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**FINAL**

# RECORD OF DECISION
# OPERABLE UNIT NO. 12 (SITE 3)

**MARINE CORPS BASE**
**CAMP LEJEUNE, NORTH CAROLINA**

**CONTRACT TASK ORDER 0274**

**JANUARY 6, 1997**

*Prepared For:*

**DEPARTMENT OF THE NAVY**
**ATLANTIC DIVISION**
**NAVAL FACILITIES**
**ENGINEERING COMMAND**
*Norfolk, Virginia*

*Under:*

**LANTDIV CLEAN Program**
**Contract N62470-89-D-4814**

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## TABLE OF CONTENTS

Page

**TABLE OF CONTENTS**
**(Continued)**

Page

## LIST OF TABLES



## LIST OF FIGURES



## LIST OF APPENDICES

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ARAR | applicable or relevant and appropriate requirement |
| Baker | Baker Environmental, Inc. |
| bgs | below ground surface |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| COPC | contaminant of potential concern |
| CP | Concrete Pad Area |
| DoN | Department of the Navy |
| DW | deep well |
| ELISA | enzyme linked immunosorbent assay |
| FS | Feasibility Study |
| HI | hazard index |
| ICR | incremental lifetime cancer risk |
| IW | intermediate well |
| µg/L | microgram per liter |
| µg/kg | microgram per kilogram |
| MCB | Marine Corps Base |
| MCL | Maximum Contaminant Level |
| MW | monitoring well |
| NA | Northern Area |
| NC DEHNR | North Carolina Department of Environment, Health, and Natural Resources |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NCWQS | North Carolina Water Quality Standards |
| ND | non detect |
| NPW | net present worth |
| O&M | operation and maintenance |
| OU | Operable Unit |
| PAH | polynuclear aromatic hydrocarbon |
| ppb | parts per billion |
| ppm | parts per million |
| PRAP | Proposed Remedial Action Plan |
| psi | pounds per square inch |
| QI | quotient index |
| RA | risk assessment |

## LIST OF ACRONYMS AND ABBREVIATIONS
## (Continued)

| | |
|---|---|
| RAA | remedial action alternative |
| RCRA | Resource Conservation and Recovery Act |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| RS | Rail Spur Area |
| SARA | Superfund Amendments and Reauthorization Act |
| SB | soil boring |
| SD | sediment |
| SSSV | surface soil screening value |
| SVOC | semivolatile organic compound |
| TA | Treatment Area |
| TAL | target analyte list |
| TBC | to be considered criteria |
| TCL | target compound list |
| USEPA | United States Environmental Protection Agency |
| VOC | volatile organic compound |

## DECLARATION

**Site Name and Location**

Operable Unit No. 12 (Site 3 - the Old Creosote Plant)
Marine Corps Base
Camp Lejeune, North Carolina

**Statement of Basis and Purpose**

This decision document presents the selected remedy for Operable Unit (OU) No. 12 (Site 3) at Marine Corps Base (MCB), Camp Lejeune, North Carolina. The remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record file for OU No. 12 (Site 3).

The Department of the Navy (DoN) and the Marine Corps have obtained concurrence from the State of North Carolina Department of Environment, Health, and Natural Resources (NC DEHNR) and the United States Environmental Protection Agency (USEPA) Region IV on the selected remedy.

**Description of the Selected Remedy: No Action**

The selected remedy for OU No. 12 (Site 3) includes excavation of contaminated soil; treatment of the contaminated soil using aerobic, solid-phase biological treatment at a biocell; land use restrictions; aquifer use restrictions; and groundwater monitoring. More specifically, the selected remedy includes:

- Excavating the subsurface soil area of concern to a depth of nine feet below ground surface (bgs) or to just above the water table.
- Confirmatory soil sampling in the excavation area to ensure that contaminated soil has been removed to acceptable levels.
- Treating the excavated soil (approximately 2,000 cubic yards) using aerobic, solid-phase biological treatment in a biocell.
- Backfilling the excavation area with "clean" soil.
- Implementing land use restrictions that will limit future land development/use at the site until the soil remediation has been completed.
- Quarterly sampling of groundwater from monitoring wells 03-MW02, 03-MW02IW, 03-MW02DW, 03-MW06, 03-MW07, 03-MW08, and 03-MW11IW; analyzing the samples for target compound list (TCL) volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). If the groundwater quality improves, the sampling frequency may be reduced from quarterly to semiannual.
- Implementing aquifer use restrictions via the Base Master Plan to prohibit future use of the shallow and Castle Hayne aquifers, within a 100 foot radius of Site 3, as potable water sources.

The selected remedy addresses the principal threat - PAH contaminants in subsurface soil and the shallow groundwater aquifer - at OU No. 12 (Site 3).

**Statutory Determinations**

The selected remedy is protective of human health and the environment and is cost-effective. Although no chemical-specific applicable or relevant and appropriate requirements (ARARs) apply to the soil at Site 3, the remedy does comply with the to-be-considered criteria (TBCs) established for soil (i.e., federal soil screening levels established for the protection of groundwater). The remedy, however, does not comply with the chemical-specific ARARs identified for groundwater (i.e., federal and state groundwater criteria). Because contaminant concentrations exceeding the ARARs will remain untreated in the groundwater, a waiver of the ARARs may be required before the remedy can be implemented. The remedy will satisfy the statutory preference for treatment of soil but not for treatment of groundwater. The remedy will require five-year reviews by the lead agency.

_____ _____

Signature (Commanding General, MCB, Camp Lejeune) Date

## DECISION SUMMARY

### 1.0 INTRODUCTION

This Record of Decision (ROD) document presents the final remedial action plan selected for Operable Unit (OU) No. 12 (Site 3) at Marine Corps Base (MCB), Camp Lejeune, North Carolina. The environmental media at this site were investigated as part of a Remedial Investigation (RI), and remedial action alternatives were developed and evaluated as part of a Feasibility Study (FS), conducted for OU No. 12 (Site 3). Based on the results of the RI and FS, preferred remedial action alternatives were identified in a Proposed Remedial Action Plan (PRAP) document. Then, the public was given the opportunity to comment on the RI, FS, and PRAP. Based on comments received during the public comment period, and any new information that became available in the interim, a final remedial action plan was selected for OU No. 12 (Site 3). This ROD document presents the final selected remedy along with a summary of the remedy selection process.

The ROD is organized into 12 main sections. Section 1.0 presents an introduction, and Section 2.0 presents the site name and location, and a brief description of the site layout. Section 3.0 presents a history of the site and previous investigations/enforcement activities conducted there. Section 4.0 highlights community participation events that have occurred during the development of this ROD. Section 5.0 describes the scope and role of the response action developed to address the site contamination, and Section 6.0 summarizes the nature and extent of this site contamination (i.e., the site characteristics). Section 7.0 summarizes the site risks as determined by human health and ecological risk assessments. Section 8.0 describes the remedial action alternatives developed for soil and groundwater, while Section 9.0 summarizes the comparative analysis of these alternatives. Finally, Section 10.0 presents the final remedy selected for OU No. 12 (Site 3), Section 11.0 evaluates the selected remedy with respect to the statutory determinations, and Section 12.0 presents a responsiveness summary.

### 2.0 SITE NAME, LOCATION, AND DESCRIPTION

Located in Onslow County, North Carolina, MCB, Camp Lejeune is a training base for the United States Marine Corps. The Base covers approximately 236 square miles and includes 14 miles of coastline. MCB, Camp Lejeune is bounded to the southeast by the Atlantic Ocean, to the northeast by State Route 24, and to the west by U.S. Route 17. The town of Jacksonville, North Carolina is located north of the Base.

OU No. 12 is one of 18 OUs located within MCB, Camp Lejeune. Operable units were developed at the Base to combine one or more individual sites that share a common element. OU No. 12 contains only one site, Site 3, which is otherwise known as the Old Creosote Plant. Figure 1 depicts the location of OU No. 12 (Site 3) within MCB, Camp Lejeune.

Figure 2 presents a map of OU No. 12 (Site 3). Located within the Mainside Supply and Storage areas at MCB, Camp Lejeune, Site 3 encompasses an area of approximately five acres and is generally flat and unpaved. Open Storage Lots 201 and 203 (i.e., Site 6) are located nearby along Holcomb Boulevard approximately 1-1/2 miles from Site 3. However, Site 3 itself is not currently used for open storage.

As shown in Figure 2, the site is intersected by two roadways: a dirt path that runs north-south and forms a loop in the southern portion of the site, and a gravel road that runs east-west and leads

directly to Holcomb Boulevard. Access to the site via these roadways is currently unrestricted. In addition, the Camp Lejeune Railroad line runs parallel to the site's western edge and intersects an old railroad spur line at the site's southern extreme. The intersection of these two lines creates a spike formation that points south. Wooded areas lie north and east of the site.

## 3.0 SITE HISTORY AND PREVIOUS INVESTIGATIONS/ ENFORCEMENT ACTIVITIES

### 3.1 Site History

The old creosote plant reportedly operated from 1951 to 1952 to supply treated lumber during construction of the Base railroad. Reportedly, an on site sawmill, located in the northern portion of the site, was used to trim logs into railroad ties. The ties were then treated with hot creosote in pressure cylinder chambers. Although the exact treatment procedures that were used are not known, records show that preservatives (i.e., creosote) were stored for reuse in a railroad tank car.

In typical pressure treatment processes, wood ties are placed inside cylindrical chambers which are filled with wood-treating preservatives. Then, hydrostatic or pneumatic pressures, ranging from 50 to 200 pounds per square inch (psi), are applied within the treatment chamber until the wood absorbs the desired amount of preservatives. When the treatment process is complete, a pump removes the excess preservative from the chamber and sends it to a storage vessel for reuse. Excess preservative is then removed from the wood by applying a vacuum, or by allowing the wood to drip dry. In the past, treated wood lay in open areas for several days, allowing preservative to drip. Today, treated wood is typically placed on lined and covered drip pads to collect excess preservative.

The main treatment area at Site 3 was most likely located within and immediately surrounding the dirt path loop in the southern portion of the site. This area contains an abandoned chimney that was probably associated with creosote heating/thinning activities. (Creosote is heated and mixed with fuel oil to create a less viscous consistency.) The 240 foot long concrete pad encircled by the dirt path loop was probably used as a drip track for pressure cylinder chambers or treated wood ties. However, the concrete pad does not contain visual evidence of contamination. South of the pad, evidence of rail lines was observed indicating that a railroad connection may have been located in this area. The railroad connection may have transported creosote or ties to and from the treatment area.

### 3.2 Previous Investigations/Enforcement Activities

Previous investigations conducted at Site 3 include a Site Inspection (1991) and a Remedial Investigation (1994-95). More detailed information is located in the Site Inspection Report (Halliburton/NUS, 1991) and the Remedial Investigation Report (Baker, 1996).

#### 3.2.1 Site Inspection, 1991

In June 1991, Halliburton/NUS conducted a Site Inspection that included soil, groundwater, and sediment investigations. Figure 3 identifies the sampling locations associated with these investigations.

Table 1 presents the analytical results for soil. The surficial soil samples collected from 0 to 2 feet below ground surface (bgs) contained semivolatile organic compounds (SVOCs), particularly

polynuclear aromatic hydrocarbons (PAHs), which were detected at concentrations ranging from 260 microgram per kilogram (µg/kg) for benzo(g,h,i)perylene to 2,200 µg/kg for benzo(b)fluoranthene. Several PAHs, including chrysene, benzo(k)fluoranthene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene, were detected in the surficial soil at concentrations exceeding 1,000 µg/kg. PAHs were not detected in the shallow subsurface soil samples collected from three to five feet bgs. However, a deep subsurface soil sample from boring 03-MW02 (15 to 17 feet bgs) contained elevated PAH concentrations. In this sample, several PAHs, including acenaphthene, fluoranthene, fluorene, naphthalene, and phenanthrene, were detected at concentrations exceeding 35,000 µg/kg; dibenzofuran was detected at 35,000 µg/kg. Based on the sample depth and sampling logs, this deep subsurface soil sample may have been collected from the saturated zone.

Table 2 presents the analytical results for groundwater. Of the three groundwater samples collected, only the sample from well 03-MW02 contained SVOCs. Several PAHs, including acenaphthene, 2-methylnaphthalene, naphthalene, and phenanthrene, were detected at concentrations exceeding 1,000 microgram per liter (µg/L). Other detected PAHs included anthracene (260 µg/L), chrysene (96 µg/L), fluoranthene (640 µg/L), fluorene (890 µg/L), and pyrene (460 µg/L). In addition, dibenzofuran was detected at a concentration of 1,100 µg/L.

In sediment, the SVOC bis(2-ethylhexyl)phthalate was detected at a concentration of 750 µg/kg. However, this constituent is a common laboratory contaminant so its presence is most likely not site-related. No other SVOCs were detected in the sediment during the Site Inspection.

### 3.2.2 Remedial Investigation, 1994-95

From 1994 through 1995, Baker Environmental, Inc. (Baker) conducted field activities for an RI at Site 3. These field activities, which included soil and groundwater investigations, were conducted in three phases. Phase 1, conducted in September 1994, consisted of a surface soil investigation using enzyme linked immunosorbent assay (ELISA) field screening (i.e., surface soil samples were collected and immediately analyzed for PAHs in the field using an ELISA field test kit). A total of 84 surface soil samples were collected and analyzed in the field. Thirty-seven of the 84 samples were sent to a laboratory for confirmatory analyses. The results of the Phase 1 surface soil investigation assisted in locating soil borings and monitoring wells at Site 3 during Phases 2 and 3 of the RI. Phase 2, conducted from October through December 1994, included surface soil, subsurface soil, and groundwater investigations. During this second phase, five shallow monitoring wells and one intermediate monitoring well (i.e., a well screened at the top of the Castle Hayne aquifer) were installed. Phase 3, conducted in June 1995, included surface soil, subsurface soil, and groundwater investigations. During this third phase, five additional shallow monitoring wells, one additional intermediate monitoring, and one deep monitoring well (i.e., a well screened in the middle of the Castle Hayne aquifer) were installed. In addition to these three RI phases, monitoring well 03-MW02DW was resampled a third time in January 1996.

Figures 4, 5, and 6 identify the soil sampling locations associated with the RI. Figure 4 identifies the sampling locations in the site's northern area (NA), Figure 5 identifies the sampling locations in the treatment area (TA)/concrete pad area (CP), and Figure 6 identifies the sampling locations in the railroad spur area (RS). Figure 7 identifies the groundwater sampling locations associated with the RI. In addition, Tables 3 and 4 present soil and groundwater sampling summaries, respectively.

Tables 5, 6, and 7 summarize the analytical results from the surface soil, subsurface soil, and groundwater investigations associated with the RI. Table 5 summarizes the surface soil results,

Table 6 summarizes the subsurface soil results, and Table 7 summarizes the groundwater results. These tables present concentration ranges for positively detected chemical constituents, and a comparison of constituent concentrations to relevant comparison criteria (i.e., federal, state, and/or local standards; background concentrations; or risk-based concentrations).

As the analytical results indicate, the most frequently detected organic contaminants were PAHs, which exhibited the highest concentrations in both soil and groundwater. Because creosote is made up of PAH compounds, the PAHs detected at Site 3 are believed to be associated with operations at the former creosote plant. The highest PAH concentrations in soil occurred in the treatment area of the site (i.e., the area encircled by the dirt path loop). Fuel constituents, such as ethylbenzene and xylene, were also detected in surface and subsurface soil at the former treatment area.

In the shallow aquifer, benzene was detected above federal and/or state standards in the central portion of the treatment area during the first and third groundwater sampling rounds, but not during the second round. Several PAHs, including naphthalene, phenanthrene, benzo(a)anthracene, chrysene, and benzo(a)pyrene, were detected above federal and/or state standards during the first sampling round. However, naphthalene was the only PAH that was detected above standards during the subsequent sampling rounds. Naphthalene was detected in the treatment area and in the rail spur area, but the locations and concentrations of detections were not consistent between the three groundwater sampling rounds.

In the Castle Hayne aquifer, volatile organic compounds (VOCs) (in particular, fuel constituents) and SVOCs (in particular, PAHs and phenols) were detected during all three sampling rounds. Benzene, chloroform, naphthalene, and phenol were the only organic contaminants detected above federal and/or state standards. Benzene was detected above standards in intermediate well 03-MW02IW during the first sampling round. During the second sampling round, benzene, phenol, and naphthalene were detected above standards in deep well 03-MW02DW (located in the treatment area). During the third sampling round, no contaminants were detected above federal and state standards in the Castle Hayne aquifer. When 03-MW02DW was resampled a third time (in January 1996) no contaminants were detected above federal and state standards.

## 4.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI, FS, and PRAP documents for OU No. 12 (Site 3) were released to the public on November 6, 1996. These documents are available in an administrative record file at information repositories maintained at the Onslow County Public Library and at the Installation Restoration Division Office (Room 238, MCB, Camp Lejeune). Also, all addresses on the OU No. 12 (Site 3) mailing list will be sent a copy of the Final PRAP and Fact Sheet. The notice of availability of the PRAP, RI, and FS documents was published in the "Jacksonville Daily News" on November 3, 1996. A public comment period was held from November 6, 1996 to December 6, 1996. In addition, a public meeting was held on November 6, 1996 to respond to questions and to accept public comments on the PRAP for OU No. 12 (Site 3). The public meeting minutes were transcribed and a copy of the transcript is presented in Appendix A of this ROD document. A copy of the transcript is also made available to the public at the aforementioned locations. A Responsiveness Summary, included as part of this ROD, has been prepared to respond to the significant comments, criticisms, and new relevant information received during the comment period. Upon signing this ROD, MCB, Camp Lejeune and the Department of the Navy (DoN) will publish a notice of availability for the ROD in the local newspaper, and place this ROD in the information repositories.

## 5.0 SCOPE AND ROLE OF THE RESPONSE ACTION

The scope of the response action for Site 3 includes two environmental media of concern: 1) subsurface soil, and 2) groundwater in the shallow aquifer. Based on the results of human health and ecological risk assessments, groundwater was the only environmental medium that generated unacceptable risk values (unacceptable human health risk values were generated under the future residential land use scenario - see Section 7.0 of this ROD). To address these unacceptable risk values, it was necessary to develop a response action for groundwater. Although subsurface soil did not generate unacceptable risk values, the subsurface soil was suspected to be contributing to the groundwater contamination by leaching PAHs. To address the potential for leaching contaminants, it was necessary to develop a response action for subsurface soil. Thus, two sets of remedial action alternatives were developed - one set for subsurface soil and one set for groundwater. A complete response action for Site 3 will combine one subsurface soil alternative and one groundwater alternative.

The response action for Site 3 focuses on specific areas of concern located within the subsurface soil and groundwater. Figure 8 depicts these areas of concern. The subsurface soil area of concern was defined based on SVOC concentrations that exceeded federal soil screening levels established to protect groundwater, and the depth of the water table. This area of concern extends from approximately three feet bgs to nine feet bgs (just above the water table). The total volume of soil within this area of concern is approximately 1,340 cubic yards. [Note: The soil area of concern does not include PAH contamination detected below the water table. This is because it is impractical to remediate this saturated soil. Continued groundwater monitoring, however, may be proposed to address this contamination.] The groundwater areas of concern were defined based on SVOC concentrations in the shallow aquifer that exceeded federal and/or state standards, or risk-based criteria. As shown in Figure 8, one groundwater area of concern is centered around well 03-MW02, and one groundwater area of concern is centered around well 03-MW06.

In the vicinity of 03-MW02, the subsurface soil area of concern is suspected to be the main source of groundwater contamination. Leaching PAHs from the subsurface soil most likely contaminated the groundwater in this area. Thus, the subsurface soil area of concern is considered a "source area" of contamination. The groundwater area of concern centered around 03-MW06 contains PAH concentrations, but at lower levels than the groundwater area of concern centered around 03-MW02. In the vicinity of 03-MW06, there does not appear to be a source area of contaminated soil.

## 6.0 SUMMARY OF SITE CHARACTERISTICS

Based on the results of a previous investigation and the RI, the most frequently detected organic contaminants at Site 3 were PAHs. Because creosote is made up of PAH compounds, the PAHs detected at Site 3 are believed to be associated with operations at the former creosote plant. Soil and groundwater (both shallow and deep) contained the highest levels of PAH compounds. In soil, the maximum PAH concentrations occurred in the treatment area of the site. In groundwater, the maximum PAH concentrations occurred in the treatment area and in the southern rail spike area. In addition to PAHs, fuel constituents, including benzene, were detected in soil and groundwater (both shallow and deep) at Site 3. The maximum concentrations of these fuel constituents, however, were scattered sporadically across the site.

## 7.0 SUMMARY OF SITE RISKS

As part of the RI, a human health risk assessment (RA) and an ecological RA were conducted to determine the potential risks associated with the chemical constituents detected at Site 3. The following subsections briefly summarize the findings of the human health and ecological RAs.

### 7.1 Human Health Risk Assessment

During the human health RA, contaminants of potential concern (COPCs) were selected for surface soil, subsurface soil, and groundwater, as shown in Table 8. The selection of COPCs was based on criteria provided in the U.S. Environmental Protection Agency (USEPA) Risk Assessment Guidance for Superfund.

For each COPC, incremental lifetime cancer risk (ICR) values and hazard index (HI) values were calculated to quantify potential carcinogenic and noncarcinogenic risks, respectively. Table 9 presents the ICR and HI values for each environmental medium and receptor evaluated. (Receptors included current military personnel, future child and adult residents, and future construction workers.) Table 9 also presents total ICR and HI values which represent risks to all environmental media combined, for each receptor. A shaded block in Table 9 indicates an ICR value that exceeds the USEPA acceptable limit of 1E-04 for carcinogens, or an HI value that exceeds the USEPA acceptable limit of 1.0 for noncarcinogens. As shown in Table 9, unacceptable risk values were generated for future child and adult residents upon exposure to groundwater.

As shown in Tables 8 and 9, the COPCs and risk values for groundwater were generated under two approaches: 1) the evaluation of Round 2 groundwater data, and 2) the evaluation of Rounds 1, 2, and 3 groundwater data combined (referred to as the "Worst Case" approach). The latter approach is more conservative.

