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**FINAL**

# INTERIM RECORD OF DECISION FOR SURFICIAL GROUNDWATER FOR A PORTION OF OPERABLE UNIT NO. 10 SITE 35 - CAMP GEIGER AREA FUEL FARM

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

**CONTRACT TASK ORDER 0232**

**SEPTEMBER 5, 1995**

*Prepared For:*

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

*Under the:*

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

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| | |
|---|---|
| ARAR/TBC | applicable or relevant and appropriate requirements/to be considered (criteria) |
| AST | aboveground storage tank |
| Baker | Baker Environmental, Inc. |
| bgs | below ground surface |
| BRA | Baseline Human Health Risk Assessment |
| BTEX | benzene, toluene, ethylbenzene, and total xylenes |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| COPC | contaminant of potential concern |
| CS | Confirmation Study |
| CSA | Comprehensive Site Assessment |
| DON | Department of the Navy |
| ERA | Ecological Risk Assessment |
| ESE | Environmental Science and Engineering, Inc. |
| FFA | Federal Facilities Agreement |
| FFS | Focused Feasibility Study |
| FS | Feasibility Study |
| HI | Health Index |
| IAS | in situ air sparging |
| ICR | Incremental Cancer Risk |
| IRP | Installation Restoration Program |
| Law | Law Engineering, Inc. |
| MCB | Marine Corps Base |
| MTBE | methyl tertiary butyl ether |
| NC DEHNR | North Carolina Department of Environment, Health and Natural Resources |
| NCDOT | North Carolina Department of Transportation |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |

| | |
|---|---|
| NCWQS | North Carolina Water Quality Standards |
| NPL | National Priorities List |
| NUS | NUS Corporation |
| O&M | operation and maintenance |
| OU | Operable Unit |
| PCB | Polychlorinated Biphenyl |
| PRAP | Proposed Remedial Action Plan |
| RAA | remedial action alternative |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| SVE | Soil Vapor Extraction |
| T-1,2-DCE | trans-1,2-dichloroethene |
| TAL | Target Analyte List |
| TCE | trichloroethylene |
| TCL | Target Compound List |
| TPH | total petroleum hydrocarbons |
| USEPA | United States Environmental Protection Agency |
| UST | underground storage tank |
| VOC | Volatile Organic Compound |
| WAR | Water and Air Research, Inc. |

## DECLARATION

### Site Name and Location

Operable Unit No. 10 (Site 35)
Marine Corps Base
Camp Lejeune, North Carolina

### Statement of Basis and Purpose

This decision document presents the selected remedy for surficial groundwater for a portion of Operable Unit (OU) No. 10 (Site 35), Marine Corps Base (MCB), Camp Lejeune, North Carolina, which 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 particular interim action focuses on contaminated surficial groundwater in the vicinity of the former Camp Geiger Fuel Farm extending downslope to Brinson Creek. This decision is based on the Administrative Record for Operable Unit No. 10.

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 Interim Record of Decision (ROD), may present a potential threat to public health, welfare, or the environment.

### Description of Selected Remedy

Five Remedial Action Alternatives (RAAs) were evaluated as part of an interim remedial investigation/feasibility study for surficial groundwater at OU No. 10 (Site 35). These RAAs included RAA 1 (No Action), RAA 2 (No Action With Institutional Controls), RAA 3 (Groundwater Collection and On-site Treatment), RAA 4 (In Situ Air Sparging and Off-Gas Carbon Adsorption) and RAA 5 (In Well Aeration and Off-Gas Adsorption). After all five RAAs were compared to established criteria, RAA 5 was selected as the preferred alternative.

RAAs 1, 2, 3 and 4 were not selected as the preferred alternative. Neither RAA 1 nor RAA 2 were selected primarily because of the potential environmental impacts associated with a no action alternative. RAA 3 was not selected primarily because of its high cost and implementation difficulties. RAA 4 was not selected primarily because of potential difficulties controlling releases of toxic vapors associated with vapor extraction. Thus, RAA 5, which was determined to be the most cost effective alternative, was selected as the preferred alternative because it best met the various selection criteria.

The selected remedy focuses on positively impacting contaminated surficial groundwater in the vicinity of the Fuel Farm as it moves downgradient towards Brinson Creek. The physical location of this remedial action will be just beyond the northern right-of-way boundary of the proposed U.S. Route 17 bypass (i.e., six-lane divided highway) in the direction of Brinson Creek, and will extend the entire width of the contaminant plume. RAA 5 is an Interim Remedial Action representing only one phase of a comprehensive investigation and remediation program at Site 35.

The selected remedy addressed in this Interim ROD provides for reduction of organic contaminants in the surficial groundwater to levels below North Carolina Water Quality Standards (NCWQS) and mitigates potential risks to human health and the environment.

The major components of the selected remedy (RAA 5) include:

- Six aeration wells spaced at approximately 180 feet (center to center). These wells would be installed in a line between the proposed highway and Brinson Creek.

- A submersible pump incorporated into each well. These pumps are placed near the bottom of the wells. They draw in contaminated groundwater and pump it to the stripping zone of the aeration system.

- An aeration system in each well. As water is pumped in from the bottom of the wells; air is injected into the water allowing the VOCs to move from the dissolved phase to the vapor phase. As the water is aerated, it is forced back out into the formation.

- A header system that delivers pressurized air from the compressor/blowers at each well to the well heads.

- An air extraction header system that runs from the well heads to a carbon adsorption unit adjacent to the well. This system is equipped with vacuum pumps that draw VOC laden air from the wellheads to carbon adsorption units.

- Carbon adsorption units that adsorb vapor phase VOCs from the contaminated air prior to discharge to the atmosphere. These units, along with the blowers, vacuum pumps, and controls will be housed in individual treatment buildings, which will also house the in well aeration well heads.

- Each well head has an upper observation well (slightly above groundwater table) and a lower observation well below the groundwater table.

- Implementation of aquifer use restrictions.

- Long-term groundwater monitoring.

