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FINAL

RECORD OF DECISION
OPERABLE UNIT NO. 7
SITES 1, 28, AND 30

MARINE CORPS BASE,
CAMP LEJEUNE, NORTH CAROLINA

CONTRACT TASK ORDER 0231

DECEMBER 14, 1995

Prepared For:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
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ENGINEERING COMMAND
Norfolk, Virginia

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LIST OF ACRONYMS AND ABBREVIATIONS

ADL	Administrative Deadline Lot
AOC	area of concern
ARAR	applicable and relevant or appropriate requirements
AST	Aboveground Storage Tank
BEHP	bis(2-ethyl hexyl)phthalate
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COPC	contaminant of potential concern
DoN	Department of the Navy
EPIC	Environmental Photographic Interpretation Center
FS	Feasibility Study
GW	groundwater
HI	hazard index
HPIA	Hadnot Point Industrial Area
IAS	Initial Assessment Study
ICR	incremental cancer risk
IR	Installation Restoration
MCB	Marine Corps Base
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
NC DEHNR	NC Department of Environment, Health, and Natural Resources
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NPW	net present worth
O&G	oil and grease
O&M	operation and maintenance
OU	Operable Unit
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
POL	petroleum, oil, and lubricants
PRAP	Proposed Remedial Action Plan
QI	quotient index

LIST OF ACRONYMS AND ABBREVIATIONS

(Continued)

RA	Risk Assessment
RAA	remedial action alternative
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	remediation level
ROD	Record of Decision
STP	sewage treatment plant
SVOCs	semivolatile organic compounds
TCE	trichloroethene
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOCs	volatile organic compounds

DECLARATION

Site Name and Location

Operable Unit No. 7 (Site 1 - French Creek Liquids Disposal Area, Site 28 - Hadnot Point Burn Dump, Site 30 - Sneads Ferry Road Fuel Tank Sludge Area)
Marine Corps Base
Camp Lejeune, North Carolina

Statement of Basis and Purpose

This decision document presents the selected remedy for Operable Unit (OU) No. 7 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. 7.

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.

Assessment of the Site

Actual or threatened releases of hazardous substances from this operable unit, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present a potential threat to public health, welfare, or the environment.

Description of Selected Remedy

The selected remedy for OU No. 7 is a combination of three separate remedies that were developed for Sites 1, 28, and 30, respectively. The main components of the selected remedy are described below.

Site 1 Remedy: Institutional Controls

- A long-term groundwater monitoring plan in which groundwater samples are collected semiannually and analyzed for volatile organic compounds (VOCs).

- Aquifer use restrictions that will prohibit the future use of the aquifer under the site as a potable water source. The restrictions will be implemented via the Base Master Plan.

- Deed restrictions that will limit the future use of land at the site, including placement of wells. The restrictions will be implemented via the Base Master Plan.

Site 28 Remedy: Institutional Controls

- A long-term groundwater monitoring plan in which groundwater samples are collected semiannually and analyzed for volatiles, lead and manganese.

- Aquifer use restrictions that will prohibit the future use of the aquifer under the site as a potable water source. The restrictions will be implemented via the Base Master Plan.

- Deed restrictions that will limit the future use of land at the site, including placement of wells. The restrictions will be implemented via the Base Master Plan.

Site 30 Remedy: No Action

- No Action. The "no action" plan involves taking no further remedial actions (this includes conducting no further environmental investigations or sampling) at the site. The site and all of the environmental media located within the site will remain as they currently are.

The selected remedy addresses the principal threats at OU No. 7. These threats include VOC contaminated groundwater in the shallow aquifer at Site 1, and inorganics contaminated groundwater in the shallow aquifer at Site 28. Because there were no principal threats identified at Site 30, no action is the selected remedy.

Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state applicable or relevant and appropriate requirements (ARARs) and criteria to be considered (TBCs) directly associated with this action, and is cost-effective. The statutory preference for treatment is not satisfied because no active treatment is necessary at Sites 1, 28, and 30 in order to maintain adequate protection of human health and the environment. Under the selected remedy, five-year reviews by the lead agency will be required for Sites 1 and 28.

_____ _____

Signature (Commanding General, MCB, Camp Lejeune) Date

1.0 SITE NAME, LOCATION, AND DESCRIPTION

Marine Corps Base (MCB), Camp Lejeune is a training base for the United States Marine Corps, located in Onslow County, North Carolina. The Base covers approximately 236 square miles and includes 14 miles of coastline.

Figure 1 presents a map of MCB, Camp Lejeune. As shown, the Base 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. 7 is one of 14 operable units located within MCB, Camp Lejeune. An "operable unit", as defined for the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), is a discrete action that comprises an incremental step toward comprehensively addressing site problems. With respect to MCB, Camp Lejeune, operable units were developed to combine one or more individual sites where Installation Restoration (IR) Program activities are or will be implemented. The sites which are combined into an operable unit share a common element. Operable Unit (OU) No. 7, the subject of this ROD, consists of three sites:

- Site 1, the French Creek Liquids Disposal Area
- Site 28, the Hadnot Point Burn Dump
- Site 30, the Sneads Ferry Road Fuel Tank Sludge Area

Sites 1, 28, and 30 were grouped together because of the similar nature of the wastes that were reportedly disposed of at the sites and the geographic proximity of the sites.

As shown on Figure 1, OU No. 7 is located on the eastern portion of the Base, situated between the New River and Sneads Ferry Road, south of the Hadnot Point Industrial Area (HPIA). The following paragraphs present brief descriptions of each of the three sites that constitute OU No. 7.

1.1 Site 1

Site 1, the French Creek Liquids Disposal Area, is the northernmost site located within OU No. 7. As shown on Figure 1, the site is located approximately one mile east of the New River and one mile southeast of the HPIA. Site 1 is situated along both the north and south sides of Main Service Road near the western edge of the Gun Park Area and Force Troops Complex.

Figure 2 presents a map of Site 1 that identifies the approximate boundaries of two suspected disposal areas at the site: the northern disposal area and the southern disposal area. The site boundaries coincide with the boundaries of these disposal areas. The following subsections describe the northern and southern portions of Site 1 and the surrounding areas.

Northern Portion of Site 1

As shown on Figure 2, the northern portion of Site 1 is surrounded by a treeline and a motor-cross training area to the north, a vehicle storage area associated with Building FC-100 to the east, Main Service Road to the south, and a treeline to the west. Most of the area within this portion of the site contains fenced-in buildings and parking areas. The former northern disposal area is located in this portion of Site 1. The majority of the former northern disposal area now contains two fenced-in areas that are associated with Buildings FC-120 and FC-134.

Building FC-120 serves as a motor transport maintenance facility for the Second Landing Support Battalion. It is a two story brick structure with offices and several vehicle maintenance bays. Building FC-134, located to the north of Building FC-120, provides offices and communication equipment storage also for the Second Battalion. It is a brick structure with offices and one garage bay.

A number of covered material storage areas are located to the north and west of Building FC-120. These smaller covered structures are used for temporary storage of paint, compressed gasses, vehicle maintenance fluids, spent or contaminated materials, and batteries. In addition to these covered storage structures, an above ground storage tank (AST) area, located adjacent to the northern side of Building FC-120, is utilized to store spent motor oil and ethylene glycol (i.e., anti-freeze). Also, a gasoline service island is located to the west of Building FC-120. The two pumps at the service island provide fuel for vehicles undergoing maintenance at Building FC-120. An underground storage tank (UST) of unknown capacity is associated with this active service island.

Two equipment wash areas are located adjacent to the northern disposal area. The first wash area is located approximately 250 feet west of Building FC-120 and the second lies approximately 100 feet east of Building FC-134. Both equipment wash areas are concrete-lined and employ an oil and water separator collection basin. A third oil and water separator is located to the northwest of Building FC-120.

There are two surface water features (a sediment retention pond and a swampy area) that influence drainage near the northern portion of the site. The retention pond, located north of Building FC-134, receives surface water runoff via a gravel drainage ditch from the parking lot, the three oil and water separators, and the surrounding areas. Surface water runoff north of Building FC-134 drains into the swampy area toward a topographic low area.

As shown on Figure 2, the approximate direction of shallow groundwater flow is northwest.

Southern Portion of Site 1

As shown on Figure 2, the southern portion of Site 1 is surrounded by Main Service Road to the north, Daly Road to the east, H. M. Smith boulevard to the south, and Gonzales Boulevard and a wooded area to the west. The area of the former southern disposal area now contains Buildings 739 and 816, a fenced-in vehicle and equipment Administrative Deadline Lot (ADL), and a fenced-in hazardous materials storage area.

The hazardous materials storage area, which is concrete-lined and bermed, is located north of Building 816. This storage area is used for the temporary storage of vehicle maintenance fluids, spent or contaminated materials, fuel, and batteries. In addition, a number of storage lockers are located throughout the southern portion of Site 1. These lockers are used to store paints and other flammable materials used by maintenance and machine shop personnel.

Several small buildings are located adjacent to the suspected southern disposal area. These buildings house a number of support offices, recreation facilities, machine shops, light-duty vehicle and equipment maintenance bays, and equipment storage areas. Heat is provided to the majority of these buildings by kerosene-fired stoves. Kerosene fuel is stored in ASTs located beside each building.

Two vehicle maintenance ramps are also located near the southern portion of Site 1. The first ramp is located immediately to the south of Building 739 and the second lies to the north of Building GP-19. Both maintenance ramps are constructed of concrete and are used for the upkeep of vehicles and equipment.

In addition, three oil and water separator collection basins are located near the southern portion of Site 1. One separator is located adjacent to the Building 739 vehicle maintenance ramp, one separator is located southeast of Building GP-19, and one separator is located approximately 100 feet south of Building 816, adjacent to an equipment wash area. Discharge from the separators and wash areas flows into a stormwater sewer and then into the drainage ditch adjacent to H. M. Smith Boulevard.

Besides receiving discharge from the separators, the drainage ditch also receives surface water runoff from the southernmost portions of the site and nearby parking lots. Although it is a site-related surface water feature, the ditch is mainly dry year round. The ditch starts within the site boundaries, flows west toward the HPIA Sewage Treatment Plant (adjacent to Site 28), then empties into Cogdels Creek. Cogdels Creek eventually discharges into the New River which is located approximately one mile west of Site 1.

1.2 Site 28

Site 28, the Hadnot Point Burn Dump, is the westernmost site located within OU No. 7 (refer to Figure 1). The site is located along the eastern bank of the New River and is approximately one mile south of the HPIA on the Mainside portion of MCB, Camp Lejeune.

Figure 3 presents a map of Site 28. As shown, the site is surrounded by the Hadnot Point Sewage Treatment Plant (STP) to the north, wooded and marshy areas to the east and south, and the New River to the west. Cogdels Creek flows into the New River at Site 28 and forms a natural divide between the eastern and western portions of the site. Vehicle access to the site is via Julian C. Smith Boulevard near its intersection with O Street. The eastern and western portions of the site are served by an improved gravel road.

A majority of the estimated 23 acres that constitute Site 28 are used for recreation and physical training exercises. The site is predominantly comprised of two lawn and recreation areas, known collectively as the Orde Pond Recreation Area, that are separated by Cogdels Creek. Picnic pavilions, playground equipment, and a stocked fish pond (Orde Pond) are located within this recreation area. They are regularly used by Base personnel and their families. In addition, field exercises and physical training activities frequently take place at the recreation area.

The Hadnot Point STP is located on and adjacent to Site 28. A portion of the STP facility (the equalization lagoon) extends across Cogdels Creek, from west to east. The STP operates a number of clarifying, settling, and aeration ponds that are located on either side of Cogdels Creek. Both operational areas of the STP are fenced with six-foot chain link. The treated water from the STP discharges into the New River approximately 400 feet from the shoreline via an outfall pipe.

As shown on Figure 3, the shallow groundwater appears to be flowing toward Cogdels Creek from all points on the site.

1.3 Site 30

Site 30, the Sneads Ferry Road Fuel Tank Sludge Area, is the southernmost site located within OU No. 7 (refer to Figure 1). The site is situated along a tank trail which intersects Sneads Ferry Road from the west, approximately 1 mile south of the intersection with Marines Road, and roughly 4-1/2 miles south of the HPIA. The site is located adjacent to the Combat Town Training Area. The surrounding training areas and adjacent artillery ranges are used to prepare specialized personnel for various tactical operations and to simulate amphibious assault conditions.

Figure 4 presents a map of Site 30. The site boundary depicted on Figure 4 coincides with the approximate extent of a suspected sludge disposal area. The majority of the Site 30 area is wooded containing trees of less than three inches in diameter and dense understory. Unimproved paths are found within and around the site. The tank trail that leads to the suspected disposal area is occasionally used as part of field training exercises. As shown on Figure 4, one of two streams which comprise the headwaters of Frenchs Creek lies approximately 1,500 feet west of Site 28. Surface water runoff and groundwater flow directions are generally to the west and north toward Frenchs Creek.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

MCB, Camp Lejeune was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) on October 4, 1989 (54 Federal Register 41015, October 4, 1989). The United States Environmental Protection Agency (USEPA) Region IV; the North Carolina Department of Environment, Health and Natural Resources (NC DEHNR); and the United States Department of the Navy (DoN) then entered into a Federal Facilities Agreement for MCB, Camp Lejeune in February 1991. The primary purpose of the Federal Facilities Agreement was to ensure that environmental impacts associated with past and present activities at MCB, Camp Lejeune were thoroughly investigated and appropriate CERCLA response/Resource Conservation and Recovery Act (RCRA) corrective action alternatives were developed and implemented as necessary to protect public health and the environment.

The following subsections describe the history (i.e., the past land usages and waste disposal practices) of Sites 1, 28, and 30, and a summary of previous site investigations/enforcement activities.

2.1 Site History

2.1.1 Site 1

Site 1 had been used by several different mechanized, armored, and artillery units since the 1940s. Reportedly, liquid wastes generated from vehicle maintenance were routinely poured onto the ground surface. During motor oil changes, vehicles were driven to a disposal point and drained of used oil. In addition, acid from dead batteries was reportedly hand carried from maintenance buildings to disposal points. At times, holes were reportedly dug for waste acid disposal and then immediately backfilled. Thus, the disposal areas at Site 1 are suspected to contain petroleum, oil, and lubricants (POL) and battery acid.

The total extent of both the northern and southern disposal areas is estimated to be between seven and eight acres. The quantity of POL waste disposed at the areas is estimated to be between 5,000 and 20,000 gallons; the quantity of battery acid waste is estimated to be between 1,000 and 10,000 gallons.

Site 1 continues to serve as a vehicle and equipment maintenance/staging area.

2.1.2 Site 28

Site 28 operated from 1946 to 1971 as a burn area for a variety of solid wastes generated on the Base. Reportedly, industrial waste, trash, oil-based paint, and construction debris were burned then covered with soil. In 1971, the burn dump ceased operations, and was graded and seeded with grass.

The total volume of fill within the dump is estimated to be between 185,000 and 375,000 cubic yards. This estimate was based upon a surface area of 23 acres and a depth ranging from five to ten feet.

2.1.3 Site 30

Site 30 was reportedly used by a private contractor as a cleaning area for emptied fuel storage tanks from other locations. The tanks were used to store leaded gasoline that contained tetraethyl lead and related compounds. Since fuel residuals remaining in the emptied tanks were reportedly washed out at Site 30, the disposal area is suspected to contain fuel sludge and wastewater from the washout of the tanks.

The suspected disposal area measures approximately 7,500 square yards. It is estimated that, at a minimum, 600 gallons of sludge were removed from tanks and drained onto the ground surface during the cleaning process. This estimate was based on the projected volume of material remaining in two 12,000 gallon tanks and the amount of material below their outflow ports. Supplemental information suggests that the site may have been used for the disposal of similar wastes from other tanks. The quantity and composition of the waste is unknown. However, it is suspected to have contained tetraethyl lead and cleansing compounds.

2.2 Previous Investigations/Enforcement Activities

Previous investigations conducted at OU No. 7 include an Initial Assessment Study (IAS), a Confirmation Study, a soil assessment at Site 1, an aerial photographic investigation, and various surface water, sediment, and groundwater investigations. A comprehensive description of each investigation is included in the RI/FS reports; brief descriptions are presented below.

2.2.1 Initial Assessment Study

In 1983, an IAS was conducted at MCB, Camp Lejeune to evaluate potential hazards at various sites throughout the Base. The IAS was based upon a review of historical records and aerial photographs, field inspections, and personnel interviews. Conclusions from the IAS indicated that a number of sites, including Sites 1, 28, and 30, contained potential source areas of contamination and warranted further investigations.

2.2.2 Confirmation Study

As a result of the IAS, a Confirmation Study was conducted at MCB, Camp Lejeune between 1984 and 1987. The study consisted of two steps: a Verification Step, performed in 1984, and a Confirmation Step, performed in 1986 and 1987. The purpose of the study was to investigate potential contaminant source areas identified during the IAS. The following paragraphs summarize the results of the Confirmation Study at Sites 1, 28, and 30, and the final recommendations that were made based on these results.

2.2.2.1 Site 1 Results

At Site 1, the Confirmation Study focused on the presence of potential contaminants in groundwater, surface water, and sediment. Organic and inorganic contaminants were identified in the groundwater samples collected at the site The volatile organic compounds (VOCs) tetrachloroethene (PCE) and trichloroethene (TCE) were identified at levels exceeding present standards in a number of groundwater samples. In addition, oil and grease (O&G) was detected in groundwater, surface water, and sediment samples. The presence of the O&G was most likely due to the POL that had reportedly been disposed of at Site 1.

2.2.2.2 Site 28 Results

At Site 28, the Confirmation Study focused on the presence of potential contaminants in groundwater, surface water, sediment, and fish tissue. Overall, inorganics were the most prevalent contaminant group detected throughout both rounds of the Confirmation Study. Groundwater, surface water, and sediment samples suggested that the inorganics, with the exception of mercury in surface water, originated from the disposal area at the site.

Concentrations of inorganics in groundwater generally decreased from one sampling round to the next, during 1984 and 1986. Inorganic concentrations in sediment, however, increased from the first to the second sampling round. Surface water samples obtained from Cogdels Creek identified cadmium and mercury at concentrations that, in certain cases, exceeded state surface water standards. Lead was detected at concentrations exceeding federal screening values in sediment samples collected from Cogdels Creek and shallow groundwater samples collected during both the 1984 and 1986 investigations. In addition, mercury was detected in surface water and shallow groundwater samples. The distribution of mercury throughout the site suggested that the contaminant was not only present at the site, but may also have migrated from an upstream location.

In addition to the inorganics detected in the groundwater, VOCs were detected in samples collected from one monitoring well at the site. The detected concentrations exceeded regulatory limits for TCE and vinyl chloride. VOCs were not detected in groundwater samples from any of the other three existing wells.

The pesticide Alpha-BHC and polychlorinated biphenyls (PCBs) were detected in fish tissue obtained from Orde Pond in 1984. However, Alpha-BHC was detected at low concentrations and the PCBs were suspected to have bioaccumulated in the food chain. Also, PCBs were not detected elsewhere during the Confirmation Study at Site 28. Thus, neither the pesticide nor the PCBs appeared to be site related.

2.2.2.3 Site 30 Results

At Site 30, the Confirmation Study focused on the presence of potential contaminants in groundwater, surface water, and sediment. For the groundwater investigation, two monitoring wells were installed at the site. Lead was detected in the samples collected from these wells at levels exceeding state and federal drinking water standards. In the surface water, no detectable levels of target compounds were identified. During the sediment investigation, data collected suggested that O&G was present in both the suspected disposal area and stream bed sediments at Site 30. However, it was not clear whether the presence of O&G could be attributed to heavy vehicular traffic or emergency vehicle maintenance in the Combat Town Training Area.

2.2.2.4 Recommendations of the Confirmation Study

The Confirmation Study recommended further characterization of Sites 1, 28, and 30 and a risk assessment to complete the RI/FS process. The Confirmation Study also recommended that additional surface water and sediment investigations of Cogdels Creek, between Site 28 and the HPIA, be conducted to determine possible upstream sources of contamination.

2.2.3 Soil Assessment at Site 1

In 1991, a soil assessment was conducted at Site 1. The purpose of this assessment was to evaluate the soil quality at the site prior to initiating a proposed construction project near the southern disposal area. Analytical results from the soil investigation identified the presence of several inorganics. Concentrations of detected inorganics, including cadmium, chromium, lead, and manganese, were, in general, consistent throughout the site. Contaminants were also detected in soil samples collected from upgradient locations. The distribution and comparable nature of detected inorganics in the soil and environmental media sampled during other investigations suggested that these inorganics are found throughout adjoining areas.

2.2.4 Aerial Photographic Investigation

In 1992, an aerial photographic investigation was completed by the USEPA's Environmental Photographic Interpretation Center (EPIC) for several areas within MCB, Camp Lejeune. The investigation employed photographs to locate and assess potential sources of contamination, and to delineate the extent of disposal activities within the study area.

At Site 1, black-and-white aerial photographs dating from 1944, 1949, 1952, 1956, 1960, 1964, 1984, 1988, and 1990 were made available for the examination of surface conditions. The photographs indicated that over time, significant clearing and construction had occurred within the suspected disposal areas. Operations including the staging of equipment and vehicles also appeared to increase over time.

At Site 28, black-and-white aerial photographs dating from 1949, 1952, 1956, 1960, and 1964 were used for the visual analysis of surface conditions. Additional photographs from 1938 and 1943 were employed to establish a basis of comparison, prior to development of the Camp Lejeune Military Reservation. The aerial photographs contained visual evidence of past waste disposal activities and assisted in defining areas of concern at the site.

At Site 30, a black-and-white aerial photograph taken in 1964 was made available for examination of surface conditions. Although the photograph was taken prior to the reported disposal event, 1970, information from the photograph was employed to evaluate potential source areas of contamination.

2.2.5 Surface Water and Sediment Investigation

In 1993, an additional surface water and sediment investigation of Cogdels Creek and the New River was conducted to support RI scoping activities. The most prevalent contaminants detected in the surface water and sediment samples were polynuclear aromatic hydrocarbon (PAH) compounds, pesticides, and inorganics. PAH compounds were detected in sediment samples from both Cogdels Creek and the New River. Some of the highest PAH concentrations were detected in a sediment sample from the New River, downstream of Site 28. PAH compounds were also detected upstream of the site, in sediments collected from Cogdels Creek.

2.2.6 Additional Groundwater Investigation

In 1993, an additional groundwater investigation was conducted at Sites 1, 28, and 30 to support RI scoping activities. This study included one round of groundwater sampling from five wells at Site 1, four wells at Site 28, and two wells at Site 30.

At Site 1, analytical results from the groundwater investigation identified the presence of inorganics. Concentrations of detected inorganics, including cadmium, chromium, lead, and manganese, were, in general, consistent throughout the site. Potential contaminants were also detected in groundwater samples obtained from upgradient locations. The distribution and comparable nature of detected inorganics in the groundwater and environmental media sampled during other investigations suggests that these inorganics are found throughout adjoining areas.

At Site 28, the most prevalent contaminants detected in the groundwater samples collected under this investigation were PAHs and inorganics. Inorganics were frequently detected at concentrations in excess of state and federal groundwater standards.

At Site 30, groundwater samples were collected from the two existing monitoring wells. Inorganics were detected in both wells with the detections at the easternmost well being generally greater than the detections at the westernmost well. Cadmium, chromium, and lead were all detected at levels exceeding federal and state standards at the easternmost well.

2.2.7 Remedial Investigation

In 1994, Baker Environmental, Inc. (Baker) conducted an RI for OU No. 7. The following investigations were conducted at each site:

- Site 1
  - Soil Investigation (128 samples)
  - Groundwater Investigation (19 samples; two rounds of samples)

- Site 28
  - Soil Investigation (94 samples)
  - Groundwater Investigation (13 samples; two rounds of samples)
  - Surface Water and Sediment Investigations (14 surface water and 27 sediment samples)
  - Benthic and Aquatic Investigations (6 benthic and 19 aquatic samples)
- Site 30
  - Soil Investigation (25 samples)
  - Groundwater Investigation (3 samples; two rounds of samples)
  - Surface Water and Sediment Investigations (3 surface water and 6 sediment samples)

Note that surface water and sediment samples were initially proposed at the drainage ditch located along the southern portion of Site 1. However, due to a lack of surface water, the ditch did not represent a classifiable surface water body used for human consumption or recreation, nor did it represent an ecological habitat.

Based on the analytical results from the sampling of environmental media, contaminants of potential concern (COPCs) were identified. A human health risk assessment (RA) and an ecological RA were conducted to evaluate the potential risks associated with these COPCs. The results of the RAs are summarized in a later section of this ROD.

The following sections briefly summarize the results of the RI conducted at each site.

2.2.7.1 Site 1 Results

Table 1 presents a summary of the RI analytical results for Site 1. This summary includes a range of detected concentrations and comparison criteria. Please note that because of asphalt and gravel overburden material, a number of surface soil samples were not retained for laboratory analysis.

Soil: VOCs were not found in surface soils, but were detected in four out of 110 subsurface soil samples. TCE and toluene were detected at very low concentrations in samples from the northern central portion of the study area.

Semivolatile organic compounds (SVOCs) were not encountered in surface soils, but were detected in a number of subsurface soil samples. Most notable among the SVOCs detected were three PAH compounds, di-n-butylphthalate, and BEHP.

The pesticides dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, endrin aldehyde, alpha-chlordane, and gamma-chlordane were detected in the soil at Site 1. Each of these pesticides was detected, at low concentrations, in at least two of the 124 soil samples. The pesticide 4,4'-DDT was the most prevalent, with 10 positive detections ranging from 1.6 to 18 micrograms per kilogram (µg/Kg), and the highest pesticide concentration was that of 4,4'-DDE at 120 µg/Kg.

The PCBs Aroclor 1254 and Aroclor 1260 were each detected once within the subsurface soil. Aroclor 1254 was detected on the southern portion of the site at a concentration of 18 µg/Kg. Aroclor 1260 was detected near the center of the northern disposal area at a concentration of 1,300 µg/Kg.

Several inorganics were also detected in the surface and subsurface soil at Site 1. However, the detected concentrations of these inorganics did not significantly differ from Base-specific background concentrations. Therefore, the positive detections of inorganics in soil did not appear to be the result of past disposal practices.

