Areal extent : _____
Seeps ☐ Location shown on site map ☐ Areal extent : _____
Soft sub grade ☐ Location shown on site map ☐ Areal extent : _____
Remarks :

9 **Slope Instability**
No evidence of slope instability ☑
Slides ☐ Location shown on site map ☐
Areal extent : _____
Remarks :

B. Benches (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		Applicable ☐	N/A ☑
C. Letdown Channels (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)		Applicable ☐	N/A ☑
D. Cover Penetrations		Applicable ☐	N/A ☑
1	**Gas Vents**		N/A ☑
2	**Gas Monitoring Probes**		N/A ☑
3	**Monitoring Wells** (within surface area of landfill) Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ Remarks : All monitoring wells that were inspected were in acceptable condition.		
4	**Leachate Extraction Wells**		N/A ☑
5	**Settlement Monuments**		N/A ☑
E. Gas Collection & Treatment		Applicable ☐	N/A ☑
F. Cover Drainage Layer		Applicable ☐	N/A ☑
G. Detention/Sedimentation Ponds		Applicable ☐	N/A ☑
H. Retaining Walls		Applicable ☐	N/A ☑
I. Perimeter Ditches/Off-Site Discharge		Applicable ☐	N/A ☑
	VIII. VERTICAL BARRIER WALLS	Applicable ☐	N/A ☑
	IX.GROUNDWATER/SURFACE WATER REMEDIES		
A. Groundwater Extraction Wells/Pumps/Pipelines		Applicable ☐	N/A ☑
B. Surface Water Collection Structures, Pumps, and Pipelines		Applicable ☐	N/A ☑
C. Treatment System		Applicable ☐	N/A ☑
D. Monitoring Data (Note: Monitoring has not been conducted since last five-year review.)			
1	Monitoring Data Is routinely submitted on time ☐	Is of acceptable quality ☐	
2	Monitoring data suggests: Release from landfill has not occurred ☐		
E. Monitored Natural Attenuation		Applicable ☐	N/A ☑
	X. OTHER REMEDIES	Applicable ☐	N/A ☑
	XI. OVERALL OBSERVATIONS		
A.	**Implementation of the Remedy**		
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Remedy designed to prevent direct exposure to landfill contents and monitor for migration of COCs. Soil cover in place and functioning as intended. Monitoring not conducted since last five-year review.		
B. Adequacy of O&M			
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Visual inspections conducted to identify deficiencies in soil cover. O&M actions conducted during five-year review period to address bare areas/stressed vegetation observed.		

C. Early indicators of Potential Remedy Problems
Describe issues and observations such as unexpected changes in the cost of scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be comprised in the future. None noted.
D. Opportunities for Optimization
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Optimization of monitoring frequency in ongoing.

I. SITE INFORMATION	
Site Name: Site 10 - Sewage Treatment Plant Landfill	**Date of Inspection:** May 15, 2013
Location and Region: JEB Little Creek, NAVFAC Mid-Atlantic	**EPA ID:** VA5170022482
Agency, office, or company leading the five-year review: NAVFAC Mid-Atlantic with USEPA and VDEQ	**Weather/ temperature:** Sunny, 85°, windy

Remedy Includes: (Check all that apply):

- Landfill cover/containment ☑
- Access controls ☐
- Institutional controls ☑
- Groundwater pump and treatment ☐
- Surface water collection and treatment ☐
- Monitored natural attenuation ☐
- Groundwater containment ☐
- Vertical barrier walls ☐

Attachments: Site map

Local regulatory authorities and response agencies (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) F

Agency	USEPA Region 3			
Contact	Jeffrey Boylan	RPM	5/15/2013	215-814-2094
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

Agency	VDEQ			
Contact	Paul Herman, P.E.	RPM	5/15/2013	804-698-4464
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

II. INTERVIEWS - NOT APPLICABLE

III. ON-SITE DOCUMENTS & RECORD VERIFIED (Check all that apply)

1.	**O&M Documents**			
	O&M manual	Readily Available ☐	Up to date ☐	N/A ☑
	As-built drawings	Readily Available ☐	Up to date ☐	N/A ☑
	Maintenance logs	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: O&M work plans developed as needed. As-built drawings contained in CCR documents. Inspection reports provided to USEPA and VDEQ as outlined in LUC RDs and subsequent LUC RD revisions.			
2.	**Site Specific Health and Safety Plan**	Readily Available ☐	Up to date ☐	N/A ☑
	Contingency/emergency response plan	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: Health and safety plans developed as needed for O&M			
3.	**O&M and OSHA Training Records**	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: As needed per Navy contracts			
4.	**Permits and Service Agreements**			
	Air discharge permit	Readily Available ☐	Up to date ☐	N/A ☑
	Effluent discharge	Readily Available ☐	Up to date ☐	N/A ☑
	Waste disposal, POTW	Readily Available ☐	Up to date ☐	N/A ☑
	Other permits_____	Readily Available ☐	Up to date ☐	N/A ☑

5.	**Gas Generation Records**	Readily Available ☐	Up to date ☐	N/A ☑
6.	**Settlement Monument Records**	Readily Available ☐	Up to date ☐	N/A ☑
7.	**Groundwater Monitoring Records**	Readily Available ☐	Up to date ☐	N/A ☑
	Remarks: Groundwater monitoring not conducted since last five-year review			
8.	**Leachate Extraction Records**	Readily Available ☐	Up to date ☐	N/A ☑
9.	**Discharge Compliance Records**			
	Air	Readily Available ☐	Up to date ☐	N/A ☑
	Water (effluent)	Readily Available ☐	Up to date ☐	N/A ☑
10.	**Daily Access/Security Logs**	Readily Available ☐	Up to date ☐	N/A ☑

IV.O&M COST

1 **O&M Organization**

State in-house ☐ Contractor for State ☐
PRP in-house ☐ Contractor for PRP ☐
Federal Facility in-house ☑ Contractor for Federal Facility ☐
Other :

2 **O&M Cost Records**

See Section 5.4 of main document.

3 **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: See Section 5.4 of main document.

V. ACCESS AND INSTITUTIONAL CONTROLS

A. Fencing

1. **Fencing damaged** N/A ☑

Location shown on site map ☐
Gates secured ☐

Remarks : Fencing associated with mission activities in place; access to site is unrestricted.

B. Other Access Restrictions

1. **Signs and other security measures** N/A ☐

Locations shown on site map ☐

Remarks : Signs in place as shown on map; contact information needs updating on select signs.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Conditions imply ICs not properly implemented
Yes ☐ No ☑ N/A ☐

Conditions imply ICs not being fully enforced
Yes ☐ No ☑ N/A ☐

Type of monitoring (e.g., self-reporting, drive by) : Visual inspection of cover, results reported to USEPA and VDEQ

Frequency : Annual

Responsible party/agency : NAVFAC Mid-LANT

Contact : Bryan Peed (Name) RPM (Title) 757-341-0480 (Phone No.)

Reporting is up to date
Yes ☑ No ☐ N/A ☐

Reports are verified by the lead agency
Yes ☑ No ☐ N/A ☐

Specific requirements in deed or decision documents have been met
Yes ☑ No ☐ N/A ☐

Violations have been reported
Yes ☑ No ☐ N/A ☐

Other problems or suggestions: Report attached ☐

See comments in Section XI.

2 **Adequacy** N/A ☐
ICs are adequate ☑
ICs are inadequate ☐

D. General

1 **Vandalism/trespassing**
Location shown on site map ☐
No vandalism evident ☑

2 **Land use changes on site** N/A ☑

3 **Land use changes off site** N/A ☑
Remarks : None observed

VI. GENERAL SITE CONDITIONS

A. Roads Applicable ☑ N/A ☐

1 **Roads damaged** N/A ☐
Location shown on site map ☑
Roads adequate ☐

B. Other Site Conditions

1 Remarks : Ruts in soil cover noted as a result of mission activities. Debris, including steel pipe, asphalt, and tires observed.

VII. LANDFILL COVERS

A. Landfill Surface

1 **Settlement**
Location shown on site map ☐
Settlement not evident ☑

2 **Cracks**
Location shown on site map ☐
Cracking not evident ☑

3 **Erosion**
Location shown on site map ☑
Erosion not evident ☐

4 **Holes**
Location shown on site map ☐
Holes not evident ☑
Areal extent : _____ Depth : _____
Remarks :

5 **Vegetative Cover**
Grass ☑
Cover properly established ☑
No signs of stress ☑
Trees/Shrubs (indicate size and locations on a diagram) ☐
Remarks : Cover is combination of grass and sand.

6 **Alternative Cover** (armored rock, concrete, etc.) N/A ☐

7 **Bulges**
Location shown on site map ☐
Bulges not evident ☑

8 **Wet Areas/Water Damage**
Wet areas/water damage not evident ☑
Wet areas ☐ Location shown on site map ☐ Areal extent : _____
Ponding ☐ Location shown on site map ☐ Areal extent : _____
Seeps ☐ Location shown on site map ☐ Areal extent : _____
Soft sub grade ☐ Location shown on site map ☐ Areal extent : _____
Remarks :

9 **Slope Instability**
No evidence of slope instability ☑
Slides ☐ Location shown on site map ☐
Areal extent : _____
Remarks :

B. Benches (Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		Applicable ☐	N/A ☑
C. Letdown Channels (Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)		Applicable ☐	N/A ☑
D. Cover Penetrations		Applicable ☐	N/A ☑
1	**Gas Vents**		N/A ☑
2	**Gas Monitoring Probes**		N/A ☑
3	**Monitoring Wells** (within surface area of landfill) Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ Remarks : All monitoring wells that were inspected were in acceptable condition.		
4	**Leachate Extraction Wells**		N/A ☑
5	**Settlement Monuments**		N/A ☑
E. Gas Collection & Treatment		Applicable ☐	N/A ☑
F. Cover Drainage Layer		Applicable ☐	N/A ☑
G. Detention/Sedimentation Ponds		Applicable ☐	N/A ☑
H. Retaining Walls		Applicable ☐	N/A ☑
I. Perimeter Ditches/Off-Site Discharge		Applicable ☐	N/A ☑
	VIII. VERTICAL BARRIER WALLS	Applicable ☐	N/A ☑
	IX.GROUNDWATER/SURFACE WATER REMEDIES		
A. Groundwater Extraction Wells/Pumps/Pipelines		Applicable ☐	N/A ☑
B. Surface Water Collection Structures, Pumps, and Pipelines		Applicable ☐	N/A ☑
C. Treatment System		Applicable ☐	N/A ☑
D. Monitoring Data (Note: Monitoring has not been conducted since last five-year review.)			
1	Monitoring Data Is routinely submitted on time ☐	Is of acceptable quality ☐	
2	Monitoring data suggests: Release from landfill has not occurred ☐		
E. Monitored Natural Attenuation		Applicable ☐	N/A ☑
	X. OTHER REMEDIES	Applicable ☐	N/A ☑
	XI. OVERALL OBSERVATIONS		
A.	**Implementation of the Remedy**		
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). Remedy designed to prevent direct exposure to landfill contents and monitor for migration of COCs. With exception of ruts observed, soil cover in place and functioning as intended. No exposed waste noted in rutted area. Surface debris, including tires, steel pipe, and asphalt were observed; however, debris does not compromise the integrity of the landfill cover. Monitoring not conducted since last five-year review.		
B. Adequacy of O&M			
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. Visual inspections conducted to identify deficiencies in soil cover and unauthorized intrusive activities. O&M actions conducted during five-year period to repair damage to soil cover resulting from vehicle traffic surrounding baseball fields. Fence installed to prevent continued vehicular traffic. Repair of existing ruts, removal of existing surface debris, and prevention of future prohibited site use is currently being evaluated.		

C. Early indicators of Potential Remedy Problems
Describe issues and observations such as unexpected changes in the cost of scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be comprised in the future. Ruts resulting from mission activities. O&M will need to adequately repair existing ruts while preventing future damage to soil cover and allowing for continued mission activities.
D. Opportunities for Optimization
Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Optimization of monitoring frequency in ongoing.

I. SITE INFORMATION

Site Name: Site 11 - Former School of Music Plating Shop	**Date of Inspection:** May 15, 2013
Location and Region: JEB Little Creek, NAVFAC Mid-Atlantic	**EPA ID:** VA5170022482
Agency, office, or company leading the five-year review: NAVFAC Mid-Atlantic with USEPA and VDEQ	**Weather/ temperature:** Sunny, 85°, windy

Remedy Includes: (Check all that apply):

- Landfill cover/containment ☐
- Access controls ☐
- Institutional controls ☑
- Groundwater pump and treatment ☐
- Surface water collection and treatment ☐
- Monitored natural attenuation ☐
- Groundwater containment ☐
- Vertical barrier walls ☐

Other : In-situ groundwater treatment (enhanced reductive dechlorination)

Attachments: Site map

1. Local regulatory authorities and response agencies (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.

Agency	USEPA Region 3			
Contact	Jeffrey Boylan	RPM	5/15/2013	215-814-2094
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

Agency	VDEQ			
Contact	Paul Herman, P.E.	RPM	5/15/2013	804-698-4464
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

II. INTERVIEWS - NOT APPLICABLE

III. ON-SITE DOCUMENTS & RECORD VERIFIED (Check all that apply)

1. **O&M Documents**

	Readily Available	Up to date	N/A
O&M manual	☐	☐	☑
As-built drawings	☐	☐	☑
Maintenance logs	☐	☐	☑

Remarks: No active operating remediation system; remedy is in place; construction completed May 2009.
Work plans for O&M, including re-injection, developed as needed.

2. **Site Specific Health and Safety Plan**

	Readily Available	Up to date	N/A
Site Specific Health and Safety Plan	☐	☐	☑
Contingency/emergency response plan	☐	☐	☑

Remarks: Health and safety plans developed as needed for monitoring and re-injection.

3. **O&M and OSHA Training Records** — Readily Available ☑ Up to date ☐ N/A ☐

Remarks: Per contract with NAVFAC

4.	**Permits and Service Agreements**			
	Air discharge permit	Readily Available ☐	Up to date ☐	N/A ☑
	Effluent discharge	Readily Available ☐	Up to date ☐	N/A ☑
	Waste disposal, POTW	Readily Available ☑	Up to date ☐	N/A ☐
	Other permits_____	Readily Available ☐	Up to date ☐	N/A ☑
5.	**Gas Generation Records**	Readily Available ☐	Up to date ☐	N/A ☑
6.	**Settlement Monument Records**	Readily Available ☐	Up to date ☐	N/A ☑
7.	**Groundwater Monitoring Records**	Readily Available ☑	Up to date ☐	N/A ☐
	Remarks: Monitoring data provided to USEPA and VDEQ during partnering meetings and as part of monitoring reports.			
8.	**Leachate Extraction Records**	Readily Available ☐	Up to date ☐	N/A ☑
9.	**Discharge Compliance Records**			
	Air	Readily Available ☐	Up to date ☐	N/A ☑
	Water (effluent)	Readily Available ☐	Up to date ☐	N/A ☑
10.	**Daily Access/Security Logs**	Readily Available ☐	Up to date ☐	N/A ☑

IV.O&M COST

1 **O&M Organization**

State in-house ☐ Contractor for State ☐
PRP in-house ☐ Contractor for PRP ☐
Federal Facility in-house ☑ Contractor for Federal Facility ☐
Other : _____

2 **O&M Cost Records**
See Section 6.4 of main document.

3 **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: See Section 6.4 of main document.

V. ACCESS AND INSTITUTIONAL CONTROLS

A. Fencing

1. **Fencing damaged** N/A ☑

B. Other Access Restrictions ☐ ☐

1. **Signs and other security measures** N/A ☑

C. Institutional Controls (ICs) ☐

1. **Implementation and enforcement**

Conditions imply ICs not properly implemented
Yes ☐ No ☑ N/A ☐
Conditions imply ICs not being fully enforced
Yes ☐ No ☑ N/A ☐
Type of monitoring (e.g., self-reporting, drive by) : Visual inspections of site and monitoring well
conditions, results reported to USEPA and VDEQ
Frequency : Annual
Responsible party/agency : NAVFAC Mid-Atlantic
Contact : Bryan Peed (Name) RPM (Title) 757-341-0480 (Phone No.)

Reporting is up to date
Yes ☑ No ☐ N/A ☐
Reports are verified by the lead agency
Yes ☑ No ☐ N/A ☐
Specific requirements in deed or decision documents have been met
Yes ☑ No ☐ N/A ☐
Violations have been reported
Yes ☐ No ☐ N/A ☑
Other problems or suggestions: Report attached ☐
See comments in Section XI.

2 **Adequacy** N/A ☐
ICs are adequate ☑
ICs are inadequate ☐
Remarks :

D. General

1 **Vandalism/trespassing**
Location shown on site map ☐
No vandalism evident ☑

2 **Land use changes on site** N/A ☑
Remarks : None observed

3 **Land use changes off site** N/A ☑
Remarks : None observed

VI. GENERAL SITE CONDITIONS

A. Roads Applicable ☐ N/A ☑

1 **Roads damaged** N/A ☑
Location shown on site map ☐
Roads adequate ☐
Remarks :

B. Other Site Conditions

1 Remarks : Site/monitoring wells in good condition. Ongoing renovation to School of Music observed.
No unauthorized intrusive activity.

VII. LANDFILL COVERS - NOT APPLICABLE

VIII. VERTICAL BARRIER WALLS Applicable ☐ N/A ☑

IX.GROUNDWATER/SURFACE WATER REMEDIES

A. Groundwater Extraction Wells/Pumps/Pipelines Applicable ☐ N/A ☑

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable ☐ N/A ☑

C. Treatment System Applicable ☑ N/A ☐

1 **Treatment Train** (Check Components that apply)
Metals removal ☐ Oil/water separation ☐ Bioremediation ☑
Air stripping ☐ Carbon adsorbers ☐
Remarks : Enhanced reductive dechlorination

2 **Electrical Enclosures and Panels** (properly rated and functional) N/A ☑

3 **Tanks, Vaults, Storage Vessels** N/A ☑

4 **Discharge Structure and Appurtenances** N/A ☑

5 **Treatment Building(s)** N/A ☑

6 **Monitoring Wells** (pump and treatment remedy) N/A ☐
Properly secured/locked ☑
Functioning ☑
Routinely sampled ☑
Good condition ☑
All required wells located ☑
Needs Maintenance ☑
Remarks : Ongoing general repairs (bolts, o-rings, etc.) to monitoring well covers.

D. Monitoring Data

1 Monitoring Data
Is routinely submitted on time ☑ Is of acceptable quality ☑

2 Monitoring data suggests:
Remedy is functioning as designed ☑

E. Monitored Natural Attenuation

1 Monitoring Wells(natural attenuation remedy) N/A ☑

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. **Implementation of the Remedy**

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Remedy consists of in-situ groundwater treatment (enhanced reductive dechlorination) with LUCs and groundwater monitoring. Remedy is in place and functioning as designed. Semi-annual groundwater LTM is ongoing in accordance with UFP SAP. Data indicate contaminant reduction is occurring however concentrations remain above cleanup goals.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Monitoring wells are labeled. Wells are inspected annually and minor repairs to monitoring well covers (bolts, o-rings, etc.) are ongoing. Required repairs do not affect short- or long-term protectiveness.

C. Early indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost of scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be comprised in the future.

None noted.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Regular optimization of monitoring program built into decision matrix included in UFP SAP.

I. SITE INFORMATION

Site Name: Site 11a - Building 3033 Former Vehicle Repair Facility and Waste Oil Tank	**Date of Inspection:** May 15, 2013
Location and Region: JEB Little Creek, NAVFAC Mid-Atlantic	**EPA ID:** VA5170022482
Agency, office, or company leading the five-year review: NAVFAC Mid-Atlantic with USEPA and VDEQ	**Weather/ temperature:** Sunny, 85°, windy

Remedy Includes: (Check all that apply):

- Landfill cover/containment ☐
- Access controls ☐
- Institutional controls ☑
- Groundwater pump and treatment ☐
- Surface water collection and treatment ☐
- Monitored natural attenuation ☐
- Groundwater containment ☐
- Vertical barrier walls ☐

Other : In-situ groundwater treatment (enhanced reductive dechlorination)

Attachments: Site map

1. Local regulatory authorities and response agencies (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.

	Name	Title	Date	Phone #
Agency	USEPA Region 3			
Contact	Jeffrey Boylan	RPM	5/15/2013	215-814-2094

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

	Name	Title	Date	Phone #
Agency	VDEQ			
Contact	Paul Herman, P.E.	RPM	5/15/2013	804-698-4464

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

II. INTERVIEWS - NOT APPLICABLE

III. ON-SITE DOCUMENTS & RECORD VERIFIED (Check all that apply)

1. **O&M Documents**

	Readily Available	Up to date	N/A
O&M manual	☐	☐	☑
As-built drawings	☐	☐	☑
Maintenance logs	☐	☐	☑

Remarks: No active operating remediation system; remedy is in place; construction completed November 2012. Work plans for O&M developed as needed.

2. **Site Specific Health and Safety Plan** Readily Available ☐ Up to date ☐ N/A ☑
   Contingency/emergency response plan Readily Available ☐ Up to date ☐ N/A ☑

   Remarks: Health and safety plans developed as needed for monitoring and re-injection.

3. **O&M and OSHA Training Records** Readily Available ☑ Up to date ☐ N/A ☐

   Remarks: Per contract with NAVFAC

4.	**Permits and Service Agreements**			
	Air discharge permit	Readily Available ☐	Up to date ☐	N/A ☑
	Effluent discharge	Readily Available ☐	Up to date ☐	N/A ☑
	Waste disposal, POTW	Readily Available ☑	Up to date ☐	N/A ☐
	Other permits_____	Readily Available ☐	Up to date ☐	N/A ☑
5.	**Gas Generation Records**	Readily Available ☐	Up to date ☐	N/A ☑
6.	**Settlement Monument Records**	Readily Available ☐	Up to date ☐	N/A ☑
7.	**Groundwater Monitoring Records**	Readily Available ☑	Up to date ☐	N/A ☐
	Remarks: Monitoring data provided to USEPA and VDEQ during partnering meetings and as part of monitoring reports.			
8.	**Leachate Extraction Records**	Readily Available ☐	Up to date ☐	N/A ☑
9.	**Discharge Compliance Records**			
	Air	Readily Available ☐	Up to date ☐	N/A ☑
	Water (effluent)	Readily Available ☐	Up to date ☐	N/A ☑
10.	**Daily Access/Security Logs**	Readily Available ☐	Up to date ☐	N/A ☑

IV.O&M COST

1 **O&M Organization**

State in-house ☐ Contractor for State ☐
PRP in-house ☐ Contractor for PRP ☐
Federal Facility in-house ☑ Contractor for Federal Facility ☐
Other : _____

2 **O&M Cost Records**
See Section 7.4 of main document.

3 **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: See Section 7.4 of main document.

V. ACCESS AND INSTITUTIONAL CONTROLS

A. Fencing

1. **Fencing damaged** N/A ☑

B. Other Access Restrictions ☐ ☐

1. **Signs and other security measures** N/A ☑

C. Institutional Controls (ICs) ☐

1. **Implementation and enforcement**

Conditions imply ICs not properly implemented
Yes ☐ No ☑ N/A ☐
Conditions imply ICs not being fully enforced
Yes ☐ No ☑ N/A ☐
Type of monitoring (e.g., self-reporting, drive by) : Visual inspections of site and monitoring well
conditions, results reported to USEPA and VDEQ
Frequency : Annual
Responsible party/agency : NAVFAC Mid-Atlantic
Contact : Bryan Peed (Name) RPM (Title) 757-341-0480 (Phone No.)

Reporting is up to date
Yes ☑ No ☐ N/A ☐
Reports are verified by the lead agency
Yes ☑ No ☐ N/A ☐
Specific requirements in deed or decision documents have been met
Yes ☑ No ☐ N/A ☐
Violations have been reported
Yes ☐ No ☐ N/A ☑
Other problems or suggestions: Report attached ☐
See comments in Section XI.

2 **Adequacy** N/A ☐
ICs are adequate ☑
ICs are inadequate ☐
Remarks :

D. General

1 **Vandalism/trespassing**
Location shown on site map ☐
No vandalism evident ☑

2 **Land use changes on site** N/A ☑
Remarks : None observed

3 **Land use changes off site** N/A ☑
Remarks : None observed

VI. GENERAL SITE CONDITIONS

A. Roads Applicable ☐ N/A ☑

1 **Roads damaged** N/A ☑
Location shown on site map ☐
Roads adequate ☐
Remarks :

B. Other Site Conditions

1 Remarks : Site monitoring wells in good condition. One remaining application well needs to be abandoned.
No unauthorized intrusive activity observed.

VII. LANDFILL COVERS - NOT APPLICABLE

VIII. VERTICAL BARRIER WALLS Applicable ☐ N/A ☑

IX.GROUNDWATER/SURFACE WATER REMEDIES

A. Groundwater Extraction Wells/Pumps/Pipelines Applicable ☐ N/A ☑

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable ☐ N/A ☑

C. Treatment System Applicable ☑ N/A ☐

1 **Treatment Train** (Check Components that apply)
Metals removal ☐ Oil/water separation ☐ Bioremediation ☑
Air stripping ☐ Carbon adsorbers ☐
Remarks : Enhanced reductive dechlorination

2 **Electrical Enclosures and Panels** (properly rated and functional) N/A ☑

3 **Tanks, Vaults, Storage Vessels** N/A ☑

4 **Discharge Structure and Appurtenances** N/A ☑

5 **Treatment Building(s)** N/A ☑

6 **Monitoring Wells** (pump and treatment remedy) N/A ☐
Properly secured/locked ☑
Functioning ☑
Routinely sampled ☑
Good condition ☑
All required wells located ☑
Needs Maintenance ☑
Remarks : Ongoing repairs (bolts, o-rings, etc) to monitoring well covers.

D. Monitoring Data

1 Monitoring Data
Is routinely submitted on time ☑ Is of acceptable quality ☑

2 Monitoring data suggests:
Remedy is functioning as designed ☑

E. Monitored Natural Attenuation

1 Monitoring Wells(natural attenuation remedy) N/A ☑

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. **Implementation of the Remedy**

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Remedy consists of in-situ groundwater treatment (enhanced reductive dechlorination) followed by monitored natural attenuation and LUCs. Remedy is in place and functioning as designed. LTM plan is currently being developed to monitor natural attenuation.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Monitoring wells are labeled. Wells are inspected annually and minor repairs to monitoring wells covers (bolts, o-rings, etc) are ongoing. Required repairs do not affect short- or long-term protectiveness.

C. Early indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost of scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be comprised in the future.

None noted.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Decision matrices for continued remedy optimization will be developed for inclusion in LTM plan.

I. SITE INFORMATION

Site Name: Site 12 - Former Exchange Laundry/Dry Cleaning Facility	**Date of Inspection:** May 15, 2013
Location and Region: JEB Little Creek, NAVFAC Mid-Atlantic	**EPA ID:** VA5170022482
Agency, office, or company leading the five-year review: NAVFAC Mid-Atlantic with USEPA and VDEQ	**Weather/ temperature:** Sunny, 85°, windy

Remedy Includes: (Check all that apply):

- Landfill cover/containment ☐
- Access controls ☐
- Institutional controls ☑
- Groundwater pump and treatment ☐
- Surface water collection and treatment ☐
- Monitored natural attenuation ☐
- Groundwater containment ☐
- Vertical barrier walls ☐

Other : In-situ groundwater treatment (enhanced reductive dechlorination)

Attachments: Site map

1. Local regulatory authorities and response agencies (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.

Agency	USEPA Region 3			
Contact	Jeffrey Boylan	RPM	5/15/2013	215-814-2094
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

Agency	VDEQ			
Contact	Paul Herman, P.E.	RPM	5/15/2013	804-698-4464
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

II. INTERVIEWS - NOT APPLICABLE

III. ON-SITE DOCUMENTS & RECORD VERIFIED (Check all that apply)

1. **O&M Documents**

	Readily Available	Up to date	N/A
O&M manual	☐	☐	☑
As-built drawings	☐	☐	☑
Maintenance logs	☐	☐	☑

Remarks: No active operating remediation system; remedy is in place; construction completed April 2007.
Work plans for O&M, including re-injection, developed as needed.

2. **Site Specific Health and Safety Plan** Readily Available ☐ Up to date ☐ N/A ☑
   Contingency/emergency response plan Readily Available ☐ Up to date ☐ N/A ☑

   Remarks: Health and safety plans developed as needed for monitoring and re-injection.

3. **O&M and OSHA Training Records** Readily Available ☑ Up to date ☐ N/A ☐

   Remarks: Per contract with NAVFAC

4.	**Permits and Service Agreements**			
	Air discharge permit	Readily Available ☐	Up to date ☐	N/A ☑
	Effluent discharge	Readily Available ☐	Up to date ☐	N/A ☑
	Waste disposal, POTW	Readily Available ☑	Up to date ☐	N/A ☐
	Other permits_____	Readily Available ☐	Up to date ☐	N/A ☑
5.	**Gas Generation Records**	Readily Available ☐	Up to date ☐	N/A ☑
6.	**Settlement Monument Records**	Readily Available ☐	Up to date ☐	N/A ☑
7.	**Groundwater Monitoring Records**	Readily Available ☑	Up to date ☐	N/A ☐
	Remarks: Monitoring data provided to USEPA and VDEQ during partnering meetings and as part of monitoring reports.			
8.	**Leachate Extraction Records**	Readily Available ☐	Up to date ☐	N/A ☑
9.	**Discharge Compliance Records**			
	Air	Readily Available ☐	Up to date ☐	N/A ☑
	Water (effluent)	Readily Available ☐	Up to date ☐	N/A ☑
10.	**Daily Access/Security Logs**	Readily Available ☐	Up to date ☐	N/A ☑

IV.O&M COST

1 **O&M Organization**

State in-house ☐ Contractor for State ☐
PRP in-house ☐ Contractor for PRP ☐
Federal Facility in-house ☑ Contractor for Federal Facility ☐
Other : _____

2 **O&M Cost Records**
See Section 8.4 of main document.

3 **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: See Section 8.4 of main document.

V. ACCESS AND INSTITUTIONAL CONTROLS

A. Fencing

1. **Fencing damaged** N/A ☑

B. Other Access Restrictions ☐ ☐

1. **Signs and other security measures** N/A ☑

C. Institutional Controls (ICs) ☐

1. **Implementation and enforcement**

Conditions imply ICs not properly implemented
Yes ☐ No ☑ N/A ☐
Conditions imply ICs not being fully enforced
Yes ☐ No ☑ N/A ☐
Type of monitoring (e.g., self-reporting, drive by) : Visual inspections of site and monitoring well
conditions, results reported to USEPA and VDEQ
Frequency : Annual
Responsible party/agency : NAVFAC Mid-Atlantic
Contact : Bryan Peed (Name) RPM (Title) 757-341-0480 (Phone No.)

Reporting is up to date
Yes ☑ No ☐ N/A ☐
Reports are verified by the lead agency
Yes ☑ No ☐ N/A ☐
Specific requirements in deed or decision documents have been met
Yes ☑ No ☐ N/A ☐
Violations have been reported
Yes ☐ No ☐ N/A ☑
Other problems or suggestions: Report attached ☐
See comments in Section XI.

2 **Adequacy** N/A ☐
ICs are adequate ☑
ICs are inadequate ☐
Remarks :

D. General

1 **Vandalism/trespassing**
Location shown on site map ☐
No vandalism evident ☑

2 **Land use changes on site** N/A ☑
Remarks : None observed

3 **Land use changes off site** N/A ☑
Remarks : None observed

VI. GENERAL SITE CONDITIONS

A. Roads Applicable ☐ N/A ☑

1 **Roads damaged** N/A ☑
Location shown on site map ☐
Roads adequate ☐
Remarks :

B. Other Site Conditions

1 Remarks : Site/monitoring wells in good condition. No unauthorized intrusive activity observed.

VII. LANDFILL COVERS - NOT APPLICABLE

VIII. VERTICAL BARRIER WALLS Applicable ☐ N/A ☑

IX.GROUNDWATER/SURFACE WATER REMEDIES

A. Groundwater Extraction Wells/Pumps/Pipelines Applicable ☐ N/A ☑

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable ☐ N/A ☑

C. Treatment System Applicable ☑ N/A ☐

1 **Treatment Train** (Check Components that apply)
Metals removal ☐ Oil/water separation ☐ Bioremediation ☑
Air stripping ☐ Carbon adsorbers ☐
Remarks : Enhanced reductive dechlorination

2 **Electrical Enclosures and Panels** (properly rated and functional) N/A ☑

3 **Tanks, Vaults, Storage Vessels** N/A ☑

4 **Discharge Structure and Appurtenances** N/A ☑

5 **Treatment Building(s)** N/A ☑

6 **Monitoring Wells** (pump and treatment remedy) N/A ☐
Properly secured/locked ☑
Functioning ☑
Routinely sampled ☑
Good condition ☑
All required wells located ☑
Needs Maintenance ☑
Remarks : Ongoing repairs (bolts, o-rings, etc.) to monitoring well covers.

D. Monitoring Data

1 Monitoring Data
Is routinely submitted on time ☑ Is of acceptable quality ☑

2 Monitoring data suggests:
Remedy is functioning as designed ☑

E. Monitored Natural Attenuation

1 Monitoring Wells(natural attenuation remedy) N/A ☑

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. **Implementation of the Remedy**

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Remedy consists of in-situ groundwater treatment (enhanced reductive dechlorination) with LUCs and groundwater monitoring. Remedy is in place and functioning as designed. Semi-annual groundwater LTM is ongoing in accordance with UFP SAP. Data indicate contaminant reduction is occurring however concentrations remain above cleanup goals.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Monitoring wells are labeled. Wells are inspected annually and minor repairs to monitoring well covers (bolts, o-rings, etc.) are ongoing. Required repairs do not affect short- or long-term protectiveness.

C. Early indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost of scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be comprised in the future.

None noted.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Regular optimization or monitoring program built into decision matrix included in UFP SAP.

