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MCAS CHERRY POINT
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FINAL PROPOSED PLAN OPERABLE UNIT 1 (OU 1) CENTRAL GROUNDWATER PLUME SITES 42, 47, 51, 52, 92, AND 98 MCAS CHERRY POINT NC

4/1/2014

CH2M HILL

Final Proposed Plan

Operable Unit 1,
Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98
Marine Corps Air Station
Cherry Point, North Carolina

April 2014

1 Introduction

This **Proposed Plan** identifies the **preferred alternative** for groundwater clean-up for the portions of **Operable Unit 1** (OU1) at Marine Corps Air Station (MCAS) Cherry Point, North Carolina, that were identified as contributing chlorinated volatile organic compounds (cVOCs) to groundwater (Sites 42, 47, 51, 52, 92, and 98) and are collectively referred to as the OU1 Central Groundwater Plume (CGWP) sites. It also summarizes the history of investigations and response actions already taken to address contamination at OU1, as well as the remedial alternatives considered for the final remedy soon to be selected.

OU1 is an industrial area in the southern portion of MCAS Cherry Point that covers approximately 565 acres and is comprised of 12 sites based on their proximity to each other within the industrialized section of MCAS Cherry Point. Two **Records of Decision** (RODs) have documented no further action (NFA) as the remedy for five of these sites (Sites 14, 15, 17, 18, and 83) (CH2M HILL, 2010; Rhēa, 2012a). Site 16 is currently being investigated separately. The remaining six sites (Sites 42, 47, 51, 52, 92, and 98) were identified as contributing cVOCs to groundwater, and are collectively denoted as the OU1 CGWP sites. This Proposed Plan only addresses the OU1 CGWP sites (Sites 42, 47, 51, 52, 92, and 98).

An interim Record of Decision (ROD) for OU1 was issued in 1996, to address the most highly-contaminated area in the surficial aquifer (i.e., the CGWP), where there was evidence that contamination was migrating downward within the aquifer. The Interim remedy was a groundwater extraction and treatment system (commonly called "pump-and-treat") (B&R, 1996b) that operated from 1998 to 2005. The preferred alternative presented in this Proposed Plan will serve as the final action.

Based on current site conditions, future anticipated land and resource uses, and the results of environmental investigations at OU1, the preferred alternative for the OU1 CGWP sites is **In-Situ Enhanced Bioremediation (ISEB**) in the Source Zone, **Zero Valent Iron (ZVI) Permeable Reactive Barriers (PRBs)** in the Downgradient Zone, **Subslab Soil Vapor** and **Indoor Air Monitoring** in identified buildings of interest, and **Monitored Natural Attenuation (MNA)** and **Land Use Controls (LUCs)** across both Source and Downgradient Zones of OU1.

This Proposed Plan is issued jointly by the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division (lead agency for site activities), MCAS Cherry Point Environmental Affairs Department (EAD), and the **U.S. Environmental Protection Agency (USEPA)** Region 4, in consultation with the **North Carolina Department of Environment and Natural Resources (NCDENR)**, in order to solicit public comments on the remedial alternatives and, in particular, the preferred **remedial action** for the OU1 CGWP sites.

Mark Your Calendar for the Public Comment Period

Public Comment Period

May 9 to June 23, 2014

Submit Written Comments

The Navy, USEPA, and NCDENR will accept written comments on the Proposed Plan during the public comment period. To submit comments or obtain further information, please detach and use the comment page at the back of this document.

Attend the Public Meeting

May 21, 2014 at 6:00 p.m.

Havelock Tourist and Event Center
201 Tourist Center Dr.
Havelock, NC 28532

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

Location of Administrative Record:

MCAS Cherry Point Environmental Restoration Program (ERP) Public web site; http://go.usa.gov/Dy59; follow "Admin Records" links
Can be accessed at any facility with an internet connection, including the local library:
Havelock-Craven County Library -
301 Cunningham Blvd.
Havelock, NC 28532
Phone (252) 447-7509

The Proposed Plan fulfills the public participation requirements in Section 117(a, b) of the **Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)** and in Section 300.430(f)(3) of the **National Oil and Hazardous Substances Pollution Contingency Plan (NCP)**.

The Navy, EAD, and USEPA, in consultation with NCDENR, will make the final decision on the remedial approach for the OU1 CGWP sites after reviewing and considering all information submitted during the 45-day **public comment period** (May 9 through June 23, 2014). The Navy and EAD, along with USEPA and in consultation with NCDENR, may modify the Preferred Alternative based on new information or public comment. Therefore, public comment on the Preferred Alternative is invited and encouraged. Information on how to participate in this decision-making process is presented in Section 9. At the end of the decision-making process, a ROD will be prepared to document the Selected Remedy for the OU1 CGWP sites.

This Proposed Plan summarizes background and technical information that can be found in greater detail in the OU1 **Remedial Investigation (RI)** report (TetraTech, 2002) (denoted as the 2002 RI in this Proposed Plan), OU1 RI Addendum (CH2M HILL, 2009), OU1 CGWP **Feasibility Study (FS)** report (CH2M HILL, 2011), and Phase II **Vapor Intrusion** Investigation report (CH2M HILL, 2012b), and other documents contained in the **Administrative Record** for OU1. Information for accessing the Administrative Record is located at the bottom of page 1 of this Proposed Plan. A glossary of key terms used in this document is attached; these key terms are identified in bold print the first time they appear.

Figure 1 – Regional Location Map

2 Site Background

2.1 Facility Description and History

MCAS Cherry Point is a 13,164-acre military reservation located adjacent to the city of Havelock in southeastern Craven County, North Carolina (**Figure 1**). MCAS Cherry Point was commissioned in 1942 and provides support facilities and services for the Second Marine Aircraft Wing, the Fleet Readiness Center-East ([FRCE], formerly Naval Aviation Depot [NADEP]), Combat Service Support Detachment 21 of the Second Marine Logistics Group, the Naval Air Maintenance Training Group Detachment, and the Defense Reutilization and Marketing Office (DRMO). MCAS Cherry Point maintains facilities for training and for supporting the Atlantic Fleet Marine Force aviation units and is a primary aviation supply point.

MCAS Cherry Point has been actively involved with environmental investigations and remediation programs since a 1983 Initial Assessment Study (IAS), which was the first investigation of potentially hazardous sites at MCAS Cherry Point. On December 16, 1994, MCAS Cherry Point was scored and ranked by USEPA for inclusion on the CERCLA (or Superfund) **National Priorities List (NPL)**. On May 12, 2005, the Navy, USEPA, and NCDENR executed a Federal Facilities Agreement (FFA) that establishes the procedural framework and schedule for implementing the CERCLA response actions for MCAS Cherry Point.

2.2 Site Description

OU1 is an industrial area approximately 565 acres in size, located in the southwestern portion of MCAS Cherry Point. OU1 is bounded by C Street and Sandy Branch to the northwest, portions of the MCAS Cherry Point flightline and runway to the northeast and southeast, and East Prong Slocum Creek to the southwest (**Figure 2**).

The major features of OU1 include the FRCE, a former borrow pit/disposal area (Site 16), the Industrial Wastewater Treatment Plant (IWTP, Site 42), the DRMO and several support facilities. The FFA identified 12 sites that were investigated as part of the OU1 RI. These sites are shown in **Figure 3** and listed as follows:

- Site 14 – Motor Transportation
- Site 15 – Ditch and Area Behind Fleet Readiness Center East (FRCE)
- Site 16 – Landfill at Sandy Branch
- Site 17 – Defense Reutilization Marketing Office (DRMO) Drainage Ditch
- Site 18 – Facilities Maintenance Compound
- Site 42 – Industrial Wastewater Treatment Plant (IWTP)
- Site 47 – Industrial Area Sewer System
- Site 51 – Building 137 Former Plating Shop
- Site 52 – Building 133 Former Plating Shop and Ditch
- Site 83 – Building 96, Former Pesticide Mixing Area
- Site 92 – VOCs in Groundwater near the Stripper Barn
- Site 98 – VOCs in Groundwater near Building 4032

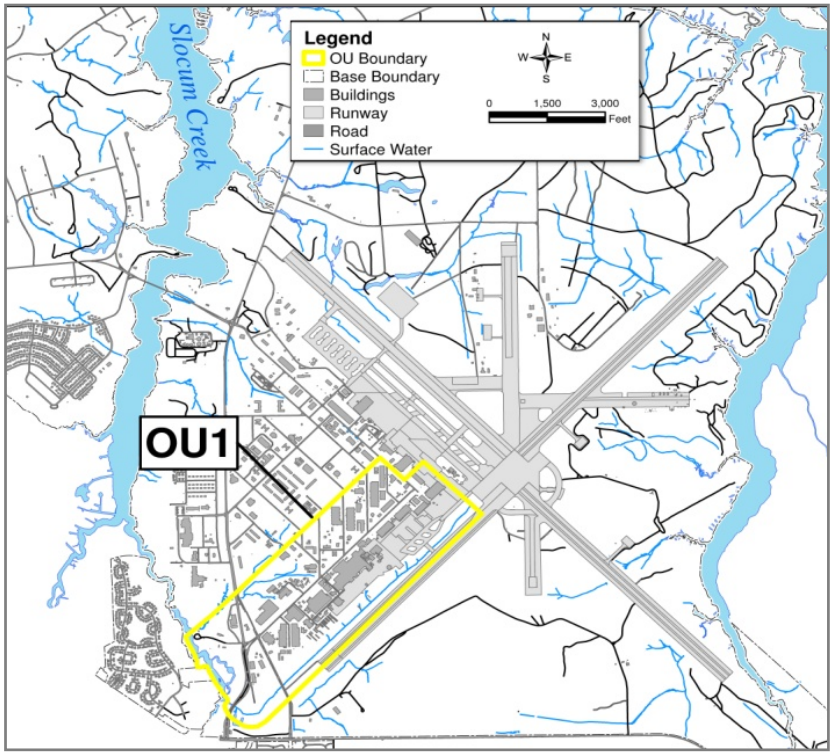


Figure 2 – OU1 Location Map

2.3 Summary of Previous Investigations and Interim Remedial Actions

Previous environmental investigations and interim remedial actions have been conducted at OU1, beginning in 1983. **Table 1** briefly summarizes the purpose and scope of investigations completed to date.

A Focused RI/FS was conducted for OU1 groundwater in 1996 that identified data gaps that were recommended to be addressed in a comprehensive OU1 RI/FS and/or prior to proceeding with design activities for interim remedial actions for the OU1 CGWP and Site 16 groundwater (B&R, 1996a).

An Interim ROD was issued to treat areas with high cVOC concentrations within the OU1 CGWP, selecting a groundwater extraction and treatment system (commonly called "pump-and-treat") for groundwater remediation (B&R, 1996b). The pump-and-treat system began operation in 1998 within the central portion of OU1. However, as a result of system ineffectiveness, decreasing efficiency, and the potential for interference with ongoing investigation activities, the system was shut down in 2005.

In 1996, a pilot-scale air sparge/soil vapor extraction (AS/SVE) system was installed within Site 16 to treat groundwater at the downgradient extent of the OU1 CGWP prior to discharge to Slocum Creek (B&R, 1997), and a full-scale system was installed in 1998. However, the system was shut down in 2005 because it was not achieving the remedial action objectives (RAOs).

A second RI was completed in 2002 that included all of the sites within OU1 (TetraTech, 2002). Fish tissue samples were collected from Slocum Creek adjacent to

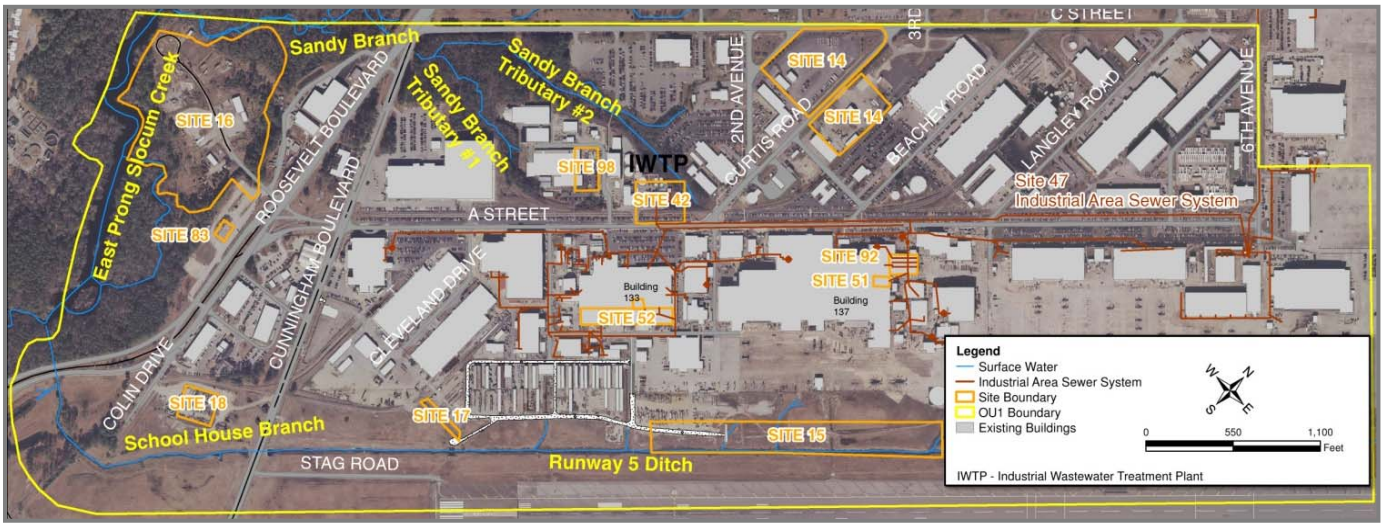


Figure 3 – OU1 Sites Location Map

OU1 in 1998, and the results indicated no potential unacceptable risk to human health from fish tissue ingestion (TetraTech, 1999). Enhanced bioremediation groundwater treatability studies were conducted in 2001 and 2004 at Buildings 133 and/or 137, which demonstrated that enhanced bioremediation was an effective treatment technology for cVOCs within the OU1 CGWP. However, during the 2004 treatability study, the groundwater plume beneath Building 133 was found to contain areas of significantly higher cVOC concentrations than previously identified as well as to extend beyond the previously characterized boundaries.

As a result of these findings, the Navy conducted additional investigations to further characterize the extent of the OU1 CGWP, primarily in the vicinity of Buildings 133 and 137, and documented the findings in the OU1 RI Addendum (CH2M HILL, 2009) and OU1 Feasibility Study (FS) Report (CH2M HILL, 2011).