### 7.2 Ecological Risk Assessment

During the ecological RA, COPCs were selected for surface soil as shown in Table 10. Then, the potential ecological impacts to terrestrial receptors were evaluated for each COPC. Several COPCs, including some SVOCs and the inorganic chromium, exceeded surface soil screening values (SSSVs) in open grass areas or along tree lines. However, most of the studies used to develop SSSVs do not take into account the soil type, which may have a large influence on the toxicity of contaminants. In addition, most of the SSSVs are based on one or two studies which limits their reliability for a wide range of site-specific circumstances. Overall, the SSSVs have a high degree of uncertainty associated with them and are not well-established. Consequently, potential ecological risks based on these SSSVs may not be completely accurate and most likely err on the conservative side. In addition, none of the quotient indices (QIs) generated for terrestrial receptors exceeded the acceptable limit of 1.0, so potential impacts to terrestrial mammals or birds are not expected. No threatened or endangered species are known to inhabit Site 3, and no wetlands were identified.

## 8.0 DESCRIPTION OF ALTERNATIVES

Based on the response action developed for Site 3, remedial action alternatives (RAAs) were developed and evaluated. Five alternatives were developed for subsurface soil:

- Soil RAA No. 1: No Action
- Soil RAA No. 2: Land Use Restrictions
- Soil RAA No. 3: Source Removal and Off Site Landfill Disposal
- Soil RAA No. 4: Source Removal and Off Site Incineration
- Soil RAA No. 5: Source Removal and Biological Treatment

Three alternatives were developed for groundwater:

- Groundwater RAA No. 1: No Action
- Groundwater RAA No. 2: Aquifer Use Restrictions and Monitoring
- Groundwater RAA No. 3: Extraction and On Site Carbon Adsorption Treatment

The following paragraphs describe these soil and groundwater alternatives.

### 8.1 Description of Soil Alternatives

#### 8.1.1 Soil RAA No. 1: No Action

| | |
|---|---|
| Capital Cost: | $0 |
| Annual Operation and Maintenance (O&M) Cost: | $0 |
| Net Present Worth (NPW): | $0 |
| Years to Implement: | None |

Under Soil RAA No. 1, no remedial actions will be implemented to address the subsurface soil area of concern. The no action alternative is required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) as a baseline for comparison with other remedial action alternatives that provide a greater level of response. Under this alternative, contaminants will remain untreated in the subsurface soil. As a result, the lead agency will be required to review the effects of this alternative at least once every five years.

#### 8.1.2 Soil RAA No. 2: Land Use Restrictions

| | |
|---|---|
| Capital Cost: | $0 |
| Annual O&M Cost: | $0 |
| NPW: | $0 |
| Years to Implement: | Less Than One Month |

Under Soil RAA No. 2, land use restrictions will be implemented to limit future development and use of the site, and to avoid future exposure to the subsurface soil contaminants. Because the subsurface soil area of concern will not receive active treatment, the lead agency will be required to review the effects of the alternative at least once every five years.

### 8.1.3 Soil RAA No. 3: Source Removal and Off Site Landfill Disposal

| | |
|---|---|
| Capital Cost: | $920,000 |
| Annual O&M Cost: | $0 |
| NPW: | $920,000 |
| Years to Implement: | Less Than One Month |

Under Soil RAA No. 3, the subsurface soil area of concern, which is considered a source of groundwater contamination at Site 3, will be excavated to a depth of nine feet bgs. Confirmatory soil samples will be collected from the excavation area to ensure that contaminated soil above the water table has been removed to acceptable limits. The excavated soil located from 0 to 9 feet bgs (approximately 2,000 cubic yards) will be sent off site to a Resource Conservation and Recovery Act (RCRA) permitted Subtitle C facility for disposal. Finally, the excavation area will be backfilled with clean fill from an on Base borrow pit. In addition to source removal and landfill disposal, Soil RAA No. 3 includes land use restrictions until the soil remediation is complete. Although the subsurface soil area of concern will be removed, a 5-year review by the lead agency may still be required for contaminated groundwater remaining at the site.

### 8.1.4 Soil RAA No. 4: Source Removal and Off Site Incineration

| | |
|---|---|
| Capital Cost: | $3,150,000 |
| Annual O&M Cost: | $0 |
| NPW: | $3,150,000 |
| Years to Implement: | Less Than One Month |

Under Soil RAA No. 4, the subsurface soil area of concern will be excavated to a depth of nine feet bgs. Confirmatory soil samples will be collected from the excavation area to ensure that contaminated soil above the water table has been removed to acceptable limits. The excavated soil located from 0 to 9 feet bgs (approximately 2,000 cubic yards) will be sent off site for thermal treatment at a permitted incineration facility. Finally, the excavation area will be backfilled with clean fill from an on Base borrow pit. In addition to source removal and incineration, Soil RAA No. 4 includes land use restrictions until the soil remediation is complete. Although the subsurface soil area of concern will be removed, a 5-year review by the lead agency may be required for contaminated groundwater remaining at the site.

### 8.1.5 Soil RAA No. 5: Source Removal and Biological Treatment

| | |
|---|---|
| Capital Cost: | $362,000 |
| Annual O&M Cost: | $35,000 |
| NPW: | $514,000 |
| Years to Implement: | Assumed to be 5 years |

Under Soil RAA No. 5, the subsurface soil area of concern will be excavated to a depth of nine feet bgs. Confirmatory soil samples will be collected from the excavation area to ensure that contaminated soil above the water table has been removed to acceptable limits. The excavated soil located from 0 to 9 feet bgs (approximately 2,000 cubic yards) will undergo aerobic, solid-phase biological treatment at one of two locations: 1) the existing Lot 203 biocell at MCB, Camp Lejeune, or 2) a biocell constructed at Site 3. The treatment location will depend on the availability of the Lot 203 biocell which is currently being used to treat petroleum, oil, and lubricant (POL)-

contaminated soil from other sites at MCB, Camp Lejeune. In addition, the treatment location will depend on the ability to modify the permit for the Lot 203 biocell so that is can accept PAH-contaminated soil. Prior to implementation, a pilot-scale treatability study will be conducted at Site 3 to further determine the effectiveness of this alternative. The treatability study is currently scheduled to begin in the Spring of 1997.

The biological treatment will be conducted using landfarming technology within a controlled unit (the "biocell"). The contaminated soil will be placed in a 12 inch lift underlain by a 24 inch lift of coarse sand, a high density polyethylene geomembrane liner, and a non-woven geotextile fabric. Leachate will be collected by a leachate collection line and sump, and periodically resprayed back onto the contaminated soil. Maintenance of the biocell will consist of periodic leachate collection and respraying, soil tilling, nutrient and fertilizer addition, and soil sampling.

Soil RAA No. 5 also includes land use restrictions until the soil remediation is complete. Although the subsurface soil area of concern will be removed and treated, a 5-year review by the lead agency will be required until the remediation levels for soil are achieved.

## 8.2 Description of Groundwater Alternatives

### 8.2.1 Groundwater RAA No. 1: No Action

| | |
|---|---|
| Capital Cost: | $0 |
| Annual O&M Cost: | $0 |
| NPW: | $0 |
| Years to Implement: | None |

Under Groundwater RAA No. 1, no remedial actions will be implemented to address the groundwater areas of concern. The no action alternative is required by the NCP as a baseline for comparison with other remedial action alternatives that provide a greater level of response. Under this alternative, contaminants will remain untreated in the groundwater. As a result, the NCP requires the lead agency to review the effects of this alternative at least once every five years.

### 8.2.2 Groundwater RAA No. 2: Aquifer Use Restrictions, and Monitoring

| | |
|---|---|
| Capital Cost: | $0 |
| Annual O&M Cost (Years 1-5): | $64,000 |
| Annual O&M Cost (Years 6-30: | $33,000 |
| NPW: | $643,000 |
| Years to Implement: | 30 Years of Groundwater Monitoring |

Under Groundwater RAA No. 2, aquifer use restrictions and a groundwater monitoring program will be implemented. The aquifer use restrictions will prohibit future use of the shallow and Castle Hayne aquifers, within a 100 foot radius of Site 3, as potable water sources. The monitoring program will include quarterly groundwater sampling and analysis at four shallow monitoring wells (03-MW02, 03-MW06, 03-MW07, and 03-MW08), two intermediate monitoring wells (03-MW02IW and 03-MW11IW), and one deep monitoring well (03-MW02DW). If the groundwater quality improves, the sampling frequency may be reduced from quarterly to semiannual. The samples will be analyzed for TCL VOCs and SVOCs to monitor contaminant concentrations in the shallow and Caste Hayne aquifers over time. For cost estimating purposes,

quarterly sampling was assumed for years 1-5, and semiannual sampling was assumed for years 6-30. Additional wells may be added to the monitoring program if necessary. Under Groundwater RAA No. 2, the groundwater areas of concern will not receive active treatment so the lead agency will be required to review the effects of this alternative at least once every five years.

### 8.2.3 Groundwater RAA No. 3: Extraction and On Site Carbon Adsorption Treatment

| | |
|---|---|
| Capital Cost: | $422,000 |
| Annual O&M Cost (Years 1-5): | $64,000 |
| Annual O&M Cost (Years 6-30): | $33,000 |
| Annual O&M Cost (Treatment System Years 1-3): | $85,000 |
| NPW: | $2,370,000 |
| Years to Implement: | 30 Years of Treatment Plant O&M;<br>30 Years of Groundwater Monitoring |

Under Groundwater RAA No. 3, a groundwater extraction and treatment system (i.e., a pump and treat system) will be installed at Site 3. Two extraction wells will be installed within the shallow aquifer at depths of approximately 20 feet bgs. One extraction well will be located near existing well 03-MW02, and one extraction well will be located near existing well 03-MW06. The wells' pumping rates will allow their cones of influence to intercept the groundwater areas of concern. (For cost estimating purposes, it is assumed that each well will pump at 5 gallons per minute and generate a 220 foot radius of influence). Once extracted, the contaminated groundwater will be transported via pipeline to an on site treatment plant located between existing wells 03-MW02 and 03-MW06. At the treatment plant, the groundwater will undergo pretreatment via oil/water separation, neutralization, precipitation, filtration, flocculation, and sedimentation. Then the groundwater will undergo liquid-phase carbon adsorption treatment. The treated groundwater will be discharged by pipeline to the nearest sanitary sewer line for subsequent discharge to a Base sewage treatment plant.

In addition to groundwater extraction and treatment, Groundwater RAA No. 3 includes land use and aquifer use restrictions and a groundwater monitoring program. (See Groundwater RAA No. 2 for a description of the restrictions and monitoring program included under Groundwater RAA No. 3.) Because the contaminated groundwater will remain on site indefinitely, 5-year reviews by the lead agency will be required.

## 9.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

This section summarizes the comparative analysis of alternatives that was conducted for the soil and groundwater RAAs. During the analysis, the RAAs were comparatively evaluated using seven USEPA evaluation criteria: overall protection of human health and the environment; compliance with applicable and relevant or appropriate requirements (ARARs)/ to-be-considered criteria (TBCs); long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. Table 11 presents definitions of these evaluation criteria.

## 9.1 Analysis of Soil Alternatives

### 9.1.1 Overall Protection of Human Health and the Environment

Under Soil RAA No. 1 (No Action) and Soil RAA No. 2 (Land Use Restrictions), no remediation actions will be implemented to remove or treat the area of concern containing contaminated subsurface soil. Because the contaminated soil will be left as is, it will continue to be a potential source of groundwater contamination (via contaminant leaching). As such, the contaminated soil will be contributing to the unacceptable human health risks associated with groundwater. (These risks were generated under the future residential land use scenario.) Soil RAA No. 1 provides no means for reducing these potential risks. Soil RAA No. 2, on the other hand, includes land use restrictions that will reduce some of the potential risks. Regardless, under both Soil RAA Nos. 1 and 2, contaminants may continue to leach from the subsurface soil to the groundwater.

Compared to Soil RAA Nos. 1 and 2, Soil RAA No. 3 (Source Removal and Off Site Landfill Disposal), Soil RAA No. 4 (Source Removal and Off Site Incineration), and Soil RAA No. 5 (Source Removal and Biological Treatment) will significantly reduce the human health risks associated with groundwater by completely removing a major source of the groundwater contamination - the subsurface soil area of concern above the water table. Because Soil RAA Nos. 3, 4, and 5 are source removal alternatives, they will prevent the further leaching of PAH contaminants from the subsurface soil (at 3 to 9 feet bgs) to the groundwater. Thus, Soil RAA No. 1 provides no additional protection of human health, Soil RAA No. 2 provides some additional protection, and Soil RAA Nos. 3, 4, and 5 provide significant protection.

Because ecological risks were determined to be insignificant, conditions at Site 3 are already considered to be protective of the environment. As a result, all five soil RAAs will provide overall protection of the environment. The biocell included under Soil RAA No. 5 could potentially present risks to terrestrial receptors. However, if the biocell is properly controlled (with a cover and a surrounding earthen berm), these ecological risks will be insignificant.

### 9.1.2 Compliance with ARARs/TBCs

Under Soil RAA Nos. 1 and 2, contaminants will remain in the subsurface soil at concentrations that exceed chemical-specific TBCs (i.e., the federal soil screening levels developed for USEPA Region III; no chemical-specific ARARs were identified for soil). Thus, soil conditions at the site will not meet chemical-specific TBCs. Under Soil RAA Nos. 3, 4, and 5, soil contaminants that exceed the federal soil screening levels will be removed from the subsurface. Thus, soil conditions at the site will meet chemical-specific TBCs.

Soil RAA Nos. 3, 4, and 5 can be designed to meet all of the location- and action-specific ARARs/TBCs that apply to them. No location- or action-specific ARARs/TBCs apply to Soil RAA Nos. 1 and 2.

### 9.1.3 Long-Term Effectiveness and Permanence

Soil RAA No. 1 does not provide long-term effectiveness and permanence. This is because Soil RAA No. 1 allows a source of groundwater contamination, the subsurface soil area of concern, to remain in place and untreated. In addition, Soil RAA No. 1 does not provide controls to manage the remaining soil contaminants. Like Soil RAA No. 1, Soil RAA No. 2 allows the subsurface soil area

of concern to remain in place and untreated. However, Soil RAA No. 2 includes land use restrictions to manage the remaining soil contaminants. Therefore, Soil RAA No. 2 provides a greater level of long-term effectiveness and permanence than Soil RAA No. 1. The restrictions will effectively prevent human exposure to the PAH contaminants. However, under Soil RAA No. 2, the contaminants will continue to leach from the subsurface soil to the groundwater.

Compared to Soil RAA Nos. 1 and 2, Soil RAA Nos. 3, 4, and 5 provide high levels of long-term effectiveness and permanence. Under Soil RAA Nos. 3, 4, and 5, the subsurface soil area of concern will be completely removed, preventing contaminants from leaching into the groundwater. Soil RAA Nos. 3, 4, and 5 also include land use restrictions which provide additional long-term effectiveness and permanence.

### 9.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Soil RAA Nos. 1 and 2 do not involve source removal or treatment processes, so these alternatives will not reduce toxicity, mobility, or volume of the soil contaminants. Soil RAA Nos. 3, 4, and 5, however, involve soil removal and treatment and/or disposal so these alternatives will result in toxicity, mobility, and volume reduction. Most importantly, Soil RAA Nos. 3, 4, and 5 will eliminate the mobility of PAH contaminants by preventing them from leaching into the groundwater.

Soil RAA Nos. 1, 2, and 3 do not satisfy the statutory preference for treatment. Soil RAA Nos. 4 and 5 do satisfy the statutory preference.

### 9.1.5 Short-Term Effectiveness

Implementation of Soil RAA Nos. 1 and 2 does not increase risks to the community or to workers because these alternatives include no actions other than administrative efforts. Soil RAA Nos. 3, 4, and 5, however, will present risks during soil excavation and backfilling activities. In addition, Soil RAA Nos. 3 and 4 will present risks during transportation of the contaminated soil to the treatment/disposal facility associated with each alternative. Soil RAA No. 4 will present additional risks by creating incinerator off-gas that may escape to the atmosphere. Soil RAA No. 5 will present risks during the initial placement of the contaminated soil, and during the treatment O&M.

Under RAAs Nos. 3 through 5, the following measures will be taken to provide adequate community and worker protection: proper materials handling procedures, personal protective equipment, and construction safety fencing. Air pollution control equipment at the incineration facility will also reduce the risks associated with off-gases under Soil RAA No. 4. In addition, a cover/liner system and periodic maintenance checks will provide additional protection for the treatment cell associated with Soil RAA No. 5. None of the RAAs will present significant environmental impacts.

### 9.1.6 Implementability

Soil RAA No. 1 is the most implementable, if not the most effective, alternative. Soil RAA No. 2 is the next most implementable alternative because the only activity it involves is ordinance procurement. The remaining RAAs (Soil RAA Nos. 3, 4, and 5) are similar in that they include the excavation of subsurface soil. Soil RAA Nos. 3 and 4 both include transportation of contaminated soil to a treatment/disposal facility. This transportation will require appropriate materials handling procedures. Compared to Soil RAA Nos. 3 and 4, however, Soil RAA No. 5 will be less easy to

implement because it involves mixing of the excavated soil with bulking agents and additives, and long-term O&M of the biocell. In addition, Soil RAA No. 5 requires a treatability study.

### 9.1.7 Cost

In terms of NPW, the no action alternative (Soil RAA No. 1) and the land use restrictions alternative (Soil RAA No. 2) will be the least expensive to implement, followed by Soil RAA No. 5, Soil RAA No. 3, and Soil RAA No. 4. The estimated NPW values, in increasing order, are

- $0 (Soil RAA No. 1 - No Action)
- $0 (Soil RAA No. 2 - Land Use Restrictions)
- $514,000 (Soil RAA No. 5 - Source Removal and Biological Treatment)
- $917,000 (Soil RAA No. 3 - Source Removal and Off Site Landfill Disposal)
- $3,150,000 (Soil RAA No. 4 - Source Removal and Off Site Incineration)

## 9.2 Analysis of Groundwater Alternatives

### 9.2.1 Overall Protection of Human Health and the Environment

Groundwater RAA No. 1 (No Action) will not reduce the human health risks associated with groundwater. On the other hand, Groundwater RAA No. 2 (Aquifer Use Restrictions and Monitoring) and Groundwater RAA No. 3 (Extraction and On Site Carbon Adsorption Treatment) will reduce human health risks because both alternatives include restrictions and monitoring programs. The restrictions will prevent human receptors from ingesting, dermally contacting, or inhaling groundwater contaminants. Monitoring will provide a warning system against contaminants that have migrated to unsafe locations, and contaminant concentrations that have increased to unsafe levels, so that human exposure can be avoided. Thus, Groundwater RAA Nos. 2 and 3 will prevent the potential for direct exposure to contaminated groundwater, but Groundwater RAA No. 1 will not. In addition, Groundwater RAA Nos. 2 and 3 will provide overall protection of human health and the environment, but Groundwater RAA No. 1 will not.

Compared to Groundwater RAA Nos. 1 and 2, Groundwater RAA No. 3 provides some additional protection of human health and the environment by collecting the groundwater contaminants and actively treating them at an on site treatment plant. However, this additional protection is not necessary to prevent future human exposure to the groundwater contaminants. PAHs exhibit low volatility and low aqueous solubility. Due to their hydrophobic nature, PAHs tend to adsorb onto soils and sediment. As a result, the PAH contaminants at Site 3 will have a low migration potential so it is unlikely that they will horizontally or vertically migrate to the nearest current receptors.

### 9.2.2 Compliance with ARARs/TBCs

Groundwater RAA Nos. 1 and 2 will allow contaminant levels exceeding chemical-specific ARARs (i.e., federal and state standards, and risk-based criteria) to remain in groundwater at the site. Because of this, Groundwater RAA Nos. 1 and 2 may require a waiver of the chemical-specific ARARs before these alternatives can be implemented. Groundwater RAA No. 3 could potentially remediate the groundwater to chemical-specific ARARs, but most likely the pump and treat system will not be capable of achieving such stringent cleanup standards. Groundwater contaminants, especially PAHs, may sorb to solid particles or escape into subsurface pore spaces or fissures where they become difficult to extract. Most likely, extraction wells will only collect a portion of the PAH

contamination; the remaining PAH contamination will remain in the aquifer. Therefore, a pump and treat system may not be able to achieve chemical-specific ARARs.

No location- or action-specific ARARs/TBCs apply to Groundwater RAA Nos. 1 and 2. Groundwater RAA No. 3 can be designed to meet all of the location- and action- specific ARARs/TBCs that apply to it.

### 9.2.3 Long-Term Effectiveness and Permanence

Groundwater RAA No. 3 will provide long-term effectiveness and permanence because it involves collection and treatment of the contaminated groundwater. Although Groundwater RAA No. 2 will allow contaminants to remain untreated at the site, this alternative will also provide long-term effectiveness and permanence. Based on the hydrophobic nature of PAH contaminants, and the results of a two-dimensional flow model conducted for the FS, leaving PAH contaminants untreated at the site will not affect the nearest, current receptor (a potable water supply well located approximately 700 feet west of Site 3). It may affect future receptors occurring in the vicinity of Site 3, but Groundwater RAA No. 2 includes aquifer use restrictions and monitoring that will effectively prevent future human exposure. Groundwater RAA No. 1, on the other hand, provides no means for preventing future human exposure so this alternative will not provide long-term effectiveness and permanence.

The pump and treat system included under Groundwater RAA No. 3 will only be adequate and reliable to a certain extent. Technologies for completely extracting contaminants from groundwater are not proven. Contaminants, especially PAHs, may adsorb to solid particles or escape into subsurface pore spaces or fissures where they become difficult to extract. Also, contaminants may continue to leach from solid particles into the groundwater. As a result, extraction wells may not be completely reliable for removing PAH contaminants from the shallow aquifer.

All three groundwater alternatives will require 5-year reviews by the lead agency to ensure that adequate protection of human health and the environment is maintained.