Groundwater: Positive detections of VOCs in groundwater were limited to the northern portion of the study area. TCE was detected in three samples obtained from the shallow aquifer. The maximum TCE concentration, 27 micrograms per liter (µg/L), was detected in the north central portion of the study area. This detected concentration slightly exceeds the federal standard for TCE, 2.8 µg/L. Figure 5 shows a possible plume of TCE that was delineated based on positive detections of this compound and the direction of groundwater flow, northwest. Two other VOCs, 1,2-dichloroethene and 1,1-dichloroethene, were observed at maximum concentrations of 21 µg/L and 2 µg/L, respectively. Neither level exceeded federal or state standards. The maximum 1,2-dichloroethene and 1,1-dichloroethene concentrations were detected at monitoring well 1-GW10, located to the west of the suspected northern disposal area. Vinyl chloride was also detected at a maximum concentration of 4 µg/L, which exceeds the state and federal drinking water standards, at monitoring well 1-GW10.

Like VOCs, the positive detections of SVOCs were limited to the northern portion of the study area. Phenol and diethylphthalate were detected during the first sampling round only in the deep aquifer at concentrations of 6 µg/L and 1 µg/L, respectively.

Inorganics were the most prevalent among contaminants detected in the groundwater at Site 1. However, the positive detections of inorganics were distributed sporadically throughout the site. As a result, most of the inorganics did not appear to be site related. Iron and manganese, in particular, were detected at maximum concentrations of 29,200 µg/L and 1,200 µg/L. These levels exceeded state drinking water standards. However, positive detections of iron and manganese were distributed sporadically throughout the site, indicative of natural site conditions rather than disposal activities. In addition, iron and manganese concentrations in groundwater throughout MCB, Camp Lejeune often exceed state and federal standards. During past studies, manganese concentrations at a nearby potable water supply well and at several Site 1 wells exceeded the standards, but fell within the range of concentrations for samples collected elsewhere at MCB, Camp Lejeune.

2.2.7.2 Site 28 Results

Table 2 presents a summary of the RI analytical results for Site 28. This summary includes a range of detected concentrations and comparison criteria.

Soil: VOCs were found in one surface soil sample and two subsurface soil samples at very low concentrations. The VOCs benzene, PCE, and 1,1,1-trichloroethane were each detected once within the 72 soil samples collected at Site 28. Based upon their wide dispersion, infrequent detection, and low concentration, the occurrence of VOCs in soils at Site 28 did not appear to be a significant problem resulting from previous disposal practices.

SVOCs, among the other organic compounds within soil at Site 28, appeared to be the most directly linked to past disposal practices. Several SVOCs were identified in both surface and subsurface soil samples, primarily from the western disposal area. A majority of SVOCs detected in soil samples were PAH compounds, most probably resulting from past burning of waste material or refuse.

The pesticides dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, and gamma-chlordane appeared to be the most widely scattered compounds within surface and subsurface soils at Site 28. Each of the five pesticides was detected in at least 15 of the 72 soil samples. The pesticide 4,4'-DDE was the most prevalent, with 44 positive detections ranging from 3.1 µg/Kg in subsurface soil to 1,600 µg/Kg in surface soil. The highest pesticide concentration was that of 4,4'-DDT at 7,300 µg/Kg in the subsurface soil. In general, higher concentrations of those pesticides more frequently detected were limited to the western portion of the site around the picnic area.

Three PCBs, Aroclor 1242, Aroclor 1254, and Aroclor 1260, were detected in subsurface soil samples. The maximum PCB concentration was 140 µg/Kg from a location in the center of the site on the northern side of the fence surrounding the treatment plant.

Inorganics were detected in both surface and subsurface soil samples from the western portion of the study area at concentrations greater than one order of magnitude above Base-specific background levels. In general, elevated inorganics concentrations were limited to soils obtained from the western portion of the study area. The inorganics copper, lead, manganese, and zinc were observed at maximum concentrations greater than two orders of magnitude above Base-specific background levels. The same three inorganics had several positive detections in excess of the one order of magnitude level.

Groundwater: Positive detections of VOCs in groundwater were limited to the central western portion of the study area. Chloroform, ethylbenzene, and xylene were detected in a single shallow groundwater sample obtained from a temporary well located there.

SVOCs were detected in five of ten shallow groundwater samples obtained during the first sampling round from the western portion of the study area. These SVOCs included fluorene, phenanthrene, fluoranthene, pyrene, and chrysene. The maximum SVOC concentration, 99 µg/L of naphthalene, was detected within the sample from a temporary monitoring well located in the central western portion of the study area. SVOC analyses of groundwater samples were not performed as part of the second sampling round.

The pesticides 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, and gamma-chlordane were each detected at least once within samples obtained from six shallow monitoring wells located on the western portion of Site 28, during the first sampling round. The pesticides 4,4'-DDE and 4,4'-DDD were detected within five and six shallow groundwater samples, respectively. The highest pesticide concentration detected was 9 µg/L of 4,4'-DDD, within the sample obtained from a monitoring well in the center of the site. A second round of groundwater samples was obtained from those monitoring wells that presented evidence of pesticide contamination during the first sampling round. However, groundwater samples obtained during the second sampling round did not contain pesticides. This was most likely the result of a low-flow sampling technique used during the second round.

Inorganics were the most prevalent and widely distributed contaminants in groundwater at Site 28 and were found distributed throughout the site. Concentrations of inorganics, in samples obtained during both sampling rounds, were generally higher in shallow groundwater samples than in samples collected from the deeper aquifer. Lead was detected, and confirmed by the second sampling round in only 1 of the 12 shallow and deep groundwater samples. Lead levels (at a maximum concentration of 126 µg/L) exceeded the state and federal drinking water standard from a well located in the north-central portion of the site. Iron and manganese were the most prevalent inorganic elements detected during both sampling rounds. Concentrations of iron and manganese

were confirmed by the second sampling round to have exceeded either federal or state standards within 7 groundwater samples.

Surface Water: In New River surface water, copper exceeded federal screening values but at levels that were indicative of a low potential for risk. Lead and zinc exceeded screening values slightly at a single station. Aluminum exceeded its screening value slightly in Orde Pond.

Sediment: In the sediments, lead exceeded screening values only once in Cogdels Creek at a low level but exceeded screening values significantly in the New River at one station. Antimony exceeded its screening value moderately at the same station in the New River. This station may be associated with runoff from an active firing range located approximately 3 miles southwest of the site. Pesticides exceeded screening values throughout Cogdels Creek with the highest exceedances in the lower reach of the creek near the confluence with the New River. However, these exceedances represent only a moderate potential for risk to aquatic receptors. The levels of pesticides detected in the sediments may be a result of routine application in the vicinity of Site 28, especially near the sewage treatment plant and recreation area.

Benthic and Aquatic: Results of the analysis of benthic macroinvertebrates and fish populations indicated that Cogdels Creek and the New River support an aquatic community that is representative of a tidally-influenced freshwater and estuarine ecosystem with both freshwater and marine species. The absence of pathologies observed in fish indicated that the surface water and sediment quality does not adversely impact the fish community. The benthic community demonstrated the typical tidal/freshwater species trend of primarily chironomids and oligochaetes in the upper reaches of Cogdels Creek and polychaetes and amphipods in the lower reaches of Cogdels Creek and the New River. Species representative of both tolerant and intolerant taxa were present and the overall community composition did not indicate a benthic community adversely impacted by surface water and sediment quality.

2.2.7.3 Site 30 Results

Table 3 presents a summary of the RI analytical results for Site 30. This summary includes a range of detected concentrations and comparison criteria.

Soil: The VOC 1,1,1-trichloroethane was the only organic compound detected in surface soil samples at Site 30. 1,1,1-trichloroethane was detected at concentrations of 2 and 3 µg/Kg from two sampling locations situated along the tank trail on the northeastern edge of the site boundary. No other positive detections of VOCs or SVOCs were observed among surface soil samples.

Inorganics were detected in the surface soil samples retained from Site 30. However, none of the positive detections of priority pollutant inorganics exceeded Base-specific background levels for surface soil.

The VOC 1,1,1-trichloroethane was the only organic compound detected in subsurface soil samples at Site 30. It was detected at a concentration of 2 µg/Kg in a sample located near the center of the suspected disposal area. No other positive detections of VOCs or SVOCs were observed among subsurface soil samples.

Chromium was the only inorganic detected in subsurface soil at concentrations greater than Base-specific background levels. The maximum chromium concentration among subsurface soil

samples was 13.2 µg/Kg. Four of the 12 chromium detections slightly exceeded the maximum Base-specific background concentration. The four detections were scattered throughout the study area.

Groundwater: Chloroform, a VOC, was the only organic compound detected in the shallow groundwater during the first sampling round. Chloroform was detected at a concentration of 9 µg/L in monitoring well 30-GW01. During the second sampling round, chloroform was once again detected (at 3 µg/L) in a groundwater sample obtained from monitoring well 30-GW01. No other VOCs were detected.

Inorganics, both total and dissolved fractions, were detected in samples obtained from each of the three monitoring wells at Site 30. Chromium, iron, lead, and manganese were each detected among the three groundwater samples at concentrations which exceeded either federal or state drinking water standards for total inorganics. Chromium, iron, lead, and manganese were detected at maximum concentrations of 111, 41,400, 59.1, and 181 µg/L, respectively. With the exception of iron, none of these positive detections, in excess of either federal or state standards, exceeded Base-specific background levels. During the second sampling round, iron was detected at a concentration of 692 µg/L (based on total inorganics analyses) in a sample from monitoring well 30-GW03. This detected concentration exceeded the state standard of 300 µg/L.

Surface Water: Three surface water samples from Frenchs Creek were submitted for laboratory analysis. Lead and mercury were the only inorganics identified at concentrations in excess of EPA Region IV screening values. Both lead and mercury detections were observed in a sample located upgradient of the study area. Lead and mercury were detected at concentrations of 2.3 and 0.15 µg/L, respectively. No other total inorganics concentrations were in excess of screening values. Further, VOCs and SVOCs were not detected in any of the three surface water samples.

Sediment: VOCs were not detected among the six sediment samples retained for analysis from Frenchs Creek. The SVOC BEHP was detected in two Frenchs Creek sediment samples. The concentrations of BEHP at the upstream and downstream locations were 3,900 and 2,600 µg/Kg, respectively. No inorganics concentrations among the six sediment samples exceeded screening values.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI/FS and PRAP documents for OU No. 7 were released to the public in July 1995. These documents were made available in an administrative record file at information repositories maintained at the Onslow County Public Library and at the Installation Restoration Division Office (Building 67, Room 238, MCB, Camp Lejeune). Also, all addresses on the OU No. 7 mailing list were sent a copy of the Final PRAP and Fact Sheet. The notice of availability of the PRAP and RI/FS documents was published in the "Jacksonville Daily News" in July, 1995. A public comment period was held from October 5, 1995 to November 3, 1995. In addition, a public meeting was held on October 5, 1995, to respond to questions and to accept public comments on the final PRAP for Site 1. The public meeting minutes were transcribed and a copy of the transcript was made available to the public at the aforementioned locations. A Responsiveness Summary, included as part of the final ROD, was prepared to respond to the significant comments, criticisms and new relevant information received during the comment period.

4.0 SCOPE AND ROLE OF THE RESPONSE ACTION

Because the potential contaminants identified at Sites 1, 28, and 30 appear to be unrelated, separate response actions were developed for each site. The response action, or selected remedy, for OU No. 7 is a combination of the three separate response actions that were developed for Sites 1, 28, and 30.

The response action for Site 1 was developed to address the groundwater area of concern (AOC) identified on Figure 5. This AOC is a plume in the shallow aquifer that contains low levels of TCE. The extent of this AOC was approximated based on monitoring well locations where TCE exceeded its remediation level, 5 µg/L. (Remediation levels are concentrations to which contaminated material must be remediated. They are based on federal, state, and local standards and risk-based criteria; they are developed for COPCs that contributed to unacceptable risk levels.)

In some shallow groundwater samples collected at Site 1, manganese and mercury exceeded their remediation levels - 50 and 1.1 µg/L, respectively. However, manganese and mercury were not included in the scope of the response action because they did not appear to be site related contaminants. The following statements support the theory that manganese and mercury are not site related contaminants.

- Manganese concentrations (i.e., both total and filtered) in groundwater at MCB, Camp Lejeune often exceed the state and federal standard of 50 µg/L (Baker, 1994). Elevated manganese levels, at concentrations above the standard, were reported in samples collected from a number of Base potable water supply wells. Manganese concentrations at several Site 1 wells exceeded the standard, but fell within the range of concentrations for samples collected elsewhere at MCB, Camp Lejeune. As a result, manganese does not appear to be a site related contaminant. Instead, manganese appears to naturally occur at concentrations exceeding its remediation level in groundwater throughout the Base.

- Mercury exceeded its remediation level at only one well by 0.1 µg/L, which is a relatively minor exceedance. In addition, mercury was not detected in any of the dissolved inorganics samples. Consequently, it is likely that suspended solids in the total inorganics sample created the high detection of mercury. Thus, mercury does not appear to be a site related contaminant.

- There is no record of any historical use, either industrial or disposal, of manganese or mercury at Site 1. This information further supports the theory that manganese and mercury are not site related contaminants.

The response action for Site 28 was developed to address the groundwater AOCs identified on Figure 6. These AOCs include monitoring well locations where manganese and lead exceeded their remediation levels - 50 and 15 µg/L, respectively.

The response action for Site 30 was developed to address site conditions that already appear to protective of human health and the environment.

5.0 SUMMARY OF SITE CHARACTERISTICS

This section contains a brief summary of the site characteristics at OU No. 7, as determined during the RI.

5.1 Site 1

- The soils underlying Site 1 are generally consistent throughout the shallow and deep subsurface. The soils consist of mostly silty sands with thinly interbedded layers of clay and silty clay which are discontinuous. One to two feet of fill material is present throughout the site, especially in areas where construction or regrading activities have occurred. The top of the deep aquifer was encountered at approximately 25 to 27 feet bgs.

- Groundwater flow within the surficial aquifer was determined to be to the west-northwest with a relatively low gradient of 0.0027. The groundwater flow direction within the deep aquifer was not determined due to a limited number of wells; however, it is expected to be to the west in the direction of the New River. Sightly different groundwater elevations (i.e., head differentials) were noted between the surficial and deep aquifer monitoring wells. In general, there is a downward movement (head) of groundwater at the site. Groundwater flow velocity within the surficial aquifer was estimated at 2.9×10^{-2} feet/day.

- Two water supply wells were identified within a one-mile radius of Site 1. Both wells, however, were put out of service by Base personnel due to VOCs in the groundwater.

- The most prevalent pesticides detected were dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, endrin aldehyde, and alpha-chlordane. They were detected, at low concentrations, in at least two of the 124 soil samples. The pesticide 4,4'-DDT was the most prevalent, and the highest pesticide concentration was that of 4,4'-DDE.

- The PCBs Aroclor 1254 and 1260 were each detected once within the subsurface sample set.

- VOCs were not found in surface soils and were detected in only four subsurface samples scattered throughout the site. In particular, TCE and toluene were detected at very low concentrations.

- SVOCs were not encountered in surface soils, but were detected in a number of subsurface samples. Most notable among the SVOCs detected were three PAH compounds and di-n-butylphthalate.

- Based on a comparison of Base-specific background levels, positive detections of inorganics at Site 1 do not appear to be the result of past disposal practices.

- Inorganics were the most prevalent among potential contaminants in groundwater at Site 1 and were found distributed throughout the site. Iron and manganese were detected at concentrations which exceeded the state drinking water standards and

barium, calcium, magnesium, potassium, and sodium were also detected in each of the shallow and deep groundwater samples.

- In general, VOC analytical results from the first and second sampling events correlated. TCE was detected in samples obtained from three shallow monitoring wells. The maximum TCE concentration was detected within a sample from monitoring well 1-GW17. The VOCs 1,2-dichloroethene, 1,1-dichloroethene, vinyl chloride, and xylenes were also observed in the shallow aquifer. The SVOCs phenol and diethylphthalate were detected during the first sampling round only in a sample from deep well 1-GW17DW.

- The potential noncarcinogenic or carcinogenic risks from exposure to the surface soil and subsurface soil at Site 1 were within acceptable levels for the current military receptor and the future construction worker receptor, respectively.

- There were potential noncarcinogenic and carcinogenic risks to the future residential child and adult receptors upon exposure to groundwater. The potential noncarcinogenic risks from groundwater are 17.8 and 7.6 for the child and adult receptor, respectively. These values exceed the acceptable level of 1.0. The potential carcinogenic risk from groundwater was $1.8x10^{-4}$ for the adult receptor. This risk exceeds the acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$. Arsenic and manganese were the primary COPCs contributing to the risks.

- On comparison of arsenic and manganese levels in the groundwater to federal and state standards, only manganese exceeds the criteria. The concentration of arsenic that was used to determine potential risk was exceeded at five wells. Three of these wells are located off site (i.e., wells 1-GW10, 1-GW11, and 1-GW12). The concentration of manganese used to determine potential risk was the maximum level (1,200 µg/L) found at off-site well 1-GW10. This level was found only once among the shallow and deep wells, excluding another off-site well, 1-GW11, which had a concentration of 1,070 µg/L. The remaining detects of manganese were at least a magnitude less than the maximum level. Although these two metals contributed to the site risks from groundwater exposure, the levels used to calculate risk were primarily from off-site wells. Consequently, it is reasonable to assume that the risks from groundwater due to the presence of arsenic and manganese may be overestimates of risk and are highly conservative values.

- Inorganics appear to be the only site related COPCs that may have the potential to affect the integrity of terrestrial receptors at Site 1. There were no aquatic receptors identified that would be exposed to site related COPCs. In addition, there were no threatened or endangered species or critical habitats identified at Site 1. Therefore, there is no ecological risk expected to these receptors.

- Surface soil quality indicated a slight potential for cadmium and chromium concentrations to decrease the integrity of terrestrial invertebrates or plants at the site. However, because the site concentrations only just exceeded the literature values, it is not expected that these contaminants would present a significant ecological risk to these terrestrial receptors.

- Other terrestrial receptors may be exposed to the contaminants in the surface soils by ingestion. For the deer, rabbit, fox, and quail receptors used in this ERA, there does appear to be a slight ecological risk to terrestrial vertebrate receptors. However, this risk is expected to be low because of the low level of the exceedances of the terrestrial reference values.

5.2 Site 28

- The soils underlying Site 28 are generally consistent throughout the shallow and deep subsurface. The soils consist of mostly silty sands with thinly interbedded layers of clay and silty clay which are discontinuous. A large quantity of fill material and debris (e.g., glass, metal, brick, and wire), varying in thickness from 3 to 22 feet, underlies the western portion of the site. The location and thickness of the fill and debris appear to coincide with existing information and results of previous investigations. The top of the deep aquifer was encountered at approximately 40 feet bgs.

- Groundwater within the surficial aquifer discharges into Cogdels Creek. The water table gradient is relatively low (0.004). Flow velocity within the surficial aquifer was estimated at 4.1×10^{-2} feet/day. Groundwater flow within the deep aquifer was determined to be to the west-southwest with a relatively low gradient of 0.0013. Sightly different groundwater elevations (i.e., head differentials) were noted between the surficial and deep aquifer monitoring wells. In general, there is a downward movement (head) of groundwater at the site.

- There are no water supply wells within a one-mile radius of Site 28.

- Among organic compounds, SVOCs within soil samples at Site 28 appear to be the most directly linked to past disposal practices. Several SVOCs were identified in both surface and subsurface soil samples, primarily from the western disposal area. A majority of SVOCs detected in soil samples were PAH compounds, most probably resulting from combustion of waste material or refuse.

- Inorganic elements were detected in both surface and subsurface soil samples from the western portion of the study area at concentrations greater than one order of magnitude above Base-specific background levels. The inorganics copper, lead, manganese, and zinc were observed at maximum concentrations greater than two orders of magnitude above Base-specific background levels. The same three metals also had several positive detections in excess of the one order of magnitude level.

- The pesticides dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, and gamma-chlordane were detected in at least 15 of the 72 soil samples. In general, higher concentrations of those pesticides more frequently detected, were limited to the western portion of the site.

- Three PCBs (Aroclor 1242, 1254, and 1260) were detected in soil samples obtained from borings at Site 28.

- The VOCs benzene, PCE, and 1,1,1-trichloroethane were each detected once within the soil samples collected at Site 28. Based upon their wide dispersion, infrequent detection, and low concentration, the occurrence of VOCs in soils does not appear to be the result of past disposal practices.

- Inorganic elements were the most prevalent and widely distributed contaminants in groundwater at Site 28 and were found distributed throughout the site. Lead was detected, and confirmed by the second sampling round, within only 1 of the 12 shallow and deep groundwater samples at a concentration which exceeded the state and federal standards. Iron and manganese were the most prevalent inorganic elements detected during both sampling rounds. Concentrations of iron and manganese were confirmed by the second sampling round to have exceeded either federal or state standards within 7 groundwater samples.

- SVOCs were detected in five of ten shallow groundwater samples obtained during the first sampling round. SVOC analyses of groundwater samples were not performed as part of the second sampling round.

- The pesticides 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, and gamma-chlordane were each detected at least once within samples obtained from six shallow monitoring wells during the first sampling round. A second round of groundwater samples was obtained from those monitoring wells that presented evidence of pesticide contamination during the first sampling round. However, groundwater samples obtained during the second sampling round did not exhibit pesticides.

- The VOCs chloroform, ethylbenzene, and xylene were detected in a single shallow groundwater sample obtained from a temporary well.

- In the current case, potential noncarcinogenic and carcinogenic risks to the military personnel, recreational adult, and fisherman were within acceptable risk levels. For the current recreational child receptor, there was a potential noncarcinogenic risk from New River sediment. The noncarcinogenic risk from the ingestion pathway was 1.2, which is slightly greater than the acceptable risk level of 1.0. The COPC driving this noncarcinogenic risk was antimony.

- In the future case, the total potential noncarcinogenic risk to the child receptor (i.e., total noncancer risk is 23) exceeds the acceptable risk level of one. This risk is attributed to exposure to groundwater, subsurface soil, and sediment from the New River. For the adult receptor, there were noncarcinogenic and carcinogenic risks from exposure to groundwater. The risks to the construction worker were within acceptable risk levels.

- The results indicate that inorganics in groundwater, subsurface soil and sediment are driving the potential noncarcinogenic and carcinogenic risks at the site. These inorganics are antimony, arsenic, copper and zinc in the subsurface soil; manganese in groundwater; and antimony in the sediment of the New River. It is important to note that upon the segregation of the soil noncarcinogenic risks based on the effects on different target organs, the soil noncarcinogenic risk may be an overestimate.

- In terms of lead health impacts, use of the lead uptake biokinetic model indicates that exposure to surface soil, subsurface soil and groundwater at this site generates blood lead levels in children that are within acceptable levels.

- It is important to note that the future exposure scenario is based on potential residential development of Site 28. At present the site is a recreational/picnic area, and is used for training military personnel. It is highly unlikely that the site will become a residential area in the foreseeable future. Consequently, exposure to subsurface soil and groundwater under a residential scenario is highly conservative and unlikely, given the present site conditions. It follows that the potential risks associated with this exposure scenario are conservative and may be overestimated values.

- Inorganics and pesticides appear to be the most significant site related COPCs that have potential to affect the integrity of the aquatic receptors at Site 28. For the terrestrial receptors at Site 28, inorganics appear to be the most significant site-related COPC that have the potential to affect the integrity of the ecosystem.

- In New River surface water, copper exceeded aquatic reference values but at levels that were indicative of a low potential risk. Lead and zinc only exceeded 1.0 slightly at a single station. Copper exceeded the surface water reference values in Cogdels Creek, and aluminum exceeded 1.0 in Orde Pond. However, the exceedance was only slightly above 1.0.

- In the sediments, lead exceeded aquatic reference values only once in Cogdels Creek at a low level but exceeded aquatic reference values significantly in the New River at one station. Antimony exceeded its sediment aquatic reference values moderately at the same station in the New River. This station may be associated with runoff from the active firing range. Pesticides exceeded the sediment aquatic reference values throughout Cogdels Creek with the highest exceedances in the lower reach of the creek near the confluence with the New River. These exceedances represent a moderate potential for risk to aquatic receptors. The levels of pesticides detected in the sediments may be a result of routine application in the vicinity of Site 28, especially near the STP and recreation area.

- Results of the analysis of benthic macroinvertebrates and fish populations indicate that Cogdels Creek and this reach of the New River support an aquatic community that is representative of a tidally-influenced freshwater and estuarine ecosystem with both freshwater and marine species. The absence of pathologies observed in the fish sampled from Cogdels Creek and the New River indicates that the surface water and sediment quality does not adversely impact the fish community relative. The benthic community demonstrated the typical tidal/freshwater species trend of primarily chironomids and oligochaetes in the upper reaches of Cogdels Creek and polychaetes and amphipods in the lower reaches of Cogdels Creek and in the New River. Species representative of both tolerant and intolerant taxa were present and the overall community composition did not indicate a benthic community adversely impacted by surface water and sediment quality.

- During the habitat evaluation, no areas of vegetation stress or gross impacts from site contaminants were noted. Based on the soil toxicity data for cadmium, chromium, copper, manganese, nickel, and zinc, these inorganics at Site 28 may decrease the integrity of terrestrial invertebrates or plants at the site. Based on the evaluation of the deer, rabbit, fox, raccoon, and quail receptors, there does appear to be an ecological risk to terrestrial vertebrate receptors. This risk is expected to be significant if greater exposure to those contaminants results.

5.3 Site 30

- The soils underlying Site 30 are generally consistent throughout the shallow and subsurface. The soils consist of mostly silty sands.

- Groundwater flow within the surficial aquifer was determined to be to the west-northwest with a moderate gradient of 0.015. Groundwater flow velocity within the surficial aquifer was estimated at 0.15 feet/day.

- Two operating water supply wells were identified within a one-mile radius of Site 30. Both wells are located hydraulically upgradient from the site and are not expected to be impacted by disposal of washwater from the tank cleaning operations at the site.