I. SITE INFORMATION

Site Name: Site 13 - Former PCP Dip Tank and Wash Rack	**Date of Inspection:** May 15, 2013
Location and Region: JEB Little Creek, NAVFAC Mid-Atlantic	**EPA ID:** VA5170022482
Agency, office, or company leading the five-year review: NAVFAC Mid-Atlantic with USEPA and VDEQ	**Weather/ temperature:** Sunny, 85°, windy

Remedy Includes: (Check all that apply):

- Landfill cover/containment ☐
- Access controls ☐
- Institutional controls ☑
- Groundwater pump and treatment ☐
- Surface water collection and treatment ☐
- Monitored natural attenuation ☐
- Groundwater containment ☐
- Vertical barrier walls ☐

Other : In-situ groundwater treatment (enhanced reductive dechlorination)

Attachments: Site map

1. Local regulatory authorities and response agencies (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.

Agency	USEPA Region 3			
Contact	Jeffrey Boylan	RPM	5/15/2013	215-814-2094
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

Agency	VDEQ			
Contact	Paul Herman, P.E.	RPM	5/15/2013	804-698-4464
	Name	Title	Date	Phone #

Problems, suggestions; Report attached : Not applicable; see comments in Section XI

II. INTERVIEWS - NOT APPLICABLE

III. ON-SITE DOCUMENTS & RECORD VERIFIED (Check all that apply)

1. **O&M Documents**

	Readily Available	Up to date	N/A
O&M manual	☐	☐	☑
As-built drawings	☐	☐	☑
Maintenance logs	☐	☐	☑

Remarks: No active operating remediation system; remedy is in place; construction completed May 2010.
Work plans for O&M, including re-injection, are developed as needed.

2. **Site Specific Health and Safety Plan**

	Readily Available	Up to date	N/A
Contingency/emergency response plan	☐	☐	☑

Remarks: Health and safety plans developed as needed for monitoring and re-injection.

3. **O&M and OSHA Training Records** — Readily Available ☑ Up to date ☐ N/A ☐

Remarks: Per contract with NAVFAC

4.	**Permits and Service Agreements**			
	Air discharge permit	Readily Available ☐	Up to date ☐	N/A ☑
	Effluent discharge	Readily Available ☐	Up to date ☐	N/A ☑
	Waste disposal, POTW	Readily Available ☑	Up to date ☐	N/A ☐
	Other permits_____	Readily Available ☐	Up to date ☐	N/A ☑
5.	**Gas Generation Records**	Readily Available ☐	Up to date ☐	N/A ☑
6.	**Settlement Monument Records**	Readily Available ☐	Up to date ☐	N/A ☑
7.	**Groundwater Monitoring Records**	Readily Available ☑	Up to date ☐	N/A ☐
	Remarks: Monitoring data provided to USEPA and VDEQ during partnering meetings and as part of monitoring reports.			
8.	**Leachate Extraction Records**	Readily Available ☐	Up to date ☐	N/A ☑
9.	**Discharge Compliance Records**			
	Air	Readily Available ☐	Up to date ☐	N/A ☑
	Water (effluent)	Readily Available ☐	Up to date ☐	N/A ☑
10.	**Daily Access/Security Logs**	Readily Available ☐	Up to date ☐	N/A ☑

IV.O&M COST

1 **O&M Organization**

State in-house ☐ Contractor for State ☐
PRP in-house ☐ Contractor for PRP ☐
Federal Facility in-house ☑ Contractor for Federal Facility ☐
Other : _____

2 **O&M Cost Records**
See Section 9.4 of main document.

3 **Unanticipated or Unusually High O&M Costs During Review Period**
Describe costs and reasons: See Section 9.4 of main document.

V. ACCESS AND INSTITUTIONAL CONTROLS

A. Fencing

1. **Fencing damaged** N/A ☑

B. Other Access Restrictions ☐ ☐

1. **Signs and other security measures** N/A ☑

C. Institutional Controls (ICs) ☐

1. **Implementation and enforcement**

Conditions imply ICs not properly implemented
Yes ☐ No ☑ N/A ☐
Conditions imply ICs not being fully enforced
Yes ☐ No ☑ N/A ☐
Type of monitoring (e.g., self-reporting, drive by) : Visual inspections of site and monitoring well conditions, results reported to USEPA and VDEQ
Frequency : Annual
Responsible party/agency : NAVFAC Mid-Atlantic
Contact : Bryan Peed (Name) RPM (Title) 757-341-0480 (Phone No.)

Reporting is up to date
Yes ☑ No ☐ N/A ☐
Reports are verified by the lead agency
Yes ☑ No ☐ N/A ☐
Specific requirements in deed or decision documents have been met
Yes ☑ No ☐ N/A ☐
Violations have been reported
Yes ☐ No ☐ N/A ☑
Other problems or suggestions: Report attached ☐
See comments in Section XI.

2 **Adequacy** N/A ☐
ICs are adequate ☑
ICs are inadequate ☐
Remarks :

D. General

1 **Vandalism/trespassing**
Location shown on site map ☐
No vandalism evident ☑

2 **Land use changes on site** N/A ☑
Remarks : None observed

3 **Land use changes off site** N/A ☑
Remarks : None observed

VI. GENERAL SITE CONDITIONS

A. Roads Applicable ☐ N/A ☑

1 **Roads damaged** N/A ☑
Location shown on site map ☐
Roads adequate ☐
Remarks :

B. Other Site Conditions

1 Remarks : Site/monitoring wells in good condition. Injection well IW06 has sinkhole surrounding cover.
Old/used refrigerators being stored onsite. No unauthorized intrusive activity observed.

VII. LANDFILL COVERS - NOT APPLICABLE

VIII. VERTICAL BARRIER WALLS Applicable ☐ N/A ☑

IX.GROUNDWATER/SURFACE WATER REMEDIES

A. Groundwater Extraction Wells/Pumps/Pipelines Applicable ☐ N/A ☑

B. Surface Water Collection Structures, Pumps, and Pipelines Applicable ☐ N/A ☑

C. Treatment System Applicable ☑ N/A ☐

1 **Treatment Train** (Check Components that apply)
Metals removal ☐ Oil/water separation ☐ Bioremediation ☑
Air stripping ☐ Carbon adsorbers ☐
Remarks : Enhanced reductive dechlorination

2 **Electrical Enclosures and Panels** (properly rated and functional) N/A ☑

3 **Tanks, Vaults, Storage Vessels** N/A ☑

4 **Discharge Structure and Appurtenances** N/A ☑

5 **Treatment Building(s)** N/A ☑

6 **Monitoring Wells** (pump and treatment remedy) N/A ☐
Properly secured/locked ☑
Functioning ☑
Routinely sampled ☑
Good condition ☑
All required wells located ☑
Needs Maintenance ☑
Remarks : Ongoing repairs (bolts, o-rings, etc.) to monitoring well covers.

D. Monitoring Data

1 Monitoring Data
Is routinely submitted on time ☑ Is of acceptable quality ☑

2 Monitoring data suggests:
Remedy is functioning as designed ☑

E. Monitored Natural Attenuation

1 Monitoring Wells(natural attenuation remedy) N/A ☑

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. **Implementation of the Remedy**

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

Remedy consists of in-situ groundwater treatment (enhanced reductive dechlorination) with LUCs and groundwater monitoring. Remedy is in place and functioning as designed. Semi-annual groundwater LTM is ongoing in accordance with UFP SAP. Data indicate contaminant reduction is occurring however concentrations remain above cleanup goals.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Monitoring wells are labeled. Wells are inspected annually and minor repairs to monitoring/injection well covers (bolts, o-rings, etc.) are ongoing. Sinkhole adjacent to injection well IW06 observed. No groundwater observed in sinkhole; no direct contact feasible at time of inspection. Required repairs do not affect short-term protectiveness; however sinkhole requires repair to prevent potential for direct contact with groundwater in the future.

C. Early indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost of scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be comprised in the future.

Sinkhole surrounding injection well IW06 requires repair to protect against future exposure to groundwater.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Regular optimization of monitoring program built into decision matrix included in UFP SAP.

DVR: \\MNUSTRICTGES01\PROJECTS\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_ER_INSPECTIONS_2013\FIGURE A-1 - SITE 7.MXD, CROWMAN 5/10/2013 2:06:23 PM

Legend

- Sign Location
- Monitoring Well
- Fence Line
- LUC Boundary

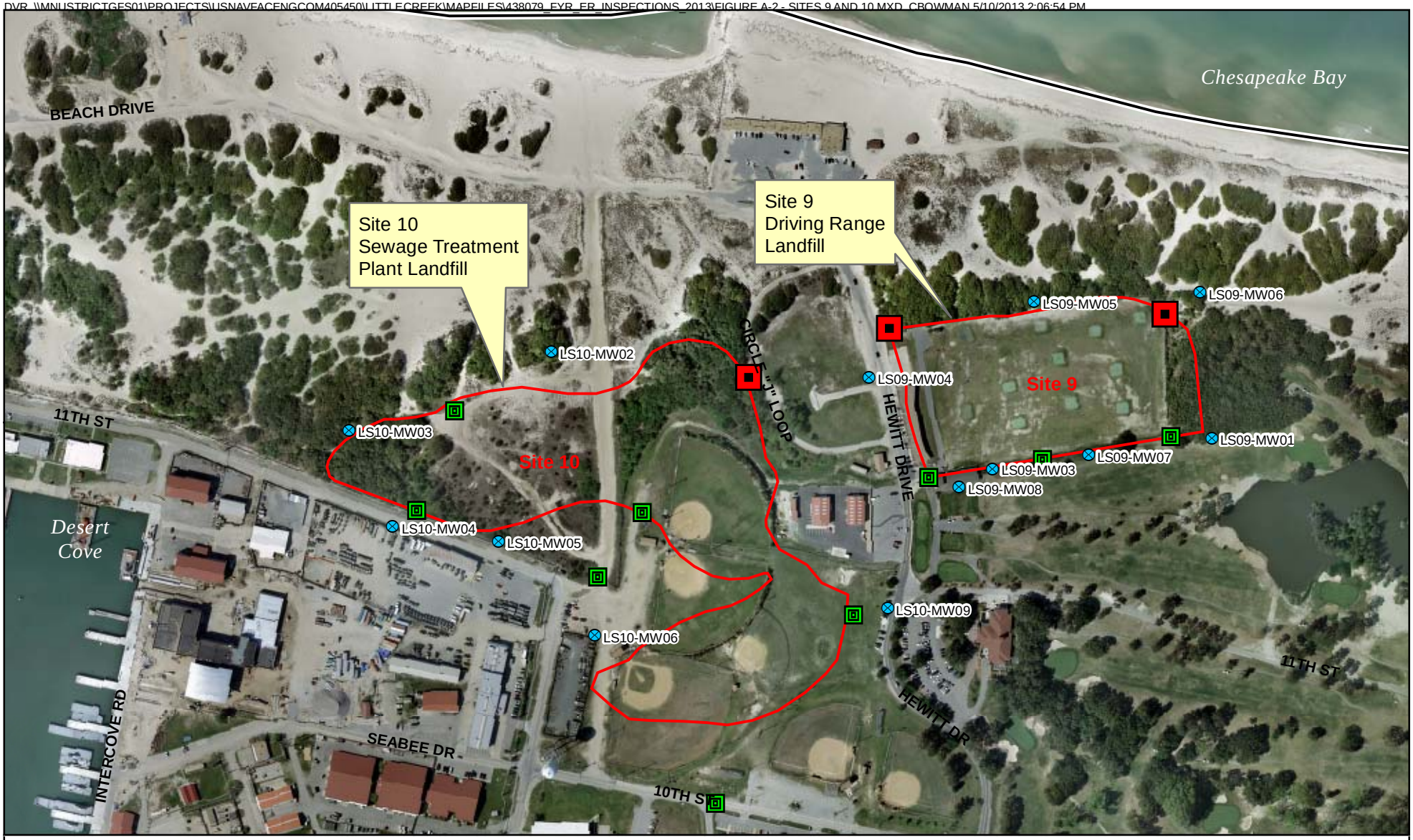
N
W E
S

0 150 300
Feet

Figure C-1
Site 7
Appendix C: ER Inspection
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

DWG: \\MNUSTRICTGES01\PROJECTS\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_ER_INSPECTIONS_2013\FIGURE A-2 - SITES 9 AND 10.MXD, CROWMAN 5/10/2013 2:06:54 PM



Legend

- 6' x 3' Sign Placement
- 2' x 2' Sign Placement
- Monitoring Wells Sampled and Slug Tested
- Installation Boundary
- LUC Boundary

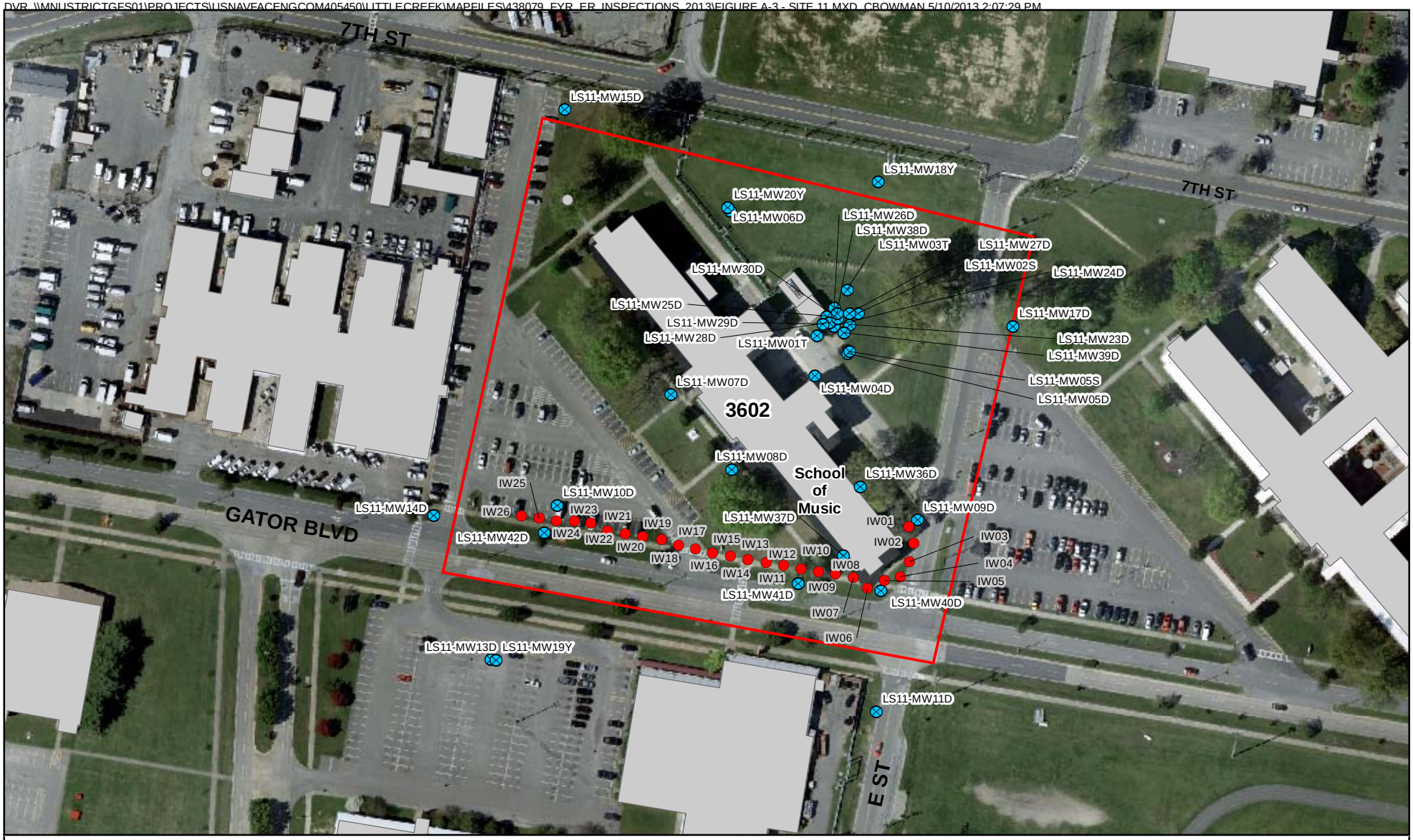
N
W E
S

0 200 400
Feet

Figure C-2
Site 9 Driving Range Landfill, and Site 10
Sewage Treatment Landfill
Appendix C: ER Inspections
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

DVR \\MNUSTRICTGES01\PROJECTS\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_FYR_ER_INSPECTIONS_2013\FIGURE A-3 - SITE 11.MXD CROWMAN 5/10/2013 2:07:29 PM



Legend

- Injection Well
- Monitoring Well
- LUC Boundary

Note:
Additional well was found during September 2008 site inspection, no well ID found.

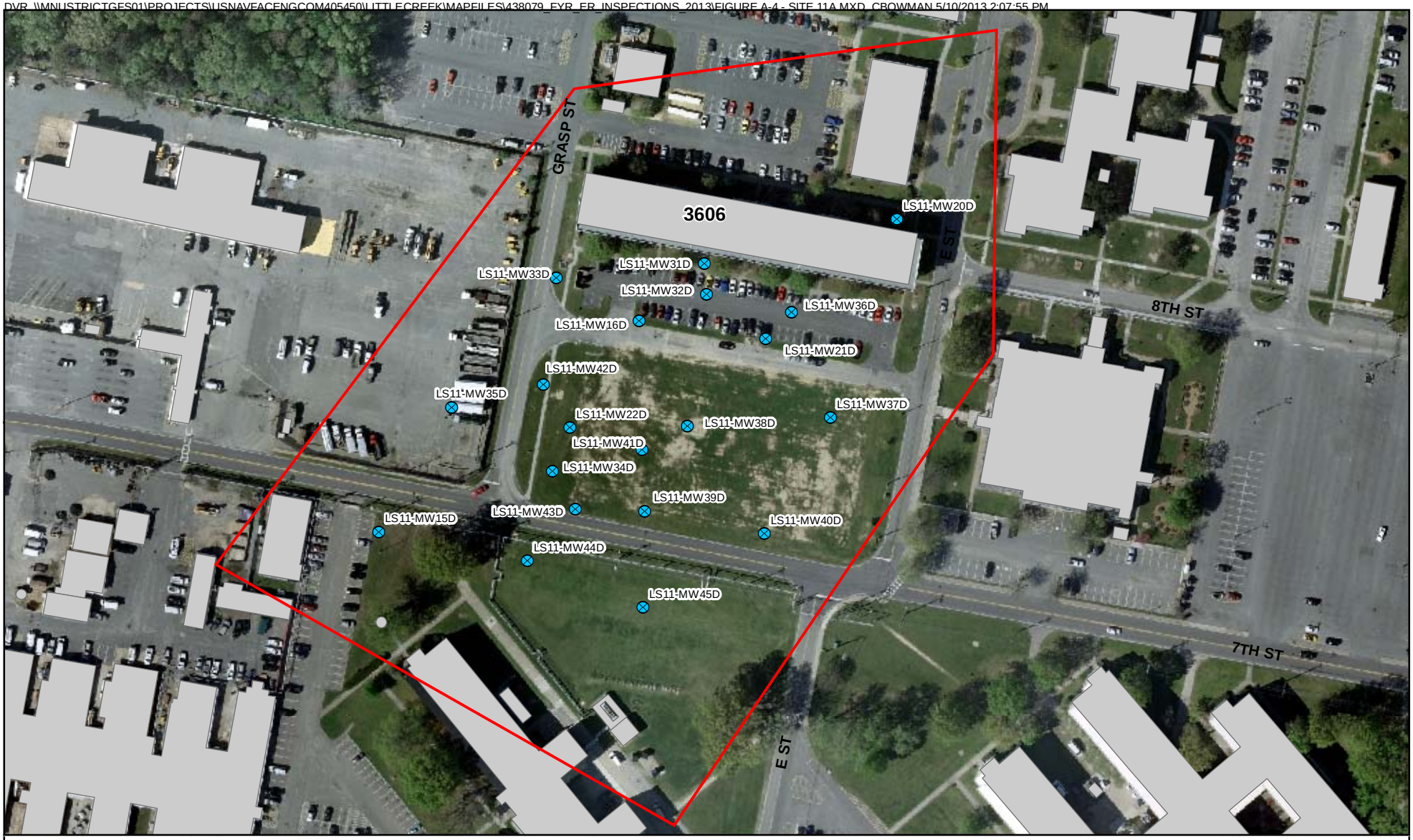
N
W E
S

0 75 150
Feet

Figure C-3
Site 11 School of Music Plating Shop
Appendix C: ER Inspection
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

DVR \\MNUSTRICTGES01\PROJECTS\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_EXR_ER_INSPECTIONS_2013\FIGURE A-4 - SITE 11A.MXD CBOWMAN 5/10/2013 2:07:55 PM



Legend

- Monitoring Well Location
- LUC Boundary

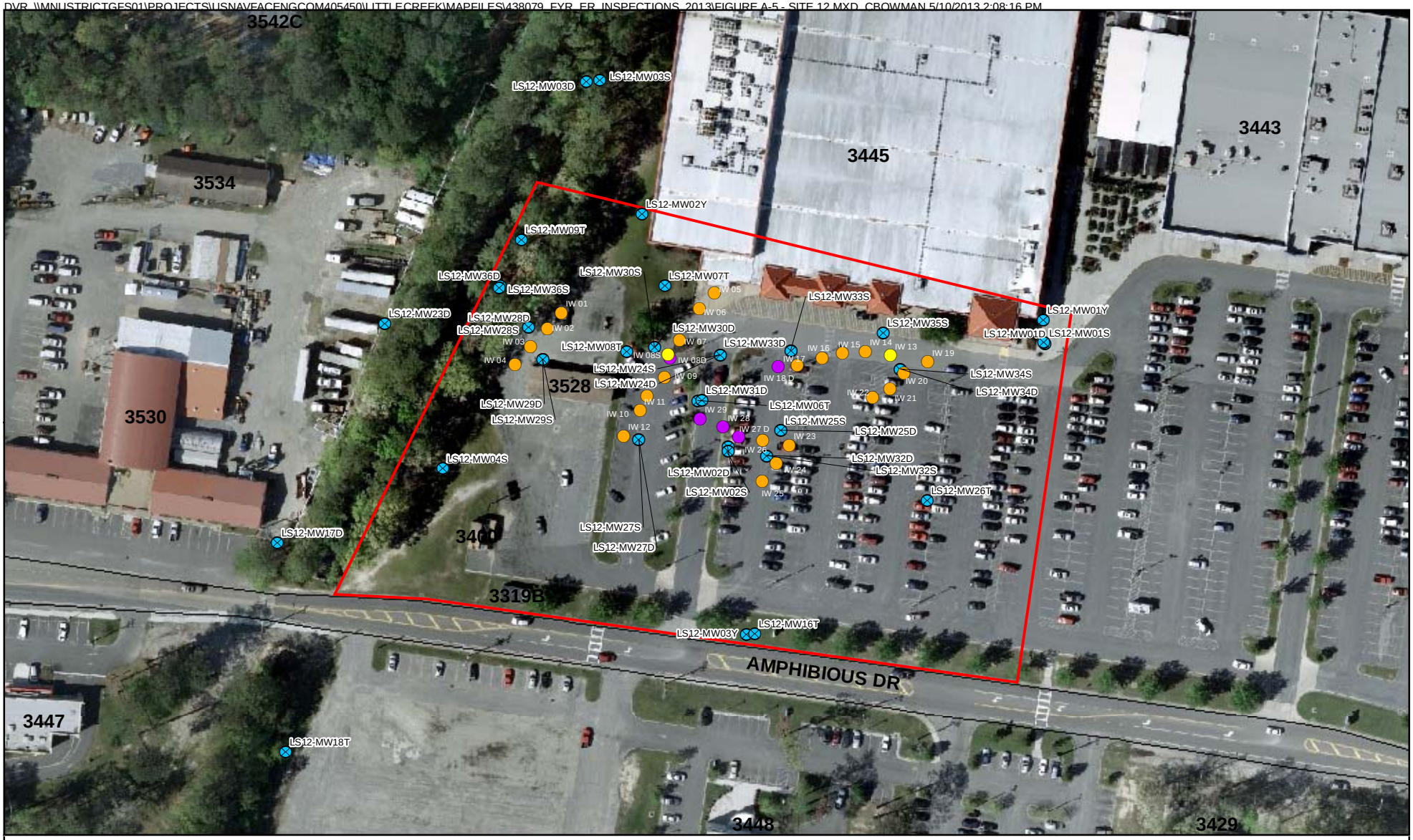
N
W E
S

0 75 150
Feet

Figure C-4
Site 11a
Appendix C: ER Inspection
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

DVR: \\MNUSTRICTGES01\PROJECTS\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_EXR_ER_INSPECTIONS_2013\FIGURE A-5 - SITE 12.MXD, CBOWMAN 5/10/2013 2:08:16 PM



Legend

- Monitoring Well
- LUC Boundary

Injection Well

- Co-located
- Deep
- Shallow

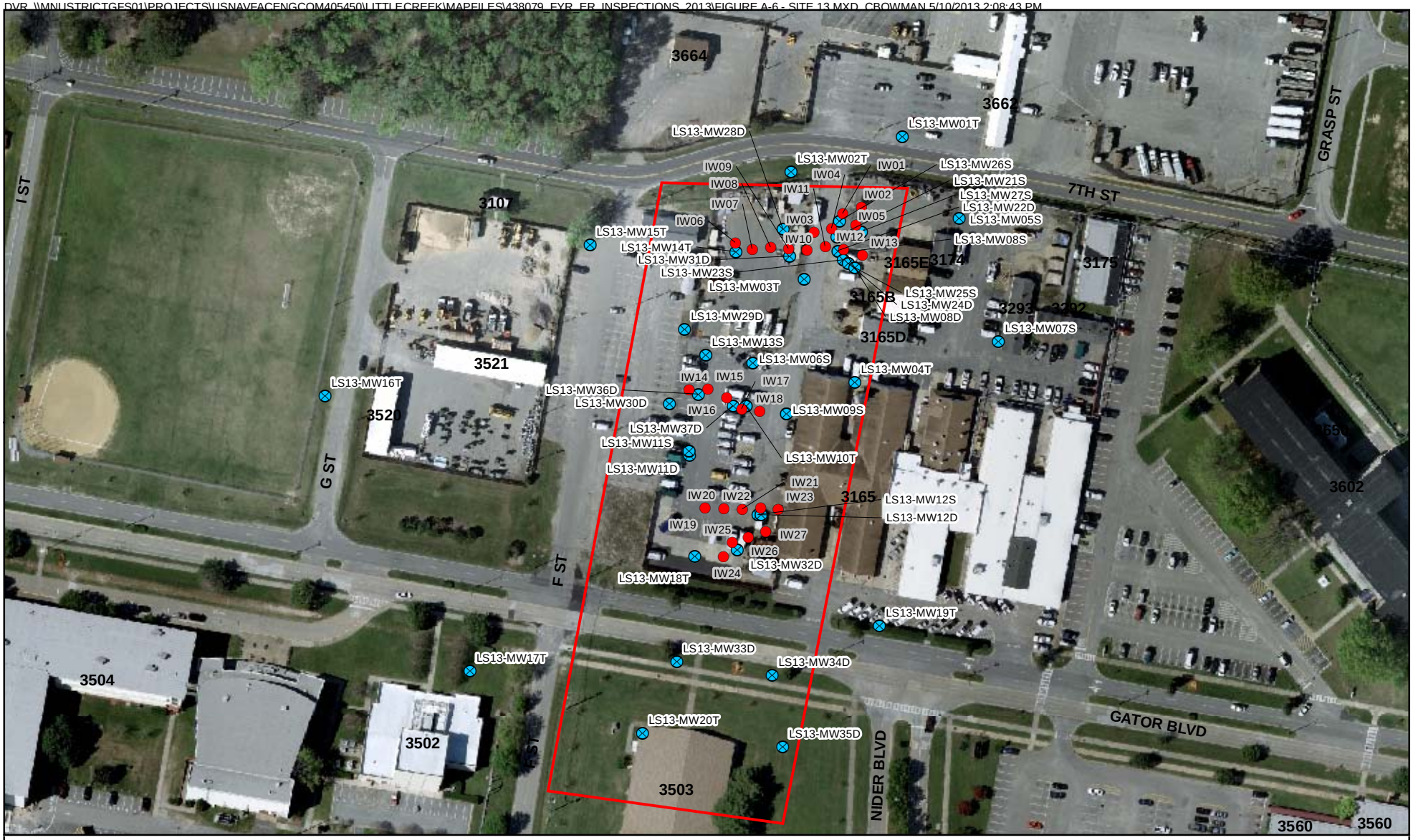
N
W E
S

0 62.5 125
Feet

Figure C-5
Site 12 Exchange Laundry Waste Disposal Area
Appendix C: ER Isnpection
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

DVR \\MNUSTRICTGES01\PROJECTS\USNAVFACENGCOM405450\LITTLECREEK\MAPFILES\438079_EXR_ER_INSPECTIONS_2013\FIGURE A-6 - SITE 13.MXD CBOWMAN 5/10/2013 2:08:43 PM



Legend

- Injection Well
- Monitoring Well
- LUC Boundary

N
W E
S

0 75 150
Feet

Figure C-6
Site 13 Public Works PCP Dip Tank and Wash Rack
Appendix C: ER Inspection
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

Appendix D
Interview Summaries

INTERVIEW RECORD			
Site Name: JEB Little Creek		**EPA ID No:** VA5170022482	
Subject: Second Comprehensive Five Year Review		**Time:** 1300	**Date:** June 27, 2013
Type: Visit		**Location:** PAO Office	
Contact Made By:			
Name: Bryan Peed	**Title:** Remedial Project Manager	**Organization:** NAVFAC	
Individuals Contacted:			
Name: Scott Mohr	**Title:** Public Affairs Officer	**Organization:** NAVFAC	
Telephone No: 757-462-8425 **Email Address:** scott.mohr@navy.mil		**Street Address:** 2600 Tarawa Ct., Ste. 100 **City, State, Zip:** Virginia Beach, VA 23459	

Summary Of Conversation

General

Q1 - What is your overall impression of the program?

Feedback from public partners is positive. Well informed regarding the program and progress.

Q2 - What impacts, if any, has the remedy had on the surrounding community? Are you aware of any community concerns?

None aware of. No negative feedback has been received.

Q3. Do you feel the fact sheet distributed to the public for Site 12 was helpful? Should this be considered for future remedy implementation activities?

Yes, all transparent information provided is helpful.

Q4. Does the program and/or site remedies affect day to day base operations? If so, how?

Overall impacts are handled well. Program/site operations are transparent. Early communication is helpful.

Q5. Are LUCs and their objectives clear to appropriate base personnel? If not, what recommendations would you make to increase awareness?

No negative impact to base personnel. Everyone may not be aware but does not seem to have negative impact.

Q6. Do you have any comments or recommendations regarding the program and/or site remedies?

Possibly get more public partners involved. Have had longstanding involvement with current public partners,

Site-Specific

Q1. Sites 11, 11a, 12, and 13: Do you feel that fact sheets distributed to the public prior to site activities are helpful?

See response to Q3.

INTERVIEW RECORD			
Site Name: JEB Little Creek		**EPA ID No:** VA5170022482	
Subject: Second Comprehensive Five Year Review		**Time:** 1330	**Date:** June 27, 2013
Type: Visit		**Location:** Base Environmental Office	
Contact Made By:			
Name: Bryan Peed	**Title:** Remedial Project Manager	**Organization:** NAVFAC	
Individuals Contacted:			
Name: Roger White	**Title:** Environmental Protection Specialist	**Organization:** NAVFAC	
Telephone No: 757-462-5364 **Email Address:** roger.l.white@navy.mil		**Street Address:** 1450 Gator Blvd., Bldg 3165, Ste. 100 **City, State, Zip:** Virginia Beach, VA 23459	

Summary Of Conversation

General

Q1 - What is your overall impression of the program?

Effective in accomplishing goals. Well informed. Some regulatory requirements set forth by CERCLA make activities difficult.

Q2 - What impacts, if any, has the remedy had on the surrounding community? Are you aware of any community concerns?

Not aware of any.

Q3. Do you feel the fact sheet distributed to the public for Site 12 was helpful? Should this be considered for future remedy implementation activities?

Not applicable.

Q4. Does the program and/or site remedies affect day to day base operations? If so, how?

Not aware of any.

Q5. Are LUCs and their objectives clear to appropriate base personnel? If not, what recommendations would you make to increase awareness?

Periodic inspections, outside of required LUC inspections, are conducted by base environmental to ensure unauthorized activities are not taking place.

Q6. Do you have any comments or recommendations regarding the program and/or site remedies?

IDW management - although within 90 day allowable timeframe, drums are present on site too long.

Site-Specific

Q1. Sites 11, 11a, 12, and 13: Do you feel that fact sheets distributed to the public prior to site activities are helpful?

Not aware of any specific feedback.

INTERVIEW RECORD		
Site Name: JEB Little Creek	**EPA ID No:** VA5170022482	
Subject: Second Comprehensive Five Year Review	**Time:** 0990	**Date:** Sept 17, 2013
Type: Visit	**Location:** MWR Building 750	

Contact Made By:		
Name: Bryan Peed	**Title:** Remedial Project Manager	**Organization:** NAVFAC

Individuals Contacted:		
Name: Dan Barnthouse	**Title:** MWR Director	**Organization:** NAVFAC

Telephone No: 757-462-8203 **Email Address:** harry.barnthouse@navy.mil	**Street Address:** 2112 Amphibious Drive, Bldg 750 **City, State, Zip:** Virginia Beach, VA 23459

Summary Of Conversation

General

Q1 - What is your overall impression of the program?

Thorough and professional. Always flexible with schedule to work around MWR schedules.
Transparent, timely communication.

Q2 - What impacts, if any, has the remedy had on the surrounding community? Are you aware of any community concerns?

Not aware of any.

Q3. Do you feel the fact sheet distributed to the public for Site 12 was helpful? Should this be considered for future remedy implementation activities?

Not applicable.

Q4. Does the program and/or site remedies affect day to day base operations? If so, how?

No.

Q5. Are LUCs and their objectives clear to appropriate base personnel? If not, what recommendations would you make to increase awareness?

Not applicable.

Q6. Do you have any comments or recommendations regarding the program and/or site remedies?

Good open communication allows staff to answer questions or guide people to answers. Easy to work with.

Site-Specific

Q1. Sites 11, 11a, 12, and 13: Do you feel that fact sheets distributed to the public prior to site activities are helpful?

Yes, facility manager indicated questions (vapor intrusion sampling) were asked and having the information available was helpful in answering or directing towards an answer.

INTERVIEW RECORD			
Site Name: JEB Little Creek		**EPA ID No:** VA5170022482	
Subject: Second Comprehensive Five Year Review		**Time:** 1500	**Date:** Sept 19, 2013
Type: Visit		**Location:** PWD Office	
Contact Made By:			
Name: Bryan Peed	**Title:** Remedial Project Manager	**Organization:** NAVFAC	
Individuals Contacted:			
Name: Nancy Rexroad	**Title:** Lead Planner	**Organization:** NAVFAC	
Telephone No: 757-462-5375 **Email Address:** nancy.rexroad@navy.mil		**Street Address:** 1450 Gator Blvd., Bldg 3165 **City, State, Zip:** Virginia Beach, VA 23459	

Summary Of Conversation

General

Q1 - What is your overall impression of the program?