### 9.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Groundwater RAA No. 3 will reduce the toxicity, mobility, and volume of contaminated groundwater that is collected by the extraction wells. However, some of the contaminated groundwater will not be collected so it will not receive treatment. This is because PAH contaminants may adsorb to soils and sediments and escape in pore spaces and fissures. Unlike Groundwater RAA No. 3, Groundwater RAA Nos. 1 and 2 do not involve groundwater extraction or active treatment processes. Therefore, Groundwater RAA Nos. 1 and 2 will not reduce the toxicity, mobility, or volume of groundwater contamination.

Unlike Groundwater RAA Nos. 1 and 2, Groundwater RAA No. 3 will create treatment residuals. The residuals associated with Groundwater RAA No. 3 (sludge, separated oil, exhausted carbon, and treated groundwater) will be voluminous and will require proper treatment and/or disposal.

Groundwater RAA No. 3 satisfies the statutory preference for treatment; Groundwater RAA Nos. 1 and 2 do not.

### 9.2.5 Short-Term Effectiveness

Implementation of Groundwater RAA Nos. 1 and 2 does not pose substantial risks to the community or to workers. Implementation of Groundwater RAA No. 3 does pose risks because it involves construction of extraction wells, underground pipelines, and a treatment facility. During pipeline construction, special care must be taken to avoid underground utilities. In addition, construction safety fencing and dust minimization procedures should provide adequate protection to the community and to workers. Groundwater RAA No. 3 also involves long-term operation and maintenance of an extraction well system and an on site treatment facility. The treatment facility will generate residual waste streams that must be properly treated and/or disposed. The use of personal protective equipment and proper materials handling procedures should provide adequate protection during operation and maintenance. Because it creates aquifer drawdown, Groundwater RAA No. 3 is the only alternative that could potentially create environmental impacts.

Under all three groundwater alternatives, the time for the action to be complete is unknown. Thirty years of groundwater monitoring was assumed for Groundwater RAA No. 2, and 30 years of groundwater monitoring and treatment system O&M was assumed for Groundwater RAA No. 3.

### 9.2.6 Implementability

Groundwater RAA No. 1 is the easiest alternative to implement, if not the most effective. Groundwater RAA No. 2 is the next most implementable alternative followed by Groundwater RAA No. 3. Groundwater RAA No. 1 requires no operation or maintenance. Groundwater RAA No. 2 requires minimal operation and maintenance (groundwater samples will be collected and wells will be replaced periodically). Groundwater RAA No. 3, however, requires extensive operation and maintenance. Under all three alternatives, additional remedial actions could easily be implemented.

Groundwater RAA Nos. 2 and 3 involve conventional equipment and services that should be readily available. Compared to Groundwater RAA No. 2, Groundwater RAA No. 3 will require more extensive coordination with the Base Public Works/Planning department. Unlike Groundwater RAA No. 1, Groundwater RAA Nos. 2 and 3 will require semiannual submission of reports that document sampling results. Unlike Groundwater RAA No. 3, Groundwater RAA Nos. 1 and 2 may require a waiver of ARARs since groundwater contaminants will be left untreated at the site.

### 9.2.7 Cost

In terms of NPW, the no action alternative (Groundwater RAA No. 1) will be the least expensive alternative to implement, followed by Groundwater RAA No. 2, then Groundwater RAA No. 3. The estimated NPW values in increasing order are

- $0 (Groundwater RAA No. 1 - No Action)
- $643,000 (Groundwater RAA No. 2 - Aquifer Use Restrictions and Monitoring)
- $2,370,000 (Groundwater RAA No. 3 - Extraction and On Site Carbon Adsorption Treatment)

## 10.0 THE SELECTED REMEDY

This section of the ROD presents the selected remedy for OU No. 12 (Site 3) which is a combination of the separate remedies selected for soil and groundwater. The following information is presented: a remedy description, which includes the rationale behind the remedy selection; the costs estimated to implement the remedy; and the remediation levels to be attained at the conclusion of the remedy.

### 10.1 Remedy Description

The selected remedy for OU No. 12 (Site 3) is a combination of Soil RAA No. 5 - Source Removal and Biological Treatment, and Groundwater RAA No. 2 - Aquifer Use Restrictions, and Monitoring. Thus, the selected remedy includes the following:

- Excavating the subsurface soil area of concern to a depth of nine feet bgs or to just above the water table.
- Confirmatory soil sampling in the excavation area to ensure that contaminated soil has been removed to acceptable levels.
- Treating the excavated soil (approximately 2,000 cubic yards) with aerobic, solid-phase biological treatment in a biocell.
- Backfilling the excavation area with "clean" soil.
- Implementing land use restrictions that will limit future land development use at the site until the soil remediation has been completed.
- Quarterly sampling of groundwater from monitoring wells 03-MW02, 03-MW02IW, 03-MW02DW, 03-MW06, 03-MW07, 03-MW08, and 03-MW11IW; analyzing the samples for TCL VOCs and SVOCs. If groundwater quality improves, the sampling frequency may be reduced from quarterly to semiannual.
- Implementing aquifer use restrictions via the Base Master Plan to prohibit future use of the shallow and Castle Hayne aquifers, within a 100 foot radius of Site 3, as potable water sources.

#### 10.1.1 The Selection of Soil RAA No. 5 - Source Removal and Biological Treatment

At Site 3, the subsurface soil area of concern appears to be the main source of groundwater contamination (via contaminant leaching). As a result, source removal alternatives (i.e., Soil RAA Nos. 3, 4, and 5) were considered to be more appropriate than alternatives that leave the soil in situ and untreated (i.e., Soil RAA Nos. 1 and 2). This is because source removal alternatives eliminate the potential for soil contaminants to leach into the groundwater. Under the source removal alternatives, contaminants that could potentially leach will be removed from the subsurface and treated and/or disposed. Because Soil RAA Nos. 1 and 2 allow a source area of contamination to remain in situ and untreated, these alternatives do not provide adequate protection of human health.

Compared to Soil RAA Nos. 3 and 4, Soil RAA No. 5 is the most cost effective source removal alternative. Although the NPW of Soil RAA No. 5 ($514,000) is similar to the NPW of Soil RAA No. 3 ($920,000), Soil RAA No. 5 includes an extra advantage. Under Soil RAA No. 5, the contaminated soil will be treated then reused at the Base as general backfill material. Under Soil RAA No. 3, the contaminated soil will be landfilled. Thus, Soil RAA No. 5 allows for the beneficial reuse of the contaminated soil.

### 10.1.2 The Selection of Groundwater RAA No. 2 - Aquifer Use Restrictions and Monitoring

The groundwater contamination at Site 3 mainly consists of PAH compounds. Because PAHs exhibit low water solubility, they tend to adsorb to soil and sediment making them relatively immobile contaminants. As a result, the PAH-contaminated groundwater, if left untreated, is not likely to migrate beyond the limits identified in Figure 8. To reinforce this theory, a two-dimensional horizontal flow model was conducted during the FS. The results of the model indicated that untreated PAH-contaminated groundwater will not pose unacceptable risks to the nearest receptor (a potable water supply well) that is currently located on Base. However, future potential receptors located in the vicinity of Site 3 could be affected by the PAH-contaminated groundwater. Thus, a no action plan (i.e., Groundwater RAA No. 1) will not maintain adequate protection of human health. Groundwater RAA No. 2, on the other hand, will maintain adequate protection. Groundwater RAA No. 2 provides aquifer use restrictions that will prohibit the future use of the aquifer, thus protecting any future receptors. In addition, Groundwater RAA No. 2 includes a groundwater monitoring program that will provide a warning system in case contaminant concentrations increase to unsafe levels. This monitoring program provides additional protection of human health.

Compared to Groundwater RAA No. 2, Groundwater RAA No. 3 is not a cost effective alternative. The NPW of Groundwater RAA No. 2 is $643,000 and the NPW of Groundwater RAA No. 3 is $2,370,000. Although Groundwater RAA No. 3 includes extraction and treatment of the contaminated groundwater, the ability of a pump and treat system to effectively extract groundwater contamination is not proven. Contaminants, especially PAHs, will sorb to soil particles and become trapped in subsurface fissures and pores where they are difficult, if not impossible, to extract. Thus, Groundwater RAA No. 3 may only have limited effectiveness. Groundwater RAA No. 2, on the other hand, will have proven effectiveness (aquifer use restrictions and groundwater monitoring are conventional and well-demonstrated). As long as the source of the contamination is removed (i.e., the subsurface soil area of concern), the PAHs in groundwater are expected to remain in the same general vicinity and naturally attenuate over time.

## 10.2 Estimated Costs

The following costs were estimated for the remedies selected for soil and groundwater remedies:

- **Source Removal and Biological Treatment**

| | |
|---|---|
| Capital Cost: | $362,000 |
| Annual O&M: | $35,000 |
| NPW: | $514,000 |

- **Aquifer Use Restrictions, and Monitoring**

| | |
|---|---|
| Capital Cost: | $0 |
| Annual O&M (Years 1-5): | $64,000 |
| Annual O&M (Years 6-30): | $33,000 |
| NPW: | $643,000 |

The following total cost was estimated for the complete OU No. 12 (Site 3) remedy (addressing both soil and groundwater):

- **Total Costs**

| | |
|---|---|
| Capital Cost: | $362,000 |
| Annual O&M (Years 1-5): | $99,000 |
| Annual O&M (Years 6-30): | $68,000 |
| NPW: | $1,157,000 |

### 10.3 Remediation Levels

Tables 12 and 13 present the remediation levels developed for soil and groundwater, respectively. The soil remediation levels are based on federal soil screening levels that were established to estimate the concentration at which soil contaminants may leach and create unsafe groundwater conditions. The groundwater remediation levels are either state standards, federal standards, or risk-based concentrations calculated specifically for Site 3.

## 11.0 STATUTORY DETERMINATIONS

A selected remedy should satisfy the statutory requirements of CERCLA Section 121 which include: (1) protect human health and the environment; (2) comply with ARARs; (3) achieve cost-effectiveness; (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element, or provide an explanation as to why this preference is not satisfied. The following paragraphs evaluate the selected remedy for OU No. 12 (Site 3) with respect to these requirements.

### 11.1 Protection of Human Health

Source Removal and Biological Treatment will protect human health by removing the source area of contamination (i.e., the subsurface soil area of concern) from the site. When this source area is removed, PAH contaminants will no longer leach from the soil to the groundwater. As a result, subsurface soil will no longer be contributing to unacceptable human health risks associated with groundwater.

Aquifer Use Restrictions and Monitoring will protect human health by preventing future human exposure to potential contaminants in the groundwater. Aquifer use restrictions will prevent future human exposure by prohibiting the use of the shallow and Castle Hayne aquifers, within a 100 foot radius of Site 3, as potable water sources. The groundwater monitoring program will prevent future human exposure by providing a warning system against contaminant concentrations that have increased to unsafe levels.

Because ecological risks were determined to be insignificant, conditions at Site 3 are already considered to be protective of the environment, regardless of any remedy that is implemented. The selected remedy will not provide any additional protection of the environment.

### 11.2 Compliance with Applicable or Relevant and Appropriate Requirements

Although there were no chemical-specific ARARs identified for soil at Site 3, the federal soil screening levels were identified as chemical-specific TBCs. Because soil with contaminant levels exceeding these screening levels will be excavated and treated, the selected remedy will achieve the soil TBCs.

Federal standards, state standards, and risk-based concentrations were identified as chemical-specific ARARs for groundwater. Because groundwater will be left untreated, the selected remedy will not achieve these ARARs. Before implementing the selected remedy, a waiver of the chemical-specific ARARs may be required. Regardless, the remedy provides adequate controls, in the form of land use restrictions, aquifer use restrictions, and monitoring, to effectively manage the untreated groundwater that will remain on site.

The selected remedy can be designed to meet all of the location- and action- specific ARARs that apply to it.

### 11.3 Cost-Effectiveness

Compared to the other soil alternatives that were considered, Source Removal and Biological Treatment was the most cost effective remedy capable of providing adequate protection to human health and the environment. Land use and aquifer use restrictions provide a cost-effective remedy since there are no significant costs, other than administrative-type efforts, associated with their implementation. Compared to the groundwater extraction/treatment alternative, Aquifer Use Restrictions and Monitoring is the most cost effective remedy for groundwater because it provides adequate protection of human health and the environment at a reasonable cost.

### 11.4 Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy will provide a permanent, long-term solution since the source area of contaminated soil will be removed and treated. In addition, the provision and enforcement of aquifer use restrictions will provide a permanent, long-term solution. The selected remedy also employs an innovative alternative treatment technology - a biocell.

### 11.5 Preference for Treatment as a Principal Element

For soil, the selected remedy satisfies the statutory preference for treatment. However, this statutory preference is not satisfied for groundwater. Regardless, the selected remedy is capable of providing adequate protection to human health and the environment.

Because ecological risks were determined to be insignificant, conditions at Site 3 are already considered to be protective of the environment, regardless of any remedy that is implemented. The selected remedy will not provide any additional protection of the environment.

### 11.2 Compliance with Applicable or Relevant and Appropriate Requirements

Although there were no chemical-specific ARARs identified for soil at Site 3, the federal soil screening levels were identified as chemical-specific TBCs. Because soil with contaminant levels exceeding these screening levels will be excavated and treated, the selected remedy will achieve the soil TBCs.

Federal standards, state standards, and risk-based concentrations were identified as chemical-specific ARARs for groundwater. Because groundwater will be left untreated, the selected remedy will not achieve these ARARs. Before implementing the selected remedy, a waiver of the chemical-specific ARARs may be required. Regardless, the remedy provides adequate controls, in the form of land use restrictions, aquifer use restrictions, and monitoring, to effectively manage the untreated groundwater that will remain on site.

The selected remedy can be designed to meet all of the location- and action- specific ARARs that apply to it.

### 11.3 Cost-Effectiveness

Compared to the other soil alternatives that were considered, Source Removal and Biological Treatment was the most cost effective remedy capable of providing adequate protection to human health and the environment. Land use and aquifer use restrictions provide a cost-effective remedy since there are no significant costs, other than administrative-type efforts, associated with their implementation. Compared to the groundwater extraction/treatment alternative, Aquifer Use Restrictions and Monitoring is the most cost effective remedy for groundwater because it provides adequate protection of human health and the environment at a reasonable cost.

### 11.4 Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy will provide a permanent, long-term solution since the source area of contaminated soil will be removed and treated. In addition, the provision and enforcement of aquifer use restrictions will provide a permanent, long-term solution. The selected remedy also employs an innovative alternative treatment technology - a biocell.

### 11.5 Preference for Treatment as a Principal Element

For soil, the selected remedy satisfies the statutory preference for treatment. However, this statutory preference is not satisfied for groundwater. Regardless, the selected remedy is capable of providing adequate protection to human health and the environment.

## 12.0 RESPONSIVENESS SUMMARY

### 12.1 Overview

The selected remedy for OU No. 12 (Site 3) is Source Removal and Biological Treatment, Aquifer Use Restrictions, and Monitoring.

Based on the comments received during the public comment period, the public appears to support the selected remedy. In addition, the USEPA Region IV and the NC DEHNR are in support of the selected remedy outlined herein.

### 12.2 Background on Community Involvement

A record review of the MCB, Camp Lejeune files indicates that the community involvement centers mainly on a social nature, including the community outreach programs and Base/community clubs. The file search did not locate written Installation Restoration Program concerns of the community. A review of historic newspaper articles indicated that the community is interested in the local drinking and groundwater quality, as well as that of the New River, but that there are no expressed interests or concerns specific to the environmental sites (including Site 3). Two local environmental groups, the Stump Sound Environmental Advocates and the Southeastern Watermen's Association, have posed questions to the Base and local officials in the past regarding other environmental issues. These groups were sought as interview participants prior to the development of the Camp Lejeune, IRP, Community Relations Plan. Neither group was available for the interviews.

Community relations activities to date are summarized below:

- Conducted additional community relations interviews, February through March 1990. A total of 41 interviews were conducted with a wide range of persons including Base personnel, residents, local officials, and off-Base residents.
- Prepared a Community Relations Plan, September 1990.
- Conducted additional community relations interviews, August 1993. Nineteen persons were interviewed, representing local business, civic groups, on- and off-Base residents, military and civilian interests.
- Prepared a revised Final Draft Community Relations Plan, February 1994.
- Established two information repositories.
- Established the Administrative Record for all of the sites at the Base.
- Formed Restoration Advisory Board (RAB) in May 1996.
- Released PRAP for public review in repositories, November 6, 1996.
- Released public notice announcing public comment and document availability of the PRAP, November 3, 1996.

- Held Restoration Advisory Board (RAB) meeting, November 6, 1996, to review PRAP and solicit comments.

- Held public meeting on November 6, 1996, to solicit comments and provide information. Approximately 16 people attended. The public meeting transcript is available in Appendix A of this ROD document, and in the information repositories.

## 12.3 Summary of Comments Received During the Public Comment Period and Agency Responses

A public meeting was held on November 6, 1996 in the Onslow County Library in Jacksonville, North Carolina. Representatives from LANTDIV, MCB, Camp Lejeune, USEPA Region IV, NC DEHNR, and OHM Corporation attended the meeting. The transcript for the public meeting is provided in Appendix A. The USEPA Region IV offered no comments. The NC DEHNR requested a more detailed explanation of the reason for not addressing contaminated soil below the water table. The State also requested that the groundwater sampling frequency be adjusted to a quarterly basis.

# TABLES

**TABLE 1**

**SUMMARY OF THE ANALYTICAL RESULTS FOR SOIL**
**SITE INSPECTION, 1991**
**OPERABLE UNIT NO. 12 (SITE 3)**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Constituent | Surface Soil (0-2 feet bgs) | | Subsurface Soil (3-12 feet bgs) | | Subsurface Soil (> 12 feet bgs) | |
|---|---|---|---|---|---|---|
| | No. of Detections/ Total No. of Samples | Range of Detected Concentrations | No. of Detections/ Total No. of Samples | Range of Detected Concentrations | No. of Detections/ Total No. of Samples | Range of Detected Concentrations |
| Acenaphthene | 0/7 | ND | 0/5 | ND | 1/2 | 37,000 |
| Antracene | 1/7 | 1,900 | 0/5 | ND | 1/2 | 8,600 |
| Benzo(a)anthracene | 2/7 | 460-660 | 0/5 | ND | 1/2 | 5,600 |
| Benzo(b)fluoranthene | 2/7 | 520-2,200 | 0/5 | ND | 1/2 | 2,300 |
| Benzo(k)fluoranthene | 2/7 | 420-1,200 | 0/5 | ND | 1/2 | 2,100 |
| Benzo(g,h,i)perylene | 2/7 | 260-720 | 0/5 | ND | 0/2 | ND |
| Benzo(a)pyrene | 2/7 | 320-1,300 | 0/5 | ND | 0/2 | ND |
| Chrysene | 2/7 | 750-1,400 | 0/5 | ND | 1/2 | 5,900 |
| Flouranthene | 2/7 | 1,000-1,600 | 0/5 | ND | 1/2 | 35,000 |
| Fluorene | 0/7 | ND | 0/5 | ND | 1/2 | 35,000 |
| Indeno(1,2,3-cd)pyrene | 2/7 | 340-1,000 | 0/5 | ND | 0/2 | ND |
| 2-Methylnaphthalene | 0/7 | ND | 0/5 | ND | 1/2 | 26,000 |
| Naphthalene | 1/7 | 550 | 0/5 | ND | 1/2 | 52,000 |
| Phenanthrene | 1/7 | 310 | 0/5 | ND | 1/2 | 81,000 |
| Pyrene | 2/7 | 920-1,400 | 0/5 | ND | 1/2 | 27,000 |
| Dibenzofuran | 0/7 | ND | 0/5 | ND | 1/2 | 35,000 |

Notes:

Concentrations expressed in µg/kg (microgram per kilogram)
bgs = Below ground surface
ND = Not detected

Reference: Halliburton/NUS, 1991. Site Inspection Report for Site 3 Old Creosote Plant. Marine Corps Base, Camp Lejeune, North Carolina.

TABLE 2

SUMMARY OF THE ANALYTICAL RESULTS FOR GROUNDWATER
SITE INSPECTION, 1991
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Constituent | North Carolina Standard | USEPA MCL | No. of Detections/ Total No. of Samples | Range of Detected Concentrations[1] | Location of Maximum Concentration |
|---|---|---|---|---|---|
| Acenaphthene | 80 | -- | 1/3 | 1,500 | 3MW02 |
| Anthracene | 2,100 | -- | 1/3 | 260 | 3MW02 |
| Chrysene | 5 | 2 | 1/3 | 96 | 3MW02 |
| Fluoranthene | 280 | -- | 1/3 | 640 | 3MW02 |
| Fluorene | -- | -- | 1/3 | 890 | 3MW02 |
| 2-Methylnaphthalene | -- | -- | 1/3 | 1,500 | 3MW02 |
| Naphthalene | -- | -- | 2/3 | 9-4,400 | 3MW02 |
| Phenanthrene | -- | -- | 1/3 | 1,600 | 3MW02 |
| Pyrene | 210 | -- | 1/3 | 460 | 3MW02 |
| Dibenzofuran | -- | -- | 1/3 | 1,100 | 3MW02 |

Notes:

[1] Shaded blocks indicate detections above the North Carolina Standard of Federal MCL.

Concentrations expressed in µg/L (microgram per liter)
USEPA = U.S. Environmental Protection Agency
MCL = Federal Maximum Contaminant Level
-- = No criteria established

Reference: Halliburton/NUS, 1991. Site Inspection Report for Site 3 Old Creosote Plant. Marine Corps Base, Camp Lejeune, North Carolina.