- The VOC 1,1,1-trichloroethane was detected in two surface soil samples retained from Site 30. No other positive detections of VOCs or SVOCs were observed among surface soil samples.

- Fourteen inorganics were detected in the surface soil samples retained from Site 30. None of the positive detections of priority pollutant metals exceeded Base-specific (i.e., MCB, Camp Lejeune) background levels for surface soil.

- 1,1,1-trichloroethane was detected in the subsurface soil sample at 30-SB09, located near the center of the suspected disposal area. No other positive detections of VOCs or SVOCs were observed among subsurface soil samples.

- Seventeen inorganics were detected in subsurface soils at Site 30. Chromium was the only inorganic detected in subsurface soil at concentrations exceeding Base-specific inorganic background levels.

- Chloroform was the only VOC or SVOC identified during the first groundwater sampling round.

- During the first sampling round, 17 total inorganics were detected within at least one groundwater sample at Site 30. Eleven dissolved inorganics were also detected within at least one of the three groundwater samples. Chromium, iron, lead, and manganese were each detected among the three groundwater samples from Site 30 at concentrations which exceeded either federal or state standards for total inorganics. None of these positive detections, in excess of either federal or state standards, were above Base-specific background levels.

- During the second sampling round, chloroform was once again detected in a groundwater sample obtained from 30-GW01. No other VOCs were detected.

- During the second sampling round, ten total inorganics were detected in at least one shallow groundwater sample from Site 30. Eight dissolved inorganics were also detected within at least one of the nine groundwater samples. Iron was detected during the second sampling round at a concentration in excess of the state standard, based on total inorganics analyses.

- Eleven total inorganics were positively identified in the surface water samples submitted for laboratory analysis from Frenchs Creek. Lead and mercury were the only inorganics identified at concentrations in excess of either chronic screening values or state standards. Further, VOCs and SVOCs were not detected in any of the surface water samples.

- VOCs were not detected among the six sediment samples retained for analysis from Frenchs Creek. The SVOC BEHP was detected in two Frenchs Creek sediment samples. Both detections were in excess of the 1,200 µg/Kg laboratory contaminant level. Sixteen inorganics were detected in at least one of the six sediment samples from Frenchs Creek. No inorganics concentrations among the six sediment samples exceeded screening values.

- The potential noncarcinogenic and carcinogenic risks associated with exposure to subsurface soil, surface water, and sediment for the receptors evaluated at this site were within acceptable levels.

- The red-cockaded woodpecker is known to inhabit Site 30. However, the potential adverse impacts to these protected species are expected to be low since the terrestrial food chain model did not show an adverse risk to the bird.

- Three inorganics were detected in the surface water at concentrations that may decrease the integrity of the aquatic community. However, because the concentrations of these inorganics were higher in the upstream station than in the downstream stations, they do not appear to be site related. No COPCs detected in the sediments exceeded any of the sediment aquatic reference values. Therefore, there does not appear to be a significant risk to aquatic receptors from site-related COPCs.

- No contaminants detected in the surface soils were retained as COPCs. In addition, the quotient index (QI) for the terrestrial food chain model was greater than the acceptable QI limit of 1.0 for only one species. The QI for the raccoon, 1.72, was slightly greater than 1.0. Therefore, there does not appear to be a significant risk to the terrestrial receptors from site-related COPCs.

6.0 SUMMARY OF SITE RISKS

As part of the RI, a human health RA and an ecological RA were conducted for Sites 1, 28, and 30. These RAs were conducted to evaluate the potential risks associated with COPCs detected at each

site. The following subsections briefly describe the results of the RAs. The RI report contains more extensive information pertaining to the RAs.

6.1 Site 1 - Human Health Risk Assessment

The human health RA investigated three environmental media at Site 1: surface soil, subsurface soils, and groundwater. Table 4 lists the COPCs that were evaluated for each of these media. (Surface water and sediment samples were collected from a drainage ditch at Site 1. However, this ditch did not represent a classifiable surface water body used for human consumption or recreation nor did it represent an ecological habitat. Consequently, the surface water and sediment samples were removed from the risk evaluation.)

Under the current exposure scenario, on-site military personnel were assumed to be the potential receptors. Under the future exposure scenario, future residents (both children and adults) and future construction workers were assumed to be the potential receptors. Exposure to soil via ingestion, dermal contact, and inhalation was analyzed for military personnel; exposure to soil via ingestion, dermal contact, and inhalation was analyzed for future construction workers; and exposure to soil and groundwater via ingestion, dermal contact, and inhalation was analyzed for future residents.

Table 5 presents the incremental cancer risk (ICR) values and the hazard index (HI) values that were generated for each COPC during the RA. ICR values indicate carcinogenic risk and HI values indicate noncarcinogenic risk. USEPA considers ICR values between or less than a $1x10^{-4}$ to $1x10^{-6}$ range, and HI values less than 1.0, to be generally acceptable and protective of human health and the environment. On Table 5, ICR and HI values that exceeded these acceptable limits are shaded.

As shown on Table 5, the potential risks (carcinogenic and noncarcinogenic) associated with exposure to the surface soil and subsurface soil COPCs were within acceptable limits. Therefore, soil was not determined to be a medium of concern at Site 1. However, there were some potential future risks associated with ingestion of the groundwater COPCs that exceeded acceptable limits. The potential noncarcinogenic risks from groundwater were calculated to be 17.3 and 7.6 for the child and adult receptors, respectively. These values exceeded the acceptable level of 1.0. In addition, the potential carcinogenic risk from groundwater was calculated to be $1.7x10^{-4}$ for the adult receptor. This risk exceeded the acceptable range of $1x10^{-4}$ to $1x10^{-6}$. Arsenic and manganese were the primary COPCs contributing to these risks. As a result, groundwater was considered a medium of concern at the site.

Although arsenic and manganese in the groundwater created some potential risk if ingested by future residents, it is important to keep in perspective the way in which this risk was determined. The approach used was highly conservative. At Site 1, it was the future residential scenario that created risk. However, this scenario is unlikely to occur in the foreseeable future because Site 1 is actively being used as vehicle maintenance and equipment storage area. In addition, ingestion of groundwater by future residents is unlikely to occur because shallow groundwater at Site 1 is not used as a potable water source.

In addition, upon comparison of arsenic and manganese levels in the groundwater to state and federal regulatory standards, only manganese exceeded its standard. Thus, although both arsenic and manganese contributed to the site risks, arsenic did not exceed regulatory standards. This indicates the highly conservative nature of the human health RA.

Another factor to consider is that the levels of arsenic and manganese used to calculate groundwater exposure risks were primarily taken from off-site wells. Also, concentrations at these off-site wells either did not exceed regulatory standards or exceeded the standards infrequently. Consequently, it is reasonable to assume that the risks associated with arsenic and manganese are over-estimations of the risk that actually exists.

6.2 Site 1 - Ecological Risk Assessment

In addition to the human health RA, an ecological RA was conducted for Site 1 during the RI. The purpose of the ecological RA was to determine if COPCs were adversely impacting the ecological integrity of aquatic and terrestrial communities on or adjacent to the site. The ecological RA also evaluated the potential effects of COPCs on sensitive environments including wetlands, protected species, and fish nursery areas. The following paragraphs describe the state of aquatic and terrestrial communities at Site 1 as determined in the ecological RA.

Within the boundaries of Site 1, there were no aquatic communities identified that would be exposed to site related COPCs. The only surface water feature in which aquatic communities could exist is the southern drainage ditch, but this ditch is dry most of the time. As a result, the assessment concluded that there is no ecological risk associated with aquatic communities.

Surface soil was the only environmental medium analyzed for terrestrial receptors. The surface soil COPCs evaluated are the same as the surface soil COPCs listed on Table 4, excluding 4,4'-DDE.

The only site related COPCs that could potentially affect terrestrial communities were inorganics. In particular, the presence of cadmium and chromium in surface soil indicated a slight potential for affecting terrestrial invertebrates and plants at the site. However, because the concentrations of these inorganics only slightly exceeded the literature values used to determine risk, cadmium and chromium were not expected to present a significant ecological risk. (Cadmium concentrations ranged from 0.62 to 2.0 mg/Kg which only slightly exceeds the literature value of 0.5 mg/Kg; chromium concentrations ranged from 1.5 to 13.1 mg/Kg which only slightly exceeds the literature value of 10 mg/Kg.)

Based on the terrestrial food chain model, there appeared to be a slight risk for deer, rabbit, fox, and quail receptors. However, this risk was expected to be insignificant because of the low levels by which terrestrial reference values were exceeded. The QI, a value which must be less than 1.0 for site conditions to be considered ecologically protective, was calculated to be less than 1.0 for all COPCs except manganese. The QI for manganese was 1.32 for the rabbit and 1.57 for the quail. However, because these QIs were less than 2.0, and because the site is located within a heavy industrial/commercial area where rabbits, quail, deer, etc. do not normally live, there is most likely only a small potential that the animals are being adversely affected by site conditions. Thus, the risk appears to be insignificant.

6.3 Site 28 - Human Health Risk Assessment

The human health RA investigated five environmental media at Site 28: surface soil, subsurface soil, groundwater, surface water, and sediment. Table 6 lists the COPCs that were evaluated for each of these media.

Under the current exposure scenario, on-site military personnel and residents (both children and adults) were assumed to be the potential receptors. Under the future exposure scenario, future residents (both children and adults) and future construction workers were assumed to be the potential receptors. Table 7 summarizes the exposure pathways that were analyzed for each potential receptor.

Tables 8, 9, and 10 present the ICR and HI values that were generated for the child receptor, the adult receptor, and the military/fisherman/construction worker receptors, respectively. USEPA considers ICR values between or less than the $1x10^{-4}$ to $1x10^{-6}$ range, and HI values less than 1.0, to be generally acceptable and protective of human health and the environment. On Tables 8, 9, and 10, ICR and HI values that exceeded these acceptable limits are shaded.

In the current case, potential noncarcinogenic and carcinogenic risks to the military personnel, recreational adult, and fisherman were within acceptable risk levels. For the current recreational child receptor, there was a potential noncarcinogenic risk from New River sediment. The noncarcinogenic risk from the ingestion pathway was 1.2, which is slightly greater than the acceptable risk level of 1.0. The COPC driving this noncarcinogenic risk was antimony.

In the future case, the total potential noncarcinogenic risk to the child receptor, 23, exceeded the acceptable risk level of 1.0. This risk was attributed to exposure to groundwater, surface soil, subsurface soil, and sediment from the New River. Antimony in the groundwater; antimony, arsenic, copper, and zinc in the subsurface soil; and antimony in the sediment were the COPCs driving this risk. Carcinogenic and noncarcinogenic risks to the potential adult residential receptor exceeded the USEPA acceptable risk range due to the exposure of contaminated groundwater. Risks to construction workers were within acceptable risk levels.

It is important to note that because the soil noncarcinogenic risks are segregated based on the effects on different target organs, the soil noncarcinogenic risk may be an overestimate. It also is important to note that the future exposure scenario was based on potential residential development of Site 28. At present, the site is a recreational/picnic area located within training areas on the base. It is highly unlikely that the site will become a residential area in the foreseeable future. Consequently, exposure to subsurface soil and groundwater under a residential scenario is highly conservative and unlikely given the present site conditions. It follows that the potential risks associated with this exposure scenario are conservative and may be overestimated values.

With respect to lead health impacts, use of the lead uptake biokinetic model indicated that exposure to surface soil, subsurface soil, and groundwater at this site generated blood lead levels in children that were within acceptable levels.

6.4 Site 28 - Ecological Risk Assessment

In addition to the human health RA, an ecological RA was conducted for Site 28 to assess potential ecological impacts associated with COPCs. The environmental media evaluated during the ecological RA included surface soil; surface water in the New River, Cogdels Creek, and Orde Pond; sediment in the New River, Cogdels Creek, and Orde Pond; and fish tissue, both fillet and whole body, in the New River and Orde Pond. Table 11 lists the COPCs evaluated for each of these environmental media.

Inorganics and pesticides appeared to be the most significant site related COPCs that could have the potential to affect the integrity of the aquatic receptors at Site 28. For the terrestrial receptors at Site 28, inorganics appeared to be the most significant site related COPC that could have the potential to affect their integrity. Although the American Alligator had been observed at Site 28, potential adverse impacts to this threatened or endangered specie were low due to the low levels of most contaminants in its critical habitat.

In the New River surface water, copper exceeded aquatic reference values but at levels that were indicative of a low potential for risk. In addition, the QIs for lead and zinc (2.8 and 4.2, respectively) only slightly exceeded the acceptable limit of 1.0 at a single station. Copper exceeded the surface water reference values in Cogdels Creek, and aluminum exceeded the surface water reference values in Orde Pond. However, these exceedences were only slightly above the reference values. As a result, the risk associated with surface water appears to be insignificant.

In the sediment, lead exceeded the sediment aquatic reference values only once in Cogdels Creek at a low level but exceeded its sediment aquatic reference values significantly in the New River at one station. Antimony exceeded its sediment aquatic reference values moderately at the same station in the New River. This station may be associated with runoff from the nearby active firing range. Therefore, the risk does not appear to be from site related sources. Pesticides exceeded the sediment aquatic reference values throughout Cogdels Creek with the highest exceedences in the lower reach of the creek near the confluence with the New River. These exceedences represented a moderate potential for risk to aquatic receptors. However, Cogdels Creek receives runoff from several other sites at MCB, Camp Lejeune so the risk does not appear to be entirely related to a source at Site 28. Also, pesticide levels detected in the sediment may be a result of routine pesticide application in the general vicinity of Site 28, especially near the STP and recreational area.

Results of the analysis of benthic macroinvertebrates and fish populations indicated that Cogdels Creek and the New River support an aquatic community that is representative of a tidally-influenced freshwater and estuarine ecosystem with both freshwater and marine species. The absence of pathologies in the fish indicated that the surface water and sediment quality did not adversely impact the fish community. The benthic community demonstrated the typical tidal/freshwater species trend of primarily chironomids and oligochaetes in the upper reaches of Cogdels Creek and polychaetes and amphipods in the lower reaches of Cogdels Creek and in the New River. Species representative of both tolerant and intolerant taxa were present, and the overall community composition did not indicate a benthic community adversely impacted by surface water and sediment quality.

During the habitat evaluation, no areas of vegetation stress or gross impacts from site contaminants were noted. Based on the soil toxicity data for several inorganics (cadmium, chromium, copper, manganese, nickel, and zinc) these constituents at Site 28 may decrease the integrity of terrestrial invertebrates or plants at the site. Based on the evaluation of the rabbit, raccoon, and quail receptors, there did appear to be an ecological risk to terrestrial vertebrate receptors. However, the QIs for the rabbit, raccoon, and quail were 58.1, 1.46, and 65.9, respectively, which only slightly exceeded the acceptable limit of 1.0. Thus, the risk appears to be insignificant.

6.5 Site 30 - Human Health Risk Assessment

For the human health RA at Site 30, the environmental media of concern were surface soil, subsurface soil, groundwater, surface water, and sediment. No COPCs were identified for surface soil or groundwater. However, COPCs for subsurface soil, surface water, and sediment were

identified and evaluated. Table 12 lists these COPCs. In addition, Table 13 summarizes the exposure dose input parameters used during the human health RA.

Table 14 presents the ICR and HI values generated for Site 30. The noncarcinogenic risk values did not exceed the acceptable level of 1.0; the carcinogenic risk values did not exceed the acceptable level of $1x10^{-4}$. As a result, unacceptable carcinogenic and noncarcinogenic risks did not appear to exist at Site 30, and the site conditions appear to be protective of human health and the environment. When carcinogenic and noncarcinogenic values do not exceed the acceptable levels, a "no action" plan (i.e., leaving the site as is; taking no further remedial actions) may be justifiable. Based on the carcinogenic and noncarcinogenic risk values for Site 30, no remedial actions are required.

6.6 Site 30 - Ecological Risk Assessment

The media of concern that were evaluated during the ecological RA include surface water, sediment, and surface soil. The COPCs evaluated for these media are the same as the human health COPCs listed on Table 12, with the addition of iron in the surface water and copper and iron in the sediment.

At Site 30, inorganics in surface water appeared to be the only site related COPCs that had the potential to impact aquatic communities. These inorganics included aluminum, lead, and mercury. However, the concentrations of these surface water inorganics were higher in the upstream sampling locations than in the downstream sampling locations. As a result, these inorganics did not appear to be site related and did not warrant a remedial action at Site 30. In sediment, COPCs were not detected at concentrations that could potentially impact aquatic communities.

COPCs in surface soil were not retained for the ecological RA evaluation, so surface soil did not appear to impact terrestrial communities. Based on the terrestrial food chain model, one COPC, manganese, had a very small potential to affect raccoons. The QI for the raccoon was 1.72 which only slightly exceeds the acceptable limit of 1.0. However, the model indicated that no other terrestrial species were being adversely impacted by COPCs at the site. Therefore, there did not appear to be a significant risk to terrestrial communities from site related COPCs. Furthermore, remedial actions did not appear to be necessary in order to protect the integrity of terrestrial communities.

Several threatened and/or endangered species are known to inhabit MCB, Camp Lejeune. The red-cockaded woodpecker, in particular, is known to inhabit the area of Site 30. However, the ecological RA conducted for terrestrial communities did not identify any significant risks within the habitats that these protected species are likely to exist. Therefore, the "no action" plan may be justifiable with respect to ecological concerns.

7.0 DESCRIPTION OF ALTERNATIVES

In the process of selecting a response action for OU No. 7, remedial action alternatives (RAAs) were developed for the contaminated media at each site. Five RAAs were developed for groundwater at Site 1:

- RAA No. 1 - No Action
- RAA No. 2 - Institutional Controls
- RAA No. 3 - Extraction and On-Site Treatment
- RAA No. 4 - In-Well Aeration and Off-Gas Carbon Adsorption

- RAA No. 5 - Extraction and Off-Site Treatment

Two RAAs were developed for groundwater at Site 28:

- RAA No. 1 - No Action
- RAA No. 2 - Institutional Controls

Alternatives employing active treatment of the groundwater COPCs were not developed for Site 28 due to the nature of the COPCs, manganese and lead. Manganese appears to naturally occur at high levels in the region, and lead was only detected at concentrations above state and federal standards in one of nine samples (in the unfiltered sample, not the filtered sample). This is strong evidence that manganese and lead are not site related contaminants. Based on this evidence, the decision was made not to develop active treatment alternatives. However, because Site 28 is used as a recreational area, a no action alternative and an institutional controls alternative were developed to ensure adequate protection of human health.

For Site 30, one RAA, the no action alternative, was developed.

The following subsections briefly describe the RAAs developed for each site. The FS report contains more detailed information pertaining to the RAAs.

7.1 Site 1 Alternatives

- ***Site 1: RAA No. 1 - No Action***

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

  Under the no action RAA, no additional remedial actions will be performed to reduce the toxicity, mobility, or volume of the groundwater AOC. The no action alternative is required by the NCP to provide a baseline for comparison with other remedial action alternatives that provide a greater level of response.

  Although this RAA does not involve active remediation, passive remediation of the groundwater may occur over time via natural attenuation processes. These processes include naturally occurring biodegradation, volatilization, dilution, photolysis, leaching, adsorption, and chemical reactions between subsurface materials.

  Since COPCs will remain at the site under this RAA, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

- ***Site 1: RAA No. 2 - Institutional Controls***

Capital Cost: $0
Annual O&M Costs: $40,000
NPW: $600,000
Time to Implement: 6 months

Under RAA No. 2, no remedial actions will be performed to reduce the toxicity, mobility, or volume of the groundwater AOC at Site 1. Instead, the following institutional controls will be implemented: a long-term groundwater monitoring plan, aquifer-use restrictions, and deed restrictions. Under the groundwater monitoring plan, samples will be collected semiannually from eight existing shallow monitoring wells, one existing deep monitoring well, and water supply well HP-638, and analyzed for VOCs. Thirty years of monitoring was assumed for cost estimating purposes.

The continued groundwater monitoring will detect any improvement or deterioration in groundwater quality at the site, and will monitor the movement of the plume. The aquifer-use restrictions will prohibit the groundwater from being used as a potable water source, and the deed restrictions will limit the future use of land at Site 1, including placement of wells.

Although this RAA does not involve active remediation, passive remediation of the groundwater may occur over time via natural attenuation processes. These processes include naturally occurring biodegradation, volatilization, dilution, photolysis, leaching, adsorption, and chemical reactions between subsurface materials.

Because COPCs will remain on site under RAA No. 2, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

- ***Site 1: RAA No. 3 - Extraction and On-Site Treatment***

Capital Cost: $990,000
Annual O&M Costs: $70,000
NPW: $2,100,000
Time to Implement: 18 months

RAA No. 3 is a source collection and treatment alternative. Under RAA No. 3, three extraction wells will be installed to pump groundwater from the surficial aquifer to the ground surface. The collection system will be designed so that the radii of influence of these wells will intercept the AOC and provide a hydraulic barrier if the AOC migrates in the direction of groundwater flow (northwest). After being extracted, the groundwater will receive treatment at an on-site treatment plant. Treatment will include air stripping for VOC (i.e., TCE) removal, and precipitation, flocculation, sedimentation, and filtration for suspended solids/inorganics removal. The treated groundwater will be discharged off site to Cogdels Creek.

The exact time required for this pump and treat alternative to remediate the aquifer is unknown given the overall complexity and uncertainty associated with groundwater remediation. However, 30 years of system operation was assumed for cost estimating purposes.

In addition to extraction, treatment, and discharge, RAA No. 3 incorporates a long-term groundwater monitoring plan to measure the effects of the remedial action alternative. Wells included under this plan will be monitored semiannually for VOCs. Also, deed restrictions and aquifer-use restrictions will be implemented under this RAA.

Until the remediation levels are met, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

- ***Site 1: RAA No. 4 - In Well Aeration and Off-Gas Carbon Adsorption***

Capital Cost: $640,000
Annual Groundwater Monitoring O&M Costs: $40,000
Annual System O&M Costs: $20,000
NPW: $1,300,000
Time to Implement: 12 months

In-well aeration is a type of air sparging in which air is injected into a well creating an in-well air-lift pump effect. This pump effect causes the groundwater to flow in a circulation pattern: into the bottom of the well and out of the top of the well. As the groundwater circulates through the well, the injected air stream strips volatiles. (As a result, in-well aeration is often referred to as in-well air stripping.) The volatiles are captured at the top of the well and treated via a carbon adsorption unit.

Under RAA No. 4, four in-well aeration wells will be installed along the lengthwise extent of the plume. The radius of influence of each well is expected to be approximately 120 to 160 feet. Thus, the wells will intercept the contaminated plume as it travels in the direction of groundwater flow.

A separate vacuum pump, knockout tank, and carbon adsorption unit will be located near the opening of each aeration well. The knockout tank will remove any liquids that have traveled up the well and the carbon adsorption unit will treat off-gases that were stripped within the well. Treated vapors from the carbon adsorption unit will be discharged to the atmosphere.

Because in-well aeration is a relatively new and innovative technology, a field pilot test is recommended prior to initiating the system design. The pilot test will determine the loss of efficiency over time as a result of inorganics precipitation and oxidation on the well screen, the radius of influence of the aeration wells under various heads of injection air pressure, the rate of off-gas organic contaminant removal via carbon adsorption, and carbon breakthrough times.

The exact time required for the in-well aeration system to remediate the aquifer is unknown given the overall complexity and uncertainty associated with groundwater remediation. However, 3 years of system operation was assumed for cost estimating purposes.

In addition to the in-well aeration system, RAA No. 4 incorporates a long-term groundwater monitoring plan to measure the effects of the remedial action alternative. Wells included under this plan will be monitored semiannually for VOCs. Also, deed restrictions and aquifer-use restrictions will be implemented under this RAA.

Until the remediation levels are met, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

- ***Site 1: RAA No. 5 - Extraction and Off-Site Treatment***

Capital Cost: $500,000
Annual Groundwater Monitoring O&M Costs: $40,000
Annual System O&M Costs: $130,000
NPW: $1,400,000
Time to Implement: 18 months

RAA No. 5 is another source collection and treatment alternative. Under RAA No. 5, three extraction wells will be installed to pump groundwater from the surficial aquifer to the ground surface. The radii of influence of these wells will intercept the AOC and provide a hydraulic barrier if the AOC migrates in the direction of groundwater flow. Once groundwater is extracted, it will be transported to the HPIA Treatment System, an existing treatment system that is located within Site 78 (the HPIA operable unit) at MCB, Camp Lejeune. Although the system is currently treating VOC contaminated groundwater from Site 78, it has the capacity to accept more. The groundwater will be transported to the system by tanker trucks. At the HPIA Treatment System, the groundwater will receive VOC and inorganics treatment via air stripping, carbon absorption, and suspended solids/metals pretreatment.

The exact time for the pump and treat system to remediate the aquifer is unknown given the overall complexity and uncertainty associated with groundwater remediation. However, 30 years of system operation was assumed for cost estimating purposes.

In addition, RAA No. 5 will incorporate a long-term groundwater monitoring plan to measure the effects of the remedial action alternative. Wells included under this plan will be monitored semiannually for VOCs. Also, deed restrictions and aquifer-use restrictions will be implemented under this RAA.

Until the remediation levels are met, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

7.2 Site 28 Alternatives

- ***Site 28: RAA No. 1 - No Action***

  Capital Cost: $0
  Annual O&M Costs: $0
  NPW: $0
  Time to Implement: None

  Under the no action RAA, no additional remedial actions will be performed to reduce the toxicity, mobility, or volume of the groundwater AOCs. The no action alternative is required by the NCP to provide a baseline for comparison with other remedial action alternatives that provide a greater level of response.

  Since COPCs will remain at the site under this RAA, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

- ***Site 28: RAA No. 2 - Institutional Controls***

  Capital Cost: $0
  Annual O&M Costs: $50,000
  NPW: $800,000
  Time to Implement: 6 months

  Under RAA No. 2, no additional remedial actions will be performed to reduce the toxicity, mobility, or volume of the groundwater AOCs. Instead, the following institutional controls will be implemented: a long-term groundwater monitoring program, aquifer-use restrictions preventing the use of the aquifer as a potable water source, and deed restrictions prohibiting the future construction of potable water supply wells. Under the groundwater monitoring program, samples will be collected semiannually (at five existing shallow wells and two existing deep wells) and analyzed for semivolatiles and metals. Thirty years of monitoring was assumed for cost estimating purposes.