The viability of in well aeration technology at Camp Lejeune needs to be determined by means of a field pilot test. Such a test is scheduled to be initiated in October 1995 at Camp Lejeune. A Draft Report of results will be available in May 1996. Additionally, the field pilot test will provide important design support data. If it is determined, based on the results of the field pilot test, that in well aeration cannot perform as required, RAA 3 (Groundwater Collection and On-Site Treatment) will be selected as the Interim Preferred Remedial Action.

The major components of RAA 3 include:

- A verticle interceptor trench (specifically, a biopolymer slurry drainage trench) approximately two feet wide, by 30 feet deep, by 1,080 feet long. This trench will be constructed from the ground surface to the semiconfining layer.

- A groundwater collection system consisting of submersible pumps and above and below ground piping. Water that is intercepted by the trench is conveyed to an on-site groundwater treatment plant.

- A groundwater treatment plant located on-site. This plant will include a treatment building which will house the following major process units: a filtration system, a settling tank, a sludge holding tank, an air stripper, an off-gas carbon adsorption unit, and a liquid phase carbon adsorption unit.

- Implementation of aquifer use restrictions.

- Long-term groundwater monitoring.

**Declaration**

This interim action 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. This action utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable, given the limited scope of the action. Because this action does not constitute the final remedy for Site 35, the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element for other media, including groundwater south and southwest of the above ground storage tank (AST) area, surface water, and sediment will be addressed at the time of the final response action. Subsequent actions are planned to address fully the principal threats posed by this site.

T. L. Howard
Signature (Commanding General, MCB Camp Lejeune)

950922
Date

## 1.0 SITE LOCATION AND DESCRIPTION

Marine Corps Base (MCB), Camp Lejeune is a training base for the U.S. Marine Corps, located in Onslow County, North Carolina. The Activity, as the base is referred to, covers approximately 236 square miles and includes 14 miles of coastline. MCB, Camp Lejeune is bounded to the southeast by the Atlantic Ocean, to the northeast by State Route 24, and to the west by U.S. Route 17. The town of Jacksonville, North Carolina, is located north of the Activity (see Figure 1).

Camp Geiger is located at the extreme northwest corner of MCB, Camp Lejeune. The main entrance to Camp Geiger is off U.S. Route 17, approximately 3.5 miles southwest of the city of Jacksonville, North Carolina. Site 35, the decommissioned Camp Geiger Area Fuel Farm, refers primarily to five, 15,000-gallon aboveground storage tanks (ASTs), a pump house, and a fuel unloading pad formerly situated within Camp Geiger just north of the intersection of Fourth and G Streets (see Figure 2).

Site 35 is contained within Operable Unit (OU) No. 10, one of 14 operable units at MCB, Camp Lejeune. An "operable unit," as defined by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), is a discrete action that comprises an incremental step toward comprehensively addressing site problems.

The Interim Feasibility Study (FS) study area consists of a portion of OU No. 10 measuring approximately 18 acres. More specifically, the study area consists of contaminated groundwater in the portion of the surficial aquifer that is located roughly between the Fuel Farm and Brinson Creek (see Figure 2).

## 2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

Construction of Camp Geiger was completed in 1945, four years after construction of MCB, Camp Lejeune was initiated. Originally, the ASTs were used for the storage of No. 6 fuel oil, but were later converted for storage of other petroleum products including unleaded gasoline, diesel fuel, and kerosene. The date of their conversion is not known. The ASTs at the site are reported to be the original tanks. Demolition of the Fuel Farm ASTs is completed, having begun in the spring of 1995.

Product was dispensed from the ASTs via trucks and underground piping. Routinely, the ASTs at Site 35 supplied fuel to an adjacent dispensing pump. A leak in the underground line from the ASTs to the dispensing island was reportedly responsible for the loss of roughly 30 gallons per day of gasoline over an unspecified period (Law, 1992). The leaking line was subsequently sealed and replaced.

The ASTs at Site 35 were used to dispense gasoline, diesel, and kerosene to government vehicles and to supply underground storage tanks (USTs) in use at Camp Geiger and the nearby New River Marine Corps Air Station until the spring of 1995. The ASTs were supplied by commercial carrier trucks which delivered product to fill ports located on the fuel unloading pad at the southern end of the facility. Six short-run (120 feet maximum), underground fuel lines were utilized to distribute the product from the unloading pad to the ASTs.

Reports of a release from an underground distribution line near one of the ASTs date back to 1957-58 (ESE, 1990). Apparently, the leak occurred as the result of damage to a dispensing pump. At that time, the Camp Lejeune Fire Department estimated that thousands of gallons of fuel were released, although records of the incident cannot be located. The fuel reportedly migrated to the east and northeast toward Brinson Creek. Interceptor trenches were excavated and the captured fuel was ignited and burned.

Another abandoned underground distribution line extended from the ASTs to the former Mess Hall Heating Plant, located adjacent to D Street, between Third and Fourth Streets. The underground line dispensed No. 6 fuel oil to a UST which fueled the Mess Hall boiler. The Mess Hall, located across "D" Street to the west, is believed to have been demolished along with its Heating Plant in the 1960s.

In April 1990, an undetermined amount of fuel had been discovered by Camp Geiger personnel along the unnamed drainage channels north of the Fuel Farm. Apparently, the source of the fuel, believed to be diesel or jet fuel, was an unauthorized discharge from a tanker truck that was never identified. The Activity reportedly initiated an emergency clean-up action that included the removal of approximately 20 cubic yards of soil.

Decommissioning of the Fuel Farm began in the spring of 1995 and was completed in July 1995. The ASTs were cleaned, dismantled and removed along with associated concrete foundations, slabs on grade, berms, and underground piping. The Fuel Farm was removed to make way for a six-lane, divided highway proposed by the North Carolina Department of Transportation (NC DOT) (see Figure 2).

In addition to the Fuel Farm dismantling, soil remediation activities began in August 1995 along the highway right-of-way as per an Interim Record of Decision executed on September 15, 1994. The soil remediation work is scheduled to be completed during the fall of 1995.