TABLE 3

SOIL SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®)[1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| Rail Spur Area | | | | | | | | | | | |
| 3-RS-SB01 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X[4] | | | | | |
| 3-RS-SB02 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | X | |
| | 04 | 9.0 | 0.0 - 9.0 | | | X[4] | | | | | |
| 3-RS-SB03 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| 3-RS-SB04 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-RS-SB05 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X[4] | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | | X[4] | | | | | |
| 3-RS-SB06 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | | X[4] | | | | | |
| 3-RS-SB07 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | | X[4] | | | | | |
| 3-RS-SB08 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-RS-SB09 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-RS-SB10 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | X | |

TABLE 3 (Continued)

SOIL SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®)[1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| Concrete Pad Area | | | | | | | | | | | |
| 3-CP-SB01 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-CP-SB02 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | X[6] | |
| 3-CP-SB03 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-CP-SB04 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| 3-CP-SB05 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| 3-CP-SB06 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-CP-SB07 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-CP-SB08 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-CP-SB09 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| 3-CP-SB10 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| Treatment Area | | | | | | | | | | | |
| 3-TA-SB01 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | X | |
| 3-TA-SB02 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB03 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | X | |
| 3-TA-SB04 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB05 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB06 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |

**TABLE 3 (Continued)**

**SOIL SAMPLING SUMMARY**
**REMEDIAL INVESTIGATION, 1994-95**
**OPERABLE UNIT NO. 12 (SITE 3)**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®)[1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| 3-TA-SB07 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB08 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | X | |
| | 04 | 9.0 | 7.0 - 9.0 | | | X[4] | | | | | |
| 3-TA-SB09 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| 3-TA-SB10 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | | X[4] | | | | | |
| 3-TA-SB11 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB12 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| 3-TA-SB13 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X[4] | | | | | |
| 3-TA-SB14 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | | X[4] | | | | | |
| 3-TA-SB15 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB16 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB17 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | | X[4] | | | | | |

TABLE 3 (Continued)

SOIL SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®) [1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| 3-TA-SB18 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X [4] | | | | | |
| 3-TA-SB19 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB20 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB21 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | X [6] | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X [4] | | | | X | |
| 3-TA-SB22 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB23 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB24 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB25 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | | X [4] | | | | | |
| 3-TA-SB26 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB27 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB28 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB29 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | X | |
| | 02 | 5.0 | 3.0 - 5.0 | | | X [4] | | | | | |

TABLE 3 (Continued)

SOIL SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®) [1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters [3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| 3-TA-SB30 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB31 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB32 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB33 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB34 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X [4] | | | | | |
| 3-TA-SB35 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB36 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X [4] | | | | | |
| 3-TA-SB37 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | | X [4] | | | | | |
| 3-TA-SB38 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB39 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | | X [4] | | | | | |
| 3-TA-SB40 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| 3-TA-SB41 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | | X [4] | | | | | |

TABLE 3 (Continued)

SOIL SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®) [1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| 3-TA-SB42 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-TA-SB43 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X [4] | | | | | |
| 3-TA-SB44 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| 3-TA-SB45 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| 3-TA-SB46 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| 3-TA-SB47 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| 3-TA-SB48 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | X | X | | | | | |
| 3-TA-SB49 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | X | X | | | | | |
| 3-TA-SB50 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | X | X | | | | | |

TABLE 3 (Continued)

SOIL SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®) [1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| North Area | | | | | | | | | | | |
| 3-NA-SB01 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | X [6] | |
| 3-NA-SB02 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-NA-SB03 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X [4] | | | | | |
| 3-NA-SB04 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | X | |
| 3-NA-SB05 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X [4] | | | | | |
| 3-NA-SB06 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-NA-SB07 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| 3-NA-SB08 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X [4] | | | | | |
| 3-NA-SB09 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-NA-SB10 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| 3-NA-SB11 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-NA-SB12 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |

TABLE 3 (Continued)

SOIL SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®) [1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| 3-NA-SB13 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | X | |
| 3-NA-SB14 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-NA-SB15 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-NA-SB16 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-NA-SB17 | 00 | 1.0 | 0.0 - 1.0 | X | | X [2] | | | | | |
| 3-NA-SB17A [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| 3-NA-SB18 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| 3-NA-SB19 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| EnSys Background | | | | | | | | | | | |
| 3-BB-SB01 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-BB-SB02 | 00 | 1.0 | 0.0 - 1.0 | X | | | | | | | |
| 3-BB-SB03 | 00 | 1.0 | 0.0 - 1.0 | X | | X[2] | | | | X | |

**TABLE 3 (Continued)**

**SOIL SAMPLING SUMMARY**
**REMEDIAL INVESTIGATION, 1994-95**
**OPERABLE UNIT NO. 12 (SITE 3)**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®) [1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| Soil Investigation Background | | | | | | | | | | | |
| 3-BB-SB01 [4] | 00 | 1.0 | 0.0 - 1.0 | | | X | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X | | | | | |
| 3-BB-SB02 [4] | 00 | 1.0 | 0.0 - 1.0 | | | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | | X | | | | | |
| 3-BB-SB03 [4] | 00 | 1.0 | 0.0 - 1.0 | | | X | | | | | |
| | 03 | 7.0 | 5.0 - 7.0 | | | X | | | | | |
| Monitoring Wells | | | | | | | | | | | |
| 3-MW02IW [4] | 00 | 1.0 | 0.0 - 1.0 | | X | X | X | X | | X | X |
| | 03 | 7.0 | 5.0 - 7.0 | | X | X | X | X | | X | X |
| | 09 | 19.0 | 17.0 - 19.0 | | | X | | | | | |
| 3-MW02DW [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| 3-MW04 [4] | 00 | 1.0 | 0.0 - 1.0 | | | X | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | | X | | | | | |

TABLE 3 (Continued)

SOIL SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®) [1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| 3-MW05 [4] | 00 | 1.0 | 0.0 - 1.0 | | X | X | X | X | X | | |
| | 10 | 21.0 | 19.0 - 21.0 | | X | X | X | X | X | | |
| 3-MW06 [4] | 00 | 1.0 | 0.0 - 1.0 | | | X | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | | X | | | | | |
| 3-MW07 [4] | 00 | 1.0 | 0.0 - 1.0 | | | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | | X | | | | | |
| 3-MW08 [4] | 00 | 1.0 | 0.0 - 1.0 | | | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | | X | | | | | |
| 3-MW09 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| 3-MW10 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| 3-MW11 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 08 | 19.0 | 17.0 - 19.0 | | X | X | | | | | |
| 3-MW11W [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 08 | 19.0 | 17.0 - 19.0 | | X | X | | | | | |

**TABLE 3 (Continued)**

**SOIL SAMPLING SUMMARY**
**REMEDIAL INVESTIGATION, 1994-95**
**OPERABLE UNIT NO. 12 (SITE 3)**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Sample Location | Depth Interval Identification | Depth of Borehole (feet, bgs) | Sampling Interval (feet, bgs) | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EnSys Sample (PAH RISC ®)[1] | TCL Volatiles | TCL Semivolatiles | TCL Pesticides/ PCBs | TAL Metals | Engineering Parameters[3] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| 3-MW12 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 02 | 5.0 | 3.0 - 5.0 | | X | X | | | | | |
| 3-MW13 [5] | 00 | 1.0 | 0.0 - 1.0 | | X | X | | | | | |
| | 04 | 9.0 | 7.0 - 9.0 | | X | X | | | | | |

Notes:

(1) Sample was collected during the first phase of the soil investigation (September 19 through September 22, 1994)
(2) EnSys confirmation sample
(3) Engineering Parameters includes Particle Size, Atterberg limits, and TOC
(4) Sample was collected during the second phase of the soil investigation (November 15 through November 22, 1994)
(5) Sample was collected during the third phase of the soil investigation (June 13 through June 20, 1995)
(6) Duplicate samples were collected for both PAH RISC ® and TCL Semivolatiles

Reference: Baker Environmental, Inc., 1996. Remedial Investigation Report Operable Unit No. 12 (Site 3). Marine Corps Base, Camp Lejeune, North Carolina.

TABLE 4

GROUNDWATER SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Date of Sampling | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TCL Volatiles | TCL Semivolatiles | TCL Pest.icides/ PCBs | TAL Inorganics | TAL Dissolved Metals | Engineering Parameters [1] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| Shallow Monitoring Wells, Round 1 | | | | | | | | | |
| 3-MW02-01 | 12/1/94 | | X | | | | | | |
| 3-MW03-01 | 12/1/94 | | X | | | | | | |
| 3-MW04-01 | 12/1/94 | | X | | | | | | |
| 3-MW05-01 | 12/2/94 | | X | | | | | | |
| 3-MW06-01 | 12/1/94 | | X | | | | | | |
| 3-MW07-01 | 12/1/94 | X | X | X | X | X | | | |
| 3-MW08-01 | 12/1/94 | X | X | X | X | X | | | |
| Intermediate Monitoring Well, Round 1 | | | | | | | | | |
| 3-MW02IW-01 | 12/3/94 | X | X | X | X | X | | X | X |
| Shallow Monitoring Wells, Round 2 | | | | | | | | | |
| 3-MW01-01 | 7/13/95 | X | X | | | | | | |
| 3-MW02-02 | 7/11/95 | X | X | | | | X | | |
| 3-MW03-02 | 7/13/95 | X | X | | | | | | |
| 3-MW04-02 | 7/11/95 | X | X | | | | | | |

TABLE 4 (Continued)

GROUNDWATER SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Date of Sampling | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TCL Volatiles | TCL Semivolatiles | TCL Pest.icides/ PCBs | TAL Inorganics | TAL Dissolved Metals | Engineering Parameters [1] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| 3-MW05-02 | 7/11/95 | X | X | | | | | | |
| 3-MW06-02 | 7/12/95 | X | X | | | | | | |
| 3-MW07-02 | 7/12/95 | X | X | | | | | | |
| 3-MW08-02 | 7/11/95 | X | X | | | | X | | |
| 3-MW09-01 | 7/13/95 | X | X | | | | | | |
| 3-MW10-01 | 7/12/95 | X | X | | | | | | |
| 3-MW11-01 | 7/12/95 | X | X | | | | | | |
| 3-MW12-01 | 7/12/95 | X | X | | | | | | |
| 3-MW13-01 | 7/13/95 | X | X | | | | | | |
| Intermediate and Deep Monitoring Wells, Round 2 | | | | | | | | | |
| 3-MW02IW-02 | 6/12/95 | X | X | | | | | | |
| 3-MW02DW-01 | 7/13/95 | X | X | | | | X | | |
| 3-MW11IW-01 | 7/12/95 | X | X | | | | | | |

TABLE 4 (Continued)

GROUNDWATER SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Date of Sampling | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TCL Volatiles | TCL Semivolatiles | TCL Pest.icides/ PCBs | TAL Inorganics | TAL Dissolved Metals | Engineering Parameters [1] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| Shallow Monitoring Wells, Round 3 | | | | | | | | | |
| 3-MW01-02 | 9/28/95 | X | X | | | | | | |
| 3-MW02-03 | 9/28/95 | X | X | | | | | | |
| 3-MW03-03 | 9/28/95 | X | X | | | | | | |
| 3-MW04-03 | 9/28/95 | X | X | | | | | | |
| 3-MW05-03 | 9/28/95 | X | X | | | | | | |
| 3-MW06-03 | 9/28/95 | X | X | | | | | | |
| 3-MW07-03 | 9/29/95 | X | X | | | | | | |
| 3-MW08-03 | 9/29/95 | X | X | | | | | | |
| 3-MW09-02 | 9/29/95 | X | X | | | | | | |
| 3-MW10-02 | 9/29/95 | X | X | | | | | | |
| 3-MW11-02 | 9/29/95 | X | X | | | | | | |
| 3-MW12-02 | 9/29/95 | X | X | | | | | | |
| 3-MW13-02 | 9/29/95 | X | X | | | | | | |

TABLE 4 (Continued)

GROUNDWATER SAMPLING SUMMARY
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Sample Location | Date of Sampling | Sample Analyses | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TCL Volatiles | TCL Semivolatiles | TCL Pest.icides/ PCBs | TAL Inorganics | TAL Dissolved Metals | Engineering Parameters [1] | Duplicate Samples | Matrix Spike/Matrix Spike Duplicate |
| Intermediate and Deep Monitoring Wells, Round 3 | | | | | | | | | |
| 3-MW02IW-03 | 9/29/95 | X | X | | | | | | |
| 3-MW02DW-02 | 9/28/95 | X | X | | | | | | |
| 3-MW11IW-02 | 9/29/95 | X | X | | | | | | |
| Deep Monitoring Well, Round 4 | | | | | | | | | |
| 3-MW02DW-03 | 1/29/96 | X | X | | | | | | |

Note:

[1] Engineering Parameters include (BOD, COD, TDS, TSS, and TOC)

Reference: Baker Environmental, Inc., 1996. Remedial Investigation Report Operable Unit No. 12 (Site 3). Marine Corps Base, Camp Lejeune, North Carolina.

## TABLE 5

## SUMMARY OF THE ANALYTICAL RESULTS FOR SURFACE SOIL
## REMEDIAL INVESTIGATION, 1994-95
## OPERABLE UNIT NO. 12 (SITE 3)
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| | | | RBC Residential Soils (µg/kg) | | (µg/kg) | (µg/kg) | | | RBC Residential Soils | | |
| Surface Soils | Volatile Organic Compounds | Toluene | 1,600,000 | NE | 2J | 2J | 3-MW13-00 | 2/17 | 0 | NA | Treatment Area |
| | | Ethylbenzene | 780,000 | NE | 2J | 2J | 3-TA-SB50-00 | 1/17 | 0 | NA | Treatment Area |
| | | Xylenes (total) | 16,000,000 | NE | 6J | 6J | 3-TA-SB50-00 | 1/17 | 0 | NA | Treatment Area |
| | Semivolatile Organic Compounds | Phenol | 4,700,000 | NE | 38J | 38J | 3-RS-SB03-00 | 1/58 | 0 | NA | Rail Spur |
| | | Naphthalene | 310,000 | NE | 38J | 200J | 3-NA-SB05-00 | 2/58 | 0 | NA | North Area, Rail Spur |
| | | 2-Methyl-naphthalene | 310,000 | NE | 41J | 41J | 3-RS-SB02-00 | 1/58 | 0 | NA | Rail Spur |
| | | Acenaphthylene | 230,000 | NE | 40J | 2,700 | 3-NA-SB03-00 | 16/58 | 0 | NA | North Area, Rail Spur, Treatment Area |
| | | Acenaphthene | 470,000 | NE | 44J | 460J | 3-NA-SB05-00 | 2/58 | 0 | NA | North Area, Rail Spur |
| | | Dibenzofuran | 31,000 | NE | 370J | 370J | 3-NA-SB05-00 | 1/58 | 0 | NA | North Area |
| | | Fluorene | 310,000 | NE | 39J | 620J | 3-NA-SB05-00 | 5/58 | 0 | NA | North Area, Rail Spur, Treatment Area |
| | | Penanthrene | 230,000 | NE | 37J | 2,900 | 3-NA-SB05-00 | 9/58 | 0 | NA | North Area, Rail Spur, Treatment Area |
| | | Anthracene | 2,300,000 | NE | 40J | 7,700 | 3-NA-SB03-00 | 26/58 | 0 | NA | Scattered |
| | | Carbazole | 32,000 | NE | 40J | 830J | 3-NA-SB03-00 | 14/58 | 0 | NA | Scattered |
| | | di-n-Butyl-phthalate | 780,000 | NE | 37J | 340J | 3-TA-SB13-00 | 37/58 | 0 | NA | Scattered |
| | | Fluoranthene | 310,000 | NE | 42J | 11,000 | 3-NA-SB03-00 | 32/58 | 0 | NA | Scattered |
| | | Pyrene | 230,000 | NE | 39J | 14,000 | 3-NA-SB03-00 | 34/58 | 0 | NA | Scattered |
| | | Benzo(a)anthracene | 880 | NE | 32J | 8,300 | 3-NA-SB03-00 | 24/58 | 5 | NA | Scattered |
| | | Chrysene | 88,000 | NE | 40J | 12,000 | 3-NA-SB03-00 | 32/58 | 0 | NA | Scattered |
| | | bis(2-Ethylhexyl)phthalate | 46,000 | NE | 36J | 91J | 3-NA-SB01-00 | 30/58 | 0 | NA | Scattered |
| | | Benzo(b)fluoranthene | 880 | NE | 39J | 13,000 | 3-NA-SB03-00 | 37/58 | 6 | NA | Scattered |
| | | Benzo(k)fluoranthene | 8,800 | NE | 37J | 9,000 | 3-NA-SB03-00 | 34/58 | 1 | NA | Scattered |
| | | Benzo(a)pyrene | 88 | NE | 38J | 8,700 | 3-NA-SB03-00 | 30/58 | 20 | NA | Scattered |
| | | Indeno(1,2,3-cd)pyrene | 880 | NE | 40J | 6,800 | 3-NA-SB03-00 | 26/58 | 5 | NA | Scattered |
| | | Dibenzo(a,h)anthracene | 88 | NE | 40J | 2,900 | 3-NA-SB03-00 | 16/58 | 6 | NA | North Area, Rail Spur, Treatment Area |
| | | Benzo(g,h,i)perylene | 230,000 | NE | 39J | 4700 | 3-NA-SB03-00 | 22/58 | 0 | NA | North Area, Rail Spur, Treatment Area |

TABLE 5 (Continued)

SUMMARY OF THE ANALYTICAL RESULTS FOR SURFACE SOIL
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| | | | RBC Residential Soils (mg/kg) | Base Background (mg/kg) | (mg/kg) | (mg/kg) | | | RBC Residential Soils | Base Background | |
| Surface Soils (Cont.) | Inorganics | Aluminum | 7,800 | 9,570 | 1,740 | 4,240 | 3-MW05-00 | 2/2 | 0 | 0 | -- |
| | | Barium | 550 | 20.8 | 6.4J | 7.8J | 3-MW05-00 | 2/2 | 0 | 0 | -- |
| | | Calcium | NE | 10,700 | 4,020 | 67,700 | 3-MW02IW-00 | 2/2 | NA | 1 | Treatment Area |
| | | Chromium | 39 | 12.5 | 2.7 | 7.1 | 3-MW02IW-00 | 2/2 | 0 | 0 | -- |
| | | Iron | 23,000 | 9,640 | 1,390 | 1,970 | 3-MW05-00 | 2/2 | 0 | 0 | -- |
| | | Lead | 400 | 142 | 4.4J | 4.4J | 3-MW02IW-00 | 1/2 | 0 | 0 | -- |
| | | Magnesium | NE | 610 | 150 | 1,020 | 3-MW02IW-00 | 2/2 | NA | 1 | Treatment Area |
| | | Manganese | 1,100 | 66 | 11.7 | 13.1 | 3-MW05-00 | 2/2 | 0 | 0 | -- |
| | | Sodium | NE | 126 | 112 | 112 | 3-MW02IW-00 | 1/2 | NA | 0 | -- |
| | | Vanadium | 55 | 28.3 | 3.3 | 5.2 | 3-MW05-00 | 2/2 | 0 | 0 | -- |
| | | Zinc | 2,300 | 2.4 | 16.6 | 16.6 | 3-MW02IW-00 | 1/2 | 0 | 0 | -- |

Notes:

[1] Shaded blocks indicate detections above comparison criteria.

NE = No criteria established
NA = Not applicable
J = Estimated value
RBC = Risk-Based Concentration
µg/kg = microgram per kilogram (ppb)
mg/kg = milligram per kilogram (ppm)

Reference: Baker Environmental, Inc. 1996. Remedial Investigation Report Operable Unit No. 12 (Site 3). Marine Corps Base, Camp Lejeune, North Carolina.

TABLE 6

SUMMARY OF THE ANALYTICAL RESULTS FOR SUBSURFACE SOIL
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| | | | RBC Residential Soils (µg/kg) | | (µg/kg) | (µg/kg) | | | RBC Residential Soils | | |
| Subsurface Soils | Volatile Organic Compounds | Acetone | 780,000 | NE | 120 | 120 | 3-NA-SB17A-02 | 1/18 | 0 | NA | North Area |
| | | Carbon Disulfide | 780,000 | NE | 1J | 1J | 3-MW12-02 | 1/18 | 0 | NA | West of North Area |
| | | Chloroform | 100,000 | NE | 3J | 3J | 3-MW11IW-08 | 1/18 | 0 | NA | West of Treatment Area |
| | | 2-Butanone | 4,700,000 | NE | 3J | 3J | 3-NA-SB19-02 | 1/18 | 0 | NA | North Area |
| | | Benzene | 22,000 | NE | 2J | 2J | 3-MW02IW-03 | 2/18 | 0 | NA | Treatment Area |
| | | Toluene | 1,600,000 | NE | 3J | 13 | 3-TA-SB49-04 | 4/18 | 0 | NA | Treatment Area |
| | | Ethylbenzene | 780,000 | NE | 3J | 110 | 3-TA-SB49-04 | 4/18 | 0 | NA | Treatment Area |
| | | Styrene | 1,600,000 | NE | 4J | 5J | 3-MW09-02 | 2/18 | 0 | NA | Treatment Area |
| | | Xylenes (total) | 16,000,000 | NE | 7J | 300 | 3-TA-SB49-04 | 4/18 | 0 | NA | Treatment Area |
| | Semivolatile Organic Compounds | Phenol | 4,700,000 | NE | 7,200J | 7,200J | 3-TA-SB48-08 | 1/47 | 0 | NA | Treatment Area |
| | | 2-Methylphenol | 390,000 | NE | 2,000J | 2,000J | 3-TA-SB48-08 | 1/47 | 0 | NA | Treatment Area |
| | | 4-Methylphenol | 39,000 | NE | 5,900J | 5,900J | 3-TA-SB48-08 | 1/47 | 0 | NA | Treatment Area |
| | | Naphthalene | 310,000 | NE | 55J | 95,000 | 3-TA-SB48-08 | 9/47 | 0 | NA | Treatment Area |
| | | 2-Methylnaphthalene | 310,000 | NE | 100J | 31,000 | 3-TA-SB48-08 | 6/47 | 0 | NA | Treatment Area |
| | | Acenaphthylene | 230,000 | NE | 190J | 190J | 3-MW02IW-09 | 1/47 | 0 | NA | Treatment Area |
| | | Acenaphthene | 470,000 | NE | 560 | 47,000 | 3-TA-SB48-08 | 6/47 | 0 | NA | Treatment Area |
| | | 4-Nitrophenol | 480,000 | NE | 570J | 570J | 3-TA-SB50-04 | 1/47 | 0 | NA | Treatment Area |
| | | Dibenzofuran | 31,000 | NE | 440 | 36,000J | 3-TA-SB48-08 | 6/47 | 0 | NA | Treatment Area |
| | | Fluorene | 310,000 | NE | 710 | 35,000J | 3-TA-SB48-08 | 6/47 | 0 | NA | Treatment Area |
| | | N-nitrosodiphenylamine | 13,000 | NE | 400J | 1,100J | 3-TA-SB48-08 | 2/47 | 0 | NA | Treatment Area |
| | | Phenanthrene | 230,000 | NE | 61J | 110,000J | 3-TA-SB50-04 | 8/47 | 0 | NA | Treatment Area |
| | | Anthracene | 2,300,000 | NE | 42J | 12,000J | 3-TA-SB48-08 | 7/47 | 0 | NA | Treatment Area |
| | | Carbazole | 32,000 | NE | 200J | 4,900 | 3-TA-SB50-04 | 6/47 | 0 | NA | Treatment Area |
| | | di-n-Butyl-phthalate | 780,000 | NE | 39J | 170J | 3-TA-SB43-03 | 18/47 | 0 | NA | Scattered |
| | | Fluoranthene | 310,000 | NE | 51J | 66,000 | 3-TA-SB50-04 | 7/47 | 0 | NA | Treatment Area |

TABLE 6 (Continued)

SUMMARY OF THE ANALYTICAL RESULTS FOR SUBSURFACE SOIL
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| | | | RBC Residential Soils (µg/kg) | | (µg/kg) | (µg/kg) | | | RBC Residential Soils | | |
| Subsurface Soils (Cont.) | | Pyrene | 230,000 | NE | 43J | 38,000J | 3-TA-SB48-08 | 10/47 | 0 | NA | Treatment Area, North Area, Rail Spur |
| | | Benzo(a)anthracene | 880 | NE | 77J | 8,000 | 3-TA-SB50-04 | 7/47 | 5 | NA | Treatment Area |
| | | Chrysene | 88,000 | NE | 86J | 8,400J | 3-TA-SB48-08 | 7/47 | 0 | NA | Treatment Area |
| | | Bis(2-ethylhexyl)phthalate | 46,000 | NE | 53J | 240J | 3-MW11IW-08 | 2/47 | 0 | NA | West of Treatment Area |
| | | Benzo(b)fluoranthene | 880 | NE | 96J | 3,500J | 3-TA-SB48-08 | 7/47 | 4 | NA | Treatment Area |
| | | Benzo(k)fluoranthene | 8,800 | NE | 79J | 3,300J | 3-TA-SB50-04 | 6/47 | 0 | NA | Treatment Area |
| | | Benzo(a)pyrene | 88 | NE | 55J | 3,300J | 3-TA-SB48-08 | 7/47 | 6 | NA | Treatment Area |
| | | Indeno(1,2,3-cd)pyrene | 880 | NE | 46J | 3,100J | 3-TA-SB48-08 | 5/47 | 1 | NA | Treatment Area |
| | | Benzo(g,h,i)perylene | 230,000 | NE | 71J | 1,200J | 3-TA-SB48-08 | 4/47 | 0 | NA | Treatment Area |
| | | | RBC Residential Soils (mg/kg) | Base Background (mg/kg) | (mg/kg) | (mg/kg) | | | RBC Residential Soils | Base Background | |
| | Inorganics | Aluminum | 7,800 | 11,000 | 3,950 | 6,570 | 3-MW02IW-03 | 2/2 | 0 | 0[2] | -- |
| | | Barium | 550 | 22.6 | 4.6J | 6.6J | 3-MW02IW-03 | 2/2 | 0 | 0 | -- |
| | | Calcium | NE | 4,410 | 77.4 | 638 | 3-MW02IW-03 | 2/2 | NA | 0 | -- |
| | | Chromium | 39 | 66.4 | 3.7 | 7.5 | 3-MW02IW-03 | 2/2 | 0 | 0 | -- |
| | | Iron | 23,000 | 90,500 | 734 | 1,030 | 3-MW02IW-03 | 2/2 | 0 | 0 | -- |
| | | Lead | 400 | 21.4 | 5.7J | 5.7J | 3-MW02IW-03 | 1/2 | 0 | 0 | -- |
| | | Magnesium | NE | 852 | 104 | 112 | 3-MW02IW-03 | 2/2 | NA | 0 | -- |
| | | Manganese | 1,100 | 19.9 | 2.8J | 2.8J | 3-MW02IW-03 | 1/2 | 0 | 0 | -- |
| | | Vanadium | 55 | 69.4 | 3.7 | 5 | 3-MW02IW-03 | 2/2 | 0 | 0 | -- |

**TABLE 6 (Continued)**

**SUMMARY OF THE ANALYTICAL RESULTS FOR SUBSURFACE SOIL**
**REMEDIAL INVESTIGATION, 1994-95**
**OPERABLE UNIT NO. 12 (SITE 3)**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

Notes:

(1) Shaded blocks indicate detections above comparison criteria.
(2) Detections compared to maximum base background concentrations.

NE = No criteria established
NA = Not applicable
J = Estimated value
RBC = Risk-Based Concentration
µg/kg = microgram per kilogram (ppb)
mg/kg = milligram per kilogram (ppm)

Reference: Baker Environmental, Inc., 1996. Remedial Investigation Report Operable Unit No. 12 (Site 3). Marine Corps Base, Camp Lejeune, North Carolina.

**TABLE 7**

**SUMMARY OF THE ANALYTICAL RESULTS FOR GROUNDWATER**
**REMEDIAL INVESTIGATION, 1994-95**
**OPERABLE UNIT NO. 12 (SITE 3)**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| | | | MCL (µg/L) | NCWQS (µg/L) | (µg/L) | (µg/L) | | | MCL | NCWQS | |
| Groundwater - Surficial Aquifer (Round One) | Volatile Organic Compounds | Carbon Disulfide | NE | 700 | 1 J | 1 J | 3-MW07-01 | 1/2 | NA | 0 | Treatment Area |
| | | Benzene | 5 | 1 | 13J | 40J | 3-MW08-01 | 2/2 | 2[2] | 2 | Treatment Area |
| | | Toluene | 1,000 | 1,000 | 5 J | 10 J | 3-MW08-01 | 2/2 | 0 | 0 | Treatment Area |
| | | Xylenes (total) | 10,000 | 530 | 6 J | 9 J | 3-MW08-01 | 2/2 | 0 | 0 | Treatment Area |
| | Semivolatile Organic Compounds | Phenol | NE | 300 | 3 J | 3 J | 3-MW02-01 | 1/7 | NA | 0 | Treatment Area |
| | | 2-Methylphenol | NE | NE | 1 J | 1 J | 3-MW02-01 | 1/7 | NA | NA | Treatment Area |
| | | 4-Methylphenol | NE | NE | 3 J | 3 J | 3-MW02-01 | 1/7 | NA | NA | Treatment Area |
| | | 2-Nitrophenol | NE | NE | 2 J | 2 J | 3-MW02-01 | 1/7 | NA | NA | Treatment Area |
| | | 2,4-Dimethylphenol | NE | NE | 2 J | 2 J | 3-MW02-01 | 1/7 | NA | NA | Treatment Area |
| | | Naphthalene | NE | 21 | 5 J | 64 | 3-MW02-01 | 4/7 | NA | 1 | Treatment Area |
| | | 2-Methylnaphthalene | NE | NE | 65 | 65 | 3-MW02-01 | 1/7 | NA | NA | Treatment Area |
| | | Acenaphthylene | NE | 210 | 3 J | 3 J | 3-MW02-01 | 1/7 | NA | 0 | Treatment Area |
| | | Acenaphthene | NE | 800 | 2 J | 280 | 3-MW02-01 | 2/7 | NA | 0 | Treatment Area |
| | | Dibenzofuran | NE | NE | 2 J | 230 | 3-MW02-01 | 2/7 | NA | NA | Treatment Area |
| | | Fluorene | NE | 280 | 1 J | 210 | 3-MW02-01 | 2/7 | NA | 0 | Treatment Area |
| | | Phenanthrene | NE | 210 | 410 | 410 | 3-MW02-01 | 1/7 | NA | 1 | Treatment Area |
| | | Anthracene | NE | 2,100 | 33 | 33 | 3-MW02-01 | 1/7 | NA | 0 | Treatment Area |
| | | Carbazole | NE | NE | 39 J | 39 J | 3-MW02-01 | 1/7 | NA | NA | Treatment Area |
| | | di-n-Butylphthalate | NE | 700 | 1 J | 1 J | 3-MW02-01 | 1/7 | NA | 0 | Treatment Area |
| | | Fluoranthene | NE | 280 | 100 | 100 | 3-MW02-01 | 1/7 | NA | 0 | Treatment Area |
| | | Pyrene | NE | 210 | 58 | 58 | 3-MW02-01 | 1/7 | NA | 0 | Treatment Area |
| | | Benzo(a)anthracene | NE | 0.05 | 8 J | 8 J | 3-MW02-01 | 1/7 | NA | 1 | Treatment Area |
| | | Chrysene | NE | 5 | 8 J | 8 J | 3-MW02-01 | 1/7 | NA | 1 | Treatment Area |
| | | Benzo(b)fluroanthene | NE | NE | 3 J | 3 J | 3-MW02-01 | 1/7 | NA | NA | Treatment Area |
| | | Benzo(k)fluoranthene | NE | NE | 3 J | 3 J | 3-MW02-01 | 1/7 | NA | NA | Treatment Area |
| | | Benzo(a)pyrene | 2 | NE | 3 J | 3 J | 3-MW02-01 | 1/7 | 1 | NA | Treatment Area |

TABLE 7 (Continued)

SUMMARY OF THE ANALYTICAL RESULTS FOR GROUNDWATER
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| | | | MCL (µg/L ) | NCWQS (µg/L) | (µg/L) | (µg/L) | | | MCL | NCWQS | |
| Groundwater - Surficial Aquifer (Round One) | Inorganics | Aluminum | 50 | NE | 447 | 4,030 | 3-MW08-01 | 2/2 | 2 | NA | -- |
| | | Barium | 2,000 | 2,000 | 88.1 | 120 | 3-MW07-01 | 2/2 | 0 | 0 | -- |
| | | Calcium | NE | NE | 2,870 | 3,870 | 3-MW08-01 | 2/2 | 0 | 0 | -- |
| | | Chromium | 100 | 50 | 31.6 | 31.6 | 3-MW08-01 | 1/2 | 0 | 0 | -- |
| | | Iron | 300 | 300 | 840 | 2,190 | 3-MW08-01 | 2/2 | 2 | 2 | -- |
| | | Lead | 15 | 15 | 3.2J | 3.2J | 3-MW08-01 | 1/2 | 0 | 0 | -- |
| | | Magnesium | NE | NE | 2,080 | 4,200 | 3-MW07-01 | 2/2 | NA | NA | -- |
| | | Manganese | 50 | 50 | 17.1J | 21.7J | 3-MW08-01 | 2/2 | 0 | 0 | -- |
| | | Nickel | 100 | 100 | 34.1 | 34.1 | 3-MW08-01 | 1/2 | 0 | 0 | -- |
| | | Potassium | NE | NE | 1,490 | 1,900 | 3-MW08-01 | 2/2 | NA | NA | -- |
| | | Sodium | NE | NE | 4,750 | 8,890 | 3-MW08-01 | 2/2 | NA | NA | -- |
| | | Zinc | 500 | 2,100 | 114 | 114 | 3-MW08-01 | 1/2 | 0 | 0 | -- |
| Groundwater - Castle Hayne (Round One) | Volatile Organic Compounds | Benzene | 5 | 1 | 11 J | 11 J | 3-MW02IW-01 | 1/1 | 1 | 1 | -- |
| | | Toluene | 1,000 | 1,000 | 4 J | 4 J | 3-MW02IW-01 | 1/1 | 0 | 0 | -- |
| | | Xylenes (total) | 100,000 | 530 | 7 J | 7 J | 3-MW02IW-01 | 1/1 | 0 | 0 | -- |
| | Semivolatile Organic Compounds | Naphthalene | NE | 21 | 3 J | 3 J | 3-MW02IW-01 | 1/1 | NA | 0 | -- |
| | | Acenaphthylene | NE | 210 | 3 J | 3 J | 3-MW02IW-01 | 1/1 | NA | 0 | -- |
| | | Acenaphthene | NE | 800 | 95 | 95 | 3-MW02IW-01 | 1/1 | NA | 0 | -- |
| | | Dibenzofuran | NE | NE | 57 | 57 | 3-MW02IW-01 | 1/1 | NA | NA | -- |
| | | Fluorene | NE | 280 | 59 | 59 | 3-MW02IW-01 | 1/1 | NA | 0 | -- |
| | | Phenanthrene | NE | 210 | 75 | 75 | 3-MW02IW-01 | 1/1 | NA | 0 | -- |
| | | Anthracene | NE | 2,100 | 5 J | 5 J | 3-MW02IW-01 | 1/1 | NA | 0 | -- |
| | | Fluoranthene | NE | 280 | 10 | 10 | 3-MW02IW-01 | 1/1 | NA | 0 | -- |
| | | Pyrene | NE | 210 | 7 J | 7 J | 3-MW02IW-01 | 1/1 | NA | 0 | -- |

TABLE 7 (Continued)

SUMMARY OF THE ANALYTICAL RESULTS FOR GROUNDWATER
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| | | | MCL (µg/L) | NCWQS (µg/kg) | (µg/L) | (µg/L) | | | MCL | NCWQS | |
| Groundwater - Surficial Aquifer (Round Two) | Volatile Organic Compounds | Chloroform | 100 | 0.19 | 1 J | 1 J | 3-MW02-02 | 1/13 | 0 | 1 | Treatment Area |
| | | Trichloroethene | 5 | NE | 1 J | 1 J | 3-MW12-01 | 2/13 | 0 | NA | Treatment Area |
| | Semivolatile Organic Compounds | Naphthalene | NE | 21 | 4 J | 110 | 3-MW06-02 | 2/13 | NA | 1 | Rail Spur |
| | | 2-Methylnaphthalene | NE | NE | 10 | 10 | 3-MW06-02 | 1/13 | NA | NA | Rail Spur |
| | | Acenaphthene | NE | 800 | 24 | 24 | 3-MW06-02 | 1/13 | NA | 0 | Rail Spur |
| | | Dibenzofuran | NE | NE | 25 | 25 | 3-MW06-02 | 1/13 | NA | NA | Rail Spur |
| | | Fluorene | NE | 280 | 28 | 28 | 3-MW06-02 | 1/13 | NA | 0 | Rail Spur |
| | | Phenanthrene | NE | 210 | 21 | 21 | 3-MW06-02 | 1/13 | NA | 0 | Rail Spur |
| | | Anthracene | NE | 2,100 | 1 J | 1 J | 3-MW06-02 | 1/13 | NA | 0 | Rail Spur |
| | | Carbazole | NE | NE | 10 | 10 | 3-MW06-02 | 1/13 | NA | NA | Rail Spur |
| | | Fluoranthenene | NE | 280 | 2 J | 2 J | 3-MW06-02 | 1/13 | NA | 0 | Rail Spur |
| | | bis(2-Ethylhexyl)phthalate | 6 | 3 | 2 J | 11 | 3-MW09-01 | 4/13 | 1 | 2 | Scattered |

**TABLE 7 (Continued)**

**SUMMARY OF THE ANALYTICAL RESULTS FOR GROUNDWATER**
**REMEDIAL INVESTIGATION, 1994-95**
**OPERABLE UNIT NO. 12 (SITE 3)**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| | | | MCL (µg/L) | NCWQS (µg/L) | (µg/L) | (µg/L) | | | MCL | NCWQS | |
| Groundwater - Castle Hayne (Round Two) | Volatile Organic Compounds | 1,1-Dichloroethene | 7 | 7 | 1 J | 1 J | 3-MW02IW-02 | 1/3 | 0 | 0 | Treatment Area |
| | | Chloroform | 100 | 0.19 | 1 J | 1 J | 3MW11IW-01 | 1/3 | 0 | 1 | West of Treatment Area |
| | | Trichloroethene | 5 | NE | 1 J | 1 J | 3-MW02IW-02 | 1/3 | 0 | NA | Treatment Area |
| | | Benzene | 5 | 1 | 3 J | 3 J | 3-MW02DW-01 | 2/3 | 0 | 1 | Treatment Area |
| | | Toluene | 1,000 | 1000 | 2 J | 15 J | 3-MW02DW-01 | 1/3 | 0 | 0 | Treatment Area |
| | | Ethylbenzene | 700 | 29 | 14 J | 14 J | 3-MW02DW-01 | 1/3 | 0 | 0 | Treatment Area |
| | | Xylenes (total) | 10,000 | 530 | 32 J | 32 J | 3-MW02DW-01 | 1/3 | 0 | 0 | Treatment Area |
| | Semivolatile Organic Compounds | Phenol | NE | 300 | 430 J | 430 J | 3-MW02DW-01 | 1/3 | NA | 1 | Treatment Area |
| | | 2-Methylphenol | NE | NE | 300 J | 300 J | 3-MW02DW-01 | 1/3 | NA | NA | Treatment Area |
| | | 4-Methylphenol | NE | NE | 690 J | 690 J | 3-MW02DW-01 | 1/3 | NA | NA | Treatment Area |
| | | 2,4-Dimethylphenol | NE | NE | 170 J | 170 J | 3-MW02DW-01 | 1/3 | NA | NA | Treatment Area |
| | | Naphthalene | NE | 21 | 2,400 J | 2,400 J | 3-MW02DW-01 | 1/3 | NA | 1 | Treatment Area |
| | | 2-Methylnaphthalene | NE | NE | 250 J | 250 J | 3-MW02DW-01 | 1/3 | NA | 0 | Treatment Area |
| | | Acenaphthylene | NE | 210 | 1 J | 1 J | 3-MW02DW-01 | 1/3 | NA | NA | Treatment Area |
| | | Acenaphthene | NE | 800 | 34 | 320 J | 3-MW02IW-02 | 2/3 | NA | 0 | Treatment Area |
| | | Dibenzofuran | NE | NE | 17 | 140 J | 3-MW02DW-01 | 2/3 | NA | 0 | Treatment Area |
| | | Fluorene | NE | 280 | 23 | 160 J | 3-MW02DW-01 | 2/3 | NA | NA | Treatment Area |
| | | Phenanthrene | NE | 210 | 130 J | 130 J | 3-MW02DW-01 | 1/3 | NA | 0 | Treatment Area |
| | | Anthracene | NE | 2,100 | 3 J | 13 J | 3-MW02DW-01 | 2/3 | NA | 0 | Treatment Area |
| | | Carbazole | NE | NE | 3 J | 87 J | 3-MW02DW-01 | 2/3 | NA | 0 | Treatment Area |
| | | Fluoranthene | NE | 280 | 17 | 21 J | 3-MW02DW-01 | 2/3 | NA | 0 | Treatment Area |
| | | Pyrene | NE | 210 | 11 | 14 J | 3-MW02DW-01 | 2/3 | NA | 0 | Treatment Area |

TABLE 7 (Continued)

SUMMARY OF THE ANALYTICAL RESULTS FOR GROUNDWATER
REMEDIAL INVESTIGATION, 1994-95
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| | | | MCL (µg/L) | NCWQS (µg/L) | (µg/L) | (µg/L) | | | MCL | NCWQS | |
| Groundwater - Surficial Aquifer (Round Three) | Volatile Organic Compounds | Benzene | 5 | 1 | 3 J | 3 J | 3-MW02-03 | 1/13 | 0 | 1 | Treatment Area |
| | | Toluene | 1,000 | 1,000 | 8 J | 11 | 3-MW02-03 | 2/13 | 0 | 0 | Treatment Area |
| | | Ethylbenzene | 700 | 29 | 1 J | 10 | 3-MW02-03 | 2/13 | 0 | 0 | Treatment Area |
| | | Xylenes (total) | 10,000 | 530 | 20 | 20 | 3-MW02-03 | 1/13 | 0 | 0 | Treatment Area |
| | Semivolatile Organic Compounds | Phenol | NE | 300 | 68 | 68 | 3-MW02-03 | 1/13 | NA | 0 | Treatment Area |
| | | 2-Methylphenol | NE | NE | 160 J | 160 J | 3-MW02-03 | 1/13 | NA | NA | Treatment Area |
| | | 4-Methylphenol | NE | NE | 200 J | 200 J | 3-MW02-03 | 1/13 | NA | NA | Treatment Area |
| | | 2,4-Dimethylphenol | NE | NE | 64 J | 64 J | 3-MW02-03 | 1/13 | NA | NA | Treatment Area |
| | | Naphthalene | NE | 21 | 360 | 1,500 | 3-MW02-03 | 2/13 | NA | 2 | Treatment Area |
| | | 2-Methylnaphthalene | NE | NE | 23 | 94 | 3-MW02-03 | 2/13 | NA | NA | Treatment Area |
| | | Acenaphthylene | NE | 210 | 2 J | 2 J | 3-MW02-03 | 1/13 | NA | 0 | Treatment Area |
| | | Acenaphthene | NE | 800 | 45 J | 55 | 3-MW02-03 | 2/13 | NA | 0 | Treatment Area |
| | | Dibenzofuran | NE | NE | 24 | 120 J | 3-MW02-03 | 2/13 | NA | NA | Treatment Area |
| | | Fluorene | NE | 280 | 20 | 80 | 3-MW02-03 | 2/13 | NA | 0 | Treatment Area |
| | | Phenanthrene | NE | 210 | 23 | 97 J | 3-MW02-03 | 2/13 | NA | 0 | Treatment Area |
| | | Anthracene | NE | 2,100 | 5 NJ | 5 NJ | 3-MW02-03 | 1/13 | NA | 0 | Treatment Area |
| | | Carbazole | NE | NE | 11 J | 82 | 3-MW02-03 | 2/13 | NA | NA | Treatment Area |
| | | Fluoranthene | NE | 280 | 3 J | 10 J | 3-MW02-03 | 2/13 | NA | 0 | Treatment Area |
| | | Pyrene | NE | 210 | 2 J | 8 J | 3-MW02-03 | 2/13 | NA | 0 | Treatment Area |
| | | bis(2-Ethylhexyl)phthalate | 6 | 3 | 1 J | 1 J | 3-MW02-03 | 2/13 | 0 | 0 | Treatment Area |

**TABLE 7 (Continued)**

**SUMMARY OF THE ANALYTICAL RESULTS FOR GROUNDWATER**
**REMEDIAL INVESTIGATION, 1994-95**
**OPERABLE UNIT NO. 12 (SITE 3)**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Environmental Medium | Fraction | Constituent | Comparison Criteria | Comparison Criteria | Detection Summary | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min. Concentration | Max. Concentration | Max. Concentration Location | No. of Detections/ Total No. of Samples | Number of Detections Above Comparison Criteria[1] | Number of Detections Above Comparison Criteria[1] | Distribution |
| Groundwater - Castle Hayne (Round Three) | Semivolatile Organic Compounds | Phenol | NE | 300 | 1 J | 1 J | 3-MW11IW-02 | 1/3 | NA | 0 | Treatment Area |
| | | Naphthalene | NE | 21 | 4 J | 4 J | 3-MW02IW-03 | 1/3 | NA | 0 | Treatment Area |
| | | 2-Methylnaphthalene | NE | NE | 1 J | 1 J | 3-MW02IW-03 | 1/3 | NA | NA | Treatment Area |
| | | Acenaphthene | NE | 800 | 25 | 25 | 3-MW02IW-03 | 1/3 | NA | 0 | Treatment Area |
| | | Dibenzofuran | NE | NE | 29 | 29 | 3-MW02IW-03 | 1/3 | NA | NA | Treatment Area |
| | | Fluorene | NE | 280 | 35 | 35 | 3-MW02IW-03 | 1/3 | NA | 0 | Treatment Area |
| | | Phenanthrene | NE | 210 | 120 | 120 | 3-MW02IW-03 | 1/3 | NA | 0 | Treatment Area |
| | | Anthracene | NE | 2,100 | 11 NJ | 11 NJ | 3-MW02IW-03 | 1/3 | NA | 0 | Treatment Area |
| | | Carbazole | NE | NE | J | 4 J | 3-MW02IW-03 | 1/3 | NA | NA | Treatment Area |
| | | Fluoranthene | NE | 280 | 28 | 28 | 3-MW02IW-03 | 1/3 | NA | 0 | Treatment Area |
| | | Pyrene | NE | 210 | 16 | 16 | 3-MW02IW-03 | 1/3 | NA | 0 | Treatment Area |

Notes:

[1] Shaded blocks indicate detections above comparison criteria.