  Since COPCs will remain at the site under this RAA, the NCP requires the lead agency to review the effects of this alternative no less often than once every five years.

7.3 Site 30 Alternatives

- ***Site 30: No Action Alternative***

  Capital Cost: $0
  Annual O&M Costs: $0
  NPW: $0
  Time to Implement: None

  Under the no action RAA, no additional remedial actions will be performed at Site 30. Conditions at the site appear to be protective of human health and the environment so the lead agency will not be required to review the effects of this alternative every five years.

8.0 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

In the process of selecting a response action for OU No. 7, the RAAs for Sites 1 and 28 were comparatively analyzed. (A comparative analysis was not conducted for Site 30 since only one alternative was developed.) This section summarizes the comparative analysis which was based on nine evaluation criteria: overall protectiveness of human health and the environment; compliance with applicable and relevant or appropriate requirements (ARARs); long-term effectiveness/permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; USEPA/state acceptance; and community acceptance. Table 15 provides definitions of these evaluation criteria, Table 16 summarizes the Site 1 RAA analysis, and Table 17 summarizes the Site 28 RAA analysis.

8.1 Site 1

8.1.1 Overall Protection of Human Health and the Environment

RAA No. 1, the no action alternative, does not reduce potential risks to human health and the environment except possibly through natural attenuation of the groundwater AOC. On the other hand, RAA Nos. 2, 3, 4, and 5 all provide some means, other than natural attenuation, for reducing potential risks. RAA Nos. 2, 3, 4, and 5 involve institutional controls which will reduce risks. In addition, RAA Nos. 3, 4, and 5 involve active remediation systems (groundwater extraction/on-site treatment, in-well aeration, and groundwater extraction/off-site treatment) which provide additional protection to human health and the environment. However, the additional protection that RAA Nos. 3, 4, and 5 provide through active remediation systems may not be necessary considering the minimal risks associated with the groundwater AOC.

If the contaminated plume is left alone to passively remediate via natural attenuation, the residual risk that remains will be minimal for the following reasons:

- TCE was detected at low concentrations, 8 µg/L and 27 µg/L, that only slightly exceed the remediation level of 5 µg/L. These low groundwater concentrations, in addition to non-detectable levels in the soil, indicate that there is no significant source of TCE at the site. Instead, the TCE is most likely the result of random, isolated spills.

- Based on the results of an analytical model for solute transport in groundwater, VOCs at Site 1 do not currently impact the nearest receptor, a former water supply well that is currently inactive.

- Vinyl chloride was detected at a low concentration, 4 µg/L, which only slightly exceeds the state standard of 0.015 µg/L and the federal standard of 2 µg/L. Based on this low concentration, and the fact that vinyl chloride was detected at only one well, it does not appear that there is a significant source of vinyl chloride at the site.

Considering the minimal risks associated with the contaminated groundwater, institutional controls (RAA No. 2) will be adequate for protecting human health and the environment. Groundwater extraction and treatment (RAA Nos. 3 and 5) and in-well aeration (RAA No. 4) will be unnecessary to provide adequate protection. No action, however, provides no protection. Therefore, RAA No. 1 may be inferior to the other four alternatives, and RAA Nos. 3, 4, and 5 may overcompensate for the minor risks that exist at the site.

8.1.2 Compliance with ARARs

Under all five RAAs, the groundwater AOC is expected to eventually meet federal and state chemical-specific ARARs. Under RAA Nos. 1 and 2, contaminants are expected to meet ARARs via passive remediation (or natural attenuation). Under RAA Nos. 3, 4, and 5, contaminants are expected to meet ARARs via active remediation (extraction/treatment or in-well aeration).

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

8.1.3 Long-Term Effectiveness and Permanence

Because all five RAAs involve some form of remediation, whether it is active or passive, they are all expected to be effective at decreasing COPC levels in the long run. In addition, the results of all RAAs are expected to be permanent.

Although residual risks associated with untreated COPCs will be minimal, RAA No. 1 is the only alternative that will allow residual risk to remain uncontrolled at the site. RAA Nos. 2, 3, 4, and 5 involve long-term groundwater monitoring plans, aquifer-use restrictions, and deed restrictions, which are all adequate and reliable controls; RAA No. 1 involves no controls. As a result, RAA Nos. 2, 3, 4, and 5 can mitigate the potential for human health exposure through the use of institutional controls, but RAA No. 1 cannot. However, the adequacy and reliability of institutional controls depends on their continued implementation and enforcement.

Under all five RAAs, untreated contaminants will remain at the site indefinitely. As a result, all five RAAs require 5-year reviews to ensure that adequate protection of human health and the environment is maintained. Under RAA Nos. 3, 4, and 5, however, this review will not be necessary once the remediation levels are achieved.

8.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

RAA Nos. 1 and 2 do not involve active treatment processes so these alternatives will only reduce toxicity, mobility, or volume of the AOC via passive remediation. RAA Nos. 3, 4, and 5, however,

involve extraction/treatment and in-well aeration so they will reduce the toxicity, mobility, and volume of the AOC via active remediation. (RAA Nos. 3, 4, and 5 satisfy the statutory preference for treatment.)

There are no treatment residuals associated with RAA Nos. 1 and 2. Under RAA Nos. 3, 4, and 5, however, active treatment processes will create residuals like metals sludge, spent carbon, and contaminated condensed vapor. These additional residuals will require proper disposal.

8.1.5 Short-Term Effectiveness

All five RAAs are expected to reduce COPC levels. However, RAA Nos. 3, 4, and 5 will create the most risk during implementation. Risks to the community and workers will be increased during extraction well, aeration well, piping, and treatment plant installation and operation. RAA No. 2 creates some minor risks associated with groundwater sampling, but these are insignificant compared to the risks associated with RAA Nos. 3, 4, and 5. Implementation of RAA No. 1 will create no risks.

The exact time required for the RAAs to remediate the aquifer is unknown given the complexity and uncertainty associated with groundwater remediation. However, the time in which RAA Nos. 3 and 5 are expected to achieve the remedial action objectives is relatively large compared to RAA No. 4. The relative amount of time required for natural attenuation to restore the aquifer (i.e., RAA Nos. 1 and 2) is expected to be much greater than the time required for RAA Nos. 3, 4, and 5. Regardless, all RAAs, with the exception of the no action alternative, involve continued groundwater monitoring for 30 years.

8.1.6 Implementability

RAA No. 1 is the most implementable, if not the most effective, alternative. RAA Nos. 2, 3, and 5 use conventional, well-demonstrated, and commercially available technologies so these RAAs are proven to be implementable and reliable. RAA No. 4 (in-well aeration), however, involves an emerging technology that does not have an extensive commercial track record. A field pilot test is necessary to determine this alternative's implementability. Regardless, RAA Nos. 3, 4, and 5 create more risk than RAA No. 2 during implementation.

8.1.7 Cost

In terms of NPW, the no action alternative (RAA No. 1) would be the least expensive RAA to implement, followed by RAA No. 2, RAA No. 4, RAA No. 5, and then RAA No. 3. The estimated NPW values in increasing order are $0 (RAA No. 1), $600,000 (RAA No. 2), $1,300,000 (RAA No. 4), $1,400,000 (RAA No. 4), and $2,100,000 (RAA No. 3).

8.1.8 USEPA/State Acceptance

To be addressed following USEPA/NC DEHNR review of the ROD.

8.1.9 Community Acceptance

To be addressed following the public comment period.

8.2 Site 28

8.2.1 Overall Protection of Human Health and the Environment

RAA No. 1, the no action alternative, does not reduce potential risks to human health and the environment. On the other hand, RAA No. 2 does reduce potential risks because it involves institutional controls that can prevent future exposure to the groundwater.

Regardless, the magnitude of residual risks is considered to be minimal. The groundwater COPCs exceeding remediation levels, lead and manganese, do not pose substantial risks to human health or the environment for the following reasons:

- Manganese concentrations (from both unfiltered and filtered samples) in groundwater at MCB, Camp Lejeune often exceed the state and federal secondary standard of 50 µg/L. Elevated manganese levels, at concentrations above the state standard, were reported in samples collected from a number of Base potable water supply wells. Manganese concentrations at several Site 28 wells exceeded the state standard, and all but one sample fell within the range of concentrations for samples collected elsewhere at MCB, Camp Lejeune.

- Lead was detected above its remediation level at only one well. This well, which is situated in an area of loosely compacted fill material, exhibited high turbidity (above 10 turbidity units) and total suspended solids (111 mg/L). In addition, lead was only detected in the unfiltered water sample, not the filtered water sample, taken at this well. All of this information suggests that the high lead concentration detected may be the result of suspended solids, and the unfiltered sample represented lead in the soil and groundwater, not just the amount of lead that is dissolved in the groundwater.

Considering the minimal risks associated with lead and manganese in the groundwater, institutional controls (RAA No.2) will be adequate for protecting human health and the environment. No action, however, provides no protection.

8.2.2 Compliance with ARARs

Under RAA Nos. 1 and 2, manganese levels are expected to exceed their chemical-specific ARARs. However, this is not a great concern because manganese at the Base appears to naturally occur at levels exceeding ARARs. Lead, however, is not expected to exceed ARARs because the high lead detection is believed to be the result of suspended solids in the unfiltered water sample.

No location- or action-specific ARARs apply to RAA Nos. 1 and 2.

8.2.3 Long-Term Effectiveness and Permanence

RAA No. 1 allows the most residual risk, and RAA No. 2 allows less residual risk. Regardless, the magnitude of any residual risk will be minimal for the three reasons stated earlier.

RAA No. 2 involves monitoring, aquifer-use restrictions, and deed restrictions, which are all adequate and reliable controls; RAA No. 1 involves no controls. As a result, RAA No. 2 can

mitigate the potential for groundwater exposure, but RAA No. 1 cannot. Also, the effectiveness of RAA No. 2 can be determined more often than the effectiveness of RAA No. 1.

Both RAAs require 5-year reviews to ensure that adequate protection of human health and the environment is maintained.

8.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

RAA Nos. 1 and 2 do not involve active treatment processes so these alternatives will not reduce toxicity, mobility, or volume of the groundwater AOC. Additionally, neither RAA satisfies the statutory preference for treatment.

8.2.5 Short-Term Effectiveness

Implementation of RAA Nos. 1 and 2 will not increase risks to the community. RAA No. 1 will not increase risks to workers, but RAA No. 2 will. RAA No. 2, however, will not significantly increase worker risks because worker protection will be utilized during groundwater sampling. In addition, groundwater sampling has been successfully implemented in the past with minimal worker risks.

No additional environmental impacts are expected under RAA Nos. 1 and 2.

8.2.6 Implementability

RAA No. 1 is the most implementable, if not the most effective, alternative. RAA No. 2 is not as implementable as RAA No. 1, but it is still easily implementable. RAA No. 2 involves conventional, well-demonstrated, and commercially available technologies, and it has been easily implemented in the past.

Unlike RAA No. 1, RAA No. 2 requires the submission of semiannual sampling reports. RAA No. 1 requires no coordination with agencies.

8.2.7 Cost

In terms of NPW, the no action alternative (RAA No. 1) would be the least expensive RAA to implement, followed by RAA No. 2. The estimated NPW values in increasing order are $0 (RAA No. 1) and $800,000 (RAA No. 2).

8.2.8 USEPA/State Acceptance

To be addressed following USEPA/NC DEHNR review of the ROD.

8.2.9 Community Acceptance

To be addressed following the public comment period.

9.0 SELECTED REMEDY

This section of the ROD presents the selected remedy for OU No. 7. A description of the selected remedy is presented along with the estimated costs to implement the remedy. In addition, the remediation levels to be attained at the conclusion of the remedy are discussed.

9.1 Remedy Description

The selected remedy for OU No. 7 consists of the three separate remedies developed for Sites 1, 28, and 30:

9.1.1 Site 1 Remedy - Institutional Controls (RAA No. 2)

- A long-term groundwater monitoring plan that is depicted in Figure 7. As shown, eight wells will be sampled semiannually and the samples will be analyzed for VOCs.
- Aquifer use restrictions that will prohibit the future use of the aquifer as a potable water source. The restrictions will be implemented via the Base Master Plan.
- Deed restrictions that will limit the future use of land at the site, including placement of wells. The restrictions will be implemented via the Base Master Plan.

9.1.2 Site 28 Remedy - Institutional Controls (RAA No. 2)

- A long-term groundwater monitoring plan that is depicted in Figure 8. As shown, six wells will be sampled semiannually and the samples will be analyzed for lead and manganese.
- Aquifer use restrictions that will prohibit the future use of the aquifer as a potable water source. The restrictions will be implemented via the Base Master Plan.
- Deed restrictions that will limit the future use of land at the site, including placement of wells. The restrictions will be implemented via the Base Master Plan.

9.1.3 Site 30 Remedy - No Action

The selected remedy for Site 30 is the "no action" plan. The "no action" plan involves taking no further remedial actions (this includes conducting no further environmental investigations or sampling) at the site. The site and all of the environmental media located within the site will remain as they currently are.

9.2 Estimated Costs

The following costs were estimated for the Sites 1, 28, and 30 remedies:

Site 1:	Capital Cost: $0 Annual O&M: $40,000 NPW: $600,000
Site 28:	Capital Cost: $0 Annual O&M: $30,000 NPW : $500,000
Site 30:	Capital Cost: $0 Annual O&M: $0 NPW: $0

The following total cost was estimated for the OU No. 7 remedy (the cost for the OU No. 7 remedy is the costs of the Sites 1, 28, and 30 remedies combined):

Total for OU No. 7:	Capital Cost: $0 Annual O&M: $70,000 NPW: $1,100,000

9.3 Remediation Levels

Although an operation period of 30 years was assumed for cost estimations, the selected remedy will actually be operated until the remediation levels developed in the FS are met. The following paragraphs describe the remediation levels for Sites 1 and 28. (Remediation levels were not developed for Site 30 because site conditions were determined to be protective of human health and the environment.)

9.3.1 Site 1

The remediation level for TCE in groundwater is 5.0 µg/L. This remediation level is based on the North Carolina state water quality standard.

Since the selected remedy does not involve active remediation, the remediation levels are expected to be achieved via passive remediation, or natural attenuation processes. The long-term groundwater monitoring plan will indicate when the remediation level has been achieved.

9.3.2 Site 28

The remediation levels for lead and manganese in groundwater are 15 µg/L and 50 µg/L, respectively. These remediation levels are based on North Carolina state water quality standards.

The long-term groundwater monitoring plan will indicate when lead has achieved its remediation level. In the case of manganese in the groundwater, however, the remediation level will probably

never be achieved because this inorganic appears to naturally occur at high levels at MCB, Camp Lejeune.

10.0 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 evaluation of how the remedy for OU No. 7 satisfies these requirements is presented below.

10.1 Protection of Human Health and the Environment

Institutional controls will provide protection to human health by preventing exposure to potential contaminants in the groundwater at Sites 1 and 28. Institutional controls prevent human exposure because they prohibit the surficial aquifer from being used as a potable water source, and they prohibit the placement of wells within the aquifer.

The selected remedies will not provide any additional protection to the environment. However, based on the ecological risk assessment for Sites 1 and 28, risks for aquatic and terrestrial receptors appear to be insignificant. At Site 1, there were no ecological risks for aquatic receptors and ecological risks for terrestrial receptors only slightly exceeded acceptable limits. In addition, Site 1 is located within a heavy industrial/commercial area where terrestrial receptors do not normally live. At Site 28, risks for aquatic receptors from surface water and sediment only slightly exceeded acceptable limits. In addition, sediment in the New River appears to be affected by a nearby active firing range rather than an on site source, and surface water and sediment in Cogdels Creek appear to be affected by runoff from other sites in addition to Site 28. Also, pesticides in the sediment appear to be the result of routine pesticide application in the general vicinity of Site 28. Although there was an ecological risk for terrestrial receptors at Site 28, the risk only slightly exceeded acceptable limits so it appears to be insignificant.

Based on these low ecological risks, additional protection to the environment was determined to be unnecessary at Sites 1 and 28.

At Site 30, the no action alternative will be protective because the site conditions already appear to be protective of human health and the environment. There were no unacceptable risks to human health and the slight risk generated for raccoons at the site appears to be insignificant.

10.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedies for Sites 1 and 28 will allow potential contaminants to remain untreated at levels exceeding chemical-specific ARARs. However, natural attenuation is expected to eventually reduce TCE levels at Site 1 to below chemical-specific ARARs. In addition, lead in the groundwater at Site 28 appears to be the result of suspended solids in the total inorganics sample. As a result, lead is expected to meet its chemical-specific ARARs during the execution of the long-term groundwater monitoring program. Manganese in the groundwater at Site 28, however, may never

meet it chemical-specific ARARs because it appears to naturally occur at the Base at levels exceeding ARARs.

At Site 30, constituents detected in the environmental media already comply with chemical-specific ARARs.

The selected remedies for Sites 1 and 28 can be designed to meet all location- and action-specific ARARs that apply to them. No location- or action-specific ARARs apply to the no action alternative for Site 30.

10.3 Cost-Effectiveness

Aquifer use and deed restrictions provide a cost-effective remedy since there are no significant costs associated with their implementation other than administrative-type efforts. Groundwater monitoring programs are also cost-effective. Compared to the more costly alternatives that employ groundwater treatment, the selected remedies are more cost-effective because they provide a comparable level of protection. Compared to the no action alternatives, the selected remedies are more cost-effective because they provide at least some protection which is necessary at Sites 1 and 28.

There are no costs associated with the no action alternative for Site 30. As a result, this alternative is considered to be cost-effective.

10.4 Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedies will provide permanent, long-term remedies through the provision and enforcement of aquifer and deed restrictions in the Base Master Plan. However, the selected remedies do not employ alternative treatment technologies.

At Site 1, alternative treatment technologies were not selected because the risks associated with TCE in the groundwater appear to be minimal. TCE was detected at low concentrations (maximum of 27 µg/L) that only slightly exceeded the remediation level (5 µg/L). In addition, TCE was not detected in the soil so there does not appear to be a significant site-related TCE source. Also, based on an analytical model for solute transport in groundwater, VOCs at Site 1 do not currently impact the nearest receptor, a former water supply well that is currently inactive. Vinyl chloride was detected at a concentration (4 µg/L) that slightly exceeded state and federal standards (0.015 and 2 µg/L, respectively). But based on this low detected concentration, and the fact that vinyl chloride was only detected in one well at the site, there does not appear to be a significant source of vinyl chloride at the site. Based on these minimal risks, alternative treatment technologies were deemed unnecessary for Site 1.

At Site 28, alternative treatment technologies were not selected because the risks associated with manganese and lead appear to be minimal. Manganese concentrations at the Base appear to naturally occur at levels exceeding the remediation level; lead was considered to be the result of high suspended solids in the one well it was detected in.

At Site 30, alternative treatment technologies were not considered because site conditions appear to be protective of human health and the environment.

10.5 Preference for Treatment as a Principal Element

The selected remedies do not satisfy the statutory preference for treatment. However, the remedies are still capable of providing adequate protection to human health and the environment. Treatment alternatives were not considered appropriate for the reasons discussed in Section 10.4.

11.0 RESPONSIVENESS SUMMARY

11.1 Overview

To be completed after the public meeting.

11.2 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 OU No. 7). 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 Community Relations Plan, February 1994.
- Established two information repositories.
- Established the Administrative Record for all of the sites at the base.
- Released PRAP for public review in repositories, July 1995.
- Released public notice announcing public comment and document availability of the PRAP, July 1995.

- Held Technical Review Committee meeting, September 19, 1995, to review PRAP and solicit comments.

- Held public meeting on October 5, 1995, to solicit comments and provide information. Five people attended.

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

A public meeting was held on October 5, 1995 in the Onslow County Library in Jacksonville, North Carolina. Five citizens from the Jacksonville area attended the meeting along with representatives of MCB, Camp Lejeune, LANTDIV, NC DEHNR, and Baker. A representative from USEPA Region IV was not present. The following summarizes the questions and responses from the public meeting.

General Questions

Question #1: How much will the National Superfund program be cut?

Response #1: The studies and cleanup programs at Camp Lejeune are funded by DERA, which will be cut by 50 percent over the next 5 years. We are hoping to get state and EPA involvement to help us ensure we secure funding for the next few years. The state of California got almost half the DERA budget. Jon Johnston at the EPA is supporting us. We hope that momentum will push the availability of funding.

Site 1 Questions

Question #1: How did you know where to look (regarding the areas to investigate)?

Response #1: The IAS (Initial Assessment Study) identified areas of concern based on personnel interviews, records, documents, and aerial photos.

Question #2: How many buildings are new construction and what are they used for?

Response #2: Most are pre-1980; one building was constructed in 1990. None of those were evaluated for environmental impact prior to construction. Now, there is an environmental working group that reviews all new construction prior to starting.

Question #3: What did this study find (regarding original 1988 investigation of Site 1)?

Response #3: Low levels of solvent in one well in the southern area (1-GW05); The possible contaminant was 1,2-DCE.

Question #4: What are TAL metals?

Response #4: These are the priority pollutant metals, the most toxic being lead, chromium, mercury, etc.

Question #5: Why do you collect samples for physical characteristics?

Response #5: To help characterize/classify the soils.

Question #6: What is the definition of shallow (regarding groundwater sampling)?

Response #6: Shallow is defined as groundwater samples collected within 25 feet of ground surface. The water table is approximately 15 feet deep. Deep is defined as greater than 100 feet below ground surface. Two deep wells and one water supply well was sampled.

Question #7: Was this well sampled and what were the results (regarding the water supply well)?

Response #7: The supply well was sampled in 1992 and had 2 parts per billion of benzene (Federal MCL is 5 ppb and the NC WQS is 1 ppb). The supply well was taken off line at that time (1992). During our investigation, the supply well was clean.

Question #8: Why did it come up clean (regarding the supply well?

Response #8: Different sampling techniques may have been used or the contaminant may have disappeared (attenuated) by the time we sampled.

Question #9: What direction does the groundwater flow at Site 1?

Response #9: Groundwater flows east to west across the site. Our sampling focused on the center of the site (within the area of concern) and on the downgradient area. We installed shallow and deep wells here which came up clean for volatiles. The water supply well also came up clean.

Question #10: What do you mean by solids (regarding suspended solids in groundwater)?

Response #10: If you pump water directly from a well, you can get particles floating or suspended. These suspended solids will contribute to the total metals in groundwater.

Question #11: What metals are common (regarding groundwater)?

Response #11: Iron

Question #12: What is the typical pH of groundwater?

Response #12: Typically between 8 and 5.5 and as low as 4 to 4.5 in marshy areas.

Question #13: Why is it lower in marshy areas?

Response #13: High organic content in soils tends to lower the pH.

Question #14: Did you find any copper and zinc?

Response #14: Yes, they appear to be fairly consistent with levels found over the entire base.

(Brief discussion of low flow groundwater sampling and the results of the sampling efforts)

Question #15: What does 14/14 mean (regarding the results presented on a hand out)?

Response #15: This is a comparison to base background. We took 14 surface soil samples and analyzed for metals and 1 out of 14 indicates we had 1 hit (detection) above background samples (collected throughout the base).

Question #16: What do you mean by detection frequency of 14 of 14 for lead?

Response #16: For 14 samples, we had 14 samples which had detections higher than base background. On that handout, lead and zinc exceeded base background most frequently.

Question #17: Have you considered taking "background" samples, in say the Hoffman forest area?

Response #17: No. We have done something similar with surface water and sediment (and fish) at the White Oak River.

Question #18: How do you know if those metals you find in the soil will end up in the water table (reference to Day Care Center - Site 2)?

Response #18: We have done a extensive investigation to determine that possibility. This subject will be covered during a discussion of the human health risk assessment.

Question #19: Would all of the semivolatiles be characterized as persistent?

Response #19: We are not too surprised to find semivolatiles because as petroleum compounds weather, these are the heavier compounds that are left.

Question #20: Is your methodology completely standardized, i.e., if you collect a volume of sample and then collect a sample using a different method, could they result in different analyses?

Response #20: Yes, we follow the USEPA Region IV sample collection procedures and USEPA laboratory procedures.

Question #21: How long has it been since DDT was used?

Response #21: Quite awhile ago, at least 10 years. They are, however, very persistent in the environment.

Question #22: Are you sure that what you found in the shallow groundwater is from a historical origin, not from recent operations?

Response #22: We think it is from more recent operations, not historical. Levels that we are seeing here are probably indicative of very small spills. The soils are very permeable here and a very small amount would be all it would take to get these levels. Surrounding wells are clean, so we see it as a very isolated plume.

(Brief discussion on the results of the human health and ecologic risk assessments)

Question #23: Is this information now logged into base files now to prevent use of groundwater?

Response #23: Part of our proposed plan is to place deed restrictions on use of shallow groundwater.

Question #24: What happens if the base is closed (BRAC)? Who is responsible for cleaning it up?

Response #24: The federal government has the responsibility for clean up prior to turning it over to the general public.

(Brief discussion on the proposed actions)

Question #25: What are you basing the monitoring time on?

Response #25: 30 years.

Question #26: What will be the conditions in 30 years?

Response #26: We expect to see a decrease due to natural degradation.

Question #27: Can the TCE degrade into something more toxic?

Response #27: Generally, TCE will degrade into DCE and eventually vinyl chloride which is more toxic. Since we have low levels (TCE and vinyl chloride), we don't expect this to be a problem.

Question 28#: How long will there be a risk with this TCE? What is the half-life?

Response #28: We do evaluate that for potential risk. We would have to look up the toxicity profiles, available in the BRA of the RI report.

Question #29: How do you get your risk based values?

Response #29: The information comes from a USEPA database.

Question #30: How far out (distance) will the aquifer restrictions extend?

Response #30: The Camp Lejeune well head protection program identifies how far away a well must be from an industrial area.

Site 28 Questions

Question #1: What is the definition of surface water, (how is it collected)?

Response #1: Surface water was collected by dipping a bottle into the very top of the water column. A sediment sample was taken at 0 to 6" and from 6 to 12".