## Previous Investigations and Findings

Previous investigations conducted at Site 35 include the Initial Assessment Study of Marine Corps Base, Camp Lejeune, North Carolina (WAR, 1983); Final Site Summary Report, MCB Camp Lejeune (ESE, 1990); Draft Field Investigation/Focused Feasibility Study, Camp Geiger Fuel Spill Site (NUS, 1990); Underground Fuel Investigation and Comprehensive Site Assessment (Law, 1992); Addendum Report of Underground Fuel Investigation and Comprehensive Site Assessment (Law, 1993); Interim Remedial Action Remedial Investigation/Feasibility Study for Soil (Baker, 1994); Comprehensive Remedial Investigation Report (Baker, 1994); and Interim Feasibility Study for Surficial Groundwater (Baker, 1994).

The Initial Assessment Study identified Site 35 as one of 23 sites warranting further investigation. Environmental media were not sampled as part of this study.

ESE performed the Confirmation Study at the Fuel Farm between 1984 and 1987. Soil, groundwater, surface water, and sediment samples were obtained and analyzed for lead, oil and grease. Groundwater was also analyzed for volatile organics. Oil and grease results indicated that soils northeast of the Fuel Farm were potentially impacted by site activities.

Additional wells were installed by NUS Corporation during the Focused Feasibility Study, which was conducted in 1990. Soil cuttings obtained from two of the four well boreholes contained hydrocarbon related contamination.

Law conducted the Comprehensive Site Assessment in 1991. A total of 18 soil borings were drilled, sampled and converted to nested wells that monitor the upper and lower portions of water table aquifer. An additional three soil borings were drilled to provide stratigraphic data. Five more soil borings were drilled to provide data regarding vadose zone contamination. Nine hand-auger samples were also obtained. A follow-up study was conducted subsequent to the Comprehensive Site Assessment. Three additional borings were drilled, sampled and converted to wells.

Law identified separate areas of impacted soil and groundwater directly beneath and apart from the Fuel Farm. The nature of the contamination included both chlorinated organic compounds (e.g., TCE, trans-1,2-DCE, and vinyl chloride) and petroleum hydrocarbons (e.g., TPH, MTBE, BTEX). The majority of the soil contamination encountered appeared to be associated with a fluctuating groundwater table. Two plumes of shallow groundwater contaminated with petroleum constituents and two plumes contaminated with chlorinated organics were identified. All four plumes were located north of Fourth Street and east of E Street except for a portion of a TCE plume extending southwest of Fourth Street. The approximate locations of these plumes are shown on Figures 3, 4, 5, and 6.

The Interim Remedial Action RI conducted by Baker in 1993 and 1994 consisted of drilling seven additional soil borings including five in those areas where groundwater contamination plumes were suspected. In general, the Interim Remedial Action RI data confirmed the findings of the CSA (Law, 1992) which indicated contaminated soil conditions at Site 35 are primarily associated with a fluctuating shallow groundwater plume.

The Interim Remedial Action RI/FS culminated with an executed Interim Record of Decision (ROD), signed on September 15, 1994, for the remediation of contaminated soil along and adjacent to the proposed highway right-of-way at Site 35. Three areas of contaminated soil have been identified (see Figure 2). The first area is located in the vicinity of the Fuel Farm and the two other areas are located north of the Fuel Farm. The larger of these two areas is located along F Street in the vicinity of monitoring well MW-25. Baker has estimated that approximately 3,600 cubic yards (4,900 tons) of contaminated soil is present in these areas. Contaminated soil located in these areas is scheduled for removal and disposal at an off-site soil recycling facility beginning July 1995.

A fourth area of soil contamination, located immediately north of Building G480, was also identified in the Interim ROD(1994). Additional data pertaining to this fourth area became available subsequent to the execution of the Interim ROD. The data indicated that contaminated soil was encountered in this area during the removal of a UST in January 1994. The contaminated soil was excavated and reportedly disposed off site; however, no documentation is available regarding how or where the soil was disposed. An additional soil investigation will be conducted in this area to confirm that the contaminated soil was not returned to the excavation and that follow-up soil remediation in this area is not necessary.

A comprehensive RI was conducted by Baker in 1994 to evaluate the nature and extent of the threat to public health and the environment caused by the release of hazardous substances, pollutants, or contaminants, and to support a Feasibility Study evaluation of potential remedial alternatives. The RI field program was initiated on April 11, 1994. Data gathering activities were derived from a soil gas survey and groundwater screening investigation, a soil investigation, a groundwater investigation, a surface water and sediment investigation, and an ecological investigation. From the results of the comprehensive RI, an Interim Feasibility Study for surficial groundwater was completed in May 1995 and is the supporting document of this Interim ROD. An Interim Proposed Remedial Action Plan (PRAP) identified In Well Aeration and Off-Gas Carbon Adsorption as the method to remediate organic contamination in the surficial groundwater in the vicinity of the Fuel Farm.

Fuel and solvent related groundwater contamination was identified in the surficial aquifer in the area north of Fourth Street. Two additional plumes of solvent related groundwater contamination have been identified adjacent to Site 35. The extent and sources of this contamination have not been identified and additional RI activities are planned. In addition, significant levels of organic and inorganic contamination were identified in sediment samples.

Two USTs located near the Fuel Farm have been the subject of previous investigations conducted under an Activity-wide UST program. The two USTs include a No. 6 fuel oil UST situated adjacent to the former Mess Hall Heating Plant, and a No. 2 fuel oil UST situated adjacent to the Explosive Ordnance and Disposal Armory, Office, and Supply Building. The former UST was abandoned in place years ago (date unknown) and has been the subject of previous environmental investigations performed by ATEC Associates, Inc. and Law. The latter UST was removed in January 1994, and is the UST associated with the fourth area of soil contamination identified in the previously mentioned Interim ROD, signed September 1994. The area from which this latter UST was removed is reported to be scheduled for an upcoming comprehensive environmental investigation.