NE = No criteria established
NA = Not applicable
J =Estimated value
MCL = Federal Maximum Contaminant Level
NCWQS = North Carolina Water Quality Standard
NJ = Estimated value/tentative identification
µg/L = microgram per liter (ppb)

Reference: Baker Environmental, Inc., 1996. Remedial Investigation Report Operable Unit No. 12 (Site 3). Marine Corps Base, Camp Lejeune, North Carolina.

TABLE 8

CONTAMINANTS OF POTENTIAL CONCERN (COPCs) EVALUATED
DURING THE HUMAN HEALTH RISK ASSESSMENT
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Surface Soil | Subsurface Soil | Round 2 Groundwater | Combined Rounds Groundwater |
|---|---|---|---|---|
| **Volatiles:** | | | | |
| 1,1-Dichloroethene | | | X | X |
| Chloroform | | | X | X |
| Trichloroethene | | | | |
| Benzene | | | X | X |
| Toluene | | | | |
| Ethylbenzene | | | | |
| Xylenes (total) | | | | |
| **Semivolatiles:** | | | | |
| Phenol | | | | |
| 2-Methylphenol | | | X | X |
| 4-Methylphenol | | | X | X |
| 2,4-Dimethylphenol | | | X | X |
| Naphthalene | | | X | X |
| 2-Methylnaphthalene | | | X | X |
| Acenaphthene | | | X | X |
| Acenaphthylene | | | | |
| Dibenzofuran | | X | X | X |
| Fluorene | | | X | X |
| Phenanthrene | | | X | X |
| Anthracene | | | | |
| Carbazole | | | X | X |
| Fluoranthene | | | | |
| Pyrene | | | | |
| Bis(2-ethylhexyl)phthalate | | | | |
| Benzo(a)anthracene | X | X | | X |
| Benzo(b)fluoranthene | X | X | | X |
| Chrysene | X | X | | X |
| Benzo(k)fluoranthene | X | X | | X |
| Benzo(a)pyrene | X | X | | X |
| Indeno(1,2,3-cd)pyrene | X | X | | |
| Dibenz(a,h)anthracene | X | | | |
| 2-Nitrophenol | | | | X |
| **Inorganics:** | | | | |
| Aluminum | | | | X |
| Chromium | | | | X |

X = Selected as a COPC for human health risk assessment.

TABLE 9

SUMMARY OF HUMAN HEALTH RISKS
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Receptors | Soil | | Round 2 Groundwater | | Worst Case Groundwater | | Total with Round 2 Groundwater Contamination | | Total with Worst Case Groundwater Contamination | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ICR | HI | ICR | HI | ICR | HI | ICR | HI | ICR | HI |
| Military Personnel | 1.7E-06 (100) | NA | NE | NE | NE | NE | 1.7E-06 | NA | 1.7E-06 | NA |
| Future Child Resident | 1.4E-05 (70)/(<1) | NA | 5.3E-06 (30) | 1.7 (100) | 7.5E-04 (100) | 2.3 (100) | 1.9E-05 | 1.7 | 7.6E-04 | 2.3 |
| Future Adult Resident | 5.4E-06 (39)/(<1) | NA | 1.1E-05 (61) | 0.7 (100) | 1.8E-03 (100) | 3.7 (100) | 1.7E-05 | 0.7 | 1.8E-03 | 3.7 |
| Future Construction Worker | 1.0E-07 (100) | <0.01 (100) | NE | NE | NE | NE | 1.7E-07 | <0.01 | 1.0E-07 | <0.01 |

Notes:

ICR = Incremental Lifetime Cancer Risk
HI = Hazard Index
Total = Soil + Groundwater
NE = Not evaluated for potential receptor
NA = Not applicable (no noncarcinogenic COPCs)
( ) = Percent contribution to total risk
( )/( ) = First is percent contribution to total risk with round 2 groundwater results; Second is percent contribution to total risk with worst case groundwater results (combined Rounds 1, 2, 3)

Shaded blocks indicate an ICR value that exceeds the acceptable limit of 1E-04, or an HI value that exceeds the acceptable limit of 1.0.

TABLE 10

CONTAMINANTS OF POTENTIAL CONCERN (COPCs)
EVALUATED DURING THE ECOLOGICAL RISK ASSESSMENT
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant of Potential Concern in Surface Soil |
|---|
| **Inorganics** |
| Chromium |
| Zinc |
| **Semivolatiles** |
| Acenaphthylene |
| Anthracene |
| Benzo(a)anthracene |
| Benzo(b)fluoranthene |
| Benzo(k)fluoranthene |
| Benzo(g,h,i)perylene |
| Benzo(a)pyrene |
| Bis(2-ethylhexyl)phthalate |
| Carbazole |
| Chrysene |
| Dibenz(a,h)anthracene |
| Di-n-butylphthalate |
| Fluoranthene |
| Fluorene |
| Indeno(1,2,3-cd)pyrene |
| Phenanthrene |
| Pyrene |
| **Volatiles** |
| Ethylbenzene |
| Toluene |
| Xylenes |

TABLE 11

GLOSSARY OF EVALUATION CRITERIA
OPERABLE UNIT NO. 12 (SITE 3)
MCB CAMP LEJEUNE, NORTH CAROLINA

- **Overall Protection of Human Health and the Environment** - addresses whether or not an alternative provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment engineering or institutional controls
- **Compliance with ARARs/TBCs** - addresses whether or not an alternative will meet the applicable or relevant and appropriate requirements (ARARs), criteria to-be-considered (TBCs), and other federal and state environmental statutes, and/or provide grounds for invoking a waiver.
- **Long-Term Effectiveness and Permanence** - refers to the magnitude of residual risk and the ability of an alternative to maintain reliable protection of human health and the environment over time once cleanup goals have been met.
- **Reduction of Toxicity, Mobility, or Volume Through Treatment** - refers to the anticipated performance of the treatment options that may be employed within an alternative.
- **Short-Term Effectiveness** - refers to the speed with which the alternative achieves protection, as well as the remedy's potential to create adverse impacts on human health and the environment that may occur during the construction and implementation period.
- **Implementability** - refers to the technical and administrative feasibility of an alternative, including the availability of materials and services required to implement the chosen solution.
- **Cost** - includes capital and operation and maintenance costs. For comparative purposes, present worth values are provided.

**TABLE 12**

**SOIL REMEDIATION LEVELS**
**OPERABLE UNIT NO. 12 (SITE 3)**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Contaminant of Concern | RL | Basis of Goal |
|---|---|---|
| Naphthalene | 30,000 | SSL |
| 2-Methylnaphthalene | 30,000 | SSL |
| Carbazole | 500 | SSL |
| Benzo(a)anthracene | 700 | SSL |
| Chrysene | 1,000 | SSL |

Notes:

RL = Remediation Level in microgram per kilogram (µg/kg)
SSL = USEPA Region III Soil Screening Level (USEPA, 1995)

## TABLE 13

## GROUNDWATER REMEDIATION LEVELS
## OPERABLE UNIT NO. 12 (SITE 3)
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant of Concern | RL | Basis of Goal | Corresponding Risk |
|---|---|---|---|
| Benzene | 1 | NCWQS | |
| Phenol | 300 | NCWQS | |
| 2-Methylphenol | 78 | Groundwater Ingestion | HI = 0.1 |
| 2,4-Dimethylphenol | 31 | Groundwater Ingestion | HI = 0.1 |
| Naphthalene | 21 | NCWQS | |
| 2-Methylnaphthalene | 63 | Groundwater Ingestion | HI = 0.1 |
| Dibenzofuran | 6 | Groundwater Ingestion | HI = 0.1 |
| Phenanthrene | 210 | NCWQS | |
| Benzo(a)anthracene | 0.05 | NCWQS | |
| Chrysene | 5 | NCWQS | |
| Chloroform | 0.19 | Groundwater Ingestion | ICR - $1 \times 10^{-6}$ |
| Carbazole | 4 | Groundwater Ingestion | ICR = $1 \times 10^{-6}$ |
| Benzo(b)fluoranthene | 0.12 | Groundwater Ingestion | ICR - $1 \times 10^{-6}$ |
| Benzo(k)fluoranthene | 1 | MCL | |
| Benzo(a)pyrene | 2 | MCL | |
| Iron | 300 | NCWQS | |
| Aluminum | 50 | SMCL | |

Notes:

RL = Remediation Level in microgram per liter (ppb)
NCWQS = North Carolina Water Quality Standard
MCL = Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
HI = Hazard Index
ICR = Incremental Cancer Risk

# FIGURES

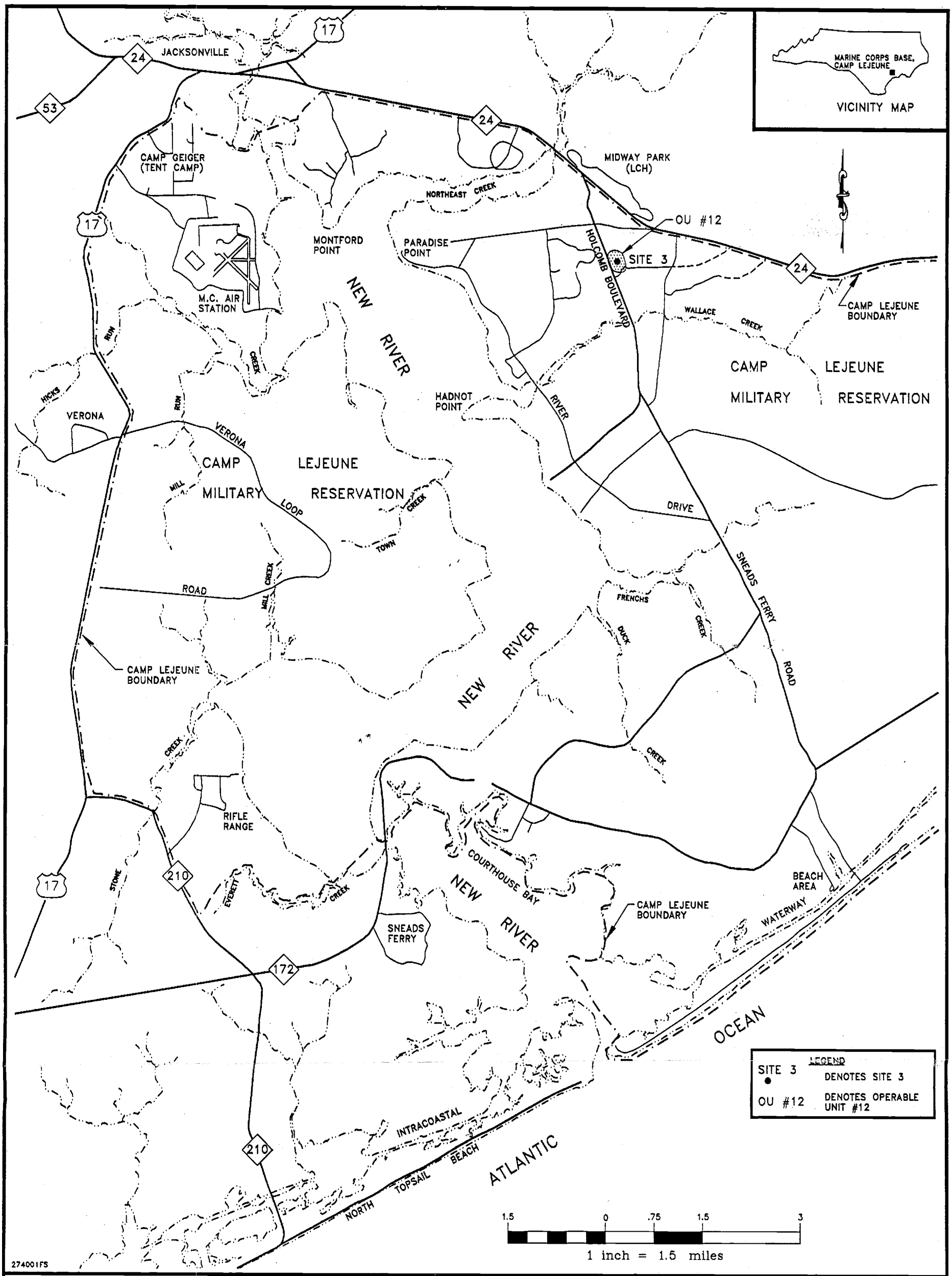
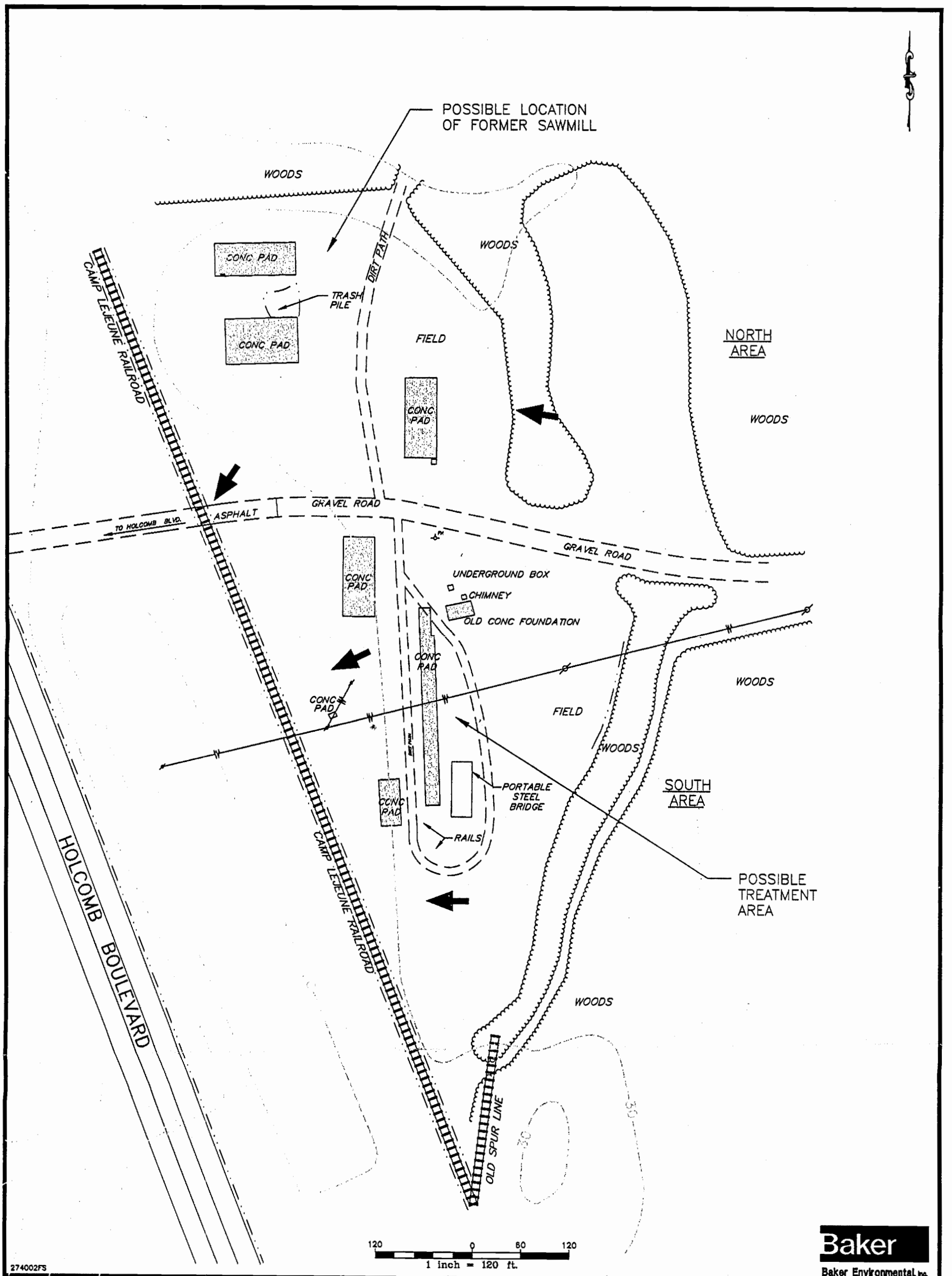



FIGURE 1

OPERABLE UNIT NO. 12 (SITE 3)
MARINE CORPS BASE, CAMP LEJEUNE

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01753JJBIZ




LEGEND

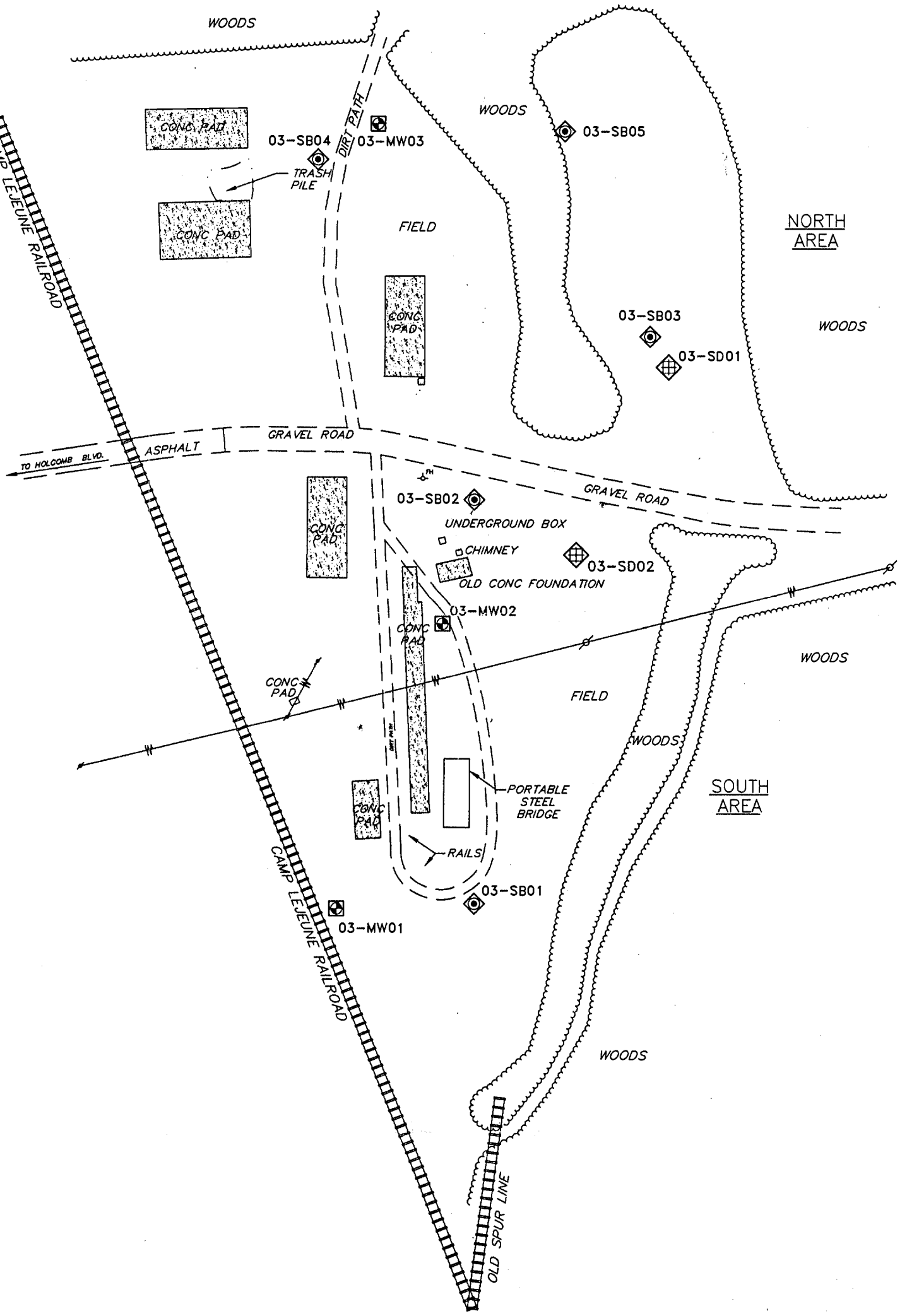
- DRAINAGE PATH
- GRAVEL ROAD/DIRT PATH
- GROUNDWATER FLOW DIRECTION IN THE SHALLOW AQUIFER
- TOPOGRAPHIC ELEVATION LINE (FEET, MSL)

SOURCE: W.K. DICKSON & Co., INC., JANUARY 1995

FIGURE 2

SITE MAP
SITE 3 – OLD CREOSOTE PLANT

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA




274003FS

Baker

Baker Environmental, Inc.