Question #2: What is the source of thallium (in surface water)?
Is it radioactive? Did it come from hospital wastes?

Response #2: We really do not know what the source of thallium.
We have not encountered it before (previous sampling). We have an isolated hit.

Question #3: How high was the mercury in the fish samples?

Response #3: The human health risk assessment found no risk associated with the fish ingestion or to aquatic communities. The only risk noted was for child receptors residents drinking the groundwater.

(Brief discussion of proposed action plan).

Question #4: How soon do you start monitoring?

Response #4: Generally within one year after the final ROD is signed.

The public meeting ended at 9:00 pm, the closing time of the Onslow County Library. Consequently, Site 30 was not discussed during the meeting.

The public comment period ended on November 5, 1995. There were no public or regulatory comments issued within the comment period.

TABLES

TABLE 1

SUMMARY OF RI RESULTS
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Surface Soil	Volatiles	ND	NA	NA			0/14	
	Semivolatiles	ND	NA	NA			0/14	
	Pesticides	Dieldrin	NA	NA	4.3 J	4.3 J	1/14	central northern
		4,4'-DDE	NA	NA	2.2 J	4.9	2/14	central northern and southern
		4-4'-DDT	NA	NA	7.0 J	12	3/14	scattered
		Endrin aldehyde	NA	NA	3.9 NJ	3.9 NJ	1/14	central northern
	PCBs	ND	NA	NA			0/14	
	Metals[1]	Antimony	NA	0.3 - 8.0	9.0 J	11.9	3/14	3 exceed BB, all near pond
		Arsenic	NA	0.2 - 1.8	0.57	2.0	6/14	1 exceeds BB, scattered
		Beryllium	NA	0.03 - 0.16	0.19	0.19	1/14	1 exceeds BB, southern
		Cadmium	NA	0.18 - 0.58	0.62	2.0	3/14	3 exceed BB, southern
		Chromium	NA	0.3 - 12.5	1.5	6.4	13/14	none exceed BB
		Copper	NA	0.5 - 87.2	1.6	4.9	6/14	none exceed BB
		Lead	NA	0.5 - 142.0	1.0	23.5	14/14	none exceed BB
		Nickel	NA	0.6 - 3.6	1.6	3	3/14	none exceed BB
		Zinc	NA	0.3 - 28.3	3.5	26.9	9/14	none exceed BB
Subsurface Soil	Volatiles	Acetone	NA	NA	490 J	490 J	1/110	southern
		Trichloroethene	NA	NA	3 J	3 J	1/110	west of Building FC-120
		1,1,2,2-TCA	NA	NA	27	27	1/110	central southern
		Toluene	NA	NA	1 J	1 J	1/110	central northern
	Semivolatiles	4-Nitrophenol	NA	NA	930	930	1/110	along Main Service Road, southern
		Phenanthrene (PAH)	NA	NA	47 J	47 J	1/110	north of Building FC-120
		di-n-butylphthalate	NA	NA	74 J	74 J	1/110	north of Building FC-120
		Fluoranthene (PAH)	NA	NA	110 J	110 J	1/110	north of Building FC-120
		Pyrene (PAH)	NA	NA	86 J	86 J	1/110	north of Building FC-120
		BEHP	NA	NA	36 J	8,700	45/110	scattered

TABLE 1 (Continued)

SUMMARY OF RI RESULTS
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Subsurface Soil (Continued)	Pesticides	Dieldrin	NA	NA	7.1 J	39 J	2/110	central northern
		4,4'-DDE	NA	NA	11	120	2/110	central northern
		Endosulfan II	NA	NA	55	55	1/110	north of Building FC-120
		4,4'-DDD	NA	NA	2.2 J	28 J	2/110	scattered, northern
		4,4'-DDT	NA	NA	1.6 J	18 J	7/110	central northern, 1 southern
		Endrin aldehyde	NA	NA	24 NJ	24 NJ	1/110	north of Building FC-120
		alpha-chlordane	NA	NA	4.2 NJ	9.2 NJ	2/110	northern
		gamma-Chlordane	NA	NA	2.5 NJ	2.9 NJ	2/110	central northern
	PCBs	Aroclor 1254	NA	NA	18 J	18 J	1/110	central, southern portion
		Aroclor 1260	NA	NA	1,300	1,300	1/110	north of Building FC-120
	Metals [1]	Antimony	NA	0.4 - 6.9	6.1 J	7.8 J	7/110	6 exceed BB, scattered
		Arsenic	NA	0.03 - 1.50	0.6	5.6	58/110	21 exceed BB, scattered
		Cadmium	NA	0.17 - 1.20	0.62	1.1	5/110	none exceed BB
		Chromium	NA	0.7 - 10.5	1.5	17.5	109/110	6 exceed BB, scattered
		Copper	NA	0.5 - 6.6	1.1	5	42/110	none exceed BB
		Lead	NA	0.5 - 11.5	1.3	60.4 J	101/110	6 exceed BB, northern
		Mercury	NA	0.01 - 0.68	0.06	0.34	7/110	none exceed BB
		Nickel	NA	0.6 - 4.7	1.2	4.4	40/110	none exceed BB
		Selenium	NA	0.12 - 0.55	0.81	1.5 J	2/110	2 exceed BB, northern and southern
		Silver	NA	0.18 - 1.00	1 J	1 J	1/110	does not exceed BB
		Zinc	NA	0.3 - 11.6	0.63 J	78.6 J	74/110	8 exceed BB, scattered
Groundwater	Volatiles [2]	Vinyl Chloride	NCWQS - 0.015	NA	2	4 J	1/19	1 exceeds ARAR, northwest
		1,1-Dichloroethene	MCL - 7	NA	2 J	2 J	1/19	does not exceed ARAR
		1,2-Dichloroethene	MCL - 100	NA	1 J	21	2/19	do not exceed ARAR
		Trichloroethene	NCWQS - 2.8	NA	1 J	27	3/19	2 exceed ARAR
		Xylenes (total)	NCWQS - 530	NA	3	19	1/19	does not exceed ARAR

TABLE 1 (Continued)

SUMMARY OF RI RESULTS
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Groundwater (continued)	Semivolatiles [2]	Phenol	NA	NA	6.1 J	6.1 J	1/19	central northern portion
		Diethylphthalate	NCWQS - 5,000	NA	1.3 J	1.3 J	1/19	does not exceed ARAR
	Pesticides	ND	MCL/NCWQS	NA			0/6	
	PCBs	ND	NA	NA			0/6	
	Total Metals [3]	Iron	NCWQS - 300	882 - 55,300	263	29,200 J	9/19	9 exceed ARAR, none exceed BB
		Manganese	NCWQS - 50	10 - 290	2.5	1,200	18/19	15 exceed ARAR, 9 exceed BB

Notes: - Concentrations are presented in µg/L for liquid and µg/Kg for solids (ppb), metal concentrations for solids and sediments are presented in mg/Kg (ppm).

(1) Metals in both surface and subsurface soils were compared to the range of Base background positive detections for priority pollutant metals only (i.e., antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc).

(2) Additional groundwater samples were collected from wells which exhibited concentrations of volatile and semivolatile compounds during the initial round.

(3) Total metals in groundwater samples were compared to the range of positive detections in upgradient wells throughout MCB, Camp Lejeune.

ARAR - Applicable or Relevant and Appropriate Requirements
BB - Base Background (Refer to Appendix M)
BEHP - Bis(2-ethylhexyl)phthalate
NA - Not Applicable
NCWQS - North Carolina Water Quality Standard
ND - Not Detected
MCL - Federal Maximum Contaminant Level
PAH - Polynuclear Aromatic Hydrocarbon
TCA - Tetrachloroethane
J - Estimated Quantity

TABLE 2

SUMMARY OF RI RESULTS
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Surface Soil	Volatiles	1,1,1-Trichloroethane	NA	NA	2 J	2 J	1/40	eastern, adjacent Orde Pond
	Semivolatiles	bis(2-chloroethyl)ether	NA	NA	69 J	69 J	1/40	eastern
		Naphthalene (PAH)	NA	NA	69 J	69 J	1/40	western
		Acenaphthene (PAH)	NA	NA	49 J	83 J	2/40	western
		Dibenzofuran	NA	NA	70 J	70 J	1/40	western
		Fluorene (PAH)	NA	NA	56 J	88 J	2/40	western
		Pentachlorophenol	NA	NA	46 J	46 J	1/40	eastern
		Phenanthrene (PAH)	NA	NA	41 J	1,100	8/40	primarily western
		Anthracene (PAH)	NA	NA	120 J	240 J	3/40	western
		Carbazole	NA	NA	69 J	170 J	3/40	western
		di-n-Butylphthalate	NA	NA	58 J	70 J	2/40	1 eastern, 1 western
		Fluoranthene (PAH)	NA	NA	43 J	1,800	12/40	primarily western
		Pyrene (PAH)	NA	NA	51 J	2,100	11/40	primarily western
		Butyl benzyl phthalate	NA	NA	88 J	88 J	1/40	western
		B(A)anthracene (PAH)	NA	NA	56 J	1,300	7/40	primarily western
		Chrysene (PAH)	NA	NA	43 J	1,200	9/40	primarily western
		B(B)fluoranthene (PAH)	NA	NA	41 J	2,100	10/40	primarily western
		B(K)fluoranthene (PAH)	NA	NA	41 J	740	7/40	primarily western
		Benzo(A)pyrene (PAH)	NA	NA	58 J	1,600	8/40	primarily western
		1(1,2,3-cd)pyrene (PAH)	NA	NA	44 J	1,500	6/40	western
		D(a,h)anthracene (PAH)	NA	NA	120 J	120 J	1/40	western
		B(g,h,i)perylene (PAH)	NA	NA	49 J	1,700	6/40	western

TABLE 2 (Continued)

SUMMARY OF RI RESULTS
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Surface Soil (Continued)	Pesticides	Heptachlor epoxide	NA	NA	8 J	43 J	3/40	2 eastern, 1 western
		Dieldrin	NA	NA	7.1 J	7.1 J	1/40	eastern
		4,4'-DDE	NA	NA	4.4 NJ	1,300	25/40	scattered
		Endrin	NA	NA	35 J	35 J	1/40	western
		4,4'-DDD	NA	NA	0.91 NJ	320 J	17/40	scattered
		Endosulfan Sulfate	NA	NA	41 J	41 J	1/40	western
		4,4'-DDT	NA	NA	2.7 J	1,400	20/40	scattered
		Endrin aldehyde	NA	NA	7.1 J	7.1 J	1/40	eastern
		alpha-Chlordane	NA	NA	1.9 NJ	160 NJ	15/40	scattered
		gamma-Chlordane	NA	NA	1.9 NJ	96 J	9/40	primarily eastern
	PCBs	Aroclor 1254	NA	NA	47 J	58 J	2/40	western
		Aroclor 1260	NA	NA	44	44	1/40	eastern
	Metals [1]	Antimony	NA	0.3 - 8.0	6.4 J	28 J	6/43	4 exceed BB, western
		Arsenic	NA	0.2 - 1.8	0.56 J	16	25/43	7 exceed BB, primarily western
		Cadmium	NA	0.18 - 0.58	0.66	12.5	13/43	13 exceed BB, primarily western
		Chromium	NA	0.3 - 12.5	1.4 J	26	42/43	8 exceed BB, primarily western
		Copper	NA	0.5 - 87.2	1.5	4,260 J	42/43	7 exceed BB, western
		Lead	NA	0.5 - 142.0	3.9	551	43/43	6 exceed BB, western
		Mercury	NA	0.01 - 0.08	0.05	1.1	28/43	22 exceed BB, scattered
		Nickel	NA	0.6 - 3.6	1.1 J	36	25/43	11 exceed BB, primarily western
		Selenium	NA	0.27 - 0.94	1.5	10 J	2/43	2 exceed BB, eastern and western
		Silver	NA	0.04 - 4.30	1.5 J	6 J	7/43	1 exceeds BB, eastern
		Thallium	NA	0.11 - 0.56	0.8	2.5	3/43	3 exceed BB, eastern and western
		Zinc	NA	0.3 - 28.3	6.7 J	23,100	41/43	24 exceed BB, higher detects west

TABLE 2 (Continued)

SUMMARY OF RI RESULTS
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Subsurface Soil	Volatiles	Benzene	NA	NA	2 J	2 J	1/32	western
		Tetrachloroethene	NA	NA	5 J	5 J	1/32	western
	Semivolatiles	1,4-Dichlorobenzene	NA	NA	44 J	140 J	2/32	western
		4-Methylphenol	NA	NA	250 J	250 J	1/32	western
		Naphthalene (PAH)	NA	NA	39 J	2,600	6/32	western
		2-Methylnaphthalene	NA	NA	82 J	89 J	2/32	western
		Dimethyl phthalate	NA	NA	79 J	220 J	2/32	western
		Acenaphthene (PAH)	NA	NA	510	2,500 J	2/32	western
		Dibenzofuran	NA	NA	220 J	1,300 J	2/32	western
		Diethylphthalate	NA	NA	100 J	100 J	1/32	western
		Fluorene (PAH)	NA	NA	78 J	2,600 J	4/32	western
		Phenanthrene (PAH)	NA	NA	38 J	27,000	9/32	western
		Anthracene (PAH)	NA	NA	330 J	8,600	2/32	western
		Carbazole	NA	NA	94 J	4,700	2/32	western
		Fluoranthene (PAH)	NA	NA	40 J	2,700	9/32	primarily western
		Pyrene (PAH)	NA	NA	51 J	2,600	6/32	western
		B(a)anthracene (PAH)	NA	NA	120 J	24,000	3/32	western
		Chrysene (PAH)	NA	NA	46 J	22,000	5/32	western
		BEHP	NA	NA	62 J	1,300	15/32	scattered, western
		B(b)fluoranthene (PAH)	NA	NA	38 J	21,000	6/32	western
		B(k)fluoranthene (PAH)	NA	NA	50 J	18,000	3/32	western
		Benzo(a)pyrene (PAH)	NA	NA	43 J	21,000	4/32	western
		I(1,2,3-cd)pyrene (PAH)	NA	NA	100 J	11,000	3/32	western
		D(a,h)anthracene (PAH)	NA	NA	110 J	2,800 J	2/32	western
		B(g,h,i)perylene (PAH)	NA	NA	50 J	10,000	4/32	western

TABLE 2 (Continued)

SUMMARY OF RI RESULTS
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Subsurface Soil (Continued)	Pesticides	4,4'-DDE	NA	NA	3.1 J	1,600	19/32	scattered
		4,4'-DDD	NA	NA	6.2	880 NJ	17/32	scattered
		4,4'-DDT	NA	NA	3 J	7,300	13/32	scattered
		alpha-Chlordane	NA	NA	2.7 J	65 J	3/32	western
		gamma-Chlordane	NA	NA	2.6 NJ	11 NJ	3/32	western
	PCBs	Aroclor 1242	NA	NA	140 J	140 J	1/32	western
		Aroclor 1260	NA	NA	25 J	77	2/32	western
	Metals [1]	Antimony	NA	0.4 - 6.9	5.9 J	46.7 J	16/51	15 exceed BB, western
		Arsenic	NA	0.03 - 1.50	0.69	25.1	41/51	30 exceed BB, scattered
		Beryllium	NA	0.03 - 2.30	0.24	1.1	4/51	none exceed BB
		Cadmium	NA	0.17 - 1.20	0.77	15.6	22/51	22 exceed BB, scattered
		Chromium	NA	0.7 - 10.5	2 J	128	50/51	27 exceed BB, primarily western
		Copper	NA	0.5 - 6.6	1.0 J	3,280	43/51	23 exceed BB, western
		Lead	NA	0.5 - 11.5	1.9 J	2,060 J	49/51	25 exceed BB, primarily western
		Mercury	NA	0.01 - 0.68	0.05	2.8	15/51	3 exceed BB, western
		Nickel	NA	0.6 - 4.7	1.6	102 J	23/51	14 exceed BB, western
		Selenium	NA	0.12 - 0.55	6 J	6 J	1/51	1 exceeds BB, western
		Silver	NA	0.18 - 1.00	1.1 J	18.4 J	13/51	13 exceed BB, scattered
		Thallium	NA	0.12 - 0.50	1	1	1/51	1 exceeds BB, western
		Zinc	NA	0.3 - 11.6	0.95 J	4,330 J	43/51	24 exceed BB, primarily western

TABLE 2 (Continued)

SUMMARY OF RI RESULTS
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Groundwater	Volatiles	Chloroform	MCL - 0.1	NA	2	2	1/13	1 exceeds ARAR, central western
		Ethylbenzene	NCWQS - 29	NA	5	5	1/13	does not exceed ARAR
		Xylenes (total)	NCWQS - 530	NA	19	19	1/13	does not exceed ARAR
	Semivolatiles	2-Methylphenol	NA	NA	1.3 J	1.3 J	1/13	western
		4-Methylphenol	NA	NA	29	29	1/13	western
		2,4-Dimethylphenol	NA	NA	2.2 J	4.0 J	2/13	central western
		2,4-Dichlorophenol	NA	NA	1.6 J	1.6 J	1/13	central western
		Naphthalene	NCWQS - 21	NA	99	99	1/13	1 exceeds ARAR, central western
		2-Methylnaphthalene	NA	NA	33	33	1/13	central western
		Dimethylphthalate	NA	NA	1 J	1 J	1/3	central western
		Acenaphthene (PAH)	NA	NA	1.3 J	31	2/13	central western
		Dibenzofuran	NA	NA	12	12	1/13	central western
		Fluorene (PAH)	NCWQS - 280	NA	18	18	1/13	does not exceed ARAR
		Phenanthrene (PAH)	NCWQS - 210	NA	14	14	1/13	does not exceed ARAR
		Anthracene (PAH)	NA	NA	2.6 J	2.6 J	1/13	central western
		Carbazole	NA	NA	11	11	1/13	central western
		di-n-Butylphthalate	NA	NA	1 J	1 J	1/13	western
		Fluoranthene (PAH)	NA	NA	1.7 J	1.7 J	1/13	central western
		Pyrene (PAH)	NA	NA	1 J	1 J	1/13	central western
	Pesticides [2]	4,4'-DDE	NA	NA	0.06 J	6.6 J	5/13	western
		4,4'-DDD	NA	NA	0.06 J	9	6/13	western
		4,4'-DDT	NA	NA	0.05 J	0.37 J	2/13	western
		gamma-Chlordane	NCWQS - 0.027	NA	0.05 J	0.05 J	1/13	does not exceed ARAR, western
	PCBs	ND	NA	NA			0/13	
	Total Metals [3]	Iron	NCWQS - 300	882 - 55,300	147 J	40,600	11/12	7 exceed ARAR, none exceed BB
		Lead	NCWQS - 15	3.0 - 78.8	8.2	126	2/12	1 exceeds ARAR and BB
		Manganese	NCWQS - 50	10 - 290	16.9	1,450	11/12	7 exceed ARAR, 1 exceeds BB

TABLE 2 (Continued)

SUMMARY OF RI RESULTS
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Orde Pond Surface Water	Volatiles	ND	NOAA/NCWQS	NA			0/2	
	Semivolatiles	ND	NOAA/NCWQS	NA			0/2	
	Pesticides	ND	NOAA/NCWQS	NA			0/2	
	PCBs	ND	NOAA	NA			0/2	
	Metals [3]	Thallium	NOAA - 4.0	ND	4.7	4.7	1/2	1 exceeds ARAR and BB
Cogdels Creek Surface Water	Volatiles	ND	NOAA/NCWQS	NA			0/7	
	Semivolatiles	ND	NOAA/NCWQS	NA			0/7	
	Pesticides	ND	NOAA/NCWQS	NA			0/7	
	PCBs	ND	NOAA	NA			0/7	
	Metals [3]	Lead	NOAA - 1.32	1.2 - 10.4	1.9	4.2	7/7	7 exceed ARAR, none exceed BB
New River Surface Water	Volatiles	ND	NOAA/NCWQS	NA			0/5	
	Semivolatiles	Phenanthrene (PAH)	NA	NA	1.4 J	1.4 J	1/5	adjacent to study area
	Pesticides	4,4'-DDE	NOAA - 10.5	NA	0.04 J	0.04 J	1/5	does not exceed ARAR
		4,4'-DDD	NOAA - 0.0064	NA	0.05 J	0.05 J	1/5	1 exceeds ARAR
	PCBs	ND	NOAA	NA			0/5	
	Metals [3]	Copper	NOAA - 6.5	4 - 129	6.6	18.1	3/5	3 exceed ARAR, none exceed BB
		Lead	NOAA - 1.32	1.2 - 10.4	1.7	23.4	3/5	3 exceed ARAR, 1 exceeds BB
		Thallium	NOAA - 4	ND	5.6 J	5.6 J	1/5	1 exceeds ARAR and BB
		Zinc	NOAA - 58.9	18 - 111	10.4	363	3/5	1 exceeds ARAR and BB
Orde Pond Sediment	Volatiles	ND	NA	NA			0/4	
	Semivolatiles	ND	NOAA	NA			0/3	
	Pesticides	4,4'-DDD	NOAA - 2	NA	8.3 J	8.3 J	1/3	1 exceeds ARAR
	PCBs	ND	NOAA	NA			0/3	
	Metals [3]	ND	NOAA	BB			0/3	

TABLE 2 (Continued)

SUMMARY OF RI RESULTS
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Cogdels Creek Sediment	Volatiles	Carbon disulfide	NA	NA	9 J	13 J	2/14	maximum upstream of site
	Semivolatiles	Phenanthrene (PAH)	NOAA - 225	NA	260 J	260 J	1/14	1 exceeds ARAR, adjacent site
		Anthracene (PAH)	NOAA - 85	NA	61 J	61 J	1/14	does not exceed ARAR, adjacent
		Fluoranthene (PAH)	NOAA - 600	NA	77 J	340 J	3/14	none exceed ARAR, adjacent
		Pyrene (PAH)	NOAA - 350	NA	63 J	250 J	5/14	none exceed ARAR, scattered
		Butyl benzyl phthalate	NA	NA	410 J	410 J	1/14	adjacent to site
		3,3'-Dichlorobenzidine	NA	NA	410 J	410 J	1/14	adjacent to site
		B(a)anthracene (PAH)	NOAA - 230	NA	56 J	140 J	2/14	neither exceed ARAR, adjacent
		Chrysene (PAH	NOAA - 400	NA	58 J	160 J	2/14	neither exceed ARAR, adjacent
		BEHP	NA	NA	100 J	1,700 J	12/14	scattered up and downstream
		B(b)fluoranthene (PAH)	NA	NA	63 J	63 J	1/14	adjacent to site
		B(k)fluoranthene (PAH)	NA	NA	42 J	42 J	1/14	adjacent to site
		Benzo(a)pyrene (PAH)	NOAA - 400	NA	47 J	1,700 J	9/14	5 exceed ARAR, all upstream
	Pesticides	4,4'-DDE	NOAA - 2	NA	6.4 J	200 J	9/14	9 exceed ARAR, scattered
		4,4'-DDD	NOAA - 2	NA	4.3 J	450 J	7/14	7 exceed ARAR, scattered
		4,4'-DDT	NOAA - 1	NA	50 J	50 J	1/14	1 exceeds ARAR, upstream of site
		alpha-chlordane	NOAA - 0.5	NA	2.6 NJ	5.9 NJ	2/14	2 exceed ARAR, upstream of site
		gamma-Chlordane	NOAA - 0.5	NA	6.1 J	8.4 J	2/14	2 exceed ARAR, upstream of site
	PCBs	ND	NOAA	NA			0.14	
	Metals [3]	Lead	NOAA - 35	1 - 314	6.8	202	14/14	7 exceed ARAR, none exceed BB
		Mercury	NOAA - 0.15	ND	0.12	0.41	6/14	4 exceed ARAR, 6 exceed BB
		Silver	NOAA - 1	7.3	2 J	2 J	1/14	1 exceeds ARAR, downstream
		Zinc	NOAA - 120	12 - 926	9.3 J	303	14/14	2 exceed ARAR, none exceed BB

TABLE 2 (Continued)

SUMMARY OF RI RESULTS
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
New River	Volatiles	Carbon disulfide	NA	NA	2 J	2 J	1/10	adjacent to site
Sediment	Semivolatiles	Acenaphthene	NOAA - 150	NA	150 J	150 J	1/10	does not exceed ARAR, upstream
		Dibenzofuran	NA	NA	60 J	60 J	1/10	upstream of site
		Fluorene (PAH)	NOAA - 35	NA	120 J	120 J	1/10	exceeds ARAR, upstream of site
		Phenanthrene (PAH)	NOAA - 225	NA	47 J	1,200	4/10	2 exceed ARAR, max. upstream
		Anthracene (PAH)	NOAA - 85	NA	97 J	320 J	4/10	2 exceed ARAR, max. upstream
		Carbazole	NA	NA	57 J	160 J	3/10	maximum upstream of site
		Fluoranthene (PAH)	NOAA - 600	NA	80 J	1,600	6/10	3 exceed ARAR, max. upstream
		Pyrene (PAH)	NOAA - 350	NA	75 J	1,700	6/10	5 exceed ARAR, max. upstream
		B(a)anthracene (PAH)	NOAA - 230	NA	150 J	1,500	5/10	4 exceed ARAR, max. downstream
		Chrysene (PAH)	NOAA - 400	NA	160 J	2,100	5/10	3 exceed ARAR, max, downstream
		BEHP	NA	NA	580	2,400	3/10	scattered up and downstream
		B(b)fluoranthene (PAH)	NA	NA	55 J	1,100	6/10	maximum upstream of site
		B(k)fluoranthene (PAH)	NA	NA	120 J	840	5/10	maximum downstream of site
		Benzo(a)pyrene (PAH)	NOAA - 400	NA	130 J	710	5/10	3 exceed ARAR, max. upstream
		I(1,2,3-cd)pyrene (PAH)	NA	NA	68 J	320 J	6/10	maximum downstream of site
		D(a,h)anthracene (PAH)	NOAA - 60	NA	47 J	47 J	1/10	does not exceed ARAR, adjacent
		B(g,h,i)perylene (PAH)	NA	NA	65 J	320 J	5/10	maximum upstream of site
	Pesticides	4,4'-DDE	NOAA - 2	NA	8.4	8.5	2/10	2 exceed ARAR, max. upstream
		4,4'-DDD	NOAA - 2	NA	8.6	15	3/10	3 exceed ARAR, max. upstream
		4,4'-DDT	NOAA - 1	NA	33	300	3/10	3 exceed ARAR, max. adjacent
		alpha-Chlordane	NOAA - 0.5	NA	4.8	6.6 J	2/10	2 exceed ARAR, max. at Cogdels
		gamma-Chlordane	NOAA - 0.5	NA	3.1 J	4.6 J	2/10	2 exceed ARAR, max. at Cogdels

TABLE 2 (Continued)

SUMMARY OF RI RESULTS
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
New River Sediment (Continued)	PCBs	ND	NOAA	NA			0/10	
	Metals [3]	Antimony	NOAA - 2	ND	8.7 J	263	2/10	2 exceed ARAR, max. upstream
		Copper	NOAA - 70	0.43 - 53,200	1.5	1,340	10/10	2 exceed ARAR, both upstream
		Lead	NOAA - 35	1 - 314	3.5 J	38,800	10/10	2 exceed ARAR, both upstream
		Silver	NOAA - 1	7.3	3.1 J	3.4 J	2/10	2 exceed ARAR, max. adjacent

Notes: - Concentrations are presented in µg/L for liquid and µg/Kg for solids (ppb), metal concentrations for solids and sediments are presented in mg/Kg (ppm).
[1] Metals in both surface and subsurface soils were compared to the range of Base background positive detections for priority pollutant metals only (i.e., antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc).
[2] Additional groundwater samples were collected from wells which exhibited concentrations of volatile and semivolatile compounds during the initial round.
[3] Total metals in groundwater samples were compared to the range of positive detections in upgradient wells throughout MCB, Camp Lejeune.