## 3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The Final Interim Proposed Remedial Action Plan (PRAP) for surficial groundwater at Site 35 was released to the public on May 9, 1995. These documents were made available to the public at the information repository maintained at the Onslow County Library and Building 67, MCB, Camp Lejeune. The notice of availability of these documents was published in *The Jacksonville Daily News* in the form of a display ad on April 29, 1995 and a legal ad on May 3, 1995. A public comment period was held from May 10 to June 10, 1995. In addition, a public meeting was held on May 10, 1995. At this meeting representatives from DON/Marine Corps were available to discuss the remedial action alternatives (RAAs) currently under consideration and address community concerns. However, no members of the community turned out for the meeting. Responses to the comments received during the comment period are included in the Responsiveness Summary, which is part of this ROD (Section 11.0).

This decision document presents the five RAAs which were considered. RAA 5 has been selected for the remediation of organic chemical contaminated surficial groundwater at Site 35. This RAA has been chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) and, to the extent practicable, the NCP. The selected RAA for surficial groundwater at Site 35 is based on the Administrative Record.

The viability of in well aeration technology (RAA 5) at Camp Lejeune will be determined by means of a field pilot test scheduled to be initiated in October 1995. A Draft Report of results will be available in May 1996. Additionally, the field pilot test will provide important data to support the full design of this alternative. If it is determined, based on the results of the field pilot test, that in well aeration cannot perform as required, RAA 3 (Groundwater Collection and On-Site Treatment) will be selected as the Interim Preferred Remedial Action.

## 4.0 SCOPE AND GOALS OF INTERIM REMEDIAL ACTION

The response action presented in this document is interim in nature because it represents only one phase of a comprehensive investigation and remediation at Site 35 and is not intended to represent the final solution for OU No. 10. This particular interim action focuses on organic groundwater contamination in the surficial aquifer located in the vicinity of the Fuel Farm and extending downgradient towards Brinson Creek. A remediation system installed in this area would be designed to mitigate the migration of groundwater contamination from OU No. 10 prior to its discharge into Brinson Creek.

Other media of concern such as sediment, and groundwater in the upgradient portion of the surficial aquifer, will be addressed during subsequent RI/FS activities that are due to commence later in 1995. Soil contamination at Site 35 was the focus of an Interim Remedial Action document that was issued by Baker on August 31, 1994.

The scope and goals for the remediation of organic chemical contaminated groundwater were developed based on North Carolina Water Quality Standards (NCWQS). In the Interim Feasibility Study, which addressed contaminated surficial groundwater at Site 35, risk-based cleanup goals were established. These goals were then compared to Federal Maximum Contaminant Levels (MCLs) and NCWQS, and the most conservative value for each contaminant was selected as the remediation goal. In each case, the most conservative criteria was the NCWQS. The remediation goals for the organic contaminants of concern are listed below:

- Benzene 1 µg/L
- Trichloroethene 2.8 µg/L
- cis-1,2-dichloroethene 70 µg/L
- trans-1,2-dichloroethene 70 µg/L
- Ethyl benzene 29 µg/L
- Methyl Tertiary Butyl Ether 200 µg/L
- Xylenes 530 µg/L

## 5.0 SITE CHARACTERISTICS

This section of the Interim ROD presents an overview of the nature and extent of surficial groundwater contamination in the vicinity of the Fuel Farm at Site 35. The nature and extent of contamination was determined based on the analytical results obtained under the RI (Baker, 1994).

Groundwater contamination was observed in the surficial aquifer along both the upper and lower monitored intervals. Fuel-related organic contaminants (e.g., BTEX), when encountered, appear more prevalent in the upper portion of the surficial aquifer. Conversely, solvent-related organic contaminants (e.g., TCE), when encountered, appear more prevalent in the lower portion of the surficial aquifer. This is likely due to the fact that the latter type of contaminants have specific gravities greater than water and tend to "sink" while fuel-related contaminants have specific gravities less than water and tend to "float".

The extent of fuel-related contamination appears to be adequately defined based on the data obtained to date. Fuel-related contaminants are present in the area north of Fourth Street in the vicinity of obvious suspected sources such as the Fuel Farm, and nearby former UST sites. The limits of fuel related contamination are depicted in Figures 3 and 4.

There are four distinct plumes of groundwater contamination in the upper portion of the surficial aquifer. The most northern plume is located immediately east of F Street and north of the ASTs at Site 35. The easternmost plume is north of Building TC474 and east of the ASTs. The westernmost plume is in the vicinity of building G480 and the football field. The southernmost portion of this plume has not been adequately defined (see Figures 3 and 5).

Groundwater contamination in the lower portion of the surficial aquifer consists of two separate plumes that conglomerate into a single plume. The easternmost plume is centered roughly under Buildings TC474, TC473, and TC470. The westernmost plume is south of Fourth Street and centered directly under E Street. The southernmost boundary of this conglomerate plume has not been adequately delineated (see Figures 4, 5 and 6). Additional investigations are planned to further evaluate the extent of this contamination.

Other medias of concern such as sediment and groundwater in the upgradient portion of the surficial aquifer will be addressed as part of a Supplemental Groundwater Investigation to be initiated in December 1995. Soil contamination at Site 35 was the focus of an Interim Remedial Action document that was issued by Baker on August 31, 1994.

## 6.0 SUMMARY OF SITE RISKS

### Baseline Human Health Risk Assessment

A baseline human health risk assessment (BRA) was performed as part of this study utilizing the data obtained under the RI field investigation. Contaminants of potential concern (COPC) for the BRA were selected for each media as shown in Table 1.