Table 1 – Previous Studies, Investigations, and Removal Actions

Previous Study / Investigation *	OU1 Sites	Date	Investigation Activities
Initial Assessment Study of Marine Corps Air Station Cherry Point, North Carolina (IAS) (Water & Air Research, Inc., 1983)	15, 16, 17, 18	1982 - 1983	Historical data from 32 potentially contaminated sites were examined and 18 were judged not to require additional assessment. Due to the potential for adverse environmental impact from contaminants of potential concern (COPCs) migrating to nearby surface waters (i.e., either Slocum or Hancock Creeks), the remaining 14 sites were recommended for further investigation.
Draft Final RCRA Facility Investigation (RFI) Report, Units 5, 10, 16, and 17 (Halliburton NUS Corporation, 1991)	16, 17, 47	1985 - 1990	Groundwater, surface water, sediment, and soil samples were collected and a soil vapor survey and slug testing were conducted. VOCs and metals were detected in surficial aquifer groundwater and surface water, and metals in sediments. Additional investigation to locate the source of the contamination, including the upgradient industrial area and the newly identified Site 47 (industrial wastewater drainage system), was recommended.
Final TDM, Infiltration and Leakage Study. Second Phase (Halliburton NUS Corporation, 1993)	47, 92	1991 - 1993	Leak testing within the industrial wastewater drainage system was performed using video camera inspections and falling-head pressure tests. Soil and groundwater samples were collected to assess potential contamination resulting from leaks.
Focused Remedial Investigation/ Feasibility Study Report for Operable Unit 1 Groundwater (Brown & Root [B & R] Environmental, 1996a)	15, 16, 40, 42, 47, 51, 52, 92	1994 - 1996	Data from previous investigations were examined and indicated widespread cVOC groundwater contamination within the surficial aquifer of OU1. Preliminary RAOs and remedial alternatives were developed for "hot spot" areas. Remedial alternatives were developed for the "NADEP Central Hot Spot Area" of the OU1 CGWP. Two additional hot spot areas were defined as the Paint-Stripper Barn Area near Site 51, and the Site 14 (Motor Transportation) Tank Farm C Area.
Interim PRAP for Operable Unit 1, NADEP Central Hot Spot Area Groundwater (B & R Environmental, 1996b)	15, 40, 42, 47, 51, 52	1996	Proposed Groundwater Extraction/Air Stripping/Discharge to IWTP or Sewage Treatment Plant as the preferred remedial alternative from those identified in the 1996 OU1 FS.
Interim Record of Decision (IROD) for Operable Unit 1, NADEP Central Hot Spot Area Groundwater (B & R Environmental, 1996c)	15, 40, 42, 47, 51, 52	1996	Decision document which presents the selected interim remedial action for OU1, NADEP Central Hot Spot Area Groundwater, Groundwater Extraction/Pre-Treatment/Discharge to IWTP, whose areal extent is defined by the total cVOC concentration contours above 1,000 micrograms per liter (µg/L).
OU1 Interim Groundwater Remediation, NADEP Central Hot Spot Area (B & R Environmental, 1996d)	15, 40, 42, 47, 51, 52	1996	Remedial design document which presents proposed construction details for the OU1, NADEP Central Hot Spot Area, Groundwater Extraction/Pre-Treatment/Discharge to IWTP system.
Treatability Study Work Plan for Pilot-Scale Air Sparge/Soil Vapor Extraction (AS/SVE), Sandy Branch Landfill (B & R Environmental, 1996e)	16	1996	Based on RAOs and alternatives developed for the Site 16 Hot Spot Area in the 1996 Focused RI/FS, it was recommended to proceed with a treatability study to design and operate a pilot-scale AS/SVE system that will generate relevant data to support full-scale design.
Action Memorandum, Operable Unit 1, Site 16 - Landfill at Sandy Branch [Pilot Scale AS/SVE System] (B & R Environmental, 1997a)	16	1996 - 1997	Presents the decision document for the proposed removal action at Site 16, a full-scale Air Sparging/Vapor Extraction (AS/SVE) system, based on the results of a 16-week pilot-scale system study, which was determined to effectively remove VOCs from the groundwater.
Declaration for the Explanation of Significant Differences, OU1 Interim Action, NADEP Central Hot Spot and the Stripper Barn (B & R Environmental, 1997b)	15, 40, 42, 47, 51, 52, 92	1997	Document presenting modifications to the 1996 IROD: (1) Extend the area covered by the selected remedy for the NADEP Central Hot Spot Area to include other areas within OU1 where elevated concentrations of petroleum-related compounds and cVOCs were detected. (2) Use of the existing IWTP, in conjunction with any necessary pretreatment systems, to treat contaminated groundwater.

Table 1 – Previous Studies, Investigations, and Removal Actions

Previous Study / Investigation *	OU1 Sites	Date	Investigation Activities
Final Remedial Investigation for Operable Unit 1 (Tetra Tech, 2002)	OU1	1994 - 2000	Environmental samples collected from OU1 surface and subsurface soil, surface water and sediment from Sandy Branch, Schoolhouse Branch, and East Prong Slocum Creek, groundwater from the surficial, Yorktown, Pungo River, and Castle Hayne aquifers, and miscellaneous drainage ditches. A Feasibility Study was recommended to address potential unacceptable risks.
Step 3A Addendum to the Ecological Risk Assessment (CH2M HILL, 2003b)	OU1	1985 - 2000	Refined exposure scenarios and added more detailed delineation of the source and spatial extent of potential risks to ecological receptors. Identified potential sources and COPCs affecting various trophic levels surrounding OU1 and in the Sandy Branch aquatic system. Recommended conducting a baseline ecological risk assessment (BERA) to further assess impacts on the environment.
Voluntary Groundwater Monitoring (CH2M HILL, 2006)	OU1	2004 - 2005	Voluntary groundwater monitoring was conducted at select monitoring wells on a semiannual basis to track potential plume migration and to maintain awareness of plume configuration.
Treatability Study Report (CH2M HILL, 2007)	OU1	2004 - 2005	An enhanced bioremediation treatability study was conducted involving the injection of EHC into the surficial aquifer at Buildings 133 and 137. The purpose of the study was to determine the effectiveness of the technique to remediate what was understood from previous investigations to be a relatively small VOC plume area in the shallow groundwater beneath each building. The treatability study included four post-injection monitoring events over a 10-month period. The treatability study was initially effective in reducing VOC concentrations in wells located near the injection points and VOC mass reduction was achieved. However, the concentrations of some of the contaminants rebounded significantly with time, in part due to under-dosing of the injected substrate as well as the likely presence of dense, non-aqueous phase liquid (DNAPL), which was not previously known to be present.
Baseline Ecological Risk Assessment (BERA) for Operable Unit 1 (CH2M HILL, 2005)	OU1	2004	Sediment samples were collected and analyzed for VOCs, SVOCs, PCBs, pesticides, metals, cyanide, and toxicity to lower trophic-level organisms from the Sandy Branch Aquatic System. No significant risks to sediment-associated receptors in the main Sandy Branch channel or at the confluence of Sandy Branch and East Prong Slocum Creek were identified, but some potentially unacceptable risk due to chemicals of concern (COCs) within Tributary 2 and portions of its drainage area and floodplain was noted. Additional sampling was recommended to find the source and better delineate COCs in Tributary 2.
System Closeout Report AS/SVE System, Operable Unit 1, Site 16 (AGVIQ/ CH2M HILL, 2006)	16	2000 - 2004	After determining the AS/SVE system had reached asymptotic conditions and was becoming less cost-effective, it was recommended to shut the system down. The system had run for 8 years and removed approximately 3,100 lbs of cumulative VOC mass.
Engineering Evaluation/Cost Analysis, Sandy Branch Tributary 2, Operable Unit 1 (CH2M HILL, 2008a)	OU1	2004 - 2006	An EE/CA was conducted to evaluate alternatives for a NTCRA to remove COC-contaminated soil/sediment to levels protective of at-risk ecological receptors (i.e., benthic macroinvertebrates) in a manner that is minimally invasive and/or harmful to the existing and functioning habitat.
Action Memorandum, Sandy Branch Tributary 2, Operable Unit 1 (CH2M HILL, 2008b)	OU1	2008	Documents approval of the NTCRA (Soil and Sediment Removal Action) for Tributary 2 of Sandy Branch and vicinity floodplain areas.
Five-Year Review Report (CH2M HILL, 2008c)	OU1	2008	Documents conclusions from earlier technical evaluations of the OU1 Central Groundwater Hotspot Pump and Treat system and the Site 16 AS/SVE system that neither system was meeting the RAOs nor operating in a cost-effective manner. In addition, it was concluded that since actions and controls were in-place to mitigate exposure pathways that could result in unacceptable risks in the short-term and that continued operation could interfere with ongoing investigations to more fully delineate the nature and extent of groundwater contamination in portions of OU1, these systems were shut down in 2005.
Final Construction Completion Report, Sandy Branch Tributary 2 - OU1 (Rhēa, 2009)	OU1	2008	Report documenting the NTCRA at Sandy Branch Tributary 2. Roughly 1,500 tons of soil and sediment were excavated from areas of ecological concern, including floodplains and streambeds of Tributary 2. Sediment/soil was disposed of as non-hazardous waste. Excavated areas were backfilled with clean material and restored.
OU1 Remedial Investigation Addendum (CH2M HILL, 2009)	16, 42, 47, 51, 52, 92, 98	2004 - 2008	Collected and evaluated subsurface characterization data for the surficial and Yorktown aquifers by collecting and analyzing groundwater samples from approximately 245 permanent monitoring wells to sufficiently characterize the existing groundwater conditions and the nature and extent of chlorinated solvent contamination. The data was then assessed for potential risks posed by COCs to human health and the environment within OU1. Recommended a Feasibility Study.
Final Construction Closeout Report OU1 Site 16 Air Sparge/ Soil Vapor Extraction System Decommission (Rhēa, 2010)	16	2009	Closed-out and decommissioned the Site 16 AS/SVE system by grouting all SVE wells and lateral header lines, removing all SVE fiberglass and metal vaults, dismantling and removing all AS/SVE equipment, demolishing Compound No. 2 concrete pad, and conducting site restoration, which included grading, backfilling, and revegetating disturbed areas.

Table 1 – Previous Studies, Investigations, and Removal Actions

Previous Study / Investigation *	OU1 Sites	Date	Investigation Activities
Operable Unit 1 Central Groundwater Plume Feasibility Study (CH2M HILL, 2011a)	OU1	2011	Evaluated remedial alternatives to mitigate VOCs in groundwater based on previous environmental investigations. These alternatives can be found in Section 7 of this Proposed Plan.
Phase I Vapor Intrusion Investigation Report (CH2M HILL, 2011b)	OU1	2009	A VI evaluation was conducted to assess potential migration of cVOCs from contaminated groundwater into overlying industrial buildings at OU1. Soil vapor and groundwater samples associated with 21 buildings of interest were collected. Eleven buildings with co-located near-slab or groundwater data that exceeded generic screening levels or those with the potential for vapor transport along subsurface utility lines located between contaminated areas were retained as buildings of interest for a recommended Phase II investigation (Buildings 131, 133, 137, 143, 188, 3402, 3997, 4026, 4224, 4225, and 4525/129).
Operable Unit 1 Central Groundwater Plume In-Situ Enhanced Bioremediation Pilot Study Implementation Report (CH2M HILL, 2012a)	OU1	2011 - 2013	Implemented a field-scale Pilot Study at OU1 to test the effectiveness of the in-situ enhanced bioremediation alternative from the 2011 FS. Injected the commercially available Slow Release Emulsified Vegetable Oil Substrate (SRS) and *Dehalococcoides* bacterial culture for bioaugmentation into a row of 14 injection wells, seven screened in the upper and seven in the lower surficial aquifer, with the intent of creating a treatment biobarrier.
Phase II Vapor Intrusion Investigation Report (CH2M HILL, 2012b)	OU1	2011	The overall objectives were to evaluate the potential for migration of site-related VOCs from contaminated groundwater and soil vapor into overlying industrial buildings at OU1, and to assess current potential risks to industrial workers from VI. Provided a second round of sampling to evaluate the potential for a complete or significant (greater than target risk levels) vapor pathway. The Phase II evaluation determined that VI is insignificant based on current conditions and therefore VI mitigation is not required for existing buildings at this time. It was recommended that periodic VI monitoring be incorporated into the selected remedy for the OU1 CGWP to monitor for potential future risk in Buildings 129, 131, 133, 137, 3997, 4026, 4225, and 4533. The Phase II evaluation also recommended that VI be considered during construction planning that will involve slab penetrations at buildings where exceedances of the generic and/or base-wide soil gas screening levels were detected (Buildings 131, 133, 137, 3997, 4026, 4225, and 4533) and that VI evaluations be conducted during the design phase for proposed building construction within the vicinity of the OU1 CGWP, to determine if VI mitigation measures (such as a vapor barrier) should be incorporated into building design.
Operable Unit 1 Central Groundwater Plume Zero-Valent Iron Permeable Reactive Barrier Implementation Plan (CH2M HILL, 2012c)	42, 47, 51, 52, 92, 98	2011-2014	Presented the field scale implementation plan for installation of a 600-foot ZVI PRB. The objectives of the ZVI PRB were to determine if a 45-ft bgs depth can be attained using the DeWind One-Pass Trench System and to evaluate the ability of the PRB to achieve 90 percent reduction of TCE and 75 percent reduction of overall VOCs over a 1-year time period in the monitoring wells immediately downgradient of the PRB.

A non-time-critical removal action (NTCRA) was conducted in 2008 to remove soil and sediment (approximately 1,500 tons) within the Sandy Branch Tributary #2 floodplain contaminated with several polycyclic aromatic hydrocarbons (PAHs), non-PAH semi-volatile organic compounds (SVOCs), pesticides, and metals. Further details of the NTCRA are provided in Section 4.2 below.

A multi-phased **vapor intrusion** (VI) evaluation was initiated in 2008 to assess the potential migration of vapors from the OU1 CGWP through soil pore spaces into overlying industrial buildings at OU1, and to assess potential current risks to industrial workers from vapor intrusion (CH2M HILL, 2012b). At the conclusion of Phase II, the evaluation determined that VI is not significant based on current conditions, and that VI mitigation is not required for existing buildings at this time. It was recommended that periodic VI monitoring be incorporated into the selected remedy for the OU1 CGWP sites to monitor for potential future VI risk in Buildings 129, 131, 133, 137, 3997, 4026, 4225, and 4533. The Phase II evaluation also recommended that VI be considered during construction planning that would involve slab penetrations at buildings where exceedances of the generic and/or base-wide soil gas screening levels were detected (Buildings 131, 133, 137, 3997, 4026, 4225, and 4533) and that VI evaluations be conducted during the design phase for proposed building construction within the vicinity of the OU1 CGWP, to determine if VI mitigation measures (such as a vapor barrier) should be incorporated into building design.

Two pilot studies were implemented at the OU1 CGWP sites in 2012 to investigate the efficacy of potential groundwater treatment options to address the OU1 CGWP (CH2M HILL, 2012a and 2012c). The purpose of these pilot studies was to gather information to aid in the selection of potential remedies and also to contribute to the Remedial Design of the selected remedy. The first was a field-scale pilot study to evaluate the site-specific effectiveness of ISEB downgradient of Building 133. The second pilot study included the construction of a 600-ft long PRB in the downgradient portion of the OU1 CGWP, near East Prong Slocum Creek.