ARAR - Applicable or Relevant and Appropriate Requirements
BB - Base Background (Refer to Appendix M)
BEHP - Bis(2-ethylhexyl)phthalate
NA - Not Applicable
NCWQS - North Carolina Water Quality Standard
ND - Not Detected
MCL - Federal Maximum Contaminant Level
PAH - Polynuclear Aromatic Hydrocarbon
TCA - Tetrachloroethane
J - Estimated Quantity

TABLE 3

SUMMARY OF RI RESULTS
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	Fraction	Detected Constituents	Comparison Criteria		Min. Concentration Detected	Max. Concentration Detected	Detection Frequency	Distribution
			ARAR	Base Background				
Surface Soil	Volatiles	1,1,1-Trichloroethane	NA	NA	2 J	3 J	2/11	both detections north of tank trail
	Semivolatiles	ND	NA	NA			0/11	
	Metals[1]	ND	NA	BB			0/14	
Subsurface Soil	Volatiles	1,1,1-Trichloroethane	NA	NA	2 J	2 J	1/11	center of suspected disposal area
	Semivolatiles	ND	NA	NA			0/11	
	Metals[1]	Chromium	NA	0.7 - 10.5	1.5	13.2	12/14	4 exceed BB, scattered
Groundwater	Volatiles[2]	Chloroform	NCWQS - 1.9	NA	3 J	9	1/3	1 exceeds ARAR, both rounds
	Semivolatiles	ND	MCL/NCWQS	NA			0/3	
	Total Metals[3]	Iron	NCWQS - 300	BB	692	692	1/3	1 exceeds ARAR, upgradient
Surface Water	Volatiles	ND	NOAA/NCWQS	NA			0/3	
	Semivolatiles	ND	NOAA/NCWQS	NA			0/3	
	Metals[3]	Lead	NOAA - 1.32	1.2 - 10.4	2.3 J	2.3 J	1/3	1 exceeds ARAR, upgradient
		Mercury	NCWQS - 0.012	0.52	0.15	0.15	1/3	1 exceeds ARAR, upgradient
Sediment	Volatiles	ND	NA	NA			0/6	
	Semivolatiles	BEHP	NA	NA	74 J	3,900	6/6	2 exceed 10X lab/blank contaminant
	Metals[3]	ND	NOAA	BB			0/6	

Notes: - Concentrations are presented in µg/L for liquid and µg/Kg for solids (ppb), metal concentrations for solids and sediments are presented in mg/Kg (ppm).

(1) Metals in both surface and subsurface soils were compared to the range of Base background positive detections for priority pollutant metals only (i.e., antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc).

(2) Additional groundwater samples were collected from wells which exhibited concentrations of volatile and semivolatile compounds during the initial round.

(3) Total metals in groundwater samples were compared to the range of positive detections in upgradient wells throughout MCB, Camp Lejeune.

ARAR - Applicable or Relevant and Appropriate Requirements
BB - Base Background (Refer to Appendix M)
BEHP - Bis(2-ethylhexyl)phthalate
NA - Not Applicable
NCWQS - North Carolina Water Quality Standard
ND - Not Detected
MCL - Federal Maximum Contaminant Level
PAH - Polynuclear Aromatic Hydrocarbon
TCA - Tetrachloroethane
J - Estimated Quantity

TABLE 4

COPCs EVALUATED DURING THE HUMAN HEALTH RISK ASSESSMENT
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Surface Soil	Aluminum Antimony Arsenic Cadmium Chromium Manganese Vanadium Zinc 4,4-DDE 4,4'-DDT
Subsurface Soil	Aluminum Arsenic Barium Cadmium Chromium Cobalt Copper Lead Manganese Nickel Vanadium Zinc BEHP
Shallow and Deep Groundwater	Arsenic Barium Manganese Mercury 1,2-dichloroethene (total) (1,2-DCE) Trichloroethene (TCE)

Note:

COPC = Contaminant of Potential Concern

TABLE 5

SUMMARY OF POTENTIAL HUMAN HEALTH RISKS
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Exposure Pathway	Future Child		Future Adult		Current Military		Future Construction Worker	
	NC Risk	Carc Risk	NC Risk	Carc Risk	NC Risk	Carc Risk	NC Risk	Carc Risk
Soil Ingestion	1.0E-01	2.3E-06	1.1E-02	1.2E-06	3.3E-02	1.5E-07	1.3E-02	5.1E-08
Soil Dermal Contact	5.8E-03	1.4E-07	3.1E-03	3.7E-07	9.5E-03	4.4E-08	5.9E-04	2.3E-09
Soil Inhalation	9.1E-05	2.4E-10	3.9E-05	5.2E-10	4.7E-05	7.2E-11	NA	NA
total	1.1E-01	2.5E-06	1.4E-02	1.6E-06	4.3E-02	1.9E-07	1.4E-02	5.4E-08
Groundwater Ingestion	17	8.2E-05	7.5	1.7E-04	NA	NA	NA	NA
Groundwater Dermal Contact	2.2E-01	1.0E-06	1.1E-01	2.5E-06	NA	NA	NA	NA
Groundwater Inhalation	NA	1.8E-07	NA	9.9E-08	NA	NA	NA	NA
total	17.2	8.3E-05	7.6	1.7E-04	NA	NA	NA	NA
Total	**17.3**	**8.5E-05**	**7.6**	**1.7E-04**	**4.3E-02**	**1.9E-07**	**1.4E-02**	**5.4E-08**

Notes:

NC = Noncarcinogenic risk (Shaded Areas Indicate HI > 1.0)
Carc = Carcinogenic Risk (Shaded Areas Indicate ICR > 1E-04)
NA = Not Applicable

TABLE 6

COPCs EVALUATED DURING THE HUMAN HEALTH RISK ASSESSMENT
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Surface Soil	Aluminum Antimony Arsenic Barium Cadmium Chromium Cobalt Copper Lead Manganese Mercury Nickel Silver Thallium Vanadium Zinc Heptachlor epoxide 4,4-DDD 4,4-DDE 4,4'-DDT Alpha-chlordane Gamma-chlordane Phenanthrene Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Indeno(1,2,3-cd)pyrene Benzo(g,h,i)perylene Carbazole Chrysene Benzo(a)pyrene
Subsurface Soil	Aluminum Antimony Arsenic Barium Beryllium Cadmium Chromium Cobalt Copper Lead Manganese Mercury Nickel Silver Vanadium Zinc 4,4-DDD 4,4-DDE 4,4'-DDT

TABLE 6 (Continued)

COPCs EVALUATED DURING THE HUMAN HEALTH RISK ASSESSMENT
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Subsurface Soil (continued)	Alpha-chlordane Gamma-chlordane 2-methylnaphthalene Naphthalene Fluorene Phenanthrene Chrysene Bis(2-ethylhexyl)phthalate Benzo(a)pyrene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(k)fluoranthene Indeno(1,2,3-cd)pyrene Benzo(g,h,i)perylene Dibenz(a,h)anthracene
Shallow and Deep Groundwater	Arsenic Barium Lead Manganese Mercury 4,4-DDD 4,4-DDE 4,4'-DDT 2,4-dimethylphenol 4-methylphenol Acenaphthene Chloroform 2-methylnaphthalene Phenanthrene
Surface Water New River	Aluminum Arsenic Cadmium Copper Lead Manganese Vanadium Zinc 4,4'-DDD 4,4'-DDE
Surface Water Cogdels Creek	Aluminum Arsenic Lead Manganese Vanadium Zinc
Surface Water Orde Pond	Aluminum Nickel Thallium

TABLE 6 (Continued)

COPCs EVALUATED DURING THE HUMAN HEALTH RISK ASSESSMENT
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Sediment New River	Antimony Arsenic Barium Copper Lead Silver Zinc 4,4'-DDD 4,4'-DDE 4,4'-DDT Alpha-chlordane Gamma-chlordane Phenanthrene Anthracene Carbazole Dibenzofuran Fluoranthene Pyrene Benzo(a)anthracene Chrysene Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(a)pyrene Indeno(1,2,3-cd)pyrene Benzo(g,h,i)perylene Bis(2-ethylhexyl)phthalate
Sediment Cogdels Creek	Aluminum Arsenic Barium Chromium Copper Lead Manganese Mercury Thallium Vanadium Zinc Bis(2-ethylhexyl)phthalate Carbon disulfide 4,4'-DDD 4,4'-DDE Alpha-chlordane Gamma-chlordane 3,3'-dichlorobenzidine Benzo(b)fluoranthene Benzo(k)fluoranthene Fluoranthene Phenanthrene Pyrene Benzo(a)anthracene Chrysene Benzo(a)pyrene

TABLE 6 (Continued)

COPCs EVALUATED DURING THE HUMAN HEALTH RISK ASSESSMENT
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Sediment Orde Pond	Aluminum Arsenic Beryllium Chromium Cobalt Copper Lead Manganese Nickel Vanadium 4,4'-DDD
Fish Tissue New River	Antimony Barium Cobalt Copper Selenium 4,4'-DDD 4,4'-DDE Alpha-chlordane
Fish Tissue Orde Pond	Barium Manganese Selenium Zinc

Note:

COPC = Contaminant of Potential Concern

TABLE 7

SUMMARY OF EXPOSURE PATHWAYS
SITE 28, HADNOT POINT BURN DUMP AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Receptor	Exposure Pathway
Current Military Personnel	Surface soil ingestion, dermal contact and inhalation Surface water ingestion and dermal contact (Orde Pond) Sediment ingestion and dermal contact (Orde Pond)
Current Residential Adult and Child	Surface soil ingestion, dermal contact and inhalation Surface water ingestion and dermal contact (New River and Cogdels Creek) Sediment ingestion and dermal contact (New River and Cogdels Creek)
Fisherman	Surface water ingestion and dermal contact (New River and Orde Pond) Sediment ingestion and dermal contact (New River and Orde Pond) Fish ingestion (New River and Orde Pond)
Future Construction Worker	Subsurface soil ingestion and dermal contact
Future Residential Adult and Child	Subsurface soil ingestion, dermal contact and inhalation Groundwater ingestion, dermal contact and inhalation Surface water ingestion and dermal contact (New River and Cogdels Creek) Sediment ingestion and dermal contact (New River and Cogdels Creek)

TABLE 8

SUMMARY OF POTENTIAL HUMAN HEALTH RISKS FOR THE CHILD RECEPTOR
SITE 28, HADNOT POINT BURN DUMP AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Exposure Pathway	NC Risk (HI)	Carc Risk (ICR)
Surface Soil Ingestion	1.3	5.8E-06
Surface Soil Dermal Contact	8.5E-02	7.6E-07
Surface Soil Inhalation	3.2E-03	4.5E-10
total	1.4	6.6E-06
Subsurface Soil Ingestion	4.4	2.1E-05
Subsurface Soil Dermal Contact	2.6E-01	2.1E-06
Subsurface Soil Inhalation	1.2E-02	1.7E-09
total	4.7	2.3E-05
Groundwater Ingestion	20	4.1E-05
Groundwater Dermal Contact	0.3	2.1E-05
total	20.3	6.2E-05
NEW RIVER		
Surface Water Ingestion	3.8E-03	6.9E-08
Surface Water Dermal Contact	8.7E-03	2.1E-07
total	1.3E-02	2.8E-07
Sediment Ingestion	1.2	3.1E-06
Sediment Dermal Contact	6.9E-02	3.3E-07
total	1.2	3.4E-06
COGDELS CREEK		
Surface Water Ingestion	1.0E-03	NA
Surface Water Dermal Contact	2.4E-03	NA
total	3.4E-03	NA
Sediment Ingestion	1.3E-01	3.0E-06
Sediment Dermal Contact	7.5E-03	3.7E-07
total	1.4E-01	3.4E-06
Current Risk (New River)	1.6	1.0E-05
Current Risk (Cogdels Creek)	1.5	1.0E-05
Future Risk (New River)	25.2	8.8E-05
Future Risk (Cogdels Creek)	25.1	8.8E-05

Notes:

NC = Noncarcinogenic Risk (Shaded Areas Indicate HI >1.0)
Carc = Carcinogenic Risk (Shaded Areas Indicate ICR >1.0E-04)
NA = Not Applicable

TABLE 9

SUMMARY OF POTENTIAL HUMAN HEALTH RISKS FOR THE ADULT RECEPTOR
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Exposure Pathway	NC Risk (HI)	Carc Risk (ICR)
Surface Soil Ingestion	1.4E-01	3.1E-06
Surface Soil Dermal Contact	4.6E-02	2.1E-06
Surface Soil Inhalation	1.4E-03	9.6E-10
total	1.9E-01	5.2E-06
Subsurface Soil Ingestion	4.7E-01	1.1E-05
Subsurface Soil Dermal Contact	1.4E-01	5.7E-06
Subsurface Soil Inhalation	4.9E-03	3.6E-09
total	6.2E-01	1.7E-05
Groundwater Ingestion	8.6	8.8E-05
Groundwater Dermal Contact	1.5E-01	5.2E-05
total	8.8	1.4E-04
NEW RIVER		
Surface Water Ingestion	8.1E-04	7.4E-08
Surface Water Dermal Contact	4.7E-03	5.8E-07
total	5.5E-03	6.5E-07
Sediment Ingestion	1.3E-01	1.7E-06
Sediment Dermal Contact	3.7E-02	8.8E-07
total	1.7E-01	2.6E-06
COGDELS CREEK		
Surface Water Ingestion	2.2E-04	NA
Surface Water Dermal Contact	1.3E-03	NA
total	1.5E-03	NA
Sediment Ingestion	1.4E-02	1.6E-06
Sediment Dermal Contact	4.1E-03	9.9E-07
total	1.8E-02	2.6E-06
Current Risk (New River)	0.4	8.4E-06
Current Risk (Cogdels Creek)	0.2	7.8E-06
Future Risk (New River)	9.5	1.6E-04
Future Risk (Cogdels Creek)	9.4	1.6E-04

Notes:

NC = Noncarcinogenic Risk (Shaded Areas Indicate HI > 1.0)
Carc = Carcinogenic Risk (Shaded Areas Indicate ICR > 1.0E-04)
NA = Not Applicable

TABLE 10

SUMMARY OF POTENTIAL HUMAN HEALTH RISKS FOR THE MILITARY, FISHERMAN, AND CONSTRUCTION WORKER RECEPTORS SITE 28, HADNOT POINT BURN DUMP MCB, CAMP LEJEUNE, NORTH CAROLINA

Exposure Pathway	Military		Fisherman		Construction Worker	
	Nc Risk	CARC Risk	NC Risk	Carc Risk	NC Risk	Carc Risk
Surface Soil Ingestion	4.7E-01	1.5E-06	NA	NA	NA	NA
Surface Soil Dermal Contact	4.2E-02	2.8E-07	NA	NA	NA	NA
Surface Soil Inhalation	1.4E-03	1.3E-10	NA	NA	NA	NA
total	5.2E-01	1.8E-06	NA	NA	NA	NA
Subsurface Soil Ingestion	NA	NA	NA	NA	5.8E-01	4.5E-07
Subsurface Soil Dermal Contact	NA	NA	NA	NA	2.6E-02	3.6E-08
Subsurface Soil Inhalation	NA	NA	NA	NA	NA	NA
total	NA	NA	NA	NA	6.1E-01	4.9E-07
Groundwater Ingestion	NA	NA	NA	NA	NA	NA
Groundwater Dermal Contact	NA	NA	NA	NA	NA	NA
total	NA	NA	NA	NA	NA	NA
Orde Pond						
Surface Water Ingestion	1.5E-05	NA	1.6E-05	NA	NA	NA
Surface Water Dermal Contact	8.5E-05	NA	9.1E-05	NA	NA	NA
total	1.0E-04	NA	1.1E-04	NA	NA	NA
Sediment Ingestion	3.5E-02	9.8E-07	4.7E-03	1.0E-06	NA	NA
Sediment Dermal Contact	1.0E-02	2.9E-07	1.4E-03	2.9E-07	NA	NA
total	4.5E-02	1.3E-06	6.1E-03	1.3E-06	NA	NA
Fish Ingestion	NA	NA	3.1E-01	NA	NA	NA
New River						
Surface Water Ingestion	NA	NA	8.6E-04	7.9E-08	NA	NA
Surface Water Dermal Contact	NA	NA	5.0E-03	6.2E-07	NA	NA
total	NA	NA	5.9E-03	7.0E-07	NA	NA
Sediment Ingestion	NA	NA	1.4E-01	1.8E-06	NA	NA
Sediment Dermal Contact	NA	NA	4.0E-02	9.4E-07	NA	NA
total	NA	NA	1.8E-01	2.7E-06	NA	NA
Fish Ingestion	NA	NA	3.8E-01	4.5E-06	NA	NA
Current Risk (Orde Pond)	0.6	3.0E-06	0.3	1.3E-06	NA	NA
Current Risk (New River)	0.5	1.8E-06	0.6	7.9E-06	NA	NA
Future Risk (Orde Pond)	4.5E-02	1.3E-06	0.3	1.3E-06	0.6	4.9E-07
Future Risk (New River)	NA	NA	0.6	7.9E-06	0.6	4.9E-07

Notes:

NC = Noncarcinogenic Risk (Shaded Areas Indicate HI >1.0)
Carc = Carcinogenic Risk (Shaded Areas Indicate ICR > 1.0E-04)
NA = Not Applicable

TABLE 11

COPCs EVALUATED DURING THE ECOLOGICAL RISK ASSESSMENT
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Surface Soil	Aluminum Antimony Arsenic Barium Cadmium Chromium Cobalt Copper Iron Lead Manganese Mercury Nickel Silver Thallium Vanadium Zinc Heptachlor epoxide 4,4-DDD 4,4-DDE 4,4'-DDT Alpha-chlordane Gamma-chlordane Phenanthrene Anthracene Benzo(a)anthracene Benzo(b)fluoranthene Benzo(k)fluoranthene Indeno(1,2,3-cd)pyrene Benzo(g,h,i)perylene Carbazole Chrysene Benzo(a)pyrene Bis(2-ethylhexyl)phthalate Fluoranthene Pyrene
Surface Water New River	Aluminum Arsenic Cadmium Copper Iron Lead Manganese Vanadium Zinc 4,4'-DDD 4,4'-DDE

TABLE 11 (Continued)

COPCs EVALUATED DURING THE ECOLOGICAL RISK ASSESSMENT
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Surface Water Cogdels Creek	Aluminum Copper Iron Lead Manganese Vanadium Zinc
Surface Water Orde Pond	Aluminum Nickel Thallium
Sediment New River	Antimony Arsenic Barium Copper Lead Silver Zinc 4,4'-DDD 4,4'-DDE 4,4'-DDT Alpha-chlordane Gamma-chlordane Phenanthrene Anthracene Carbazole Dibenzofuran Fluorene Fluoranthene Pyrene Benzo(a)anthracene Chrysene Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(a)pyrene Indeno(1,2,3-cd)pyrene Benzo(g,h,i)perylene
Sediment Cogdels Creek	Aluminum Arsenic Barium Beryllium Cadmium Chromium Copper Iron

TABLE 11 (Continued)

COPCs EVALUATED DURING THE ECOLOGICAL RISK ASSESSMENT
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Sediment Cogdels Creek (continued)	Lead Manganese Mercury Silver Thallium Vanadium Zinc Bis(2-ethylhexyl)phthalate Carbon disulfide 4,4'-DDD 4,4'-DDE Alpha-chlordane Gamma-chlordane Fluoranthene Pyrene Benzo(a)anthracene Chrysene Benzo(a)pyrene
Sediment Orde Pond	Aluminum Arsenic Beryllium Chromium Cobalt Copper Iron Lead Manganese Nickel Vanadium 4,4'-DDD
Fish Fillet Tissue New River	Antimony Barium Cobalt Copper Selenium 4,4'-DDD 4,4'-DDE Alpha-chlordane
Fish Whole Body Tissue New River	Aluminum Antimony Arsenic Barium Cadmium Chromium Cobalt Copper Iron Manganese Mercury

TABLE 11 (Continued)

COPCs EVALUATED DURING THE ECOLOGICAL RISK ASSESSMENT
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Fish Whole Body Tissue New River (continued)	Selenium Silver Vanadium Zinc 4,4'-DDD 4,4'-DDE Alpha-Chlordane
Fish Fillet Tissue Orde Pond	Barium Manganese Selenium Zinc
Fish Whole Body Tissue Orde Pone	Arsenic Barium Chromium Cobalt Copper Iron Manganese Mercury Selenium Zinc 4,4'-DDE Alpha-Chlordane

Note:

COPC = Contaminant of Potential Concern

TABLE 12

COPCs EVALUATED DURING THE HUMAN HEALTH RISK ASSESSMENT
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Medium	COPC
Surface Soil	No COPCS were identified for Site 30 surface soil.
Subsurface Soil	Aluminum Arsenic Chromium Cobalt Copper Manganese Mercury Nickel Vanadium
Groundwater	No COPCS were identified for Site 30 groundwater.
Surface Water	Aluminum Lead Manganese Mercury
Sediment	Aluminum Chromium Lead Manganese Nickel Vanadium Zinc

Note:

COPC = Contaminant of Potential Concern

TABLE 13

SUMMARY OF EXPOSURE DOSE INPUT PARAMETERS
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Input Parameter	Units	Receptor			
		Child	Adult	Military Personnel	Construction Worker
Soil (mg/kg)					
Ingestion Rate, IR	mg/d	200	100	100	480
Fraction Ingested, FI	unitless	1	1	1	1
Exposure Frequency, EF	d/y	350	350	250	90
Exposure Duration, ED	y	6	30	4	1
Surface Area, SA	cm^2	2300	5800	4,300	4300
Absorption Factor, AF	mg/cm^3	1	1	1	1
Averaging Time, Noncarc., ATnc	d	2190	10,950	1,460	365
Averaging Time, Carc., ATcarc	d	25550	25,550	25,550	25,550
Body Weight, BW	kg	15	70	70	70
Conversion Factor, CF	kg/mg	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-6}$
Absorbance Factor, ABS	unitless	Organics = 0.01; Inorganics = 0.001			
Sediment (mg/kg)					
Ingestion Rate, IR	mg/d	200	100	100	NA
Fraction Ingested, FI	unitless	1	1	1	NA
Exposure Frequency, EF	d/y	45	45	45	NA
Exposure Duration, ED	y	6	30	4	NA
Surface Area, SA	cm^2	2300	5800	5800	NA
Absorption Factor, AF	mg/cm^3	1	1	1	NA
Averaging Time, Noncarc., ATnc	d	2,190	10,950	1,460	NA
Averaging Time, Carc., ATcarc	d	25,550	25,550	25,550	NA
Body Weight, BW	kg	15	70	70	NA
Conversion Factor, CF	kg/mg	$1x10^{-6}$	$1x10^{-6}$	$1x10^{-6}$	NA
Absorbance Factor, ABS	unitless	Organics = 0.01; Inorganics = 0.001			
Surface Water (mg/L)					
Ingestion Rate, IR	L/h	0.005	0.005	0.005	NA
Exposure Time, ET	h/d	2.6	2.6	2.6	NA
Exposure Frequency, EF	d/y	45	45	45	NA
Exposure Duration, ED	y	6	30	4	NA
Surface Area, SA	cm^2	2300	5800	5800	NA
Averaging Time, Noncarc., ATnc	d	2,190	10,950	1,460	NA
Averaging Time, Carc., ATcarc	d	25,550	25,550	25,550	NA
Conversion Factor, CF	L/cm^3	0.001	0.001	0.001	NA

TABLE 13 (Continued)

SUMMARY OF EXPOSURE DOSE INPUT PARAMETERS
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Input Parameter	Units	Receptor			
		Child	Adult	Military Personnel	Construction Worker
Air (mg/m^3)					
Outdoor Air					
Inhalation Rate, IR	m^3/d	10	20	30	20
Exposure Frequency, EF	d/y	350	350	250	90
Exposure Duration, ED	y	6	30	4	1
Averaging Time, Noncarc., ATnc	d	2,190	10,950	1,460	365
Averaging Time, Carc,. ATcarc	d	25,550	25,550	25,550	25,550
Body Weight, BW	kg	15	70	70	70

References:

USEPA Risk Assessment For Superfund Volume I. Human Health Manual (Part A) Interim Final, December, 1989.
USEPA Exposure Factors Handbook, July, 1989.
USEPA Risk Assessment For Superfund Volume I. Human Health Evaluation Manual Supplemental Guidance. "Standard Default Exposure Factors" Interim Final. March 25, 1991.
USEPA Dermal Exposure Assessment: Principles and Applications. Interim Report. January, 1992.
USEPA Region IV Guidance for Soil Absorbance. (USEPA, 1992d)

TABLE 14

SUMMARY OF POTENTIAL HUMAN HEALTH RISKS
SITE 30, SNEADS FERRY ROAD FUEL TANK SLUDGE AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Environmental Media	Exposure Pathway	Current Risk for the Military Receptor		Future Risk for the Child Receptor		Future Risk for the Adult Receptor		Future Risk for the Construction Worker	
		NC Risk	Carc Risk	NC Risk	Carc Risk	NC Risk	Carc Risk	NC Risk	Carc Risk
Subsurface Soil	Ingestion	NA	NA	7.8E-02	1.7E-06	8.4E-03	9.1E-07	1.0E-02	3.7E-08
	Dermal Contact	NA	NA	4.5E-03	9.8E-08	2.4E-03	2.6E-07	4.6E-04	1.7E-09
	Inhalation	NA	NA	6.6E-05	1.6E-10	2.8E-05	3.4E-10	NA	NA
	Total	NA	NA	8.3E-02	1.8E-06	1.1E-02	1.2E-06	1.1E-02	3.9E-08
Surface Water	Ingestion	6.2E-05	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	5.6E-04	NA	NA	NA	NA	NA	NA	NA
	Total	6.0E-04	NA	NA	NA	NA	NA	NA	NA
Sediment	Ingestion	7.2E-03	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	2.1E-03	NA	NA	NA	NA	NA	NA	NA
	Total	9.3E-03	NA	NA	NA	NA	NA	NA	NA
	Total	**9.9E-03**	**NA**	**8.3E-02**	**1.8E-06**	**1.1E-02**	**1.2E-06**	**1.1E-02**	**3.9E-08**

Notes:

NC = Noncarcinogenic Risk (Shaded Areas Indicate HI>1.0)
Carc = Carcinogenic Risk (Shaded Areas Indicate ICR>1.0E-04)
NA = Not Applicable

TABLE 15

GLOSSARY OF EVALUATION CRITERIA

•	**Overall Protection of Human Health and 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 all of the applicable or relevant and appropriate requirements (ARARs), other criteria to be considered (TBCs), or other federal and state environmental statues 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 in an alternative.
•	**Short-Term Effectiveness** - refers to the speed with which the alternative achieves protection, as well as the alternative'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 needed to implement the chosen solution.
•	**Cost** - includes capital and operation and maintenance (O&M) costs. For comparative purposes, presents net present worth (NPW) values.