## LEGEND

03-MW01 — MONITORING WELL INSTALLED BY HALLIBURTON NUS, NOVEMBER 1991

03-SB03 — SOIL BORING INSTALLED BY HALLIBURTON NUS, NOVEMBER 1991

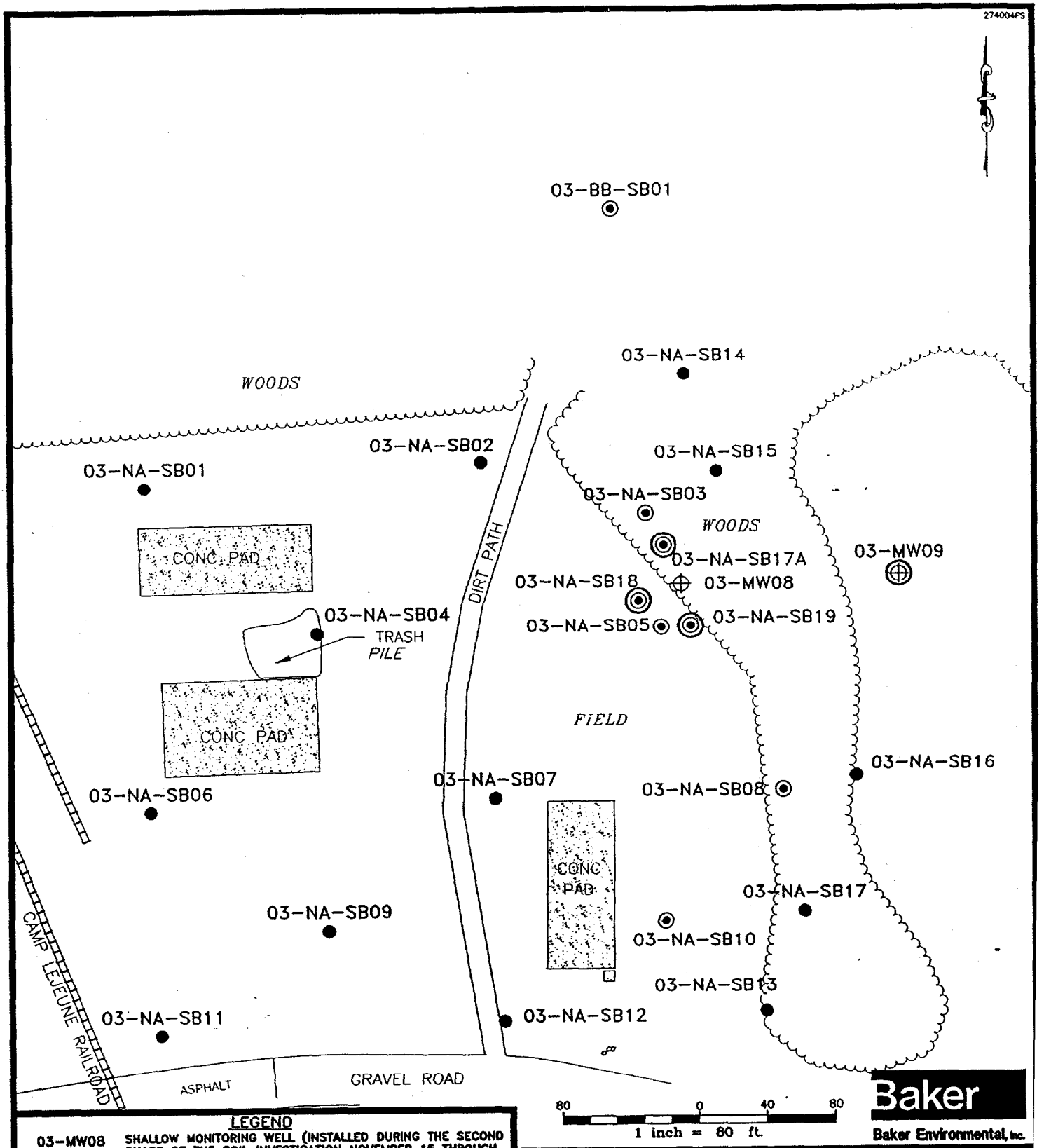
03-SD01 — SEDIMENT SAMPLE COLLECTED BY HALLIBURTON NUS, NOVEMBER 1991

SOURCE: W.K. DICKSON & Co., INC., JANUARY 1995

# FIGURE 3

## SAMPLING LOCATIONS
## SITE INSPECTION, 1991
## SITE 3 – OLD CREOSOTE PLANT

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA




**LEGEND**

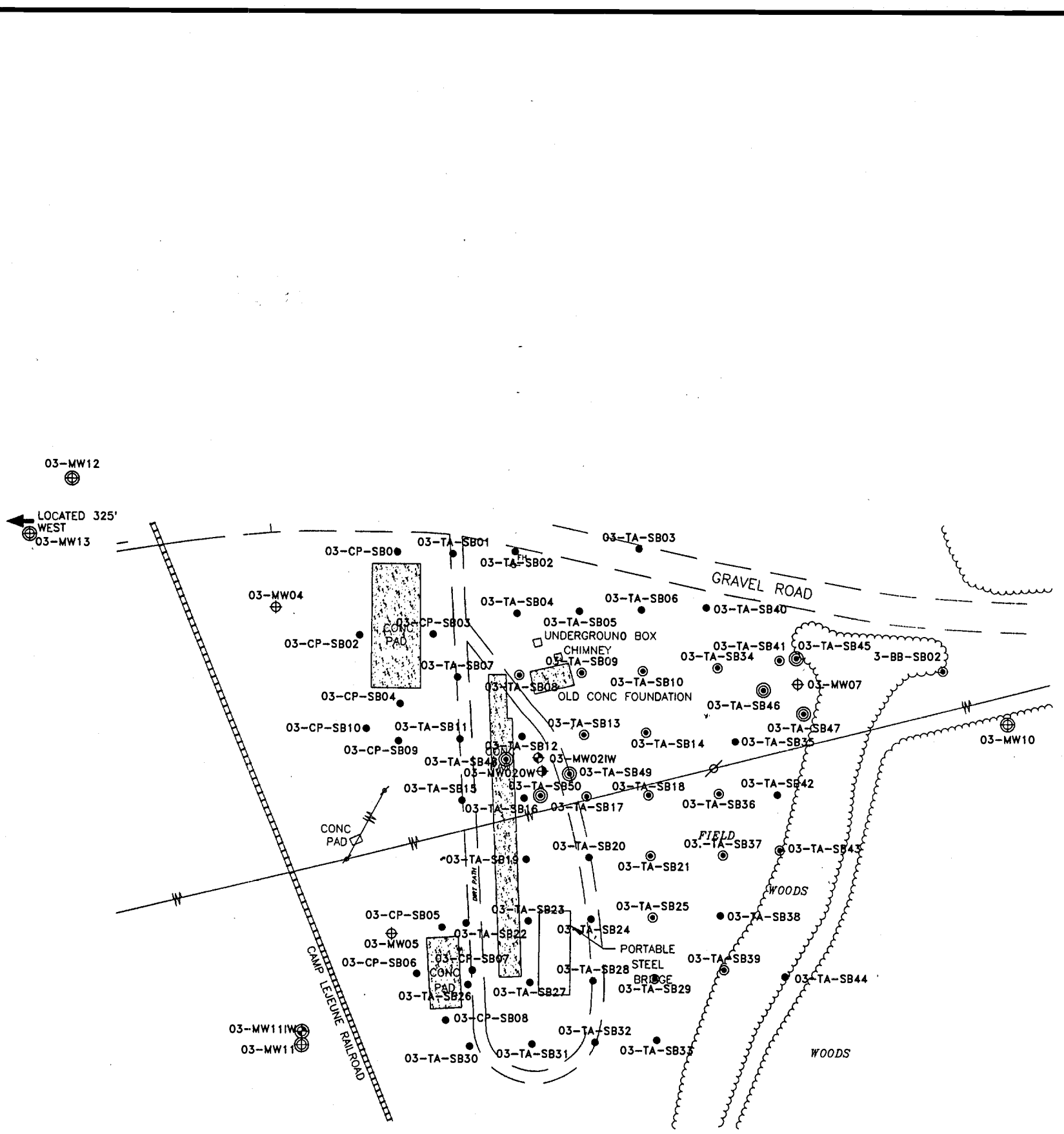
| | |
|---|---|
| 03-MW08 ⊕ | SHALLOW MONITORING WELL (INSTALLED DURING THE SECOND PHASE OF THE SOIL INVESTIGATION NOVEMBER 15 THROUGH NOVEMBER 22, 1994). |
| 03-NA-SB03 ◉ | SOIL BORING LOCATION (INSTALLED DURING THE SECOND PHASE OF THE SOIL INVESTIGATION NOVEMBER 15 THROUGH NOVEMBER 22, 1994). |
| 03-NA-SB01 ● | ENSYS SURFACE SOIL BORING (INSTALLED DURING THE FIRST PHASE OF THE SOIL INVESTIGATION SEPTEMBER 19 THROUGH SEPTEMBER 22, 1994). |
| 03-MW09 ⊕ | SHALLOW MONITORING WELL (INSTALLED DURING THE THIRD PHASE OF THE SOIL INVESTIGATION JUNE 12 THROUGH JUNE 29, 1995). |
| 03-NA-SB17A ◉ | SOIL BORING LOCATION (INSTALLED DURING THE THIRD PHASE OF THE SOIL INVESTIGATION JUNE 12 THROUGH JUNE 29, 1995). |

W.K. DICKSON & CO.,INC., JANUARY 1995

# FIGURE 4

## SOIL SAMPLING LOCATIONS REMEDIAL INVESTIGATION, 1994-95 SITE 3 - OLD CREOSOTE PLANT (NORTHERN AREA)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

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LEGEND

- 03-MW04 — SHALLOW MONITORING WELL LOCATION (INSTALLED DURING THE SECOND PART OF THE SOIL INVESTIGATION NOVEMBER 15 THROUGH NOVEMBER 22, 1994).
- 03-MW02IW — INTERMEDIATE MONITORING WELL LOCATION (INSTALLED DURING THE SECOND PART OF THE SOIL INVESTIGATION NOVEMBER 15 THROUGH NOVEMBER 22, 1994).
- 03-TA-SB08 — SOIL BORING LOCATION (INSTALLED DURING THE FIRST AND SECOND PART OF THE SOIL INVESTIGATION AUGUST 19 THROUGH AUGUST 22, 1994 AND NOVEMBER 15 THROUGH NOVEMBER 22, 1994).
- 03-TA-SB01 — ENSYS SURFACE SOIL BORING (INSTALLED DURING THE FIRST PART OF THE SOIL INVESTIGATION AUGUST 19 THROUGH AUGUST 22, 1994).
- 03-MW10 — SHALLOW MONITORING WELL LOCATION (INSTALLED DURING THE THIRD PART OF THE SOIL INVESTIGATION JUNE 12 THROUGH JUNE 29, 1995).
- 03-MW11IW — INTERMEDIATE MONITORING WELL LOCATION (INSTALLED DURING THE THIRD PART OF THE SOIL INVESTIGATION JUNE 12 THROUGH JUNE 29, 1995).
- 03-MW02DW — DEEP MONITORING WELL LOCATION (INSTALLED DURING THE THIRD PART OF THE SOIL INVESTIGATION JUNE 12 THROUGH JUNE 29, 1995).
- 03-TA-SB45 — SOIL BORING LOCATION (INSTALLED DURING THE THIRD PART OF THE SOIL INVESTIGATION JUNE 12 THROUGH JUNE 29, 1995).

SOURCE: LANTDIV, OCT. 1991

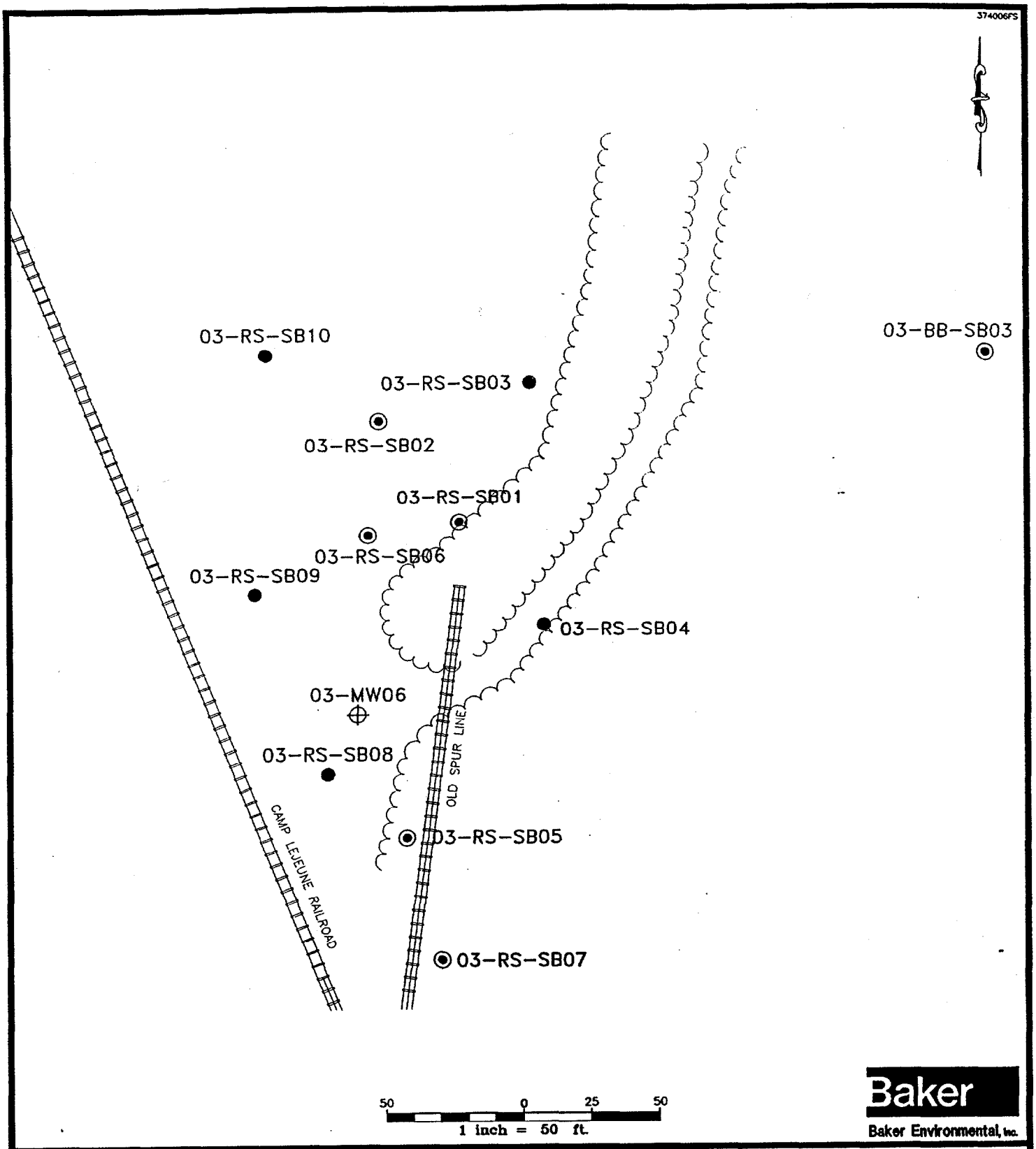
100 0 50 100
1 inch = 100 ft.

Baker
Baker Environmental, Inc.

# FIGURE 5
## SOIL SAMPLING LOCATIONS REMEDIAL INVESTIGATION, 1994-95 SITE 3 - OLD CREOSOTE PLANT (TREATMENT AND CONCRETE PAD AREAS)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01753JJ01Z




## LEGEND

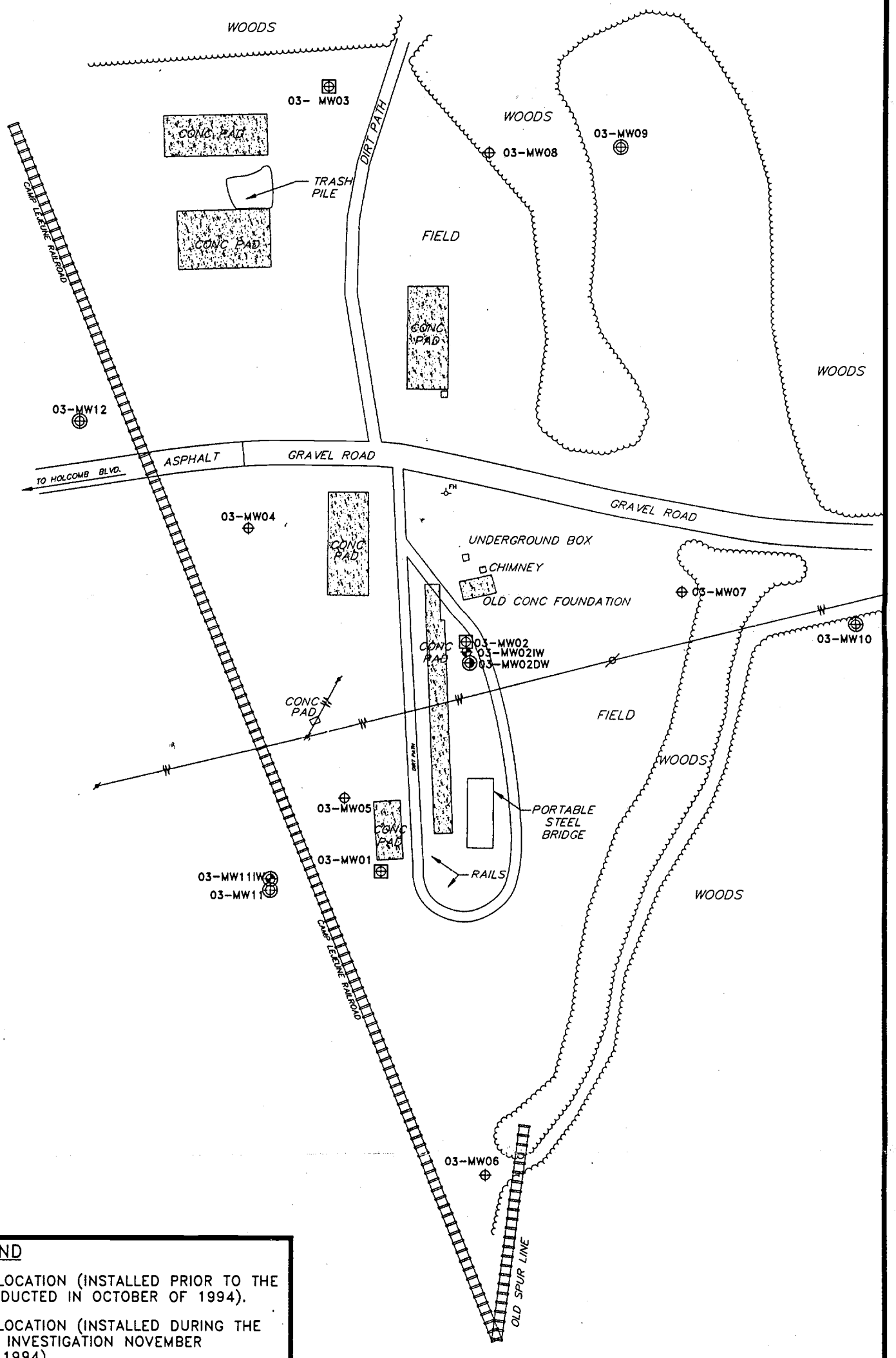
| | |
|---|---|
| 03-MW06 ⊕ | SHALLOW MONITORING WELL LOCATION (INSTALLED DURING THE SECOND PHASE OF THE SOIL INVESTIGATION NOVEMBER 15 THROUGH NOVEMBER 22, 1994). |
| 03-RS-SB01 ◉ | SOIL BORING LOCATION (INSTALLED DURING THE SECOND PHASE OF THE SOIL INVESTIGATION NOVEMBER 15 THROUGH NOVEMBER 22, 1994). |
| 03-RS-SB03 ● | ENSYS SURFACE SOIL BORING (INSTALLED DURING THE FIRST PHASE OF THE SOIL INVESTIGATION SEPTEMBER 19 THROUGH SEPTEMBER 22, 1994). |

SOURCE: W.K. DICKSON & CO., INC., JANUARY 1995

# FIGURE 6

## SOIL SAMPLING LOCATIONS REMEDIAL INVESTIGATION, 1994-95 SITE 3 - OLD CREOSOTE PLANT (RAIL SPUR AREA)

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA




274007FS

## LEGEND

- 03-MW01 — SHALLOW MONITORING WELL LOCATION (INSTALLED PRIOR TO THE REMEDIAL INVESTIGATION CONDUCTED IN OCTOBER OF 1994).
- 03-MW04 — SHALLOW MONITORING WELL LOCATION (INSTALLED DURING THE SECOND PHASE OF THE SOIL INVESTIGATION NOVEMBER 15 THROUGH NOVEMBER 22, 1994).
- 03-MW02IW — INTERMEDIATE MONITORING WELL LOCATION (INSTALLED DURING THE SECOND PHASE OF THE SOIL INVESTIGATION NOVEMBER 15 THROUGH NOVEMBER 22, 1994).
- 03-MW09 — SHALLOW MONITORING WELL LOCATION (INSTALLED DURING THE THIRD PHASE OF THE SOIL INVESTIGATION JUNE 12 THROUGH JUNE 29, 1995).
- 03-MW11IW — INTERMEDIATE MONITORING WELL LOCATION (INSTALLED DURING THE THIRD PHASE OF THE SOIL INVESTIGATION JUNE 12 THROUGH JUNE 29, 1995).
- 03-MW02DW — DEEP MONITORING WELL LOCATION (INSTALLED DURING THE THE THIRD PHASE OF THE SOIL INVESTIGATION JUNE 12 THROUGH JUNE 29, 1995).