Well managed; good working relationship with RPM.

Q2 - What impacts, if any, has the remedy had on the surrounding community? Are you aware of any community concerns?

Not aware of any.

Q3. Do you feel the fact sheet distributed to the public for Site 12 was helpful? Should this be considered for future remedy implementation activities?

Not applicable.

Q4. Does the program and/or site remedies affect day to day base operations? If so, how?

No.

Q5. Are LUCs and their objectives clear to appropriate base personnel? If not, what recommendations would you make to increase awareness?

Yes, clear to appropriate base personnel.

Q6. Do you have any comments or recommendations regarding the program and/or site remedies?

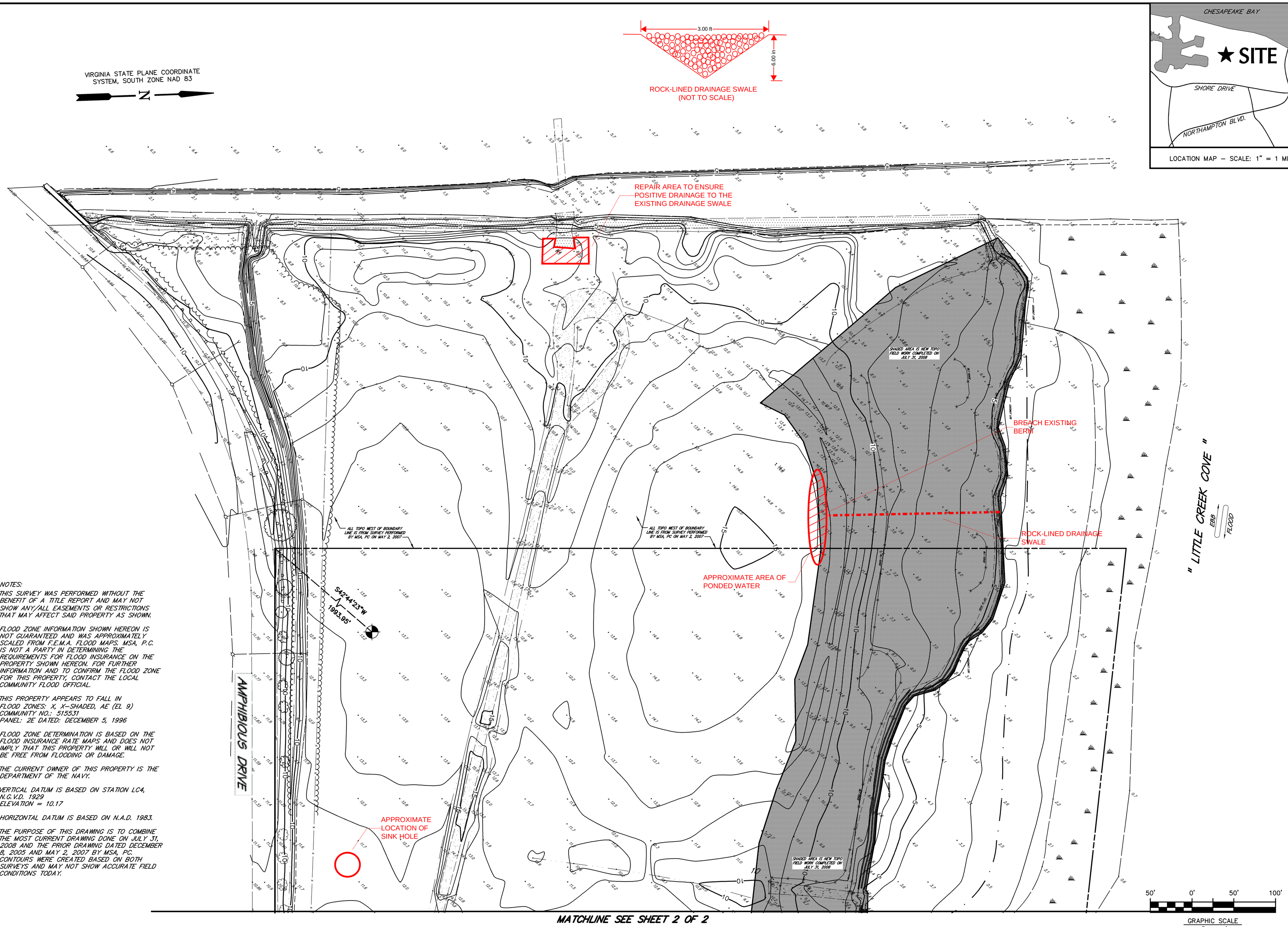
No comments, keep up good work. Appreciate support and willingness to evaluate alternatives to meet facility needs.

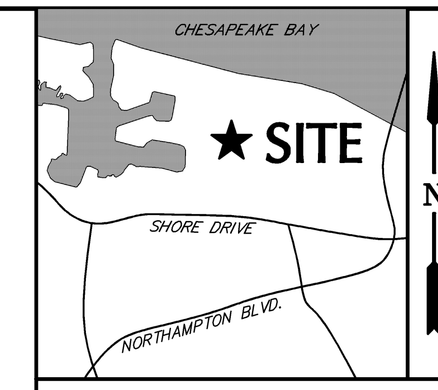
Site-Specific

Q1. Sites 11, 11a, 12, and 13: Do you feel that fact sheets distributed to the public prior to site activities are helpful?

Not applicable.

Appendix E
Site 7 – 2012 O&M Action Summary Figure





LOCATION MAP – SCALE: 1" = 1 MILE

NOTES:

1. THIS SURVEY WAS PERFORMED WITHOUT THE BENEFIT OF A TITLE REPORT AND MAY NOT SHOW ANY/ALL EASEMENTS OR RESTRICTIONS THAT MAY AFFECT SAID PROPERTY AS SHOWN.
2. FLOOD ZONE INFORMATION SHOWN HEREON IS NOT GUARANTEED AND WAS APPROXIMATELY SCALED FROM F.E.M.A. FLOOD MAPS. MSA, P.C. IS NOT A PARTY IN DETERMINING THE REQUIREMENTS FOR FLOOD INSURANCE ON THE PROPERTY SHOWN HEREON. FOR FURTHER INFORMATION AND TO CONFIRM THE FLOOD ZONE FOR THIS PROPERTY, CONTACT THE LOCAL COMMUNITY FLOOD OFFICIAL.

   THIS PROPERTY APPEARS TO FALL IN FLOOD ZONES: X, X-SHADED, AE (EL 9)
   COMMUNITY NO.: 515531
   PANEL: 2E DATED: DECEMBER 5, 1996

   FLOOD ZONE DETERMINATION IS BASED ON THE FLOOD INSURANCE RATE MAPS AND DOES NOT IMPLY THAT THIS PROPERTY WILL OR WILL NOT BE FREE FROM FLOODING OR DAMAGE.
3. THE CURRENT OWNER OF THIS PROPERTY IS THE DEPARTMENT OF THE NAVY.
4. VERTICAL DATUM IS BASED ON STATION LC4, N.G.V.D. 1929
   ELEVATION = 10.17
5. HORIZONTAL DATUM IS BASED ON N.A.D. 1983.
6. THE PURPOSE OF THIS DRAWING IS TO COMBINE THE MOST CURRENT DRAWING DONE ON JULY 31, 2008 AND THE PRIOR DRAWING DATED DECEMBER 8, 2005 AND MAY 2, 2007 BY MSA, P.C. CONTOURS WERE CREATED BASED ON BOTH SURVEYS AND MAY NOT SHOW ACCURATE FIELD CONDITIONS TODAY.

FB CS 362, PG 35–36

MSA, P.C.
Landscape Architecture • Planning
Surveying • Engineering
Environmental Sciences
5033 ROUSE DRIVE, VIRGINIA BEACH, VA 23462–3708
PHONE (757) 490–9264 • FAX (757) 490–0634

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DESIGNED ____
DRAWN JBN
CHECKED ____
APPROVED ____
DATE 9–10–08

TOPOGRAPHIC SURVEY OF
SITE 7, LANDFILL
LITTLE CREEK NAB

VIRGINIA
NORFOLK

SHEET 1
1 of 2 Sheets

SCALE: 1"=50'

PROJ. NO.: 08121

Appendix F
Groundwater Monitoring Data since First Five-Year Review

TABLE F-1a

Site 11 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS11-MW04D			LS11-MW05D			LS11-MW06D			LS11-MW07D				
Sample ID		LS11-MW04D-0312	LS11-MW04D-0912	LS11-MW04D-0313	LS11-MW05D-0312	LS11-MW05D-0912	LS11-MW05D-0313	LS11-MW06D-0312	LS11-MW06D-0912	LS11-MW06D-0313	LS11-MW07D-0312	LS11-MW07D-0612	LS11-MW07D-0912	LS11-MW07DP-0912	LS11-MW07D-0313
Sample Date		03/09/12	09/19/12	03/14/13	03/09/12	09/19/12	03/14/13	03/09/12	09/19/12	03/14/13	03/13/12	06/04/12	09/20/12	09/20/12	03/15/13
Chemical Name															
Volatile Organic Compounds (UG/L)															
1,1,1-Trichloroethane	200	0.5 U	2.5 U	0.5 U	2.5 U	5 U	2.5 U	**23**	**22.4**	**14.4**	0.5 U	NA	2.5 U	2.5 U	2.5 U
1,1-Dichloroethane	2900**	**23.3**	**15.2**	**9.83**	**20.4**	**15.3**	**7.75**	**59.3**	**59.4**	**43.4**	**29.3**	NA	**27.4**	**28**	**16.8**
1,1-Dichloroethene	7	**0.53 J**	2.5 U	0.5 U	2.5 U	5 U	2.5 U	**9.8**	**9.35**	**8.09**	**7.94**	NA	**9.85**	**9.45**	**7.05**
1,2-Dichloroethane	5	0.5 U	2.5 U	0.5 U	2.5 U	5 U	2.5 U	0.5 U	2.5 U	0.5 U	0.5 U	NA	2.5 U	2.5 U	2.5 U
1,2-Dichloropropane	5	0.5 U	2.5 U	0.5 U	2.5 U	5 U	2.5 U	0.5 U	2.5 U	0.5 U	0.5 U	NA	2.5 U	2.5 U	2.5 U
Chloroform	9.6**	0.5 U	2.5 U	0.5 U	2.5 U	5 U	2.5 U	**0.37 J**	2.5 U	0.5 U	0.5 U	NA	2.5 U	2.5 U	2.5 U
cis-1,2-Dichloroethene	70	**1.89**	**2.55 J**	**0.71 J**	2.5 U	5 U	2.5 U	**229**	**196**	**157**	**32.1**	NA	**31.4**	**33.2**	**23.2**
Methylene chloride	5	1 U	5 U	1 U	5 U	10 U	5 U	1 U	5 U	1 U	1 U	NA	5 U	5 U	5 U
trans-1,2-Dichloroethene	100	0.5 U	2.5 U	0.5 U	2.5 U	5 U	2.5 U	**1.13**	**1.7 J**	**0.96 J**	0.5 U	NA	2.5 U	2.5 U	2.5 U
Trichloroethene	5	**2.72**	**2.35 J**	**0.59 J**	2.5 U	5 U	2.5 U	**21.4**	**19.4**	**30.2**	**33.6**	NA	**35.2**	**37.8**	**27.7**
Vinyl chloride	2	**6.19**	**5.25**	**4.04**	**8.75**	5 U	**6.5**	**201**	**213**	**195**	**4.44**	NA	**5.45**	**5.25**	**3.6 J**
Semivolatile Organic Compounds (UG/L)															
No Detections		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals (UG/L)															
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)															
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry															
Acetate (mg/l)	--	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	NA	0.5 U	0.5 U	NA	0.25 U
Butyrate (mg/l)	--	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	NA	0.5 U	0.5 U	NA	0.25 U
Ethane (ug/l)	--	2 U	2 U	NA	2 U	2 U	2 U	2 U	2 U	**1.39 J**	NA	2 U	2 U	NA	2 U
Ethene (ug/l)	--	**8.23**	**1.91 J**	**4.24**	**17.2**	**15.1**	**9.36**	**62.9**	**58.7**	**47.1**	NA	2 U	2 U	NA	2 U
Formic acid (mg/l)	--	NA	NA	0.25 U	NA	NA	0.25 U	NA	NA	0.25 U	NA	NA	NA	NA	0.25 U
Lactate (mg/l)	--	10 U	10 U	0.25 U	10 U	10 U	0.25 U	10 U	10 U	0.25 U	NA	10 U	10 U	NA	0.25 U
Methane (ug/l)	--	**21.4**	**42**	**17.3**	**412**	**310**	**215**	**1,820 D**	**1,870 D**	**1060 D**	NA	**75.9**	**60.7**	NA	**51.7**
Nitrate (mg/l)	--	**0.048 H1J**	NA	0.1 U	0.5 H1U	NA	0.1 U	**0.043 H1J**	NA	0.1 U	NA	0.1 U	NA	NA	**0.05 J**
Nitrite (mg/l)	--	0.05 H1MUN	NA	0.1 U	0.5 H1MUN	NA	0.1 U	0.05 H1MUN	NA	0.1 U	NA	0.1 MU	NA	NA	0.1 U
Propionate (mg/l)	--	0.5 U	0.5 U	0.25 U	0.5 U	**1**	0.25 U	0.5 U	**0.18 J**	0.25 U	NA	0.5 U	**0.17 J**	NA	0.25 U
Pyruvate (mg/l)	--	2 U	2 U	0.25 U	2 U	2 U	0.25 U	2 U	2 U	0.25 U	NA	2 U	2 U	NA	0.25 U
Sulfate (mg/l)	--	**11.2**	NA	**9.89**	**24.8 D**	NA	**35.5**	**13**	NA	**13.9**	NA	**13.1 M**	NA	NA	**13.7**
Sulfide (mg/l)	--	1.85 U	NA	1.85 U	1.85 U	NA	1.69 U	1.85 U	NA	1.69 U	NA	1.72 UN	NA	NA	1.85 U
Total organic carbon (TOC) (mg/l)	--	**8.9**	**8.59**	**6.48**	**50.6**	**26.6**	**21.4**	**8.76**	**10.6**	**8.57**	NA	**15.2**	**16.7**	NA	**17.1**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

**No MCL exists. Risk-based cleanup level was caluclated.

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

D - Compound identified in an analysis at a secondary dilution factor

H1 - Holding time exceedance

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

M - Duplicate injection precision criteria not met

N - The MS/MSD accuracy and/or precision are outside criteria

Q - One or more quality control criteria failed

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

X - The parameter shows a potential positive bias on a reported concentration due to an ICV or CCV exceeding the upper control limit on the high side.

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-1a

Site 11 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS11-MW08D			LS11-MW09D			LS11-MW10D			LS11-MW11D		LS11-MW12D	
Sample ID		LS11-MW08D-0312	LS11-MW08D-0912	LS11-MW08D-0313	LS11-MW09D-0312	LS11-MW09D-0912	LS11-MW09D-0313	LS11-MW10D-0312	LS11-MW10D-0912	LS11-MW10D-0313	LS11-MW11D-0312	LS11-MW11D-0313	LS11-MW12D-0312	LS11-MW12D-0313
Sample Date		03/13/12	09/20/12	03/15/13	03/12/12	09/19/12	03/14/13	03/13/12	09/19/12	03/14/13	03/13/12	03/15/13	03/12/12	03/15/13
Chemical Name														
Volatile Organic Compounds (UG/L)														
1,1,1-Trichloroethane	200	0.5 U	2.5 U	2.5 U	0.5 U	1 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	2900**	**21.5**	**11.8**	**6.95**	**2.62**	**2.12**	**0.94 J**	**2.72**	**2.35 J**	**1.8**	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethene	7	**19.4**	**11**	**6.65**	**3.48**	1 U	**1.49**	**52.7**	**42.3**	**38.4**	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	5	0.5 U	2.5 U	2.5 U	0.5 U	1 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	5	0.5 U	2.5 U	2.5 U	0.5 U	1 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	9.6**	0.5 U	2.5 U	2.5 U	0.5 U	1 U	0.5 U	**1.02**	2.5 U	**0.62 J**	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,2-Dichloroethene	70	**36**	**23.9**	**16.2**	**12.9**	**9.46**	**4.71**	**9.99**	**8.9**	**8.82**	0.5 U	0.5 U	0.5 U	0.5 U
Methylene chloride	5	1 U	5 U	5 U	1 U	2 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	100	0.5 U	2.5 U	2.5 U	0.5 U	1 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	**89.2**	**39.6**	**25.5**	**16.4**	**13.5**	**7.81**	**210**	**190**	**190**	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl chloride	2	**3.74**	**3.85 J**	2.5 U	**0.252 J**	1 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Semivolatile Organic Compounds (UG/L)														
No Detections		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals (UG/L)														
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	6 XU	1.5 UN	1.5 U	1.5 U
Dissolved Metals (UG/L)														
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	6 U	1.5 UN	6 U	1.5 U
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry														
Acetate (mg/l)	--	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.25 U	0.5 U	0.25 U
Butyrate (mg/l)	--	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.25 U	0.5 U	0.25 U
Ethane (ug/l)	--	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Ethene (ug/l)	--	**3.62 J**	**3.1 J**	**3.14 J**	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Formic acid (mg/l)	--	NA	NA	0.25 U	NA	NA	0.25 U	NA	NA	0.25 U	NA	0.25 U	NA	0.25 U
Lactate (mg/l)	--	10 U	10 U	0.25 U	10 U	10 U	0.25 U	10 U	10 U	0.25 U	10 U	0.25 U	10 U	0.25 U
Methane (ug/l)	--	**58**	**16.9**	**22.1**	**25.1**	**13.1**	**5.83**	**712**	**409**	**668**	2 U	2 U	**37.8**	**10**
Nitrate (mg/l)	--	**0.413**	NA	**0.075 J**	**0.047 J**	NA	**0.072 J**	**0.21**	NA	**0.159 J**	**0.589**	**0.857**	**0.206**	0.1 U
Nitrite (mg/l)	--	0.1 U	NA	0.1 U	0.1 MU	NA	0.1 U	0.1 U	NA	0.1 U	0.1 U	0.1 U	0.1 MU	0.1 U
Propionate (mg/l)	--	0.5 U	**0.3 J**	0.25 U	0.5 U	**0.19 J**	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.25 U	0.5 U	0.25 U
Pyruvate (mg/l)	--	2 U	2 U	0.25 U	2 U	2 U	0.25 U	2 U	2 U	0.25 U	2 U	0.25 U	2 U	0.25 U
Sulfate (mg/l)	--	**19.4**	NA	**23.1**	**40.1**	NA	**39.3**	**36.8**	NA	**34.5**	**26.3**	**38.6**	**26**	**23.2**
Sulfide (mg/l)	--	1.69 QUN	NA	1.85 U	1.69 U	NA	1.85 U	1.85 QUN	NA	1.85 U	1.85 QUN	1.85 U	1.69 U	1.85 U
Total organic carbon (TOC) (mg/l)	--	**16.6**	**12**	**7.86**	**4.58**	**4.35**	**3.04**	**0.832 J**	2.5 U	2.5 U	**1.43**	2.5 U	**1.03**	**1.77 J**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

**No MCL exists. Risk-based cleanup level was caluclated.

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

D - Compound identified in an analysis at a secondary dilution factor

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M - Duplicate injection precision criteria not met

N - The MS/MSD accuracy and/or precision are outside criteria

Q - One or more quality control criteria failed

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

X - The parameter shows a potential positive bias on a reported concentration due to an ICV or CCV exceeding the upper control limit on the high side.

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-1a

Site 11 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS11-MW13D				LS11-MW14D			LS11-MW15D		LS11-MW17D	
Sample ID		LS11-MW13D-0312	LS11-MW13DP-0312	LS11-MW13D-0313	LS11-MW13DP-0313	LS11-MW14D-0312	LS11-MW14D-0912	LS11-MW14D-0313	LS11-MW15D-0312	LS11-MW15D-0313	LS11-MW17D-0312	LS11-MW17D-0313
Sample Date		03/13/12	03/13/12	03/15/13	03/15/13	03/13/12	09/19/12	03/15/13	03/13/12	03/15/13	03/09/12	03/14/13
Chemical Name												
Volatile Organic Compounds (UG/L)												
1,1,1-Trichloroethane	200	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	2900**	0.5 U	0.5 U	0.5 U	2.5 U	**0.438 J**	**0.44 J**	**0.39 J**	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethene	7	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	5	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	5	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	9.6**	0.5 U	0.5 U	0.5 U	2.5 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-Dichloroethene	70	0.5 U	0.5 U	0.5 U	2.5 U	**0.287 J**	**0.36 J**	**0.35 J**	0.5 U	**0.39 J**	0.5 U	0.5 U
Methylene chloride	5	1 U	1 U	1 U	5 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	100	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	0.5 U	0.5 U	0.5 U	2.5 U	**0.453 J**	**0.47 J**	**0.39 J**	0.5 U	**3.37**	0.5 U	0.5 U
Vinyl chloride	2	0.5 U	0.5 U	0.5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Semivolatile Organic Compounds (UG/L)												
No Detections		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals (UG/L)												
Arsenic	10	6 XU	6 XU	**1.78 JN**	**1.75 JN**	NA	NA	NA	NA	NA	6 U	1.5 U
Dissolved Metals (UG/L)												
Arsenic, Dissolved	10	6 U	6 U	**1.77 JN**	NA	NA	NA	NA	NA	NA	6 XU	1.5 U
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry												
Acetate (mg/l)	--	0.5 U	NA	0.25 U	NA	0.5 U	0.5 U	0.25 U	0.5 U	0.25 U	0.5 U	0.25 U
Butyrate (mg/l)	--	0.5 U	NA	0.25 U	NA	0.5 U	0.5 U	0.25 U	0.5 U	0.25 U	0.5 U	0.25 U
Ethane (ug/l)	--	2 U	NA	2 U	NA	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Ethene (ug/l)	--	2 U	NA	NA	NA	2 U	2 U	NA	2 U	NA	2 U	2 U
Formic acid (mg/l)	--	NA	NA	0.25 U	NA	NA	NA	0.25 U	NA	0.25 U	NA	0.25 U
Lactate (mg/l)	--	10 U	NA	0.25 U	NA	10 U	10 U	0.25 U	10 U	0.25 U	10 U	0.25 U
Methane (ug/l)	--	**3.55 J**	NA	**1.5 J**	NA	2 U	**2.03 J**	2 U	**18.6**	**11.4**	**4.36**	2 U
Nitrate (mg/l)	--	**0.443**	NA	**0.399**	NA	**1.08**	NA	**1.19**	**0.048 J**	0.1 U	**0.077 H1J**	**0.607**
Nitrite (mg/l)	--	**0.079 J**	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.1 U	0.05 H1MUN	0.1 U
Propionate (mg/l)	--	0.5 U	NA	0.25 U	NA	0.5 U	0.5 U	0.25 U	0.5 U	0.25 U	0.5 U	0.25 U
Pyruvate (mg/l)	--	2 U	NA	0.25 U	NA	2 U	2 U	0.25 U	2 U	0.25 U	2 U	0.25 U
Sulfate (mg/l)	--	**10**	NA	**6.97**	NA	**38.1**	NA	**37.2**	**25.4**	**24.9**	**43**	**59.4**
Sulfide (mg/l)	--	1.85 QUN	NA	1.85 U	NA	1.85 QUN	NA	1.69 U	1.85 QUN	1.69 U	1.85 U	3.33 U
Total organic carbon (TOC) (mg/l)	--	**2.2**	NA	**2.61 J**	NA	**0.705 J**	2.5 U	2.5 U	**1.5**	**1.26 J**	**1.44**	**1.63 J**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

**No MCL exists. Risk-based cleanup level was caluclated.

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

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M - Duplicate injection precision criteria not met

N - The MS/MSD accuracy and/or precision are outside criteria

Q - One or more quality control criteria failed

U - The material was analyzed for, but not detected

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X - The parameter shows a potential positive bias on a reported concentration due to an ICV or CCV exceeding the upper control limit on the high side.

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-1a

Site 11 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS11-MW36D				LS11-MW38D		
Sample ID		LS11-MW36D-0312	LS11-MW36D-0912	LS11-MW36DP-0912	LS11-MW36D-0313	LS11-MW38D-0312	LS11-MW38D-0912	LS11-MW38D-0313
Sample Date		03/09/12	09/19/12	09/19/12	03/14/13	03/09/12	09/19/12	03/14/13
Chemical Name								
Volatile Organic Compounds (UG/L)								
1,1,1-Trichloroethane	200	1 U	5 U	5 U	0.5 U	**42,400**	**44,300**	**39,000**
1,1-Dichloroethane	2900**	**17.1**	**48.4**	**47.3**	**58.5**	**19,000**	**15,600**	**9,280**
1,1-Dichloroethene	7	**7.34**	5 U	**18.3**	**23.1**	**5,510**	**6,150**	**4,140**
1,2-Dichloroethane	5	1 U	5 U	5 U	**0.26 J**	500 U	250 U	100 U
1,2-Dichloropropane	5	1 U	5 U	5 U	0.5 U	500 U	250 U	100 U
Chloroform	9.6**	1 U	5 U	5 U	0.5 U	500 U	250 U	100 U
cis-1,2-Dichloroethene	70	**54.9**	**165**	**163**	**194**	**276,000**	**249,000**	**135,000**
Methylene chloride	5	2 U	10 U	10 U	1 U	3,410 B	**2,730**	**1,780**
trans-1,2-Dichloroethene	100	1 U	5 U	5 U	**2.28**	**420 J**	**580**	**962**
Trichloroethene	5	**19.5**	**57.1**	**56.3**	**71.7**	**13,500**	**14,600**	**19,300**
Vinyl chloride	2	**7.28**	**39.3**	**35**	**53.9**	**6,320**	**11,200**	**9,020**
Semivolatile Organic Compounds (UG/L)								
No Detections		NA	NA	NA	NA	NA	NA	NA
Total Metals (UG/L)								
Arsenic	10	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)								
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry								
Acetate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.25 U	**540**	**620**	**553**
Butyrate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.25 U	**6.9**	**16**	**8.7**
Ethane (ug/l)	--	2 U	2 U	2 U	2 U	2 U	**2.72 J**	**2.21 J**
Ethene (ug/l)	--	**4.52**	**31.5**	**27.1**	**22.2**	**305**	**524**	**409**
Formic acid (mg/l)	--	NA	NA	NA	0.25 U	NA	NA	**0.62 J**
Lactate (mg/l)	--	10 U	10 U	10 U	0.25 U	10 U	250 U	0.25 U
Methane (ug/l)	--	**11.7**	**53.1**	**41.5**	**40.4**	**9,620 D**	**7,610 D**	**5230 D**
Nitrate (mg/l)	--	0.05 H1U	NA	NA	0.1 U	1 H1U	NA	0.1 U
Nitrite (mg/l)	--	0.05 H1MUN	NA	NA	0.1 U	1 H1MUN	NA	0.1 U
Propionate (mg/l)	--	0.5 U	0.64	0.5 U	0.25 U	**100**	**92**	**31.5**
Pyruvate (mg/l)	--	2 U	2 U	2 U	0.25 U	2 U	**12 J**	0.25 U
Sulfate (mg/l)	--	**10.3**	NA	NA	**28.1**	10 U	NA	1 U
Sulfide (mg/l)	--	1.85 U	NA	NA	1.69 U	1.85 U	NA	1.69 U
Total organic carbon (TOC) (mg/l)	--	**14.6**	**95.4**	**95**	**114 D**	**631 D**	**629 D**	**427 D**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

**No MCL exists. Risk-based cleanup level was caluclated.

NA - Not analyzed

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X - The parameter shows a potential positive bias on a reported concentration due to an ICV or CCV exceeding the upper control limit on the high side.

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-1b

Site 11 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS11-MW39D					LS11-MW40D			LS11-MW41D		
Sample ID		LS11-MW39D-0312	LS11-MW39DP-0312	LS11-MW39D-0912	LS11-MW39D-0313	LS11-MW39DP-0313	LS11-MW40D-0312	LS11-MW40D-0912	LS11-MW40D-0313	LS11-MW41D-0312	LS11-MW41D-0912	LS11-MW41D-0313
Sample Date		03/09/12	03/09/12	09/19/12	03/14/13	03/14/13	03/12/12	09/19/12	03/15/13	03/12/12	09/20/12	03/15/13
Chemical Name												
Volatile Organic Compounds (UG/L)												
1,1,1-Trichloroethane	200	2.5 U	2.5 U	**12.7**	2.5 U	2.5 U	2.5 U	5 U	2.5 U	1 U	2.5 U	2.5 U
1,1-Dichloroethane	2900**	**109**	**123**	**225**	**115**	**103**	**4.78 J**	5 U	2.5 U	1 U	2.5 U	2.5 U
1,1-Dichloroethene	7	2.5 U	2.5 U	5 U	2.5 U	2.5 U	2.5 U	5 U	2.5 U	**1.28 J**	2.5 U	2.5 U
1,2-Dichloroethane	5	2.5 U	2.5 U	5 U	2.5 U	2.5 U	2.5 U	5 U	2.5 U	1 U	2.5 U	2.5 U
1,2-Dichloropropane	5	2.5 U	2.5 U	5 U	2.5 U	2.5 U	2.5 U	5 U	2.5 U	1 U	2.5 U	2.5 U
Chloroform	9.6**	2.5 U	2.5 U	5 U	2.5 U	2.5 U	2.5 U	5 U	2.5 U	1 U	2.5 U	2.5 U
cis-1,2-Dichloroethene	70	2.5 U	2.5 U	**51.1**	2.5 U	2.5 U	**5.08**	**5.5 J**	2.5 U	**1.67 J**	2.5 U	**1.6 J**
Methylene chloride	5	5 U	5 U	10 U	5 U	5 U	5 U	10 U	5 U	2 U	5 U	5 U
trans-1,2-Dichloroethene	100	2.5 U	2.5 U	5 U	2.5 U	2.5 U	2.5 U	5 U	2.5 U	1 U	2.5 U	2.5 U
Trichloroethene	5	2.5 U	2.5 U	**4.2 J**	2.5 U	2.5 U	**1.62 J**	5 U	2.5 U	**2.83**	**1.85 J**	**2.55 J**
Vinyl chloride	2	**9.95**	**10.1**	**28.2**	**5.4**	**5.45**	**20.4**	**23.8**	**7.55**	**20.6**	**16.8**	**40.4**
Semivolatile Organic Compounds (UG/L)												
No Detections		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals (UG/L)												
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)												
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry												
Acetate (mg/l)	--	**3.8**	NA	0.5 U	0.25 U	NA	0.5 U	0.5 U	0.25 U	0.5 U	**1.5**	0.25 U
Butyrate (mg/l)	--	0.5 U	NA	0.5 U	0.25 U	NA	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U
Ethane (ug/l)	--	**64.7**	NA	**70.1**	**23.8**	NA	2 U	2 U	2 U	2 U	2 U	2 U
Ethene (ug/l)	--	**470**	NA	**276**	**307**	NA	**4.03**	2 U	NA	**5.52**	**3.34 J**	NA
Formic acid (mg/l)	--	NA	NA	NA	0.25 U	NA	NA	NA	0.25 U	NA	NA	0.25 U
Lactate (mg/l)	--	10 U	NA	10 U	0.25 U	NA	10 U	10 U	0.25 U	10 U	10 U	0.25 U
Methane (ug/l)	--	**8,310 D**	NA	**10,500 D**	**3510 D**	NA	**8,490 D**	**13,500 D**	**4730 D**	**13,300 D**	**9,010 D**	**11800.0 D**
Nitrate (mg/l)	--	0.5 H1U	NA	NA	0.1 U	NA	2 U	NA	0.1 U	2 U	NA	0.1 U
Nitrite (mg/l)	--	0.5 H1MU	NA	NA	0.1 U	NA	2 MU	NA	0.1 U	2 MU	NA	0.1 U
Propionate (mg/l)	--	**3.1**	NA	**0.83**	0.25 U	NA	0.5 U	**0.12 J**	0.25 U	0.5 U	**0.12 J**	0.25 U
Pyruvate (mg/l)	--	2 U	NA	2 U	0.25 U	NA	2 U	2 U	0.25 U	2 U	**0.25 J**	0.25 U
Sulfate (mg/l)	--	**28.6 D**	NA	NA	**39.6**	NA	**9.82 DJ**	NA	**5.82**	20 U	NA	**2.98**
Sulfide (mg/l)	--	1.85 U	NA	NA	1.69 U	NA	1.69 U	NA	1.85 U	1.85 U	NA	1.69 U
Total organic carbon (TOC) (mg/l)	--	**113 D**	NA	**136 D**	**90.2**	NA	**15.4 D**	**8.17**	**5.3**	**6.83**	**8.74**	**18.4**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

**No MCL exists. Risk-based cleanup level was caluclated.

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D - Compound identified in an analysis at a secondary dilution factor

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MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-1b

Site 11 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS11-MW42D		
Sample ID		LS11-MW42D-0312	LS11-MW42D-0912	LS11-MW42D-0313
Sample Date		03/13/12	09/19/12	03/15/13
Chemical Name				
Volatile Organic Compounds (UG/L)				
1,1,1-Trichloroethane	200	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	2900**	**0.59 J**	**0.7 J**	**0.52 J**
1,1-Dichloroethene	7	**7.06**	**8.21**	**7.11**
1,2-Dichloroethane	5	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	5	0.5 U	0.5 U	0.5 U
Chloroform	9.6**	0.5 U	0.5 U	0.5 U
cis-1,2-Dichloroethene	70	**3.27**	**3.66**	**3.41**
Methylene chloride	5	1 U	1 U	1 U
trans-1,2-Dichloroethene	100	0.5 U	0.5 U	0.5 U
Trichloroethene	5	**43.7**	**47.4**	**44.5**
Vinyl chloride	2	0.5 U	0.5 U	0.5 U
Semivolatile Organic Compounds (UG/L)				
No Detections		NA	NA	NA
Total Metals (UG/L)				
Arsenic	10	NA	NA	NA
Dissolved Metals (UG/L)				
Arsenic, Dissolved	10	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA
Wet Chemistry				
Acetate (mg/l)	--	0.5 U	0.5 U	0.25 U
Butyrate (mg/l)	--	0.5 U	0.5 U	0.25 U
Ethane (ug/l)	--	2 U	2 U	2 U
Ethene (ug/l)	--	2 U	2 U	NA
Formic acid (mg/l)	--	NA	NA	0.25 U
Lactate (mg/l)	--	10 U	10 U	0.25 U
Methane (ug/l)	--	**3.35 J**	**14.9**	**4.47**
Nitrate (mg/l)	--	**0.254**	NA	**0.394**
Nitrite (mg/l)	--	0.1 U	NA	0.1 U
Propionate (mg/l)	--	0.5 U	0.5 U	0.25 U
Pyruvate (mg/l)	--	2 U	2 U	0.25 U
Sulfate (mg/l)	--	**31.8**	NA	**39.9**
Sulfide (mg/l)	--	1.69 QUN	NA	1.69 U
Total organic carbon (TOC) (mg/l)	--	**1**	2.5 U	2.5 U

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

**No MCL exists. Risk-based cleanup level was caluclated.

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

D - Compound identified in an analysis at a secondary dilution factor

H1 - Holding time exceedance

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M - Duplicate injection precision criteria not met

N - The MS/MSD accuracy and/or precision are outside criteria

Q - One or more quality control criteria failed

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

X - The parameter shows a potential positive bias on a reported concentration due to an ICV or CCV exceeding the upper control limit on the high side.