TABLE 16

SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Institutional Controls	RAA No. 3 Extraction and On-Site Treatment	RAA No. 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA No. 5 Extraction and Off-Site Treatment
OVERALL PROTECTIVENESS • Human Health	No reduction in potential human health risks, except through natural attenuation of the contaminated groundwater.	Institutional controls and natural attenuation will reduce potential human health risks.	Institutional controls, natural attenuation, and the groundwater extraction/ treatment system will reduce potential human health risks.	Institutional controls, natural attenuation, and in-well aeration will reduce potential human health risks.	Institutional controls, natural attenuation, and the groundwater extraction/ treatment system will reduce potential human health risks.
• Environmental Protection	No reduction in potential risks to ecological receptors, except through natural attenuation of the contaminated groundwater.	Institutional controls and natural attenuation will reduce potential risks to ecological receptors.	Institutional controls, natural attenuation, and the groundwater extraction/ treatment system will reduce potential risks to ecological receptors.	Institutional controls, natural attenuation, and in-well aeration will reduce potential risks to ecological receptors.	Institutional controls, natural attenuation, and the groundwater extraction/ treatment system will reduce potential risks to ecological receptors.
COMPLIANCE WITH ARARS • Chemical-Specific ARARs	No active effort made to reduce COPC levels to below federal or state ARARs. However, COPCs are expected to meet ARARs via natural attenuation processes.	No active effort made to reduce COPC levels to below federal or state ARARs. However, COPCs are expected to meet ARARs via natural attenuation processes.	COPCs within the wells' radii of influence are expected to meet chemical-specific ARARs.	COPCs within the wells' radii of influence are expected to meet chemical-specific ARARs.	COPCs within the wells' radii of influence are expected to meet chemical-specific ARARs.
• Location-Specific ARARs	Not applicable.	Not applicable.	Can be designed to meet location-specific ARARs.	Can be designed to meet location-specific ARARs.	Can be designed to meet location-specific ARARs.
• Action-Specific ARARs	Not applicable.	Not applicable.	Can be designed to meet action-specific ARARs.	Can be designed to meet action-specific ARARs.	Can be designed to meet action-specific ARARs.

TABLE 16

SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Institutional Controls	RAA No. 3 Extraction and On-Site Treatment	RAA No. 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA No. 5 Extraction and Off-Site Treatment
OVERALL PROTECTIVENESS • Human Health	No reduction in potential human health risks, except through natural attenuation of the contaminated groundwater.	Institutional controls and natural attenuation will reduce potential human health risks.	Institutional controls, natural attenuation, and the groundwater extraction/ treatment system will reduce potential human health risks.	Institutional controls, natural attenuation, and in-well aeration will reduce potential human health risks.	Institutional controls, natural attenuation, and the groundwater extraction/ treatment system will reduce potential human health risks.
• Environmental Protection	No reduction in potential risks to ecological receptors, except through natural attenuation of the contaminated groundwater.	Institutional controls and natural attenuation will reduce potential risks to ecological receptors.	Institutional controls, natural attenuation, and the groundwater extraction/ treatment system will reduce potential risks to ecological receptors.	Institutional controls, natural attenuation, and in-well aeration will reduce potential risks to ecological receptors.	Institutional controls, natural attenuation, and the groundwater extraction/ treatment system will reduce potential risks to ecological receptors.
COMPLIANCE WITH ARARS • Chemical-Specific ARARs	No active effort made to reduce COPC levels to below federal or state ARARs. However, COPCs are expected to meet ARARs via natural attenuation processes.	No active effort made to reduce COPC levels to below federal or state ARARs. However, COPCs are expected to meet ARARs via natural attenuation processes.	COPCs within the wells' radii of influence are expected to meet chemical-specific ARARs.	COPCs within the wells' radii of influence are expected to meet chemical-specific ARARs.	COPCs within the wells' radii of influence are expected to meet chemical-specific ARARs.
• Location-Specific ARARs	Not applicable.	Not applicable.	Can be designed to meet location-specific ARARs.	Can be designed to meet location-specific ARARs.	Can be designed to meet location-specific ARARs.
• Action-Specific ARARs	Not applicable.	Not applicable.	Can be designed to meet action-specific ARARs.	Can be designed to meet action-specific ARARs.	Can be designed to meet action-specific ARARs.

TABLE 16 (Continued)

SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Institutional Controls	RAA No. 3 Extraction and On-Site Treatment	RAA No. 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA No. 5 Extraction and Off-Site Treatment
LONG-TERM EFFECTIVENESS AND PERMANENCE • Magnitude of Residual Risk	The residual risk from untreated COPCs will be minimal; natural attenuation will mitigate any residual risk that may exist.	The residual risk from untreated COPCs will be minimal; institutional controls and natural attenuation will mitigate any residual risk that may exist.	The residual risk from untreated COPCs will be minimal; institutional controls and the extraction/ treatment system will mitigate any residual risk that may exist.	The residual risk from untreated COPCs will be minimal; institutional controls and in-well aeration will mitigate any residual risk that may exist.	The residual risk from untreated COPCs will be minimal; institutional controls and the extraction/ treatment system will mitigate any residual risk that may exist.
• Adequacy and Reliability of Controls	No controls	The proposed monitoring plan is adequate and reliable for determining the alternative's effectiveness; aquifer-use and deed restrictions are adequate and reliable for preventing human health exposure.	The proposed monitoring plan is adequate and reliable for determining the alternative's effectiveness; aquifer-use and deed restrictions are adequate and reliable for preventing human health exposure until remediation levels are met.	The proposed monitoring plan is adequate and reliable for determining the alternative's effectiveness; aquifer-use and deed restrictions are adequate and reliable for preventing human health exposure until remediation levels are met.	The proposed monitoring plan is adequate and reliable for determining the alternative's effectiveness; aquifer-use and deed restrictions are adequate and reliable for preventing human health exposure until remediation levels are met.
• Need for 5-year Review	Review will be required to ensure adequate protection of human health and the environment.	Review will be required to ensure adequate protection of human health and the environment.	Until remediation levels are met, review will be required to ensure adequate protection of human health and the environment.	Until remediation levels are met, review will be required to ensure adequate protection of human health and the environment.	Until remediation levels are met, review will be required to ensure adequate protection of human health and the environment.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT • Treatment Process Used	No active treatment process applied.	No active treatment process applied.	The treatment process includes air stripping for VOC removal and neutralization, precipitation, flocculation, sedimentation, and filtration as pretreatment for the air stripper.	The treatment process includes in-well air stripping and off-gas carbon adsorption for VOC removal.	The treatment processes include air stripping and carbon adsorption for VOC removal; also, flocculation and sedimentation for metals removal.

TABLE 16 (Continued)

SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Institutional Controls	RAA No. 3 Extraction and On-Site Treatment	RAA No. 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA No. 5 Extraction and Off-Site Treatment
• Amount Destroyed or Treated	Eventually, the majority of the COPCs are expected to be treated by natural attenuation.	Eventually, the majority of the COPCs are expected to be treated by natural attenuation.	Eventually, the majority of the COPCs are expected to be treated by the extraction/treatment system.	The majority of the COPCs are expected to be treated by the in-well aeration system.	Eventually, the majority of the COPCs are expected to be treated by the extraction/ treatment system.
• Reduction of Toxicity, Mobility, or Volume Through Treatment	No COC reduction except by natural attenuation.	No COC reduction except by natural attenuation.	Nearly 100% reduction in toxicity, mobility, and volume is expected.	Nearly 100% reduction in contaminant toxicity, mobility, and volume is expected.	Nearly 100% reduction in contaminant toxicity, mobility, and volume is expected.
• Residuals Remaining After Treatment	No active treatment process applied.	No active treatment process applied.	Treatment residuals will include sludge, off-gases from the air stripper, and treated groundwater. The sludge should be non-hazardous, the off-gases will be within acceptable air discharge limits, and the treated groundwater will be within acceptable groundwater discharge limits.	Treatment residuals will include the small amount of liquid left in the knockout tank (most likely less than 5 gallons) and spent carbon. The liquid should be non-hazardous, but the spent carbon will contain adsorbed contaminants.	Treatment residuals will include spent carbon, sludge, off-gases from the air stripper, and treated groundwater. The sludge should be non-hazardous, the off-gases will be within acceptable air discharge limits, and the treated groundwater will be within acceptable groundwater discharge limits.
• Statutory Preference for Treatment	Not satisfied.	Not satisfied.	Satisfied.	Satisfied.	Satisfied.
SHORT-TERM EFFECTIVENESS • Community Protection	Potential risks to the community will not be increased.	Potential risks to the community will not be increased.	Potential risks to the community will be increased during system installation and operation.	Potential risks to the community will be increased during system installation and operation.	Potential risks to the community will be increased during system installation and operation.
• Worker Protection	No risks to workers.	No significant risks to workers.	Potential risks to workers will be increased; worker protection is required.	Potential risks to workers will be increased; worker protection is required.	Potential risks to workers will be increased; worker protection is required.

TABLE 16 (Continued)

SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Institutional Controls	RAA No. 3 Extraction and On-Site Treatment	RAA No. 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA No. 5 Extraction and Off-Site Treatment
• Environmental Impact	No additional environmental impacts.	No additional environmental impacts.	No additional environmental impacts if aquifer drawdown does not affect surrounding water bodies.	No additional environmental impacts.	No additional environmental impacts if aquifer drawdown does not affect surrounding water bodies.
• Time Until Action is Complete	Unknown.	Thirty years was used to estimate NPW costs. The exact time for completion of remediation is unknown.	Thirty years was used to estimate NPW costs. The exact time for completion of remediation is unknown.	Three years was used to estimate in-well aeration costs; 30 years was used to estimate monitoring costs. The exact time for completion of remediation is unknown.	Three years was used to estimate trucking costs; 30 years was used to estimate monitoring costs. The exact time for completion of remediation is unknown.
IMPLEMENTABILITY • Ability to Construct and Operate	No construction or operation activities.	No construction or operation activities; institutional controls have been easily implemented in the past.	The infrastructure within a developed area like Site 1 poses some minor construction problems. O&M may be difficult because groundwater must be lifted above ground surface for treatment, and metals precipitation could clog well screens.	The technology has been commercially applied, but it is still relatively new. The infrastructure within a developed area like Site 1 poses some minor construction problems. also, metals precipitation could clog well screens.	The infrastructure within a developed area like Site 1 poses some minor construction problems. Also, metals precipitation could clog well screens.
• Ability to Monitor Effectiveness	No proposed monitoring plan; failure to detect contamination could result in potential ingestion of groundwater.	Proposed monitoring plan will detect contaminants before significant exposure can occur.	Proposed monitoring plan will detect contaminants before significant exposure can occur; O&M checks will provide notice of a system failure.	Proposed monitoring plan will detect contaminants before significant exposure can occur; O&M checks will provide notice of a system failure.	Proposed monitoring plan will detect contaminants before significant exposure can occur; O&M checks will provide notice of a system failure.
• Availability of Services and Capacities; Equipment	No services or equipment required.	No special services or equipment required.	Services and equipment are readily available.	The patented technology is exclusively licensed to a single vendor.	Services and equipment are readily available.

TABLE 16 (Continued)

SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1, FRENCH CREEK LIQUIDS DISPOSAL AREA
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Institutional Controls	RAA No. 3 Extraction and On-Site Treatment	RAA No. 4 In-Well Aeration and Off-Gas Carbon Adsorption	RAA No. 5 Extraction and Off-Site Treatment
• Requirements for Agency Coordination	None required.	Must submit semiannual reports to document sampling.	The substantive requirements of air and water discharge permits must be met.	The substantive requirements of air and water discharge permits must be met.	Air and water discharge permits may be required if existing permits are not adequate for the additional groundwater load.
COST (Net Present Worth)	$0	$600,000	$2,100,000	$1,300,000	$1,400,000

TABLE 17

SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Institutional Controls
OVERALL PROTECTIVENESS • Human Health	No reduction in potential human health risks.	Institutional controls reduce potential human health risks.
• Environmental Protection	No reduction in potential risks to ecological receptors.	Institutional controls reduce potential risks to ecological receptors.
COMPLIANCE WITH ARARS • Chemical-Specific ARARs	Manganese is expected to exceed chemical-specific ARARs, but it appears to naturally exceed ARARs in groundwater throughout MCB, Camp Lejeune. Lead is believed to be the result of suspended solids so it is not expected to exceed ARARs.	Manganese is expected to exceed chemical-specific ARARs, but it appears to naturally exceed ARARs in groundwater throughout MCB, Camp Lejeune. Lead is believed to be the result of suspended solids so it is not expected to exceed ARARs.
• Location-Specific ARARs	Not applicable.	Not applicable.
• Action-Specific ARARs	Not applicable.	Not applicable.
LONG-TERM EFFECTIVENESS AND PERMANENCE • Magnitude of Residual Risk	The residual risk from untreated lead and manganese will be minimal.	The residual risk from untreated lead and manganese will be minimal; institutional controls will mitigate any residual risk that may exist.
• Adequacy and Reliability of Controls	Not applicable-no controls.	The monitoring plan is adequate and reliable for determining effectiveness; aquifer-use and deed restrictions are adequate and reliable for preventing human health exposure.
• Need for 5-year Review	Review will be required to ensure adequate protection of human health and the environment.	Review will be required to ensure adequate protection of human health and the environment.
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT • Treatment Process Used	No treatment process.	No treatment process.
• Amount Destroyed or Treated	None.	None.
• Reduction of Toxicity, Mobility, or Volume	None.	None.
• Residuals Remaining After Treatment	Not applicable-no treatment.	Not applicable-no treatment.
• Statutory Preference for Treatment	Not satisfied.	Not satisfied.
SHORT-TERM EFFECTIVENESS • Community Protection	Potential risks to the community will not be increased.	Potential risks to the community will not be increased.
• Worker Protection	No risks to workers.	No significant risks to workers.

TABLE 17 (Continued)

SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 28, HADNOT POINT BURN DUMP
MCB, CAMP LEJEUNE, NORTH CAROLINA

Evaluation Criteria	RAA No. 1 No Action	RAA No. 2 Institutional Controls
• Environmental Impact	No additional environmental impacts; current impacts will continue.	No additional environmental impacts; current impacts will continue.
• Time Until Action is Complete	Not applicable.	Estimated 30 years.
IMPLEMENTABILITY • Ability to Construct and Operate	No construction or operation activities.	No construction or operation activities; institutional controls have been easily implemented in the past.
• Ability to Monitor Effectiveness	No monitoring plan; failure to detect increases in COPC levels could result in potential ingestion of groundwater.	Proposed monitoring plan will detect increases in COPC levels before significant exposure can occur.
• Availability of Services and Capacities; Equipment	No services or equipment required.	No special services or equipment required.
• Requirements for Agency Coordinations	None required.	Must submit semiannual reports to document sampling.
COST (Net Present Worth)	$0	$800,000

FIGURES

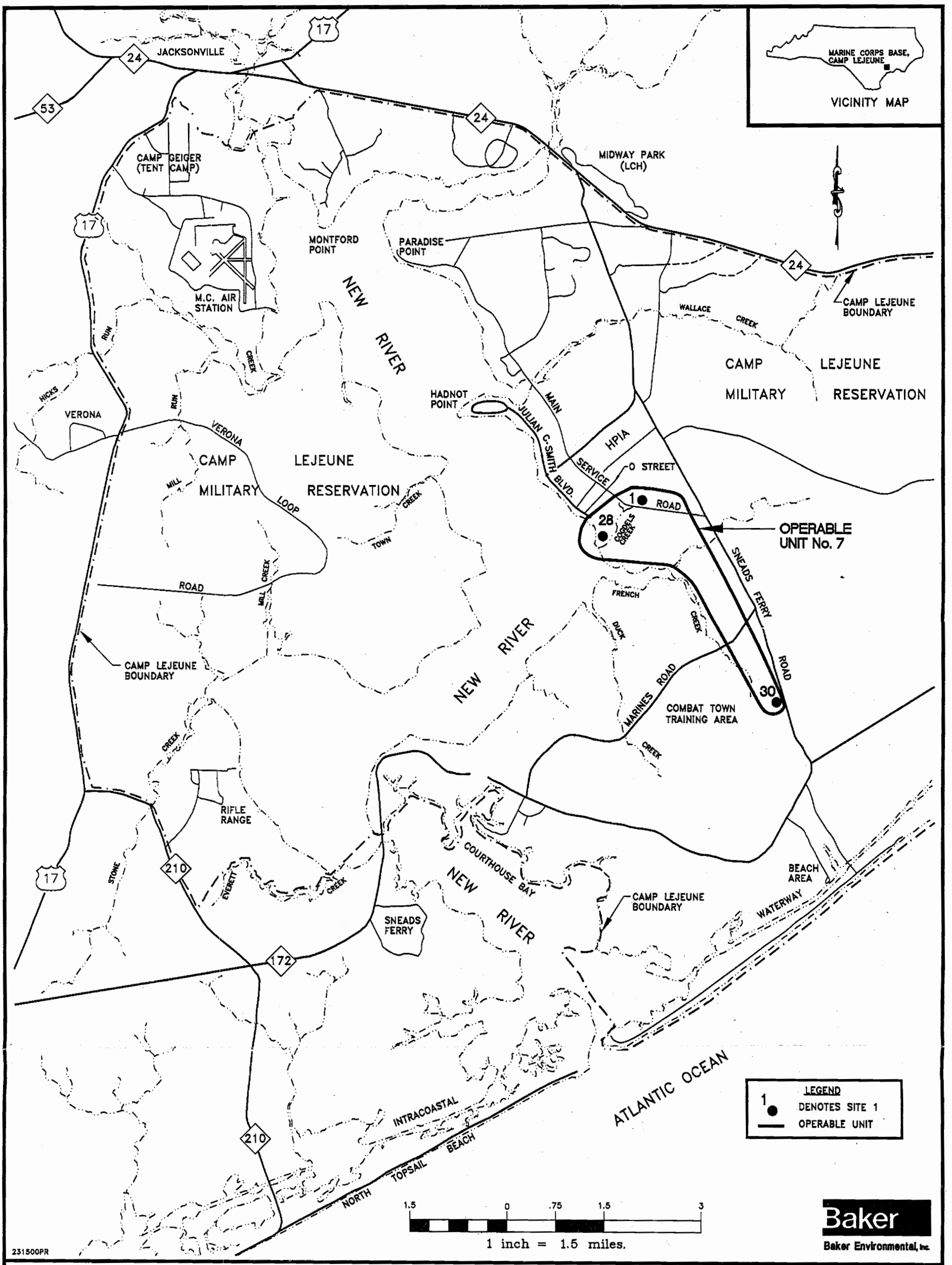
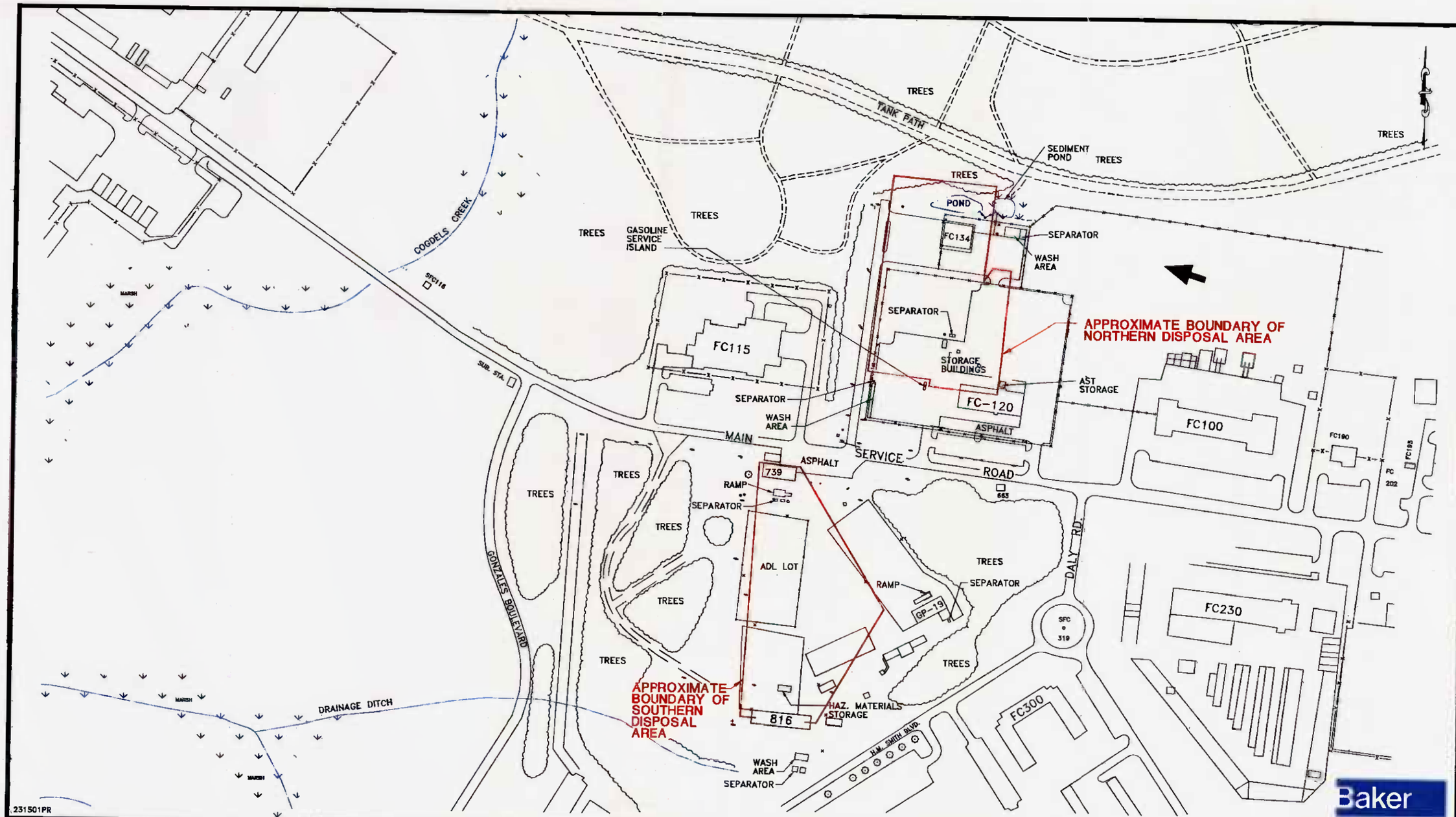


FIGURE 1
OPERABLE UNIT No. 7 – SITES 1, 28, AND 30
MARINE CORPS BASE, CAMP LEJEUNE

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01784JJ012



LEGEND

- VEGETATION
- FENCE
- CREEK/DRAINAGE
- MARSH
- UNIMPROVED ROAD
- APPROXIMATE DIRECTION OF SHALLOW GROUNDWATER FLOW

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON &-ASSOC., JUNE 1994

300 0 150 300 600

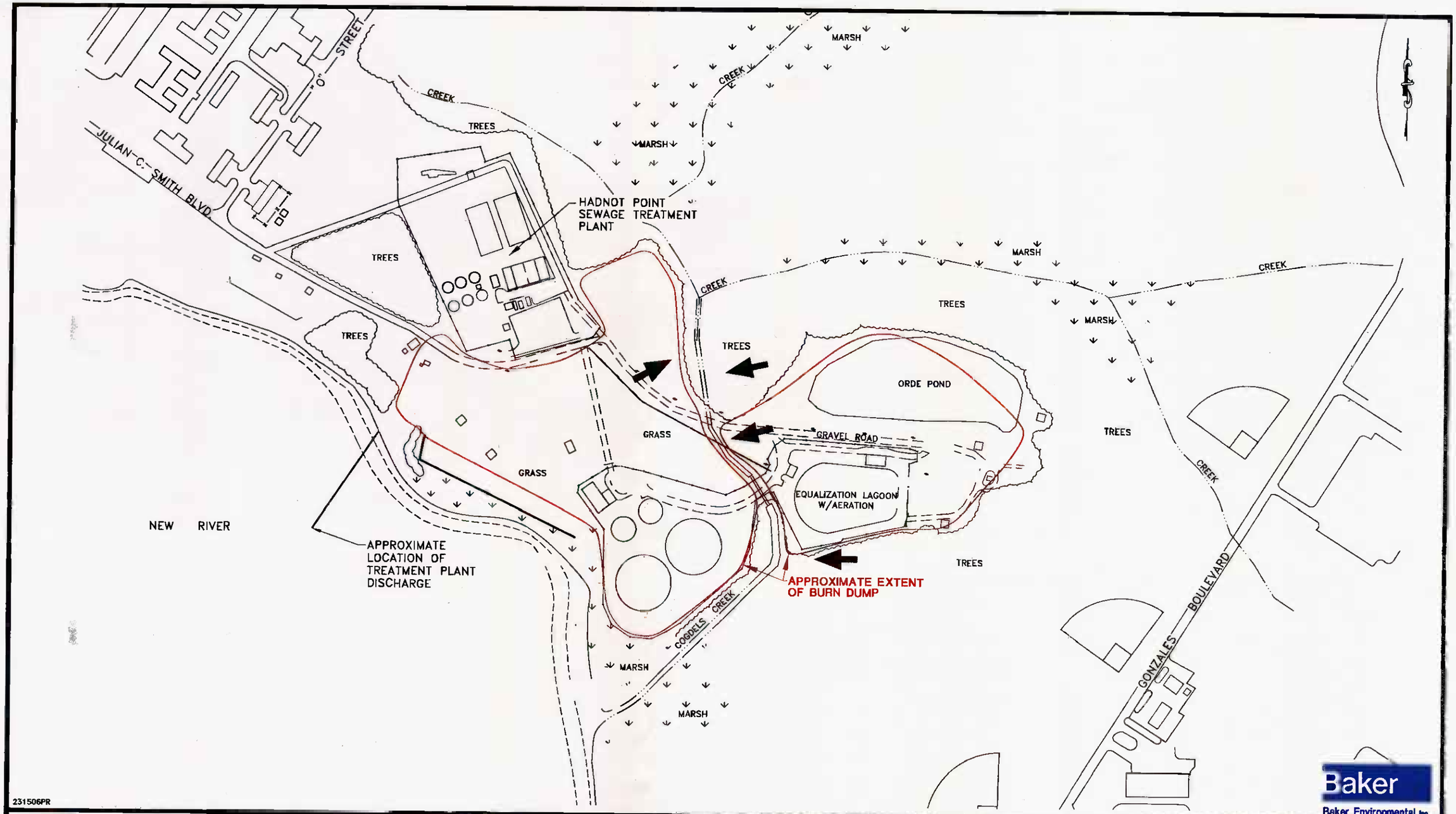
1 inch = 300 ft.