3 Site Characteristics

3.1 Physical Characteristics

The majority of OU1 generally consists of paved or concrete surfaces with buildings in between. The ground surface is relatively flat, with elevations that range from 18 to 24 feet above mean sea level (msl). However, in the southwestern portion of OU1 along East Prong Slocum Creek, the surface elevation drops to approximately 2 to 10 feet above msl. A **conceptual site model** (CSM) of OU1 is included in **Figure 4**.

Surface water bodies present within OU1 include East Prong Slocum Creek and its tributaries Schoolhouse Branch and Sandy Branch. East Prong Slocum Creek flows into Slocum Creek and eventually the Neuse River. East Prong Slocum Creek, Schoolhouse Branch, and Sandy Branch have been classified by the State of North Carolina as Class C fresh water bodies, which consists of surface water intended for fish and wildlife propagation, agriculture, secondary recreation (i.e., recreational activities not involving whole-body contact), and other uses except primary recreation or as a source of water supply for drinking, culinary, or food-processing purposes (CH2M HILL, 2009).

Sandy Branch and its tributaries include wide, swampy adjacent areas, and a few areas where the banks are steep. Schoolhouse Branch is heavily vegetated, with grasses near the runway and a heavily wooded area between Roosevelt Boulevard and East Prong Slocum Creek (TetraTech, 2002).

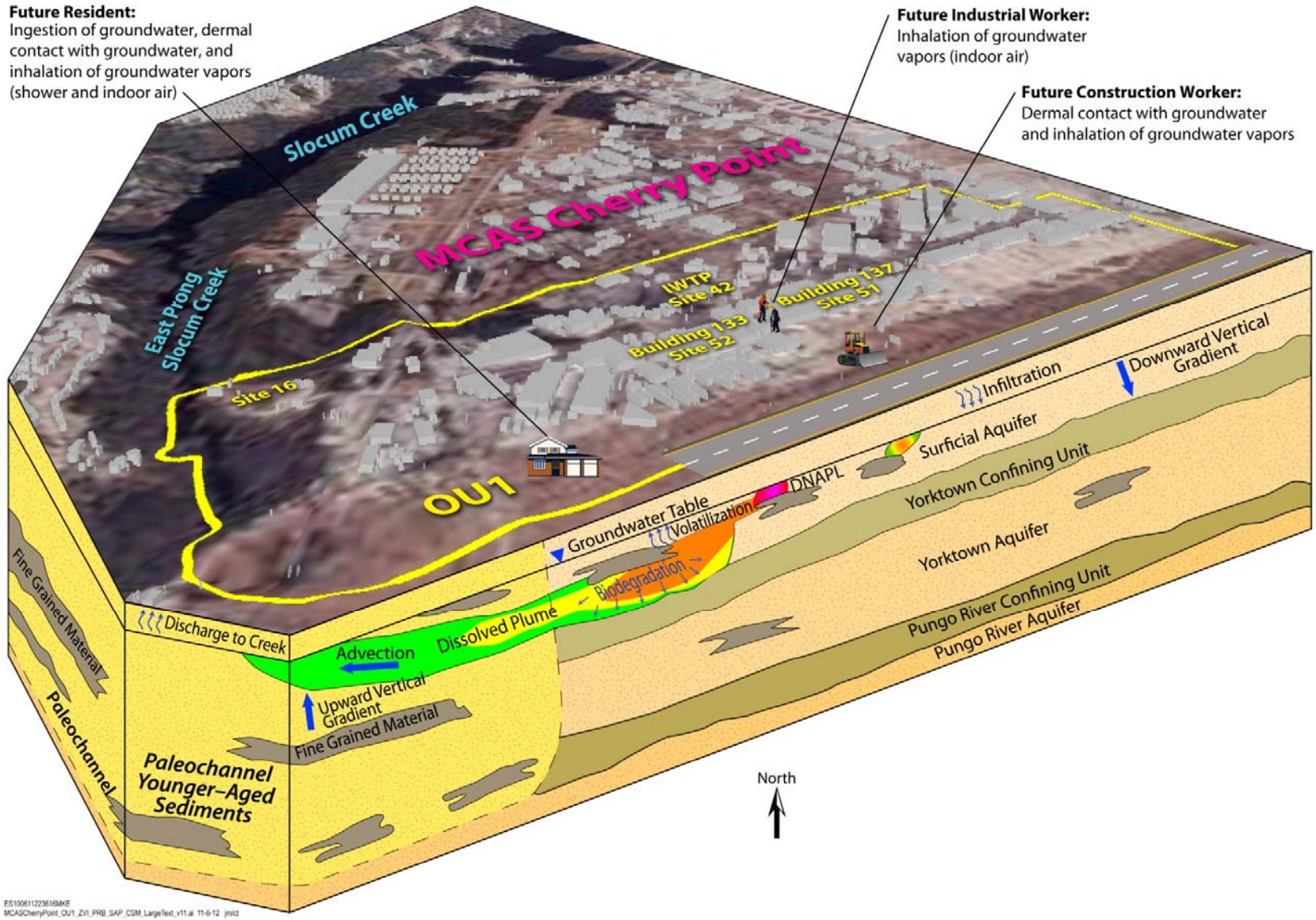
The first encountered groundwater beneath OU1 is the unconfined surficial aquifer, at depths ranging from approximately 4 to 21 feet below ground surface (ft bgs). The surficial aquifer has a saturated thickness of approximately 30 to 45 feet, and is controlled by the fine-grained Yorktown confining unit at the base of the aquifer. The surficial aquifer has been subdivided for evaluation purposes into two different groundwater zones: the upper surficial aquifer (defined as the upper 10 to 15 feet) and the lower surficial aquifer (defined as the lower 20 to 30 feet). This is, in part, due to minor differences in aquifer properties, but primarily to facilitate spatial delineation of contamination vertically. The upper and lower surficial aquifers are in direct hydraulic communication and there is no confining unit or geologic boundary between them.

The Yorktown aquifer occurs beneath the Yorktown confining unit and is generally a confined to semi-confined aquifer. The saturated thickness is approximately 40 feet and is controlled by the Yorktown confining unit at the top and the Pungo River confining unit at its base, where present.

A regional **paleochannel** eroded portions of the Yorktown and Pungo River confining units and deposited younger-aged sediments in the southwestern portion of OU1 (**Figure 4**). As a result, the uppermost aquifers may be in direct hydraulic communication within the paleochannel. Groundwater levels outside the paleochannel, where the Yorktown confining unit exists, show that the Yorktown confining unit acts as an **aquitard** and a downward vertical gradient exists between the surficial and Yorktown aquifers. Groundwater levels within the paleochannel generally show similar groundwater levels between the surficial and Yorktown aquifers, and the vertical gradient is weakly upward from the Yorktown aquifer to the surficial aquifer.

Groundwater at OU1 generally flows to the west in the upper and lower surficial aquifers towards East Prong Slocum Creek and Sandy Branch. The average horizontal hydraulic gradient is approximately 0.004 feet per foot (ft/ft). Groundwater flow appears to have minimal discharge to Sandy Branch Tributaries #1 and #2 and flows parallel to their general direction in this area. The average linear horizontal groundwater velocity in the upper and lower surficial aquifer is estimated at approximately 0.1 to 0.2 ft/day. Groundwater beneath OU1 is classified by the State of North Carolina as Class GA, which is groundwater that may be considered an existing or potential source of drinking water (CH2M HILL, 2009).

Figure 4 – OU1 Simplified Conceptual Site Model



3.2 Proposed Land Use

The future land use of OU1 is anticipated to remain similar to the current land use, as the industrial area of the Air Station. Groundwater from within OU1 is not used as a source of drinking water at MCAS Cherry Point or by the City of Havelock. The water supply wells that are in use are completed within the deeper Pungo River aquifer (City of Havelock) and Castle Hayne aquifer (MCAS Cherry Point), and are not connected hydraulically to the surficial aquifer within OU1 where contamination is present (CH2M HILL, 2009).

3.3 Nature and Extent of Contamination

Analytical data collected during the OU1 2002 RI and 2009 RI Addendum provided the basis for the evaluation of the nature and extent of contamination in soil, groundwater, surface water, and sediment. Constituents detected above screening criteria and MCAS Cherry Point background concentrations (for inorganic constituents) are summarized in **Tables 2 through 5**. Data for each analyte were compared to the appropriate regulatory and risk-based screening values to evaluate preliminary risks to human and ecological receptors and for the consideration of a constituent as a chemical of potential concern (COPC), which is discussed further in Section 4 below.

Site-specific soil investigations were conducted during the 2002 RI, and the nature and extent of contamination in soil were evaluated by grouping sites that are located in close proximity to one another (eight soil groupings). Chemicals detected above screening criteria within soil included VOCs, SVOCs, pesticides, polychlorinated biphenyls (PCBs), and inorganic constituents (**Table 2**). Inorganic constituents were generally determined to be attributable to background conditions; detected pesticide concentrations were found to be attributable to normal, historical applications to control termites and other pests, which are not considered releases under CERCLA regulations (TetraTech, 2002).

The cVOC trichloroethene (TCE) is the most prevalent chemical detected within OU1 groundwater. Under anaerobic (low oxygen) conditions, naturally-occurring microorganisms in the subsurface can biodegrade TCE and its degradation products in groundwater in a process called reductive dechlorination, in which chlorine atoms in the parent molecule are sequentially replaced with hydrogen atoms. Each step in the reductive dechlorination process produces a degradation product with one fewer chlorine atom per molecule than the parent chemical. TCE degradation products include 1,2-dichloroethene (1,2-DCE) and vinyl chloride; the extents of these cVOCs in the OU1 CGWP generally mimics that of TCE, but are smaller in size.

Three distinct plumes of TCE and its degradation products occur within OU1, which collectively constitute the OU1 CGWP (**Figures 5** and **6**). The first is where the most-elevated TCE concentrations occur beneath Building 133 (source zone), at concentrations that may be indicative of the presence of dense, non-aqueous phase liquid (DNAPL), with a maximum concentration of 62,000 µg/L. Beneath Building 133, TCE generally occurs only within the upper surficial aquifer, but extends into the lower surficial aquifer at locations downgradient of Building 133. The OU1 CGWP extends over 3,000 feet downgradient to where the groundwater discharges to East Prong Slocum Creek and Sandy Branch.

The second distinct TCE plume occurs within the upper surficial aquifer beneath Building 137, and extends into the lower surficial aquifer downgradient of the building, where it mixes with the plume originating beneath the IWTP.

A third TCE groundwater plume within the upper surficial aquifer occurs near the IWTP. The TCE plume from this area migrates downgradient within the upper and lower surficial aquifers beneath Sandy Branch Tributary #2, and also joins the larger plume that extends from beneath Building 133.

Other VOCs, SVOCs, PCBs, and inorganic constituents have been detected in groundwater above screening criteria at low frequencies, as detailed in the OU1 RI Addendum (CH2M HILL, 2009) and OU1 FS Report (CH2M HILL, 2011). Benzene and other petroleum-related hydrocarbons detected in groundwater at OU1 are being investigated and addressed under the MCAS Cherry Point Underground Storage Tank (UST) Program and are not included as part of this Proposed Plan. Although this Proposed Plan does not address petroleum-related hydrocarbons, there is close coordination between the CERCLA and UST programs to ensure all contamination is being addressed in a timely and efficient manner.

3.4 Principal Threat

"Principal threat wastes" are source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should they be exposed. As described in the USEPA's Guide to Principal Threat and Low-level Threat Waste (USEPA OSWER Pub.9380.3-06FS, Nov. 1991), liquids (e.g., in buried drums), non–aqueous-phase liquids (NAPLs), and/or high concentrations of toxic compounds in soil are considered principal threat wastes. Contaminated groundwater generally is not considered to be a source material; however, NAPLs in groundwater may be viewed as a source material. Dissolved concentrations of a cVOC in groundwater between approximately 1 to 5 percent of a compound's solubility suggest the possible nearby

presence of that compound in dense NAPL (DNAPL) form in the subsurface.

USEPA generally expects that the quantity of free-phase NAPL (i.e., "free product") should be reduced to the extent practicable and that an appropriately designed containment strategy should be developed for NAPLs that cannot be removed from the subsurface (USEPA - Rules of Thumb For Superfund Remedy Selection - OSWER 9355.0-69).

The major source of the groundwater contamination for the OU1 CGWP is the likely TCE DNAPL area located beneath Building 133. To most-expediently remediate the DNAPL area, an aggressive source treatment would be required and would need to encompass the entire DNAPL area. Treatment of the entire DNAPL area would require a dense network of treatment points. To implement such a design, unrestricted component placement and uninterrupted system operation would be needed. Due to the current industrial use of Building 133, extensive subsurface infrastructure beneath the building, low overhead clearance within the building, tight spacing of equipment and workspaces, and round-the-clock operational schedule, it would be difficult or impossible to properly implement an in situ treatment technology throughout the source area.

In addition, a source zone treatment beneath Building 133 would have the potential to generate increased vapor intrusion risks to the current workers at the building. Thus, implementation of a source treatment remedy would likely result in a greater overall risk to human health for current receptors. Therefore, it has been determined that source zone DNAPL treatment for the OU1 CGWP is not currently feasible. However, if Building 133 is ever taken out of service or demolished, the efficacy and feasibility of a source zone remedial action in that location will be re-evaluated at that time.

Table 2 – Maximum Detected Chemical Concentration Above Screening Criteria and Background Soil, OU1

	Maximum Concentrations Detected Above Screening Criteria and Background						Screening Criteria	
	Sites 42 and a portion of Site 47		Site 51 and a portion of Site 47		Site 52		Reg. 9 PRG Residential Soil[1]	Reg. 9 PRG Industrial Soil[1]
	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil[3]		
Volatile Organic Compounds (µg/kg)								
1,1-Dichloroethene	--	--	--	**15,000 J**	--	--	54 C	120 C
1,4-Dichlorobenzene	--	**5,700 J**	--	--	--	**8,200**	3,400 C	8,100 C
1,4-Dioxane	--	--	--	**140,000 J**	--	--	44,000 C	220,000 C
Benzene	--	--	--	--	--	--	650 C	1,500 C
Tetrachloroethene	--	**20,000**	--	--	--	--	5,700 C	19,000 C
Trichloroethene	--	**7,100**	**6,400**	**20,000**	--	--	2,800 C	6,100 C
Vinyl Chloride	--	--	--	**800 J**	--	--	150 C	830 C
Semivolatile Organic Compounds (µg/kg)								
Benzo(a)anthracene*	--	--	--	--	--	--	620 C	2,900 C
Benzo(a)pyrene*	--	--	--	--	--	--	62 C	290 C
Benzo(b)fluoranthene*	--	--	--	--	--	--	620 C	2,900 C
Dibenz(a,h)anthracene*	--	--	--	--	--	--	62 C	290 C
Indeno(1,2,3-cd)pyrene*	--	--	--	--	--	--	620 C	2,900 C
Pesticides/PCBs (µg/kg)								
alpha-Chlordane	--	--	--	**18,000**	--	**5,300 J**	1,600 C	11,000 C
Dieldrin	--	--	--	**27,000 J**	--	**9,100 J**	30 C	150 C
Heptachlor Epoxide	--	**69 J**	--	**9,800 J**	--	**4,600**	53 C	270 C
Inorganics (mg/kg)								
Arsenic	**2.6**	**8.9**	**3.88**	**10.5 J**	--	**4.8**	0.39 C	2.7 C
Cadmium	--	--	--	**136 J**	--	--	37 N	810 N
Chromium	--	--	--	**2,630**	--	**274**	210 C	450 C
Cyanide	--	--	**76**	**37.6**	--	--	11 N	35 N
Lead	--	--	--	--	--	**679 J**	400	750

Notes:
Only data that exceeded one or more screening criteria are shown
Data from 2002 RI (TetraTech, 2002) unless noted
J - Estimated
C - Carcinogenic
N - Noncarcinogenic
* - Polycyclic aromatic hydrocarbon (PAH)
[1] - USEPA Region IX Preliminary Remediation Goals Table, November 1, 2000. Residential and Industrial values (Cancer benchmark value = 1E-6, HI - 0.1)
[2] - USEPA Soil Screening Guidance: Technical Background Document, May 1996
[3] - Combined surface and subsurface soil data from 2004-2006 sampling events as part of the *Sites 47 and 52 Soil Evaluation Technical Memorandum, OU1 RI Addendum (CH2M HILL, 2009)*

Table 3 – Maximum Detected Chemical Concentration Above Screening Criteria, Groundwater, OU1

	Maximum Chemical Concentration in Groundwater Detected Above Background or Screening Criteria			Screening Criteria		
	Surficial Aquifer	Yorktown Aquifer	Pungo River & Castle Hayne Aquifers	Background Value	USEPA Region 9 $PRG_{Tapwater}$[1]	NC 2L[2]
Volatile Organic Compounds (µg/L)						
1,1,1-Trichloroethane	**49,000**	--	--	NA	540 N	200
1,1,2,2-Tetrachloroethane	**6 J**	--	--	NA	0.055 C	0.2
1,1,2-Trichloroethane	**39 J**	--	--	NA	0.2 C	5[3]
1,1-Dichloroethane	**8,800 J**	--	--	NA	810 N	6
1,1-Dichloroethene	**2,900**	--	--	NA	0.046 C	7[3]
1,2,4-Trimethylbenzene	--	--	--	NA	12 N	400
1,2-Dichlorobenzene	**470**	--	--	NA	370 N	20
1,2-Dichloroethane	**14**	--	--	NA	0.12 C	0.4
1,2-Dichloroethene (total)	**16,000**	--	--	NA	61 N	70
1,2-Dichloropropane	**4 J**	--	--	NA	0.16 C	0.6
1,3,5-Trimethylbenzene	--	--	--	NA	12 N	400
1,3-Dichlorobenzene	**34**	--	--	NA	6 N	200
1,4-Dichlorobenzene	**98 J**	**1.4 J**	--	NA	0.5 C	6
2-Butanone	**50,000**	--	--	NA	1,900 N	4,000
Benzene	**7,700**	**0.61 J**	--	NA	0.35 C	1
Bromodichloromethane	**9 J**	**4 J**	--	NA	0.18 C	0.6
Chlorobenzene	**930**	--	--	NA	110 N	50
Chloroethane	**1100**	--	--	NA	4.6 C	3,000
Chloroform	**25 J**	**40**	--	NA	0.16 C	70
Chloromethane	**100**	--	--	NA	1.5 C	3
cis-1,2-Dichloroethene	**33,000**	--	--	NA	61 N	70
Ethylbenzene	**1,770**	--	--	NA	1,300 N	600
Isopropylbenzene	**1,100**	--	--	NA	660 N	70
Methylene Chloride	**71**	--	--	NA	4.3 C	5
Tetrachloroethene	**71**	--	--	NA	1.1 C	0.7
Toluene	**7,100**	--	--	NA	720 N	600
trans-1,2-Dichloroethene	**1,100**	--	--	NA	120 N	100
Trichloroethene	**62,000**	--	--	NA	1.6 C	3
Vinyl Chloride	**8,000**	--	--	NA	0.041 C	0.03
Xylenes (total)	**5,200**	--	--	NA	1,400 N	500
Semivolatile Organic Compounds (µg/L)						
2-Methylnaphthalene*	**78**	--	--	NA	6.2 N	30
4-Methylphenol	**470**	--	--	NA	180 N	40
Chrysene*	**38 J**	--	--	NA	9.2 C	5
Naphthalene*	**340**	--	--	NA	6.2 N	6
Pesticides/PCBs (µg/L)						
alpha-Chlordane	0.034 J	--	--	NA	0.19 C	0.1
Dieldrin	0.06 J	--	--	NA	0.0042 C	0.002
Inorganics (mg/L)						
Arsenic	**56.1**	--	--	6.16	0.045 C	10
Cadmium	**4 J**	--	--	ND	5 N	2
Iron	**268,000 J**	--	--	4,740	11,000 N	300
Manganese	**3,180**	--	**227**	93.4	880 N	50
Thallium	--	--	**8.2**	ND	2.4 N	2[3]

Notes:
Only data that exceeded one or more screening criteria are shown
J - Estimated
NA - Not Applicable
ND - Non-detect
* - Polycyclic aromatic hydrocarbon (PAH)
C - Carcinogenic
N - Noncarcinogenic
sat - Soil Saturation Concentration
max - Ceiling Limit
SSL - Soil Screening Level
PRG - Preliminary Remediation Goal
[1] - USEPA Region IX Preliminary Remediation Goals Table, November 1, 2000. Residential and Industrial values (Cancer benchmark value = 1E-6, HI - 0.1)
[2] - North Carolina Groundwater Quality Standards (NC 2L) (NCDENR: Administrative Code 15A NCAC 2L .0202C), April 1, 2013.
[3] – No NC 2L Standard or based on more conservativeUSEPA Maximum Contaminant Level (MCL).
Data from additional investigations which took place between 2000 and 2007

Table 4: Maximum Detected Chemical Concentration Above Screening Criteria, Surface Water, OU1

	Maximum Contaminant Concentration in Surface Water Detected Above Background or Screening Criteria				Screening Criteria
	Sandy Branch	School- house Branch	East Prong Slocum Creek	Miscellaneous Drainage Ditches	NCSWQS[1]
Pesticides/PCBs (µg/L)					
alpha-Chlordane	--	--	**0.0073 J**	--	0.0008
Endosulfan I	--	**0.027 J**	--	--	0.009
gamma-Chlordane	--	--	**0.0057 J**	--	0.0008
Inorganics (mg/L)					
Chromium	**20.9**	--	--	--	20
Copper	**17**	**38.8**	**15.3**	**27.1**	3
Cyanide	--	**46.1**	--	--	1
Lead	10.4	**25.9**	--	6.2	25
Mercury	**0.03**	**0.06**	--	**0.03**	0.025
Nickel	--	**59.9**	**--**	**41.1**	8.3
Silver	--	--	**3**	--	0.1
Zinc	--	**99.9**	--	**116**	86

Notes:

Bold indicates exceedance of one or more screening criteria

Only data that exceeded one or more screening criteria are shown

J - Estimated

* - Polycyclic aromatic hydrocarbon (PAH)

[1] - North Carolina Surface Water Quality Standard - Value shown is the most conservative of either the Human Health or Saltwater Aquatic Life; NCAC, 2B, 0208 (2). 2001.

Table 5 – Maximum Detected Chemical Concentration Above Screening Criteria, Sediment, OU1

	Maximum Chemical Concentration in Sediment Detected Above Background or Screening Criteria				Screening Criteria	
	Sandy Branch	Sandy Branch Tributary 2	Schoolhouse Branch	East Prong Slocum Creek	Reg. 9 PRG Residential Soil[1]	Reg. 9 PRG Industrial Soil[1]
Volatile Organic Compounds (µg/kg)						
Vinyl Chloride	**88 J**	**170**	--	--	150 C	830 C
Semivolatile Organic Compounds (µg/kg)						
2-Methylnaphthalene*	--	**35,000**	--	--	56,000 N	19,000 N
Benzo(a)anthracene*	--	--	**94,000**	--	620 C	2,900 C
Benzo(a)pyrene*	**290 J**	**360 J**	**74,000**	**370 J**	62 C	290 C
Benzo(b)fluoranthene*	--	**740 J**	**76,000**	**980 J**	620 C	2,900 C
Benzo(k)fluoranthene*	--	--	**34,000**	--	6,200 C	29,000 C
bis(2-Ethylhexyl)phthalate	--	--	**83,000**	--	35,000 C	180,000 C
Carbazole	--	--	**36,000**	--	24,000 C	120,000 C
Chrysene*	--	--	**96,000**	--	62,000 C	290,000 C
Dibenzo(a,h)anthracene*	--	--	**21,000**	--	62 C	290 C
Indeno(1,2,3-cd)pyrene*	--	--	**48,000**	--	620 C	2,900 C
Pesticides/PCBs (µg/kg)						
Aldrin	**51 J**	--	--	--	29 C	150 C
alpha-BHC	--	**310 J**	--	--	90 C	590 C
Aroclor (total)	**2,800**	--	**6,900**	**440**	220 C	1,000 C
Dieldrin	**240 J**	--	--	--	30 C	150 C
Heptachlor Epoxide	**74 J**	--	--	--	53 C	270 C
Inorganics (mg/kg)						
Arsenic	**14**	**9.4**	**7 J**	**10**	0.39 C	2.7 C
Cadmium	**62.7 J**	**676**	--	--	37 N	810 N
Chromium	**401 J**	**947**	--	--	210 C	450 C
Iron	--	**31,000**	--	**36,200 J**	23,000 N	100,000 max
Lead	--	**1150**	**449 J**	--	400	750

Notes:

Only data that exceeded one or more screening criteria are shown

J - Estimated

C - Carcinogenic

N - Noncarcinogenic

NA - Not Analyzed

* - Polycyclic aromatic hydrocarbon (PAH)

[2] - USEPA Soil Screening Guidance: Technical Background Document, May 1996

[3] - SB/EPSC - Sandy Branch/East Prong Slocum Creek

Data from Baseline Ecological Risk Assessment (BERA) (CH2M HILL, 2005)

Figure 5 – Trichloroethene (TCE) Isoconcentration Map, Upper Surficial Aquifer

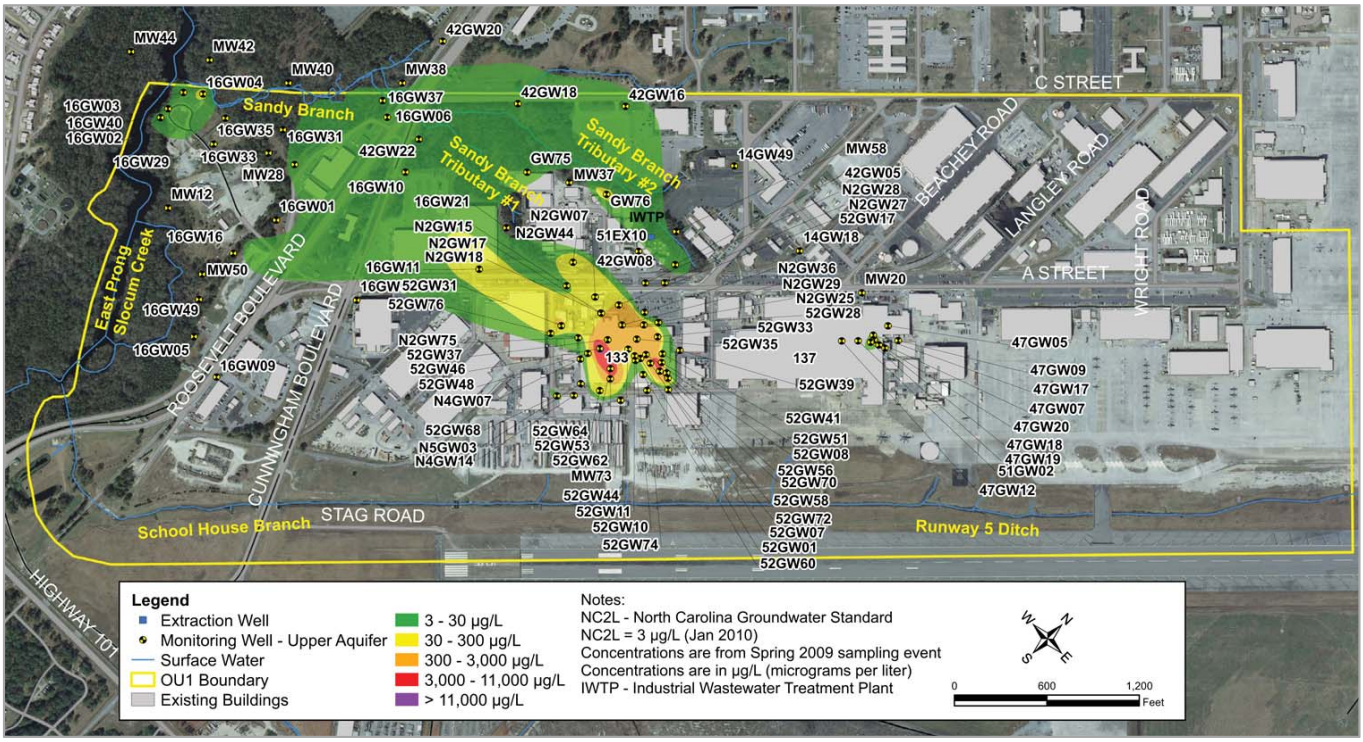
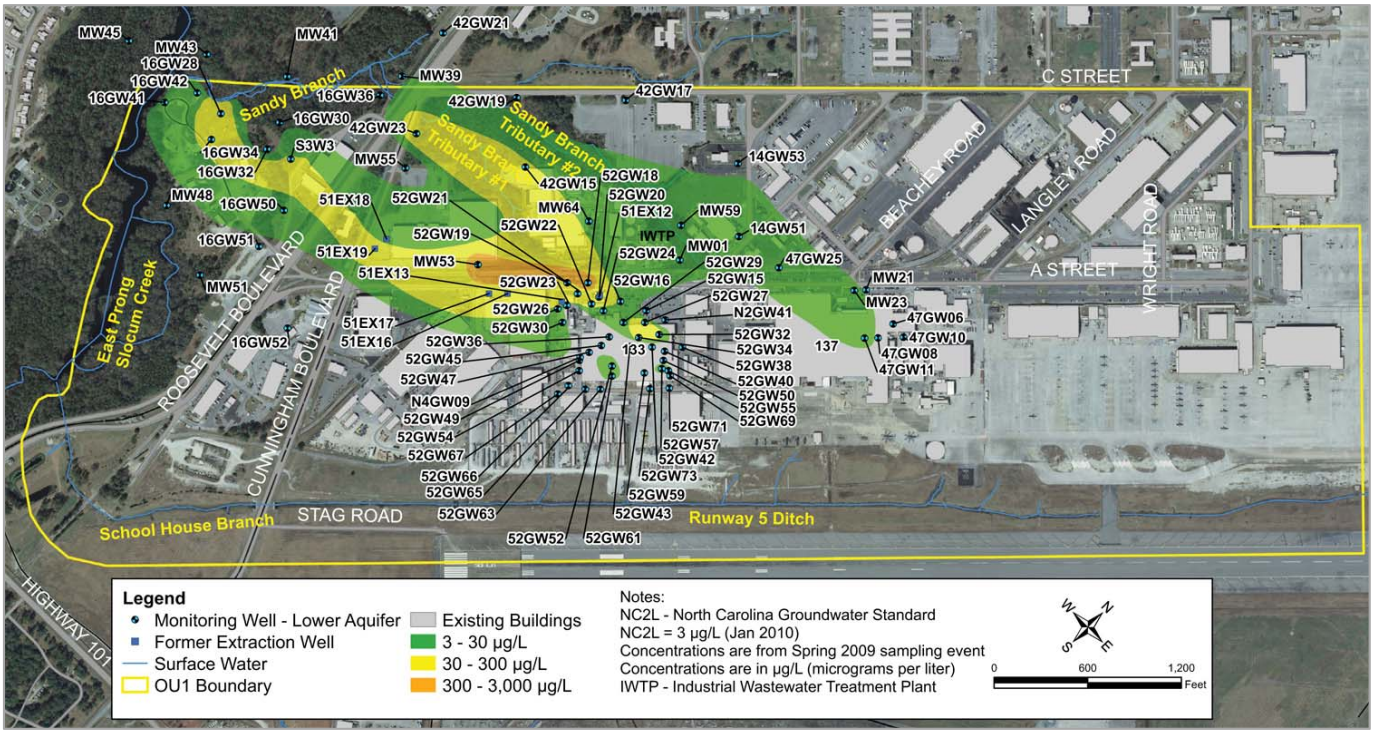


Figure 6 – Trichloroethene (TCE) Isoconcentration Map, Lower Surficial Aquifer



Surface water and sediment samples were collected from East Prong Slocum Creek, Sandy Branch, and Schoolhouse Branch as part of the 2002 RI (**Tables 3 and 4**). VOCs, SVOCs, PCBs, pesticides, and inorganic constituents were observed in surface water and sediment within OU1. Concentrations were generally determined to be either likely associated with background conditions, the result of elevated turbidity during sampling, or false positive detections resulting from the laboratory method. Details of the surface water and sediment sampling results are provided in the OU1 RI Addendum (CH2M HILL, 2009) and OU1 FS Report (CH2M HILL, 2011).

The results of the VI evaluation determined that VI is insignificant based on current conditions and therefore VI mitigation is not required for existing buildings at this time. It was recommended that periodic VI monitoring be incorporated into the selected remedy for the OU1 CGWP to monitor for potential future risk in Buildings 129, 131, 133, 137, 3997, 4026, 4225, and 4533. The Phase II evaluation also recommended that VI be considered during construction planning that will involve slab penetrations at buildings where exceedances of the generic and/or base-wide soil gas screening levels were detected (Buildings 131, 133, 137, 3997, 4026, 4225, and 4533). It was also recommended that VI evaluations be conducted during the design phase for proposed building construction within the vicinity of the OU1 CGWP, to determine if VI mitigation measures (such as a vapor barrier) should be incorporated into building design. Details of the multi-phased VI evaluations are summarized in Section 4.1 below.

3.4 Natural Attenuation Evaluation

The geochemical characteristics of the surficial aquifer were measured to evaluate the progress and potential for natural attenuation as part of the OU1 RI Addendum (CH2M HILL, 2009). The presence of TCE degradation products and the nature of **geochemical parameters** indicated that conditions were generally favorable for the natural clean-up of COCs in groundwater.

Groundwater transport and chemical degradation evaluations utilized in the FS predicted that PCE, TCE, cis-1,2-DCE, and vinyl chloride would naturally degrade to below **North Carolina Surface Water Quality Standards** (NCSWQS) prior to their discharge to the upgradient portion of Sandy Branch. However, the vinyl chloride concentration is not likely to drop below the NCSWQS prior to plume discharge into the downgradient portion of Sandy Branch. At present concentration levels, TCE is also not expected to decrease below NCSWQS prior to plume discharge to East Prong Slocum Creek (CH2M HILL, 2011). Thus, a remedial action at the site is recommended to reduce TCE and vinyl chloride concentrations to a level that would prevent plume discharge to Sandy Branch and East Prong Slocum Creek above NCSWQS.

4 Summary of Site Risks

A summary of the **human health risk assessment (HHRA)** and **ecological risk assessment (ERA)** conducted for OU1 during the 2002 RI, RI Addendum, and the Phase II VI evaluation is included in the following subsections. The 2002 RI, RI Addendum, Phase II Vapor Intrusion Evaluation Report, and Baseline Ecological Risk Assessment (BERA) provide more detailed analysis and evaluation, and are available in the Administrative Record File. **Table 6** summarizes the risk assessment results.

Table 6 – OU1 Risk Summary

Medium	Human Health Risk	Ecological Risk
Surface/Subsurface Soil	Acceptable	Acceptable
Sediment	Acceptable	Acceptable
Groundwater – Surficial Aquifer	Unacceptable	Acceptable
Groundwater – Yorktown Aquifer	Acceptable	Acceptable
Surface Water	Acceptable	Acceptable
Indoor Air	Acceptable (Current Risk)	Not Applicable

4.1 Human Health Risk Assessment

The HHRA was conducted to evaluate potential human health risks associated with exposure to soil, sediment, groundwater, surface water, fish ingestion, and indoor air at OU1. Health risks are based on a health-protective estimate of the potential carcinogenic risk and the potential non-cancer hazard, which is expressed as a hazard index (HI). Exposure scenarios evaluated for site media included construction workers, maintenance workers, full-time employees, adolescent trespassers, adult recreational users, child residents, adult residents, lifelong residents, and fish consumers based on current and future land use. Conservative exposure pathways included ingestion, dermal contact, and inhalation of chemicals by direct contact with groundwater either in the field or in a shower scenario. Estimated current human health risks were also calculated for the industrial scenario for the indoor air pathway using indoor air data collected from 14 buildings. It is important to note that some of these exposure scenarios are not likely to occur, but were considered as a health-protective measure to ensure that appropriate decisions are made with respect to the need for remediation.

What is Human Health Risk and How is it Calculated?

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

Step 1: Data Collection and Evaluation

Step 2: Exposure Assessment

Step 3: Toxicity Assessment

Step 4: Risk Characterization

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

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

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

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

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

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

- Two types of risk are considered: cancer risk and non-cancer hazard.
- The likelihood of developing cancer as a result of site exposure is expressed as an upper-bound probability; for example, a "1 in 10,000 chance." In other words, for every 10,000 people that might be exposed under the conditions identified in Step 2, one additional case of cancer may occur as a result of site exposure. An additional cancer case indicates one more person than the number that may get cancer without site exposure.
- For non-cancer health effects, a "hazard index" (HI) is calculated. The HI represents the ratio between the "reference dose", which is the dose at which no adverse health effects are expected to occur, and the RME dose for a person contacting COPCs at the site. The key concept here is that a "threshold level" (measured as an HI of 1) exists, below which no non-cancer health effects are expected to occur.
- The potential risks from the individual COPCs and exposure pathways are summed and a total site risk is calculated for each receptor.
- The risk estimates are evaluated to determine if they are high enough to cause health problems for people at or near the site.

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

Future potable use of groundwater from the surficial aquifer by hypothetical future residents may result in **unacceptable risks**, primarily associated with tetrachloroethene (PCE), TCE, and vinyl chloride (**Table 7**). LUCs, including the prohibition of groundwater use except for monitoring purposes, are an integral component of the remedial alternatives in order to mitigate these hypothetical future risks. Risk estimates for the deeper aquifers (Yorktown and Castle Hayne aquifers) and for other media (soil, surface water, sediment, fish tissue, and indoor air) are within acceptable levels; therefore, COCs were not identified for soil, surface water, sediment, fish, and indoor air within the OU1 CGWP sites.

The VI evaluation concluded that currently, VI is not occurring or is insignificant for all buildings in proximity to the OU1 CGWP. Because building characteristics can have significant influence on whether VI occurs, the Navy will continue to assess the potential for future VI while a subsurface vapor source is present. Consequently future VI evaluations are a recommended component of the remedial alternatives for the OU1 CGWP (CH2M HILL, 2012b). Additional concurrent subslab soil vapor and indoor and outdoor air sampling was recommended as part of a future long-term monitoring program to be implemented with the selected remedy.

Table 7 – Human Health Risk, OU1

Human Health Risk At OU1										
	Surface/ Subsurface Soil							Groundwater (by aquifer)		
Receptors	Sites 42 and 47 (Soil Grouping 5 [2002 RI])	Sites 47 and 51 (Soil Grouping 6 [2002 RI])	Site 52 (Soil Grouping 7 [2002 RI])		Sediment (2002 RI)	Surface Water (2002 RI)	Vapor Intrusion (2012 VI)	Surficial (RI Addendum[7])	Yorktown (RI Addendum[7])	Castle Hayne (2002 RI)
Construction Workers	ILCR = 4.4E-07 HI = 0.07 Acceptable	ILCR = 3.2E-05 HI = 6.7 Acceptable*[1]	ILCR = 1.3E-05 HI = 2.7 Acceptable*[2]		ILCR = 7.5E-06 HI = 0.03 Acceptable	ILCR = 3.1E-07 HI = 0.1 Acceptable	NA[5]	ILCR = 2.2E-05 HI = 1.8 Acceptable[8]	NA	NA
Maintenance Workers	ILCR = 1.1E-07 HI = 0.002 Acceptable	ILCR = 2.7E-09 HI = 0.0008 Acceptable	ILCR = 0.0E+00 HI = 0.00005 Acceptable		ILCR = 4.2E-05 HI = 0.01 Acceptable	ILCR = 3.8E-06 HI = 0.2 Acceptable	NA[5]	NA	NA	NA
Full-Time Employees	ILCR = 3.0E-07 HI = 0.008 Acceptable	ILCR = 1.4E-08 HI = 0.002 Acceptable	ILCR = 0.0E+00 HI = 0.0001 Acceptable		ILCR = 2.4E-05 HI = 0.006 Acceptable	ILCR = 3.8E-06 HI = 0.2 Acceptable	ILCR = 7.3E-06 HI = 1.0 Acceptable	NA	NA	NA
Adolescent Trespassers	ILCR = 2.7E-08 HI = 0.001 Acceptable	ILCR = 5.6E-11 HI = 0.0003 Acceptable	ILCR = 0.0E+00 HI = 0.00002 Acceptable		ILCR = 1.1E-05 HI = 0.004 Acceptable	ILCR = 1.3E-06 HI = 0.1 Acceptable	NA[5]	NA	NA	NA
Adult Recreational Users	ILCR = 1.8E-07 HI = 0.002 Acceptable	ILCR = 2.8E-10 HI = 0.0007 Acceptable	ILCR = 0.0E+00 HI = 0.00004 Acceptable		ILCR = 7.3E-05 HI = 0.009 Acceptable	ILCR = 1.6E-05 HI = 0.4 Acceptable	NA[5]	NA	NA	NA
Child Resident	ILCR = 2.6E-06 HI = 0.1 Acceptable	ILCR = 4.3E-08 HI = 0.05 Acceptable	ILCR = 0.0E+00 HI = 0.003 Acceptable		ILCR = 1.3E-04 HI = 0.3 Acceptable[4]	ILCR = 7.6E-06 HI = 1.0 Acceptable	NA[6]	ILCR = NA HI = 61 Unacceptable (N)	ILCR = NA HI = 0.23 Acceptable	ILCR = 0.0E+00 HI = 6.1 Acceptable*[3]
Adult Resident	ILCR = 1.1E-06 HI = 0.02 Acceptable	ILCR = 2.4E-08 HI = 0.005 Acceptable	ILCR = 0.0E+00 HI = 0.0003 Acceptable		ILCR = 5.9E-05 HI = 0.009 Acceptable	ILCR = 1.3E-05 HI = 0.4 Acceptable	NA[6]	ILCR = NA HI = 25 Unacceptable (N)	ILCR = NA HI = 0.089 Acceptable	ILCR = 0.0E+00 HI = 2.6 Acceptable*[3]
Lifelong Resident	ILCR = 3.7E-06 HI = NA Acceptable	ILCR = 6.7E-08 HI = NA Acceptable	ILCR = 0.0E+00 HI = NA Acceptable		ILCR = 1.9E-04 HI = NA Acceptable[4]	ILCR = 2.0E-05 HI = NA Acceptable	NA[6]	ILCR = 3.8E-03 HI = NA Unacceptable (C)	ILCR = 1E-04 HI = NA Acceptable	ILCR = 0.0E+00 HI = NA Acceptable

Notes:

ILCR - Incremental Lifetime Cancer Risk
HI - Hazard Index
(C) - Cancer Risk is Unacceptable
(N) - Non-Cancer Risk is Unacceptable
NA - Not applicable for this receptor

Unacceptable Risk based on EPA's target risks:
Unacceptable ILCR > 10^{-4}
Unacceptable HI > 1.0
Acceptable

*Pesticides and inorganic constituents contributed to potential unacceptable risks; pesticides are attributable to regulated pesticide application and not a result of a spill, improper storage, disposal, or use; inorganic constituents are attributable to background and not site related:

- Pesticides are present in environmental media at OU1 likely as a result of application to control pests. This type of regulated pesticide use is distinct from pesticide contamination that is the result of a spill or improper storage, disposal, or use, and the resulting concentrations are not required to be remediated under CERCLA. The concentrations of pesticides detected in OU1 media are consistent with concentrations detected across multiple sites and attributed to normal pesticide application. Therefore, pesticide COPCs were not identified as COCs.

[1]Pesticides alpha chlordane, dieldrin, and heptachlor epoxide were the major contributors to HI at Site 51.

[2]Pesticides dieldrin and heptachlor epoxide were the major contributors to HI at Site 52.

- Inorganic COPCs that are wholly or primarily attributable to background were not identified as COCs.

[3]Inorganic constituent thallium was the major contributor to HI in Castle Hayne for child resident receptor. Due to uncertainty with the analytical method for thallium, and since thallium was not detected in historical groundwater samples and was detected very infrequently and at low concentrations only in soil, the thallium detections are believed to be false detections and not site related.

[4]Benzo(a)pyrene equivalents was the major contributor to ICLR from only one sample from Schoolhouse Branch. Thus, risk levels are considered acceptable since impacts are isolated and limited in extent.

[5]Full-time employee represents the most conservative receptor scenario; construction workers, maintenance workers, adult trespassers, and adult recreational users have a lesser exposure time.

[6]Evaluated as acceptable in the 2002 RI, but not re-evaluated in the Multi-Phase Vapor Evaluation.

[7]The more conservative Reasonable Maximum Exposure (RME) values are included.