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-2

Validated Indoor Air Exceedance Analytical Results

Site 11

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Project Action Level**	LS11-IA01		LS11-IA02		LS11-IA03		LS11-IA04				LS11-IA05	
Sample ID		LS11-IA01-0512	LS11-IA01-1212	LS11-IA02-0512	LS11-IA02-1212	LS11-IA03-0512	LS11-IA03-1212	LS11-IA04-0512	LS11-IA04P-0512	LS11-IA04-1212	LS11-IA04P-1212	LS11-IA05-0512	LS11-IA05-1212
Sample Date		05/01/12	12/11/12	05/01/12	12/11/12	05/01/12	12/11/12	05/01/12	05/01/12	12/11/12	12/11/12	05/01/12	12/11/12
Chemical Name													
Volatile Organic Compounds (UG/M3)													
Chloromethane	39	5 U	**2 J**	5 U	**2 J**	5 U	**2 J**	5 U	5 U	**2 J**	**2 J**	5 U	**2 J**
Methylene chloride	260	11 B	10 B	20 B	9 B	10 B	11 B	6 B	25 B	9 B	**35 J**	5 B	6 B
Propylene	1,300	4 U	**41**	4 U	**8**	4 U	**3 J**	4 U	4 U	**3 J**	**3 J**	4 U	**3 J**

Notes:

Exceeds all criteria

Bold indicates detections

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

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

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/M3 - Micrograms per cubic meter

TABLE F-2

Validated Indoor Air Exceedance Analytical Results

Site 11

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Project Action Level**	LS11-IA06		LS11-IA07		LS11-IA08		LS11-IA09			LS11-IA10		LS11-IA11		
Sample ID		LS11-IA06-0512	LS11-IA06-1212	LS11-IA07-0512	LS11-IA07-1212	LS11-IA08-0512	LS11-IA08-1212	LS11-IA09-0512	LS11-IA09P-0512	LS11-IA09-1212	LS11-IA10-0512	LS11-IA10-1212	LS11-IA11-0512	LS11-IA11-1212	LS11-IA11P-1212
Sample Date		05/01/12	12/11/12	05/01/12	12/11/12	05/01/12	12/11/12	05/01/12	05/01/12	12/11/12	05/01/12	12/11/12	05/01/12	12/11/12	12/11/12
Chemical Name															
Volatile Organic Compounds (UG/M3)															
Chloromethane	39	5 U	**2 J**	5 U	**2 J**	5 U	**2 J**	5 U	5 U	**2 J**	5 U	**2 J**	5 U	**0.7 J**	**0.8 J**
Methylene chloride	260	**31**	3 B	14 B	**11**	13 B	4 B	7 B	7 B	3 B	4 B	**12**	5 B	3 B	12 B
Propylene	1,300	4 U	**23**	4 U	**2 J**	4 U	**1 J**	4 U	4 U	**1 J**	4 U	**1 J**	4 U	**0.5 J**	**0.6 J**

Notes:

Exceeds all criteria

Bold indicates detections

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

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

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/M3 - Micrograms per cubic meter

TABLE F-2

Validated Indoor Air Exceedance Analytical Results

Site 11

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Project Action Level**	LS11-IA12		LS11-IA13		LS11-IA14		LS11-IA15	
Sample ID		LS11-IA12-0512	LS11-IA12-1212	LS11-IA13-0512	LS11-IA13-1212	LS11-IA14-0512	LS11-IA14-1212	LS11-IA15-0512	LS11-IA15-1212
Sample Date		05/01/12	12/11/12	05/01/12	12/11/12	05/01/12	12/11/12	05/01/12	12/11/12
Chemical Name									
Volatile Organic Compounds (UG/M3)									
Chloromethane	39	5 U	**2 J**	5 U	**2 J**	5 U	**2 J**	5 U	**2 J**
Methylene chloride	260	18 B	10 B	16 B	16 B	7 B	9 B	5 B	2 B
Propylene	1,300	4 U	**1 J**	4 U	**6**	4 U	**26**	4 U	**4**

Notes:

Exceeds all criteria

Bold indicates detections

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

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

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/M3 - Micrograms per cubic meter

TABLE F-3a

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW01D			LS12-MW01S			LS12-MW02D					
Sample ID		LS12-MW01D-0311	LS12-MW01D-0312	LS12-MW01D-0313	LS12-MW01S-0311	LS12-MW01S-0312	LS12-MW01S-0313	LS12-MW02D-0311	LS12-MW02D-0911	LS12-MW02D-0312	LS12-MW02D-0912	LS12-MW02DP-0912	LS12-MW02D-0313
Sample Date		03/10/11	03/11/12	03/13/13	03/10/11	03/11/12	03/13/13	03/08/11	09/27/11	03/11/12	09/18/12	09/18/12	03/12/13
Chemical Name													
Volatile Organic Compounds (UG/L)													
1,1-Dichloroethene	7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**1.09 J**	**0.666 J**	2.5 U	5 U	5 U	2.5 U
1,2-Dichloroethene (total)	70	**1.82 J**	**1.23 J**	NA	1 U	1 U	NA	**72.5**	**34.6**	**31.2**	10 U	10 U	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**1.82**	**1.23**	**1.46**	0.5 U	0.5 U	0.5 U	**71.6**	**34.6**	**31.2**	5 U	5 U	**6.1**
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	**0.46 J**	**0.938 J**	**2.32**	**88.2**	**14.6**	2.5 U	5 U	5 U	2.5 U
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.986 J**	0.5 UJ	2.5 U	5 U	5 U	2.5 U
Trichloroethene	5	**6.79**	**5.31**	**5.95**	0.5 U	0.5 U	0.5 U	**48.4**	**24.8**	**4.77 J**	5 U	5 U	2.5 U
Vinyl chloride	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**55.4**	**16.9**	**24.7**	**13.5**	**10.3**	**20.3**
Total Metals (UG/L)													
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)													
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry													
Acetate (mg/l)	--	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	**65**	0.5 U	NA	0.25 U
Butyrate (mg/l)	--	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	**1.5**	0.5 U	NA	0.25 U
Ethane (ug/l)	--	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 UH	2 U	2 U	NA	**6.99**
Ethene (ug/l)	--	2 U	2 U	2 U	2 U	2 U	NA	**2.16 J**	2 UH	**13.2**	**20.6**	NA	NA
Lactate (mg/l)	--	10 U	10 U	0.25 U	10 U	10 U	0.25 U	10 U	10 U	10 U	10 U	NA	0.25 U
Methane (ug/l)	--	**96.9**	**19.8**	**23.5**	2 U	**1.77 J**	2 U	**8,790 D**	**25,500 DH**	**20,600 D**	**7,830 D**	NA	**29400.0 D**
Nitrate (mg/l)	--	NA	NA	0.1 U	NA	NA	**3.34**	NA	NA	NA	NA	NA	0.1 U
Propionate (mg/l)	--	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	**63**	0.5 U	NA	0.25 U
Pyruvate (mg/l)	--	2 U	2 U	0.25 U	2 U	2 U	0.25 U	2 U	2 U	**0.63 J**	2 U	NA	0.25 U
Sulfate (mg/l)	--	NA	NA	**46.1**	NA	NA	**32.2**	NA	NA	NA	NA	NA	1 U
Sulfide (mg/l)	--	NA	NA	1.69 U	NA	NA	1.85 U	NA	NA	NA	NA	NA	**1 J**
Total organic carbon (TOC) (mg/l)	--	**0.708 J**	**1.06**	2.5 U	**1.13**	**1.43**	**1.78 J**	**13.3**	**10.7**	**82**	**16.3**	NA	**41.7**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

D - Compound identified in an analysis at a secondary dilution factor

H - Holding time exceedance

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

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U - The material was analyzed for, but not detected

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MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-3a

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW02S					LS12-MW04S				
Sample ID		LS12-MW02S-0311	LS12-MW02S-0911	LS12-MW02S-0312	LS12-MW02S-0912	LS12-MW02S-0313	LS12-MW04S-0311	LS12-MW04SP-0311	LS12-MW04S-0312	12-MW04S-0312-	LS12-MW04S-0313
Sample Date		03/08/11	09/27/11	03/11/12	09/18/12	03/12/13	03/07/11	03/07/11	03/10/12	03/13/12	03/12/13
Chemical Name											
Volatile Organic Compounds (UG/L)											
1,1-Dichloroethene	7	**13.8 J**	50 U	25 U	25 U	20 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
1,2-Dichloroethene (total)	70	**9,050**	**10,800**	**3,300**	**6,730**	NA	1 U	1 U	1 U	NA	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**9,000**	**10,800**	**3,270**	**6,700**	**4,400**	0.5 U	0.5 U	0.5 U	NA	0.5 U
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	**19.7 J**	50 U	25 U	25 U	20 U	0.5 U	0.5 U	0.5 U	NA	0.5 U
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	**58.3**	**59 J**	**24.1 J**	**32.5 J**	**22 J**	0.5 U	0.5 U	0.5 U	NA	0.5 U
Trichloroethene	5	**250**	**867**	**53.4**	**18 J**	**39.2 J**	0.5 U	0.5 U	0.5 U	NA	0.5 U
Vinyl chloride	2	**3,950**	**5,270**	**3,050**	**3,560**	**1,920**	0.5 U	0.5 U	0.5 U	NA	0.5 U
Total Metals (UG/L)											
Arsenic	10	NA	NA	NA	NA	NA	**2.56**	**2.73**	**42.6**	NA	**7.48**
Dissolved Metals (UG/L)											
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	**2.38 J**	**2.68**	NA	**10**	**6.69**
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry											
Acetate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	NA	0.5 U	NA	0.25 U
Butyrate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	NA	0.5 U	NA	0.25 U
Ethane (ug/l)	--	**12.1**	**31.2 H**	**4.35**	**2.94 J**	**6.85**	2 U	NA	2 U	NA	2 U
Ethene (ug/l)	--	**137**	**652 H**	**126**	**110**	NA	2 U	NA	2 U	NA	NA
Lactate (mg/l)	--	10 U	10 U	10 U	10 U	0.25 U	10 U	NA	10 U	NA	0.25 U
Methane (ug/l)	--	**1,450 D**	**5,740 DH**	**16,900 D**	**5,170 D**	**8900 D**	**50.2**	NA	**31.7**	NA	**2.68 J**
Nitrate (mg/l)	--	NA	NA	NA	NA	0.1 U	NA	NA	NA	NA	**0.192 J**
Propionate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	NA	0.5 U	NA	0.25 U
Pyruvate (mg/l)	--	2 U	2 U	2 U	2 U	0.25 U	2 U	NA	2 U	NA	0.25 U
Sulfate (mg/l)	--	NA	NA	NA	NA	**57.1**	NA	NA	NA	NA	**19.7**
Sulfide (mg/l)	--	NA	NA	NA	NA	1.85 U	NA	NA	NA	NA	1.85 U
Total organic carbon (TOC) (mg/l)	--	**8.36**	**6.87**	**5.62**	**3.65**	**7.1**	**2.03**	NA	**1.89**	NA	**1.99 J**

Notes:

Exceeds all criteria

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MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-3a

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW07T							LS12-MW23D			
Sample ID		LS12-MW07T-0311	LS12-MW07T-0312	LS12-MW07TP-0312	LS12-MW07T-0312-02	LS12-MW07TP-0312-02	LS12-MW07T-0313	LS12-MW07TP-0313	LS12-MW23D-0311	LS12-MW23D-0312	LS12-MW23D-0312-02	LS12-MW23D-0313
Sample Date		03/08/11	03/10/12	03/10/12	03/13/12	03/13/12	03/14/13	03/14/13	03/11/11	03/12/12	03/13/12	03/14/13
Chemical Name												
Volatile Organic Compounds (UG/L)												
1,1-Dichloroethene	7	0.5 U	2.5 U	2.5 U	NA	NA	2.5 U	2.5 U	0.5 U	0.5 U	NA	0.5 U
1,2-Dichloroethene (total)	70	**4.7**	**4.42 J**	**3.67 J**	NA	NA	NA	NA	1 U	1 U	NA	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**4.59**	**4.42 J**	**3.67 J**	NA	NA	**41.7**	**45**	0.5 U	0.5 U	NA	0.5 U
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	0.5 U	2.5 U	2.5 U	NA	NA	2.5 U	2.5 U	0.5 U	0.5 U	NA	0.5 U
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	2.5 U	2.5 U	NA	NA	2.5 U	2.5 U	0.5 U	0.5 U	NA	0.5 U
Trichloroethene	5	0.5 U	2.5 U	2.5 U	NA	NA	**7.05**	**8.1**	0.5 U	0.5 U	NA	0.5 U
Vinyl chloride	2	**1.96**	**2.18 J**	**1.96 J**	NA	NA	**26.6**	**27.8**	0.5 U	**0.259 J**	NA	0.5 U
Total Metals (UG/L)												
Arsenic	10	**61**	**74.3 D**	**73.8 D**	NA	NA	**115 D**	**114 D**	1.5 U	1.5 U	NA	1.5 U
Dissolved Metals (UG/L)												
Arsenic, Dissolved	10	**59.9**	NA	NA	**48.5 D**	**47.7 D**	**119 D**	**129 D**	1.5 U	NA	1.5 U	1.5 U
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry												
Acetate (mg/l)	--	0.5 U	0.5 U	NA	NA	NA	0.25 U	NA	0.5 U	0.5 U	NA	0.25 U
Butyrate (mg/l)	--	0.5 U	0.5 U	NA	NA	NA	0.25 U	NA	0.5 U	0.5 U	NA	0.25 U
Ethane (ug/l)	--	**12.6**	2 U	NA	NA	NA	2 U	NA	2 U	2 U	NA	2 U
Ethene (ug/l)	--	**7.07**	**5.64**	NA	NA	NA	**18**	NA	2 U	2 U	NA	2 U
Lactate (mg/l)	--	10 U	10 U	NA	NA	NA	0.25 U	NA	10 U	10 U	NA	0.25 U
Methane (ug/l)	--	**6,210 D**	**15,900 D**	NA	NA	NA	**5140 D**	NA	**10.2**	**14.4**	NA	**7.96**
Nitrate (mg/l)	--	NA	NA	NA	NA	NA	0.1 U	NA	NA	NA	NA	**0.093 J**
Propionate (mg/l)	--	0.5 U	0.5 U	NA	NA	NA	0.25 U	NA	0.5 U	0.5 U	NA	0.25 U
Pyruvate (mg/l)	--	2 U	2 U	NA	NA	NA	0.25 U	NA	2 U	2 U	NA	0.25 U
Sulfate (mg/l)	--	NA	NA	NA	NA	NA	**5.91**	NA	NA	NA	NA	**29.8**
Sulfide (mg/l)	--	NA	NA	NA	NA	NA	1.69 U	NA	NA	NA	NA	1.85 U
Total organic carbon (TOC) (mg/l)	--	**10.8**	**9.05**	NA	NA	NA	**20.2**	NA	**1.48**	**2.19**	NA	**1.68 J**

Notes:

Exceeds all criteria

Bold indicates detections

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MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-3a

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW24D					LS12-MW24S					LS12-MW26T		
Sample ID		LS12-MW24D-0311	LS12-MW24D-0911	LS12-MW24D-0312	LS12-MW24D-0912	LS12-MW24D-0313	LS12-MW24S-0311	LS12-MW24S-0911	LS12-MW24S-0312	LS12-MW24S-0912	LS12-MW24S-0313	LS12-MW26T-0311	LS12-MW26T-0312	LS12-MW26T-0313
Sample Date		03/11/11	09/26/11	03/10/12	09/19/12	03/12/13	03/11/11	09/26/11	03/10/12	09/19/12	03/12/13	03/09/11	03/10/12	03/12/13
Chemical Name														
Volatile Organic Compounds (UG/L)														
1,1-Dichloroethene	7	2.5 U	5 U	2.5 U	5 U	1.25 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethene (total)	70	**11.5**	10 U	**14.1**	**5 J**	NA	**62.8**	**14.2**	**9.58**	**57.2**	NA	1 U	1 U	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**11.5**	**2.55 J**	**14.1**	**5 J**	**5.15**	**62.5**	**14.2**	**9.58**	**57.2**	**28.4**	**0.373 J**	**0.367 J**	0.5 U
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	**771**	**628**	**579**	**545**	**628**	**35.4**	**16.2**	**8.93**	**89.8**	**18**	0.5 U	0.5 U	0.5 U
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	2.5 U	5 UJ	2.5 U	5 U	1.25 U	**0.29 J**	0.5 UJ	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	**63.3**	**47.1**	**62.7**	**56.3**	**53.1**	**4.68**	**1.92**	**1.7**	**12.1**	**4.47**	**0.998 J**	**0.901 J**	**0.74 J**
Vinyl chloride	2	2.5 U	5 U	**1.42 J**	5 U	1.25 U	**2.02**	**0.648 J**	**0.459 J**	**3.68**	**2.21**	0.5 U	0.5 U	0.5 U
Total Metals (UG/L)														
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)														
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry														
Acetate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U
Butyrate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U
Ethane (ug/l)	--	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Ethene (ug/l)	--	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	NA
Lactate (mg/l)	--	10 U	10 U	10 U	10 U	0.25 U	10 U	10 U	10 U	10 U	0.25 U	10 U	10 U	0.25 U
Methane (ug/l)	--	**911**	**2,270 DH**	**1,360 D**	**1,160 D**	**768 D**	**2,890 D**	**598**	**346**	**1,910 D**	**768**	**5.94**	**2.64 J**	2 U
Nitrate (mg/l)	--	NA	NA	NA	NA	0.1 U	NA	NA	NA	NA	**0.081 J**	NA	NA	**0.176 J**
Propionate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.25 U
Pyruvate (mg/l)	--	2 U	2 U	2 U	2 U	0.25 U	2 U	2 U	2 U	2 U	0.25 U	2 U	2 U	0.25 U
Sulfate (mg/l)	--	NA	NA	NA	NA	**25.4**	NA	NA	NA	NA	**94.8**	NA	NA	**54.9**
Sulfide (mg/l)	--	NA	NA	NA	NA	**1 J**	NA	NA	NA	NA	**1 J**	NA	NA	**0.997 J**
Total organic carbon (TOC) (mg/l)	--	**0.792 J**	**0.877 J**	**1.15**	**1.26 J**	**1.29 J**	**1.52**	**1.21**	**1.39**	**2.38 J**	**2.68 J**	**0.786 J**	**1.24**	2.5 U

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

D - Compound identified in an analysis at a secondary dilution factor

H - Holding time exceedance

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

N - The MS/MSD accuracy and/or precision are outside criteria. The predigested spike recovery is not within control limits for the associated parameter.

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-3a

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW27D				LS12-MW27S				LS12-MW28D				
Sample ID		LS12-MW27D-0311	LS12-MW27D-0911	LS12-MW27D-0312	LS12-MW27D-0313	LS12-MW27S-0311	LS12-MW27S-0911	LS12-MW27S-0312	LS12-MW27S-0313	LS12-MW28D-0311	LS12-MW28D-0911	LS12-MW28D-0312	LS12-MW28D-0912	LS12-MW28D-0313
Sample Date		03/11/11	09/28/11	03/11/12	03/13/13	03/11/11	09/28/11	03/11/12	03/13/13	03/08/11	09/26/11	03/10/12	09/18/12	03/13/13
Chemical Name														
Volatile Organic Compounds (UG/L)														
1,1-Dichloroethene	7	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	2.5 U	1 U	2.5 U	1.25 U
1,2-Dichloroethene (total)	70	1 U	1 U	1 U	NA	1 U	1 U	1 U	NA	**266**	**351**	**292**	**137**	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**237**	**345**	**289 J**	**134**	**279**
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	0.5 U	**0.288 J**	**0.295 J**	**0.28 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	1 U	2.5 U	1.25 U
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**4.69**	**5.96 J**	**3.66**	**2.4 J**	**2.62**
Trichloroethene	5	**0.725 J**	**0.754 J**	**0.711 J**	**0.53 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**22.8**	1 U	2.5 U	1.25 U
Vinyl chloride	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**86.2**	**66.2**	**75.7**	**48.6**	**41.3**
Total Metals (UG/L)														
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)														
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry														
Acetate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U
Butyrate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U
Ethane (ug/l)	--	2 U	2 UH	2 U	2 U	2 U	2 UH	2 U	2 U	**4.34**	2 U	2 U	**6.88**	**2.14 NJ**
Ethene (ug/l)	--	2 U	2 UH	2 U	2 U	2 U	2 UH	2 U	NA	**12.1**	**24.9**	**19.3**	**27.8**	**9.54 N**
Lactate (mg/l)	--	10 U	10 U	10 U	0.25 U	10 U	10 U	10 U	0.25 U	10 U	10 U	10 U	10 U	0.25 U
Methane (ug/l)	--	**1,010**	**610 H**	**579**	**400**	**8.41**	**7.04 H**	**1.9 J**	**13.5**	**3,640 D**	**15,000 D**	**16,500 DN**	**5,740 D**	**3280 DN**
Nitrate (mg/l)	--	NA	NA	NA	**0.047 J**	NA	NA	NA	**0.328**	NA	NA	NA	NA	0.1 U
Propionate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U
Pyruvate (mg/l)	--	2 U	2 U	2 U	0.25 U	2 U	2 U	2 U	0.25 U	2 U	2 U	2 U	2 U	0.25 U
Sulfate (mg/l)	--	NA	NA	NA	**34.2**	NA	NA	NA	**55**	NA	NA	NA	NA	**17.8**
Sulfide (mg/l)	--	NA	NA	NA	1.69 U	NA	NA	NA	1.69 U	NA	NA	NA	NA	1.85 U
Total organic carbon (TOC) (mg/l)	--	**0.873 J**	**0.636 J**	**0.993 J**	**1.66 J**	**1.87**	**2.46**	**2.36**	**2 J**	**6.42**	**5.28**	**6.69**	**6.13**	**4.27**

Notes:

Exceeds all criteria

Bold indicates detections

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MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-3a

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW28S				LS12-MW30D					
Sample ID		LS12-MW28S-0311	LS12-MW28S-0911	LS12-MW28S-0312	LS12-MW28S-0313	LS12-MW30D-0311	LS12-MW30D-0911	LS12-MW30D-0312	LS12-MW30D-0912	LS12-MW30DP-0912	LS12-MW30D-0313
Sample Date		03/08/11	09/26/11	03/10/12	03/13/13	03/09/11	09/26/11	03/11/12	09/18/12	09/18/12	03/13/13
Chemical Name											
Volatile Organic Compounds (UG/L)											
1,1-Dichloroethene	7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	5 U	5 U	2.5 U
1,2-Dichloroethene (total)	70	**1.29 J**	**1.44 J**	1 U	NA	**3.36**	1 U	5 U	10 U	10 U	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**1.29**	**1.25**	0.5 U	**0.64 J**	**3.36**	**0.481 J**	2.5 U	5 U	5 U	**2.15 J**
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	5 U	5 U	2.5 U
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 UJ	2.5 U	5 U	5 U	2.5 U
Trichloroethene	5	**0.405 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	5 U	5 U	2.5 U
Vinyl chloride	2	**0.413 J**	**1.31**	**0.318 J**	**0.54 J**	**11.9**	**0.45 J**	2.5 U	5 U	5 U	**7.6**
Total Metals (UG/L)											
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)											
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry											
Acetate (mg/l)	--	0.5 U	**19**	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.25 U
Butyrate (mg/l)	--	0.5 U	**1.2**	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.25 U
Ethane (ug/l)	--	**3.72 J**	2 U	2 U	2 U	**56.8**	**71.8**	**40.9**	**39.5**	NA	**40.4**
Ethene (ug/l)	--	2 U	2 U	2 U	2 U	**10.3**	2 U	2 U	**5.2**	NA	**6.82**
Lactate (mg/l)	--	10 U	**6.1 J**	10 U	0.25 U	10 U	10 U	10 U	10 U	NA	0.25 U
Methane (ug/l)	--	**942 D**	**8,680 D**	**11,400 D**	**685 D**	**13,400 D**	**13,700 D**	**13,500 D**	**5,990 D**	NA	**12900.0 D**
Nitrate (mg/l)	--	NA	NA	NA	0.1 U	NA	NA	NA	NA	NA	0.1 U
Propionate (mg/l)	--	0.5 U	**25**	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.25 U
Pyruvate (mg/l)	--	2 U	**0.55 J**	2 U	0.25 U	2 U	2 U	2 U	2 U	NA	0.25 U
Sulfate (mg/l)	--	NA	NA	NA	**36.2**	NA	NA	NA	NA	NA	**1.27 J**
Sulfide (mg/l)	--	NA	NA	NA	1.85 U	NA	NA	NA	NA	NA	1.85 U
Total organic carbon (TOC) (mg/l)	--	**1.76**	**29.2**	**4.87**	**2.55 J**	**28.3**	**29.2**	**31.7**	**33.1**	NA	**34.9**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

NA - Not analyzed

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UG/L - Micrograms per liter

TABLE F-3a

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW30S									LS12-MW31D				
Sample ID		LS12-MW30S-0311	LS12-MW30SP-0311	LS12-MW30S-0911	LS12-MW30SP-0911	LS12-MW30S-0312	LS12-MW30SP-0312	LS12-MW30S-0912	LS12-MW30S-0313	LS12-MW30SP-0313	LS12-MW31D-0311	LS12-MW31D-0911	LS12-MW31D-0312	LS12-MW31D-0912	LS12-MW31D-0313
Sample Date		03/09/11	03/09/11	09/26/11	09/26/11	03/11/12	03/11/12	09/18/12	03/13/13	03/13/13	03/11/11	09/27/11	03/12/12	09/18/12	03/12/13
Chemical Name															
Volatile Organic Compounds (UG/L)															
1,1-Dichloroethene	7	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	5 U	2.5 U	2.5 UJ	1 U	1 U	**0.416 J**	1 U	0.5 U
1,2-Dichloroethene (total)	70	**3.63**	**3.48**	**4.65**	**4.57**	**3.97 J**	**4.19 J**	10 U	NA	NA	**196**	**62.1 J**	**153**	**49**	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**3.63**	**3.48**	**4.65**	**4.57**	**3.97 J**	**4.19 J**	5 U	**11.2**	**14.1 J**	**195**	**62.1**	**153**	**49**	**70.7**
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	5 U	2.5 U	2.5 UJ	**4.07**	1 U	**0.363 J**	1 U	**0.38 J**
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	0.5 U	0.5 UJ	0.5 UJ	2.5 U	2.5 U	5 U	2.5 U	2.5 UJ	**0.656 J**	1 UJ	**0.478 J**	1 U	0.5 U
Trichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	5 U	2.5 U	2.5 UJ	**9.65**	**2.12**	**1.61**	1 U	**0.66 J**
Vinyl chloride	2	**18.5**	**18.9**	**15.3**	**16.2**	**29.6**	**25.2**	**12.8**	**25.6**	**28.4 J**	**390**	**219**	**230**	**200**	**145**
Total Metals (UG/L)															
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)															
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry															
Acetate (mg/l)	--	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.25 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U
Butyrate (mg/l)	--	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.25 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U
Ethane (ug/l)	--	2 U	NA	2 U	NA	2 U	NA	2 U	**1.32 J**	NA	2 U	2 UH	2 U	**5.2**	**16**
Ethene (ug/l)	--	**4.71**	NA	2 U	NA	**5.02**	NA	**4.58**	**3.89 J**	NA	**298**	**716 H**	**236**	**149**	NA
Lactate (mg/l)	--	10 U	NA	10 U	NA	10 U	NA	10 U	0.25 U	NA	10 U	10 U	10 U	10 U	0.25 U
Methane (ug/l)	--	**11,600 D**	NA	**13,900 D**	NA	**11,700 D**	NA	**7,060 D**	**8750 D**	NA	**17,100 D**	**22,000 DH**	**6,850 D**	**6,330 D**	**5900 D**
Nitrate (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	0.1 U	NA	NA	NA	NA	NA	0.1 U
Propionate (mg/l)	--	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.25 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U
Pyruvate (mg/l)	--	2 U	NA	2 U	NA	2 U	NA	**0.3 J**	0.25 U	NA	2 U	2 U	2 U	2 U	0.25 U
Sulfate (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	**4.61**	NA	NA	NA	NA	NA	1 U
Sulfide (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	1.85 U	NA	NA	NA	NA	NA	1.69 U
Total organic carbon (TOC) (mg/l)	--	**26.4**	NA	**37**	NA	**34**	NA	**24.7**	**26.4**	NA	**11.7**	**11.4**	**10.9**	**9.47**	**10.9**

Notes:

Exceeds all criteria

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TABLE F-3b

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW32D					LS12-MW32S				
Sample ID		LS12-MW32D-0311	LS12-MW32D-0911	LS12-MW32D-0312	LS12-MW32D-0912	LS12-MW32D-0313	LS12-MW32S-0311	LS12-MW32S-0911	LS12-MW32S-0312	LS12-MW32S-0912	LS12-MW32S-0313
Sample Date		03/09/11	09/27/11	03/10/12	09/18/12	03/12/13	03/09/11	09/27/11	03/10/12	09/18/12	03/12/13
Chemical Name											
Volatile Organic Compounds (UG/L)											
1,1-Dichloroethene	7	0.5 U	0.5 U	0.5 U	5 U	2.5 U	0.5 U	0.5 U	2.5 U	5 U	2.5 U
1,2-Dichloroethene (total)	70	**6.74**	**42.8**	**2.75**	**20.6**	NA	**0.695 J**	**0.633 J**	5 U	10 U	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**6.74**	**42.4**	**2.75**	**20.6**	**148**	**0.695 J**	**0.633 J**	**1.93 J**	5 U	2.5 U
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	5 U	2.5 U	0.5 U	0.5 U	2.5 U	5 U	2.5 U
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	**0.364 J**	0.5 U	5 U	**1.65 J**	0.5 U	0.5 UJ	2.5 U	5 U	2.5 U
Trichloroethene	5	0.5 U	0.5 U	0.5 U	5 U	2.5 U	0.5 U	0.5 U	2.5 U	5 U	2.5 U
Vinyl chloride	2	**82.9**	**267**	**136**	**306**	**1,610**	**5.39**	**2.84**	**79.9**	**40.6**	**1.4 J**
Total Metals (UG/L)											
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)											
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry											
Acetate (mg/l)	--	**2**	**16**	0.5 U	0.5 U	0.25 U	**0.24 J**	**490**	**5.8**	0.5 U	0.25 U
Butyrate (mg/l)	--	0.5 U	**0.43 J**	0.5 U	0.5 U	0.25 U	0.5 U	**23**	0.5 U	0.5 U	0.25 U
Ethane (ug/l)	--	**125**	**232 DH**	**13.6**	**134**	**362**	**3.06 J**	50 UH	**23.3**	**90.6**	**2.63 J**
Ethene (ug/l)	--	**2,100**	**9,080 DH**	**884**	**570**	**1200**	**2.51 J**	50 UH	**750**	**155**	2 U
Lactate Acid (mg/l)	--	10 U	10 U	10 U	10 U	0.25 U	10 U	**470**	10 U	10 U	0.25 U
Methane (ug/l)	--	**8,210 D**	**18,200 DH**	**1,300 D**	**3,920 D**	**5800 D**	**13,000 D**	**16,200 DH**	**9,200 D**	**3,720 D**	**3400 D**
Nitrate (mg/l)	--	NA	NA	NA	NA	0.1 U	NA	NA	NA	NA	0.1 U
Propionate (mg/l)	--	0.5 U	**5.5**	0.5 U	0.5 U	0.25 U	0.5 U	**170**	**30**	0.5 U	0.25 U
Pyruvate (mg/l)	--	2 U	2 U	2 U	2 U	0.25 U	2 U	**1 J**	2 U	2 U	0.25 U
Sulfate (mg/l)	--	NA	NA	NA	NA	1 U	NA	NA	NA	NA	**14.3**
Sulfide (mg/l)	--	NA	NA	NA	NA	**1 J**	NA	NA	NA	NA	**1 J**
Total organic carbon (TOC) (mg/l)	--	**130 D**	**198 D**	**3.38**	**52.6**	**164 D**	**28.1**	**820 D**	**68.4**	**51.4**	**32.2**

Notes:

Exceeds all criteria

Bold indicates detections

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D - Compound identified in an analysis at a secondary dilution factor

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MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-3b

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW33D					LS12-MW33D			
Sample ID		LS12-MW33D-0311	LS12-MW33DP-0311	LS12-MW33D-0911	LS12-MW33DP-0911	LS12-MW33D-0312	LS12-MW33DP-0312	LS12-MW33D-0912	LS12-MW33D-0313	LS12-MW33DP-0313
Sample Date		03/13/11	03/13/11	09/28/11	09/28/11	03/12/12	03/12/12	09/19/12	03/13/13	03/13/13
Chemical Name										
Volatile Organic Compounds (UG/L)										
1,1-Dichloroethene	7	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	5 U	2.5 U	2.5 UJ
1,2-Dichloroethene (total)	70	**0.782 J**	**1.05 J**	**1.8 J**	**1.62 J**	5 U	5 U	10 U	NA	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**0.782 J**	**1.05**	**1.8**	**1.62**	2.5 U	2.5 U	5 U	2.5 U	2.5 UJ
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	5 U	2.5 U	2.5 UJ
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	5 U	2.5 U	2.5 UJ
Trichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	5 U	2.5 U	2.5 UJ
Vinyl chloride	2	**54.1**	**58.8**	**25.5**	**25.9**	**10.1**	**10.4**	5 U	**5.95**	**7.95 J**
Total Metals (UG/L)										
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)										
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry										
Acetate (mg/l)	--	0.5 U	NA	0.5 U	NA	**1.4**	NA	0.5 U	0.25 U	NA
Butyrate (mg/l)	--	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.25 U	NA
Ethane (ug/l)	--	**172**	NA	**557 H**	NA	**257**	NA	**128**	**247**	NA
Ethene (ug/l)	--	**341**	NA	**358 H**	NA	**42.2**	NA	2 U	**4.29**	NA
Lactate Acid (mg/l)	--	10 U	NA	10 U	NA	10 U	NA	10 U	0.25 U	NA
Methane (ug/l)	--	**22,700 D**	NA	**22,400 DH**	NA	**9,470 D**	NA	**8,750 D**	**11300.0 D**	NA
Nitrate (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	0.1 U	NA
Propionate (mg/l)	--	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.25 U	NA
Pyruvate (mg/l)	--	2 U	NA	2 U	NA	2 U	NA	2 U	0.25 U	NA
Sulfate (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	1 U	NA
Sulfide (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	1.85 U	NA
Total organic carbon (TOC) (mg/l)	--	**19.9**	NA	**17.9**	NA	**11.4**	NA	**16.9**	**24.8**	NA