The BRA highlights the media of interest from the human health standpoint at OU No. 10 by identifying areas with elevated Incremental Cancer Risk (ICR) and Health Index (HI) values. Current and future potential receptors at the site include current military personnel, future residents (i.e., children and adults), and future construction workers. The total risk from each site for these receptors was estimated by logically summing the multiple exposure pathways likely to affect the receptor during a given activity. The risk to human health was derived based on the following receptors and contaminant exposure routes:

1. Current Military Personnel

   a. Incidental ingestion of COPC in surface soil + dermal contact with COPC in surface soil + inhalation of airborne COPC

2. Future Residents (Children and Adults)

   a. Incidental ingestion of COPC in surface soil + dermal contact with COPC in surface soil + inhalation airborne of COPC

   b. Ingestion of COPC in groundwater + dermal contact with COPC in groundwater + inhalation of volatile COPC

3. Future Construction Worker

   a. Incidental ingestion of COPC in on-site subsurface soil + dermal contact with COPC in subsurface soil + inhalation of airborne COPC

4. Current Residents (Children and Adults)

   a. Ingestion of COPC in surface water and sediment + dermal contact with COPC in surface water and sediment

   b. Ingestion of fish tissue (adults only)

The total site ICR and HI values associated with current and future receptors at this site are presented in Table 2. The total site ICR estimated for future residential children (2.0E-03) and adults (4.3E-03) exceeded the USEPA's upper bound risk range (1E-04). The total site ICR estimated value for the current residential child (3.0E-07) is below the USEPA's upper bound risk range, while the current residential adult (1.4E-04) is slightly above the risk range (1E-04 to 1E-06). The total site ICR estimated for future construction workers (1E-07) was less than the USEPA's lower bound target risk (1E-06). The total site ICR estimated value for current military personnel (3.2E-06) is within the USEPA's risk range (1E-04 to 1E-06). Additionally, USEPA guidance provides for a maximum HI value of 1.0. The total site HI for future residential children (65) and adults (28) exceed unity (i.e., 1.0). The total site HI for current residential child (2.4E-02) is less than unity, while the total site HI for the current residential adult (3.5) is greater than unity. The total site HI estimated for the future construction worker (1.7E-02) did not exceed unity. Finally, the total site HI for the current military personnel (1.0E-01) did not exceed unity. The total site risk was driven by future potential exposure to groundwater contaminated with cis-1,2-dichloroethene, trichloroethane, benzene, antimony, arsenic, barium, beryllium, chromium, cadmium, manganese, and vanadium; and current potential exposure to fish due to mercury.

## Ecological Risk Assessment

As part of this study an ecological risk assessment (ERA) was conducted to assess the potential impacts to ecological receptors from contaminants detected at Site 35. Additional data obtained along Brinson Creek from Site 36, located downstream of Site 35, was also used in the ERA.

Similar to the BRA, COPC were selected for the media considered in the ERA. These media include sediment, surface water, surface soil, and biota.

Overall, metals and pesticides appear to be the most significant site related COPCs that have the potential to affect the integrity of the aquatic and terrestrial receptors at OU No. 10. Although the American alligator and red-cockade woodpecker have been observed at OU No. 10, potential adverse impacts to these threatened or endangered species are low due to the low levels of contaminants in their critical habitats.

### Aquatic Ecosystem

Surface water quality showed exceedances of aquatic reference values for lead, mercury, and zinc. For sediments, concentrations of lead and the organics dieldrin, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, endrin, alpha-chlordane, and gamma-chlordane exceeded the aquatic reference values. In the surface water, mercury exceeded aquatic reference values in the upstream stations. Although these levels were indicative of a high potential for risk (QI > 100), mercury is not believed to be site related. Zinc exceeded unity slightly and was only found at a single station. Lead has a single exceedance of the aquatic reference value by slightly greater than 10 indicating a moderate potential for risk to aquatic receptors.

In the sediments, lead exceeded the lower sediment aquatic reference value throughout Brinson Creek. The only exceedances of the higher sediment aquatic reference value occurred downstream of Site 35 with the highest QI of 137 representing a high potential for risk to aquatic receptors. The lead detected in sediments is likely site related, the result of past reported surface spills/runoff and past and ongoing groundwater discharges to surface water. Pesticides exceeded the sediment aquatic reference values throughout Brinson Creek. The highest QI, 2,600 for dieldrin, represents a high potential for risk to aquatic receptors. There is no documented pesticide disposal or storage/preparation activities at Site 35. The pesticide levels detected in the sediments probably are a result of routine application (i.e., pest control) in the general vicinity of Site 35.

Although the pesticides in the sediments were found at levels indicating contamination throughout the watershed, the highest levels were observed in the lower reaches of Brinson Creek. This deposition trend may be related to the higher organics in the sediments in the lower reach, which would accumulate more of these types of contaminants.

The fish community sampled in Brinson Creek was representative of an estuarine ecosystem with both freshwater and marine species present. In addition, the presence of blue crabs, grass shrimp, and crayfish support the active use of Brinson Creek by aquatic species.

The absence of pathologies observed in the fish collected from Brinson Creek indicates that the surface water and sediment quality does not adversely impact the fish community.

The benthic macroinvertebrate community demonstrated the typical tidal/freshwater species trend of primarily chironmids and oligochaetes in the upper reaches and polychaetes and amphipods in the lower reaches. Species representative of both tolerant and intolerant taxa were present. Species richness and densities were representative of an estuarine ecosystem.

In summary, the aquatic community in Brinson Creek was representative of an estuarine community and does not appear to be adversely impacted by surface water and sediment quality.

**Terrestrial Ecosystem**

Surface soil quality indicated an infrequent potential for adversely impacting the terrestrial receptors that have indirect contact with the surface soils. This adverse impact is primarily due to arsenic and chromium concentrations in the surface soils. For the larger receptors (rabbit, raccoon, and quail) the terrestrial reference values exceeded unity only slightly. Therefore, there is no significant adverse impact to terrestrial receptors from site-related contaminants.

## 7.0 DESCRIPTION OF ALTERNATIVES

Numerous technologies and process options were screened and evaluated under the Interim FS. Based upon screening criteria, many of the technologies and process options were eliminated. Ultimately, five RAAs were developed with the following titles:

- RAA 1 - No action
- RAA 2 - No Action with Institutional Controls
- RAA 3 - Groundwater Collection and On-Site Treatment
- RAA 4 - In Situ Air Sparging and Off-Gas Carbon Adsorption
- RAA 5 - In Well Aeration and Off-Gas Carbon Adsorption

A brief description of each alternative, as well as the estimated cost and timeframe to implement the alternative, are as follows:

- **RAA 1 - No Action**
  Capital Cost: $0
  Annual Operation and Maintenance (O&M): $0
  Total Net Present Worth (30 Years): $0
  Months to Implement: 0

  Under RAA 1, no remedial actions will be performed to reduce the toxicity, mobility, or volume of the contaminated surficial groundwater at Operable Unit No. 10. This method assumes that passive remediation will occur via natural attenuation processes and that the contaminant levels will be reduced over an indefinite period of time. However, the achievable reductions versus time is difficult, if not impossible, to predict.