[8]No individual constituents or target organs had HIs above USEPA's target level of 1.0. The carcinogenic risk to a future construction worker from exposure to surficial aquifer groundwater is within USEPA's target risk range. Therefore, there were no calculated hazards or risks to a future construction worker above USEPA's target levels.

What is Ecological Risk and How is it Calculated?

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

An ERA has three principal components:

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

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

2. **Risk Analysis which includes:**

- Exposure Estimate - An estimate of potential exposures (concentrations of chemicals in applicable media) to plants and animals (receptors). This includes direct exposures of chemicals in site media (such as soil) to lower trophic-level receptors (organisms low on the food chain such as plants and insects) and upper trophic- level receptors (organisms higher on the food chain such as birds and mammals). This also includes the estimated chemicals dose to upper trophic-level receptors via consumption of chemicals accumulated in lower food chain organisms.
- Effects Assessment - The concentrations of chemicals at which an adverse effect may occur.

3. **Risk Calculation or Characterization:**

- The information developed in the first two steps is used to estimate the potential risk to plants and/or animals by comparing the exposure estimates with the effects threshold.
- Also included is an evaluation of the uncertainties (that is, potential degree of error) associated with the predicted risk estimate and their effects on ERA conclusions.

4.2 Ecological Risk Assessment

An ERA was conducted to determine if potentially unacceptable risks to ecological receptors are present that warrant additional assessment or action at OU1. Step 3A of the ERA indicated that ecological risks were present from a few organic chemicals and inorganic constituents in surface soil and sediment in specific areas at OU1 (TetraTech, 2002). A Step 3A Addendum report was prepared in 2003 (CH2M HILL, 2003) and identified several inorganic and organic COPCs for both terrestrial and aquatic receptors, and recommended that potential risk from these chemicals be evaluated in a BERA for OU1. The BERA was completed in 2005, and concluded that significant ecological risk was present for aquatic, lower trophic-level receptors (benthic macroinvertebrates) in Sandy Branch Tributary #2 and its adjacent floodplain areas from exposure to inorganic and organic COPCs (CH2M HILL, 2005).

Additional sampling within Sandy Branch Tributary #2 and adjacent flood plain areas was performed in 2006 to delineate the spatial extent of COPCs (several PAHs, non-PAH SVOCs, pesticides, and metals) and establish preliminary remediation goals (PRGs) for a sediment cleanup of the tributary. A NTCRA was conducted in 2008 at Sandy Branch Tributary #2 that removed COPC-contaminated media to levels protective of at-risk ecological receptors (Rhēa, 2009). Following the completion of the NTCRA, no unacceptable risks were identified, and NCDENR and USEPA Region 4 concurred that no further evaluation or action is warranted at OU1 for ecological receptors.

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

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

5 Scope and Role of Response Action

In cooperation with USEPA and NCDENR, and in accordance with the FFA and applicable guidance, the Navy performed investigations at OU1 to evaluate the nature and extent of contamination within environmental media associated with past CERCLA releases related to Navy activities and to assess the potential risks to human health and the environment. The preferred alternative presented in this Proposed Plan is intended to address potentially unacceptable risks to receptors exposed to OU1 CGWP contamination and ensure that aquifer and land use within the OU1 boundary is controlled. The preferred alternative is intended to be the final remedy for the OU1 CGWP Sites 42, 47, 51, 52, 92, and 98, and it does not include or affect any other sites at the facility under the CERCLA process.

MCAS Cherry Point was placed on the NPL on December 16, 1994 (Comprehensive Environmental Response, Compensation, and Liability Information System [CERCLIS] National Superfund database identification number: NC1170027261). OU1 is one of nine OUs of the ERP sites that are part of the comprehensive environmental investigation and cleanup currently being performed at MCAS Cherry Point under the CERCLA program. The status of all the ERP sites at MCAS Cherry Point can be found in the current version of the Site Management Plan, which is located in the Administrative Record.

6 Remedial Action Objectives

Remedial action objectives (RAOs) are statements that define the extent to which sites require cleanup to protect human health and the environment. The RAOs reflect the associated contamination and exposure routes and **receptors** at OU1. The RAOs for the OU1 CGWP sites are as follows:

- Restore groundwater quality at OU1 to the NC 2L and MCL standards, based on the classification of the aquifer as a potential source of drinking water (Class GA or Class GSA) under 15A NCAC 02L.0201.
- Prevent human exposure to groundwater above levels that would cause unacceptable risks.
- Prevent migration or discharge of COCs in groundwater to sediment and surface water in East Prong Slocum Creek and Sandy Branch at levels that would cause unacceptable risks to human or ecological receptors.
- Prevent human exposure to inhalation risks resulting from potential future vapor intrusion to buildings.

The remediation goal (RG) concentrations for each of the COCs in groundwater are shown in **Table 8**. The RG for each COC was determined by selecting the most conservative of either the NC 2L, MCL, and/or calculated risk-based performance standard. Petroleum-related compounds (investigated and managed by the MCAS Cherry Point UST Program) and naturally-occurring inorganic constituents were specifically excluded as COCs, since they are not related to historical CERCLA-regulated releases at OU1.

RGs are not necessary for soil, sediment, surface water, fish tissue, and indoor air, as there are no unacceptable risks from exposure to these environmental media or sampling results exceeding applicable regulatory standards.

Table 8 – Remediation Goals, OU1

COC	Groundwater RG (µg/L)
1,1-Dichloroethane (1,1-DCA)	6
1,1-Dichloroethene (1,1-DCE)	7
1,2-Dichloroethane (1,2-DCA)	0.4
1,2-Dichloroethene (1,2-DCE) (total)	70
1,1,2,2-Tetrachloroethane (1,1,2,2-PCA)	0.2
1,1,1-Trichloroethane (1,1,1-TCA)	200
1,1,2-Trichloroethane (1,1,2-TCA)	5
Chloroform	70
cis-1,2-Dichloroethene (cis-1,2-DCE)	70
trans-1,2-Dichloroethene (trans-1,2-DCE)	100
Tetrachloroethene (PCE)	0.7
Trichloroethene (TCE)	3
Vinyl Chloride	0.03

RGs are based on North Carolina Groundwater Quality Standards (NC 2L Standards) except for 1,1,2-TCA and 1,1-DCE which are based on the Maximum Contaminant Level (MCL).

COC - Chemical of Concern

RG - Remediation Goal

µg/L - micrograms per liter

7 Summary of Remedial Alternatives

The remedial alternatives developed and evaluated to address the OU1 CGWP sites are detailed in the OU1 FS Report. As part of the screening of various technologies, remedial target areas were defined to support the development of remedial alternatives. Two separate groundwater zones were defined as part of remedial alternative selection: Source Zone (Zone 1) corresponds to areas with the highest dissolved-phase COC concentrations (concentrations greater than 1,000 µg/L) and Downgradient Zone (Zone 2)

corresponds to areas with lower dissolved phase COC concentrations.

In addition, the feasibility of a source zone treatment specifically beneath Building 133 was evaluated, since the primary source of the OU1 CGWP occurs beneath this building. The evaluation concluded that, for several reasons, source zone treatment beneath Building 133 was not feasible:

- It would be difficult or impossible to properly implement an in-situ treatment technology beneath Building 133 due to extensive subsurface infrastructure, low overhead clearance, dense spacing of equipment, and a 24 hours per day/ 7 days per week operational schedule for mission-critical activities in the building.
- Building 133 is a critical component of FRCE, which is the only source of repair within the continental U.S. for many military aircraft engines. FRCE also provides services for the Navy, Marine Corps, Air Force, Army, other federal agencies, and multiple foreign governments. Operations at Building 133 are considered mission-critical for these services during both peacetime and current wartime efforts. Disruption of Building 133 operations to implement a treatment remedy is not practicable.
- The exposure scenario with potentially unacceptable human health risk is for potable use by a hypothetical future resident. Since this exposure scenario does not currently exist, and can be prevented via institutional controls, source area treatment beneath Building 133 is not the only means to reduce the human health risk.
- Source zone treatment beneath Building 133 has the potential to generate increased vapor intrusion risks to current workers in and around the building.

Therefore, it was agreed by the Navy, in partnership with the EPA and NCDENR, that a source zone treatment was not feasible beneath the building and Source Zone alternatives would instead focus on the higher COC concentrations adjacent to the building.

Following the screening of various technologies, a number of remedial alternatives were selected for detailed evaluation and comparative analysis. Details of the evaluated remedial alternatives for the Source Zone (Zone 1) and the Downgradient Zone (Zone 2), respectively, are summarized in **Tables 9 and 10**, and conceptual layouts are shown in **Figures 7 to 10**. Each alternative, with the exception of the no-action alternative, was developed to meet the RAOs. Consistent with the NCP, a no-action alternative was evaluated as a baseline for the comparative analysis.

The three alternatives considered for Zone 1 (Source Zone) are:

- Alternative 1 – No Action
- Alternative 2 – Monitored Natural Attenuation (MNA) and Land Use Controls (LUCs)
- Alternative 3 – In-Situ Enhanced Bioremediation (ISEB), MNA, and LUCs

The five alternatives considered for Zone 2 (Downgradient Zone) are:

- Alternative 1 – No Action
- Alternative 2 – MNA and LUCs
- Alternative 3 – Permeable Reactive Barriers (PRBs), MNA, and LUCs
- Alternative 4 – ISEB, MNA, and LUCs
- Alternative 5 – Air Sparge (AS) Curtain, MNA, and LUCs

The NCP outlines the requisite approach for comparing remedial alternatives. Evaluation of the alternatives uses nine evaluation criteria, which consist of “threshold,” “primary balancing,” and “modifying” criteria (**Table 11**). To be considered for selection as the preferred alternative, a remedial alternative must first meet the two threshold criteria, overall protection of human health and the environment and compliance with ARARs. The five primary balancing criteria, which are technical criteria based on environmental protection, cost, and engineering feasibility, are then considered to determine which alternative provides the best combination of attributes. Finally, upon receipt of public comments on a Proposed Plan such as this one, the preferred alternative is evaluated further against two modifying criteria, state acceptance and community acceptance.

Each remedial alternative was evaluated in the OU1 FS report against the first seven of the nine criteria identified in the NCP. The two remaining criteria will be evaluated after the public comment period for this Proposed Plan.

While potential VI impacts were considered during the technology screening evaluation of the RI/FS, specific VI considerations were deferred to the VI evaluation that was conducted later. The VI evaluation concluded that the preferred alternative must include, as one of its elements, long-term monitoring of subslab soil vapor and indoor air at eight buildings within OU1 to monitor for potential future VI. The vapor intrusion pathway will also be evaluated on a building-specific basis as part of OU1 LUCs when future construction activities involve slab penetrations or new construction is planned over any portion of the OU1 CGWP.

Table 9 – Description of Remedial Alternatives for Groundwater, Source Zone, OU1

Alternative	Components	Details	Cost	
1 – No Action	None	None	**Total Cost**	**$0**
			Timeframe	**Indefinite**
2 – MNA and LUCs	MNA/LUCs	MNA and LUCs utilized to monitor the natural decrease in contaminant concentration and to prevent exposure to groundwater for 100 years.	MNA and LUC costs will be covered under the implemented Downgradient Zone remedial alternative (as shown in **Table 10**).	
3 – ISEB, MNA, LUCs	ISEB Injections	Injection of a slow-release carbon source into clustered well pairs[1] covering the upper and lower surficial aquifers, every 2 years for a duration of 10 years.	Capital cost	$1,539,000
			Future Costs	$4,917,000
	MNA/LUCs	MNA and LUCs utilized to monitor the natural decrease in contaminant concentration and to prevent exposure to groundwater for 30 years.	**Total present value**	**$6,456,000**
			Timeframe	**30 years**

Table 10 – Description of Remedial Alternatives for Groundwater, Downgradient Zone, OU1

Alternative	Components	Details	Cost	
1 – No Action	None	None	**Total Cost**	**$0**
			Timeframe	**Indefinite**
2 – MNA and LUCs	MNA/LUCs	MNA and LUCs utilized to monitor the natural decrease in contaminant concentration and to prevent exposure to groundwater for 100 years.	Capital cost	**$364,000**
			Future Costs	**$5,881,000**
			Total present value	**$6,245,000**
			Timeframe	**100 years**
3 – PRB, MNA, and LUCs	PRB in front of southern lobe of plume	Install a PRB[2] constructed of a ZVI/sand mixture via trenching across the southern lobe of the CGWP, within Site 16.	Capital Cost	$4,287,000
			Future Costs	$3,418,000
	PRB in front of northern lobe of plume	Install a PRB[3] across the northern lobe of the plume via the installation of closely spaced vertical injection points of a ZVI/sand mixture. Inject micro-scale ZVI every 6 years for a duration of 30 years.		
	MNA/LUCs	MNA and LUCs utilized to monitor the natural decrease in contaminant concentration and to prevent exposure to groundwater for 30 years.	**Total Present Value**	**$7,705,000**
			Timeframe	**30 years**
4 – ISEB Barrier, MNA, and LUCs	ISEB Injections	Injection of EVO carbon source and bioaugmentation culture into 38 wells in a row spaced 25 ft apart to a depth of 50 ft every 2 years for a duration of 10 years.	Capital cost	$1,648,000
			Annual monitoring	$8,119,000
	MNA/LUCs	MNA and LUCs utilized to monitor the natural decrease in contaminant concentration and to prevent exposure to groundwater for 30 years.	**Total present value**	**$9,767,000**
			Timeframe	**30 years**
5 – AS Curtain, MNA, and LUCs	Air Sparging	Install 2 directionally drilled AS wells at depths of 50 and 70 ft and roughly 1,100 ft long with 400-500 ft slotted pipe. Run system for 30 years.	Capital cost	$1,486,000
			Annual monitoring	$5,331,000
	MNA/LUCs	MNA and LUCs utilized to monitor the natural decrease in contaminant concentration and to prevent exposure to groundwater for 30 years.	**Total present value**	**$6,816,000**
			Timeframe	**30 years**

[1] For cost-estimating purposes, 50 well pairs were assumed. The actual number of required wells will be determined in the Remedial Design, to be completed following selection and approval of the final remedy in a ROD.

[2] For cost-estimating purposes, a 950-ft long PRB installed to a depth of 35 feet was assumed. The actual PRB specifications will be determined in the Remedial Design, to be completed following selection and approval of the final remedy in a ROD.

[3] For cost-estimating purposes, 30 vertical injection points spaced 25-ft apart and installed to a depth of 50 feet were assumed. The actual PRB specifications will be determined in the Remedial Design, to be completed following selection and approval of the final remedy in a ROD.