FIGURE 2
SITE 1 – FRENCH CREEK LIQUIDS DISPOSAL AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Baker
Baker Environmental, Inc.

01784 JJ B1Y



Baker
Baker Environmental, Inc.

LEGEND

- VEGETATION
- FENCE
- CREEK/DRAINAGE
- MARSH
- APPROXIMATE DIRECTION OF SHALLOW GROUNDWATER FLOW

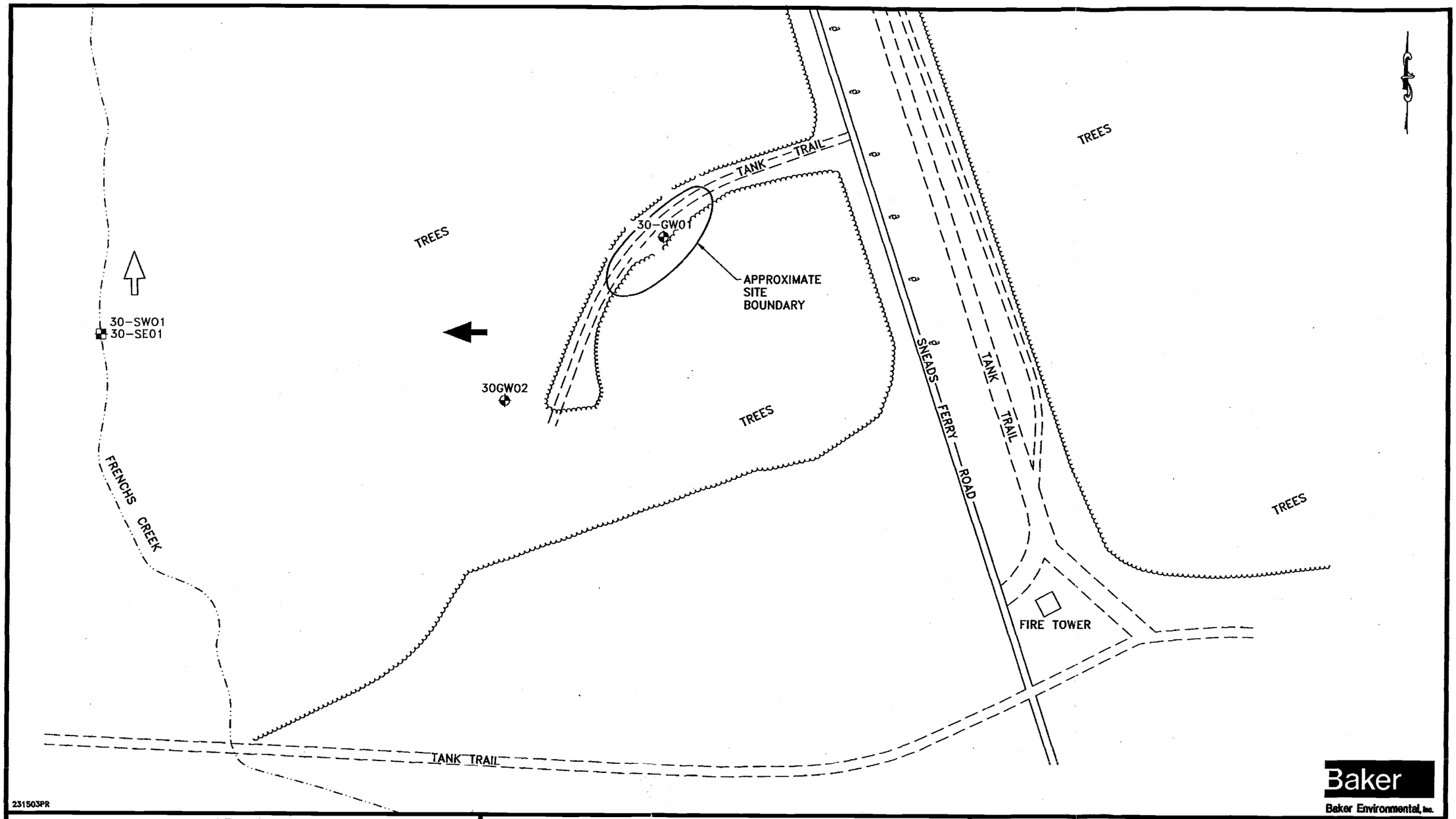
SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON, JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

FIGURE 3
SITE 28 – HADNOT POINT BURN DUMP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



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LEGEND

- 30-GW01 — SHALLOW MONITORING WELL
- 30-SW01 / 30-SE01 — SURFACE WATER AND SEDIMENT SAMPLING STATION
- ASPHALT ROAD
- UNIMPROVED ROAD (TANK TRAIL)
- CREEK
- UTILITY POLE
- VEGETATION
- APPROXIMATE DIRECTION OF SHALLOW GROUNDWATER FLOW
- APPROXIMATE DIRECTION OF SURFACE WATER FLOW

SOURCE: LANTDIV, FEB. 1992 AND W.K. DICKSON, JUNE 1994

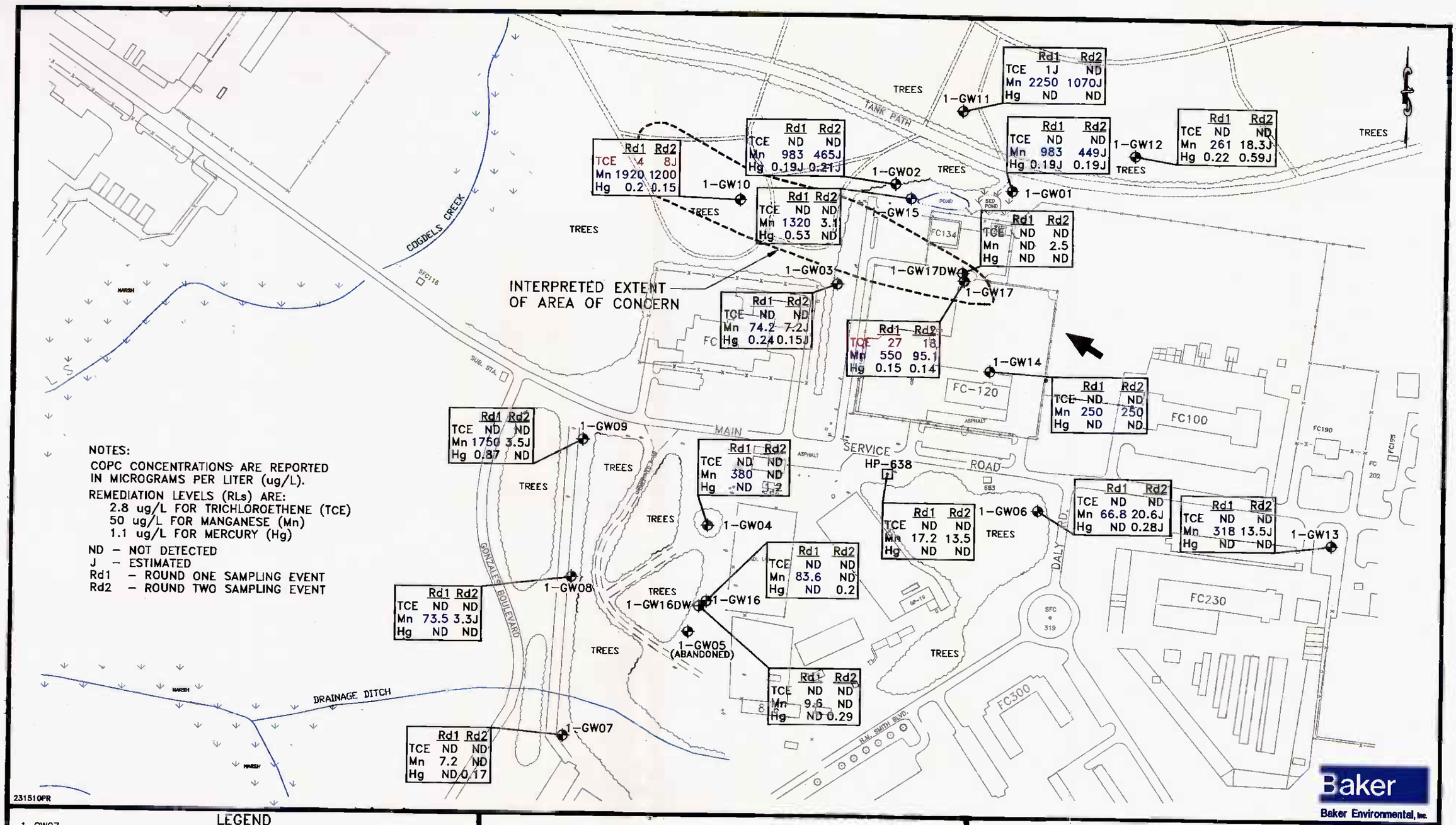
300 0 150 300 600

1 inch = 300 ft.

FIGURE 4
SITE 30 – SNEADS FERRY ROAD FUEL TANK SLUDGE AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01784JJ02Z



NOTES:

COPC CONCENTRATIONS ARE REPORTED IN MICROGRAMS PER LITER (ug/L).

REMEDIATION LEVELS (RLs) ARE:
- 2.8 ug/L FOR TRICHLOROETHENE (TCE)
- 50 ug/L FOR MANGANESE (Mn)
- 1.1 ug/L FOR MERCURY (Hg)

ND – NOT DETECTED
J – ESTIMATED
Rd1 – ROUND ONE SAMPLING EVENT
Rd2 – ROUND TWO SAMPLING EVENT

LEGEND

- 1-GW07 — SHALLOW MONITORING WELL
- 1-GW16DW — DEEP MONITORING WELL
- HP-638 — EXISTING WATER SUPPLY WELL
- TCE 8J — CONCENTRATION EXCEEDING THE TCE RL
- Mn 1200 — CONCENTRATION EXCEEDING THE MANGANESE RL
- Hg 1.2 — CONCENTRATION EXCEEDING THE MERCURY RL
- → APPROXIMATE DIECTION OF SHALLOW GROUNDWATER FLOW

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON & ASSOC., JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

FIGURE 5
GROUNDWATER AREA OF CONCERN
SITE 1 – FRENCH CREEK LIQUIDS DISPOSAL AREA

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Baker
Baker Environmental, Inc.

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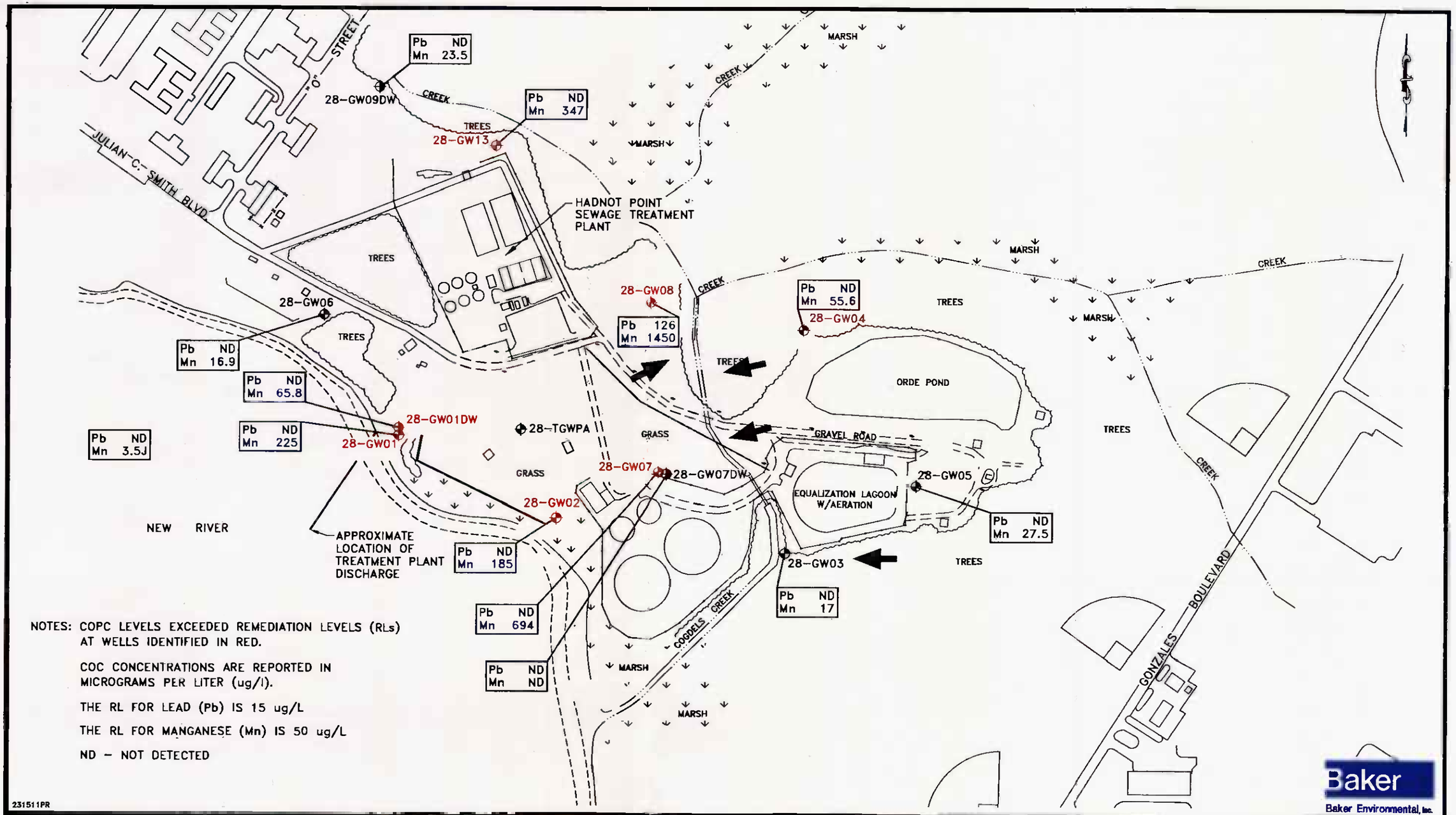


LEGEND

- 28-GW01 — SHALLOW MONITORING WELL
- 28-GW01DW — DEEP MONITORING WELL
- → APPROXIMATE DIRECTION OF SHALLOW GROUNDWATER FLOW
- Pb 126 — CONCENTRATION EXCEEDING THE LEAD RL
- Mn 1450 — CONCENTRATION EXCEEDING THE MANGANESE RL

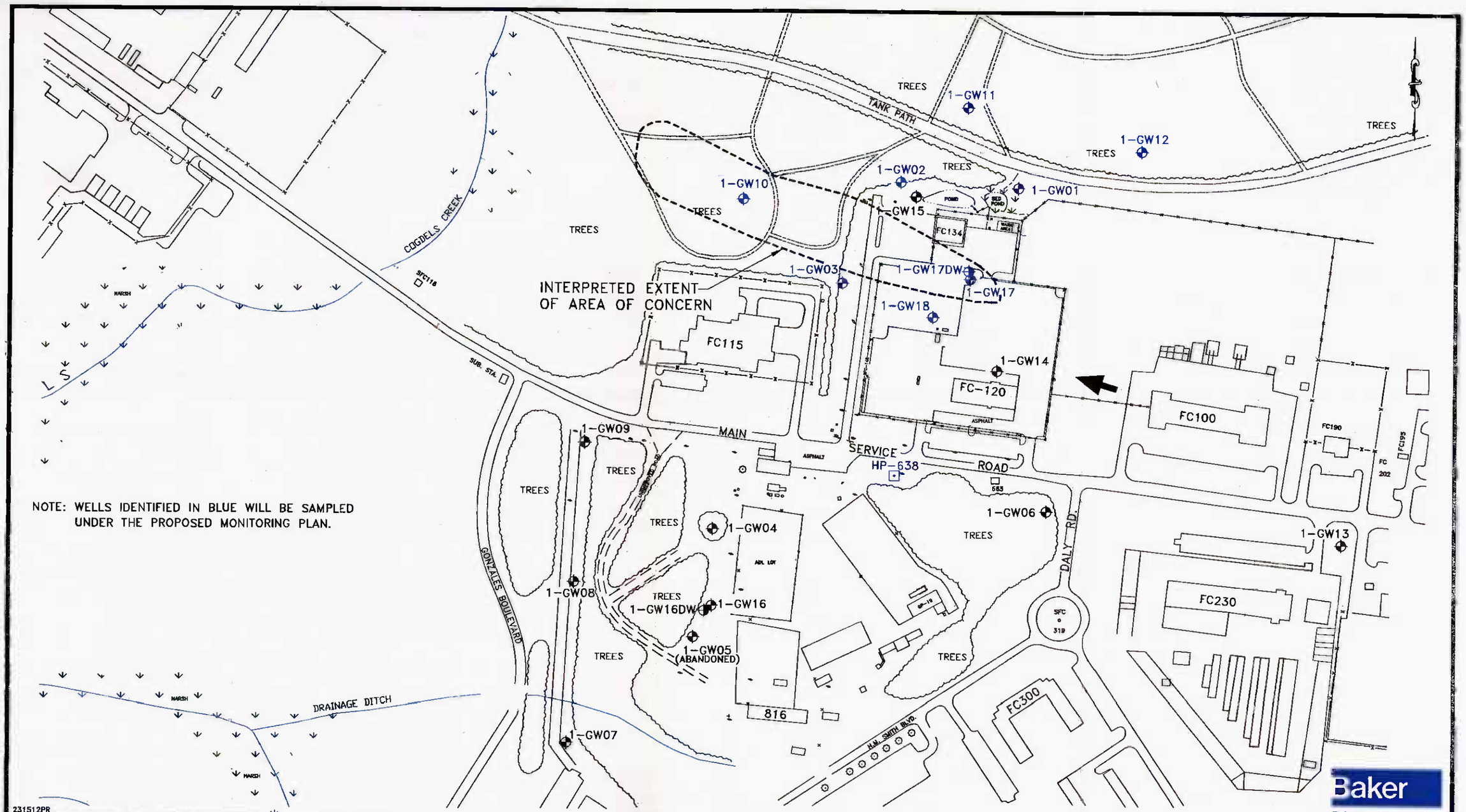
SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON, JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

FIGURE 6
GROUNDWATER AREAS OF CONCERN
SITE 28 - HADNOT POINT BURN DUMP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA



LEGEND

- 1-GW07 — SHALLOW MONITORING WELL
- 1-GW16DW — DEEP MONITORING WELL
- HP-638 — WATER SUPPLY WELL THAT IS NOT IN SERVICE
- APPROXIMATE DIRECTION OF SHALLOW GROUNDWATER FLOW

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON & ASSOC., JUNE 1994

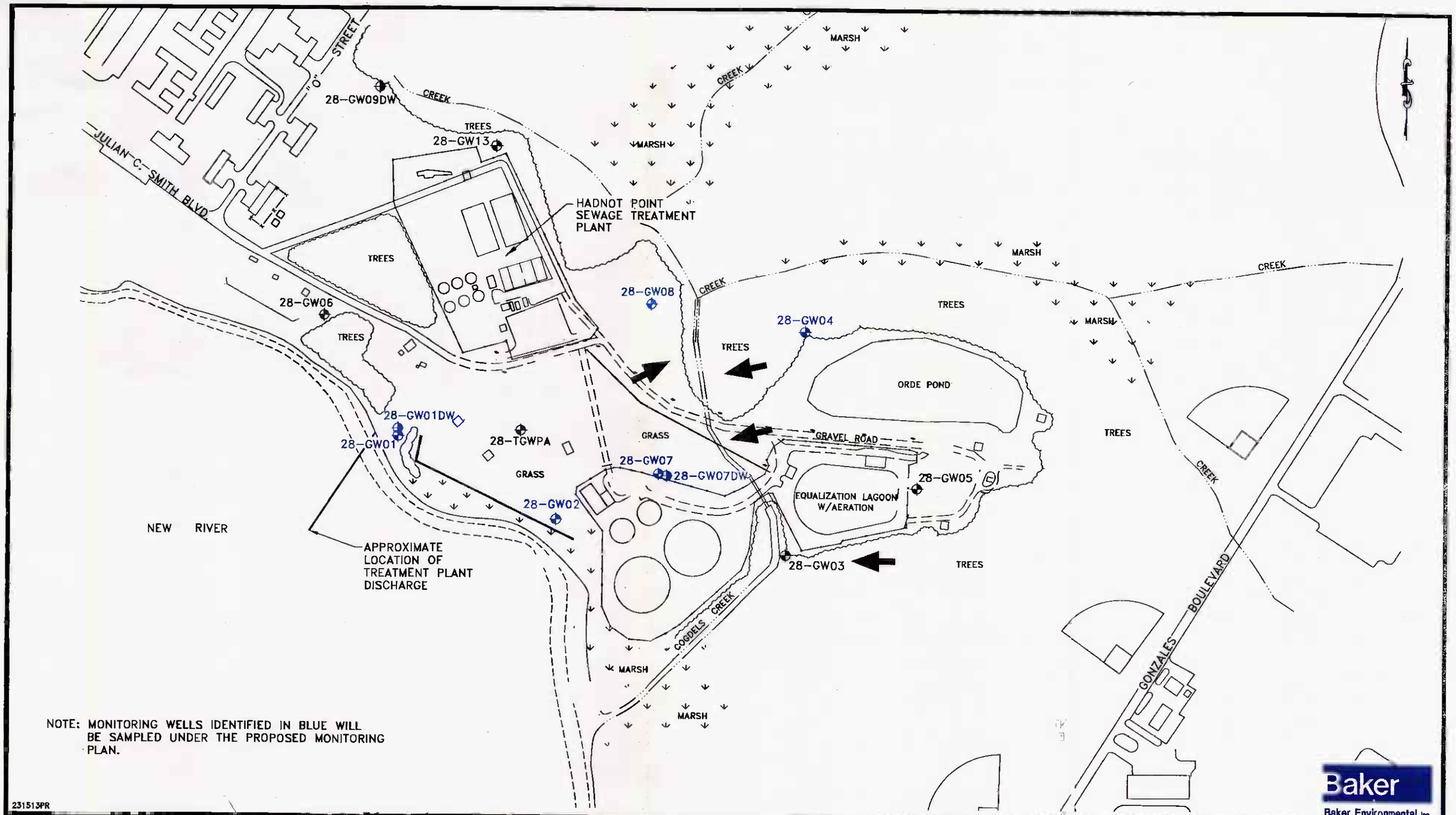
300 0 150 300 600

1 inch = 300 ft.

FIGURE 7
THE SELECTED REMEDY FOR SITE 1:
INSTITUTIONAL CONTROLS–MONITORING PLAN

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

Baker Environmental, Inc.



NOTE: MONITORING WELLS IDENTIFIED IN BLUE WILL BE SAMPLED UNDER THE PROPOSED MONITORING PLAN.

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LEGEND

28-GW01 SHALLOW MONITORING WELL

28-GW01DW DEEP MONITORING WELL

APPROXIMATE DIRECTION OF SHALLOW GROUNDWATER FLOW

SOURCE: LANTDIV, FEBRUARY 1992 AND W.K. DICKSON, JUNE 1994

300 0 150 300 600

1 inch = 300 ft.

FIGURE 8
THE SELECTED REMEDY FOR SITE 28:
INSTITUTIONAL CONTROLS – MONITORING PLAN

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA