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MCB CAMP LEJUENE
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PROPOSED REMEDIAL ACTION PLAN SITE 35 OPERABLE UNIT 10 (OU 10) MCB CAMP LEJEUNE NC

4/1/2009

CH2M HILL

Proposed Remedial Action Plan

Site 35: Operable Unit No. 10

Marine Corps Base, Camp Lejeune
North Carolina

April 2009

1 Introduction

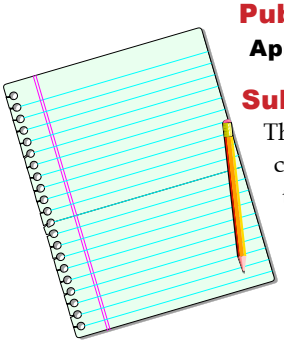
This **Proposed Remedial Action Plan (PRAP)** identifies the Preferred Alternative for addressing **groundwater** contamination at **Site** 35: **Operable Unit (OU)** No. 10, the former Camp Geiger Area Fuel Farm, located at Marine Corps Base (MCB) Camp Lejeune in Onslow County, North Carolina. OU No. 10, composed entirely of Site 35, is one of several operable units in the **Installation Restoration Program (IRP)** and will hereafter be referred to as Site 35. The Preferred Alternative is **Air Sparging (In-Situ Aeration) using a Horizontal Well, Monitoring of the Natural Degradation of Chemicals of Concern (COCs), and Land Use Controls (LUCs)**. LUCs will be implemented as part of the remedy to prevent exposure to the impacted groundwater and maintained until site conditions allow for unlimited use and unrestricted exposure.

This PRAP is issued jointly by the U.S. Department of the Navy (Navy), the lead agency for site activities, MCB Camp Lejeune, and the **U.S. Environmental Protection Agency (EPA)**, 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 Site 35. This PRAP fulfills the public participation responsibilities required under Section 117(a) of the **Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)** and Section 300.430(f)(2) of the **National Oil and Hazardous Substances Pollution Contingency Plan (NCP).**

This PRAP summarizes the remedial alternatives evaluated for Site 35. Detailed background information for Site 35 is contained in the Supplemental **Remedial Investigation (RI)** (CH2M HILL, 2009), the **Feasibility Study (FS)** (CH2M HILL, 2009), and other documents in the **Administrative Record** file and **Information Repository** for MCB Camp Lejeune. Key information from the FS report, including all remedial options considered and the rationale for selection of air sparging as the preferred remedy for Site 35, is summarized in this PRAP. A glossary of key terms used in this PRAP is attached, and are identified in bold print the first time they appear.

The Navy, MCB Camp Lejeune, and the EPA, in consultation with NCDENR will make the final decision on the remedial approach for Site 35 after reviewing and considering all information submitted during the 30-day **public comment period**. The Navy and MCB Camp Lejeune, along with EPA, may modify the Preferred Alternative based on

Mark Your Calendar for the Public Comment Period



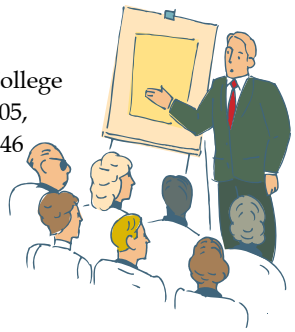
Public Comment Period
April 21 - May 20, 2009

Submit Written Comments
The Navy will accept written comments on the PRAP during the public comment period. To submit comments or obtain further information, please refer to the insert page.

Attend the Public Meeting
April 21, 2009 at 6:00 p.m.

Place – Coastal Carolina Community College
Business Technology Building, Room 105,
444 Western Blvd. Jacksonville, NC 28546

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



Location of Information Repository

Available for Review Online: http://public.lantops-ir.org/sites/public/lejeune/Site35_73Prap.aspx
Access to the website is available at:
Onslow County Library
58 Doris Avenue East
Jacksonville, NC 28540
(910)455-7350

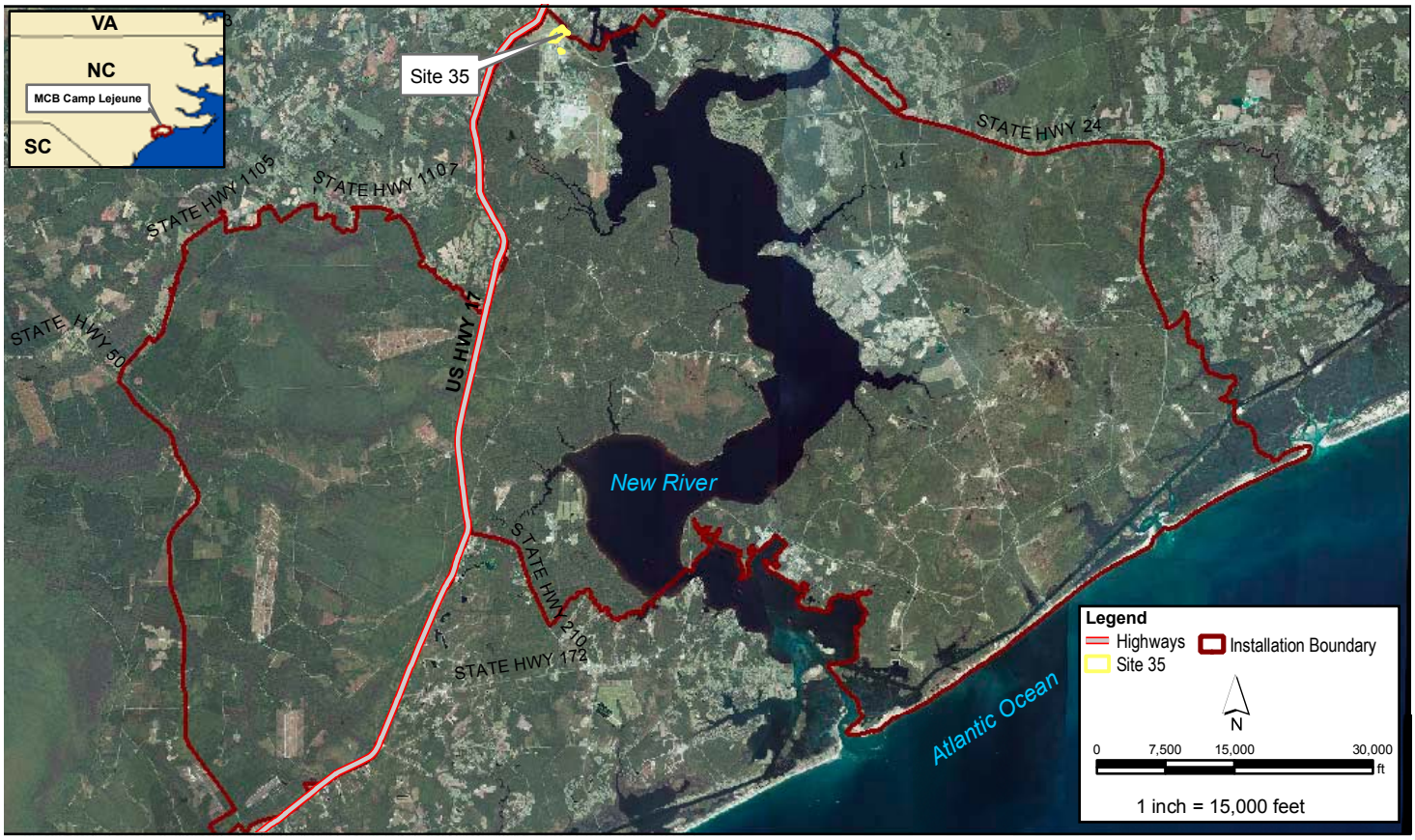


Figure 1 – Base and Site Location Map

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 10. The State of North Carolina will issue a letter of concurrence at the appropriate time once the final **Record of Decision (ROD)** has been submitted.

