# QC Review Page

## Record of Decision
## Site 73, Operable Unit Number No. 21

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

CLEAN 1000 Program
Contract Number N62470-08-D-1000
Contract Task Order 081

*Prepared by*

CH2M HILL

December 2009

Approved by: _____ Date: 12/14/09
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# 1 Declaration

## Site Name and Location

This Record of Decision (ROD) document presents the Selected Remedy for Operable Unit (OU) 21, Site 73 at the Marine Corps Base (MCB) Camp Lejeune, located in Onslow County, North Carolina. MCB Camp Lejeune was placed on the United States Environmental Protection Agency (USEPA) National Priorities List (NPL) effective November 4, 1989 (USEPA ID: NC6170022580). This remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on information contained in the Administrative Record file for this site. Information not specifically summarized in this ROD or its references, but contained in the Administrative Record has been considered and is relevant to the selection of the remedy at OU 21. Thus, the ROD is based upon and relies upon the entire Administrative Record file in making the decision. As a result of the NPL listing and pursuant to CERCLA, the USEPA Region 4, the North Carolina Department of Environment and Natural Resources (NCDENR), the United States Department of the Navy (Navy), and the Marine Corps entered into a Federal Facilities Agreement (FFA) for MCB Camp Lejeune in 1991. The primary purpose of the FFA is to ensure that the environmental impacts associated with past and present activities at the Base are thoroughly investigated. The Installation Restoration Program (IRP) is responsible for ensuring that appropriate CERCLA response alternatives are developed and implemented as necessary to protect public health, welfare, and the environment. No enforcement activities have been recorded at Site 73.

## Statement of Basis and Purpose

The Navy is the lead agency and provides funding for site cleanups at MCB Camp Lejeune. The remedy set forth in this ROD has been selected by the Navy, MCB Camp Lejeune, and USEPA. NCDENR, the support regulatory agency, actively participated throughout the investigation process and, hence, has reviewed this ROD and the materials on which it is based and concurs with this Selected Remedy (Appendix A).

## Scope and Role of Response Action

OU 21 is one of 22 OUs in the IRP sites that are part of the comprehensive environmental investigation and cleanup currently being performed at MCB Camp Lejeune under the

CERCLA program. The status of all the IRP sites at MCB Camp Lejeune can be found in the current version of the Site Management Plan (SMP), which is located in the Administrative Record. OU 21 is solely comprised of Site 73. This ROD documents the final remedial action for Site 73 and does not include or affect any other sites at the facility.

## 1.1 Selected Remedy

### Assessment of the Site

The response action selected in this ROD is necessary to protect the public health, welfare and/or the environment from actual or threatened releases of hazardous substances. Previous investigations have identified the presence of the chemicals of concern (COCs) benzene and chlorinated volatile organic compounds (CVOCs), including trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1-dichloroethene (1,1-DCE), and vinyl chloride (VC) in groundwater and C11-C22 petroleum aromatic hydrocarbon fraction class compounds in subsurface soil at concentrations that pose a potential threat to human health under future residential land use scenarios. The response action for Site 73 addresses CVOC and benzene contamination in shallow and intermediate groundwater and C11-C22 petroleum aromatic hydrocarbon fraction class compounds in subsurface soil.

The Selected Remedy for Site 73 is Air Sparging using a Horizontal Well, Downgradient Enhanced Reductive Dechlorination (ERD) Injections, Monitoring of the Natural Degradation of COCs, and Land Use Controls (LUCs). Long-term groundwater monitoring will be conducted and LUCs will be maintained on soil and groundwater until the concentrations of hazardous substances in the soil and groundwater have been reduced to levels that allow for unlimited use and unrestricted exposure.

### Statutory Determinations

The Selected Remedy meets the statutory requirements and is protective of human health and the environment, complies with Federal and State regulations that are applicable or relevant and appropriate to the remedial action, is cost-effective, utilizes permanent solutions to the maximum extent practicable, and satisfies the preference for treatment as a principle element of the remedy. Because this remedy will result in pollutants or contaminants remaining onsite in soil and groundwater above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after the initiation of the remedial action to ensure that the remedy is protective of human health and the environment.

## 1.2 Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record[1] file for MCB Camp Lejeune, Site 73.

- COCs and their respective concentrations (Section 2.3 and associated tables)
- Baseline risk represented by the COCs (Section 2.5)

[1] **Bold blue text identifies detailed site information available in the Administrative Record and listed in the References Table.**

- Cleanup levels established for COCs and the basis for these levels (Section 2.7)
- How source materials constituting principal threats will be addressed (Section 2.6)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD (Section 2.4)
- Potential land and ground-water use that will be available at the site as a result of the Selected Remedy (Section 2.9.4 and Table 6)
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.8)
- Key factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (Section 2.9.1)

If contamination posing an unacceptable risk to human health or the environment is discovered after execution of this ROD, the Navy will undertake all necessary actions to ensure continued protection of human health and the environment.

## 1.3 Authorizing Signatures

This ROD presents the Selected Remedy at Site 73, OU 21, Amphibious Vehicle Maintenance Facility, at the MCB Camp Lejeune, located in Onslow County, North Carolina.

15 Oct. 09
Date

R. P. Flatau, Jr.
Colonel, United States Marine Corps
Commanding Officer
Marine Corps Base, Camp Lejeune

12/1/09
Date

Franklin E. Hill, Director
Superfund Division
United States Environmental Protection Agency, Region 4

With concurrence from:

11-12-09
Date

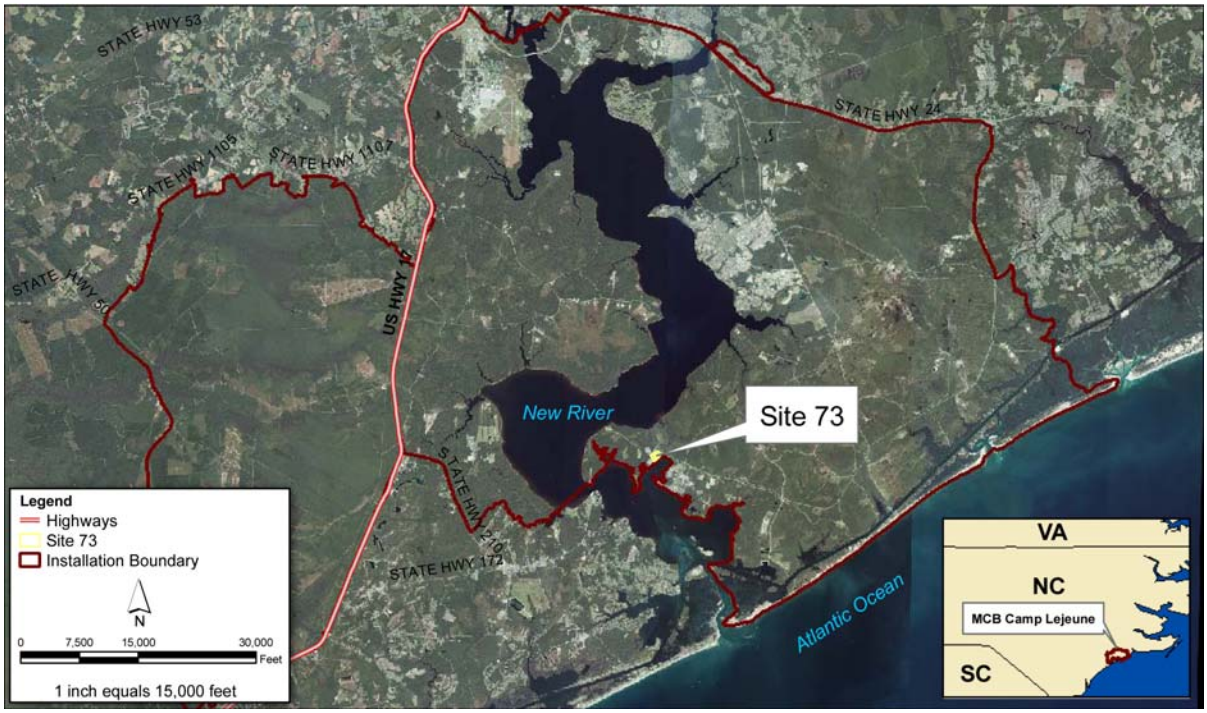
Dexter R. Matthews, Director
Division of Waste Management
North Carolina Department of Environment and Natural Resources

# 2 Decision Summary

## 2.1 Site Description and History

MCB Camp Lejeune is a 156,000-acre facility located in Onslow County, North Carolina, adjacent to the southern side of the City of Jacksonville (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.

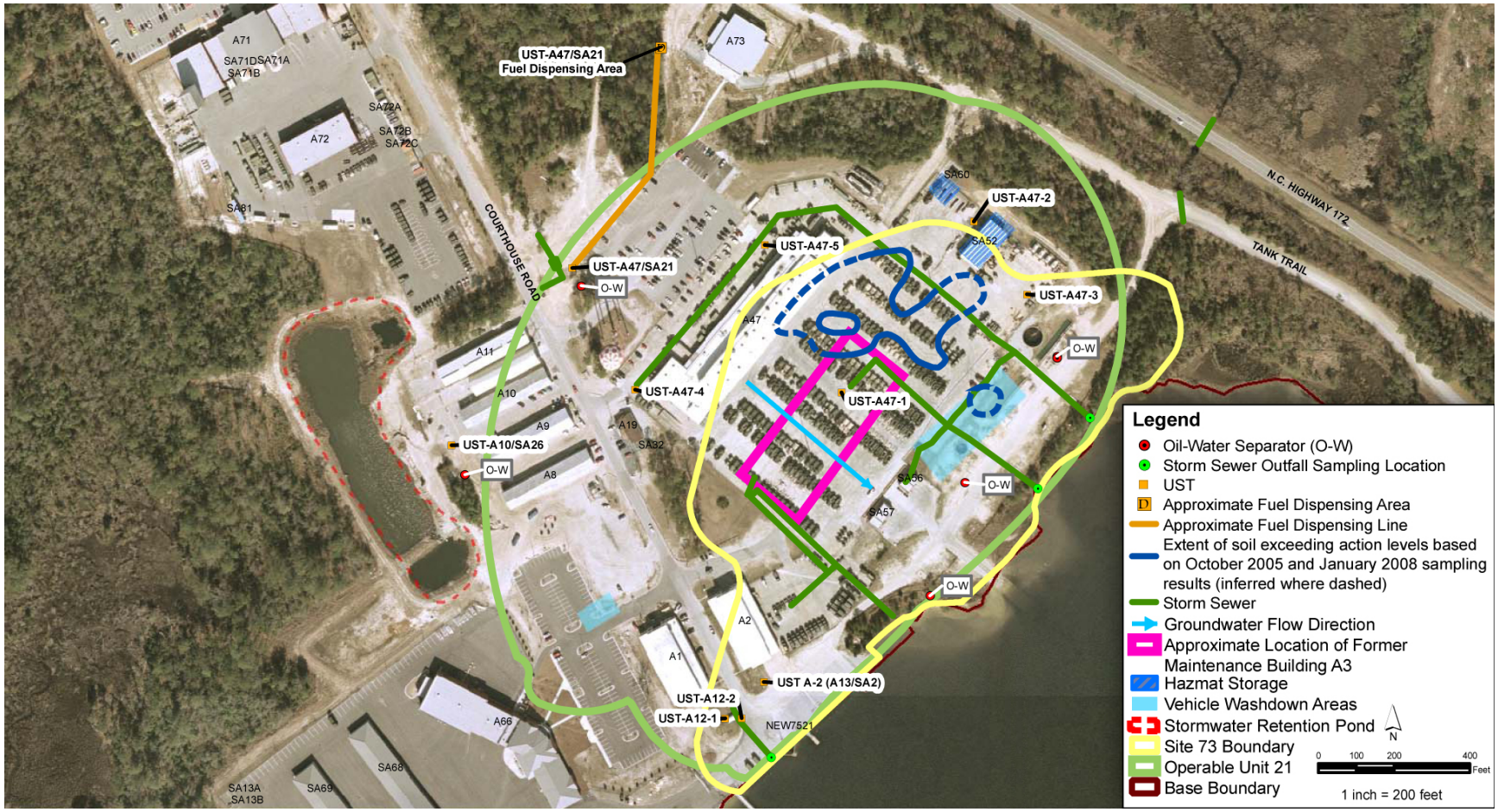
FIGURE 1
Base Map




Site 73 encompasses the Amphibious Vehicle Maintenance Facility in the Courthouse Bay Area of MCB Camp Lejeune, directly north of Courthouse Bay (Figure 2). OU 21 is approximately 31.6 acres and consists solely of Site 73. Site 73 is an active facility that contains the main maintenance facility (Building A47), numerous support buildings, aboveground storage tanks, vehicle wash racks, and oil-water separators.