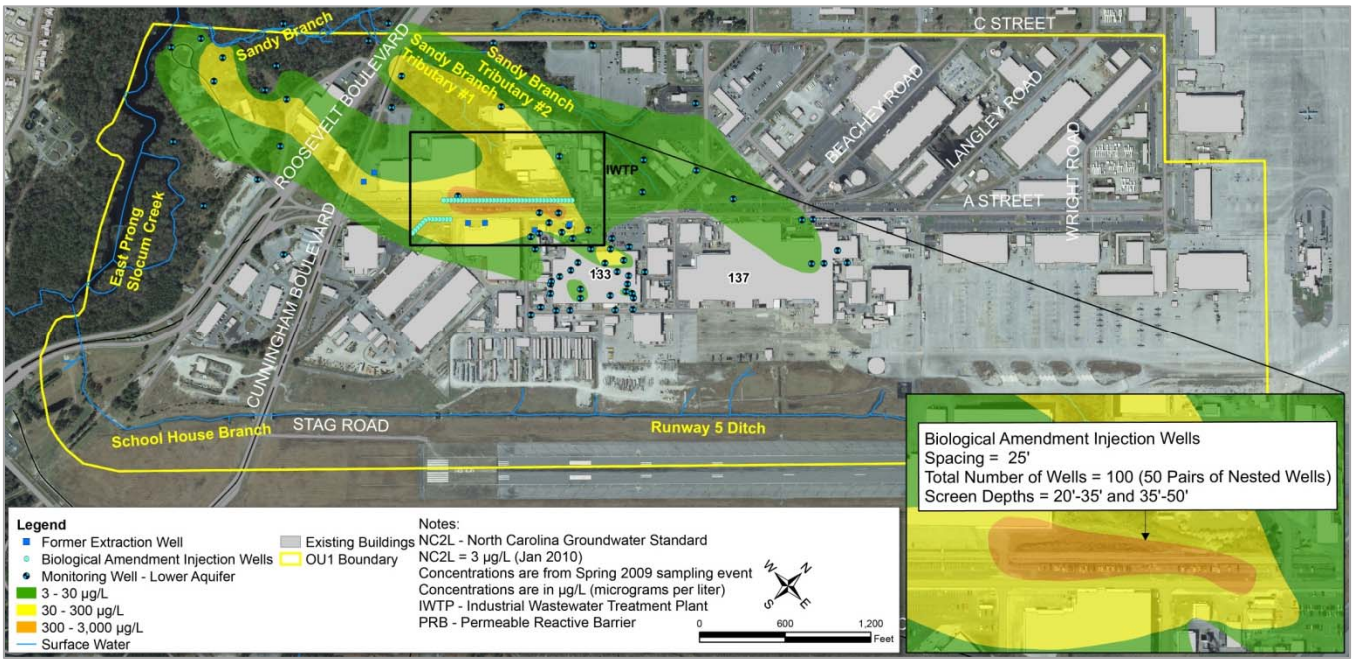


Figure 7 – Conceptual Layout of Source Zone Alternative 3 – In-Situ Enhanced Bioremediation with Monitored Natural Attenuation and Land Use Controls

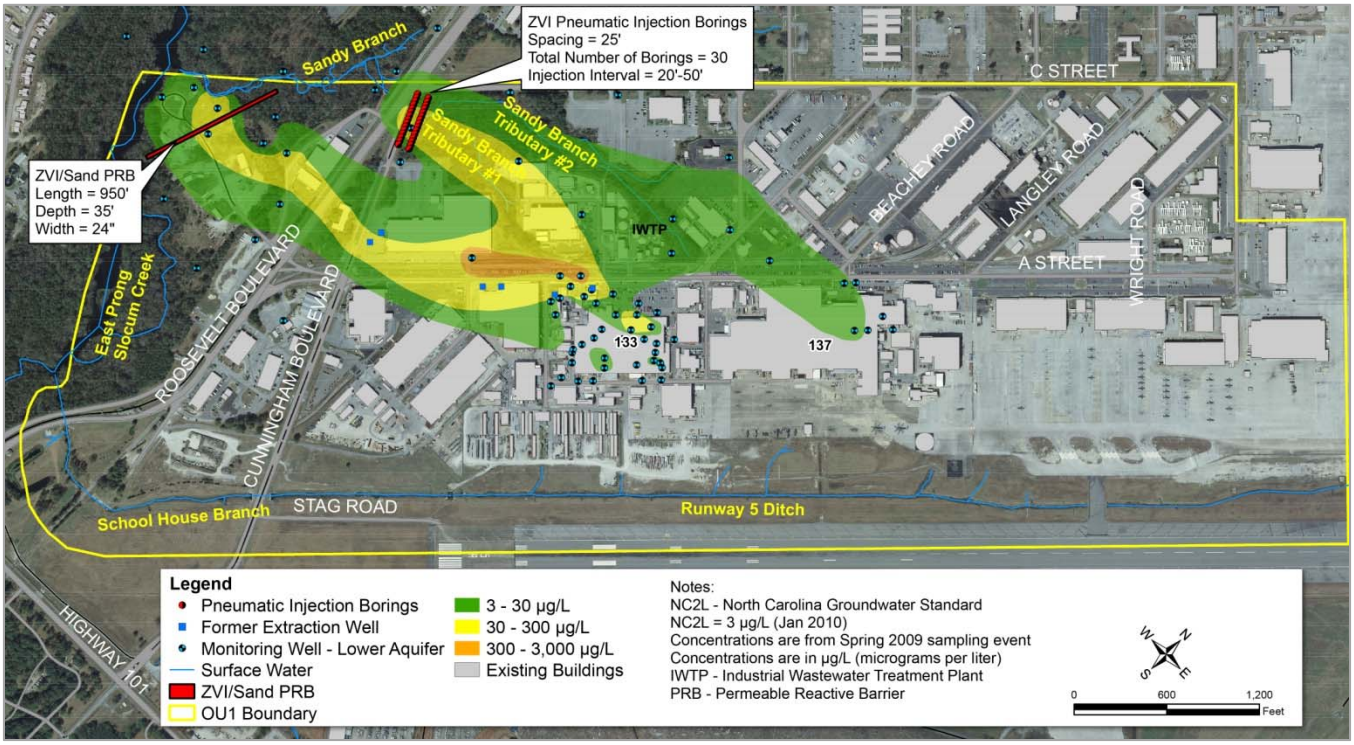


Figure 8 – Conceptual Layout of Downgradient Zone Alternative 3 – Zero Valent Iron Permeable Reactive Barrier with Monitored Natural Attenuation and Land Use Controls

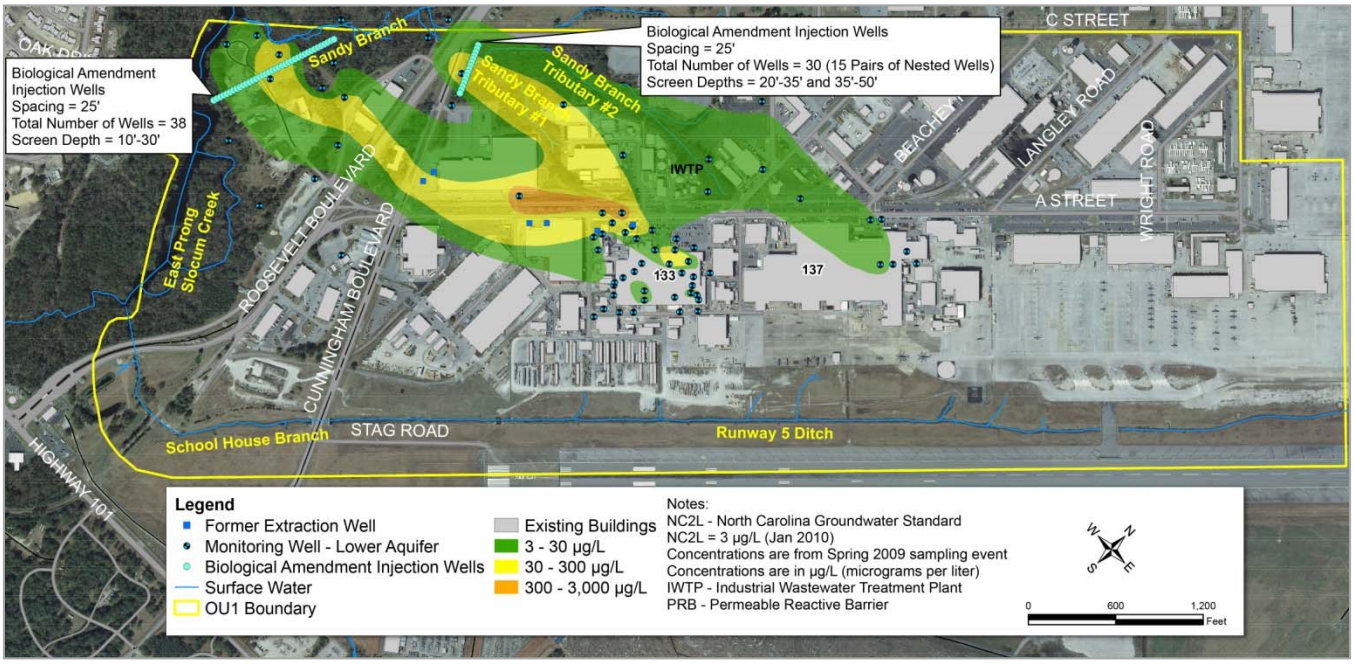


Figure 9 – Conceptual Layout of Downgradient Zone Alternative 4 – In-Situ Enhanced Bioremediation Barrier, with MNA and LUCs

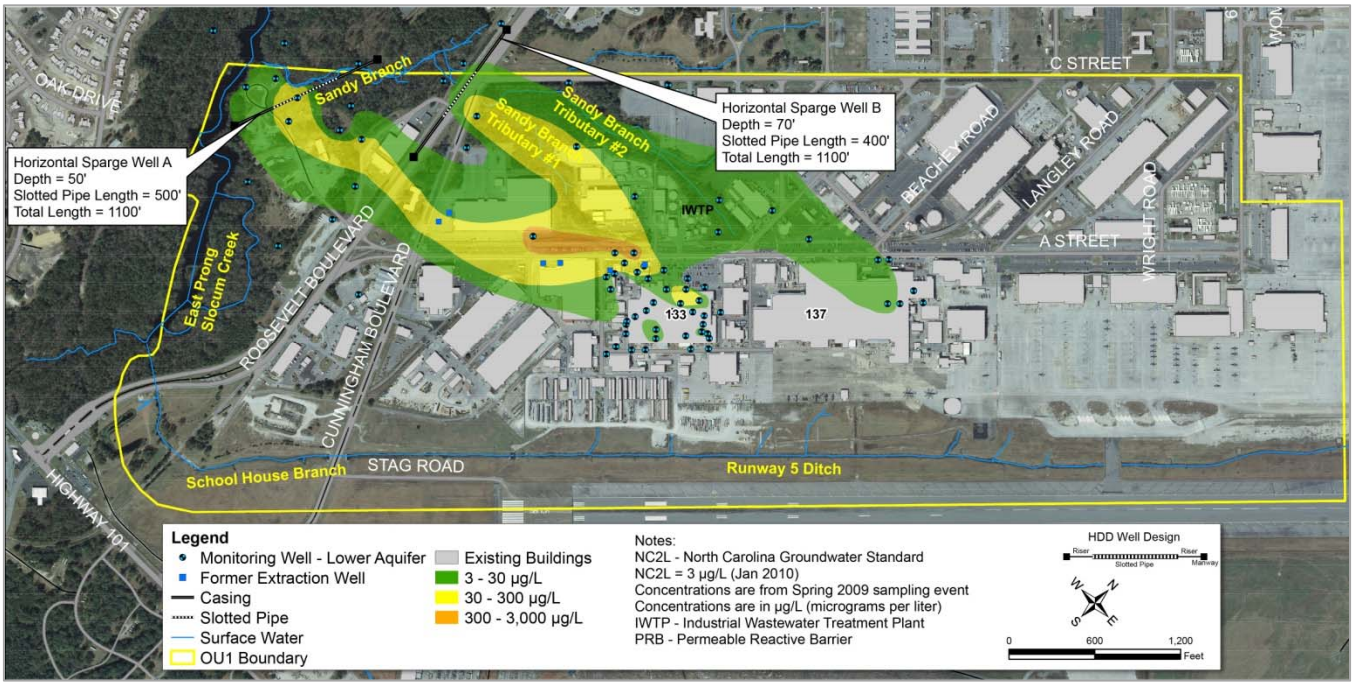


Figure 10 – Conceptual Layout of Downgradient Zone Alternative 5 – Horizontal Air Sparge with Monitored Natural Attenuation and Land Use Controls

7.1 Relative Evaluation of Alternatives

The comparative analysis of alternatives with respect to the first seven evaluation criteria is summarized below. The OU1 FS Report provides a more-detailed discussion of the evaluation.

Threshold Criteria

Overall Protection of Human Health and the Environment. Alternative 1 (no action) does not achieve RAOs in either zone. All of the other alternatives are protective of human health and the environment and reduce the exposure to contaminants by the implementation of LUCs or by reducing groundwater COC concentrations via MNA, ISEB, PRB, or AS.

Compliance with ARARs. All alternatives except the no action alternative can comply with the **Applicable or Relevant and Appropriate Requirements (ARARs)**. A complete list of the ARARs is included in the OU1 FS Report.

Primary Balancing Criteria

Long-Term Effectiveness and Permanence. Each of the alternatives, with the exception of the no action alternative, is expected to achieve long-term effectiveness and permanence. Alternative 2 for both zones relies on **natural attenuation** to reduce COC concentrations, which can take considerably longer than the alternatives with active treatment, which vary in duration and effectiveness. In the end, all will reduce the contaminant concentrations to below the remediation goals.

Reduction in Toxicity, Mobility, or Volume through Treatment. Aside from the no-action alternative, all remedies reduce the toxicity, mobility, and volume of COCs through anaerobic biodegradation or mechanical stripping (AS).

Short-Term Effectiveness. In addition to evaluating the timeframe required to achieve protection and potentially adverse impacts during the implementation phase, a sustainability analysis was also conducted for each of the eight remedial alternatives as part of this criterion for consideration. Sustainability is a "green remediation" consideration focused on energy conservation, reduction of green house gases such as carbon dioxide, waste minimization, and re-use and recycling of materials.

Alternative 1 for both zones has the least short-term construction impacts and the lowest environmental footprint since there would be no remedial construction activities. The other alternatives would include construction activities with varying levels of potential impacts to construction workers, the community, and the environment. The amount of impact is proportional to the amount of time spent drilling and injecting and the engineering controls put in place to protect workers from these activities. More operations and maintenance or injection events also require more heavy truck traffic and disruption of the natural system.

Implementability. Alternative 1 for both zones would not obtain administrative approval since it does not meet the RAOs. For the Source Zone, Alternative 2 (MNA and LUCs) is relatively easy to implement; however, current site operations, infrastructure, and utilities make it difficult to install the injection wells included in Alternative 3, although the subsequent injection events would not be hindered. For the Downgradient Zone, Alternatives 4 and 5 are roughly equivalent in implementability, with only minor disruptions probable. Downgradient Zone Alternative 3, which requires the construction of a 950 ft PRB trench, would be more difficult to implement due to coordination challenges and the fact that there are currently only two vendors capable of constructing the PRB.