2 Site Background

MCB Camp Lejeune is a 156,000-acre facility located in Jacksonville, North Carolina within Onslow County **(Figure 1)**. The mission of MCB Camp Lejeune is to maintain combat-ready units for expeditionary deployment. The Base provides housing, training facilities, and logistical support for Fleet Marine Force Units and other assigned units.

2.1 Site Description and Background

Site 35 was originally the former Camp Geiger Area Fuel Farm, which was composed of five 15,000-gallon aboveground storage tanks (ASTs), underground fuel transmission lines, a pump house, a fuel unloading pad, an oil-water separator, and a distribution island, situated north of the intersection of Fourth Street and 'G' Street **(Figure 2)**.

The fuel farm was in operation from 1945 until 1995, when it was dismantled to make way for the NC Highway 17 Bypass. The ASTs were installed in 1945 as part of the original Camp Geiger construction and have stored various fuels, including No. 6 fuel oil, diesel, kerosene, and gasoline. During the active life of the fuel farm, several releases were reported. During subsequent phases of investigation of the petroleum hydrocarbon contamination, **chlorinated volatile organic compounds (CVOCs)** were also detected, primarily in groundwater.

The source of the CVOC contamination is likely a result of historical disposal practices at the former vehicle maintenance garage and at the area east of Building G533, which was reportedly used for weapons cleaning. Petroleum hydrocarbon contamination associated with former UST sites is being addressed under the NCDENR UST Program and will not be addressed by this remedial action.

Site 35 comprises roadways, buildings, former building foundations, large parking areas, and large grass-covered areas. Portions of Site 35 are currently used by the Camp Geiger School of Infantry for training exercises. An armory occupies Building G480, and additional armory operations are conducted in Buildings TC341 and TC342. Several warehouses, general storage buildings, and troop barracks also occupy the area.

2.2 Summary of Previous Investigations

Site 35 was characterized under numerous investigations and studies between 1983 and the present. The following is a chronological list of those studies **(Table 1)**.

Previous Study / Investigation*	Date	Investigation Activities
Initial Assessment Study (Water and Air Research, 1983)	1983	Site 35 was identified for further study due to potential for petroleum hydrocarbon impacts from historical site activities and recorded spills.
Confirmation Study (Environmental Science and Engineering, Inc., 1985)	1985	Soil, groundwater, and surface water samples were collected to delineate contamination. Results indicated soil and groundwater were potentially impacted by site activities.
Focused FS (NUS Corporation, 1990)	1990	Soil, groundwater, surface water, and sediment samples were collected in area of 1990 petroleum release. Risks to human health or the environment and interim measures to remediate area were evaluated. No unacceptable risks were found. Remediation was recommended because petroleum hydrocarbon levels exceeded cleanup standards.
Comprehensive Site Assessment (Law, 1992)	1991 to 1992	Soil and groundwater samples were collected to identify the source, nature, and extent of petroleum hydrocarbon impacts. Petroleum hydrocarbon related contamination was found in soil (generally located at or below groundwater table) and in shallow groundwater. CVOC contamination was found in shallow and intermediate groundwater.
Interim Remedial Action Remedial Investigation/Feasibility Study (Baker, 1994)	1993 to 1994	Additional soil samples were collected for petroleum hydrocarbons to support selection of an interim remedial action.
Interim Record of Decision (ROD) for Contaminated Soil (Baker, 1994)	1994	Selected Remedy was excavation and offsite disposal of contaminated soil. Approximately 15,700 tons of petroleum hydrocarbon contaminated soil was excavated for offsite disposal or recycling from 1995 to 1997.
RI (Baker, 1995)	1994 to 1995	Soil gas, soil, groundwater, surface water, and sediment samples collected to evaluate nature and extent of contamination and potential risks to human health and environment. Primary impacted media was groundwater: COCs included petroleum hydrocarbons (primarily benzene), CVOCs (primarily trichloroethene [TCE] and cis-1,2-dichloroethene [cis-1,2-DCE]), and metals.
Supplemental Groundwater Investigation (SGI) (Baker, 1996)	1995 to 1996	Soil, groundwater, surface water, and sediment samples collected to fill data gaps from RI and support air sparging pilot study. COCs driving risk were benzene, TCE, cis-1,2-DCE, and arsenic.
Interim FS for Surficial Groundwater for a Portion of OU 10 (Baker, 1995)	1995	Addressed groundwater impacts and identified remedial actions for a focused area near the fuel farm, a known source of groundwater contamination.
Interim ROD for Surficial Groundwater, OU 10 (Baker, 1995)	1995	Issued based on the Interim FS for remediation of surficial groundwater near the fuel farm. Air sparging was the Selected Remedy.
Natural Attenuation Evaluation (NAE) (CH2M HILL, Baker, and CDM, 2003)	1998 to 2002	Seasonal changes, **plume** stability, and presence of natural degradation was evaluated. Results indicated natural attenuation was degrading CVOCs but biological degradation appeared stalled in some locations.
Long-Term Monitoring (LTM) (CH2M HILL, 2005)	1999 to 2004	Groundwater samples were collected, quarterly in 1999 and semi-annually from 2000 to 2004, to assess seasonal changes in contaminant distribution. LTM was discontinued in 2004 when a Supplemental RI was initiated.
Hot Spot Characterization (Baker, 2003)	1999 to 2004	Further delineation and characterization of two TCE hot spots (concentration > 280 mg/L) was conducted. One shallow hot spot was co-mingled with petroleum hydrocarbons near Building G480, and a deeper, larger hot spot extended from Building TC470 under the US HWY 17 Bypass to wetland area west of Brinson Creek.
Technical Evaluation (CH2M HILL, 2003)	2003	Developed and evaluated remedial action alternatives for groundwater. **In Situ Chemical oxidation (ISCO)** via modified **Fenton's Reagent** followed by potassium permanganate, was recommended for TCE removal. Air sparging with vertical wells was recommended for the petroleum hydrocarbon contamination.
Pilot Study (CH2M HILL, 2006)	2003	Evaluated the effectiveness of ISCO for the remediation of TCE-impacted groundwater. TCE was reduced by 80 to 98 percent and total VOCs were reduced by 72 to 85 percent within the pilot study area.
Supplemental RI (CH2M HILL, 2009)	2003 to 2005	Soil, groundwater, surface water, and sediment samples collected to delineate extent of contamination. No unacceptable risks in all media except groundwater. Benzene and several CVOCs detected in groundwater exceeding **North Carolina Groundwater Quality Standards (NCGWQS)** and/or **Maximum Contaminant Levels (MCLs)**.
Non-Time Critical Removal Action (NTCRA) (CH2M HILL, 2008)	2005 to 2008	**Enhanced reductive dechlorination (ERD)** via injection of emulsified vegetable oil and lactate using direct-push technology was evaluated to address CVOCs in groundwater east of Building G533. Results indicated minimal reduction of COCs.
FS Site 35 - OU 10 (CH2M HILL, 2009)	2009	The following remedial alternatives for CVOC-impacted groundwater were assessed: no action, monitored natural attenuation, enhanced ERD with bioaugmentation, ISCO, and air sparging.

Notes: *Documents listed are available in the Administrative Record and provide detailed information to support remedy selection at Site 35.

Table 1 – Previous Studies and Investigations

3 Site Characteristics

Site 35 is located in the northeast corner of Camp Geiger, which is in the far northwest portion of MCB Camp Lejeune. The surface of Site 35 is covered with a mix of vegetation, asphalt roadways, concrete, and buildings. Site 35 is generally flat; however, construction of the US Highway 17 Bypass required raising the roadbed, so the natural topography of the site has been altered in this area. The eastern portion of the site, adjacent to Brinson Creek, is heavily wooded and slopes toward Brinson Creek. Stormwater is conveyed via manmade drainage ditches, storm drains, and catch basins, and is discharged into Brinson Creek and its tributaries, where it then flows southeast into the New River.

Groundwater investigations completed at Site 35 have focused on the surficial and underlying Castle Hayne aquifers. For the purposes of the PRAP, the aquifers have been designated as three zones corresponding to the following depths: shallow [surficial aquifer - 0 to 25 feet below ground surface (bgs)], intermediate (Castle Hayne Aquifer - 25 to 45 feet bgs), and deep (Castle Hayne aquifer - 46 to 68 feet bgs). Based on groundwater measurements collected during the 2008 sampling activities, groundwater is encountered at approximately 5 to 7 feet bgs. The variation in the depth to groundwater is primarily attributed to topographical changes. In general, groundwater flow within the shallow, intermediate, and deep aquifers zones at Site 35 is to the northeast. Hydraulic gradients range from approximately 0.003 to 0.018 feet per feet and average linear seepage velocities for the surficial aquifer were estimated to range from 2.3 to 4.6 feet per year and from 24.5 to 49.1 feet per year in the Castle Hayne aquifer.

Potable water for MCB Camp Lejeune and the surrounding residential area is provided by public water supply wells that pump groundwater from the Castle Hayne aquifer. Regionally in southeastern North Carolina, the Castle Hayne aquifer may be used as a potable source of domestic water supply, watering lawns, or filling swimming pools. One public supply well is located within 1,500 ft upgradient of Site 35. This well is inactive and has been recommended for abandonment.

3.1 Nature and Extent of Contamination

During the May 2008 field activities, TCE, cis-1,2-DCE, VC, and benzene were detected in groundwater at concentrations exceeding the NCGWQS and/or federal MCLs in one or more of the monitoring wells in the shallow, intermediate, and deep aquifer zones. **Table 2** provides the maximum concentration detected for each COC at Site 35. The extent of impacted groundwater has been assessed and fully delineated horizontally and vertically. **Figure 3** shows the horizontal extents of the COCs. Contamination in the northern area appears to be associated with: (1) the area extending from east of Building G480 (former fuel farm area) towards Brinson Creek and (2) the area east of Building G533 and south of Building TC342 **(Figure 3)**.

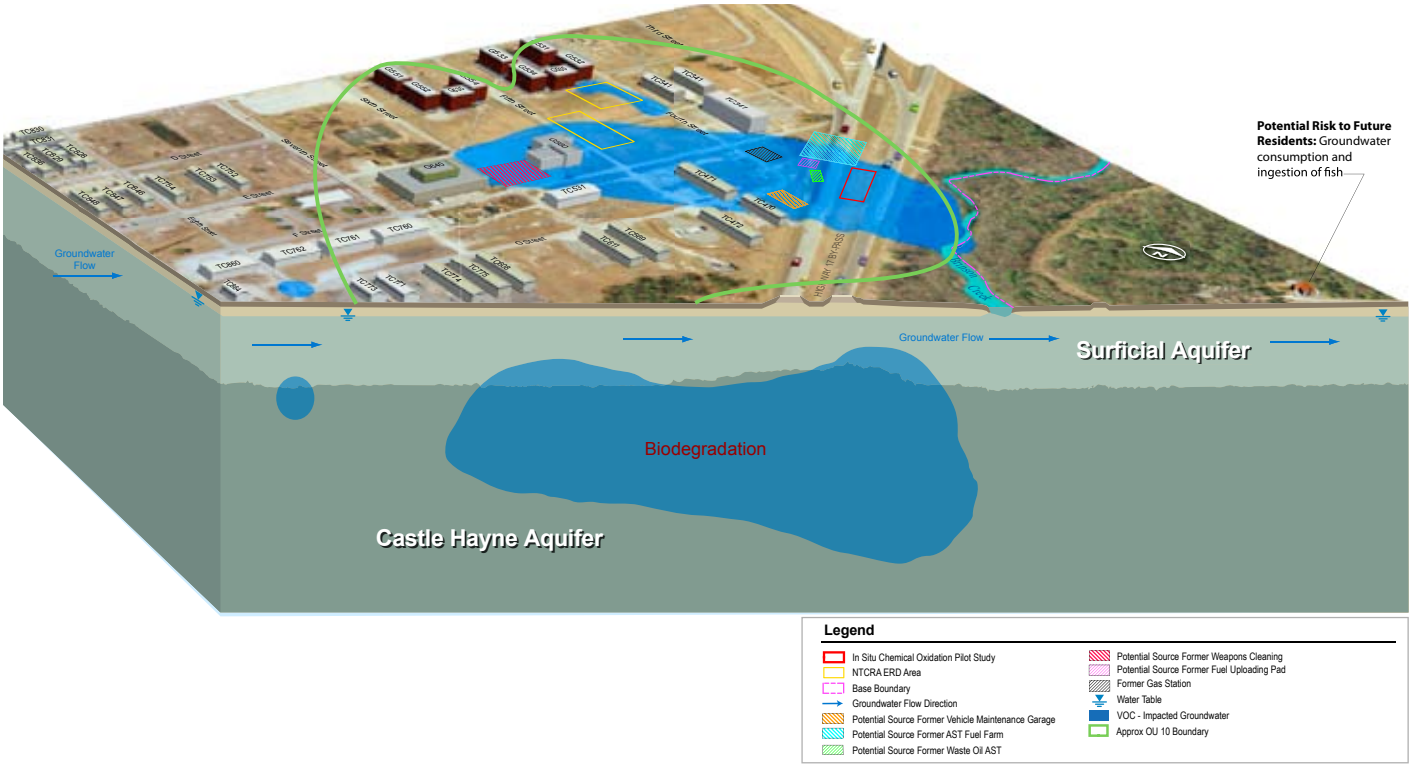


Figure 2 – Conceptual Site Model

The southern area is a small dissociated plume. The vertical extent of the contamination is primarily limited to the shallow and intermediate aquifer zones.

COCs	Maximum Concentration (µg/L)
TCE	180
cis-1,2-DCE	240
Vinyl chloride	220
Benzene	18

Table 2 – Maximum Concentration for COCs (2008)

3.2 Fate and Transport of Contamination

The primary contaminant migration pathway is through groundwater flow in the shallow and intermediate aquifers zones. Principal transport mechanisms are dissolution, advection, and dispersion. Previous investigations indicated that the groundwater is generally flowing northeast, with a vertical migration between the shallow and intermediate aquifer zones. The groundwater flow direction is towards Brinson Creek (shallow and intermediate aquifer zones) and the New River (deep aquifer zone). Groundwater contamination in the northern plume is not currently impacting Brinson Creek and modeling predicts that natural contaminant degradation will occur, resulting in discharge of groundwater to surface water below regulatory criteria. The low concentration COCs present in the southern dissociated plume will not migrate to Brinson Creek before the concentrations have naturally degraded below both North Carolina groundwater and surface water quality standards.

3.3 Principal Threats

"Principal threat wastes" are source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should they be exposed. Contaminated groundwater generally is not considered to be a source material; however, **Non–Aqueous Phase Liquids (NAPLs)** in groundwater may be viewed as a source material. Dissolved concentrations of COCs in groundwater at approximately 1 to 5 percent of a compound's solubility would suggest the presence of **Dense Non-Aqueous Phase Liquids (DNAPL)** in the subsurface. The maximum concentrations of TCE, cis-1,2-DCE, and VC observed in the May 2008 sampling event at Site 35 were present in concentrations of less than 1 percent of their respective solubilities. Therefore, NAPLs are not considered to be principal threat wastes at Site 35. **Light Non-Aqueous Phase Liquid (LNAPL)** was not identified within the CVOC plume.

Because no significant source materials are present and there are no realistic exposures scenarios to COC-impacted groundwater, it can be concluded that there is no principal threat waste at Site 35.