  The No Action RAA is required by the NCP to provide a baseline for comparison with other alternatives. Since contaminants will remain at the site under this alternative, DON is required by the NCP [40 CFR 300.430(f)(4)] to review the effects of this alternative no less often than every five years after initiation of the selected remedial action.

- **RAA 2 - No Action with Institutional Controls**
  Capital Cost: $6,200
  Annual Operation and Maintenance (O&M) Costs: $19,100
  Total Net Present Worth (30 years): $299,800
  Months to Implement: 1

  Under RAA No.2, no remedial actions will be performed to reduce the toxicity, mobility, or volume of the contaminated surficial groundwater at Operable Unit No. 10. This RAA assumes that the Base Master Plan will be modified to include restrictions on the use of the surficial aquifer in the vicinity of the Fuel Farm. These institutional controls will reduce the risk to human health and the environment posed by eliminating potential exposure to shallow groundwater; however, without additional remediation the contaminated surficial groundwater will remain a future source of contamination for Brinson Creek via groundwater discharge.

  In addition to aquifer-use restrictions, long-term groundwater monitoring is included under this RAA to provide data regarding the impact of natural attenuation and the progress of contaminant migration. Long-term groundwater monitoring will include: the semi-annual collection and analysis (TCL VOCs) of groundwater samples from 11 monitoring wells; the development of a semi-annual monitoring report; and the replacement of one monitoring well every five years.

  Since contaminants will remain at the site under this alternative, the DON is required by the NCP [40 CFR 300.430(f)(4)] to review the effects of this alternative no less often than every five years after initiation of the selected remedial action.

- **RAA 3 - Groundwater Collection and On-Site Treatment**
  Capital Cost: $2,122,700
  Annual Operation and Maintenance (O&M) Costs: $57,100
  Total Net Present Worth (30 years): $3,000,500
  Months to Implement: 3

  RAA 3 is a source collection and treatment alternative; the source being the contaminated surficial groundwater in the vicinity of the Fuel Farm at Operable

Unit No. 10. Under this alternative a vertical interceptor trench will be installed at the downgradient edge of the contaminated plume in the area between the proposed highway and Brinson Creek (see Figure 7). The interceptor trench will extend from the ground surface to the semi-confining layer at the base of the surficial aquifer (see Figure 8). The purpose of the interceptor trench is to collect contaminated surficial groundwater for transfer to an on-site treatment facility prior to it being discharged to Brinson Creek.

The type of interceptor trench proposed under RAA 3 is termed a "biopolymer slurry drainage trench." This type of trench can be installed without dewatering or structural bracing. Through the use of a natural, biodegradable slurry, the walls of a trench excavation can be supported and the trench can be installed without personnel entering an excavation. Compared to other trenching methods, this technique is safer and more cost-effective in areas with a high groundwater and unstable soil because dewatering and shoring are not required.

The interceptor trench will be designed to collect groundwater at a rate roughly equal to the rate of groundwater flow (5 to 10 gpm) across the upgradient face of the trench (31,900 square feet). Flow across the downgradient face of the trench will be restricted by an impermeable geomembrane barrier. Drawdown of the groundwater surface will be minimized so as to mitigate the potential of excessive ground settlement beneath the highway. The collected groundwater will be conveyed to an on-site treatment system located just east of the proposed highway right-of-way, creek-side, where it appears that adequate space and firm ground is available.

Baker, LANTDIV, and MCB, Camp Lejeune will negotiate with NC DOT regarding the specifics of site access to the creek side of the new highway. EPA and NC DEHNR will be kept abreast of developments regarding this subject. In this Interim ROD, Baker proposes an access road running parallel to the east side of the highway from the south.

The collected groundwater will be treated sufficiently to allow for its discharge to Brinson Creek at a point downstream of OU No. 10. It is anticipated that the groundwater treatment system will include filtration for the removal of suspended solids, precipitation for the removal of inorganics, sludge collection and disposal, volatilization (air stripping) for the removal of volatile organic contaminants (VOCs), and secondary treatment of VOC emissions from the air stripper and of the treated groundwater (i.e., via carbon adsorption). Figure 9 is a process flow diagram of this treatment train. The treatment plant effluent will be sampled once a month to insure that water discharged to Brinson Creek meets all applicable water quality standards.

RAA 3 assumes that the Base Master Plan will be modified to include restrictions on the use of the surficial aquifer in the vicinity of the Fuel Farm. This institutional control will reduce the risk to human health and the environment posed by this media by eliminating potential exposure to shallow groundwater.

In addition to aquifer-use restrictions, long-term groundwater monitoring is to be included under this RAA to provide data regarding the impact of natural attenuation and the progress of contaminant migration. Long-term groundwater monitoring will include: the semi-annual collection and analysis (TCL VOCs) of groundwater samples from 11 monitoring wells; the development of a semi-annual monitoring report; and the replacement of one monitoring well every five years.

Since contaminants will remain at the site under this alternative, the DON is required by the NCP [40 CFR 300.430(f)(4)] to review the effects of this alternative no less often than every five years after initiation of the selected remedial action.

- **RAA 4 - In Situ Air Sparging And Off-Gas Carbon Adsorption**
  Capital Cost: $1,068,400
  Annual Operation and Maintenance (O&M) Costs: $90,100
  Total Net Present Worth (30 years): $2,459,600
  Months to Implement: 3

In situ air sparging (IAS) is a technique in which air is injected into water saturated zones for the purpose of removing organic contaminants primarily via volatilization and secondarily via aerobic biodegradation. IAS systems introduce contaminant-free air into an impacted aquifer near the base of the zone of contamination, forcing contaminants to transfer from the groundwater into sparged air bubbles. The air bubbles are then transported into soil pore spaces in the unsaturated zone where they are typically collected via soil vapor extraction (SVE) and conveyed to an above-ground off-gas treatment system.

An IAS system typically is comprised of the following components: 1) air injection wells; 2) an air compressor; 3) air extraction wells; 4) a vacuum pump; 5) associated piping and valving for air conveyance; and 6) an off-gas treatment system (e.g., activated carbon, combustion, or oxidation). Under RAA 4, a line of air sparging wells will be installed between the proposed highway and Brinson Creek in order to treat and contain the contaminant plume near its downgradient extreme. Based on empirical data from similar sites, the radius of influence of an air sparging well ranges from five to almost 200 feet, but is typically on the order of 25 feet (EPA, 1992). The proposed off-gas treatment system, consisting primarily of activated carbon units, will be located just east of the proposed highway right-of-way, creek-side, where it appears that there is adequate space and firm foundation material available. The air emissions from the off-gas treatment system will be sampled monthly to insure that all applicable air emissions standards are being met.

Air sparging systems are most effective in sandy soils, but can be adversely impacted by high levels of inorganic compounds in the groundwater which oxidize and precipitate when contacted by the sparged air. These inorganics can form a heavy scale on well screens and clog the well space of the sand pack surrounding the well screen resulting in a reduction in permeability. A field pilot test is recommended to determine the loss of efficiency over time as a result of inorganics precipitation and oxidation, the radius of influence of the wells under various heads of injection air pressure, and the rate of off-gas organic contaminant removal via carbon adsorption and carbon breakthrough.

Baker, LANTDIV, and MCB, Camp Lejeune will negotiate with NC DOT regarding the specifics of site access to the creek side of the new highway. EPA and NC DEHNR will be kept abreast of developments regarding this subject. In this Interim ROD, Baker proposes an access road running parallel to the east side of the highway from the south.

RAA 4 assumes that the Base Master Plan will be modified to include restrictions on the use of the surficial aquifer in the vicinity of the Fuel Farm. This institutional control will reduce the risk to human health and the environment posed by this media by eliminating potential exposure to contaminated shallow groundwater.

In addition to aquifer-use restrictions, long-term groundwater monitoring is to be included under this RAA to provide data regarding the impact of natural attenuation and the progress of contaminant migration. Long-term groundwater monitoring will include: the semi-annual collection and analysis (TCL VOCs) of groundwater samples from 11 monitoring wells; the development of a semi-annual monitoring report; and the replacement of one monitoring well every five years.

Since contaminants will remain at the site under this alternative, the DON is required by the NCP [40 CFR 300.430(f)(4)] to review the effects of this alternative no less often than every five years after initiation of the selected remedial action.

- **RAA 5 - In Well Aeration and Off-Gas Carbon Adsorption**
  Capital Cost: $1,248,300
  Annual Operation and Maintenance (O&M): $82,320
  Total Net Present Worth (30 years): $2,519,700
  Months of Implementation: 3

In well aeration is a new technology that utilizes circulating air flow within a groundwater well that, in effect, turns the well into an air stripper. In well aeration differs from air sparging in that volatilization occurs outside the well via air sparging and within the well via aeration. Similar to air sparging, this technique removes organic contaminants from groundwater primarily via volatilization and secondarily via aerobic biodegradation. Under RAA 5, a line of in well aeration wells will be installed between the proposed highway and Brinson Creek in order to treat and contain the contaminated plume near its downgradient extreme (see Figure 10).

The radius of influence of an in well aeration well is reportedly much greater than a typical air sparging well system. At Site 35, the radius of the influence has been calculated by the technology's developers to be over 100 feet. The radius of influence is based upon site-specific geological and hydrogeological parameters. Volatilized organic contaminants collected by the in well aeration system, unlike air sparging, will be conveyed to independent carbon adsorption units placed adjacent to each well system (see Figure 11). The air emissions from the off-gas treatment system will be sampled monthly to insure that all applicable air standards are met. Each well and above-ground off-gas treatment system will be housed in a small prefabricated building.

In well aeration systems, like IAS systems, are most effective in sandy soils, but can be adversely impacted by high levels of inorganic compounds in the groundwater which oxidize and precipitate when contacted by air. These inorganics can form a heavy scale on well screens and clog the well space of the sand pack surrounding the well screen resulting in a reduction in permeability. The results of a field pilot test will help determine the loss of efficiency over time as a result of inorganics precipitation and oxidation, the radius of influence of the wells under various heads of injection air pressure, and the rate of off-gas organic contaminant removal via carbon adsorption and carbon breakthrough.

Baker, LANTDIV, and MCB, Camp Lejeune will negotiate with NC DOT regarding the specifics of site access to the creek side of the new highway. EPA and NC DEHNR will be kept abreast of developments regarding this subject. In this Interim ROD, Baker proposes an access road running parallel to the east side of the highway from the south.

RAA 5 assumes that the Base Master Plan will be modified to include restrictions on the use of the surficial aquifer in the vicinity of the Fuel Farm. This institutional control will reduce the risk to human health and the environment posed by this media by eliminating future potential exposure to shallow groundwater.

In addition to aquifer-use restrictions, long-term groundwater monitoring is included under this RAA to provide data regarding the impact of natural attenuation and the progress of contaminant migration. Long-term groundwater monitoring will include: the semi-annual collection and analysis (TCL VOCs) of groundwater samples from 11 monitoring wells; the development of a semi-annual monitoring report; and the replacement of one monitoring well every five years.

Since contaminants will remain at the site under this alternative, the DON is required by the NCP [40 CFR 300.430(f)(4)] to review the effects of this alternative no less often than every five years after initiation of the selected remedial action.