Cost. The no-action alternative is the most cost-effective, but does not meet the RAOs. For the Source Zone, Alternative 2 would be covered under the selected Downgradient Zone remedy, therefore, Alternative 3 has a present-worth cost of $6,456,000 more. For the Downgradient Zone, the ISEB alternative, Alternative 4, is substantially more expensive than the other alternatives, with the Air Sparging, Alternative 5, as the most cost-effective.

Modifying Criteria

State Acceptance. Considers the comments of the State support agency, NCDENR, on the Proposed Plan.

Community Acceptance. Community acceptance will be evaluated after the public comment period for the Proposed Plan, and substantive public comments will be addressed and documented in the forthcoming ROD for the OU1 CGWP sites.

Table 11 – Evaluation Criteria for Comparative Analysis of Alternatives

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

8 Preferred Alternative

The Navy and USEPA, in consultation with NCDENR, agree that the preferred alternative consists of the following:

- *Source Zone:* Alternative 3 (ISEB, MNA, and LUCs)
- *Downgradient Zone:* Alternative 3 (ZVI PRBs, MNA, and LUCs)
- *Sitewide:* Subslab soil vapor and indoor air long-term monitoring

Based on the evaluation of the data and information currently available, as well as the results of the comparative analysis, it is concluded that the preferred alternative meets the statutory requirements of CERCLA for protection of human health and the environment.

9 Community Participation

The community relations program at MCAS Cherry Point fosters two-way communication of investigation and remediation activities between the stakeholder agencies (Navy, EAD, USEPA, and NCDENR) and the public. A Restoration Advisory Board (RAB) was formed in 1995 to provide for expanded community participation. RAB meetings are held periodically and are open to the public to provide an opportunity for comments and questions. In addition, a public information repository, newsletters and fact sheets, public notices, an Environmental Restoration Program (ERP) website, and a Community Involvement Plan provide detailed information on community participation for the ERP.

Public input is a key element in the decision-making process and any questions and comments on the preferred alternative are strongly encouraged during the comment period. The Navy will summarize and respond to substantive comments in a Responsiveness Summary, which will become part of the official remedy selection decision for the OU1 CGWP sites.

The Proposed Plan fulfills the public participation requirements of CERCLA Section 117(a), which specifies that the lead agency (the Navy) must publish a plan outlining any remedial alternatives evaluated for a site and identify the preferred alternative.

The public comment period for the Proposed Plan provides an opportunity for input regarding the preferred alternative. The public comment period will be from May 9 to June 23, 2014, and a public meeting will be held on May 21, 2014, at 6:00 PM at the Havelock Tourist and Event Center. All interested parties are encouraged to attend the public meeting to learn more about the remedial alternatives developed and evaluated for the OU1 CGWP sites. The public meeting will provide an additional opportunity to submit comments on the Proposed Plan to the Navy.

Comments on the preferred alternative, or this Proposed Plan, must be postmarked no later than June 23, 2014. On the basis of comments or new information, the Navy and USEPA, in consultation with NCDENR, may modify the preferred alternative or choose other alternatives. The comment page included as part of this Proposed Plan may be used to provide comments to the Navy.

The Community Involvement Plan and technical reports pertaining to the investigations and interim remedial actions at OU1 and the development of the preferred alternative presented in this Proposed Plan are available for download by the public via the MCAS Cherry Point ERP Public web site at the following address: http://go.usa.gov/Dy59. These and other MCAS Cherry Point Administrative Record documents can be accessed by clicking on the "Admin Records" link at the top of the web site home page. If a computer and internet access is not available from home, hard copies of these documents (or access to the MCAS Cherry Point ERP Public web site) are available at the Havelock-Craven County Library at the location below. Please contact the library for days and hours of operation and whether there are any restrictions on accessing the internet (e.g., charging for use, limiting time, limiting printing, age restrictions, etc.).

Havelock-Craven County Library
301 Cunningham Blvd
Havelock, NC 28532
Phone 252-447-7509
http://www.havelocknc.us/AboutHavelock/HavelockLibrary.aspx

MCAS Cherry Point ERP Public Web Site
Administrative Record
http://go.usa.gov/Dy59

If individuals have any questions or comments about OU1 they may call or write one of the following contacts:

Mr. Bryan Revell
NAVFAC Mid-Atlantic
Marine Corps North Carolina IPT
6506 Hampton Blvd.
Building C, 3rd Floor, Code OPQE3
Norfolk, VA 23508-1278
(757) 322-4636

Ms. Gena Townsend
USEPA – Atlanta Federal Center
SUPERFUND – FFB
61 Forsyth Street
Atlanta, GA 30303-3104
(404) 562-8538

Mr. George Lane
NC Dept of Environment & Natural Resources
Superfund Section
217 W. Jones St.
1646 Mail Service Center
Raleigh, NC 27699
(919) 707-8338

10 Glossary

This glossary defines in non-technical language the more commonly used environmental terms appearing in this PRAP. The definitions do not constitute the Navy's, USEPA's, or NCDENR's official use of terms and phrases for regulatory purposes, and nothing in this glossary should be construed to alter or supplant any other Federal or State document. Official terminology may be found in the laws and related regulations as published in such sources as the Congressional Record, Federal Register, and elsewhere.

Acceptable Risk: USEPA's acceptable risk range for Superfund hazardous waste sites is 1×10^{-4} to 1×10^{-6}, meaning there is 1 additional chance in 10,000 (1×10^{-4}) to 1 additional chance in 1 million (1×10^{-6}) that a person will develop cancer if exposed to contaminants at a site that is not remediated.

Administrative Record: A compilation of documents and information for CERCLA sites that is made available to the public for review.

Applicable or Relevant and Appropriate Requirements (ARARs): As discussed in greater detail within CERCLA Section 121(d)(2), these may be federal or state standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate with respect to the proposed remedial action.

Aquitard: a subsurface zone that restricts groundwater flow from one aquifer to another, typically consisting of impermeable layers of either clay or some type of non-porous rock.

Background Concentrations: Concentrations of naturally occurring and anthropogenic (due to

mankind) constituents, such as inorganic constituents, found in groundwater, soil, sediment, and surface water at levels not influenced by site-specific releases. Background concentrations of some inorganic constituents and other compounds are often at levels that may pose a risk to human health or the environment. However, background concentrations of site chemicals are factored into risk management determinations to ensure remedial actions are not implemented for constituents whose concentrations are attributable to background conditions and not indicative of a site-related release.

Cancer Risk: Cancer risks are expressed as a probability reflecting the increased chance that a person will develop cancer if exposed to chemicals or substances at a particular site and exposure scenario, as described in the Human Health Risk Assessment.

Chemical of Concern (COC): A contaminant that contributes risk or hazard above acceptable levels to a receptor.

Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA): A Federal law passed in 1980 (United States Code Title 42, Chapter 103), commonly referred to as the "Superfund" Program, that provides for cleanup and emergency response in connection with numerous existing, inactive hazardous substance disposal sites that endanger public health and safety or the environment. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986.

Conceptual site model (CSM): A description of a site and its environment that is based on existing knowledge and that assists in planning, interpreting data, and communicating. It describes sources of contamination (i.e., spills) and receptors (i.e., humans) and the interactions that link the two.

Ecological Risk Assessment (ERA): An evaluation of the risk posed to ecological receptors (i.e., plants and animals) if remedial activities are not performed.

Feasibility Study (FS): a study undertaken by the lead agency to develop and evaluate options for remedial action. The FS emphasizes data analysis and is generally performed concurrently and in an interactive fashion with the remedial investigation (RI), using data gathered during the RI. RI data are used to define the objectives of the response action, to develop remedial action alternatives, and to undertake an initial screening and detailed analysis of the alternatives.

Geochemical Parameters: Groundwater quality parameters such as temperature, dissolved oxygen, conductivity, pH, and oxidation-reduction potential.

Groundwater: The supply of water beneath the Earth's surface that occurs in the pore spaces between soil grains or within fractures in geologic formations that are fully saturated.

Human Health Risk Assessment (HHRA): A qualitative and quantitative evaluation of the risk posed to human health by the presence of specific pollutants. Elements include: identification of the hazardous substances present in the environmental media; assessment of exposure and exposure pathways; assessment of toxicity of site's hazardous substances; and characterization of human health risks.

Indoor Air: The air contained within a building or structure that could potentially be inhaled by occupants within. Indoor air is a critical media for the VI exposure pathway where compounds may pose a potential long-term chronic risk to the health of residents, workers, and other building occupants through inhalation of indoor air that has been affected by vapors emitted from subsurface contaminated soil or groundwater.

In-Situ Enhanced Bioremediation (ISEB): Process by which the natural of biodegradation of COCs via microbially mediated chemical reactions is promoted in place through amending the area of concern with suitable substrates to aid in microbial growth and activity, or, to add such microorganisms capable of degrading the target COCs, a process referred to as bioaugmentation.

Land Use Control (LUC): Physical, legal, or administrative methods that restrict the use of or limits access to property to reduce risks to human health and the environment.

Maximum Contaminant Level (MCL): The standard that is set by the United States Environmental Protection Agency for drinking water quality.

Monitored natural attenuation (MNA): Periodic monitoring of groundwater or surface water to track changes in COC concentrations and natural attenuation parameters.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): The Federal regulations (Code of Federal Regulations [CFR], Volume 40, Page 300 [40 CFR 300]) that guide determination of the sites to be corrected under both the Superfund (CERCLA) program and the program to prevent or control spills into surface waters or elsewhere.

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

Natural attenuation (NA): Reduction in mass or concentration of a constituent over time or distance from the source through naturally occurring physical, chemical, and biological processes.

Nine Evaluation Criteria: The NCP outlines the approach for comparing remedial alternatives using these evaluation criteria:

- **Overall Protection of Human Health and the Environment** – Addresses whether a remedy provides adequate protection and how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.
- **Compliance with ARARs** - A statutory requirement for remedy selection that an alternative will either meet all of the ARARs or that there is a good rationale for waiving an ARAR.
- **Long-term Effectiveness and Permanence** - Addresses the expected residual risk that will remain at the site after completion of the remedial action and the ability of a remedy to maintain reliable protection of human health and the environment in the future and in the short term.
- **Reduction of Toxicity, Mobility, and Volume through Treatment** - The anticipated performance of the treatment technologies that a remedy may employ in their ability to reduce toxicity, mobility or volume of contamination.
- **Short-term Effectiveness** - Considers the short-term impacts of the alternatives on the neighboring community, the plant workers, remedial construction workers, and the surrounding environment, including potential threats to human health and the environment associated with the collection, handling, treatment, and transport of hazardous substances.
- **Implementability** - The technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement an option.
- **Cost** - Encompasses all construction, operation, and maintenance costs incurred over the life of the project, expressed as the net present value.
- **State Acceptance** - Considers substantial and meaningful state involvement in the PRAP.
- **Community Acceptance** - The public's general response to the alternatives described in the PRAP and the RI and FS reports. The specific responses to the public comments are addressed in the Responsiveness Summary section of the ROD.

Non-Cancer Hazards: Non-cancer hazards (or risk) are expressed as a quotient that compares the potential exposure to contaminants at a particular site to the acceptable level of exposure. There is a level of exposure (the reference dose) below which it is unlikely for even a sensitive population to experience adverse health effects. USEPA's threshold level for non-cancer risk at Superfund sites is 1, meaning that if the exposure at a particular site exceeds the threshold, there may be a concern for potential non-cancer effects.

North Carolina Department of Environment and Natural Resources (NCDENR): The state agency responsible for administration and enforcement of state environmental regulations.

North Carolina Groundwater Quality Standards (NC 2L): Enforceable standards developed by NCDENR under 15A NCAC 02L .0202. They are the maximum allowable contaminant concentrations resulting from any discharge of contaminants to the land or waters of the state, which may be tolerated without creating a threat to human health.

North Carolina Surface Water Quality Standards (NCSWQS): Enforceable standards developed by NCDENR: The maximum allowable contaminant concentrations in surface waters in the state, which may be tolerated without creating a threat to human health or which would otherwise render the groundwater unsuitable for its intended best usage.

Operable unit (OU): A discrete action that comprises an incremental step toward comprehensively addressing site problems. The cleanup of a site can be divided into a number of OUs, depending on the complexity of the problems associated with the site. OUs can address geographical portions of a site, specific site problems, or different phases of remediation at a site.

Long-Term Monitoring: Design considerations for monitoring networks and methods for determining remedy effectiveness with routine evaluations of institutional controls and measurements of chemical, geologic and hydrologic parameters. The collected measurements will be compared to appropriate threshold criteria to determine whether further action may be required.

Permeable Reactive Barrier (PRB): Passive groundwater treatment system that creates a subsurface (in-situ) zone to treat contaminants dissolved in groundwater as they flow through. The PRB technology relies on natural hydraulic gradients to bring contaminants into the reactive treatment medium; thus, the ideal PRB is oriented perpendicular to groundwater flow.

Preferred Alternative: With respect to the nine criteria specified in the NCP for evaluating remedial alternatives, the Preferred Alternative is the proposed remedy that meets the threshold criteria and is deemed to provide the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria.

Proposed Plan: A document that presents the preferred remedial alternative and requests public input regarding its proposed selection.

Public Comment Period: The time allowed for the members of a potentially affected community to express views and concerns regarding an action

proposed to be taken at a site, such as a rulemaking, permit, or remedy selection.

Receptors: Humans, animals, or plants that may be exposed to contaminants related to a given site.

Record of Decision (ROD): A legal document that describes the cleanup action or remedy selected for a site, the basis for choosing that remedy, and reflects the public comments that were considered regarding the selected remedy.

Remedial Action: A cleanup method or specified action to address contaminants at a site.

Remedial action objectives (RAOs) are statements that define the extent to which sites require cleanup to protect human health and the environment. The RAOs reflect the COCs, acceptable contaminant concentrations, and exposure routes and receptors for each medium of concern.

Remedial Investigation (RI): A study in support of the selection of a remedy at a site where hazardous substances have been released. The RI identifies the nature and extent of contamination and assesses human health and ecological risk associated with the contamination.

Soil vapor: The atmosphere present in soil pore spaces. Volatile compounds introduced into the subsurface can be present in the vapor phase or more commonly, can undergo a transition from a liquid or sorbed phase (pure product, dissolved, or adsorbed to soil) to become part of the soil atmosphere.

Subslab Soil Vapor: Soil vapor that can collect beneath the slab of a building.

Unacceptable Risk: Risk that exceeds the USEPA's maximum acceptable risk range for Superfund hazardous waste site of 1×10^{-4}.

United States Environmental Protection Agency (USEPA): The Federal agency responsible for administration and enforcement of CERCLA (and other Federal environmental statutes and regulations).

Vapor intrusion: The migration of volatile chemicals from the subsurface into overlying buildings.

Zero Valent Iron (ZVI): A commonly used reactive agent for PRBs for degradation of chloroethenes using an abiotic (not microbially mediated) reductive dechlorination process which occurs on the surface of the iron. Oxidation of the ZVI under anaerobic conditions yields hydrogen, which is used during the reductive dechlorination process.

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