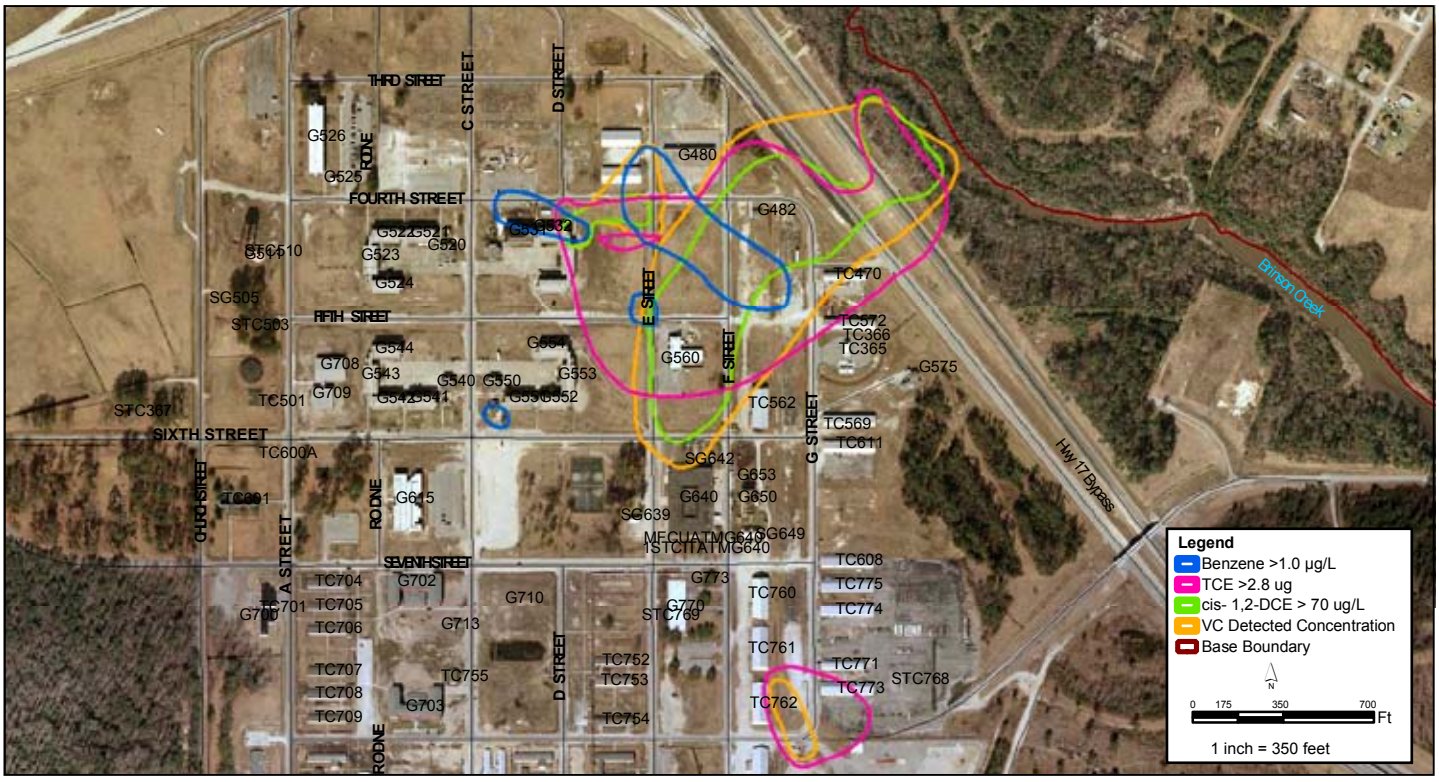


Figure 3 – Extent of Contamination

4 Scope and the Role of the Action

MCB Camp Lejeune was placed on EPA's **National Priorities List (NPL)** effective November 4, 1989 (54 *Federal Register* 41015, October 4, 1989) under the narrative "Camp Lejeune Military Reservation (USNAVY)" and EPA ID# NC6170022580. There are 22 discrete OUs under CERCLA investigation at MCB Camp Lejeune. OU No. 10 consists solely of Site 35. The response action for Site 35 does not include or affect any other sites at the facility. Information on the status of all the OUs and sites at MCB Camp Lejeune can be found in the current version of the Site Management Plan, in the Administrative Record. This is the final remedial action for Site 35 and it does not include or affect any other sites at the facility.

5 Summary of Site Risks

As part of the RI, SGI, and Supplemental RI, a baseline **Human Health Risk Assessment (HHRA)** and an **Ecological Risk Assessment (ERA)** were conducted. Detailed results of the HHRA and ERA are presented in the 1995 RI, 1996 SGI, and 2009 Supplemental RI. The following subsections and **Table 3** briefly summarize the findings of these risk assessment studies.

Media	Human Health Risk	Ecological Risk
Surface Soil	Acceptable	Acceptable
Subsurface Soil	Acceptable	Not Applicable
Groundwater	Unacceptable	Not Applicable
Sediment	Acceptable	Acceptable
Surface Water	Acceptable	Acceptable
Fish and Crab Tissue	Acceptable	Acceptable
Benthic Macroinvertebrates	Not Applicable	Acceptable

Table 3 – Site 35 Risk Summary

5.1 Human Health Risk Summary

The HHRA was conducted to evaluate the potential human health risks associated with current receptors (industrial workers, military personnel), hypothetical future receptors (construction workers, adult residents, child residents, lifetime residents), and exposure scenarios (soil or water ingestion; dermal, or skin, contact; and inhalation, through showering or breathing indoor air) if no remedial action were implemented. Health risks are based on a conservative estimate of the potential cancer risk or the potential to cause other health effects not related to cancer [non-cancer hazard, or **hazard index (HI)**]. EPA identifies an acceptable **cancer risk** range of 1 in 10,000 (10^{-4}) to 1 in 1,000,000 (10^{-6}) and an acceptable non-cancer hazard as an HI of less than 1. This information was used to determine if any further actions were required to sufficiently protect human health. Based on the results of these HHRAs, it was concluded:

- Current site use poses no unacceptable risk to human health.
- There is a potential cancer risk to future residential receptors driven by the presence of CVOCs in groundwater.

North Carolina requires chemical concentrations in groundwater to meet promulgated cleanup standards, NCGWQS, for protection of groundwater potentially used for drinking. TCE, cis-1,2-DCE, VC, and benzene were identified in groundwater at Site 35 above the NCGWQS. The **Conceptual Site Model (CSM)** (Figure 2) depicts the potential risk identified at Site 35, including the exposure **media**, exposure routes, and potential human health **receptors**.

5.2 Ecological Risk Summary

An ERA was completed to evaluate whether past site operations have adversely affected terrestrial and aquatic communities on or adjacent to Site 35. Soil, surface water, and sediment samples were compared to published values for toxicity in various aquatic and terrestrial species. In addition, fish, crabs, and benthic macroinvertebrates were collected and analyzed against toxicological information for contaminants detected in these media, which was then used to evaluate the potential adverse ecological effects to those receptors. The point of exposure included species living in, or coming into contact with contaminated surface soil, or bioaccumulation from consumption of smaller organisms because bioaccumulation was considered likely to occur at Site 35.

The risk characterization evaluates the potential for decrease in the aquatic and terrestrial populations from contaminants identified at the site. The Quotient Index (QI) approach was used to characterize the risk to aquatic receptors from exposure to surface water and sediments and to terrestrial receptors from exposure to surface soil, surface water, and biota. A QI greater than 1 indicates a significant potential risk. The QI equation is dependent on exposure concentration, chronic daily intake surface, water screening values, sediment screening values, and terrestrial reference values.

Overall, the ERA concluded that no site-related risks to terrestrial and aquatic receptors were present at Site 35.

It is the current judgment of the Navy, MCB Camp Lejeune, and EPA, in consultation with NCDENR, that the Preferred Alternative identified in this PRAP, or one of the other active measures considered in the PRAP, is

necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

6 Remedial Action Objectives

The **Remedial Action Objectives (RAOs)** at Site 35 are as follows:

- Restore groundwater quality at Site 35 to the NCGWQS 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, and to prevent human ingestion of water containing COCs (benzene, TCE, cis-1,2-DCE, and VC) at concentrations above NCGWQS or MCL standards, whichever is more conservative, until the RAO has been obtained.
- Minimize migration of COCs in groundwater to surface water.

Project remediation goals based on the more-conservative NCGWQS were developed for COCs contributing to unacceptable risks and hazards from exposure to groundwater at Site 35. Project remediation goals are identified in **Table 4**.

COC	NCGWQS* (µg/L)
TCE	2.8
cis-1,2-DCE	70
Vinyl chloride	0.015
Benzene	1.0
* NCGWQS are more conservative than the MCLs for the COCs	

Table 4 – Remediation Goals For Groundwater

7 Summary of Remedial Alternatives

Remedial alternatives developed and evaluated to address COCs in groundwater at Site 35 are detailed in the FS. With the exception of the no-action alternative (Alternative 1), all alternatives comply with **Applicable or Relevant, and Appropriate Requirements (ARARs)**, have the same RAOs, expected outcomes, and anticipated future land uses. Alternative 1 does not protect human health and the environment, but is presented as a baseline for comparison purposes. A summary of remedial alternatives is presented in **Table 5**.

8 Summary of Remedial Alternatives

The NCP outlines the approach for comparing remedial alternatives using the **nine evaluation criteria** listed below (see Glossary for a detailed description of each). Each remedial alternative for Site 35 was evaluated against the nine criteria listed below. Alternative 1 (no action) does not meet the RAOs and was not considered further.

8.1 Threshold Criteria

Protection of human health and the environment

Alternatives 2 (MNA), 3 (ERD), 4 (ISCO), and 5 (Air Sparging) are all protective of human health and the environment. Alternative 2 is considered to be less protective than Alternatives 3, 4, and 5 because it relies on natural degradation, which adds a higher degree of uncertainty for the rate of contaminant reduction and length of time to achieve RAOs. Alternatives 3, 4, and 5 are similar in protectiveness because they each employ an active treatment to reduce chemical concentrations. Monitoring will be conducted and LUCs will provide adequate protection of human health and the environmental by controlling exposure to groundwater until the RAOs are achieved.

Compliance with ARARs

Alternatives 2, 3, 4, and 5 are expected to comply with ARARs. Alternative 2 will have a longer timeframe associated with meeting the ARARs because it relies on natural degradation, whereas Alternatives 3, 4, and 5 employ active treatment and will therefore meet the ARARs in a shorter timeframe than Alternative 2.

8.2 Primary Balancing Criteria

Long-term effectiveness and permanence

Once RAOs have been achieved, Alternatives 2, 3, 4, and 5 are expected to have residual risks of approximately the same magnitude. Because Alternative 2 is dependent on the rate of natural biodegradation, it may not be effective for more than 30 years whereas the active treatment component of Alternatives 3, 4, and 5 is intended to reduce groundwater contaminant concentration to levels below regulatory limits in a shorter timeframe (less than 20 years) although "**rebound**" is a potential issue with any injection or air sparging scenario. Alternative 5 is expected to provide the greatest degree of long-term effectiveness if rebound occurs because a permanent horizontal well will be installed for air sparging and would allow for cost-effective implementation of subsequent treatment if RAOs are not achieved.

Reduction in toxicity, mobility, or volume through treatment

Alternatives 3, 4, and 5 will reduce the toxicity, mobility, and volume through active treatment, which is the statutory preference. Although Alternative 2 is not considered

Alternative	Components	Details	Cost	
1 - No Action	None	None	Total Cost	$0
			Timeframe	**30 years**
2 - MNA / LUCs	MNA	Groundwater monitoring and reporting to assess the progress of natural attenuation over time.	Capital Cost	$83,025
			Annual monitoring	$66,123
	LUCs	LUCs to prevent exposure to groundwater.	**Total Present Value**	**$1,111,188**
			Timeframe	**30 years**
3 – ERD with Bioaugmentation / LUCs	Enhanced bioremediation	Injection of microbial culture and electron source/substrate to promote anaerobic biodegradation of CVOCs by reductive dechlorination.	Capital cost	$1,520,721
			Quarterly monitoring (yrs 1-2)	$134,946
			Annual monitoring (yrs 3-20)	$66,123
			Total present value	**$2,479,944**
	Groundwater monitoring	Long-term groundwater monitoring and reporting to evaluate: - Effectiveness of the ERD injections - Potential impacts to surface water - Progress of natural attenuation over time - Potential migration to the deep aquifer		
	LUCs	LUCs to prevent exposure to groundwater.	**Timeframe**	**20 years**
4 – ISCO using Persulfate / LUCs	Chemical oxidation of COCs	Injection of chemical oxidant and activation agent to chemically degrade COCs.	Capital cost	$900,207
			Quarterly monitoring (yrs 1-2)	$134,946
			Annual Monitoring (yrs 3-20)	$66,123
			Total present value	**$1,859,430**
	Groundwater monitoring	Long-term groundwater monitoring and reporting to evaluate: - Effectiveness of the ISCO injections - Potential impacts to surface water - Progress of natural attenuation over time - Potential migration to the deep aquifer		
	LUCs	LUCs to prevent exposure to groundwater.	**Timeframe**	**20 years**
5 – Air Sparging / LUCs	Air Sparging	Injection of air to induce mass transfer (stripping) of VOCs from groundwater and/or aerobic biodegradation.	Capital cost	$690,255
			Annual O&M (yrs 1-3)	$219,543
			Annual monitoring (yrs 4-20)	$66,123
			Total present value	**$1,939,910**
	Groundwater monitoring	Long-term groundwater monitoring and reporting to evaluate: - Effectiveness of the air sparging - Potential impacts to surface water - Progress of natural attenuation over time - Potential migration to the deep aquifer		
	LUCs	LUCs to prevent exposure to groundwater.		
			Timeframe	**20 years**

Table 5 – Description of Remedial Alternatives for Site 35

active treatment, the natural reduction of contaminant concentrations through a variety of physical, chemical, or biological activities is expected over time.

Short-term effectiveness

Alternative 2 does not rely on an active treatment and there is no implementation time or impacts to the community; however, there is a higher potential for impacts to Brinson Creek based on the extended time frame to achieve RAOs. The time-frame to implement Alternatives 3, 4, and 5 and any impacts to the community or environment are similar because treatments rely on injection technology. Alternatives 3, 4, and 5 involve active treatment to reduce contaminant mass, resulting in less potential for impacts to Brinson Creek.

Alternative 4 has a higher short-term risk to site workers during implementation because it involves handling of and potential exposure to oxidants and strong corrosive chemicals. During implementation of Alternative 5, there is a potential short-term risk from contaminant volatilization; however, modeling suggests that no exposures would exceed risk-based criteria. Risks to site workers can be addressed through the use of appropriate personal protective equipment and air monitoring.

The horizontal well component of Alternative 5 has only two surface disturbance areas, resulting in minimal impacts to the Base training areas, in comparison to the multiple injection components of Alternatives 3 and 4.

Implementability

Alternatives 3, 4, and 5 can be implemented using materials and services readily available. However, subsurface injections rely heavily on the ability to effectively distribute reagents uniformly in the subsurface. Air sparging (Alternative 5) has been successfully implemented in the past at MCB Camp Lejeune whereas injection of ERD (Alternative 3) and ISCO (Alternative 4) have been less effective at some sites due to challenges associated with substrate distribution. In addition, ISCO (Alternative 4) would require extra health and safety precautions for the handling of both the oxidant and the activator.

Cost

Table 5 summarizes the capital costs, as well as long-term O&M costs for the alternatives. Projected capital costs for alternatives using active remediation processes (Alternatives 3, 4, and 5) are greater than alternatives for no action or MNA, (Alternatives 1 and 2, respectively). The highest capital cost is $2.5 million for Alternative 3, followed by $1.9 million for Alternatives 4 and 5. Both technologies are expected to require 20 years to achieve the ARARs, while Alternatives 1 and 2 are expected to require more than 30 years to achieve the ARARs. Alternative 2 has high capital costs ($1.1 million) because several new monitoring wells will be installed to track contaminant movement and degradation processes.

8.3 Modifying Criteria

State Acceptance

State involvement has been solicited throughout the CERCLA and remedy selection process. NCDENR supports the Preferred Alternative, and its final concurrence will be solicited following the review of all comments received during the public comment period.

Community Acceptance

These modifying criteria will be evaluated after the public comment period for the PRAP.

A comparative analysis of the alternatives is presented in **Table 6**, and is detailed in the FS.

CERCLA Criteria	No Action (1)	MNA (2)	ERD (3)	ISCO (4)	Air Sparging (5)
Threshold Criteria					
Protection of human health and the environment	❍	◘	●	●	●
Compliance with ARARs	❍	◘	●	●	●
Primary Balancing Criteria					
Long-term effectiveness and permanence	❍	◘	◘	◘	●
Reduction in toxicity, mobility, or volume through treatment	❍	◘	●	●	●
Short-term effectiveness	❍	◘	◘	◘	●
Implementability	●	●	◘	◘	●
Present Cost	$0	$1.1 M	$2.5 M	$1.9 M	$1.9 M

Relative Ranking: ● High ◘ Moderate ❍ Low

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

Table 6 – Relative Ranking of Alternatives

9 Preferred Alternative

Alternative 5, air sparging with LUCs, is the Preferred Alternative to address groundwater contamination at Site 35. Alternative 5 was chosen over Alternatives 2, 3, and 4 because it has been proven effective at MCB Camp Lejeune, would allow for subsequent treatment if RAOs are not achieved, results in less impacts to the active training area, meets the statutory preference for treatment, and costs are lower or similar.

Alternative 5 involves the installation of one horizontal well along the approximate centerline of the plume, parallel to the groundwater flow at the base of the intermediate aquifer (approximately 65 ft bgs). The treatment area is located in the highest TCE contamination in area, as shown in **Figure 4**. Long-term groundwater monitoring will be conducted to monitor the effectiveness of air sparging, changes in the concentration, and location of the plume. Although the effectiveness of mitigation of COCs in groundwater will be measured by comparison to the remediation goals **(Table 4)**, the remedial technology is not guaranteed to reduce COC concentrations to levels at or below remediation goals across Site 35. However, natural attenuation processes will continue to reduce VOC concentrations over time.

LUCs including, but not limited to, land use restrictions in the Base Master Plan, NOTICE OF CONTAMINATED SITE, Deed and/or Lease Restrictions, and administrative procedures to prohibit unauthorized intrusive activities (e.g., excavation, well installation, or construction) will be implemented as part of the remedy to prevent exposure to the residual contamination on the site that exceeds the remediation goals. The LUCs will be implemented and maintained by the Navy and MCB Camp Lejeune until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unlimited use and unrestricted exposure. The LUC performance objectives include:

- To prohibit human consumption of groundwater from the surficial and Castle Hayne aquifers underlying Site 35 (unless prior written approval is obtained from the Navy, MCB Camp Lejeune, EPA and NCDENR); and
- To maintain the integrity of any existing or future monitoring or remediation system at the site.

The estimated LUC boundary is provided in **Figure 5**, the actual LUC boundaries will be finalized in the Remedial Design (RD) document. The LUC implementation actions, including monitoring and enforcement requirements, will be provided in an LUC Implementation Plan (LUCIP) that will be prepared by the Navy after the ROD has been finalized. The Navy will submit the LUCIP to EPA and NCDENR for review and approval pursuant to the Primary Document review procedures stipulated in the Federal Facility Agreement. The Navy will maintain, monitor (including conducting periodic inspections), and enforce the LUCs according to the requirements con-

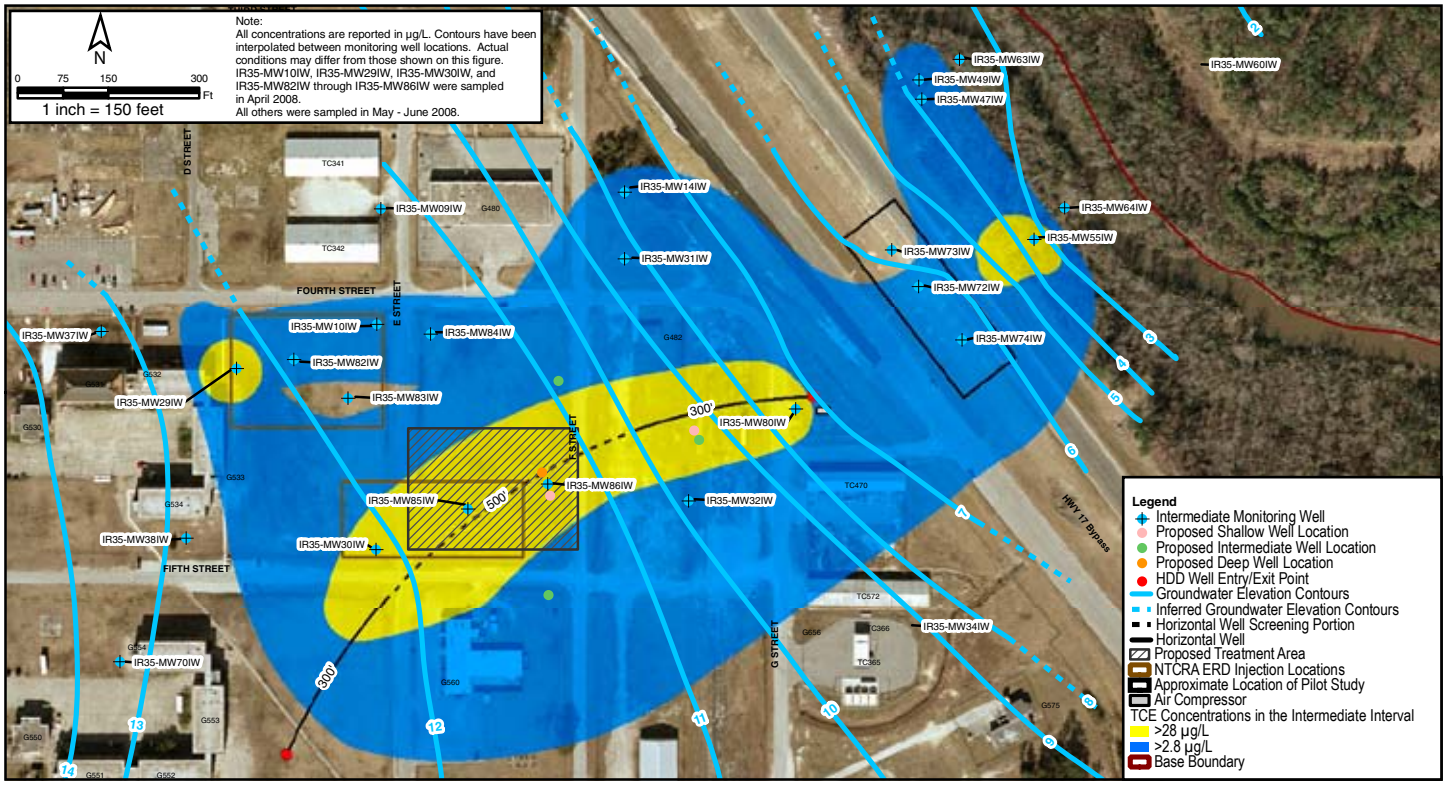


Figure 4 - Proposed Air Sparge Horizontal Well Installation

tained in the LUCIP and the ROD. The need for LUCs to prevent exposure and ensure protection will be periodically reassessed as COC concentrations are reduced over time.

Based on information currently available, the Navy, MCB Camp Lejeune, EPA, and NCDENR believe the Preferred Alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The Navy expects the Preferred Alternative to satisfy the following requirements of CERCLA: 1) protective of human health and the environment, 2) comply with ARARs, 3) cost-effective, 4) utilize permanent solutions and alternative treatment technologies to the maximum extent practicable, and 5) satisfy the preference for treatment as a principal element. The Preferred Alternative can change in response to public comment or new information.

Because COCs will remain at the site above levels that allow for unlimited use and unrestricted exposure, the Navy will review the final remedial action no less than every 5 years after initiation of the remedial action in accordance with CERCLA Section 121(c) and the NCP at 40 CFR300.4309f)(4)(ii). If results of the 5-year reviews reveal that remedy integrity is compromised and protection of human health is insufficient, the additional remedial actions would be evaluated by the parties and implemented by the Navy.

10 Community Participation

The Navy and EPA provide information regarding environmental cleanups at Site 35 to the public through the Restoration Advisory Board, public meetings, the Administrative Record file for the site, the Information Repository, and announcements published in *Jacksonville Daily News, The Globe* and *RotoVue*. The public is encouraged to gain a more comprehensive understanding of Site 35 and the IRP. The public comment period for this PRAP is from April 21, 2009 – May 20, 2009, and a public meeting will be held on April 21, 2009 at 6:00 pm (see Page 1 of this report for details). Minutes of the public meeting will be included in the Administrative Record file. The Navy will summarize and respond to comments in a Responsiveness Summary, which will become part of the official **ROD** and will also be included in the Administrative Record file.

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

Mr. Bryan Beck
NAVFAC
Attn: Matt Louth
5700 Cleveland Street, Suite 101
Virginia Beach, VA 23462
Phone (757) 322-4734
Fax (757) 322-8280
bryan.k.beck@navy.mil

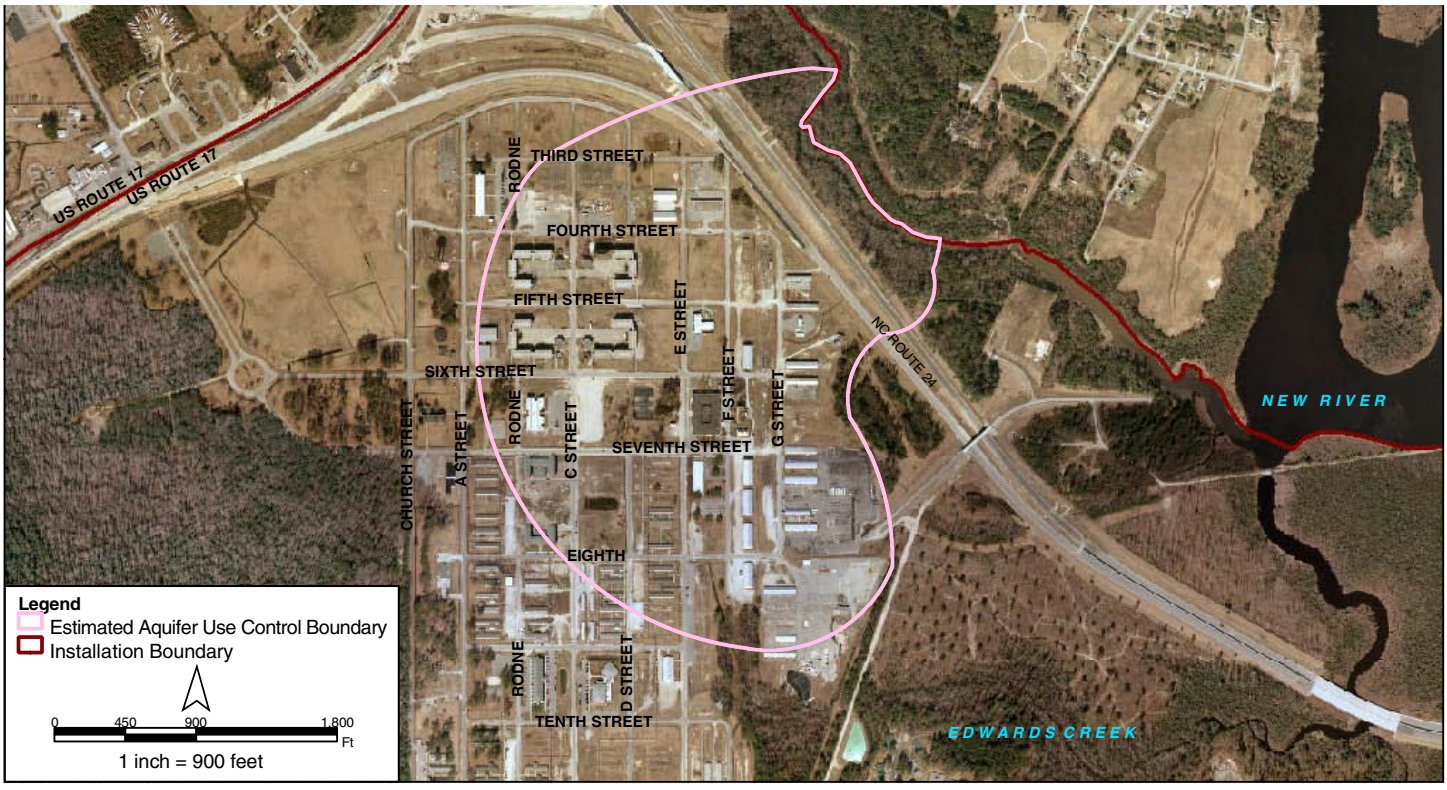


Figure 5 - Estimated LUC Boundary

Mr. Robert Lowder
Commanding General
EMD/EQB
Marine Corps Base
PSC Box 20004
Camp Lejeune, NC 28542-0004
Phone (910) 451-9607
Fax (910) 451-5997
robert.a.lowder@usmc.mil

Ms. Gena Townsend
Remedial Project Manager
EPA Region 4
Sam Nunn Atlanta Federal Center
61 Forsyth Street SW
Atlanta, GA 30303
Phone (404) 562-8538
Fax (404) 562-8518
townsend.gena@epamail.epa.gov

Mr. Randy McElveen
NC Dept. of Environment and Natural Resources
Remedial Project Manager
401 Oberlin Road, Suite 150
1646 Mail Service Center
Raleigh, NC 27699-1646
Phone (919) 508-8467
Fax (919) 733-4811
Randy.McElveen@ncmail.net

Location of Administrative Record and Information Repository Available Online at:

http://public.lantops-ir.org/sites/public/lejeune/Site35_73Prap.aspx

Internet access is available at the
Onslow County Library
58 Doris Avenue East
Jacksonville, NC 28540
(910) 455-7350

Glossary of Terms

This glossary defines in non-technical language the more commonly used environmental terms appearing in this Proposed Remedial Action Plan. The definitions do not constitute the Navy's, EPA'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.

Administrative Record: A compilation of site-related information for public review.

Air Sparging: injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of hydrocarbons from a dissolved state to a vapor phase.

Applicable or Relevant and Appropriate Requirements (ARARs):'Applicable' requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site.

Aquifer: Underground bed of soil or rock from which groundwater can be usefully extracted.

Cancer risk: Cancer risks are expressed as a number reflecting the increased chance that a person will develop cancer if exposed to chemicals or substances. For example, EPA's acceptable risk range for Superfund 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 a site that is not remediated.

Chlorinated volatile organic compound (CVOC): Manufactured chemical that evaporates easily and is typically used in manufacturing as industrial chlorinated solvents, such as degreasers. See also "volatile organic compound."

Cis-1,2-dichloroethene (cis-1,2-DCE): VOC that results from the breakdown of TCE and tetrachloroethene (PCE) in groundwater.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): A federal law, commonly referred to as the Superfund Program, passed in 1980 and amended in 1986 by the Superfund Amendments and Reauthorization Act codified at 42 U.S.C. §§ 9601 et seq., and amended again in 2000. CERCLA created a Trust Fund known as Superfund which is available to USEPA to investigate and clean up abandoned or uncontrolled hazardous waste sites.

Conceptual site model: 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 (e.g., spills) and receptors (e.g., humans) and the interactions that link the two.

Chemical of concern (COC): A subset of the chemicals of potential concern that are identified in the RI/FS as needing to be addressed by the proposed response action.

Direct-push technology (DPT): Technology used for performing subsurface investigations by driving, pushing, and/or vibrating small-diameter hollow steel rods into the ground. Also known as direct drive, drive point, or push technology.

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

Enhanced Reductive Dechlorination (ERD): An anaerobic (without oxygen) process in which an electron donor source is injected into the subsurface to allow chlorine atoms on a parent CVOC molecule to be sequentially replaced with hydrogen and break down COCs.

Feasibility Study (FS): An investigation of the nature and extent of contamination at a given site, for the purpose of developing and evaluating remedial alternatives, as appropriate.

Fenton's Reagent: A solution of hydrogen peroxide and an iron catalyst that is used to oxidize environmental contaminants.

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

Hazard Index (HI): A number indicative of non-cancer health effects that is the ratio of the existing level of exposure to an acceptable level of exposure. A value equal to or less than 1 indicates that the human population is not likely to experience adverse effects.

Hot spot: An area of contamination that has an elevated concentration than the surrounding areas.

Human Health Risk Assessment (HHRA): An evaluation of the risk posed to human health should remedial activities not be implemented at a site.

Information Repository: A file containing information, technical reports, and reference documents regarding an NPL site. This file is usually maintained at a location with easy public access, such as a public library.

Installation Restoration Program (IRP): The Navy, as the lead agency, acts in partnership with EPA and NCDENR to address environmental investigations at the facility through the IRP. The current IRP is consistent with CERCLA and applicable state environmental laws.

In Situ Chemical Oxidation (ISCO): Use of oxidizing chemicals to break down groundwater contaminants into carbon dioxide and water.

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

Lead Agency: Means the agency that provides the OSC/RPM to plan and implement response actions under the NCP. EPA, the USCG, another federal agency, or a state (or political subdivision of a state) operating pursuant to a contract or cooperative agreement executed pursuant to section 104(d)(1) of CERCLA, or designated pursuant to a Superfund Memorandum of Agreement (SMOA) entered into pursuant to subpart F of the NCP or other agreements may be the lead agency for a response action. In the case of a release of a hazardous substance, pollutant, or contaminant, where the release is on, or any facility or vessel under the jurisdiction, custody, or control of Department of Defense (DOD) or Department of Energy (DOE), then DOD or DOE will be the lead agency. Where the release is on, or the sole source of the release is from, any facility or vessel under the jurisdiction, custody, or control of a federal agency other than EPA, the USCG, DOD, or DOE, then that agency will be the lead agency for remedial actions and removal actions other than emergencies. The federal agency maintains its lead agency responsibilities whether the remedy is selected by the federal agency for non-NPL sites or by EPA and the federal agency or by EPA alone under CERCLA section 120. The lead agency will consult with the support agency, if one exists, throughout the response process.

Maximum Contaminant Levels (MCLs): Enforceable standards that apply to public water systems, developed by EPA. The highest level of a contaminant that is allowed in drinking water.

Media (singular, medium): Soil, groundwater, surface water, or sediments at the site.

Non-Aqueous Phase Liquids (NAPLs): Either singular free-product organic compounds or mixtures of organic compounds that are resistant to mixing with water. NAPL zones are the delineated portions of the subsurface (including one or more aquifers) where such liquids (free-phase or residual NAPL) are present. There are two types of NAPLs: Light Non-Aqueous Phase Liquids (LNAPLs) and Dense Non-Aqueous Phase Liquids (DNAPLs):

- **LNAPLs** are less dense than water and tend to float on the water table (e.g., gasoline).
- **DNAPLs** have a density greater than water. This property allows them to sink through the water table and penetrate the deeper portions of an aquifer, making them difficult to locate and remediate. Examples of DNAPLs include some chlorinated solvents (e.g., TCE), coal tar wastes, creosote-based wood-treating oils, and some pesticides.

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

National Priorities List (NPL): A list developed by EPA 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 as well as in the short term.
- **Reduction of Toxicity, Mobility, and Volume Through Treatment** - The anticipated performance of the treatment technologies 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 of these costs.
- **State Acceptance** - Considers substantial and meaningful state involvement on the Proposed Remedial Action Plan.
- **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 risk: Non-cancer risks are expressed as a quotient that compares the existing level of exposure 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. EPA's threshold level for non-cancer hazard at Superfund sites is 1, meaning that if the exposure 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 (NCGWQS): Enforceable standards developed by NCDENR. They are the maximum allowable 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 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.

Plume: A space in air, water, or soil containing pollutants released from a point source.

Pneumatic fracturing: A process whereby a gas is injected into the subsurface at pressures exceeding the natural in-situ pressures present in the soil/rock interface (i.e. overburden pressure, cohesive stresses, etc.) and at flow volumes exceeding the natural permeability of the subsurface

Proposed Remedial Action Plan (PRAP): A document that presents and requests public input regarding the proposed cleanup alternative.

Public comment period: The time allowed for the members of an affected community to express views and con-

cerns regarding an action proposed to be taken by the Navy and EPA, such as a rulemaking, permit, or Superfund-remedy selection.

Rebound: An increase in contaminant concentrations after a treatment system has been turned off. It occurs because not all contamination has been removed and, as the subsurface returns to equilibrium, additional dissolution of residual contamination occurs.

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

Record of Decision (ROD): A public document that explains which cleanup alternative(s) will be used at NPL sites where, under CERCLA, trust funds pay for the cleanup.

Remedial Action Objectives (RAOs): Objectives of remedial actions that are based on contaminated media, COCs, potential receptors and exposure scenarios, human health and ecological risk assessments, and attainment of regulatory cleanup levels, if any exist.

Remedial action: A cleanup method proposed or selected to address contaminants at a site.

Resource Conservation and Recovery Act (RCRA): A federal law that established a system for controlling hazardous waste from the time it is generated until its ultimate disposal

Remedial Investigation (RI): A study to determine the nature and extent of contaminants present at a site and the problems caused by their release.

Site: The area of the facility where a hazardous substance, hazardous waste, hazardous constituent, pollutant, or contaminant from the facility has been deposited, stored, disposed of, placed, has migrated, or otherwise come to be located.

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

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

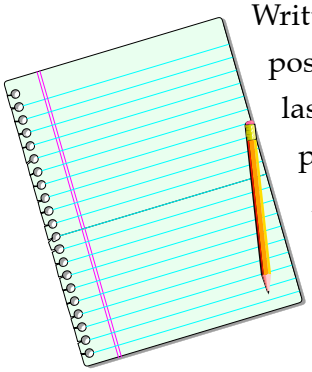
Volatile organic compound (VOC): A compound that easily vaporizes and has low water solubility. Many VOCs are manufactured chemicals, such as those associated with paint, solvents, and petroleum. VOCs are common groundwater contaminants.

Please print or type your comments for Site 35 here

Mark Your Calendar for the Public Comment Period

Public Comment Period
April 21 – May 20, 2009

Submit Written Comments



Written comments must be postmarked no later than the last day of the public comment period, which is May 20, 2009. Based on the public comments or on any new information obtained, the Navy may modify the Preferred Alternative. The insert page of this Proposed Plan may be used to provide comments, although the use of the form is not required. If the form is used to submit comments, please fold page, seal, add postage where indicated, and mail to addressee as provided.

Attend the Public Meeting
April 21, 2009 at 6:00pm

Coastal Carolina Community College
Business Technology Building, Room 105
4444 Western Blvd.
Jacksonville, NC 28546

The public comment period will include a public meeting during which the Navy, EPA, and MCB Camp Lejeune will provide an overview of the site, previous investigation findings, remedial alternatives evaluated and the Preferred Alternative; answer questions; and accept public comments on the Proposed Plan.

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Mr. Bryan Beck
NAVFAC Mid-Atlantic Division
Attn: Matt Louth
5700 Cleveland Street, Suite 101
Virginia Beach, VA 23462