Notes:

Exceeds all criteria

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MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-3b

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW33S					LS12-MW34D					
Sample ID		LS12-MW33S-0311	LS12-MW33S-0911	LS12-MW33S-0312	LS12-MW33S-0912	LS12-MW33S-0313	LS12-MW34D-0311	LS12-MW34D-0911	LS12-MW34D-0312	LS12-MW34D-0912	LS12-MW34D-0313	LS12-MW34D-0313A
Sample Date		03/13/11	09/28/11	03/12/12	09/19/12	03/13/13	03/10/11	09/28/11	03/12/12	09/18/12	03/13/13	03/15/13
Chemical Name												
Volatile Organic Compounds (UG/L)												
1,1-Dichloroethene	7	0.5 U	0.5 U	2.5 U	2.5 U	2.5 U	0.5 U	0.5 U	2.5 U	5 U	2.5 U	NA
1,2-Dichloroethene (total)	70	**2.75**	**6.39**	**23.6**	**40.9**	NA	**2.3**	**1.7 J**	5 U	10 U	NA	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**2.75**	**6.39**	**23.6**	**40.9**	**39.3**	**2.3**	**1.7**	**1.68 J**	5 U	**2.75 J**	NA
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	**14.7**	0.5 U	**4.04 J**	2.5 U	**35.5**	0.5 U	0.5 U	2.5 U	5 U	2.5 U	NA
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	0.5 U	2.5 U	2.5 U	2.5 U	0.5 U	0.5 U	2.5 U	5 U	2.5 U	NA
Trichloroethene	5	**6.9**	**0.853 J**	**8.39**	**4.3 J**	**27.4**	0.5 U	0.5 U	2.5 U	5 U	2.5 U	NA
Vinyl chloride	2	**6.25**	**6.62**	**8.17**	**22.7**	**10.2**	**2.8**	**1.75**	**2.99 J**	5 U	**5.35**	NA
Total Metals (UG/L)												
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)												
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry												
Acetate (mg/l)	--	0.5 U	**49**	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	NA
Butyrate (mg/l)	--	0.5 U	**3.1**	0.5 U	0.5 U	0.25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	NA
Ethane (ug/l)	--	2 U	2 UH	2 U	2 U	2 NU	2 U	2 UH	2 U	2 U	NA	2 U
Ethene (ug/l)	--	**2.5 J**	2 UH	2 U	2 U	2 NU	2 U	2 UH	2 U	2 U	NA	NA
Lactate Acid (mg/l)	--	10 U	**9.7 J**	10 U	10 U	0.25 U	10 U	10 U	10 U	10 U	**0.92 J**	NA
Methane (ug/l)	--	**15,900 N, D**	**13,900 DH**	**13,500 DN**	**8,850 DN**	**8740 DN**	**17,700 D**	**17,600 DH**	**7,480 D**	**7,490 D**	NA	**14900.0 D**
Nitrate (mg/l)	--	NA	NA	NA	NA	0.1 U	NA	NA	NA	NA	0.1 U	NA
Propionate (mg/l)	--	0.5 U	**66**	0.5 U	0.5 U	0.25 U	0.5 U	**0.11 J**	0.5 U	0.5 U	0.25 U	NA
Pyruvate (mg/l)	--	2 U	**0.32 J**	2 U	2 U	0.25 U	2 U	2 U	2 U	2 U	0.25 U	NA
Sulfate (mg/l)	--	NA	NA	NA	NA	**55**	NA	NA	NA	NA	1 U	NA
Sulfide (mg/l)	--	NA	NA	NA	NA	1.85 U	NA	NA	NA	NA	1.85 U	NA
Total organic carbon (TOC) (mg/l)	--	**7.76**	**155 D**	**22.8**	**8.24**	**5.62**	**174 D**	**111 D**	**150 D**	**173 D**	**198 D**	NA

Notes:

Exceeds all criteria

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MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-3b

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW34S					LS12-MW36D						
Sample ID		LS12-MW34S-0311	LS12-MW34S-0911	LS12-MW34S-0312	LS12-MW34S-0912	LS12-MW34S-0313	LS12-MW36D-0311	LS12-MW36D-0611	LS12-MW36DP-0611	LS12-MW36D-0911	LS12-MW36D-1211	LS12-MW36DP-1211	LS12-MW36D-0312
Sample Date		03/10/11	09/28/11	03/12/12	09/18/12	03/13/13	03/07/11	06/28/11	06/28/11	09/27/11	12/29/11	12/29/11	03/10/12
Chemical Name													
Volatile Organic Compounds (UG/L)													
1,1-Dichloroethene	7	0.5 U	0.5 U	2.5 U	5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethene (total)	70	**1.6 J**	**3.22**	5 U	10 U	NA	**37.8**	**6.82**	**5.41**	**7.39**	**27.2**	**26.5**	**41.2**
2-Butanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**1.6**	**3.22**	**1.33 J**	5 U	**2.9 J**	**37.8**	**6.82**	**5.41**	**7.39**	**27.2**	**26.5**	**40.9**
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	0.5 U	0.5 U	2.5 U	5 U	2.5 U	**7.64**	**2.32 J**	**2.36 J**	**4.26**	**4.33**	**3.43**	**4.01**
Toluene	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	0.5 U	2.5 U	5 U	2.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U
Trichloroethene	5	0.5 U	0.5 U	2.5 U	5 U	2.5 U	**1.82**	**2.3**	**2.37**	**4.65**	**3.74**	**3.45**	**2.55**
Vinyl chloride	2	**62.8**	**44.1**	**70.4**	**85.5**	**273**	**11**	**0.932 J**	**0.764 J**	**0.596 J**	**2.75**	**2.65**	**7.11**
Total Metals (UG/L)													
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)													
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry													
Acetate (mg/l)	--	**1.1**	0.5 U	0.5 U	0.5 U	0.25 U	NA	NA	NA	NA	NA	NA	NA
Butyrate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	NA	NA	NA	NA	NA	NA	NA
Ethane (ug/l)	--	2 U	2 UH	2 U	2 U	2 U	NA	NA	NA	NA	NA	NA	NA
Ethene (ug/l)	--	**11**	**11.4 H**	**13.2**	**11.5**	NA	NA	NA	NA	NA	NA	NA	NA
Lactate Acid (mg/l)	--	10 U	10 U	10 U	10 U	0.25 U	NA	NA	NA	NA	NA	NA	NA
Methane (ug/l)	--	**12,600 D**	**15,100 DH**	**10,200 D**	**4,890 D**	**22300.0 D**	NA	NA	NA	NA	NA	NA	NA
Nitrate (mg/l)	--	NA	NA	NA	NA	0.1 U	NA	NA	NA	NA	NA	NA	NA
Propionate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U	0.25 U	NA	NA	NA	NA	NA	NA	NA
Pyruvate (mg/l)	--	2 U	2 U	2 U	2 U	0.25 U	NA	NA	NA	NA	NA	NA	NA
Sulfate (mg/l)	--	NA	NA	NA	NA	1 U	NA	NA	NA	NA	NA	NA	NA
Sulfide (mg/l)	--	NA	NA	NA	NA	1.69 U	NA	NA	NA	NA	NA	NA	NA
Total organic carbon (TOC) (mg/l)	--	**16.9**	**15.8**	**13**	**12.1**	**9.82**	NA	NA	NA	NA	NA	NA	NA

Notes:

Exceeds all criteria

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UG/L - Micrograms per liter

TABLE F-3b

Site 12 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS12-MW36D					
Sample ID		LS12-MW36D-0612	LS12-MW36DP-0612	LS12-MW36D-0912	LS12-MW36D-1212	LS12-MW36D-P-1212	LS12-MW36D-0313
Sample Date		06/04/12	06/04/12	09/18/12	12/28/12	12/28/12	03/13/13
Chemical Name							
Volatile Organic Compounds (UG/L)							
1,1-Dichloroethene	7	0.5 U	0.5 U	0.5 U	2.5 U	2.5 U	0.5 U
1,2-Dichloroethene (total)	70	**37.2**	**37.4**	**60.2**	**87.6**	**80.1**	NA
2-Butanone	--	NA	NA	NA	NA	NA	NA
2-Hexanone	--	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	--	NA	NA	NA	NA	NA	NA
Acetone	--	NA	NA	NA	NA	NA	NA
Carbon disulfide	--	NA	NA	NA	NA	NA	NA
Chloroform	80	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	70	**37.2**	**37.4**	**59.2**	**86.4**	**78.8**	**61**
Isopropylbenzene	--	NA	NA	NA	NA	NA	NA
m- and p-Xylene	--	NA	NA	NA	NA	NA	NA
Methyl acetate	--	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	--	NA	NA	NA	NA	NA	NA
o-Xylene	--	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	**5.27**	**5.15**	**5.48**	**2.55 J**	**1.65 J**	**6.45**
Toluene	1,000	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	100	0.5 U	0.5 U	**0.99 J**	2.5 U	**1.25 J**	**1.91**
Trichloroethene	5	**2.95**	**2.86**	**4.88**	**2.65 J**	**2 J**	**2.98**
Vinyl chloride	2	**9.94 J**	**10.1 J**	**7.55**	**21.4**	**21.3**	**5.98**
Total Metals (UG/L)							
Arsenic	10	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)							
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA
Wet Chemistry							
Acetate (mg/l)	--	NA	NA	0.5 U	NA	NA	0.25 U
Butyrate (mg/l)	--	NA	NA	0.5 U	NA	NA	0.25 U
Ethane (ug/l)	--	NA	NA	2 U	NA	NA	2 U
Ethene (ug/l)	--	NA	NA	2 U	NA	NA	NA
Lactate Acid (mg/l)	--	NA	NA	10 U	NA	NA	0.25 U
Methane (ug/l)	--	NA	NA	**913**	NA	NA	**2450 D**
Nitrate (mg/l)	--	NA	NA	NA	NA	NA	0.1 U
Propionate (mg/l)	--	NA	NA	0.5 U	NA	NA	0.25 U
Pyruvate (mg/l)	--	NA	NA	2 U	NA	NA	0.25 U
Sulfate (mg/l)	--	NA	NA	NA	NA	NA	**3.04**
Sulfide (mg/l)	--	NA	NA	NA	NA	NA	1.85 U
Total organic carbon (TOC) (mg/l)	--	NA	NA	**2.48 J**	NA	NA	**2.72 J**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

D - Compound identified in an analysis at a secondary dilution factor

H - Holding time exceedance

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

N - The MS/MSD accuracy and/or precision are outside criteria. The predigested spike recovery is not within control limits for the associated parameter.

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-4a

Site 13 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS13-MW02T		LS13-MW03T		LS13-MW04T		LS13-MW05S		LS13-MW06S		LS13-MW07S	
Sample ID		LS13-MW02T-12C	LS13-MW02T-13A	LS13-MW03T-12C	LS13-MW03T-13A	LS13-MW04T-12C	LS13-MW04T-13A	LS13-MW05S-12C	LS13-MW05S-13A	LS13-MW06S-12C	LS13-MW06S-13A	LS13-MW07S-12C	LS13-MW07S-13A
Sample Date		09/27/12	03/25/13	09/26/12	03/26/13	09/26/12	03/28/13	09/27/12	03/28/13	09/26/12	03/27/13	09/27/12	03/28/13
Chemical Name													
Volatile Organic Compounds (UG/L)													
cis-1,2-Dichloroethene	70	0.5 U	0.5 U	**130**	**40**	**7.9**	**4.7**	0.5 U	0.5 U	**2.6**	**1.4**	0.5 U	0.5 U
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	**0.78 J**	**0.6 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	0.5 U	1 U	**1.9**	**1.1**	**3**	**2.2**	0.5 U	1 U	0.5 U	**0.91 J**	0.5 U	1 U
Vinyl chloride	2	0.5 U	0.5 U	**31**	**19**	**3.2**	**3.6**	0.5 U	0.5 U	**2.1**	**0.67 J**	0.5 U	0.5 U
Semivolatile Organic Compounds (UG/L)													
Pentachlorophenol	1	0.5 U	0.5 U	0.5 U	0.5 U	**0.3 J**	**2**	0.5 U	0.5 U	0.5 U	**8.3**	0.5 U	0.5 U
Total Metals (UG/L)													
Arsenic	10	**0.51 J**	**0.51 J**	NA	NA	NA	NA	**2.6**	**1.3**	NA	NA	0.5 U	**0.34 J**
Iron	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)													
Arsenic, Dissolved	10	**0.2 J**	**0.54 J**	NA	NA	NA	NA	**2**	**1.7**	NA	NA	**0.8 J**	**0.53 J**
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry													
Acetate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Alkalinity (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butyrate (mg/l)	--	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Ethane (ug/l)	--	0.91 U	0.91 U	**4.3**	**9.1**	0.91 U	**0.68 J**	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U
Ethene (ug/l)	--	0.84 U	0.84 U	**3.3**	**9.1**	**0.39 J**	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	**1.2**	0.84 U
Lactate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methane (ug/l)	--	**0.22 J**	0.47 U	**2,300**	**1300**	**690**	**86**	**990**	**1600**	**4,400**	**1300**	**0.74**	**0.65**
Nitrate (mg/l)	--	**0.98**	**2.3**	0.1 U	0.1 U	**0.13 J**	**0.85**	**0.37**	**0.57**	0.1 U	0.25 U	**2.3**	**5.1**
Nitrite (mg/l)	--	0.05 U	0.1 U	0.25 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.25 U	0.25 U	0.05 U	0.1 U
Propionate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Pyruvate (mg/l)	--	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	0.5 U	0.5 U	0.5 U
Sulfate (mg/l)	--	**8.6**	**19**	**32**	**23**	**24**	**19**	**16**	**17**	**25**	**24**	**86**	**59**
Total organic carbon (TOC) (mg/l)	--	**1.3**	**1.4**	**8.6**	**6.8**	**3.5**	**2.4**	**2.1**	**2.5**	**4.1**	**3.5**	**1.1**	**1.1**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

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L - Analyte present, value may be biased low, actual value may be higher

R - Unreliable Result

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

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-4a

Site 13 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS13-MW09S		LS13-MW10T		LS13-MW11D		LS13-MW11S		LS13-MW12D		LS13-MW12S			
Sample ID		LS13-MW09S-12C	LS13-MW09S-13A	LS13-MW10T-12C	LS13-MW10T-13A	LS13-MW11D-12C	LS13-MW11D-13A	LS13-MW11S-12C	LS13-MW11S-13A	LS13-MW12D-12C	LS13-MW12D-13A	LS13-MW12S-12C	LS13-MW12SP-12C	LS13-MW12S-13A	LS13-MW12SP-13A
Sample Date		09/26/12	03/28/13	09/25/12	03/27/13	09/26/12	03/27/13	09/26/12	03/27/13	09/25/12	03/27/13	09/25/12	09/25/12	03/27/13	03/27/13
Chemical Name															
Volatile Organic Compounds (UG/L)															
cis-1,2-Dichloroethene	70	**3.1**	**2.9**	**3.4**	**1.8**	**1.9**	**1.2**	0.5 U	0.5 U	**20**	**8.2**	**28**	**24**	**8.7**	**9.3**
Tetrachloroethene	5	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	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	0.5 U	1 U	0.5 U	**0.77 J**	**1**	**1.1**	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	1 U	1 U
Vinyl chloride	2	**3.8**	**6.2**	**6.1**	**1.2**	0.5 U	0.5 U	0.5 U	0.5 U	**14**	**12**	**25**	**19**	**8**	**8**
Semivolatile Organic Compounds (UG/L)															
Pentachlorophenol	1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.54 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
Total Metals (UG/L)															
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)															
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry															
Acetate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	**0.91 J**	1 U	1 U	1 U	1 U	NA	1 U	NA
Alkalinity (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butyrate (mg/l)	--	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	NA	2 U	NA
Ethane (ug/l)	--	0.91 U	**1.2**	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	**2.5**	**3.1**	**1.9**	NA	0.91 U	NA
Ethene (ug/l)	--	**0.79 J**	**0.56 J**	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	**2.7**	**2.8**	**4.1**	NA	**1.2**	NA
Lactate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA
Methane (ug/l)	--	**6,500**	**8200**	**1,300**	**490**	**4,100**	**1700**	**9,900**	**380**	**12,000**	**12,000**	**1,100**	NA	**11000**	NA
Nitrate (mg/l)	--	0.1 U	0.25 U	0.1 U	0.5 U	0.1 U	1 U	0.1 U	**0.013 J**	0.1 U	1 U	0.1 U	NA	0.5 U	NA
Nitrite (mg/l)	--	0.25 U	0.25 U	0.25 U	0.5 U	0.25 U	1 U	0.25 U	0.05 U	0.25 U	1 U	0.25 U	NA	0.5 U	NA
Propionate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA
Pyruvate (mg/l)	--	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	0.5 U	0.5 U	NA	0.5 U	NA
Sulfate (mg/l)	--	**14**	**26**	**53**	**58**	**7.7 J**	20 U	5 U	**13**	5 U	**5.3 J**	**33**	NA	**7.4 J**	NA
Total organic carbon (TOC) (mg/l)	--	**7.4**	**6.3**	**5.9**	**4.2**	**3.6**	**3.1**	**8.7**	**3.8**	**36**	**42**	**5.3**	NA	**11**	NA

Notes:

Exceeds all criteria

Bold indicates detections

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R - Unreliable Result

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

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-4a

Site 13 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS13-MW13S		LS13-MW14T		LS13-MW18T		LS13-MW19T			
Sample ID		LS13-MW13S-12C	LS13-MW13S-13A	LS13-MW14T-12C	LS13-MW14T-13A	LS13-MW18T-12C	LS13-MW18T-13A	LS13-MW19T-12C	LS13-MW19TP-12C	LS13-MW19T-13A	LS13-MW19TP-13A
Sample Date		09/25/12	03/27/13	09/26/12	03/26/13	09/26/12	03/28/13	09/27/12	09/27/12	03/25/13	03/25/13
Chemical Name											
Volatile Organic Compounds (UG/L)											
cis-1,2-Dichloroethene	70	0.5 U	0.5 U	0.5 U	0.5 U	**26**	**28**	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethene	5	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	0.5 U
Trichloroethene	5	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	1 U	1 U
Vinyl chloride	2	0.5 U	0.5 U	0.5 U	0.5 U	**18**	**30**	0.5 U	0.5 U	0.5 U	0.5 U
Semivolatile Organic Compounds (UG/L)											
Pentachlorophenol	1	**0.88**	**2**	0.5 U	**33**	0.5 U	0.54 U	0.5 U	0.5 U	0.5 U	0.5 U
Total Metals (UG/L)											
Arsenic	10	NA	NA	NA	NA	NA	NA	**0.37 J**	**0.29 J**	0.5 U	**0.64 J**
Iron	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)											
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	0.5 U	**0.83 J**	**0.48 J**	**0.53 J**
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry											
Acetate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA
Alkalinity (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butyrate (mg/l)	--	2 U	2 U	2 U	2 U	2 U	2 U	2 U	NA	2 U	NA
Ethane (ug/l)	--	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	NA	0.91 U	NA
Ethene (ug/l)	--	0.84 U	0.84 U	0.84 U	0.84 U	**0.98 J**	**1.3**	0.84 U	NA	0.84 U	NA
Lactate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA
Methane (ug/l)	--	**21**	**19**	**7,600**	**3400**	**2,800**	**1300**	**0.22 J**	NA	0.47 U	NA
Nitrate (mg/l)	--	**2.2**	**2.8**	0.02 U	0.25 U	0.1 U	1.2 U	**2.1**	NA	**2.7**	NA
Nitrite (mg/l)	--	0.05 U	0.05 U	0.05 U	0.25 U	0.25 U	1.2 U	0.05 U	NA	0.05 U	NA
Propionate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA
Pyruvate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	NA
Sulfate (mg/l)	--	**29**	**32**	**0.56 J**	**12**	**13**	25 U	**21**	NA	**25**	NA
Total organic carbon (TOC) (mg/l)	--	**1.4**	**1.1**	**18.0**	**14**	**6.1**	**5.5**	**0.7 J**	NA	**0.58 J**	NA

Notes:

Exceeds all criteria

Bold indicates detections

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UL - Analyte not detected, quantitation limit is probably higher

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-4a

Site 13 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS13-MW20T		LS13-MW21S		LS13-MW24D		LS13-MW25S			LS13-MW26S		
Sample ID		LS13-MW20T-12C	LS13-MW20T-13A	LS13-MW21S-12C	LS13-MW21S-13A	LS13-MW24D-12C	LS13-MW24D-13A	LS13-MW25S-12C	LS13-MW25S-13A	LS13-MW26S-12C	LS13-MW26SP-12C	LS13-MW26S-13A	LS13-MW26SP-13A
Sample Date		09/27/12	03/25/13	09/26/12	03/26/13	09/25/12	03/26/13	09/26/12	03/26/13	09/26/12	09/26/12	03/26/13	03/26/13
Chemical Name													
Volatile Organic Compounds (UG/L)													
cis-1,2-Dichloroethene	70	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	0.5 U	0.5 U	0.5 U
Tetrachloroethene	5	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	0.5 U	0.5 U	0.5 U
Trichloroethene	5	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	1 U	1 U
Vinyl chloride	2	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	0.5 U	0.5 U	0.5 U
Semivolatile Organic Compounds (UG/L)													
Pentachlorophenol	1	0.5 U	0.54 UL	**5.2**	**0.6**	**28**	0.5 U	**3.7**	**17**	**2.3**	**0.74**	**5.5 J**	**2.9 J**
Total Metals (UG/L)													
Arsenic	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)													
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry													
Acetate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA
Alkalinity (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butyrate (mg/l)	--	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	NA	2 U	NA
Ethane (ug/l)	--	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	NA	0.91 U	NA
Ethene (ug/l)	--	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	NA	0.84 U	NA
Lactate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA
Methane (ug/l)	--	**190**	**210**	**8,000**	**6400**	**3,900**	**10000**	**2,200**	**3900**	**4,600**	NA	**820**	NA
Nitrate (mg/l)	--	**0.019 J**	0.05 U	0.1 U	0.25 U	0.1 U	0.25 U	0.1 U	0.25 U	0.04 U	NA	0.1 U	NA
Nitrite (mg/l)	--	0.05 U	0.05 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.1 U	NA	0.1 U	NA
Propionate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA
Pyruvate (mg/l)	--	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	NA	0.5 U	NA
Sulfate (mg/l)	--	**0.88 J**	**0.61 J**	**19**	**11**	**35**	**7.2 J**	**22**	**19**	**17**	NA	**20**	NA
Total organic carbon (TOC) (mg/l)	--	**0.7 J**	**0.78 J**	**4.8**	**4.2**	**8.6**	**13**	**8.6**	**7**	**5.3**	NA	**3.4**	NA

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

NA - Not analyzed

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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

R - Unreliable Result

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

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-4a

Site 13 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS13-MW27S		LS13-MW28D	
Sample ID		LS13-MW27S-12C	LS13-MW27S-13A	LS13-MW28D-12C	LS13-MW28D-13A
Sample Date		09/26/12	03/26/13	09/25/12	03/26/13
Chemical Name					
Volatile Organic Compounds (UG/L)					
cis-1,2-Dichloroethene	70	0.5 U	0.5 U	**1,800**	**690**
Tetrachloroethene	5	0.5 U	0.5 U	**150**	**92**
Trichloroethene	5	0.5 U	1 U	**720**	**91**
Vinyl chloride	2	0.5 U	0.5 U	**520**	**110**
Semivolatile Organic Compounds (UG/L)					
Pentachlorophenol	1	0.5 U	0.56 U	**37**	**67**
Total Metals (UG/L)					
Arsenic	10	NA	NA	NA	NA
Iron	--	NA	NA	NA	NA
Manganese	--	NA	NA	NA	NA
Dissolved Metals (UG/L)					
Arsenic, Dissolved	10	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA
Wet Chemistry					
Acetate (mg/l)	--	1 U	1 U	1 U	1 U
Alkalinity (mg/l)	--	NA	NA	NA	NA
Butyrate (mg/l)	--	2 U	2 U	2 U	2 U
Ethane (ug/l)	--	0.91 U	0.91 U	**29**	**9.8**
Ethene (ug/l)	--	0.84 U	0.84 U	**41**	**8**
Lactate (mg/l)	--	1 U	1 U	1 U	1 U
Methane (ug/l)	--	**8,300**	**13000**	**1,800**	**1500**
Nitrate (mg/l)	--	**0.065 J**	0.25 U	0.1 U	0.1 U
Nitrite (mg/l)	--	0.25 U	0.25 U	0.25 U	0.1 U
Propionate (mg/l)	--	1 U	1 U	1 U	1 U
Pyruvate (mg/l)	--	0.5 U	0.5 U	0.5 U	0.5 U
Sulfate (mg/l)	--	**220**	**12**	**15**	**16**
Total organic carbon (TOC) (mg/l)	--	**19.0**	**17**	**5.4**	**3.9**

Notes:

Exceeds all criteria

Bold indicates detections

*Clean-up levels are Maximum Contaminant Levels (MCLs)

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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

R - Unreliable Result

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

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-4b

Site 13 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS13-MW29D		LS13-MW30D		LS13-MW31D		LS13-MW32D		LS13-MW33D		LS13-MW34D	
Sample ID		LS13-MW29D-12C	LS13-MW29D-13A	LS13-MW30D-12C	LS13-MW30D-13A	LS13-MW31D-12C	LS13-MW31D-13A	LS13-MW32D-12C	LS13-MW32D-13A	LS13-MW33D-12C	LS13-MW33D-13A	LS13-MW34D-12C	LS13-MW34D-13A
Sample Date		09/27/12	03/27/13	09/26/12	03/25/13	09/27/12	03/26/13	09/25/12	03/28/13	09/27/12	03/27/13	09/27/12	03/25/13
Chemical Name													
Volatile Organic Compounds (UG/L)													
cis-1,2-Dichloroethene	70	0.5 U	0.5 U	**0.59 J**	0.5 U	0.5 U	0.5 U	**3.8**	**3**	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethene	5	**0.42 J**	**0.71 J**	0.5 U	0.5 U	**4.1**	**5.2**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	0.5 U	**0.33 J**	0.5 U	1 U	**0.44 J**	**0.28 J**	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U
Vinyl chloride	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**5.5**	**11**	0.5 U	0.5 U	0.5 U	0.5 U
Semivolatile Organic Compounds (UG/L)													
Pentachlorophenol	1	**1.9**	0.53 U	0.5 UL	**1.4 L**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Total Metals (UG/L)													
Arsenic	10	**0.99 J**	**0.85 J**	NA	NA	NA	NA	NA	NA	**0.56 J**	**1.2**	**0.48 J**	**1.1**
Iron	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)													
Arsenic, Dissolved	10	**1.1**	**0.68 J**	NA	NA	NA	NA	NA	NA	**0.35 J**	**1.1**	**0.61 J**	**0.56 J**
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wet Chemistry													
Acetate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Alkalinity (mg/l)	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butyrate (mg/l)	--	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Ethane (ug/l)	--	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	0.91 U	**1.9**	**5.5**	0.91 U	0.91 U	0.91 U	0.91 U
Ethene (ug/l)	--	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	0.84 U	**0.33 J**	**1.8**	0.84 U	0.84 U	0.84 U	0.84 U
Lactate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methane (ug/l)	--	**31**	**21**	**170**	**130**	**26**	**10**	**12,000**	**14000**	**660**	**420**	**0.39 J**	**0.48 J**
Nitrate (mg/l)	--	**0.35**	0.1 U	0.02 U	0.05 U	0.02 U	0.1 U	0.1 U	1 U	**0.025 J**	0.1 U	**0.36**	**0.65**
Nitrite (mg/l)	--	0.05 U	0.1 U	0.05 U	0.1 U	0.05 U	0.1 U	0.25 U	1 U	0.05 U	0.1 U	0.05 U	0.05 U
Propionate (mg/l)	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Pyruvate (mg/l)	--	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	0.5 U	0.5 U	0.5 U
Sulfate (mg/l)	--	**21**	**25**	**25**	**29**	**5.5**	**5.4**	5 U	20 U	**1.1 J**	**1.1 J**	**21**	**15**
Total organic carbon (TOC) (mg/l)	--	**1.9**	**1.3**	**1.8**	**1.7**	1 U	1 U	**70**	**27**	**1.7**	**1.4**	**1.1**	**1.2**

Notes:

Exceeds all criteria

Bold indicates detections

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UL - Analyte not detected, quantitation limit is probably higher

MG/L - Milligrams per liter

UG/L - Micrograms per liter

TABLE F-4b

Site 13 Validated Groundwater Exceedance Analytical Results

Second Comprehensive Five-Year Review

JEB Little Creek

Virginia Beach, Virginia

Station ID	**Cleanup Level***	LS13-MW36D				LS13-MW37D	
Sample ID		LS13-MW36D-12C	LS13-MW36DP-12C	LS13-MW36D-13A	LS13-MW36DP-13A	LS13-MW37D-12C	LS13-MW37D-13A
Sample Date		09/25/12	09/25/12	03/28/13	03/28/13	09/25/12	03/27/13
Chemical Name							
Volatile Organic Compounds (UG/L)							
cis-1,2-Dichloroethene	70	**0.47 J**	**0.48 J**	0.5 U	0.5 U	**2.1**	**0.93 J**
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	0.5 U	0.5 U	1 U	1 U	0.5 U	1 U
Vinyl chloride	2	**0.41 J**	**0.41 J**	0.5 U	0.5 U	0.5 U	0.5 U
Semivolatile Organic Compounds (UG/L)							
Pentachlorophenol	1	**2.8**	**7.9**	**45**	**43**	0.5 U	0.5 U
Total Metals (UG/L)							
Arsenic	10	NA	NA	NA	NA	NA	NA
Iron	--	NA	NA	NA	NA	NA	NA
Manganese	--	NA	NA	NA	NA	NA	NA
Dissolved Metals (UG/L)							
Arsenic, Dissolved	10	NA	NA	NA	NA	NA	NA
Iron, Dissolved	--	NA	NA	NA	NA	NA	NA
Manganese, Dissolved	--	NA	NA	NA	NA	NA	NA
Wet Chemistry							
Acetate (mg/l)	--	1 U	NA	1 U	NA	1 U	1 U
Alkalinity (mg/l)	--	NA	NA	NA	NA	NA	NA
Butyrate (mg/l)	--	2 U	NA	2 U	NA	2 U	2 U
Ethane (ug/l)	--	0.91 U	NA	0.91 U	NA	0.91 U	0.91 U
Ethene (ug/l)	--	0.84 U	NA	0.84 U	NA	0.84 U	0.84 U
Lactate (mg/l)	--	1 U	NA	1 U	NA	1 U	1 U
Methane (ug/l)	--	**1,000**	NA	**60**	NA	**2,300**	**1000**
Nitrate (mg/l)	--	0.1 U	NA	0.1 U	NA	0.1 U	0.25 U
Nitrite (mg/l)	--	0.25 U	NA	0.1 U	NA	0.25 U	0.25 U
Propionate (mg/l)	--	1 U	NA	1 U	NA	1 U	1 U
Pyruvate (mg/l)	--	0.5 U	NA	0.5 U	NA	0.5 U	0.5 U
Sulfate (mg/l)	--	**24**	NA	**24**	NA	**24**	**21**
Total organic carbon (TOC) (mg/l)	--	**1.7**	NA	**1.4**	NA	**4.5**	**3.6**

Notes:

Exceeds all criteria

Bold indicates detections

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MG/L - Milligrams per liter

UG/L - Micrograms per liter

Appendix G
Trend Data

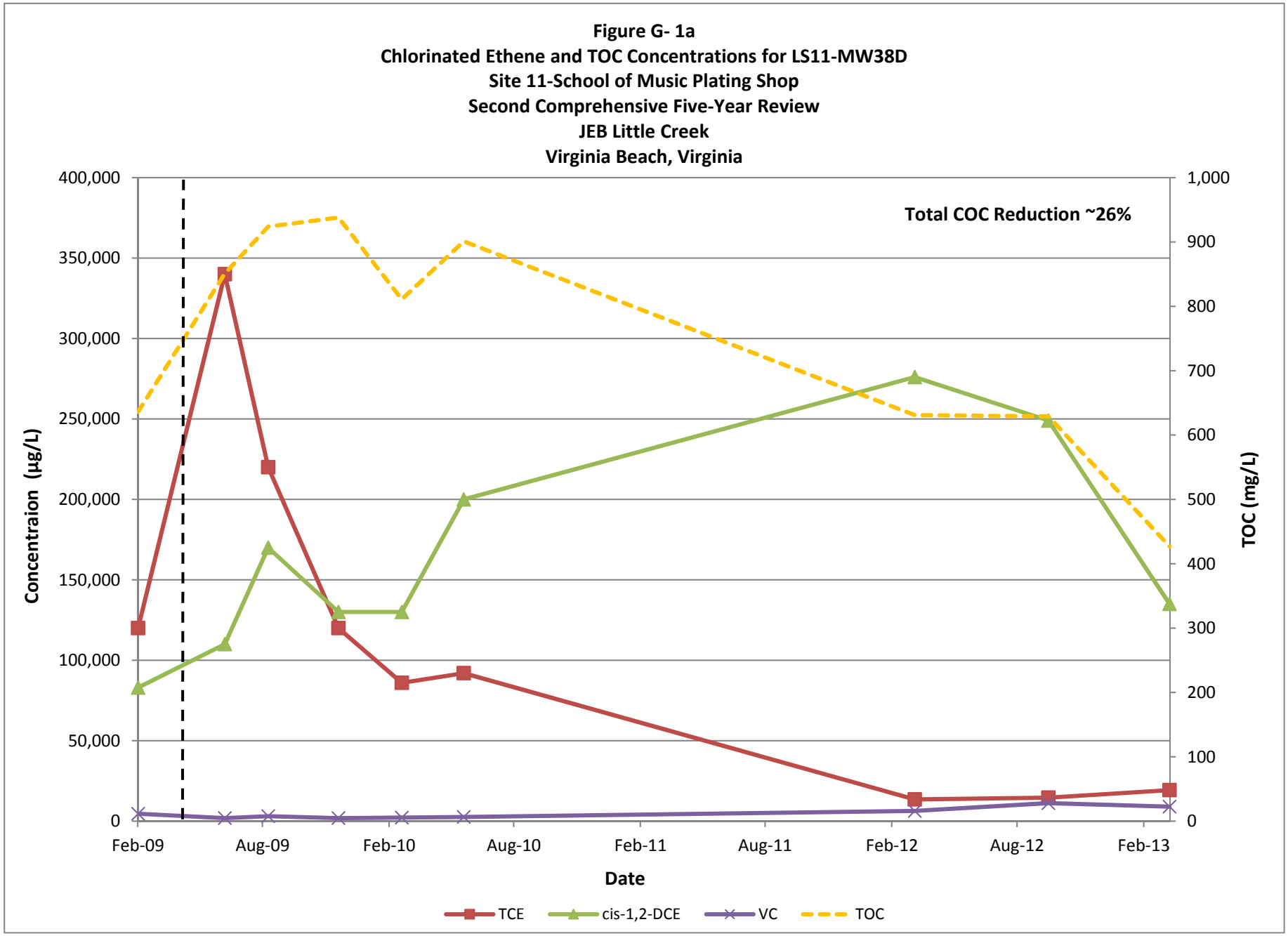


Figure G- 1a
Chlorinated Ethene and TOC Concentrations for LS11-MW38D
Site 11-School of Music Plating Shop
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total COC Reduction ~26%
Concentraion (µg/L)
TOC (mg/L)
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1,000
900
800
700
600
500
400
300
200
100
0
Feb-09
Aug-09
Feb-10
Aug-10
Feb-11
Aug-11
Feb-12
Aug-12
Feb-13
Date
TCE
cis-1,2-DCE
VC
TOC

Figure G-1b
Chlorinated Ethane, Chlorinated Methane and TOC Concentrations for LS11- MW38D
Site 11-School of Music Plating Shop
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

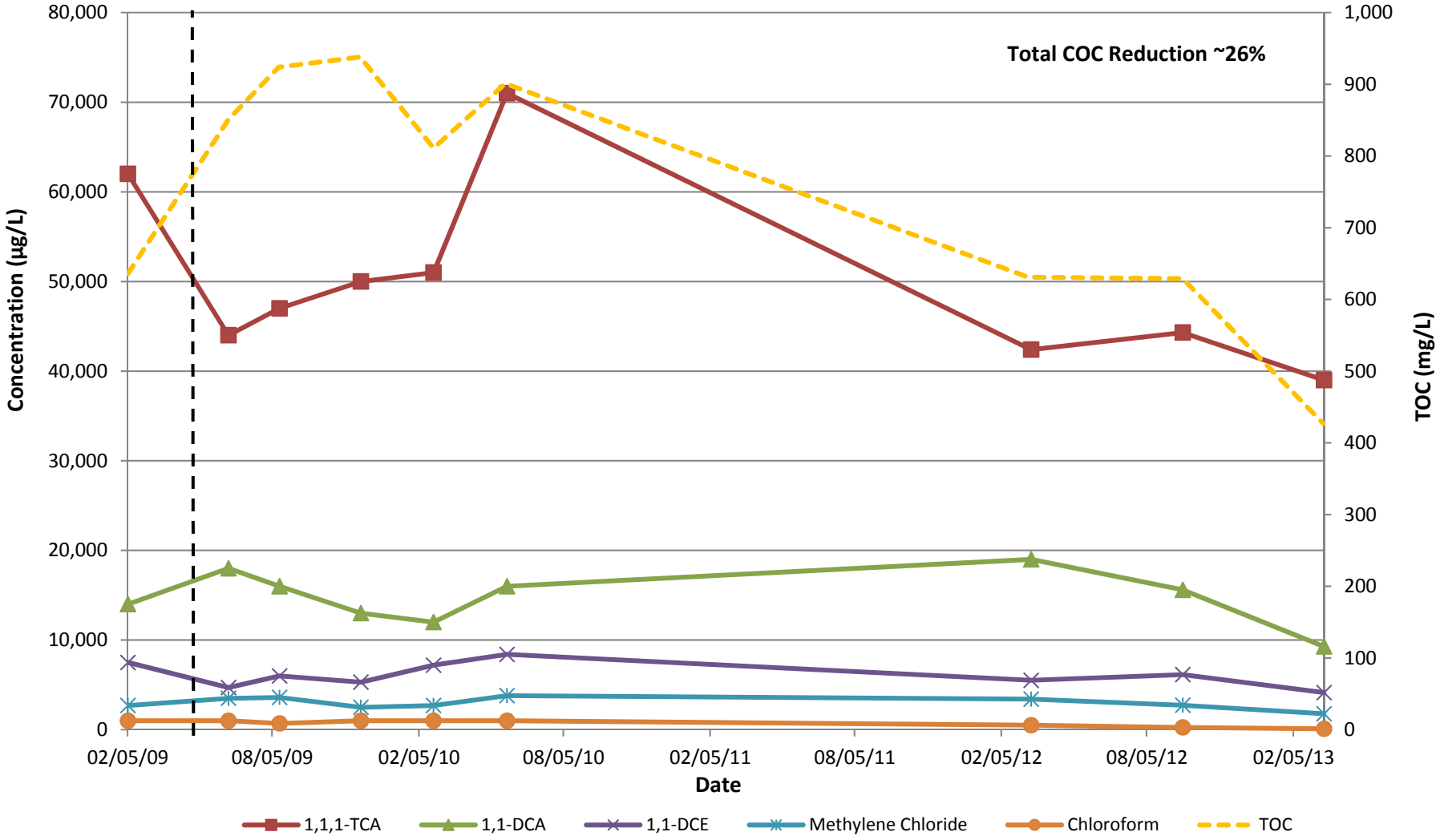


Figure G-1c
Chlorinated Ethene and TOC Concentrations for LS11-MW39D
Site 11-School of Music Plating Shop
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

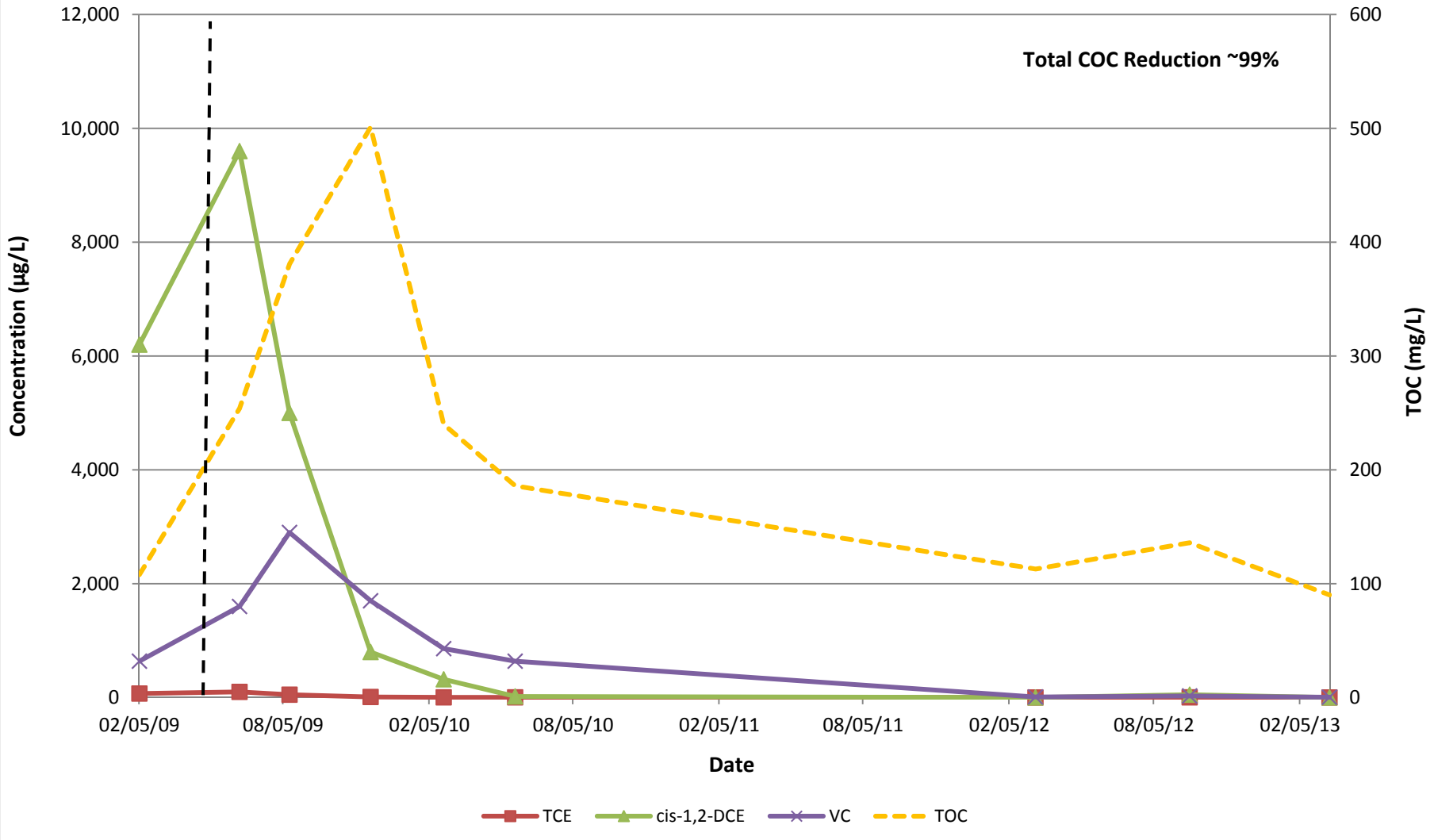


Figure G-1d
Chlorinated Ethane and TOC Concentrations for LS11- MW39D
Site 11-School of Music Plating Shop
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

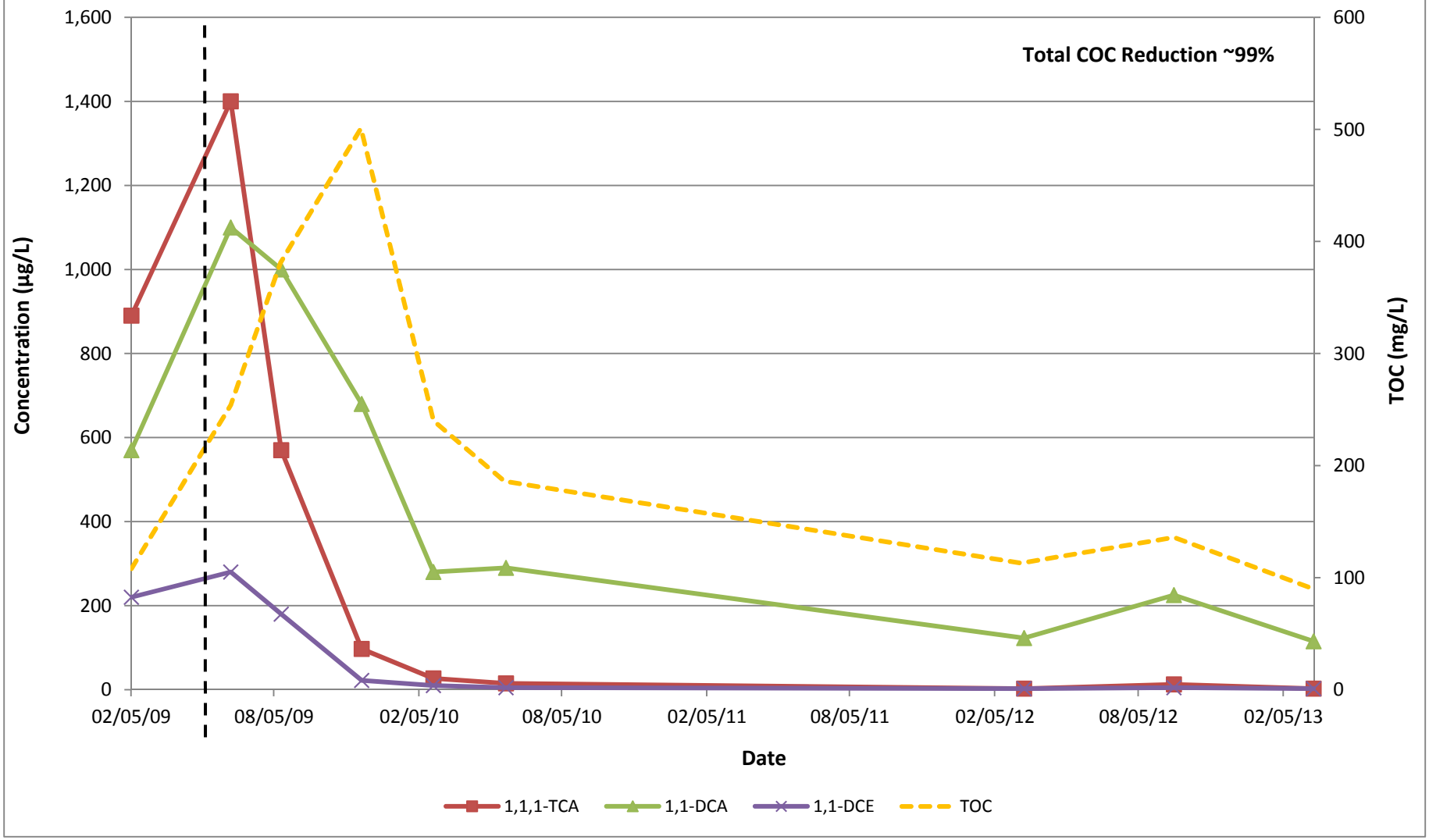


Figure G-1e
Chlorinated Ethane and TOC Concentrations for LS11-MW09D
Site 11-School of Music Plating Shop
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

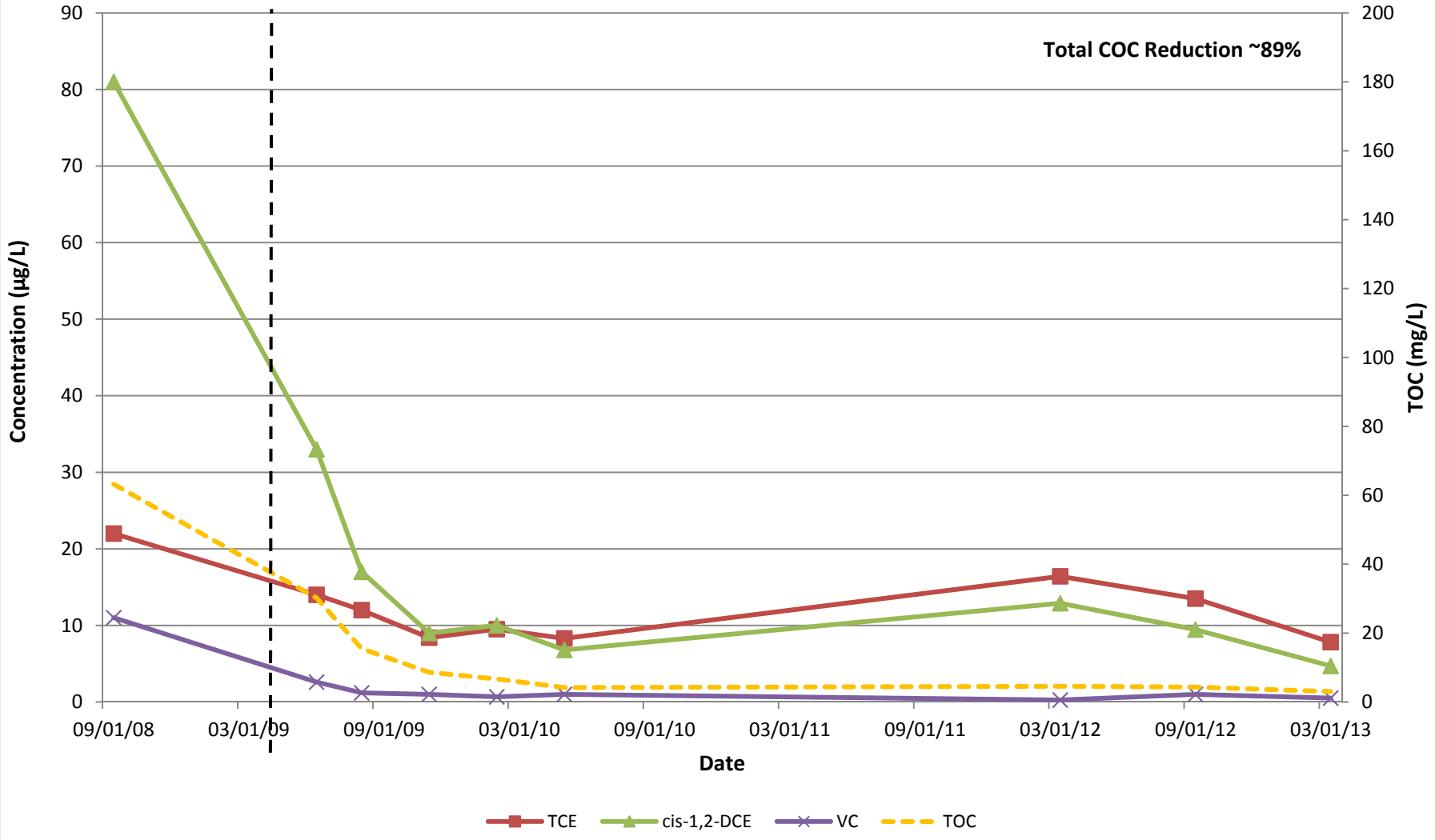


Figure G-1f
Chlorinated Ethene and TOC Concentrations for LS11-MW40D
Site 11-School of Music Plating Shop
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

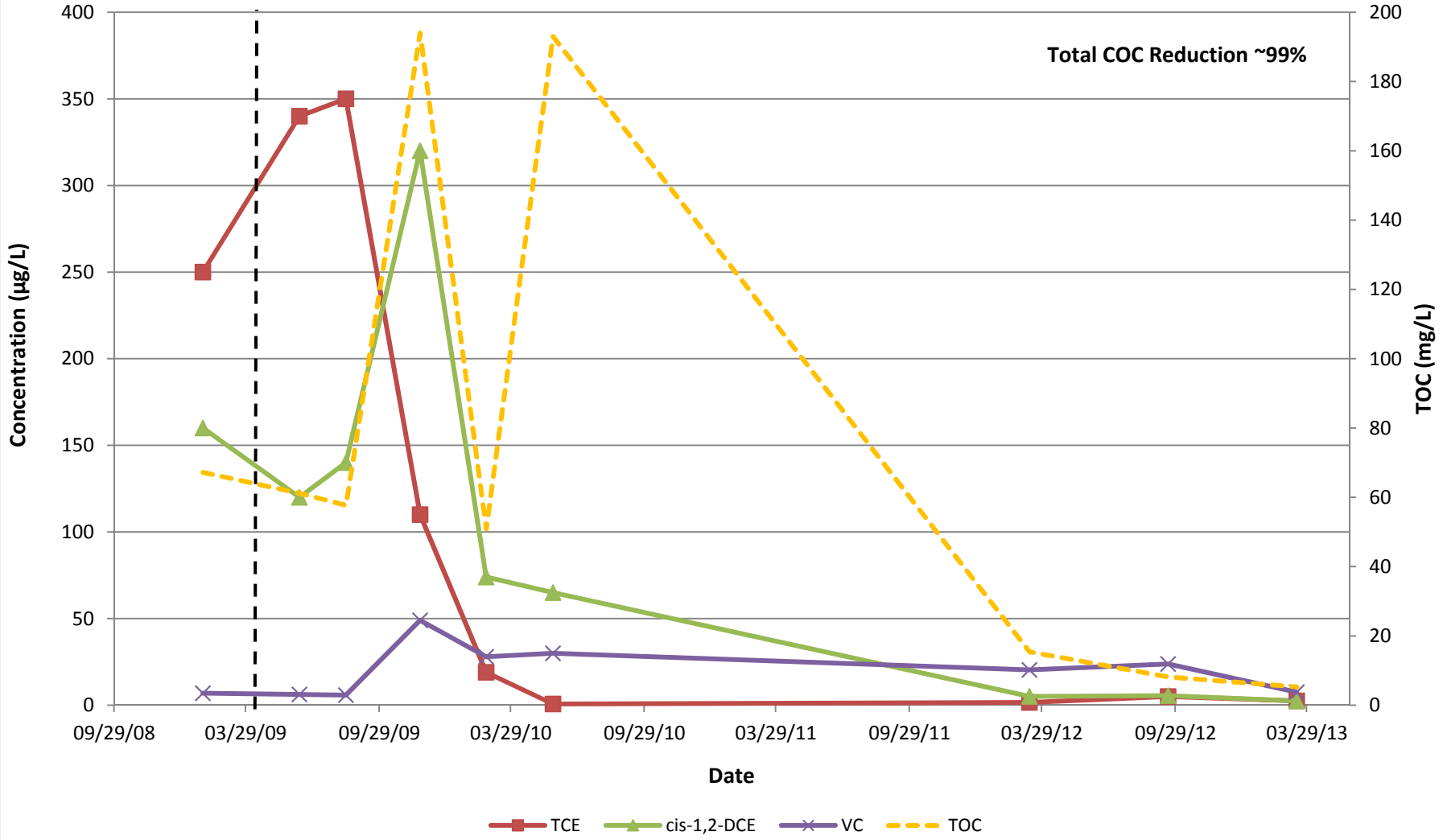


Figure G-1g
Chlorinated Ethene and TOC Concentrations for LS11-MW41D
Site 11-School of Music Plating Shop
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

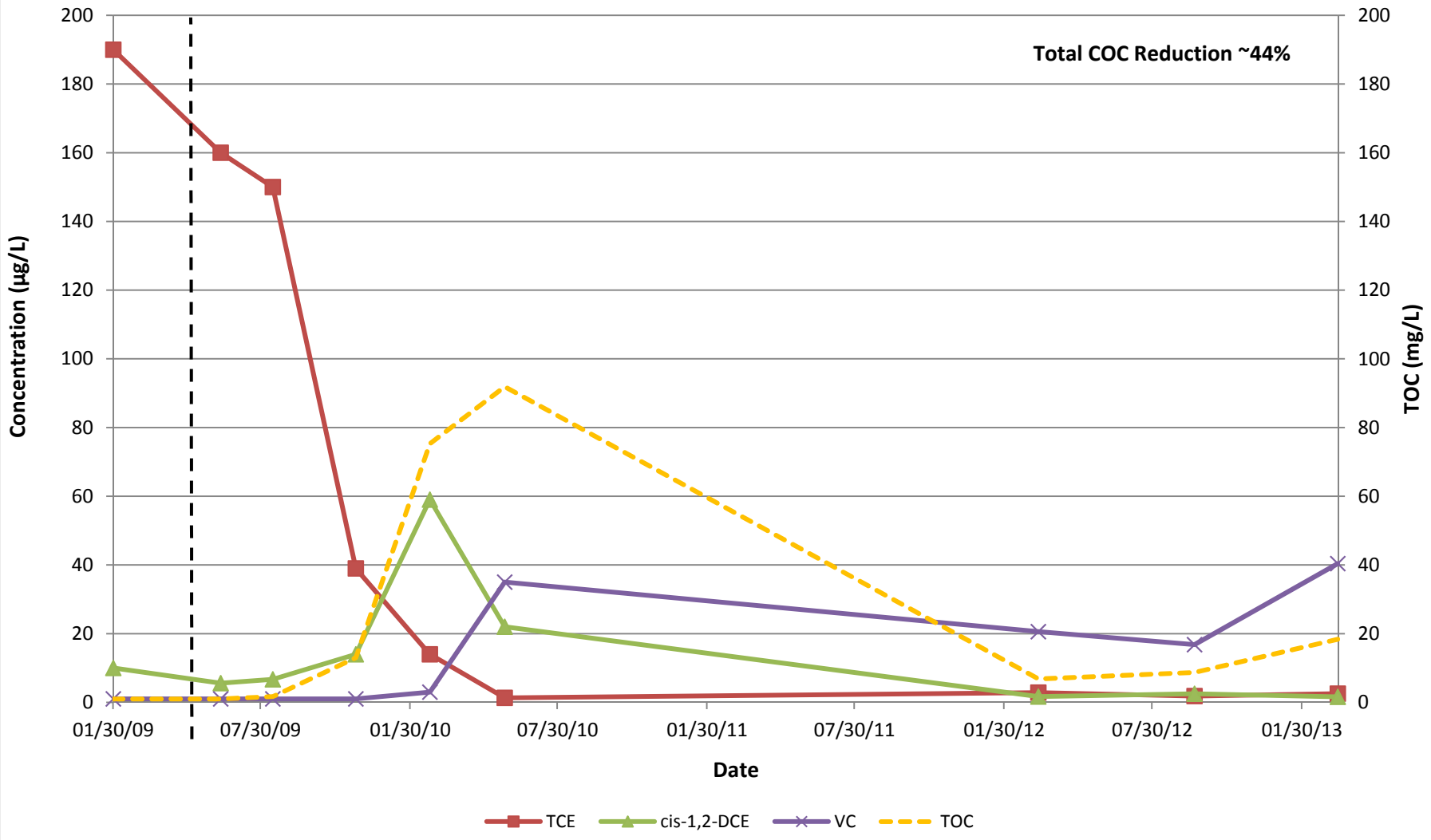
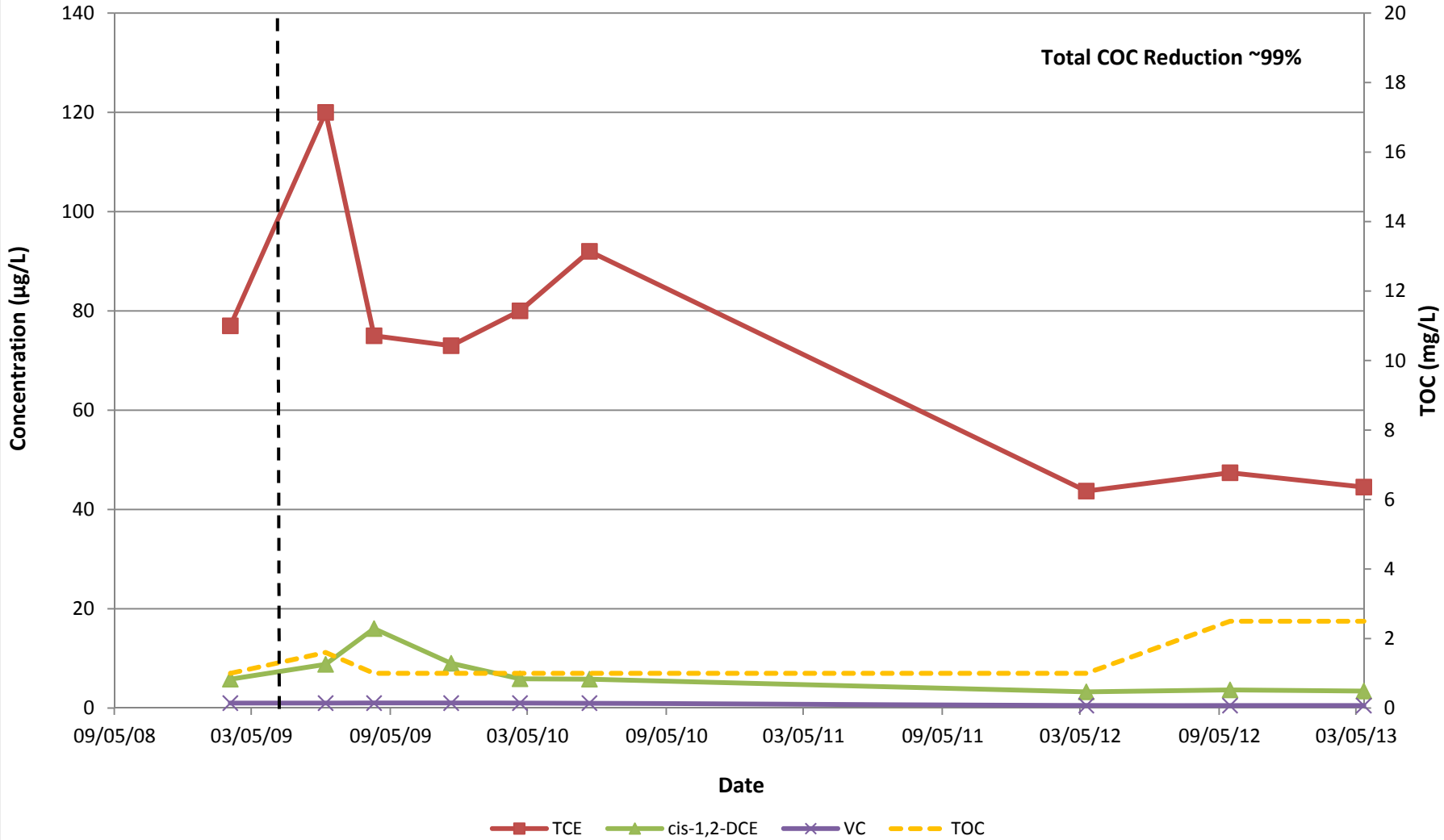


Figure G-1h
Chlorinated Ethene and TOC Concentrations for LS11-MW42D
Site 11-School of Music Plating Shop
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia



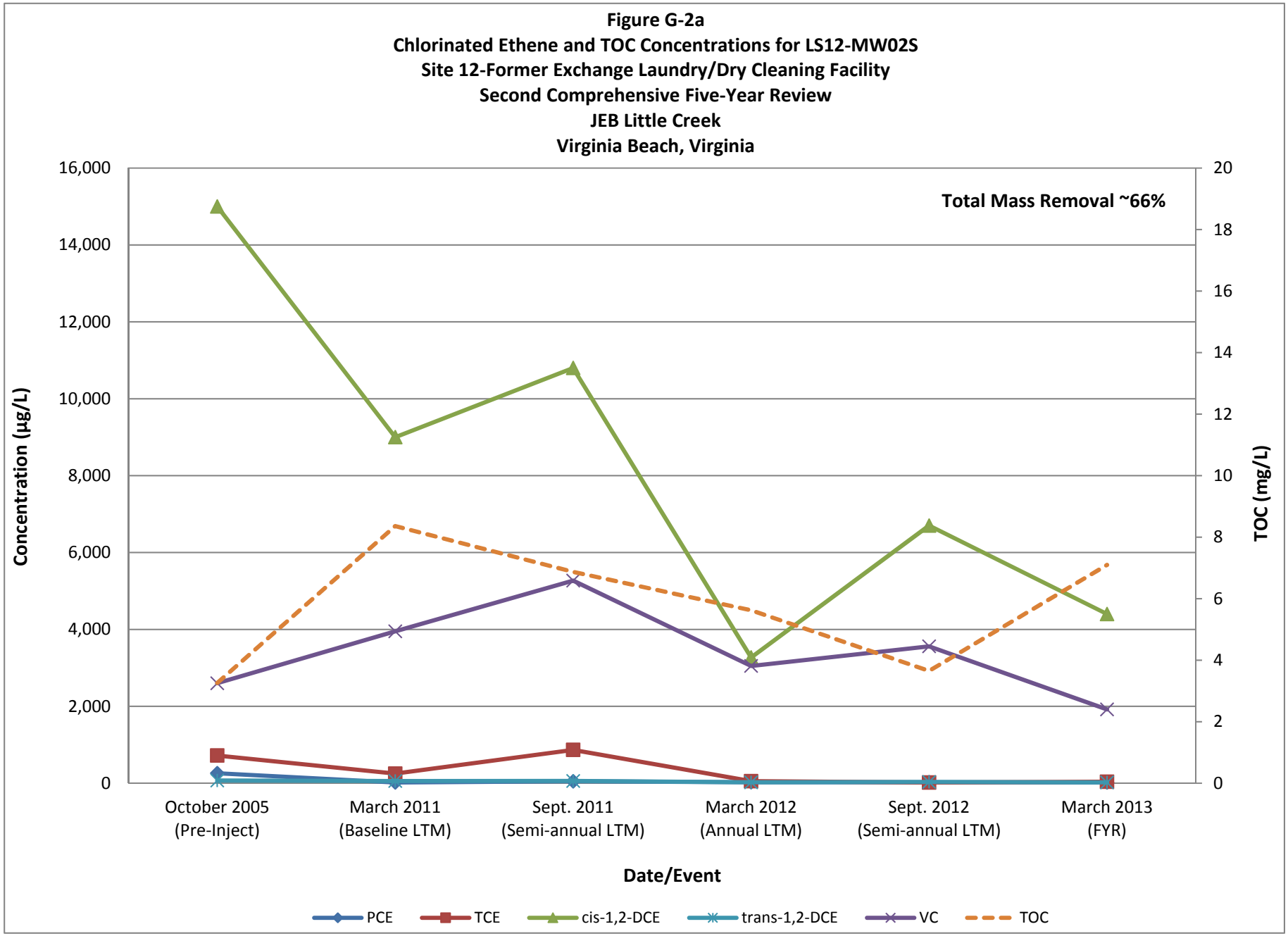


Figure G-2a
Chlorinated Ethene and TOC Concentrations for LS12-MW02S
Site 12-Former Exchange Laundry/Dry Cleaning Facility
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total Mass Removal ~66%
Concentration (µg/L)
TOC (mg/L)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
20
18
16
14
12
10
8
6
4
2
0
October 2005 (Pre-Inject)
March 2011 (Baseline LTM)
Sept. 2011 (Semi-annual LTM)
March 2012 (Annual LTM)
Sept. 2012 (Semi-annual LTM)
March 2013 (FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
trans-1,2-DCE
VC
TOC

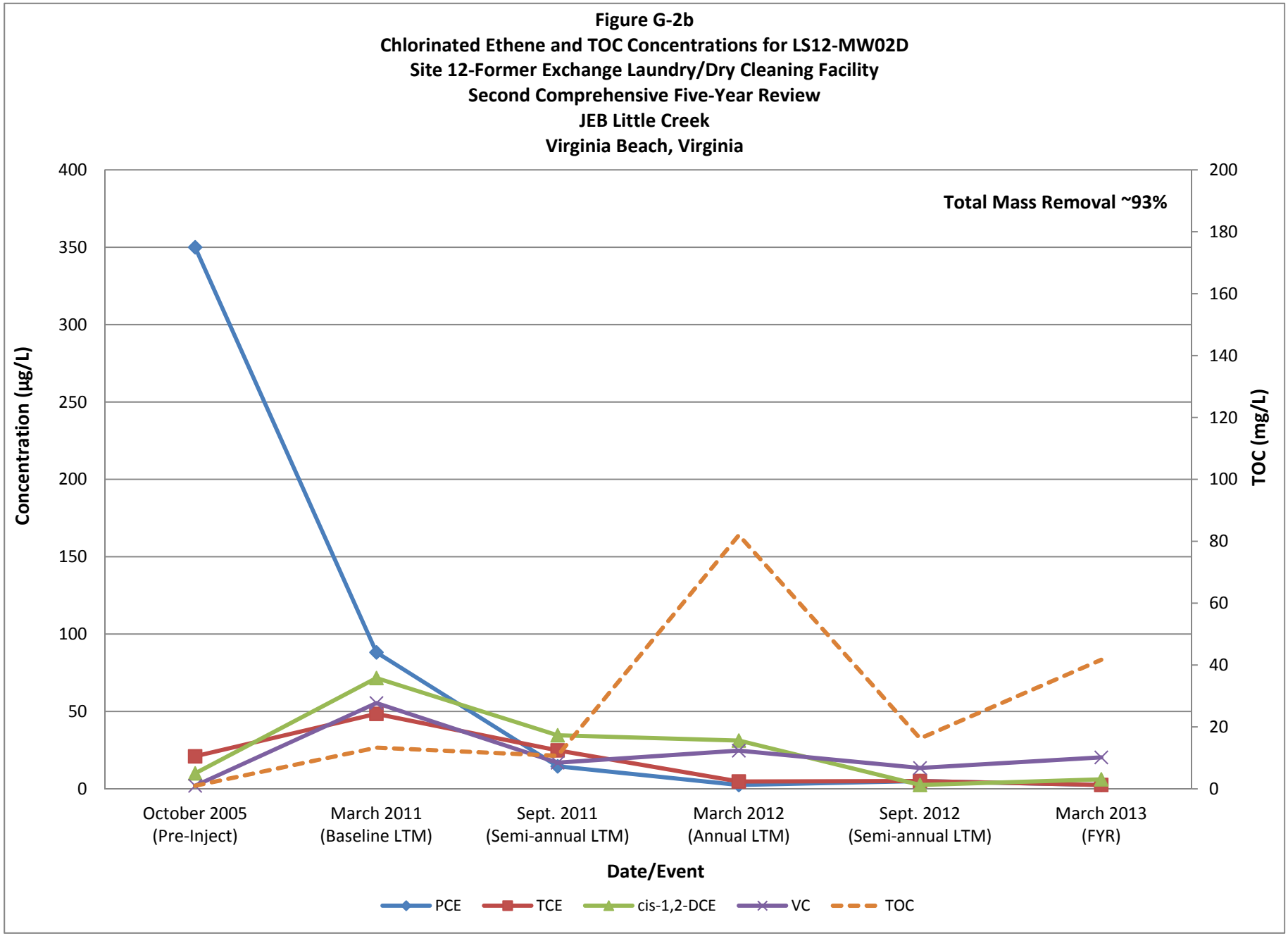


Figure G-2b
Chlorinated Ethene and TOC Concentrations for LS12-MW02D
Site 12-Former Exchange Laundry/Dry Cleaning Facility
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total Mass Removal ~93%
Concentration (µg/L)
TOC (mg/L)
400
350
300
250
200
150
100
50
0
200
180
160
140
120
100
80
60
40
20
0
October 2005 (Pre-Inject)
March 2011 (Baseline LTM)
Sept. 2011 (Semi-annual LTM)
March 2012 (Annual LTM)
Sept. 2012 (Semi-annual LTM)
March 2013 (FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
TOC

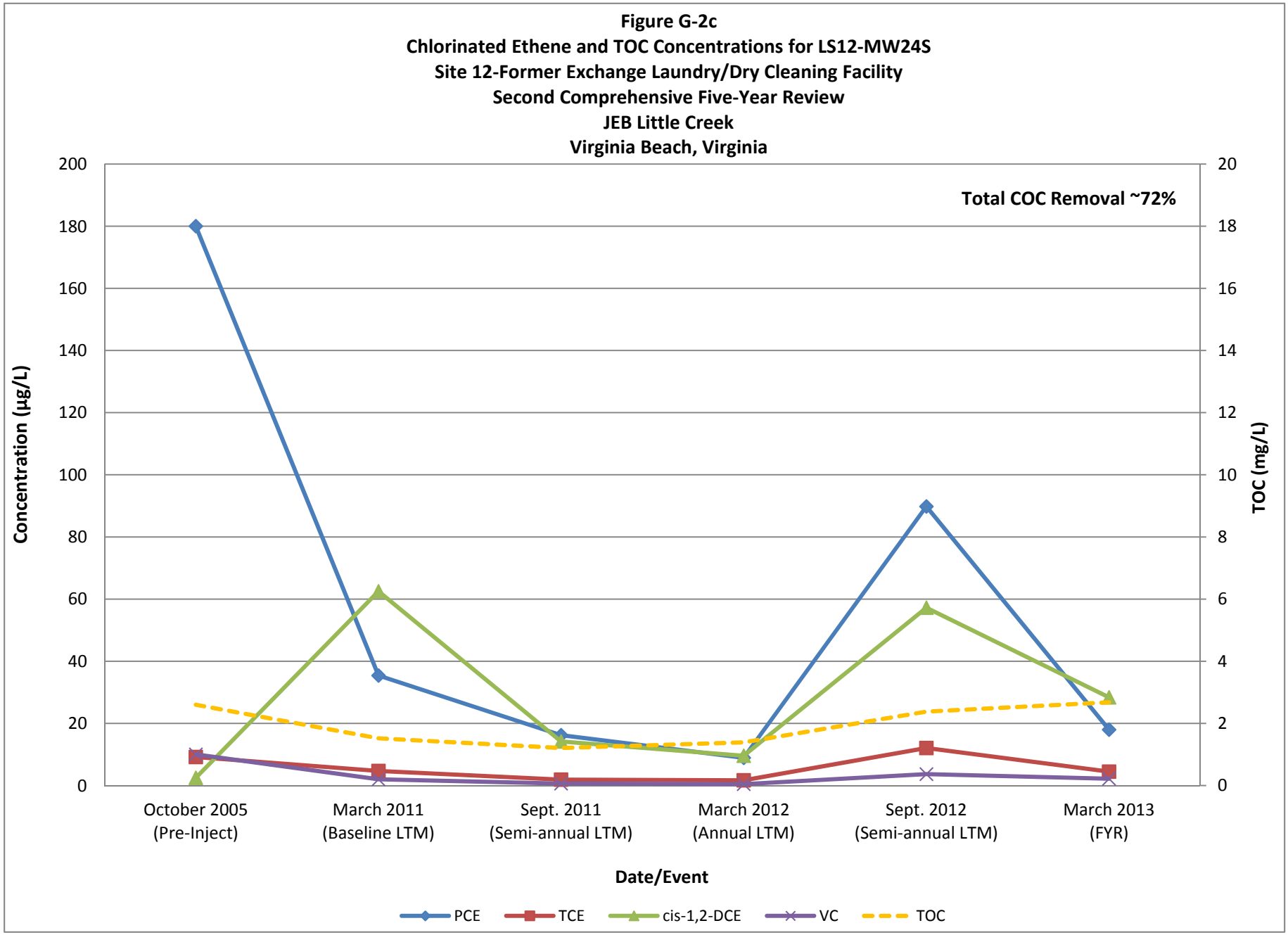


Figure G-2c
Chlorinated Ethene and TOC Concentrations for LS12-MW24S
Site 12-Former Exchange Laundry/Dry Cleaning Facility
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total COC Removal ~72%
Concentration (µg/L)
TOC (mg/L)
200
180
160
140
120
100
80
60
40
20
0
20
18
16
14
12
10
8
6
4
2
0
October 2005 (Pre-Inject)
March 2011 (Baseline LTM)
Sept. 2011 (Semi-annual LTM)
March 2012 (Annual LTM)
Sept. 2012 (Semi-annual LTM)
March 2013 (FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
TOC

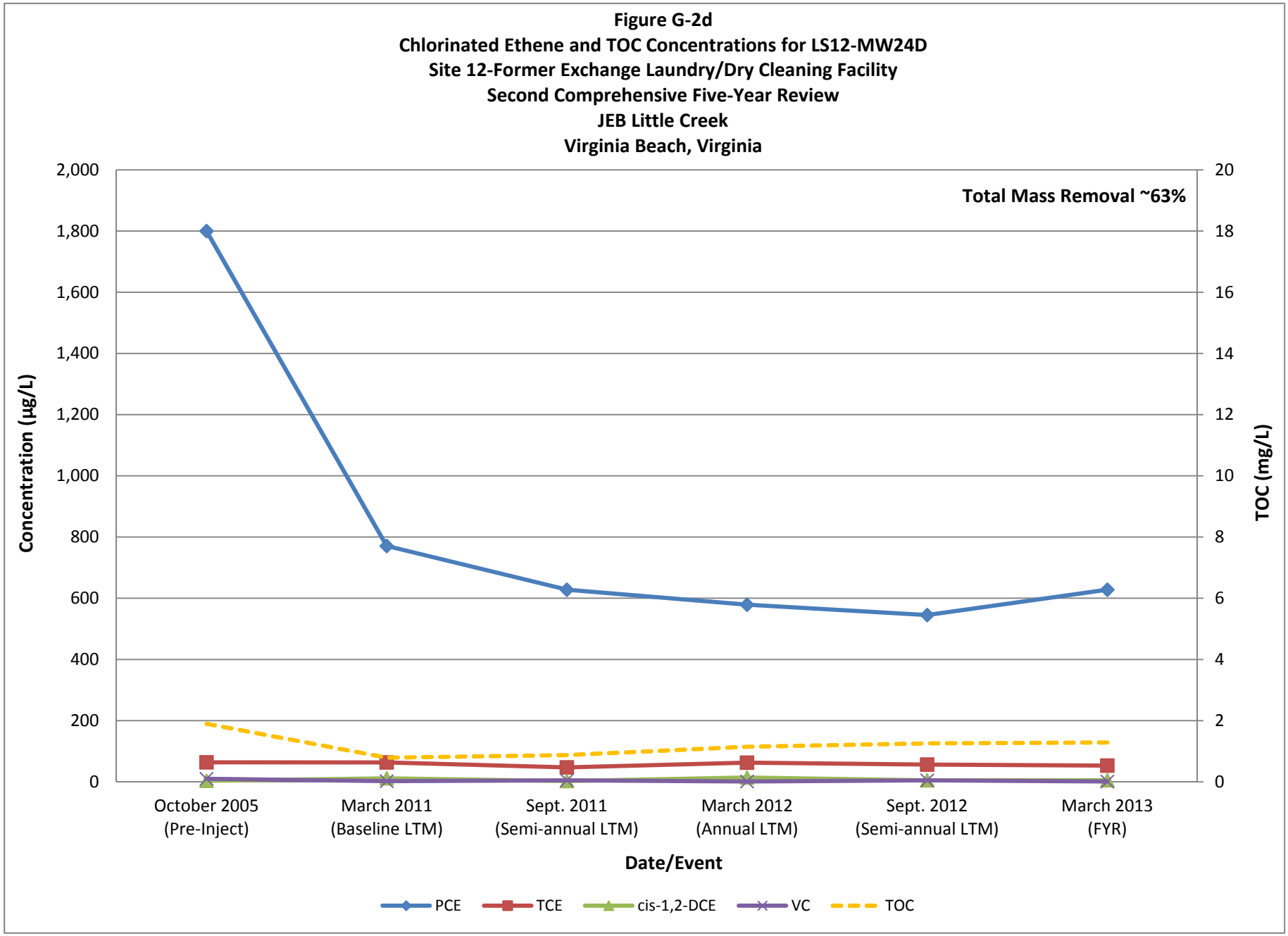


Figure G-2d
Chlorinated Ethene and TOC Concentrations for LS12-MW24D
Site 12-Former Exchange Laundry/Dry Cleaning Facility
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total Mass Removal ~63%
Concentration (µg/L)
TOC (mg/L)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
20
18
16
14
12
10
8
6
4
2
0
October 2005 (Pre-Inject)
March 2011 (Baseline LTM)
Sept. 2011 (Semi-annual LTM)
March 2012 (Annual LTM)
Sept. 2012 (Semi-annual LTM)
March 2013 (FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
TOC

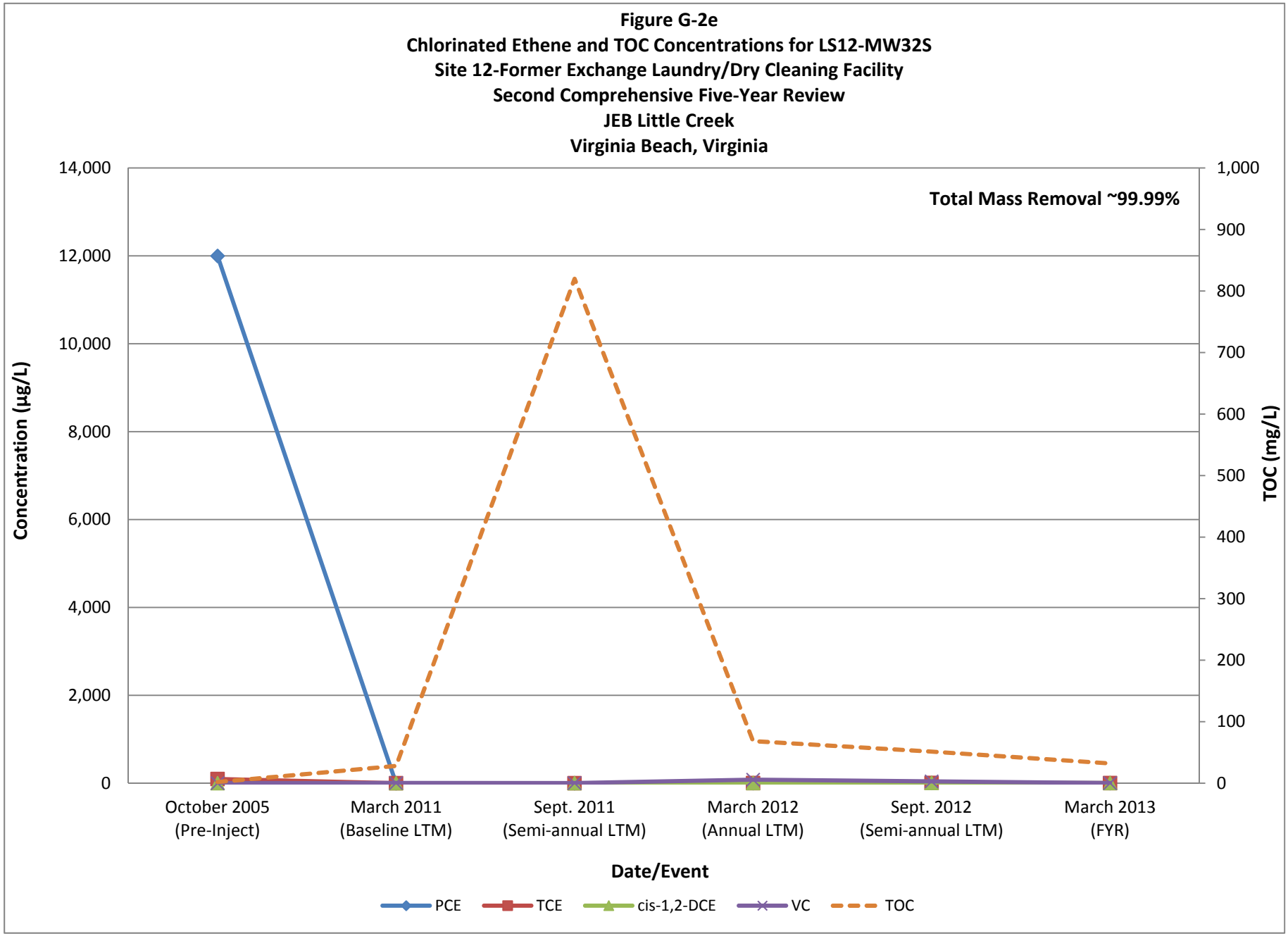


Figure G-2e
Chlorinated Ethene and TOC Concentrations for LS12-MW32S
Site 12-Former Exchange Laundry/Dry Cleaning Facility
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total Mass Removal ~99.99%
Concentration (µg/L)
TOC (mg/L)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1,000
900
800
700
600
500
400
300
200
100
0
October 2005 (Pre-Inject)
March 2011 (Baseline LTM)
Sept. 2011 (Semi-annual LTM)
March 2012 (Annual LTM)
Sept. 2012 (Semi-annual LTM)
March 2013 (FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
TOC

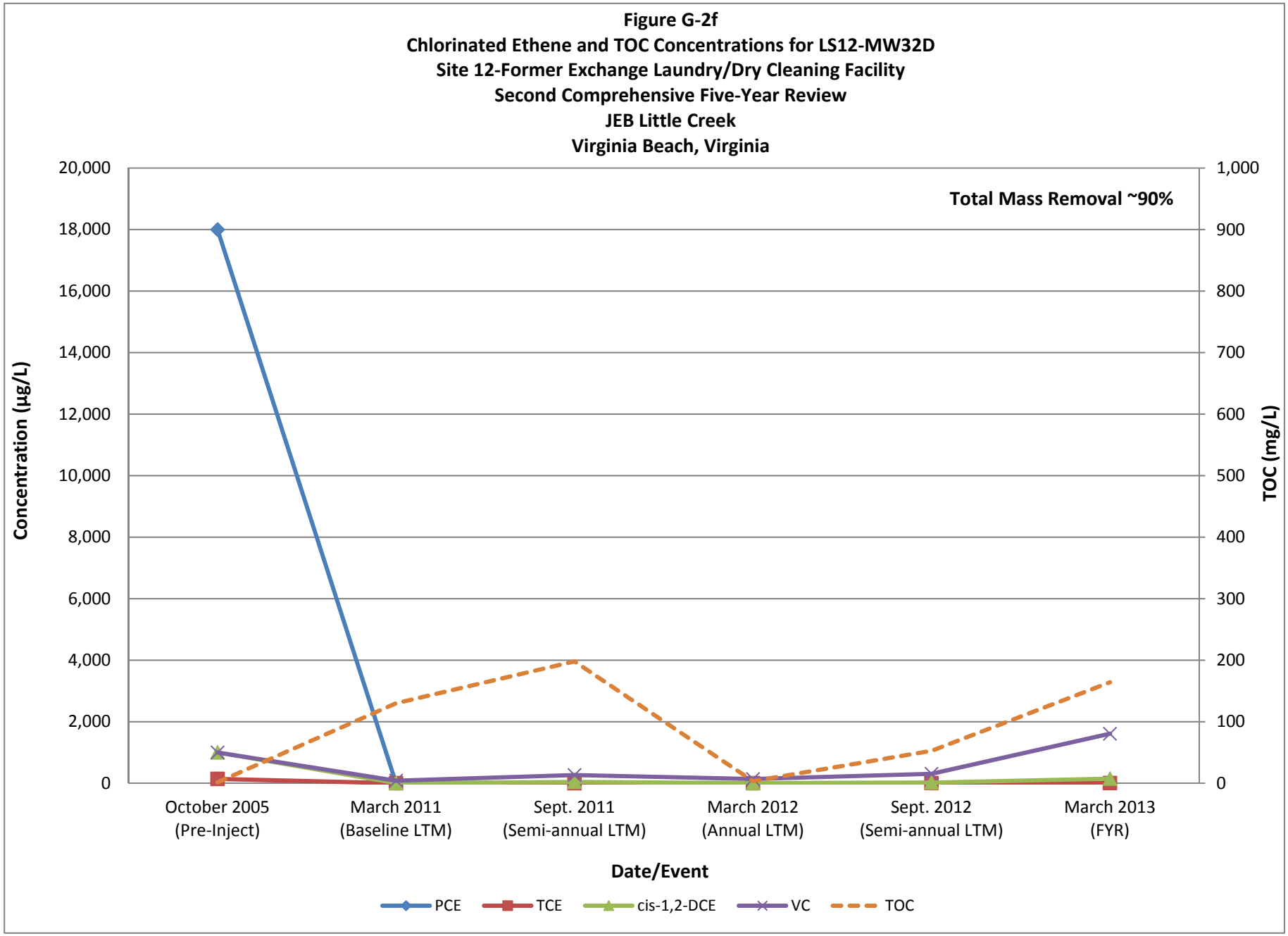
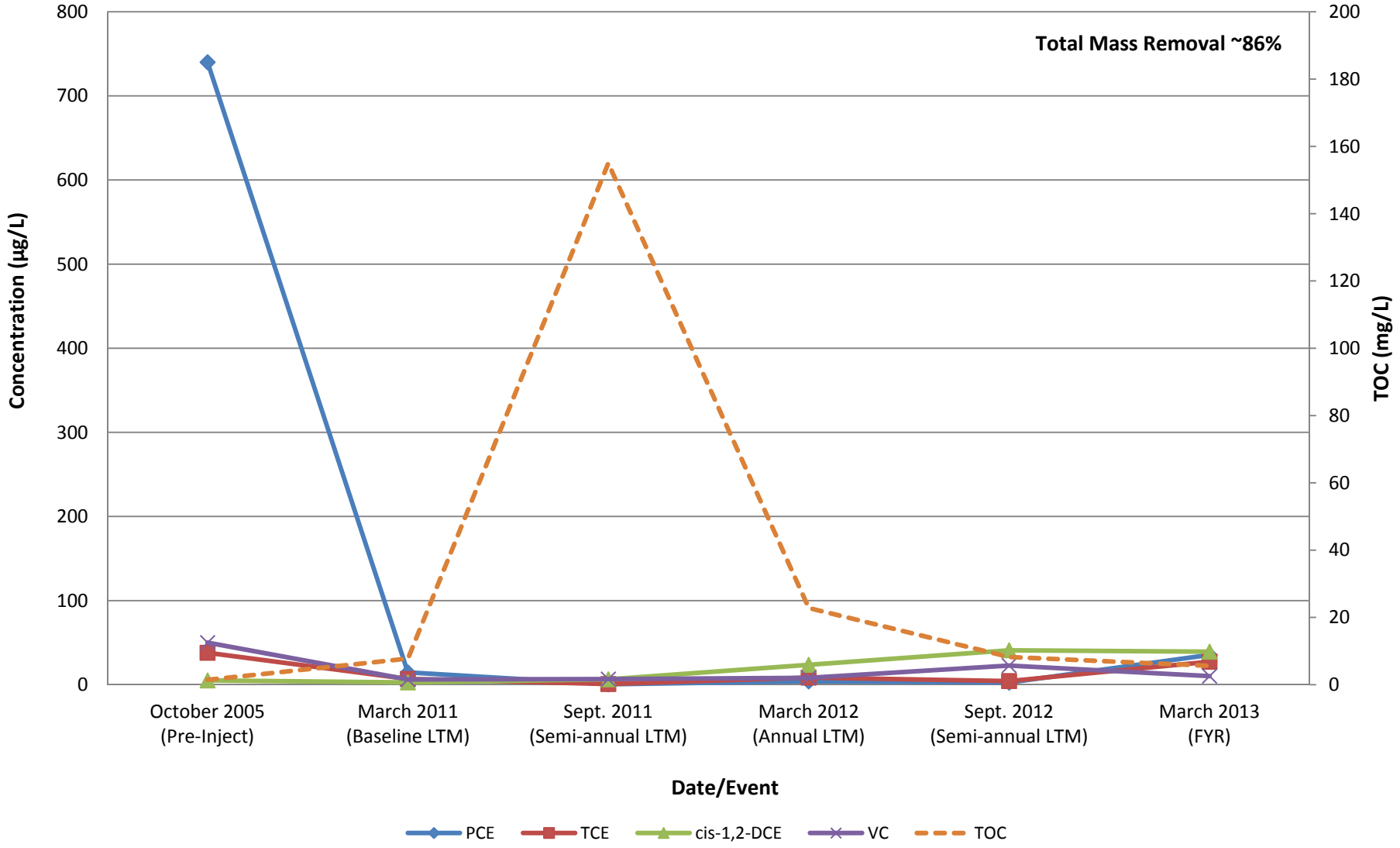


Figure G-2f
Chlorinated Ethene and TOC Concentrations for LS12-MW32D
Site 12-Former Exchange Laundry/Dry Cleaning Facility
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total Mass Removal ~90%
Concentration (µg/L)
TOC (mg/L)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1,000
900
800
700
600
500
400
300
200
100
0
October 2005 (Pre-Inject)
March 2011 (Baseline LTM)
Sept. 2011 (Semi-annual LTM)
March 2012 (Annual LTM)
Sept. 2012 (Semi-annual LTM)
March 2013 (FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
TOC

Figure G-2g
Chlorinated Ethene and TOC Concentrations for LS12-MW33S
Site 12-Former Exchange Laundry/Dry Cleaning Facility
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia



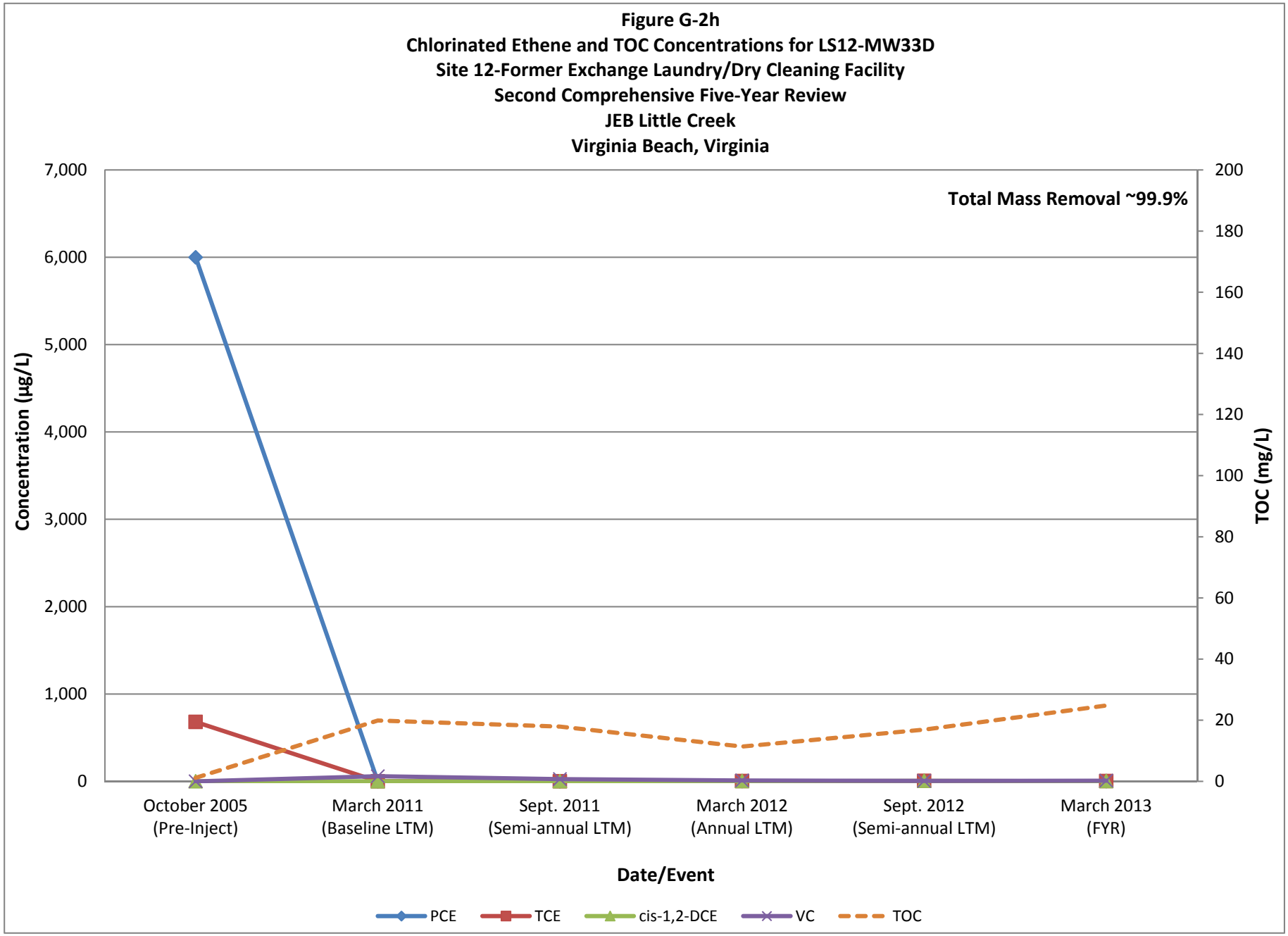
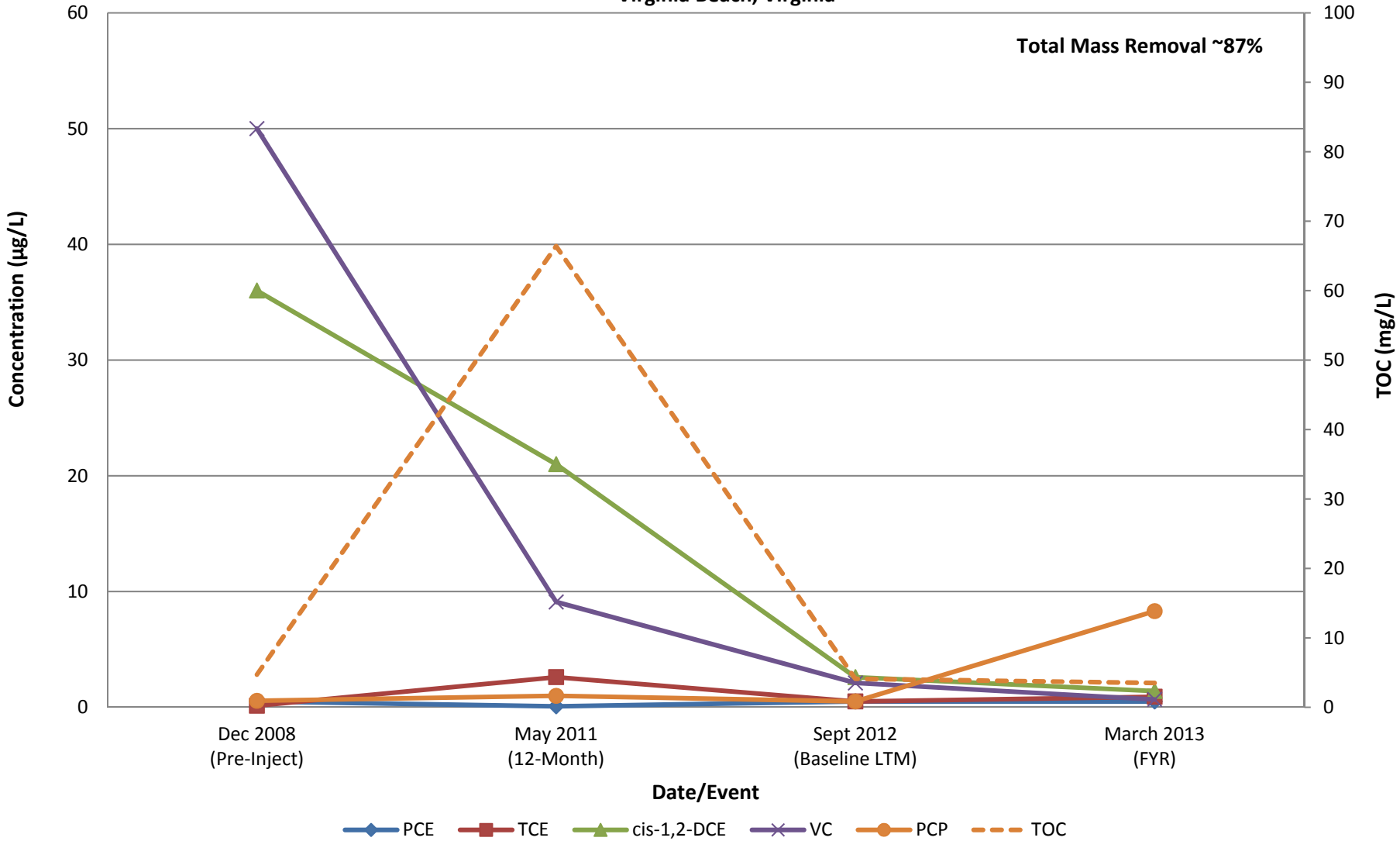


Figure G-2h
Chlorinated Ethene and TOC Concentrations for LS12-MW33D
Site 12-Former Exchange Laundry/Dry Cleaning Facility
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total Mass Removal ~99.9%
Concentration (µg/L)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
TOC (mg/L)
200
180
160
140
120
100
80
60
40
20
0
October 2005 (Pre-Inject)
March 2011 (Baseline LTM)
Sept. 2011 (Semi-annual LTM)
March 2012 (Annual LTM)
Sept. 2012 (Semi-annual LTM)
March 2013 (FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
TOC

Figure G-3a
Chlorinated Ethene and TOC Concentrations for LS13-MW06S
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia



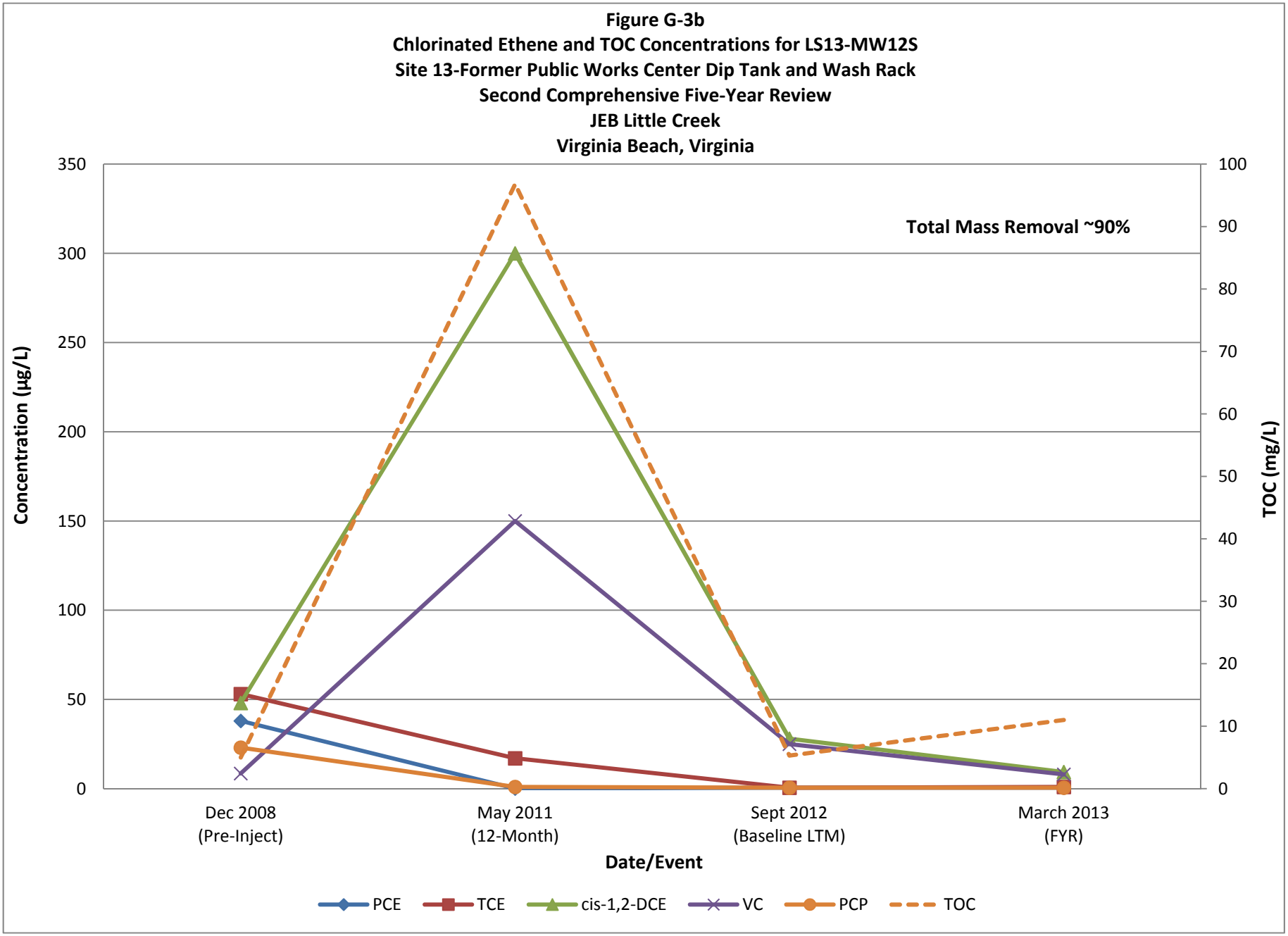


Figure G-3b
Chlorinated Ethene and TOC Concentrations for LS13-MW12S
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total Mass Removal ~90%
Concentration (µg/L)
TOC (mg/L)
350
300
250
200
150
100
50
0
100
90
80
70
60
50
40
30
20
10
0
Dec 2008
(Pre-Inject)
May 2011
(12-Month)
Sept 2012
(Baseline LTM)
March 2013
(FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
PCP
TOC

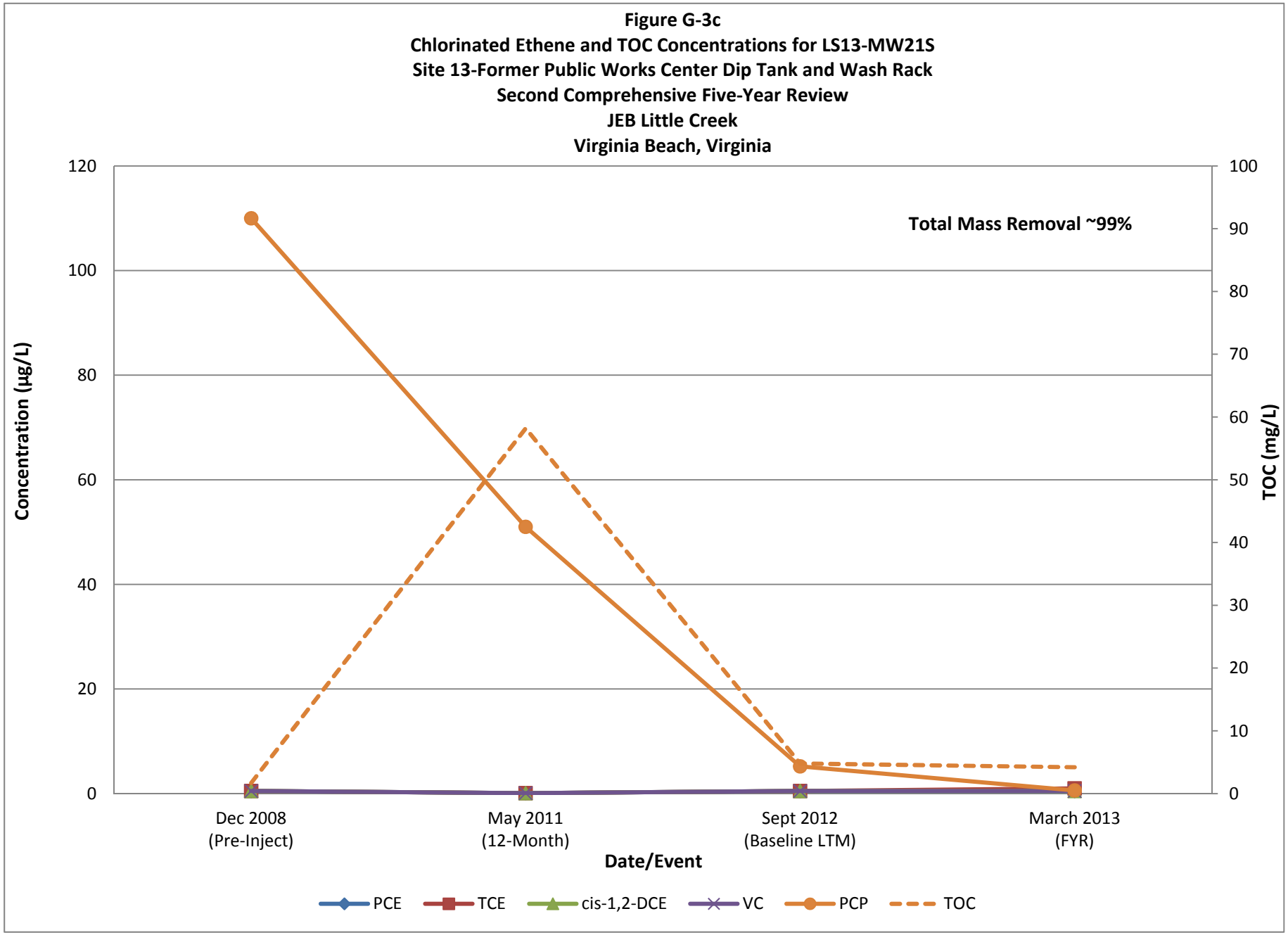


Figure G-3c
Chlorinated Ethene and TOC Concentrations for LS13-MW21S
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total Mass Removal ~99%
Concentration (µg/L)
TOC (mg/L)
120
100
80
60
40
20
0
100
90
80
70
60
50
40
30
20
10
0
Dec 2008
(Pre-Inject)
May 2011
(12-Month)
Sept 2012
(Baseline LTM)
March 2013
(FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
PCP
TOC

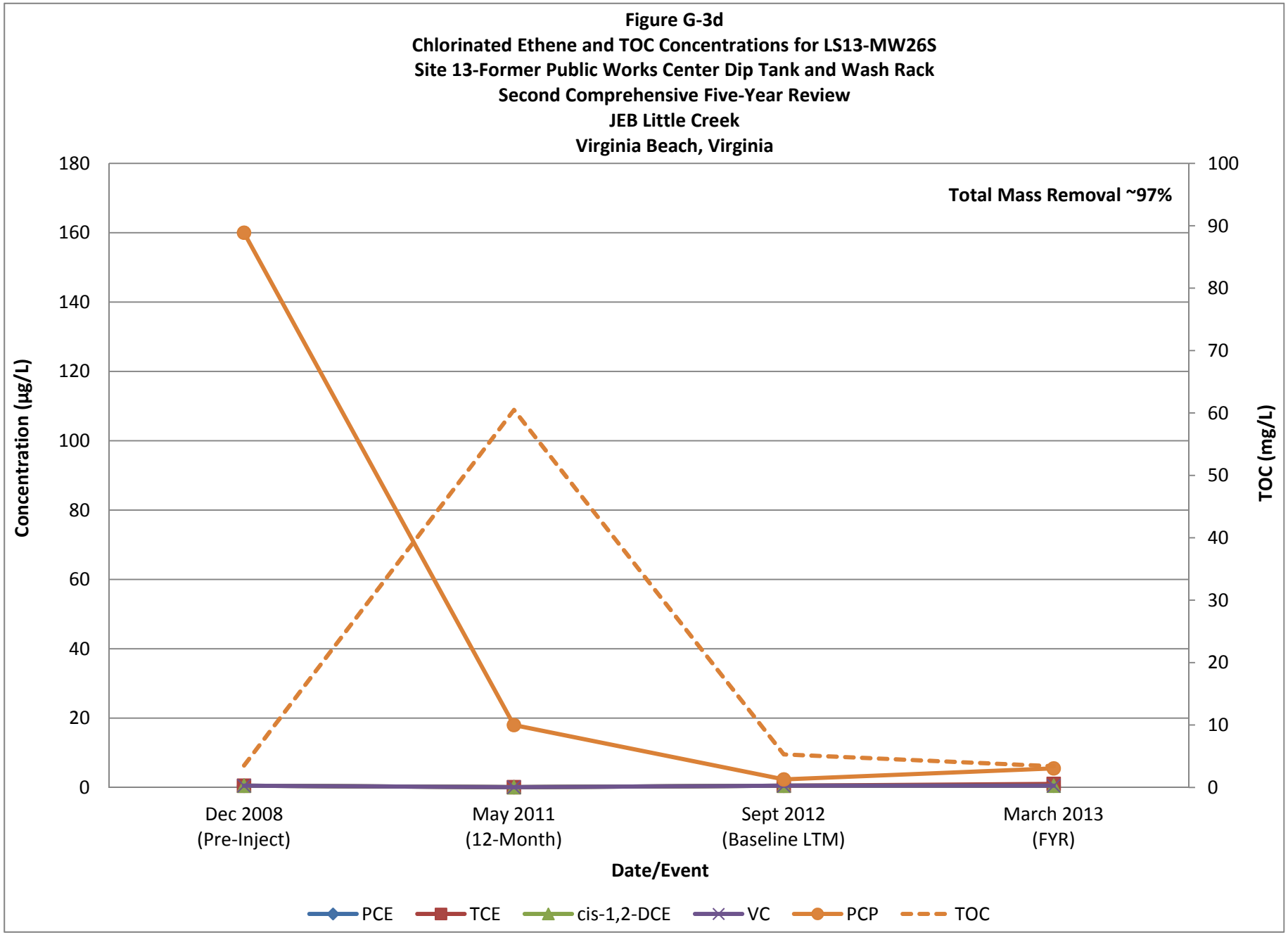


Figure G-3d
Chlorinated Ethene and TOC Concentrations for LS13-MW26S
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Total Mass Removal ~97%
Concentration (µg/L)
TOC (mg/L)
180
160
140
120
100
80
60
40
20
0
100
90
80
70
60
50
40
30
20
10
0
Dec 2008
(Pre-Inject)
May 2011
(12-Month)
Sept 2012
(Baseline LTM)
March 2013
(FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
PCP
TOC

Figure G-3e
Chlorinated Ethene and TOC Concentrations for LS13-MW03T
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

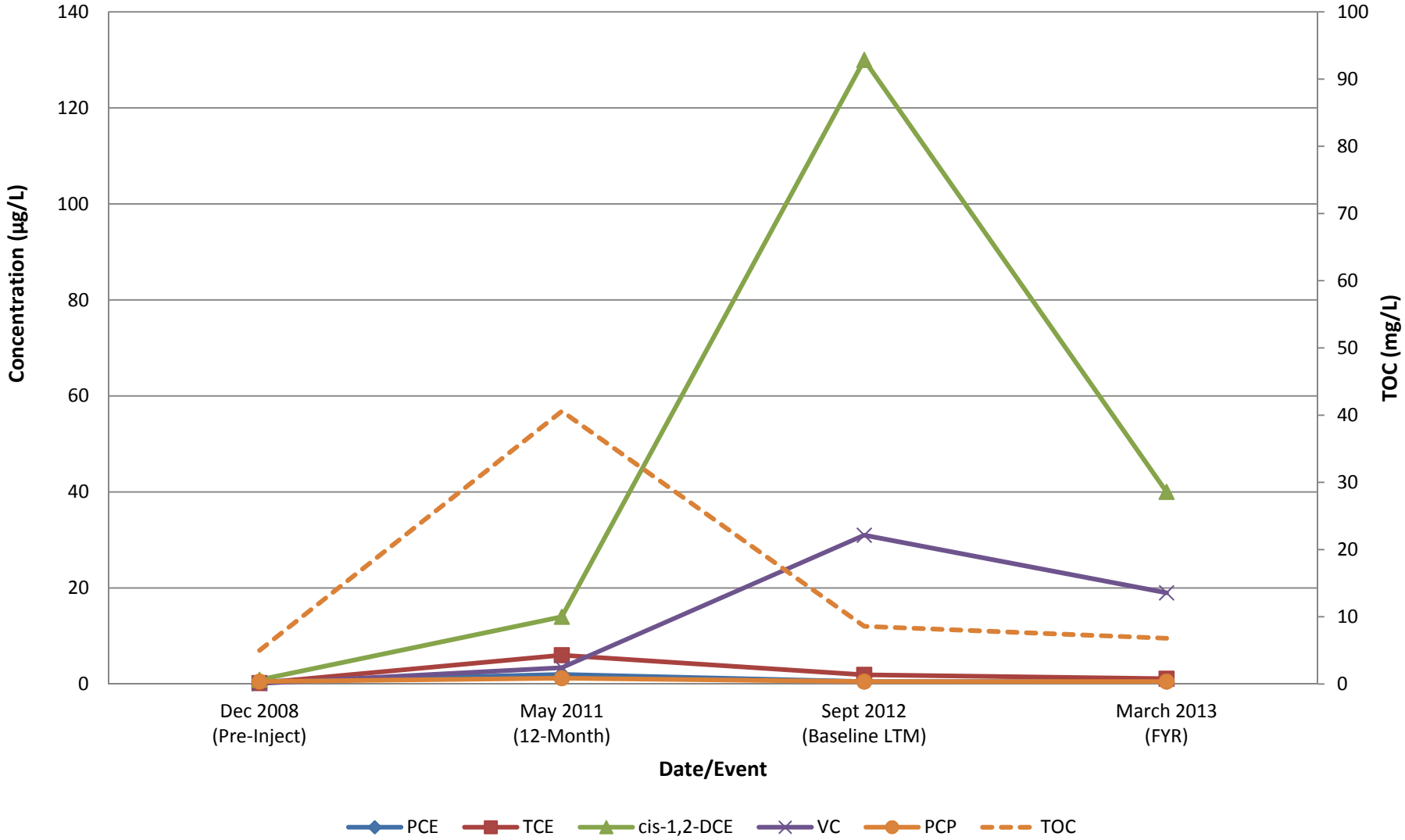


Figure G-3f
Chlorinated Ethene and TOC Concentrations for LS13-MW10T
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

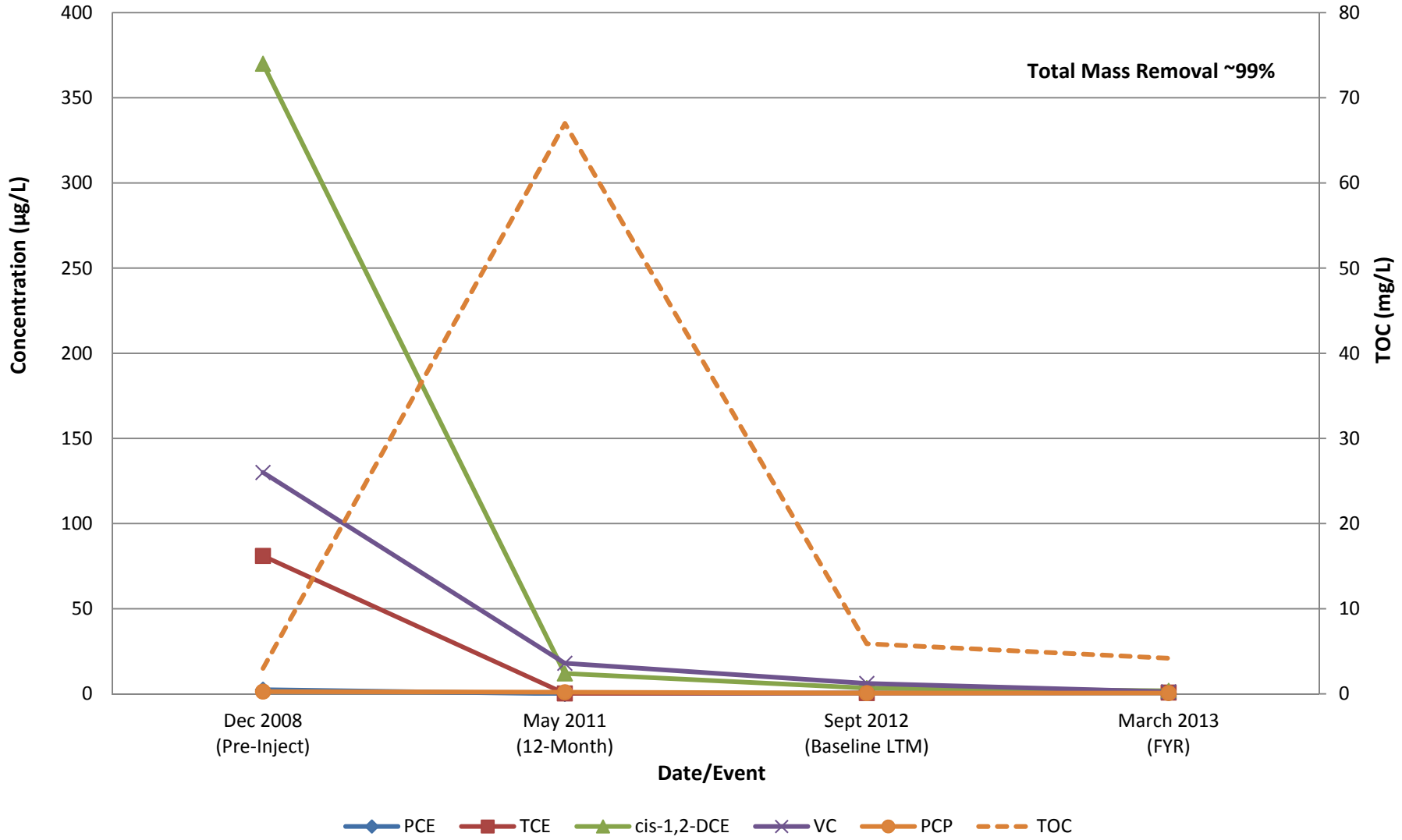


Figure G-3g
Chlorinated Ethene and TOC Concentrations for LS13-MW14T
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia

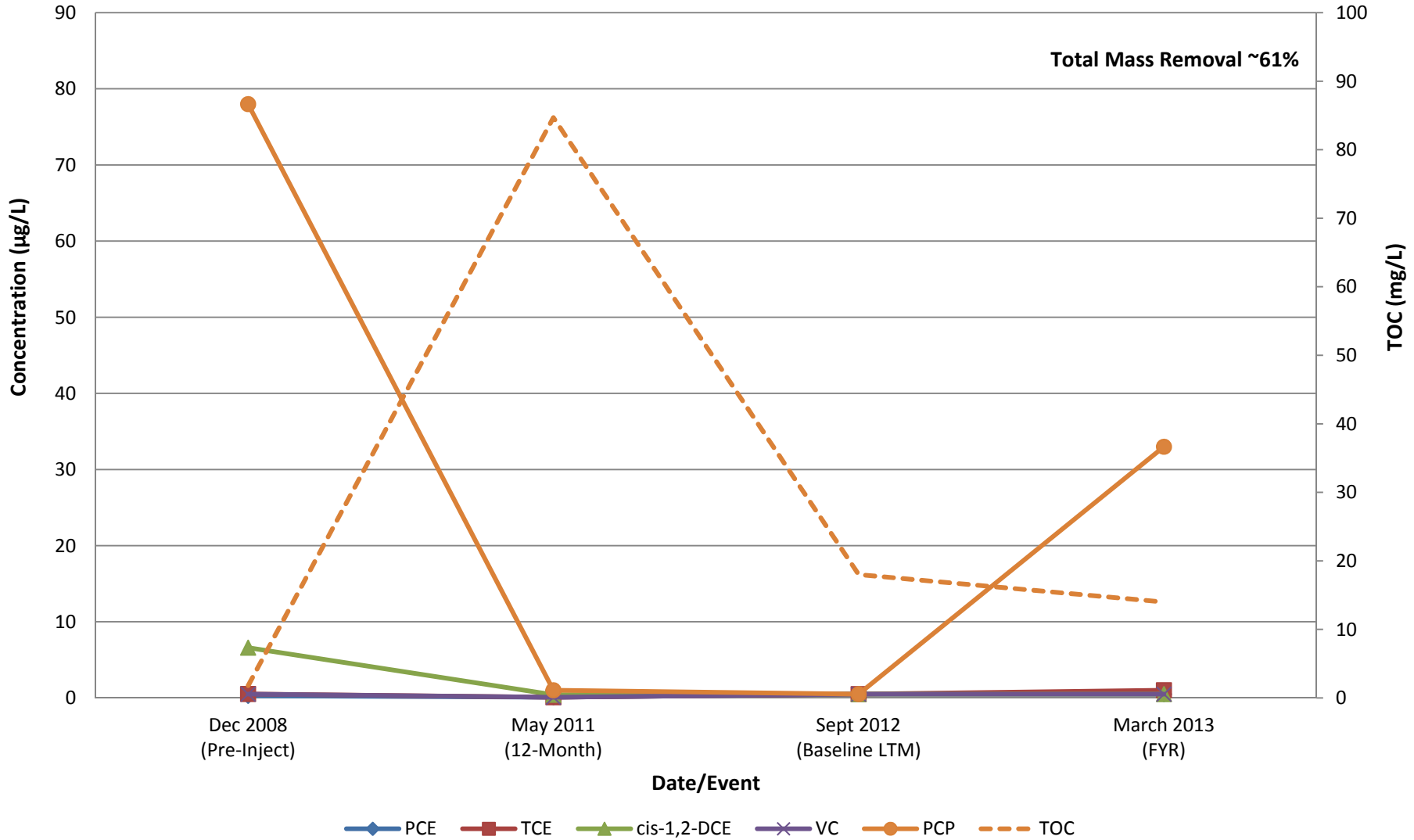
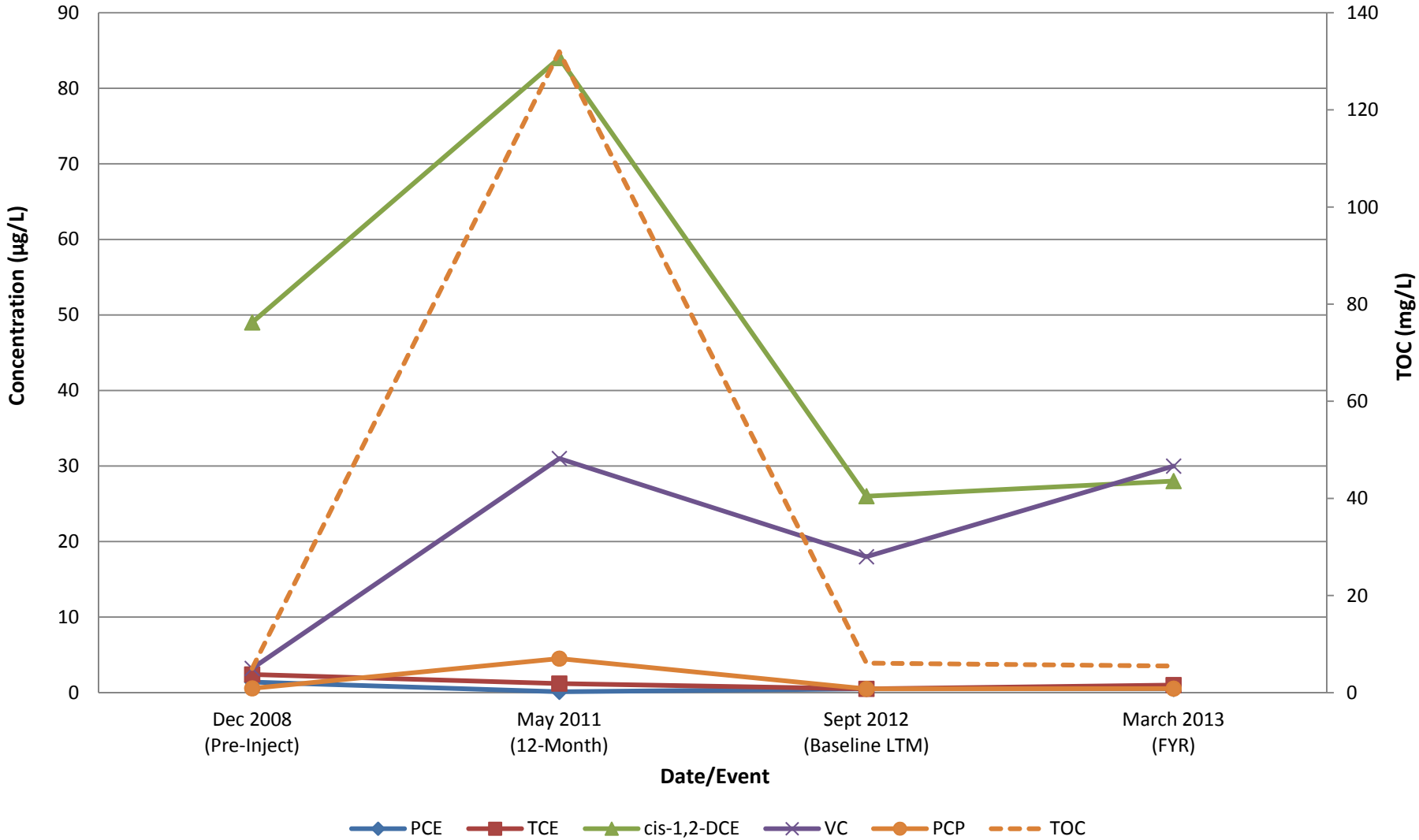


Figure G-3h
Chlorinated Ethene and TOC Concentrations for LS13-MW18T
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia



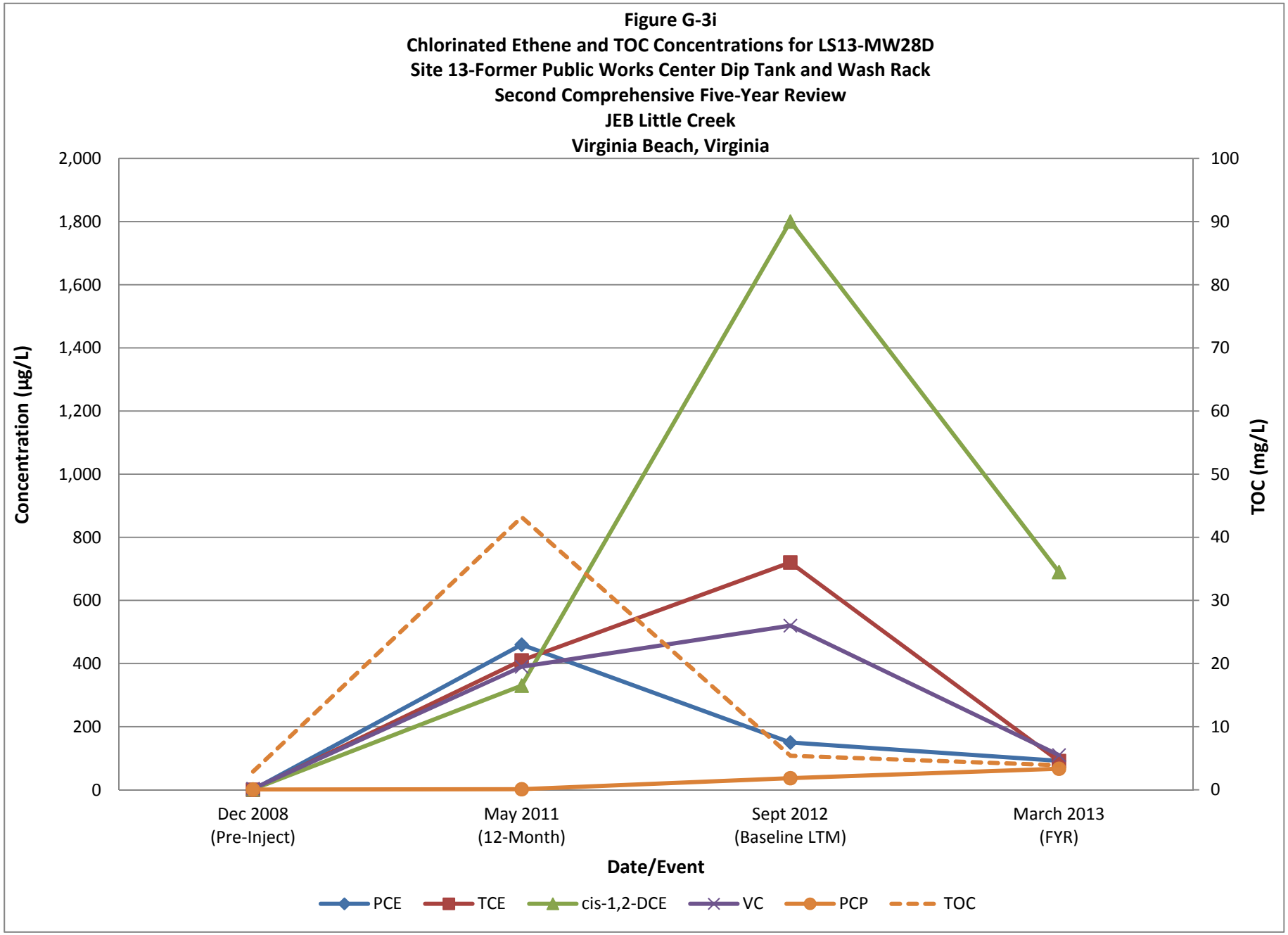


Figure G-3i
Chlorinated Ethene and TOC Concentrations for LS13-MW28D
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia
Concentration (µg/L)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
TOC (mg/L)
100
90
80
70
60
50
40
30
20
10
0
Dec 2008 (Pre-Inject)
May 2011 (12-Month)
Sept 2012 (Baseline LTM)
March 2013 (FYR)
Date/Event
PCE
TCE
cis-1,2-DCE
VC
PCP
TOC

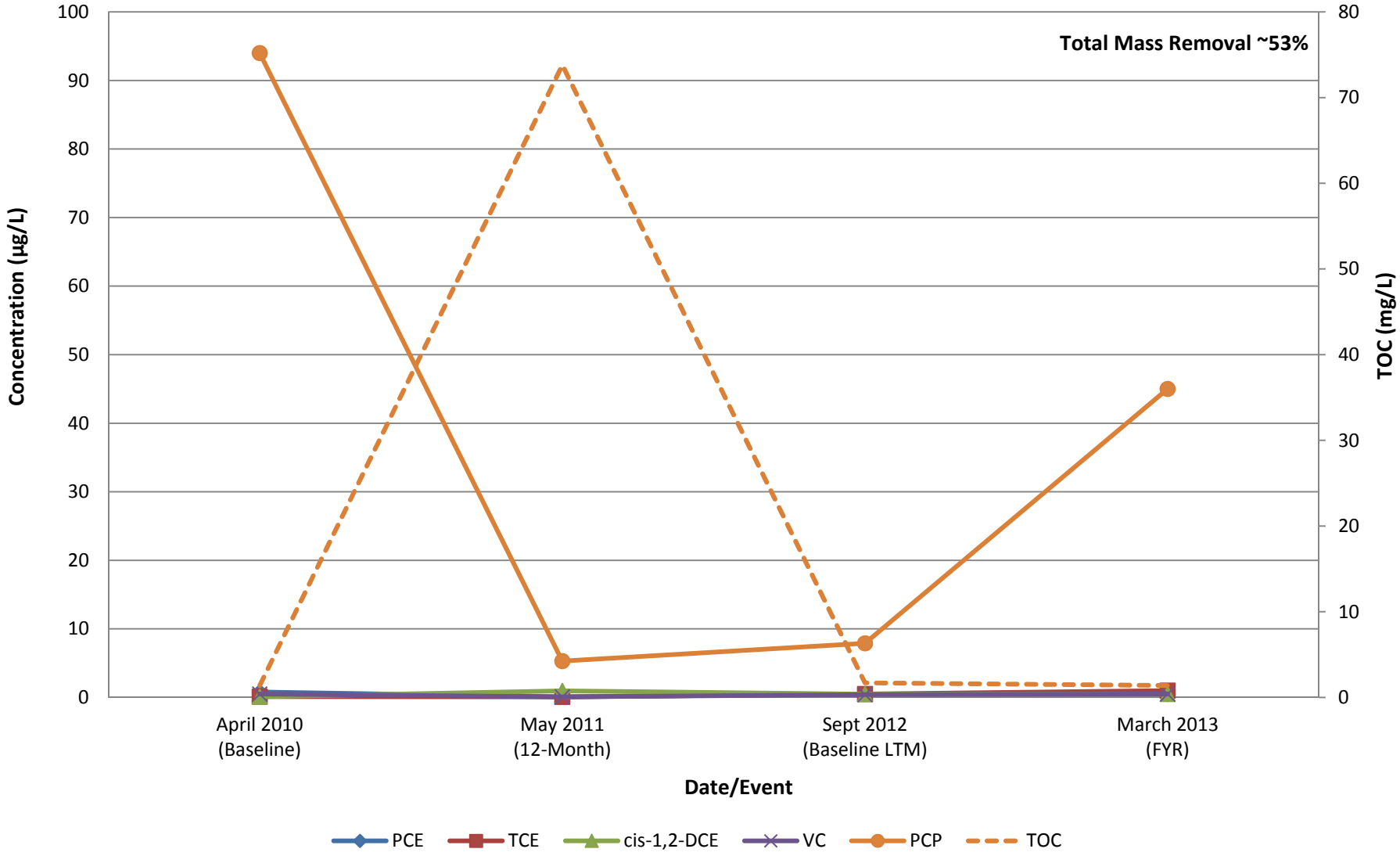



Figure G-3j
Chlorinated Ethene and TOC Concentrations for LS13-MW36D
Site 13-Former Public Works Center Dip Tank and Wash Rack
Second Comprehensive Five-Year Review
JEB Little Creek
Virginia Beach, Virginia