The Amphibious Vehicle Maintenance Facility was constructed in 1946. Maintenance activities were historically conducted in the former maintenance building (Building A3), located southeast of the current Building A47. **Used motor oil and battery acid** resulting from maintenance activities were reportedly discharged directly to the ground surface northeast of Building A3. Between 1983 and 1989, Building A3 was demolished and Building A47 was constructed. Based on the nature of maintenance activities conducted and **CVOCs identified in groundwater**, it is likely that other hazardous substances including chlorinated solvents, were also disposed of in this area. Significant development of the Courthouse Bay area surrounding Site 73 has occurred in the last 10 to 15 years and the current land use is industrial.

FIGURE 2
Site Map



Ten underground storage tanks (USTs) containing various petroleum hydrocarbon products (diesel fuel, gasoline, and/or waste oil) were formerly located at Site 73 to support the Amphibious Vehicle Maintenance Facility operations (Figure 2). All USTs except A47-1 have been removed (approximate location of A47-1 is within the footprint of the former maintenance building). UST A47-1 is currently not in use and is believed to be closed in place. **NCDENR issued No Further Action** (NFA) for five of the USTs (A47-2, A47-4, A47-5, A-2, and A-10/SA26). Investigations are currently being completed under the UST Program for four of the USTs (A47-3, UST-A47/SA21, A12-1, and A12-2).

## 2.2 Site Characteristics

Site 73 has been defined historically as the area around the former maintenance building, Building A3, and the current Building A47 in the Courthouse Bay area. Site 73 is an industrial area, and most of the ground surface is covered with buildings and asphalt and/or concrete, with intermittent grass-covered areas. A stormwater retention pond and storage buildings are located to the west of Site 73.

The general topography of the Site 73 area is moderate, with a gentle slope towards Courthouse Bay. There are two small unnamed tributaries to the east and west, and retention ponds to the west, all ultimately discharging to Courthouse Bay. There is a broad marshy area associated with the western tributary. Directly north of the site is another large marsh and stream that discharges north into the New River. The marsh lying directly north is separated from the site by Sneads Ferry Road (State Route 172), which represents a local topographic high and surface water runoff divide.

The surficial and Castle Hayne aquifer **hydrogeologic units found at Site 73** have been further differentiated for the purposes of this ROD into aquifer zones designated as shallow (0 to 25 feet below ground surface [bgs] – surficial aquifer), intermediate (Castle Hayne, 45 to 90 feet bgs – upper Castle Hayne Aquifer), and deep (100 to 150 feet bgs – middle Castle Hayne Aquifer), based on lithology.

The shallow aquifer zone is characterized by undifferentiated silty sands with intermittent clay lenses ranging from 0.1 to 0.5 ft thick. The shallow and intermediate aquifer zones are divided by the Castle Hayne confining unit (Belgrade Formation) which consists predominately of sandy silts and clays. At best, the Belgrade Formation at Site 73 can be classified as a semi-confining unit or a "retarding layer" as it is laterally discontinuous and does not exhibit completely confining conditions. The inconsistent nature of the Belgrade Formation suggests that a hydraulic connection exists between the shallow and intermediate aquifer zones. The intermediate aquifer zone is primarily composed of cemented sands and shell fragments with interbedded silty sand layers while the deep aquifer zone is composed mainly of silty sands.

In general, groundwater flow direction within the shallow, intermediate, and deep aquifers at Site 73 is to the south-southeast towards Courthouse Bay. The shelly, cemented sands within the intermediate zone provide a less conductive zone for groundwater movement as compared to the undifferentiated silty sands of the shallow and deep aquifer zones. The **average hydraulic conductivity** (groundwater velocity) was estimated to range from 38 to 70 feet per year in the shallow aquifer zone and from 5 to 10 feet per year in the Castle Hayne (intermediate and deep zones) aquifer.

## 2.3 Previous Investigations

Site 73 was characterized under numerous investigations and studies between 1983 and the present. Based on the investigation findings, the **COCs at Site 73** are TCE, its daughter products (cis-1,2-DCE and VC), 1,1-DCE, and benzene in groundwater, and the C11–C22 petroleum aromatic hydrocarbon fraction class compounds in subsurface soil. Table 1 provides a chronological list and brief summary of previous investigations conducted at Site 73 and summarizes the sampling strategy employed during each previous investigation. The respective investigations are a part of the Administrative Record and can be referenced for further details for specific sampling strategies, media investigations, and when and where the sampling was performed.

TABLE 1
Previous Investigations Summary

| Previous Study / Investigation* | Date | Investigation Activities |
|---|---|---|
| Initial Assessment Study (Water and Air Research [WAR], 1983) | 1983 | A review of historical records, aerial photographs, and field inspections found that an estimated 400,000 gallons of waste oil was discharged directly onto the ground surface, primarily near Building A-47. Approximately 20,000 gallons of waste battery acid was also reportedly disposed in the area northeast of Building A-47. Therefore, Site 73 was recommended for additional study. |
| Confirmation Study (Environmental Science and Engineering, Inc. [ESE], 1985) | 1985 | Groundwater samples were collected in areas where washing had occurred, or locations of existing or suspected former USTs. Shallow groundwater was impacted by VOCs and metals. |
| Remedial Investigation (Baker, 1997) | 1997 | Surface soil, subsurface soil, groundwater, sediment, and surface water samples, and benthic and aquatic species were collected to evaluate the nature and extent of contamination and potential risks to human health and the environment. COCs identified were benzene, TCE, cis-1,2-DCE, 1,1-DCE, and VC in shallow and intermediate groundwater. No unacceptable, site related risks were found to be present in soil, sediment or surface water. |
| Supplemental Groundwater Investigation (Baker, 1998) | 1998 | Shallow and intermediate groundwater samples were collected for further delineation. The results indicated that natural attenuation was occurring; the shallow benzene plume was stable and decreasing in concentration; and the shallow CVOC area of concern had not changed in shape or size but was not fully delineated in both the shallow and intermediate aquifer zones. |
| FS (Baker, 1998) | 1998 | Remedial alternatives were developed for groundwater in both the shallow and intermediate aquifer zones to mitigate the potential for direct exposure and to treat impacted groundwater. |
| Groundwater Modeling Report (Baker, 1998) | 1998 | **Groundwater modeling** was conducted to predict the fate and transport of CVOCs. The results indicated that natural degradation was occurring in the deep aquifer zone and that intermediate and deep groundwater was discharging to Courthouse Bay and the New River. |
| Long Term Monitoring Optimization Report (CH2M HILL, 2005) | 2000-2005 | Long-term monitoring of CVOCs and benzene in shallow, intermediate, and deep groundwater was conducted to verify the plumes were stable and not expanding. As a result of Site 73 being part of an active CERCLA investigation, the 2005 Long Term Monitoring Optimization Report recommended that long-term monitoring be discontinued. . |
| Natural Attenuation Evaluation Study (CH2M HILL/Baker/CDM, 2002) | 2002 | A study was conducted to evaluate the **extent and rate of natural attenuation**. Benzene was the only fuel-related compound detected in the shallow and intermediate aquifer zones; it was degrading by natural, in-situ processes and was not discharging to Courthouse Bay. Reduced levels of TCE, cis-1,2-DCE, and VC and their patterns of occurrence in the shallow aquifer zone, were indicative of natural attenuation, but the potential for VC to discharge into Courthouse Bay was identified. TCE, cis-1,2-DCE, and VC were identified in the intermediate aquifer zone but were considered not likely discharging to Courthouse Bay. Additional delineation was recommended to verify the extent of impacts. |

TABLE 1
Previous Investigations Summary

| Previous Study / Investigation* | Date | Investigation Activities |
|---|---|---|
| Technology Evaluation (Baker, 2003) | 2003 | Potential **remedial options** were evaluated for treatment of intermediate groundwater with TCE concentrations above 1,000 micrograms per liter (µg/L) ("hot spot" area), near Building A47. Five treatment technologies (in-situ chemical oxidation using permanganate, abiotic reduction using colloidal iron injection, ERD promoted by hydrogen release compound (HRC™), bio-augmentation, sparging with hydrogen, cometabolic sparging with air and propane, or sparging with ozone using horizontal wells) were evaluated based on effectiveness, site constraints, depth of the contaminant mass, presence of underground utilities, land use, and cost. Hydrogen sparging delivered via a horizontal directionally drilled (HDD) well was recommended. |
| Pilot Study Report (MicroPact/Baker, 2006) | 2006 | A 900-foot-long **horizontal well** with 400 feet of screened area was installed to a depth of 85 feet below ground surface in the "hot spot" area. Approximately 40 **hydrogen injections** were completed in 2004 and 2005. The average TCE concentration decreased by approximately 35% and the average total VOC concentration decreased by approximately 8%. |
| Phase 2 Pilot Study Report (AGVIQ/CH2M HILL, 2008) | 2008 | A pilot study was conducted to evaluate **air and ozone sparging** for removal of CVOCs present in the "hot spot" area using the existing HDD well. Results indicated that TCE concentrations in the intermediate aquifer zone decreased by 75% with ERD and sparging being the primary treatment mechanisms. |
| Supplemental RI (SRI) (CH2M HILL, 2009) | 2009 | An SRI was completed to summarize the nature and extent of impacts and potential risks to human health and the environment. Primary COCs identified were VOCs (TCE, cis-1,2-DCE, 1,1-DCE, VC, and benzene). The greatest VOC concentrations are located beneath the paved area associated with Building A47. COCs detected in the surficial aquifer (TCE, VC, and benzene) appear to originate in the vicinity of UST A47-3. The **greatest concentrations of COCs** detected within the Castle Hayne aquifer were detected between Building A47 and the approximate footprint of the former maintenance building.<br><br>Soil samples were collected in 2006 and 2008 to delineate the extent of petroleum-related impacts. No significant source of free-phase petroleum was identified; however, an area of **petroleum hydrocarbon-impacted soil** was delineated in the area corresponding with historic waste oil discharge. The source of contamination is likely from multiple surficial spills associated with maintenance activities that occurred before the concrete-paved parking area was constructed. |
| Feasibility Study (CH2M HILL, 2009) | 2009 | Potential remedial alternatives were identified to address CVOCs in groundwater and petroleum hydrocarbon impacted soil. Four remedial alternatives were selected for detailed comparative analysis: (1) no action, (2) monitored natural attenuation (MNA), (3) ERD using existing horizontal well and downgradient ERD injections, and (4) air sparging with downgradient ERD injections. |

**Notes:**
*The documents listed are available in the Administrative Record and provide detailed information used to support remedy selection at Site 73.

The Site 73 conceptual site model (CSM) (Figure 3) depicts the site characteristics, nature and extent of contamination, and transport pathways at Site 73. Groundwater impacts appear to be limited to the shallow and intermediate aquifer zones in the vicinity of the concrete parking area, south of Building A47 (Figures 4 and 5). The overall magnitude of impacts has decreased significantly since the air sparging pilot test through the horizontal well in 2006. The operation of the air sparge system decreased the extent and magnitude of TCE impacts in the intermediate aquifer zone while concentrations of cis-1,2-DCE and VC have increased, indicating that anaerobic degradation by reductive dechlorination is occurring.

FIGURE 3
Conceptual Site Model

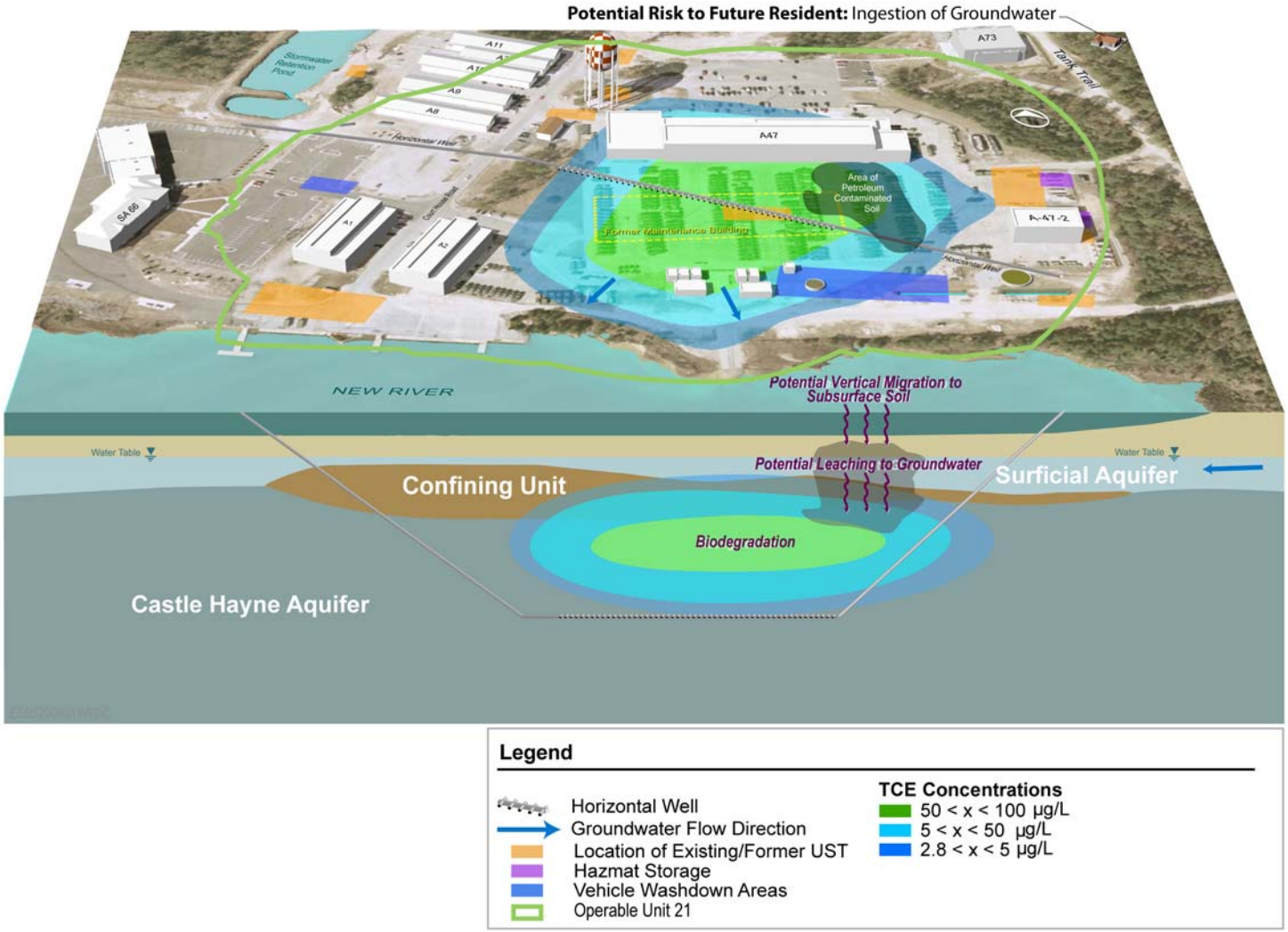
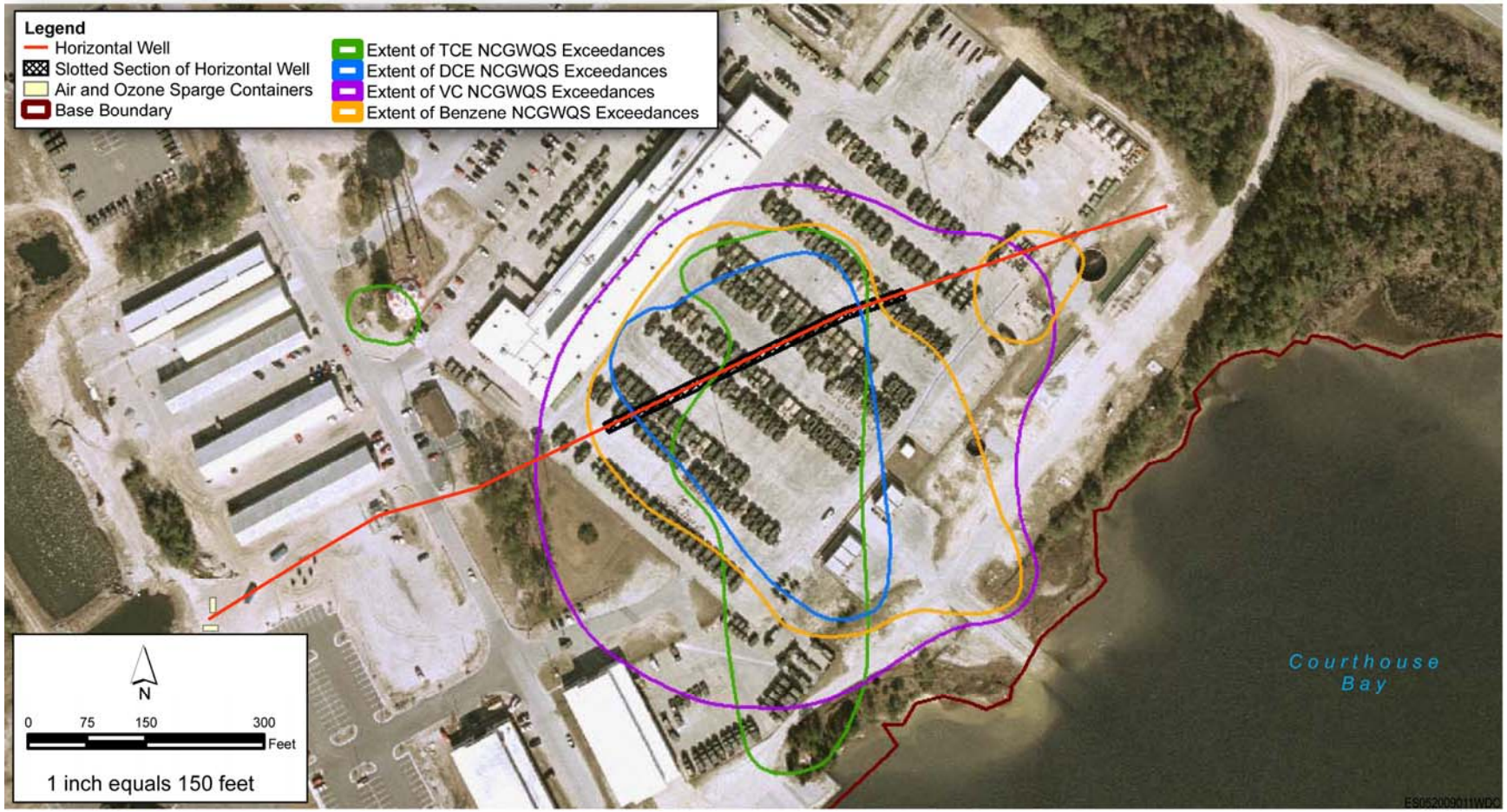


FIGURE 4
Shallow Groundwater Impacts

FIGURE 5
Intermediate Groundwater Impacts



The current nature and extent of groundwater contamination at Site 73 was estimated using analytical data from the **July 2008 groundwater sampling event**. The following compounds were detected in one or more wells above NCGWQS or USEPA Maximum Contaminant Levels (MCLs): benzene, TCE, cis-1,2-DCE, 1,1-DCE, and VC. COCs are most prevalent in the intermediate aquifer zone with sporadic exceedances of benzene, 1,1-DCE and VC in the shallow zone and exceedances of benzene and VC in one well as deep as 110 ft. The horizontal extents of contamination in the shallow and intermediate aquifer zones are shown on Figure 4 and 5, respectively. Based on groundwater flow and the location of the contaminant plume, there is a potential for contaminants to discharge into Courthouse Bay, currently or in the future, at concentrations exceeding the North Carolina Surface Water Quality Standards (NCSWQS). However, TCE, cis-1,2-DCE, 1,1-DCE, and VC have not been detected in Courthouse Bay.

Exceedances of benzene and VC in the groundwater from one deep zone monitoring well suggest a downward migration component of contaminant flow. Based on the absence of impacts in remaining deep monitoring wells, deep impacts appear to be limited in extent.

Free product has been observed historically in one shallow monitoring well (IR73-MW14) within the footprint of the former maintenance building and near the approximate location of UST A47-1, however free product was not observed during the most recent sampling in event in July 2008. Analytical results of the groundwater sample collected from monitoring well IR73-MW14 in July 2008 did not indicate any COCs were present above the NCGWQS or MCLs.

Although no sources of the free product were identified in the vicinity of monitoring well IR73-MW14, an area of petroleum hydrocarbon-impacted soils was identified beneath the concrete parking area adjacent to Building A47 and directly north of the former maintenance building (Figure 3). The investigation concluded that impacts are likely the result of multiple surficial spills, rather than a single event, that occurred before the concrete-paved parking area was constructed. Risk-based analysis of soil samples identified only the petroleum aromatic hydrocarbon fraction class C11-C22 at concentrations exceeding the North Carolina Hazardous Waste Section Soil Screening Levels (NC HWS SSLs).

Surface water and sediment sampling in Courthouse Bay and its surrounding tributaries were thoroughly investigated during the 1997 RI. Based on the results of the RI, it was concluded that CVOCs were not present in surface water or sediment samples. The RI also concluded that low level pesticides and polynuclear aromatic hydrocarbons (PAHs) detected in sediment samples and low level metals detected in surface water and sediment were not site related and did not pose an unacceptable risk to human or ecological receptors.

The primary fate and contaminant migration pathway for COCs in groundwater at Site 73 is through groundwater flow in the shallow and intermediate aquifer zones. The mechanisms of transport include dissolution, advection, and dispersion. Currently, the COCs in groundwater at Site 73 are undergoing chemical and biological changes over time. Although no site-related COCs have been identified in Courthouse Bay, groundwater in the shallow and intermediate aquifer zones is likely discharging into Courthouse Bay.

The primary contamination migration pathways for petroleum hydrocarbon constituents in impacted soils is through the potential vertical migration through subsurface soil followed

by the potential leaching of the COCs to groundwater. However, petroleum hydrocarbon-impacted soils are effectively capped by approximately 18 inches of concrete paving present in the parking area, significantly reducing the potential for leaching of petroleum hydrocarbon constituents into groundwater. Groundwater sampling conducted in July 2008 indicated that petroleum hydrocarbon constituents were not present in groundwater at levels exceeding the NCGWQS or MCLs in the affected soil area. Thus, it is unlikely that a pathway exists for petroleum hydrocarbon-impacted soils to affect groundwater.

## 2.4 Current and Potential Future Land and Water Uses

Site 73 is located within the Amphibious Vehicle Maintenance Facility, which is currently an active industrial facility. There are no current plans for the activities or distinguishing features at Site 73 to change in the future.

Groundwater is not currently used as a potable water supply at Site 73. Three active water supply wells are within a 1-mile radius of Site 73, and two active wells are just beyond the 1-mile radius. All water supply wells are located across Courthouse Bay which acts as a natural barrier. The water supply wells are not impacted by Site 73 and groundwater modeling indicates that impacted groundwater at Site 73 will not impact the water supply wells in the future.

## 2.5 Summary of Site Risks

Potential human health and ecological risks at Site 73 were evaluated and documented in the RI, and Supplemental RI. The RI, Supplemental RI, following subsections, and Table 2 briefly summarize the findings of these risk assessments.

TABLE 2
Summary of Human Health and Ecological Risks by Media

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

### 2.5.1 Human Health Risk Summary

A HHRA was conducted to evaluate the potential human health risks associated with current and hypothetical future receptors. The **current and future receptors** evaluated were current military personnel, current trespassers, current adult fisherman, current child receptors, future residents, and future construction workers. The **exposure scenarios** evaluated were exposure to surface soil, surface water, and sediment for current receptors; ingestion of fish and crab tissue for adult fisherman and child receptors; and surface soil, shallow and intermediate groundwater, surface water, and sediment exposure for future

receptors. The potential for vapor intrusion issues was also evaluated to assess if any Site 73 buildings were located within 100 feet of groundwater impacts exceeding site-specific vapor intrusion screening levels. These evaluations were used to assess if any further actions were needed at Site 73 to sufficiently protect human health. Table 3 summarizes the potential human health risks.

TABLE 3
Summary of Potential Human Health Risks

| Receptor | Media† | Pathway | Chemical of Concern | Exposure Point Concentration | RME Cancer Risk | RME Non-Cancer Risk (HI) | CT Cancer Risk | CT Non-Cancer Risk (HI) | Cancer Toxicity Factor (CSF) mg/kg-day$^{-1}$ | Non-Cancer Toxicity Factor (RfD) mg/kg-day$^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Future Adult Resident | Subsurface Soil | Inhalation | C11-C22 Aromatic Hydrocarbon Fraction | 3,062 mg/kg | NA | 2.92 | NA | 0.711 | Not carcinogenic | 3 x 10$^{-2}$ |
| | Groundwater | Ingestion | VC | 6.52 µg/L | 1.5E-04 | 0.0 | 2.0E-05 | 0.0 | 1.9 | 0.0 |
| Future Child Resident | Subsurface Soil | Incidental Ingestion | C11-C22 Aromatic Hydrocarbon Fraction | 3,062 mg/kg | NA | 1.30 | NA | 0.159 | Not carcinogenic | 3 x 10$^{-2}$ |
| | | Inhalation | | | NA | 2.92 | NA | 0.711 | | |

Notes:
Potential unacceptable risks are shaded yellow
† - Subsurface soil risks in table are based on MADEP results; and
- Groundwater risks based on the Phase II Investigation
µg/L = micrograms per liter
mg/kg = milligrams per kilogram
Toxicity Factors in this table are from the 1997 RI HHRA and 2009 FS HHRA Addendum
RfD = Reference Dose (non cancer toxicity factor); CSF = Cancer Slope Factor (cancer toxicity factor); NA = Not Applicable;
HI = hazard index

Potential cancer and non-cancer risks were calculated based on reasonable maximum exposure (RME) and central tendency (CT) exposure point concentrations. The RME assumes the highest level (maximum concentration) of human exposure that could reasonably be expected to occur, whereas the CT reflects a more realistic human exposure to levels (average concentrations) across the site. **Potential unacceptable risks** are based on a conservative estimate of the potential **cancer risk** or the potential to cause other health effects not related to cancer (noncancer hazard, or **hazard index** [HI]). For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between $10^{-4}$ (a 1 in 10,000 chance of developing cancer) and $10^{-6}$ (a 1 in 1,000,000 chance of developing cancer) using information on the relationship between dose and response. The $10^{-6}$ risk level is used as the point of departure for determining performance standards for alternatives when Applicable or Relevant and Appropriate Requirements (ARARs) are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure. A non-cancer hazard of 1.0 is used as an upper limit to which calculated hazard index (HI) values are compared. Any HI exceeding 1.0 indicates an existing non-cancer hazard.

The conclusions of the HHRA were that current site use and site-related impacts do not pose an unacceptable risk to human health. The only potential unacceptable risk to human health is to future residential receptors from ingestion of CVOCs in shallow and intermediate groundwater and inhalation/incidental ingestion of petroleum aromatic hydrocarbons - fraction class C11-C22 in subsurface soils (Table 3).

The CSM (Figure 3) depicts the potential risk identified at Site 73, including the exposure media, exposure routes, and potential human health receptors. Although concentrations of benzene, TCE, and TCE degradation products 1,1-DCE and cis-1,2-DCE in groundwater did not pose unacceptable risk individually, the concentrations contribute to cumulative unacceptable risk and they were detected at concentrations above drinking water standards (i.e., MCLs or NCGWQS) and therefore are retained as COCs.

### 2.5.2 Ecological Risk Summary

An ERA was completed as part of the original 1997 RI and an **ERA Addendum** was completed as part of the 2009 SRI to evaluate whether past site operations have adversely affected terrestrial and aquatic communities on or adjacent to Site 73. Soil, surface water, and sediment samples collected during RI activities 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 73.

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. The ERA Supplemental Information in the 2009 SRI provides the CSM and associated tables prepared during the ERA evaluation. A detailed discussion of the ERA evaluation and results is presented in the 1997 RI and 2009 SRI.

Overall, the ERA and ERA Addendum concluded that **no site-related risks to terrestrial and aquatic receptors** were present at Site 73. Although minimal potential risks associated with **pesticides and metals** were identified; they were determined not to be site-related as they were not attributed to historical site activities.

### 2.5.3 Basis for Response Action

It is the current judgment of the Navy, MCB Camp Lejeune, and USEPA, in concurrence with NCDENR, that the Selected Remedy identified in this ROD, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Based on the HHRA, exposure to groundwater at Site 73 poses an unacceptable risk to human health due to the presence of VC. In addition, under **North Carolina's groundwater classification**, the surficial and Castle Hayne aquifers are considered Class GA, a potential source of drinking water. NCDENR identified NCGWQS as 'relevant and appropriate' Chemical-specific requirements for groundwater remediation of this aquifer. Remedial action at this site has been determined to be necessary due to unacceptable risk from potential human consumption of the contaminated groundwater and exceedance of the NCGWQS or MCLs (measures that define acceptable levels for drinking water). As a result,

TCE, cis-1,2-DCE, 1,1-DCE, and benzene, identified in groundwater at Site 73 above the NCGWQS (Table 4) are also considered COCs. Cis-1,2-DCE and 1,1-DCE are degradation products of TCE and thus have the potential of creating future human health risk with an increase in contaminant concentrations.

The HHRA also indentified an unacceptable risk for potential future residential exposure to soils containing C11-C22 aromatic fraction hydrocarbons. In addition, the to-be-considered (TBC) criteria (NC HWS SSLs) have been determined to be pertinent to the remedy for soil because these criteria reflect the constituent concentration in soil that would result in a constituent concentration in groundwater below NCGWQS.

The concentrations of COCs requiring a response action are summarized in Table 4 and the extent of groundwater impacts is shown on Figures 4 and 5. The extent of petroleum-impacted soil is shown on Figure 2.

TABLE 4
COCs Requiring a Response Action

| Groundwater Chemicals of Concern | Detection Frequency | Max Value (µ/L) | | NCGWQS* (µg/L) |
|---|---|---|---|---|
| **Shallow Aquifer Zone** | | | | |
| Benzene | 17 / 29 | 3.8 | D | 1 |
| TCE | 8 / 29 | 2.6 | | 2.8 |
| cis-1,2-DCE | 18 / 29 | 85 | D | 70 |
| 1,1-DCE | 3 / 29 | 0.38 | J | 7 |
| VC | 2 / 29 | 2.1 | | 0.015 |
| **Intermediate Aquifer Zone** | | | | |
| Benzene | 14 / 21 | 11 | | 1 |
| TCE | 11 / 21 | 340 | D | 2.8 |
| cis-1,2-DCE | 13 / 21 | 1,300 | D | 70 |
| 1,1-DCE | 9 / 21 | 11 | | 7 |
| VC | 11 / 21 | 430 | D | 0.015 |
| **Deep Aquifer Zone** | | | | |
| Benzene | 1 / 7 | 2 | | 1 |
| TCE | 0 / 7 | ND | | 2.8 |
| cis-1,2-DCE | 1 / 7 | 2.4 | | 70 |
| 1,1-DCE | 0 / 7 | ND | | 7 |
| VC | 1 / 7 | 10 | | 0.015 |
| **Subsurface Soil Chemicals of Concern** | **Detection Frequency** | **Max Value (mg/kg)** | | **NC HWS SSL** (mg/kg)** |
| Petroleum Aromatic Carbon Fraction Class C9-C22 | 6 / 11 | 10,220 | D | 33.6 |

Notes:
*NCGWQS - North Carolina Ground Water Quality Standards
- NCGWQS are more stringent than MCLs for some COCs
**NC HWS SSLs - North Carolina Hazardous Waste Section Soil Screening Levels
- No separate NC HWS SSL for Petroleum Aromatic Carbon Fraction Class C11-C22
Result details can be found in the 2009 Feasibility Study (CH2M HILL, 2009)
µg/L = micrograms per liter
mg/kg = milligrams per kilogram
D = Sample dilution was required for analysis
ND = Not Detected

## 2.6 Principal Threat Wastes

Principal threat wastes are those 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 exposure occur.

Contaminated groundwater generally is not considered to be a source material; however, non-aqueous phase liquids (NAPLs) in groundwater may be viewed as source material. LNAPL was not observed at Site 73 during the July 2008 groundwater sampling event. In addition, benzene has only been detected at low concentrations with minimal risk to future receptors.

Dissolved concentrations of CVOCs in groundwater at approximately 1 to 5 percent of a compound's solubility would suggest the presence of dense non-aqueous phase liquid (DNAPL) in the subsurface. The maximum concentrations of TCE and cis-1,2-DCE observed in the July 2008 sampling event at Site 73 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 73.

Because no significant source materials are present and there are no realistic exposures scenarios to COC-impacted soil and groundwater, it can be concluded that there is no principal threat waste at Site 73.

## 2.7 Remedial Action Objectives

The Remedial Action Objectives (RAOs) for Site 73 are based upon the potential of future residential receptors using groundwater as a potable water supply and having direct contact with subsurface soil. The RAOs for Site 73 are as follows:

- Restore groundwater quality at Site 73 to the NCGWQS and maximum contaminant level (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, 1,1-DCE, and VC) at concentrations above NCGWQS or MCL standards, whichever is more stringent, until the remediation goals have been obtained.
- Prevent future residential exposure to petroleum hydrocarbon-contaminated soils above the NC HWS SSL and minimize transport to groundwater.
- Minimize migration of COCs in groundwater to surface water.

Remediation goals to meet the RAOs are identified in Table 5.

## 2.8 Description and Comparative Analysis of Remedial Alternatives

### 2.8.1 Description of Remedial Alternatives

Remedial alternatives to address groundwater and soil impacts at Site 73 were developed and are detailed in the 2009 FS. Based on initial **screening of technologies**, four remedial alternatives were retained for detailed comparative analysis. A description is provided in Table 6.

TABLE 5
Remediation Goals for Groundwater and Soil

| Groundwater Chemical of Concern | NCGWQS (µg/L) |
|---|---|
| Benzene | 1 |
| TCE | 2.8 |
| cis-1,2-DCE | 70 |
| 1,1-DCE | 7 |
| VC | 0.015 |
| **Soil Chemical of Concern** | **NC HWS SSL (mg/kg)** |
| Petroleum Aromatic Carbon Fraction Class C9-C22 | 33.6 |

Notes:
µg/L = micrograms per liter
mg/kg = milligrams per kilogram
NCGWQS - North Carolina Ground Water Quality Standards
are more stringent than MCLs for some COCs
NC HWS SSL - North Carolina Hazardous Waste Section Soil Screening Level

TABLE 6
Description of Remedial Alternatives

| Alternative | Components | Details | Cost | |
|---|---|---|---|---|
| 1—No Action | None | Allow the COCs to breakdown naturally over time | Capital Cost | $0 |
| | | | Annual operation and maintenance (O&M) | $0 |
| | | | Total Present-Worth | $0 |
| | | | Timeframe | 30 years |
| 2 –MNA / LUCs | MNA | Groundwater monitoring and reporting to assess the progress of natural attenuation over time | Capital Cost | $13,500 |
| | | | Annual O&M | $48,249 |
| | LUCs | LUCs to prevent exposure to groundwater and petroleum hydrocarbon-impacted soil | Total Present-Worth | $763,736 |
| | | | Timeframe | 30 years |
| 3 –ERD using existing Horizontal Well and Downgradient ERD Injections / Monitoring / LUCs | Enhanced Anaerobic Bioremediation through Horizontal Well | Injection of electron donors through existing horizontal well to stimulate anaerobic biodegradation of CVOC source by reductive dechlorination | Capital Cost | $854,751 |
| | | | Annual O&M | $48,295 |
| | | | Total Present-Worth | $1,946,816 |
| | Enhanced Anaerobic Bioremediation via Downgradient Injections | Injection of electron donors in wells downgradient from horizontal well, upgradient of Courthouse Bay, to stimulate anaerobic biodegradation of CVOCs by reductive dechlorination and minimize migration of CVOCs to Courthouse Bay | Timeframe | 20 years |
| | LUCs | LUCs to prevent exposure to groundwater and petroleum hydrocarbon-impacted soil | | |
| | Groundwater Monitoring | Long-term groundwater monitoring and reporting to evaluate:<br>-Effectiveness of the ERD injections<br>-Potential impacts to surface water<br>-Progress of natural attenuation over time<br>-Potential migration to the deep aquifer | | |

TABLE 6
Description of Remedial Alternatives

| Alternative | Components | Details | Cost | |
|---|---|---|---|---|
| 4 – Air Sparging with Downgradient ERD Injections / Monitoring / LUCs | Air Sparging | Injection of air into saturated matrices through existing horizontal well to remove CVOC source through volatilization and/or bioremediation | Capital Cost | $585,988 |
| | | | Annual O&M | $51,140 |
| | | | Total Present-Worth | $1,778,608 |
| | Enhanced Anaerobic Bioremediation via Downgradient Injections | Injection of electron donors in wells downgradient from horizontal well, upgradient of Courthouse Bay, to stimulate anaerobic biodegradation of CVOCs by reductive dechlorination and minimize migration of CVOCs to Courthouse Bay | Timeframe | 20 years |
| | LUCs | LUCs to prevent exposure to groundwater and petroleum hydrocarbon-impacted soil | | |
| | Groundwater Monitoring | Long-term groundwater monitoring and reporting to evaluate:<br>-Effectiveness of the ERD injections<br>-Potential impacts to surface water<br>-Progress of natural attenuation over time<br>-Potential migration to the deep aquifer | | |

The No Action alternative does not protect human health and the environment, but is presented as a baseline for comparison purposes. With the exception of the No Action alternative, the common elements of the remedial alternatives are groundwater monitoring and reporting until all COCs have achieved their goals for four consecutive sampling events and LUCs until COC concentrations in groundwater and subsurface soil are reduced to levels that allow unlimited use and unrestricted exposure.

The most distinguishing feature of the alternatives is the expected timeframe to achieve RAOs within the treatment area. Alternatives 3 (ERD) and 4 (Air Sparge with ERD) have the shortest timeframe within the treatment area, although all alternatives are expected to require at least 20 years to meet RAOs due to the natural attenuation process at Site 73.

### 2.8.2 Comparative Analysis of Alternatives

A comparative analysis of alternatives with respect to the **nine evaluation criteria** was completed and is provided below. Table 7 depicts a relative ranking of the alternatives. Alternative 1 (No Action) does not achieve RAOs and is not considered further in this ROD.

#### Threshold Criteria

***Overall Protection of Human Health and the Environment.*** Alternatives 2, 3, and 4 are all protective of human health and the environment. Alternative 2 is considered to be less protective than Alternatives 3 and 4 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. There would also be a potential for discharging of COCs to Courthouse Bay above surface water standards. Alternatives 3 and 4 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 environment by controlling exposure to groundwater and petroleum hydrocarbon-impacted soil until the RAOs are achieved.

TABLE 7
Relative Ranking of Alternatives

| CERCLA Criteria | Alternatives | | | |
|---|---|---|---|---|
| | No Action (1) | MNA (2) | ERD (3) | Air Sparging and ERD (4) |
| **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 | ❍ | ● | ● | ● |
| Short-Term Effectiveness | ❍ | ● | ● | ● |
| Implementability | ● | ● | ● | ● |
| Present-Worth Cost | $0 | $0.76 M | $1.95 M | $1.78 M |
| **Modifying Criteria** | | | | |
| State Acceptance | ❍ | ❍ | ● | ● |
| Community Acceptance | NC | NC | NC | NC |

Relative Ranking: ● High ● Moderate ❍ Low
Rankings are provided as qualitative descriptions of the relative compliance of each alternative with the criteria
NC = No significant comments were received from Community Members

***Compliance with ARARs.*** The ARARs include any Federal or State standards, requirement, criteria, or limitations that are determined to be legally applicable or relevant and appropriate to a CERCLA site or action. TBC criteria are non-promulgated advisories or guidance issued by Federal or State government and do not have the status of potential ARARs but are evaluated along with ARARs. The ARARs for Site 73 are provided in Appendix B as Tables B-1, B-2 and B-3. The timeframe for compliance with Chemical-specific ARARs will vary with different remedial alternatives. Location-specific ARARS remain the same for each alternative and Action-specific ARARs may vary to some extent with the different remedial alternatives. Alternatives 2, 3, and 4 are expected to comply with **ARARs and TBC criteria**. Alternative 2 will have a longer timeframe associated with meeting the ARARs because it relies on natural degradation, whereas Alternatives 3 and 4, which are similar, employ active treatment and will therefore meet the ARARs in a shorter timeframe.

## Primary Balancing Criteria

***Long-term Effectiveness and Permanence.*** Once RAOs have been achieved, Alternatives 2, 3, and 4 are expected to have residual risks of approximately the same magnitude. Alternative 2 may not be effective for more than 30 years. Alternatives 3 and 4 are expected to be effective in the long term (estimated 20 years), although "rebound" is a potential issue

with any injection or air sparging scenario, although the system can be turned on again to address this issue. Reviews at least every 5 years, as required, would be necessary to evaluate the effectiveness of any of these alternatives because hazardous substances would remain on-site in concentrations above health-based levels.

***Reduction of Toxicity, Mobility, or Volume through Treatment.*** Alternatives 3 and 4 will reduce the toxicity, mobility, and volume through treatment for groundwater, which is the statutory preference. Although the groundwater monitoring for natural attenuation component of Alternative 2 and the LUCs for soil under Alternatives 2, 3, and 4 are not considered active treatment, the natural reduction of contaminant concentrations through a variety of physical, chemical, or biological activities is expected over time.

***Short-term Effectiveness.*** The short-term effectiveness associated with Alternatives 3 and 4 are similar with regard to how they would affect the community because both treatments rely on direct injection technology for implementation; however, Alternative 2 has a lesser impact on the community because it does not rely on an active treatment. Alternative 4 presents a slightly higher risk to construction workers during implementation than Alternative 3, based on the potential for vapor intrusion during the operation of the air sparge system. However, air monitoring during previous operation of the air sparge system indicated there were no risks. None of the alternatives would affect the community for the petroleum-impacted soils as they are effectively capped with concrete.

***Implementability.*** Alternatives 2, 3, and 4 can be implemented using standard and widely available technologies. However, the chemical injections for Alternatives 3 and 4 rely heavily on the ability to effectively distribute material in the subsurface. The air sparging component of Alternative 4 has been successfully implemented in the past and would be easier to implement than Alternative 3 because it may be challenging to distribute ERD substrate from the horizontal well. The groundwater monitoring and LUCs components of each alternative can easily be implemented using standard procedures.

***Cost.*** Table 6 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, and 4) are greater than alternatives for no action or MNA, (Alternatives 1 and 2, respectively). The highest capital cost is $855,000 for Alternative 3, followed by $586,000 for Alternative 4. 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.

### Modifying Criteria

***State Acceptance.*** State involvement has been solicited throughout the CERCLA process. NCDENR, as the designated State support agency in North Carolina, concurs with the Selected Remedy.

***Community Acceptance.*** The public meeting was held on April 21, 2009 to present the Proposed Remedial Action Plan (PRAP) and answer community questions regarding the proposed remedial action at Site 73. The questions and concerns raised at the meeting were general inquiries for informational purposes only. No comments requiring amendment to the PRAP were received from the public during the meeting and public comment period.

## 2.9 Selected Remedy

Alternative 4, Air Sparging using a Horizontal Well, Downgradient ERD Injections, Monitoring of the Natural Degradation of COCs, and LUCs is the Selected Remedy to address groundwater and soil impacts at Site 73.

### 2.9.1 Rationale for the Selected Remedy

Alternatives 3 and 4 were preferred over Alternatives 1 and 2 based on the relatively short time needed to reduce the highest COC concentrations and reduced time required for natural degradation to achieve site clean up goals. Alternative 4 was chosen over Alternative 3 based on the ease of implementation and lower associated cost. The horizontal well is currently operational for air sparging and it may be challenging to retrofit the system to distribute ERD substrate from the well effectively. In addition, Alternative 3 has the added ERD substrate cost for injection into the horizontal well, so overall; the cost of implementing Alternative 3 would be higher.

Finally, the Selected Remedy meets the statutory preference for active treatment with lower or similar costs to comparable alternatives.

### 2.9.2 Description of the Selected Remedy

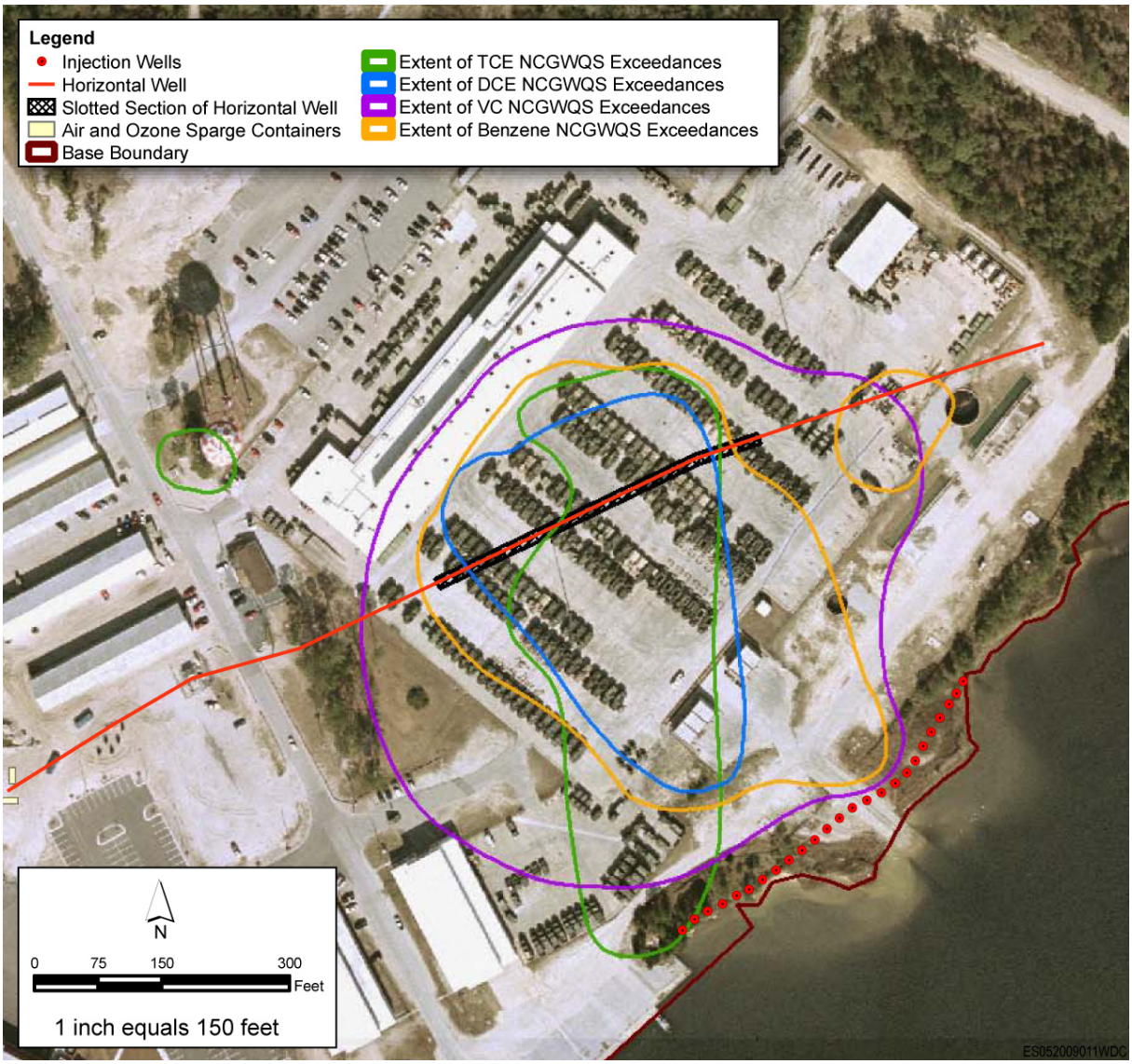
The Selected Remedy includes injection of air in an area with the highest CVOC concentrations, downgradient ERD injections along Courthouse Bay, long-term monitoring (LTM) for MNA in areas outside of the active treatment area to ensure that natural degradation is occurring, and LUCs to prevent the exposure to contaminated soil and prevent the use of the contaminated groundwater until the concentrations of hazardous substances are at such levels as to allow for unrestricted use and unlimited exposure. The active treatment area, proposed monitoring wells, and proposed location of the air sparge well is shown on Figure 6.

The existing air sparge treatment is a horizontal well installed with a screened interval of 400 feet at a depth of 75 feet bgs and 250 feet of riser at the proximal and distal ends. Using a compressor, air is injected through the horizontal well promoting mass transfer of CVOCs and/or biological degradation. Based on previous pilot studies, the radius of influence for the horizontal air sparge system is approximately 50 to 100 feet. Any oxygen would quickly be consumed within the zone of influence of the HDD well. The system will be operated for up to 5 years or until the remedial goals were met within the radius of influence, whichever is the shortest period.

Downgradient ERD injections would then allow for the continued biodegradation of COCs downgradient of the plume and will act as a biobarrier to reduce the potential for migration of impacted-groundwater into Courthouse Bay at concentrations that exceed the NCSWQS. ERD injections promote the natural anaerobic biodegradation of CVOCs (reductive dechlorination) through the addition of carbon sources, or electron donors. An insufficient or inappropriate indigenous microbial population can also prevent the complete biodegradation of CVOCs. Since the results of a microbial population study at Site 73 were below detection limits, bioaugmentation will also be conducted. The injection of bioenhancing substrate (ERD) and bioaugmentation culture will be based on the results of bench-scale studies and pilot studies conducted during the remedial design. These studies

will provide the well locations, numbers, depths, spacing, injection substrates and injection frequency. Subsequent ERD injections will be determined based on site conditions. Based on the potential future risk identified for consumption of VC-impacted groundwater and based on the fact that VC is more recalcitrant than TCE and cis-1,2-DCE, contaminant velocities for VC were used to estimate the amount of time required to maintain the biobarrier wall. The VC contaminant velocity calculated in the Natural Attenuation Evaluation Study (NAES) of 23 feet per year (ft/yr) was used to estimate the biobarrier will need to be maintained for approximately 15 to 20 years to treat impacted groundwater not influenced by the air sparging.

FIGURE 6
Proposed Injection Well Locations



Groundwater monitoring will be conducted on a quarterly basis during the operation of the air sparge system and then on an annual basis thereafter. Samples collected from the monitoring wells will be analyzed for COCs and analytical results will be used to monitor the effectiveness of the air sparge system, monitor downward migration of contaminants into the deep aquifer zone, monitor MNA, and monitor COC discharge to Courthouse Bay. Although MNA was evaluated further in the FS, it is not considered a stand-alone remedial alternative because it does not prevent human exposure to COCs in groundwater. Because of the low concentrations of COCs in areas outside of the active treatment zone and evidence that **natural biodegradation is occurring** at Site 73, MNA is an effective remedy component in conjunction with air sparging and LUCs.

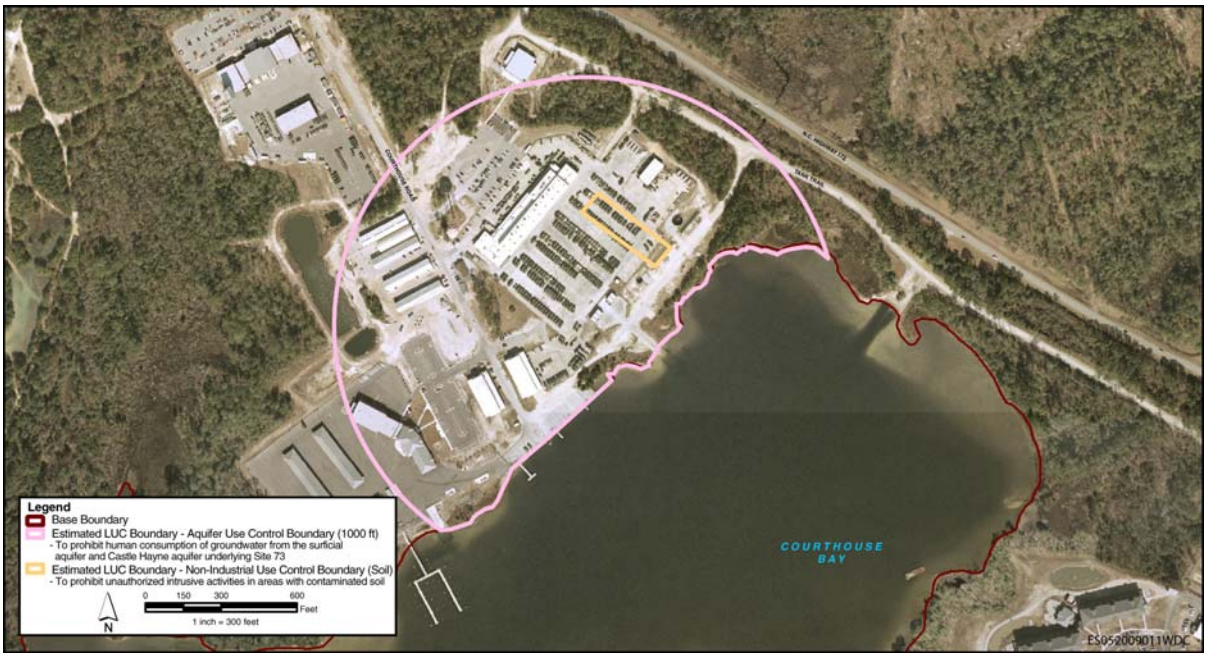
LUCs including, but not limited to, land use restrictions in the Base Master Plan, Notice of Contaminated Site, and administrative procedures to prohibit unauthorized intrusive activities (e.g., excavation, well installation, construction) will be implemented as a part of the Selected Remedy to prevent exposure to the residual contamination on the site that exceeds the remediation goals. The Navy and MCB Camp Lejeune are responsible for implementing, maintaining, reporting on, and enforcing the LUCs. Although, the Navy and MCB Camp Lejeune may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Navy and MCB Camp Lejeune shall retain ultimate responsibility for the remedy integrity. 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 (Figure 7). The LUC performance objectives include:

- To prohibit human consumption of groundwater from the surficial aquifer and Castle Hayne aquifer underlying Site 73;
- To prohibit residential/recreational uses and development at the site including, but not limited to, any form of housing, any kind of school, child-care facilities, playgrounds, and adult nursing facilities;
- To prohibit unauthorized intrusive activities in areas with contaminated soil; and
- To maintain the integrity of any existing or future monitoring or remediation system at the site such as monitoring wells, concrete cover, and horizontal air sparge system.

The specific types of LUCs which will be implemented include:

1. Incorporating land and groundwater use prohibitions into the MCB Camp Lejeune Base Master Plan;
2. Recording a Notice of Contaminated Site filed in Onslow County real property records per North Carolina General Statutes (NCGS) 143B-279.9 and 143B-279.10;
3. Maintain the integrity of any current or future remedial or monitoring system such as conducting site inspections to verify the integrity of the monitoring wells, horizontal air sparge system, concrete cover, and to verify compliance with use restrictions; and
4. Deed and/or lease restrictions in the event of transfer for any portion of Site 73.

FIGURE 7
Approximate LUC Boundary




The Navy shall prepare, in accordance with USEPA guidance, and submit to the USEPA and NCDENR, a Remedial Design (RD) containing LUC implementation and maintenance actions, including periodic inspections, within 90 days of the ROD signature, for review and approval. The Navy/MCB Camp Lejeune are responsible for implementing, maintaining, inspecting, reporting on, and enforcing the LUCs described in this ROD in accordance with the ROD and the approved RD.

### 2.9.3 Expected Outcomes of the Selected Remedy

Current land uses are expected to continue at Site 73 and there are no other planned land uses in the foreseeable future, or for development of adjacent lands. Remediation goals for the Selected Remedy are based on unlimited use and unrestricted exposure. Exposure will be controlled through LUCs until COCs in groundwater and soil are reduced to the remediation goals. The air sparge system will be operated for up to 5 years or until the remedial goals within the radius of influence were met, whichever is the shortest period. System effectiveness will be evaluated annually by comparison of current concentrations of COCs in treatment area monitoring wells to pretreatment concentrations and the remediation goals. The ERD biobarrier wall will be maintained until groundwater COCs concentrations have met the remediation goals, as described below, or until it is determined by the Navy, Marine Corps, USEPA and the State that biodegradation can be maintained naturally and further enhancements are not required.

In accordance with LUC objectives, groundwater use will be restricted to monitoring or remedial purposes. LTM will be conducted until each COC in groundwater is at or below its respective remediation goal for four consecutive monitoring events. The Navy and Marine Corps, in partnership with USEPA and the State, will evaluate the discontinuation of monitoring of individual COCs that have met the remediation goals after four rounds based

on site conditions. The results of LTM will be documented in an annual monitoring report. When all COCs have achieved their goals for four consecutive sampling events, site closure will be initiated. Once RAOs for this groundwater action have been achieved, the Site 73 area is expected to be suitable for unlimited use and unrestricted exposure for groundwater. Therefore, the Navy, USEPA, and NCDENR may agree for the groundwater LUC component of the Selected Remedy to be terminated at site closeout.

LUCs, restricting any potential future residential exposure to impacted soils, will be maintained until the concentration of COCs in the soil are at such levels that allow for unrestricted use and unlimited exposure.

### 2.9.4 Statutory Determinations

Remedial actions undertaken at NPL sites must meet the statutory requirements of Section 121 of CERCLA and thereby achieve adequate protection of human health and the environment, comply with ARARs of both federal and state laws and regulations, be cost-effective, and use, to the maximum extent practicable, permanent solutions and alternative treatment or resource recovery technologies. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, and/or mobility of hazardous waste as the principal element. The following discussion summarizes the statutory requirements that are met by the Selected Remedy.

**Protection of Human Health and the Environment—** Because there is unacceptable risk to human health, due to the contaminated soil and contaminated groundwater at this site that is considered a potential drinking water source, a remedial action is required to eliminate the exposure to impacted soil and restore the groundwater to meet drinking water standards (i.e., MCLs or NCGWQS). Although there is no risk based on current land use, the Selected Remedy will protect human health and the environment by reducing site risks through groundwater treatment and the implementation of LUCs to eliminate the threat of exposure to the COCs via ingestion of impacted groundwater and via direct contact with impacted soil.

**Compliance with ARARs and TBC Criteria—** Section 121(d) of CERCLA, as amended, specifies, in part, that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more stringent state environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs) to the hazardous substances or particular circumstances at a site or obtain a waiver. See also 40 C.F.R. § 300.430(f)(1)(ii)(B). ARARs include only federal and state environmental or facility citing laws/regulations and do not include occupational safety or worker protection requirements. Compliance with OSHA standards is required by 40 C.F.R. § 300.150 and therefore the CERCLA requirement for compliance with or wavier of ARARs does not apply to OSHA standards. In addition to ARARs, the lead and support agencies may, as appropriate, identify other advisories, criteria, or guidance to be considered for a particular release. The "to-be-considered" (TBC) category consists of advisories, criteria, or guidance that were developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies. See 40 C.F.R. § 300.400(g)(3). In accordance with 40 C.F.R. § 300.400(g), Navy, USEPA and NCDENR have identified the ARARs and TBCs for the selected remedy. Appendix B lists respectively the Chemical-, Location- and Action-Specific

ARARs/TBCs for the Selected Remedy. The Selected Remedy will meet all identified ARARs.

**Cost-Effectiveness—**The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used to determine cost-effectiveness, "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness (NCP §300.430(f)(1)(ii)(D)". This analysis was accomplished by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria. The costs are proportional to overall effectiveness by achieving long-term effectiveness and permanence within a reasonable timeframe.

**Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable—**The Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at Site 73. Because long-term effectiveness and permanence along with reduced toxicity and volume are achieved in the shortest timeframe with the Selected Remedy, the Navy, MCB Camp Lejeune, USEPA, and NCDENR determined that the Selected Remedy provides the best balance of tradeoffs in terms of the balancing criteria, while also considering the statutory preference for treatment as a principal element and considering State and community acceptance.

**Preference for Treatment as a Principal Element—**The Selected Remedy uses treatment as a principal element, and therefore satisfies the statutory preference for treatment.

**Five-Year Review Requirements—** This remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure; therefore in accordance with CERCLA Section 121(c) and the NCP at 40 CFR300.430 (f)(4)(ii) a statutory review will be conducted by the Navy within 5 years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment. If the remedy is determined not to be protective of human health and the environment because, for example, LUCs have failed or treatment is unsuccessful, then additional remedial actions would be evaluated by the FFA parties and the Navy may be required to undertake additional remedial action.

## 2.10 Community Participation

The Navy, MCB Camp Lejeune, USEPA, and NCDENR provide information regarding the cleanup of MCB Camp Lejeune to the public through the community relations program which includes a Restoration Advisory Board (RAB), public meetings, the Administrative Record file for the site, and announcements published in local newspapers. RAB meetings continue to be held to provide an information exchange among community members, the Navy, MCB Camp Lejeune, USEPA, and NCDENR. These meetings are open to the public and are held quarterly.

In accordance with Sections 113 and 117 of CERCLA, the Navy provided a public comment period from April 21, 2009 through May 20, 2009 for the Proposed Remedial Action Plan (PRAP) for Site 73. A public meeting to present the PRAP was held on April 21, 2009 at the Carolina Coastal Community College. Public notice of the meeting and availability of

documents was placed in *The Jacksonville Daily News*, *The Globe*, and the *RotoVu* newspapers on April 8 and April 19, April 9 and April 16, and April 15, respectively.

The PRAP for Site 73 was released for public comment on April 21, 2009. The PRAP identified Alternative 4, air sparging with enhanced reductive dechlorination injections, as the Preferred Alternative for groundwater remediation.

The Administrative Record, Community Relations Plan, IRP fact sheets, and final technical reports concerning Site 73 can be obtained from the IRP web site: http://public.lantops-ir.org/sites/public/lejeune/Site35_73Prap.aspx. Internet access is available to the public at the following location:

Onslow County Public Library
58 Doris Avenue East
Jacksonville, North Carolina 28540
(910) 455-7350

## 2.11 Documentation of Significant Changes

The PRAP for Site 73 was released for public comment on April 21, 2009. No comments were received during the public meeting or comment period. It was determined that no significant changes to the remedy, as originally identified in the PRAP were necessary or appropriate.

# 3 Responsiveness Summary

The participants in the Public Meeting held on April 21, 2009, included representatives of the Navy, MCB Camp Lejeune, USEPA, and NCDENR. Two community members attended the meeting. Questions received during the public meeting were general inquiries and are described in the public meeting minutes in the Administrative Record. There were no comments received at the public meeting requiring amendment to the PRAP and no additional written comments, concerns, or questions were received from community members during the public comment period.

# Appendix A
# NCDENR Concurrence Letter

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Dexter R. Matthews
Director

Beverly Eaves Perdue
Governor

Dee Freeman
Secretary

August 24, 2009

NAVFAC Mid-Atlantic
Attn: Dave Cleland Code: OPQE
USMC NC IPT, EV Business Line
6506 Hampton Blvd
Norfolk, VA 23508

RE: Concurrence with the August 2009 revised Draft Final Record of Decisions for OU# 21, Site 73 at MCB Camp Lejeune, NC, Soil and Groundwater
Camp Lejeune, NC6170022580
Jacksonville, Onslow County, North Carolina

Dear Mr. Cleland:

The NC Superfund Section has received and reviewed the revised Draft Final Record of Decision (ROD) for Ou#21, Site 73 at MCB, Camp Lejeune dated August 2009 and concurs that the selected remedy is protective of human health and the environment.

The State's concurrence is based solely on the information contained in the Revised Draft Final ROD dated August 2009 for OU#21, Site 73. Should we receive additional information that significantly affects the conclusions of the ROD, we may modify or withdraw this concurrence with written notice to the Naval Facilities Engineering Command for Camp Lejeune and the EPA Region IV.

If you have any questions or comments, please contact me at (919) 508 8464 or email **David.Lown@ncdenr.gov** .

Sincerely,

David J. Lown, LG, PE
Head, Federal Remediation Branch
Superfund Section

Cc: Elizabeth Hartzell, NC Superfund Section
Bob Lowder, EMD/IR
Gena Townsend, USEPA

# Appendix B
# ARARs and TBC

TABLE B-1

| Federal and North Carolina Chemical-Specific ARARs and TBC | | | |
|---|---|---|---|
| **Media** | **Requirement** | **Prerequisite** | **Citation** |
| Classification of contaminated groundwater | Groundwaters in the state naturally containing 250 mg/L or less of chloride are *classified as GA* under 15A NCAC 02L .0201(1) | Groundwaters located within the boundaries or under the extraterritorial jurisdiction of the State of North Carolina **- Applicable** | 15A NCAC 02L .0302(1) |
| | Groundwaters in the state naturally containing greater than 250 mg/L of chloride are *classified as GSA* under 15A NCAC 02L .0201(2) | | 15A NCAC 02L .0302(2) |
| Restoration of contaminated groundwater | Shall not exceed the groundwater quality standards[1] for contaminants specified in Paragraphs (g) or (h) for the site related contaminants of concern.<br>Benzene (1 µg/L)<br>cis-1,2-DCE (70 µg/L)<br>1,1-DCE (70 µg/L)<br>TCE (2.8 µg/L)<br>Vinyl Chloride (0.015 µg/L) | Class GA or GSA groundwaters with contaminant(s) concentrations exceeding standards listed in 15A NCAC 02L .0202 **– Relevant and Appropriate** | 15A NCAC 02L .0202(a) and (b) |
| | Shall not exceed the Safe Drinking Water Act National Revised Primary Drinking Water Regulations: maximum contaminant levels (MCLs) for organic contaminants specified in 40 CFR 141.61(a). | Groundwaters classified as GA or GSA which are an existing or potential source of drinking water **- Relevant and Appropriate** | 40 CFR 141.61(a)<br>15A NCAC 18C .1517 |
| Protection of adjacent surface water body | Monitor and undertake management practices for sources of pollution such that water quality standards and best usage of receiving waters and all downstream waters will not be impaired. | Indirect discharges of waste or other source of water pollution into Tidal Salt Waters classified as Class SC **- Relevant and Appropriate** | 15A NCAC 02B .0203 |
| | The concentrations of toxic substances, either alone or in combination with other wastes, in surface waters shall not render waters injurious to aquatic life or wildlife, recreational activities, public health, or impair the waters for any designated uses. | Nonpoint discharges into Tidal Salt Waters classified as Class SC **- Relevant and Appropriate** | 15A NCAC 02B .0208 |
| | Toxic substances: shall not exceed the numerical quality standards (maximum permissible levels) to protect human health from carcinogens through consumption of fish (and shellfish).<br>Benzene (51 µg/L)<br>cis-1,2-DCE<br>1,1-DCE<br>TCE (30 µg/L)<br>Vinyl Chloride (2.4 µg/L) | Nonpoint discharges (containing toxic substances which are carcinogens) into Tidal Salt Waters classified as Class SC **- Relevant and Appropriate** | 15A NCAC 02B .0208(a)(2)B) |

TABLE B-1

| Federal and North Carolina Chemical-Specific ARARs and TBC | | | |
|---|---|---|---|
| **Media** | **Requirement** | **Prerequisite** | **Citation** |
| Protection of adjacent surface water body (cont.) | Shall not exceed 25 NTU turbidity level (unless due to natural background conditions).<br>Compliance with this standard can be met when land management activities employ Best Management Practices [as defined by Rule .0202 of this Section]. | Nonpoint discharges into Tidal Salt Waters classified as Class SC in 15A NCAC 02B .0220 **- Relevant and Appropriate** | 15A NCAC 02B .0220(3)(l) |
| | Toxic substances: shall not exceed the numerical quality standards (maximum permissible levels) provided in subparagraphs (i) through (xi) to protect aquatic life. | | 15A NCAC 02B .0220(m) |
| Clean-up of soils contaminated with hazardous chemicals | Requires contaminated soil to be remediated to risk-based levels that protect both human health and the underlying groundwater, or site-specific background levels.<br>Petroleum Aromatic Carbon Fraction Class C9-C22 (33,600 µg/kg) | The Division of Waste Management's (DWM) HWS has jurisdiction for the remediation of contamination resulting from the spill or release of hazardous wastes as defined in 40 CFR 261, and adopted by reference in 15A NCAC 13A .0106 – **To Be Considered** | North Carolina Department of Environment and Natural Resources Division of Waste Management Hazardous Waste Section – Generator Closure Guidelines, June 18, 2008 |

Notes:

[1] Groundwater quality standards established on the basis of a National secondary drinking water standards are not utilized as remediation goals since these are based on taste, odor and other considerations unrelated to human health.

TABLE B-2

| Federal and North Carolina Action-Specific ARARs and TBC | | | |
|---|---|---|---|
| **Action** | **Requirement** | **Prerequisite** | **Citation** |
| ***General Construction Standards — All Land-disturbing Activities (i.e., excavation, clearing, grading, etc.)*** | | | |
| Managing storm water runoff from land-disturbing activities | Shall install erosion and sedimentation control devices and practices sufficient to retain the sediment generated by the land-disturbing activity within the boundaries of the tract during construction. | Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-52 of more than 1 acre of land **– Relevant and Appropriate** | N.C.G.S. Ch.113A-57(3) |
| | Shall plant or otherwise provide permanent ground cover sufficient to restrain erosion after completion of construction. | | N.C.G.S. Ch.113A-57(3) |
| | Shall take all reasonable measures to protect all public and private property from damage caused by such activities. | Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-52) of more than 1 acre of land **– Relevant and Appropriate** | 15A NCAC 4B.0105 |
| | Erosion and sedimentation control plan must address the following basic control objectives: | | 15A NCAC 4B.0106 |
| | (1) Identify areas subject to severe erosion, and off-site areas especially vulnerable to damage from erosion and sedimentation. | | |
| | (2) Limit the size of the area exposed at any one time. | | |
| | (3) Limit exposure to the shortest feasible time. | | |
| | (4) Control surface water run-off originating upgrade of exposed areas . | | |
| | (5) Plan and conduct land-disturbing activity so as to prevent off-site sedimentation damage. | | |
| | (6) Include measures to control velocity of storm water runoff to the point of discharge. | | |
| | Erosion and sedimentation control measures, structures, and devices shall be planned, designed, and constructed to provide protection from the run-off of 10 year storm. | Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-52) of more than 1 acre of land **– Relevant and Appropriate** | 15A NCAC 4B.0108 |
| | Shall conduct activity so that the post-construction velocity of the 10-year storm run-off in the receiving watercourse to the discharge point does not exceed the parameters provided in this Rule. | | 15A NCAC 4B.0109 |
| | Shall install and maintain all temporary and permanent erosion and sedimentation control measures. | | 15A NCAC 4B.0113 |
| Managing fugitive dust emissions | Shall not cause or allow fugitive dust emissions to cause or contribute to substantive complaints, or visible emissions in excess of that allowed under paragraph (e) of this Rule. | Activities within facility boundary that will generate fugitive dust emissions **- Relevant and Appropriate** | 15A NCAC 02D .0540(c) |
| | Implement methods (e.g. wetting dry soils) to control dust emissions that could travel beyond the facility boundary. | | 15A NCAC 02D .0540(g) |

TABLE B-2

**Federal and North Carolina Action-Specific ARARs and TBC**

| Action | Requirement | Prerequisite | Citation |
|---|---|---|---|
| ***Monitoring Well Installation, Operation, and Abandonment*** | | | |
| Construction of groundwater monitoring well(s) | No well shall be located, constructed, operated, or repaired in any manner that may adversely impact the quality of groundwater. | Installation of wells (including temporary) other than for water supply **- Applicable** | 15A NCAC 02C .0108(a) |
| | Shall be located, designed, constructed, operated and abandoned with materials and by methods which are compatible with the chemical and physical properties of the contaminants involved, specific site conditions, and specific subsurface conditions. | | 15A NCAC 02C .0108(c) |
| | Must comply with general requirements for construction of a well as provided in 15A NCAC 02C .0108(c)(1) through (12) | | 15A NCAC 02C .0108(c) |
| | Shall be constructed in such a manner as to preclude the vertical migration of contaminants with and along borehole channel. | | 15A NCAC 02C .0108(f) |
| Implementation of groundwater monitoring system | Shall be constructed in a manner that will not result in contamination of adjacent groundwaters of a higher quality. | Installation of monitoring system to evaluate effects of any actions taken to restore groundwater quality, as well as the efficacy of treatment **- Applicable** | 15A NCAC 02L .0110 (b) |
| Maintenance of groundwater monitoring well(s) | Every well shall be maintained by the owner in a condition whereby it will conserve and protect groundwater resources, and whereby it will not be a source or channel of contamination or pollution to the water supply or any aquifer. | Installation of wells (including temporary wells) other than for water supply **- Applicable** | 15A NCAC 02C .0112(a) |
| | Broken, punctured, or otherwise defective or unserviceable casing, screens, fixtures, seals, or any part of the well head shall be repaired or replaced, or the well shall be abandoned pursuant to 15A NCAC 02C .0113 | | 15A NCAC 02C .0112(c) |
| | All materials used in the maintenance, replacement, or repair of any well shall meet the requirements for new installation. | | 15A NCAC 02C .0112(b) |
| Abandonment of groundwater monitoring well(s) | Shall be abandoned in accordance with the requirements of 15A NCAC 02C .0113(b)(1) and (2) | Permanent abandonment of wells (including temporary wells) other than for water supply **- Applicable** | 15A NCAC 02C .0113(b) |
| ***Underground Injection Well Installation, Operation, and Abandonment*** | | | |
| Construction of injection well(s) for *in-situ* treatment of groundwater | Construction, use or operation may be allowed provided the injected material does not contain any waste or any substance of a composition and concentration such that, if it were discharged to the land or waters of the state, would create a threat to human health or would otherwise render those waters unsuitable for their intended usage. | Installation of Class 5 underground injection well (Type I – In-situ Groundwater Remediation Well) **- Applicable** | 15A NCAC 02C .0209(e)(3) |
| | Shall provide information on the injection well, procedure, and material otherwise required for obtaining a permit in the Remedial Design or Remedial Action Work Plan. | | 15A NCAC 02C .0211(d)(3) |

TABLE B-2

**Federal and North Carolina Action-Specific ARARs and TBC**

| Action | Requirement | Prerequisite | Citation |
|---|---|---|---|
| Location of injection well(s) for *in-situ* treatment of groundwater | Shall not be located in an area generally subject to flooding. Areas which are generally subject to flooding include those with concave slope, alluvial or colluvial soils, gullies, depressions, and drainage ways. | Installation of Class 5 underground injection well (Type I – In-situ Groundwater Remediation Well) **- Applicable** | 15A NCAC 02C .0213(a)(1) |
| | Shall not be located at a point where the injectant would degrade the existing quality of the groundwater in the water-bearing unit into which the injectant is being released. | Installation of Class 5 underground injection well (Type I – In-situ Groundwater Remediation Well) where the concentration of any component of the injectant *exceeds* the groundwater quality standards specified in 15A NCAC 2L .0202 **- Applicable** | 15A NCAC 02C .0213(a)(2)(A)(i) |
| | Shall not be located at a point where the injectant would result in a contravention of any of the aforementioned groundwater quality standards in the water-bearing unit into which the injectant is being released. | Installation of Class 5 underground injection well (Type I – In-situ Groundwater Remediation Well) where the concentration of any component of the injectant *is less than* the groundwater quality standards specified in 15A NCAC 2L .0202 **- Applicable** | 15A NCAC 02C .0213(a)(2)(B) |
| Construction of injection well(s) for *in-situ* treatment of groundwater | Shall follow the procedures, methods, specified materials, and requirements specified in the subparagraphs (A) through (G) of this Rule for Drilling, Casing, Screens and Testing. | Installation of Class 5 underground injection well (Type I – In-situ Groundwater Remediation Well) **- Applicable** | 15A NCAC 02C .0213(c)(1) through (4) |
| | Shall follow the procedures, methods, specified materials, and requirements specified in the paragraphs (1) through (8) of this Rule for Grouting and Sand-and-Gravel Packing. | | 15A NCAC 02C .0213(d) |
| Operating an injection well(s) for *in-situ* treatment of groundwater | Pressure at the well head shall be limited to a maximum which will ensure the pressure in the injection zone does not initiate new fractures or propagate existing fractures in the injection zone, initiate fractures in the confining zone, or cause the migration of injected or formation fluids outside the injection zone or area. | | 15A NCAC 02C .0213(e) |
| Abandonment of injection well(s) for *in-situ* treatment of groundwater | Shall be abandoned in accordance with the requirements of subparagraphs (1) and (2) of 15A NCAC 02C .0114. | Installation of Class 5 underground injection well (Type I – In-situ Groundwater Remediation Well *or* Type 5L Closed-Loop Groundwater Remediation Well), including exploratory or test wells **- Applicable** | 15A NCAC 02C .0214 |
| ***Control of Diffuse VOC Emissions from Groundwater Treatment*** | | | |
| Emissions of VOCs from groundwater treatment (e.g., sparging system) | Shall not emit any of the toxic air pollutants listed in the table of the Rule in such quantities that may cause or contribute beyond the premises (adjacent property boundary) to any significant ambient air concentration that may adversely affect human health. | Emissions of toxic air pollutants (e.g., VOCs) from facility into the ambient air **- Applicable** | 15A NCAC 02D .1104 |
| | Shall install and operate reasonable available control technology to limit emissions of VOCs. | Air emissions of VOCs from facilities where there is no other applicable emissions control rule **- Relevant and Appropriate** | 15A NCAC 02D .0951(c) |

TABLE B-2

**Federal and North Carolina Action-Specific ARARs and TBC**

| Action | Requirement | Prerequisite | Citation |
|---|---|---|---|
| Emissions of VOCs from groundwater treatment (e.g., sparging system) (cont.) | One of the applicable test methods in Appendix M in 40 CFR part 51 or Appendix A in 40 CFR Part 60 shall be used to determine compliance with VOC emission standards. | VOC emission source not covered by 15A NCAC 02D.2613(b) through (e) **- Relevant and Appropriate** | 15A NCAC 02D .2613(g) |
| | Control emissions by meeting limitations and work practice standards reflecting application of the maximum achievable control technology. Periodic inspection of equipment and monitoring are required for the life of the remediation. | Air emissions of organic Hazardous Air Pollutants (e.g., VOCs) from site remediation **- Relevant and Appropriate** | 40 CFR 63 Subpart GGGGG, NESHAPS for Site Remediation |
| ***Waste Characterization and Storage — Primary Wastes (i.e., excavated contaminated soils)*** | | | |
| Characterization of solid waste (e.g., well soil cuttings) | Must determine if solid waste is hazardous waste or if waste is excluded under 40 CFR 261.4(b); and | Generation of solid waste as defined in 40 CFR 261.2 and which is not excluded under 40 CFR 261.4(a) **- Applicable** | 40 CFR 262.11(a) |
| | Must determine if waste is listed under 40 CFR Part 261; or | | 40 CFR 262.11(b) |
| | Must characterize waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used. | | 40 CFR 262.11(c) |
| | Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste. | Generation of solid waste which is determined to be hazardous **- Applicable** | 40 CFR 262.11(d) |
| Storage of solid waste | All solid waste shall be stored in such a manner as to prevent the creation of a nuisance, insanitary conditions, or a potential public health hazard. | Generation of solid waste which is determined *not* to be hazardous **- Relevant and Appropriate** | 15A NCAC 13B .0104(f) |
| | Containers for the storage of solid waste shall be maintained in such a manner as to prevent the creation of a nuisance or insanitary conditions. Containers that are broken or that otherwise fail to meet this Rule shall be replaced with acceptable containers. | | 15A NCAC 13B .0104(e) |
| Characterization of hazardous waste | Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 CFR 264 and 268. | Generation of RCRA-hazardous waste for storage, treatment or disposal **- Applicable** | 40 CFR 264.13(a)(1) |
| | Must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the waste. | Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal **- Applicable** | 40 CFR 268.9(a) |
| | Must determine if the waste is restricted from land disposal under 40 CFR 268 *et seq.* by testing in accordance with prescribed methods or use of generator knowledge of waste. | | 40 CFR 268.7 |
| | Must determine each USEPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 CFR 268.40 *et. seq*. | | 40 CFR 268.9(a) |

TABLE B-2

**Federal and North Carolina Action-Specific ARARs and TBC**

| Action | Requirement | Prerequisite | Citation |
|---|---|---|---|
| Temporary storage of hazardous waste in containers | A generator may accumulate hazardous waste at the facility provided that:<br>waste is placed in containers that comply with 40 CFR 265.171-173; and | Accumulation of RCRA hazardous waste on site as defined in 40 CFR 260.10 **- Applicable** | 40 CFR 262.34(a)<br>40 CFR 262.34(a)(1)(i) |
| | the date upon which accumulation begins is clearly marked and visible for inspection on each container | | 40 CFR 262.34(a)(2) |
| | container is marked with the words "hazardous waste"; or | | 40 CFR 264.34(a)(3) |
| | container may be marked with other words that identify the contents. | Accumulation of 55 gal. or less of RCRA hazardous waste at or near any point of generation **- Applicable** | 40 CFR 262.34(c)(1) |
| Use and management of hazardous waste in containers | If container is not in good condition (e.g. severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition. | Storage of RCRA hazardous waste in containers **- Applicable** | 40 CFR 265.171 |
| | Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired. | | 40 CFR 265.172 |
| | Keep containers closed during storage, except to add/remove waste. | | 40 CFR 265.173(a) |
| | Open, handle and store containers in a manner that will not cause containers to rupture or leak. | | 40 CFR 265.173(b) |
| ***Waste treatment and disposal—primary wastes (excavated contaminated soils)*** | | | |
| Disposal of solid waste | Shall ensure that waste is disposed of at a site or facility which is permitted to receive the waste. | Generation of solid waste intended for off-site disposal **- Relevant and Appropriate** | 15A NCAC 13B .0106(b) |
| Disposal of RCRA-hazardous waste in a land-based unit | May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal. | Land disposal, as defined in 40 CFR 268.2, of restricted RCRA waste **- Applicable** | 40 CFR 268.40(a) |
| | Must be treated according to the alternative treatment standards of 40 CFR 268.49(c) or<br>Must be treated according to the UTSs [specified in 40 CFR 268.48 Table UTS] applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal. | Land disposal, as defined in 40 CFR 268.2, of restricted hazardous soils **- Applicable** | 40 CFR 268.49(b) |
| ***Transportation of Wastes*** | | | |
| Transportation of hazardous waste on-site | The generator manifesting requirements of 40 CFR 262.20-262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 CFR 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way. | Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way **- Applicable** | 40 CFR 262.20(f) |

TABLE B-2

| Federal and North Carolina Action-Specific ARARs and TBC | | | |
|---|---|---|---|
| **Action** | **Requirement** | **Prerequisite** | **Citation** |
| Transportation of hazardous waste off-site | Must comply with the generator requirements of 40 CFR 262.20-23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 262.12 to obtain USEPA ID number. | Off-site transportation of RCRA-hazardous waste **- Applicable** | 40 CFR 262.10(h) |
| | Must comply with the requirements of 40 CFR 263.11-263.31. | Transportation of hazardous waste within the United States requiring a manifest **- Applicable** | 40 CFR 263.10(a) |
| | A transporter who meets all applicable requirements of 49 CFR 171-179 and the requirements of 40 CFR 263.11 and 263.31 will be deemed in compliance with 40 CFR 263. | | |
| Transportation of hazardous materials | Shall be subject to and must comply with all applicable provisions of the HMTA and DOT HMR at 49 CFR 171-180. | Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material **- Applicable** | 49 CFR 171.1(c) |
| ***Institutional Controls for Contamination Left in Place*** | | | |
| Notice of Contaminated Site | Prepare and certify by professional land surveyor a survey plat which identifies contaminated areas which shall be entitled "NOTICE OF CONTAMINATED SITE". | Contaminated site subject to current or future use restrictions included in a remedial action plan as provided in G.S. 143B-279.9(a) **- To-Be-Considered** | NCGS 143B-279.10(a) |
| | Notice shall include a legal description of the site that would be sufficient as a description in an instrument of conveyance and meet the requirements of NCGS 47-30 for maps and plans. | | |
| | The Survey plat shall identify:<br>• the location and dimensions of any disposal areas and areas of potential environmental concern with respect to permanently surveyed benchmarks;<br>• the type location, and quantity of contamination known to exist on the site; and<br>•any use restriction on the current or future use of the site. | | NCGS 143B-279.10(a)(1)-(3) |
| | Notice (survey plat) shall be filed in the register of deeds office in the county which the site is located in the grantor index under the name of the owner. | | NCGS 143B-279.10(b) and (c) |
| | The deed or other instrument of transfer shall contain in the description section, in no smaller type than used in the body of the deed or instrument, a statement that the property is a contaminated site and reference by book and page to the recordation of the Notice. | Contaminated site subject to current or future use restrictions as provided in G.S. 143B-279.9(a) that is to sold, leased, conveyed or transferred **- To-Be-Considered** | NCGS 143B-279.10(e) |

TABLE B-3

| Federal Location-Specific ARARs and TBC | | | |
|---|---|---|---|
| **Location** | **Requirement** | **Prerequisite** | **Citation** |
| Presence of floodplain designated as such on a map | Shall consider alternatives to avoid, to the extent possible adverse effects and incompatible development in the floodplain. | Federal actions that involve potential impacts to, or take place within, floodplains **- To-Be-Considered** | Executive Order 11988 Section 2(a)(2) |
| Presence of federally endangered or threatened species, as designated in 50 CFR 17.11 and 17.12 -**or**- critical habitat of such species listed in 50 CFR 17.95 | Actions that jeopardize the existence of a listed species or results in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken. | Action that is likely to jeopardize fish, wildlife, or plant species or destroy or adversely modify critical habitat **– Relevant and Appropriate** | 16 USC 1531 *et seq*., Sect. 7(a)(2) |
| | Except as provided in the Rule, no person may take the specified reptiles. | Action that is likely to jeopardize or adversely modify critical habitat for American alligator, green turtle, and/or loggerhead turtle **– Relevant and Appropriate** | 50 CFR 17.42(a) and (b) |

# Appendix C
# Acronyms and Abbreviations

# Acronyms and Abbreviations

| | |
|---|---|
| ARAR | applicable or relevant and appropriate requirement |
| bgs | below ground surface |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| COC | chemical of concern |
| CSM | conceptual site model |
| DCE | dichloroethene |
| DNAPL | dense non-aqueous phase liquid |
| ERA | ecological risk assessment |
| ERD | enhanced reductive dechlorination |
| FFA | Federal Facilities Agreement |
| FS | Feasibility Study |
| HHRA | Human Health Risk Assessment |
| HI | hazard index |
| IRP | Installation Restoration Program |
| LNAPL | light non-aqueous phase liquid |
| LTM | long-term monitoring |
| LUC | land use control |
| MCB | Marine Corps Base |
| MCL | maximum contaminant level |
| MNA | monitored natural attenuation |
| msl | mean sea level |
| NAES | Natural Attenuation Evaluation Study |
| NAPL | non-aqueous phase liquid |
| Navy | United States Navy |
| NC HWS SSL | North Carolina Hazardous Waste Section Soil Screening Level |
| NCDENR | North Carolina Department of Environment and Natural Resources |
| NCGWQS | North Carolina Groundwater Quality Standards |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NCSWQS | North Carolina Surface Water Quality Standards |
| NFA | no further action |
| O&M | Operation and Maintenance |
| OU | operable unit |
| POL | petroleum, oil, and lubricant |
| PRAP | Proposed Remedial Action Plan |
| QI | quotient index |

| | |
|---|---|
| RAB | Restoration Advisory Board |
| RAO | remedial action objective |
| RD | Remedial Design |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| SARA | Superfund Amendments and Reauthorization Act |
| SMP | Site Management Plan |
| SRI | Supplemental Remedial Investigation |
| TBC | to-be-considered |
| TCE | trichloroethene |
| USEPA | United States Environmental Protection Agency |
| UST | underground storage tank |
| VC | vinyl chloride |
| VOC | Volatile Organic Compound |


| Reference Number | Reference Phrase in ROD | Location in ROD | Identification of Referenced Document Available in the Administrative Record |
|---|---|---|---|
| 1 | Used motor oil and battery acid | Section 2.1 | Initial Assessment Study of Marine Corps Base Camp Lejeune, North Carolina. Section 2.4.19. Water and Air Research, Inc., April 1983. |
| 2 | CVOCs identified in groundwater | Section 2.1 | Confirmation Study, Marine Corps Base Camp Lejeune, North Carolina. Page 2-111. Environmental Science and Engineering, Inc., January 1985. |
| 3 | NCDENR issued No Further Action | Section 2.1 | Underground Storage Tank and POL Soil Investigation Summary, Operable Unit 21 (Site 73) –MCB Camp Lejeune, Jacksonville, North Carolina – Technical Memorandum. CH2M HILL, December 2008. |
| 4 | hydrogeologic units found at Site 73 | Section 2.2 | Supplemental Remedial Investigation, Site 73 – Operable Unit No. 21, Amphibious Vehicle Maintenance Facility, Marine Corps Base Camp Lejeune, Jacksonville, North Carolina. Section 4.3.2. CH2M HILL, March 2009. |
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Detailed site information referenced in this ROD in bold blue text is contained in the Administrative Record.