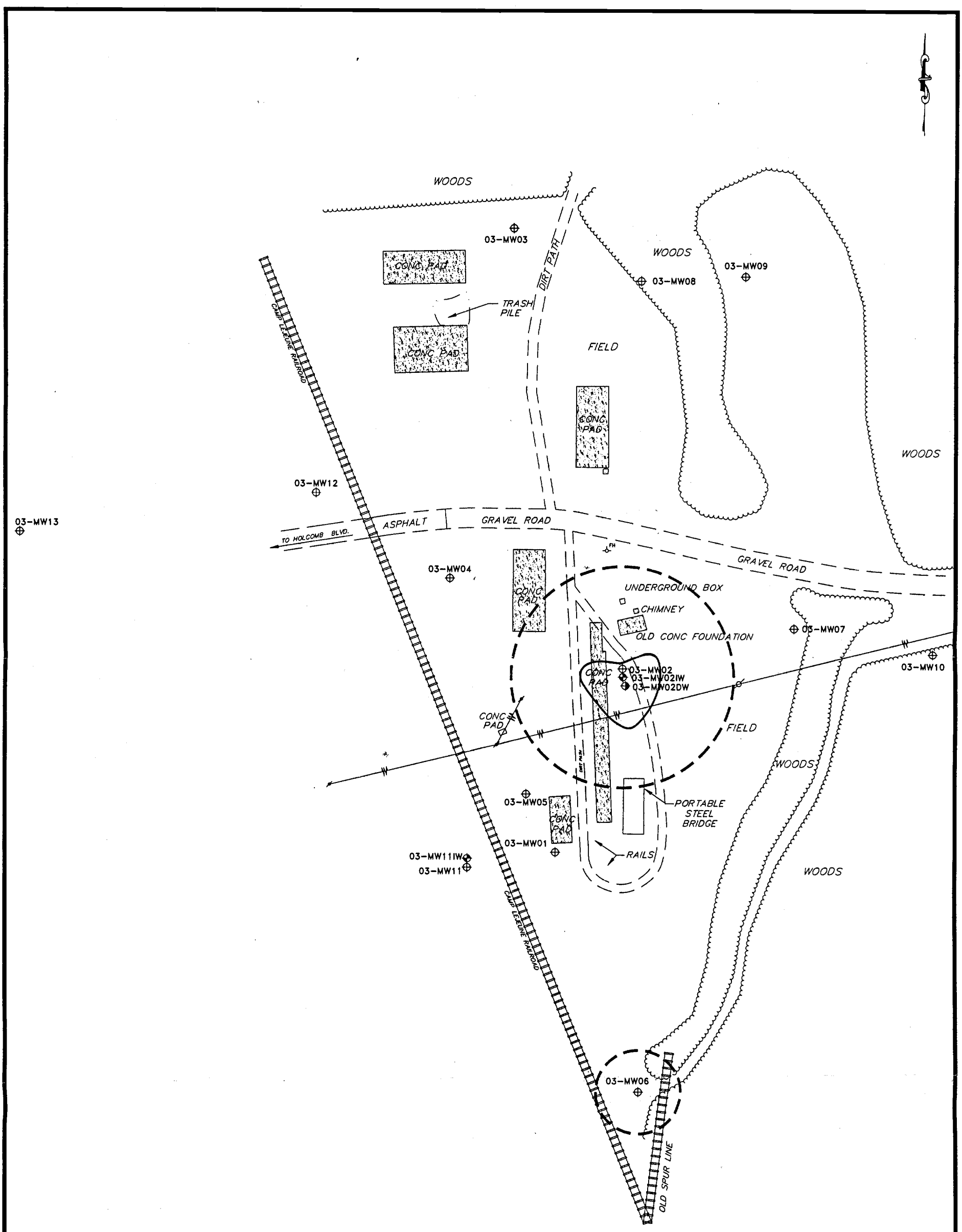
SOURCE: W.K. DICKSON & Co., INC., JANUARY 1995

FIGURE 7

GROUNDWATER SAMPLING LOCATIONS
REMEDIAL INVESTIGATION, 1994-95
SITE 3 - OLD CREOSOTE PLANT

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01753JJ B2Z




LEGEND

- 03-MW01 ⊕ SHALLOW MONITORING WELL LOCATION
- 03-MW02IW ⊕ INTERMEDIATE MONITORING WELL LOCATION
- 03-MW02DW ⊕ DEEP MONITORING WELL LOCATION
- — — — GROUNDWATER AREA OF CONCERN (SHALLOW AQUIFER)
- ——— SUBSURFACE SOIL AREA OF CONCERN

SOURCE: W.K. DICKSON & Co., INC., JANUARY 1995

# FIGURE 8

## AREAS OF CONCERN
## SITE 3 – OLD CREOSOTE PLANT

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

# APPENDIX A
# PUBLIC MEETING TRANSCRIPT

# RESTORATION ADVISORY BOARD MEETING

## Proposed Remedial Action Plan

Operable Unit No.12 (Site 3)
Operable Unit No.13 (Site 63)

November 6, 1996.
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questions are from and that will help us when we go to address these questions with a response summary that will be provided later.

As Matt talked about earlier, as he went through each of the operable units, there are 18 operable units. Some of those operable units are comprised of more than one site.

It just so happens that Operable Unit 13 is comprised of only one site and that's Site 63, the Verona Loop Dump.

A sense of where the site is located, it's in the western part of the facility over here, about two miles south of the Marine Corps Air Station.

The next slide has a little bit better regional location of it.

It's about a mile east of Highway 17 for Verona and it's about a mile-and-a-half west of the New River.

MR.CARRAWAY: That's the one we did not see on our field trip.

MR.MORRIS: We went there, but there were trees down across the entrance.

MR.TREBILCOCK: Yes.

training area.

This is one that the personnel trenched out, a sort of foxhole that they've dug out there.

This area and the site are also used for hunting and recreational hunting, but primarily for exercises, training exercises, things like that.

Let me get this in a little better focus.

But, this shows some of the things that were observed out at the site and this is what--there are a few mounds of the same type of - it looks like construction material, but it's concrete, some metal, scrap metal and in some of the other piles, there have been derelict vehicles, vehicle parts, tires, wheel covers and things like that.

So, you know, although we don't have a definition of "bivouac" waste, from these piles out there we could see the concrete and other - looks like construction material.

There's a small tributary to Mill Run on this side of the Base and it runs right--abuts sort of the site itself.

This creek tends to dry up in the summer but

samples were collected.

The findings from the soil investigation indicated that among the 96 soil samples that were collected, 20 of those samples had - let me get this in focus - 20 of those samples had detectable levels of pesticides.

Now it's sliding away. This slide projector is living up to its name - sliding.

Twenty of those samples had pesticides, detectable levels of pesticides in them.

Nineteen of the samples had detectable levels of semi-volatile organic compounds in them.

And, then two of the ninety some samples had polychlorinated biphenyls or what's commonly referred to as PCBs.

And, then, finally, one sample had detectable levels of volatile organic compounds.

Now, the concentrations of these compounds with the exception of the semi-volatile organic compounds were below one hundred parts per billion.

Now, only a few, actually one semi-volatile organic compound was detected above that and it was

If there are any questions--[laughter]--I'm kind of rolling through this.

MS.ELEANOR WOOD: I have one in looking at this chart and it talks about chlordane and it compares some criteria of stream sediment and there is no chlordane and I was curious about that.

MR.TREBILCOCK: That's right, for soil.

MS.WOOD: For soil.

MR.TREBILCOCK: Yes, that's right.

For some of the pesticides there are standards and they're related to how and what concentration in soil would a contaminant potentially impact groundwater.

And, for chlordane, for example, does not--

MS.WOOD: You don't have to deal with soil.

MR.TREBILCOCK: Well, it doesn't have a standard.

I'm sure there probably is a concentration of it that would impact groundwater, but I guess it hasn't been established.

I don't know.

Are there any other questions?

[No response]

MR.TREBILCOCK: It pretty much follows what we've seen in other sites, you know. It gets back I think not too long ago, actually '57 or sixties or fifties, pesticides were fairly commonly used around the Base.

And, when we do find them, they're pretty scattered throughout the Base.

MR.SWARTZENBERG: The same is true for the heavy metals and PCB's and all that.

MR.TREBILCOCK: Yeah, there were no particular--

MR.SWARTZENBERG: Next to where the concrete was?

MR.TREBILCOCK: Well, yeah, there were higher metals detected where we had--where we did observe some in the main part of the site there.

Visually, you could see metals in the sample like rusted iron so in those samples we have a higher concentration of iron.

But, that's where we had buried material mostly. There were only a few places.

But, it usually did correlate.

Pesticides in sedment at least, they tend to adhere to particles so where the surface water flows

fill in a low area.

MR.TREBILCOCK: Well, it's not a landfill.

MR.CARAWAY: Well, I know, but it was a dump site.

MR.TREBILCOCK: A dump site.

MR.CARAWAY: Yeah, okay, dump site, landfill, there's a definition now. Back then there wasn't.

If you have a low area you want to fill it in, you start in the lowest part of the area and work your way up.

So my question is not being able to see the area--

MR.TREBILCOCK: Right.

MR.CARAWAY: --Was the ridge part of the waste area, or was there a ridge and it was put on top and the things filtered down?

MR.TREBILCOCK: It looks like that just this area within the site boundary had the evidence of, you know, that construction debris.

And, I think those are what originally indicated where the site might be, the location of those debris piles.

Now, you know, we dug down in the ground over 46 spots and only two of those spots did we find any evidence of something buried and that was within this area here, within this same--

MR.CARAWAY: Well, that was part of my question was--

MR.TREBILCOCK: Yeah.

MR.CARAWAY: --That if we start by the creek and work our way towards and the further we got towards and then we worked towards 17 we're getting more samples, we're getting our information toward the 17 side versus the creek side.

MR.TREBILCOCK: Yeah.

MR.CARAWAY: Okay.

MR.TREBILCOCK: Yeah, I follow you.

And, actually, this out here had no evidence of much of anything. In fact, it looks like they're following the scenario that you described.

They were beginning to fill in or dump things down towards the creek from the top, you know, down.

MR.CARAWAY: Yeah.

MR.TREBILCOCK: You know, like pull up a truck

carcinogenic or cancer risks, at what level and at what number do they pose a threat.

And, that number is below this number up here.

And, for non-carcinogenic or non-cancerous risk, the number is less than one.

Well, after going through exposure scenarios for the various potential receptors we had, we came up with a potential non-carcinogenic risk to future adult residents and future child residents.

And, those numbers are based on the ingestion of groundwater from the site.

Now, if you remember, we didn't see any indication of organic contaminants in groundwater, but we saw indications of metals, high metal concentrations in the groundwater samples.

So, these two scenarios assume that for the future adult resident and future child resident that groundwater that we collected would be their primary source of potable water, or drinking water.

So, that's how those are and so it's a very conservative number that represents based on what we are doing.

MR.TREBILCOCK: Well, I think maybe Neal might have a better handle on that.

I think in the past we've sort of just said instead of suggesting, you know, if you say, well, we're going to clean up the site from the aesthetic point of view, you might indicate that, well, you think there might be something there that could cause future contamination.

Right now, we don't think that, you know, concrete or the scrap metal or whatever else is going to cause anything.

But, that's pretty much just a housecleaning thing that I don't know whether Camp Lejeune--

MR.SWARTZENBERG: That's not the problem in other words.

MR.TREBILCOCK: No.

MR.NEAL PAUL: No, that's not the problem.

MS.KATHERINE LANDMAN: It's not a problem of contaminated site.

You might consider it an eyesore--

MR.TREBILCOCK: Yeah.

MS.LANDMAN: --But, you know, at such time as

about the site itself?

MR.SWARTZENBERG: If they did do the Clean Sweep thing - I don't want to run his over--

MR.TREBILCOCK: Oh, no, no.

MR.SWARTZENBERG: If you did do the Clean Sweep though, from what you said it wouldn't change your figures at all?

MR.TREBILCOCK: No, no.

MR.SWARTZENBERG: It would just make it look a little better.

MR.PAUL: It would make it look a little better.

MR.CARAWAY: Wouldn't it change the figures ten years down the road if that metal continues to deteriorate?

Is the metal above the ground?

MR.TREBILCOCK: Well, it could, but, you know, once again, it would be iron and things that really wouldn't be hazardous to people or to the environment.

I mean, it could become more unsightly, you know, if you have iron oxidizing and you're going to have a stain or whatever on your ground, but not from a hazard standpoint.

probably migrating from the site into the sediment in the form of particulates or, you know, tiny pieces absorbed have washed into the creek and are now at the bottom of the creek so when you collect a sediment sample, well, you're going to see pesticides on that particle absorbed.

MS.DeBOW: Yes.

MR.TREBILCOCK: Now it has become a piece of sediment, but it had been just a piece of regular surface water.

MS.DeBOW: But, from what I saw, the pesticides were below State minimum acceptable limits.

MR.TREBILCOCK: Yes.

MS.DeBOW: Yeah, okay.

MR.TREBILCOCK: In fact, this is one of the-- this site is probably at lower levels of pesticides than what we typically see.

And, fewer in number too.

MS.WOOD: And, the same would apply to the naphtha?

MR.TREBILCOCK: Yeah, it had two detections in the soil and they were both under one hundred parts per billion, so, yeah, the same thing would apply to those

meeting if you want to talk to me about any specifics about the site, but I'll turn it over to Matt.

We're sort of going in backwards order. I talked about Operable Unit 13 and Matt Bartman's going to talk about Operable Unit 12.

MR. BARTMAN: The discussion that I'll be dealing with is Operable Unit 12, Site 3, which is also referred to as the old Creosote Plant.

I know these pictures are difficult to see.

But, the old creosote plant, I'm going to pass around this photo.

This is an aerial photo from 1949.

The old creosote plant is also referred to, like I said, to Operable Unit 12, Site 3, and it's located on Holcomb Boulevard, about a half-mile off of Holcomb Boulevard, the main side of the Base.

It's also referred to as Lot 204 and that's the big chimney, if anyone's going to the site you'll be able to see this site.

This is from the entrance coming from Holcomb Boulevard to the site.

And, this is what we refer to as the northern

That's all taken place in the northern area of the site from the hurricane that's taken place.

Now you can see the north area is the staging area for all the downed trees.

This is a very quick slide of the layout of the site.

Again we have the northern area where the downed trees are now staged.

This is what we refer to as the treatment area and then the railroad spike or the southern portion of the site.

Mainly all the creosote treating operations were conducted in this area. Again, the reason the chimney is located here.

A dirt track and the railroad spike area which not only comes to about here, but you can see remanants of it where they used the pumps where they appeared to derive water.

Field Investigation Summary.

What Baker Environmental did here, we had a multi-phase field program which was conducted from September 1994 to September 1996.

locate through subsurface soil contamination in '94 that we had additional problems.

This is again the treatment area and this is just to give you an indication of how many samples we collected out here.

The pink being the ENSYS investigation.

The green being the different phases of the investigation we did in November of '94 and June of '95.

And, this does not even show the northern area where we had several soil samples taken and also the railroad spike area.

The multi-phase investigation also included groundwater investigation.

In December of 1994 we put in seven shallow and one intermediate monitoring well.

And, then due to the contamination we found there, we came back out and had to put in eight. We sampled the eight existing shallow monitoring wells.

We installed five new shallow monitoring wells.

One intermediate well and one deep well.

The shallow wells being roughly 25 to 30 feet.

Intermediate depth, 40 to 60 feet below ground

or absence of contamination.

That was again by September of 1995.

Through the findings of September of 1995, we kind of have suspected misleading information between July of '95 and September of '95 and wanted to confirm that and that was in the deep well.

We only put in one deep well.

So, we had contamination in '95. We did see the contamination in September of '95 and we came back out in January of '96 and sampled that water and confirmed that there was an absence of contamination deep.

Had we found contamination, we would've had to go deeper.

But, given the nature of the contaminants which again the majority of them are PAHs, again the contaminants don't travel or migrate very readily in soil.

Usually you don't see them in the groundwater because they don't have a high mobility, or high leachability into the groundwater.

But, unfortunately, given the levels of creosote in our soil, we saw them in groundwater.

This figure indicates the areas where our

groundwater monitoring wells were placed.

I apologize for the figures.

Again, the pink indicates the shallow monitoring wells.

The blue are the intermediate wells.

And, the purple is the deep well.

You see we have wells on the north area, the treatment area and the southern portions of the site.

Due to contamination we had here in this intermediate well, in the second phase, we decided to put in this intermediate well.

And, then go back and due to the contamination put in this deep well.

What we found in all these phases of investigations was that a majority of our contamination both in soil and in groundwater, as we suspected but had to confirm, was all of our contamination was in what we were thinking would be the treatment area.

The chimney area used to heat the creosote.

If you don't know what creosote is, I could explain it, but I think everybody knows what it is.

But, at first, it's a very tarry material that

adult, both carcinogenic and non-carcinogenic risks.

And, this is from the ingestion of groundwater.

However, shallow groundwater in this area is not even used as a potable water supply.

However, we still have to consider it as a potential exposure to future adult, to future residents.

Given that we don't have a risk to subsurface soils, which the construction worker is the only exposed receptor to subsurface soil.

However, we knew that that was part of our readings and our findings or detections, we knew that subsurface soil was where our contamination was. However, there's no risk.

That puts us in a Catch-22 because we have contamination but it's not causing risk, so what do you do with it?

So, we knew that our sources was the soil. Our groundwater was causing our contamination and causing our risks.

So, we had to remove the source and that's what we plan on doing as part of our proposed remedial action.

We went through five different alternatives.

We know it exceeds regulatory levels.

We know that it poses a potential risk.

However, we feel that the source is really the soil, so therefore we remove the soil.

All we want to do here is monitor the groundwater.

Apparently, it's not posing a risk.

So, what we want to do is, again, monitor the groundwater, see if once we remove the source what happens to the concentrations in the groundwater?

Do they remain the same?

Do they increase?

Is there another source out there?

So, this monitoring will be conducted over a 30 year period, probably on a semi-annual basis and will be up for a five year review by the regulators.

So, that's roughly what's going to be happening at Site 3.

MS.WOOD: It says here the clinical phase, this is because it is impractical to remediate the saturated soil, which earlier it states is detectable for PAH contamination because of water--[inaudible].

And, that's exactly what's happened in this case.

MS.GOOD: Thank you.

MR.JOE BARNETT: You said the risk looks like is higher for children, or I didn't understand that statistic.

It looked like it was less for children.

MR.BARTMAN: Can't remember.

MS.DeBOW: It was ten to the minus three.

MR.BARTMAN: Ten to the minus three.

It's actually less for children, higher for an adult.

MR.BARNETT: Does that mean for the adult, because it started as a child and there's--

MR.BARTMAN: Basically--

MR.BARNETT: --A cumulative effect over your lifetime for carcinogenic effect?

MR.BARTMAN: Exactly.

MR.BARNETT: Okay.

MR.BARTMAN: Also, exposure, the amount ingested is higher for an adult. Exposure period's longer, so you're at a higher risk.

MR.PAUL: This is high performance storage facility is POLs?

MR.MORRIS: Yes, PLOs.

MR.BARTMAN: It probably wouldn't be a problem from our standpoint if it's that treatment area.

The southern portion, there's a monitoring well on WO6 which I believe is the most downgraded shallow well.

It's going to be one of the wells that we're going to need to monitor because, for some reason, we found contamination of subsurface soil and in that groundwater as well.

So, as far as, I mean, as long as they don't disturb any of the wells that we'll be using for longterm monitoring, we're probably in good shape.

MR.PAUL: Is that an old site or new site?

MR.MORRIS: For?

MR.PAUL: What you talked about.

MR.BARTMAN: That is not the existing site that we've been planning on--

MR.MORRIS: This is the one that NEPA is still doing documentation on.

metals, as well as on select samples of soil and groundwater, we ran full scan.

And, we did find trace levels of detections in fish which was the volatile contaminants and in groundwater and in soil.

So, that's when we go back to this multi-phase groundwater samples to find out where that contamination was coming from.

So, I just want to let everybody know that we didn't just blow off certain chemical parameters. We did examine other things.

The PAHs are driving our risks and our contamination problems, so that's what our remedial effort goes out to.

MR.PAUL: What units will be discussed after our meeting will be more than likely--

MR.BARTMAN: Will be eleven which is Site 7, Tarawa Terrace and also Site 80 which is the Paradise Point Golf Course.

If there's any questions on that now, what's going on with those sites, what's happened at those sites, I can answer those also.

Unregulated pesticides are not being used.

MS.GOOD: Yeah, okay.

MR.DUNN: The area is still a maintenance area for the golf course.

They still apply pesticides to the golf course, but they're not the hazardous pesticides that we used in the past.

MS.WOOD: Okay, so the hazardous pesticides were stopped around '78?

MR.DUNN: I believe that's right.

MS.GOOD: DDT?

MR.DUNN: The DDT earlier, but the chlordane I think was in '78.

MR.BARTMAN: Yeah, the Chlordane

MS.LANDMAN: The highest concentration area in that particular site was probably due to a single event spill rather than--I mean, there were other trace areas that may have been due to washout or overspill to poor mixing practices.

But, the one main area was most likely due to one single incident spill in time which, you know, we wouldn't know.