## 8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

A detailed analysis was performed on the RAAs using the nine evaluation criteria in order to select a site remedy. A brief summary of each alternative's strengths and weaknesses with respect to the evaluation criteria follows. (Table 3 presents a complete summary of the alternatives evaluation; Table 4 provides a glossary of the evaluation criteria.)

### Overall Protection of Human Health and the Environment

RAA 1 (No Action) and RAA 2 (No Action With Institutional Controls) are similar in that neither alternative involves active treatment. RAA 2 provides for some overall protection to human health through the incorporation of aquifer-use restrictions which are not included under RAA 1.

RAA 3 (Groundwater Collection and On-Site Treatment), RAA 4 (In Situ Air Sparging And Off-Gas Carbon Adsorption), and RAA 5 (In Well Aeration And Off-Gas Carbon Adsorption) have a common element in that each is intended to reduce groundwater contamination at the downgradient extreme of the contaminated plume and to serve as a barrier to future contaminated groundwater discharge to Brinson Creek. RAA 3 would likely be the most effective barrier in that it is designed to span the entire length and depth of the contaminated portion of the surficial aquifer and will be equipped with an impermeable geomembrane along its downgradient face. RAA 3 is the only treatment alternative that will impact both organic and inorganic contaminants which could be important if it is determined in the future that inorganic contaminants in groundwater are still a concern.

### Compliance With ARARs

RAA 1 (No action) and RAA 2 (No Action With Institutional Controls) are no action alternatives that will not comply with ARARs. RAA 3 (Groundwater Collection and On-Site Treatment), RAA 4 (In Situ Air Sparging And Off-Gas Carbon Adsorption), and RAA 5 (In Well Aeration And Off-Gas Carbon Adsorption) are primarily source control measures that will reduce contaminant levels over a limited area defined as the particular zone of influence of each system.

Wetlands disturbance will be an issue with RAA 3, 4, and 5, but, most significantly with RAA 3 which includes the excavation of an approximately two-foot wide, by 30-foot deep, by 1,080-foot interceptor trench. The disturbance associated with RAA 4 and 5 is limited primarily to drilling and well installations, although of the two, RAA 4 will have the greater impact due to the large number of wells to be installed.

Treated air and groundwater discharge are provisions of RAA 3, whereas, only air emissions are a part of RAA 4 and 5. These discharges will need to comply with applicable ARARs.

**Long-Term Effectiveness and Permanence**

In the case of all five RAAs, contamination will remain at the site and require the DON to review the effectiveness of the alternative on a five-year basis. RAA 1 (No Action) and RAA 2 (No Action With Institutional Controls) provide for no active means of contaminant reduction although, under RAA 2, aquifer-use restrictions will provide a permanent means for protection against direct human exposure to the contaminated surficial groundwater.

The effectiveness of RAA 3 (Groundwater Collection and On-Site Treatment), RAA 4 (In Situ Air Sparging And Off-Gas Carbon Adsorption), and RAA 5 (In Well Aeration and Off-Gas Carbon Adsorption) can be assumed to be roughly equivalent without the benefit of the results of field pilot-scale testing. RAA 3 may be the most difficult of the three to install, however, once installed it will likely be the most reliable and easiest to control. RAA 4 and 5 may encounter clogging problems if dissolved metals precipitate out of solution when placed in contact with forced air. At a minimum the metals problem will prompt increased maintenance which could lead to complete well replacement. RAA 4 has the additional problem of releasing toxic vapors to the atmosphere during operation because it is difficult to apply sufficient vacuum to the vadose zone where the groundwater surface is within a few feet of the ground surface.

**Reduction of Toxicity, Mobility, or Volume Through Treatment**

No reduction of contaminants will occur under RAA 1 (No Action) and RAA 2 (No Action With Institutional Controls) as the result of active treatment because active treatment is not provided for under these RAAs.

RAA 3 (Groundwater Collection and On-Site Treatment) provides for on-site treatment of the collected contaminated groundwater (organics and inorganics) using standard wastewater treatment technology. Conversely, RAA 4 (In Situ Air Sparging And Off-Gas Carbon Adsorption) and RAA 5 (In Well Aeration And Off-Gas Carbon Adsorption) provide for treatment of the organic phase of contaminated groundwater in-situ. Both RAA 4 and 5 primarily utilize volatilization technology and biodegradation technology secondarily. The principle difference between the two is that under RAA 4, both volatilization and biodegradation occur outside the well and within the soil column. Under RAA 5, volatilization occurs within the well while biodegradation occurs outside the well within the soil column. Under RAA 4, it may be difficult to efficiently collect all of the volatilized organic contaminants via conventional soil vapor extraction because of the proximity of the groundwater surface to the ground surface at this site. Without an efficient means of collecting the volatilized organics under RAA 4, toxic vapors may be released to the atmosphere. The zone of influence of an air sparging system may also be significantly reduced due to vapor extraction wells only four to five feet deep, the depth of groundwater. Vapor extraction wells this close to the ground surface may short circuit and actually draw in air from the atmosphere. Under RAA 5 these are not of concern because the volatilization is conducted within the well and vapors are conveyed to activated carbon via piping which means the system is essentially a closed loop.

RAA 3 will produce the highest volume of residual waste during operation because it is the only alternative involving groundwater treatment. However, the volume of air treatment under RAA 3 will be less than that under RAAs 4 and 5 because the latter are specifically designed as air volatilization systems. Under RAAs 4 and 5 a small volume of contaminated water will be generated because extracted air contains water which condenses and collects in a knock-out tank at the treatment facilities.

**Short-Term Effectiveness**

Worker protection against exposure will not be a significant issue for any of the RAAs. Each system provided for under RAA 3 (Groundwater Collection and On-Site Treatment), RAA 4 (In Situ Air Sparging and Off-Gas Carbon Adsorption), and RAA 5 (In Well Aeration and Off-Gas Carbon Adsorption) will require approximately 30 to 60 days to install with the total time in the field for construction being a little longer. It has also been assumed that system start-up and testing operations will require an additional 90 days.

Under RAA 1 (No Action) and RAA 2 (No Action With Institutional Controls) there will be no increase in the risks to the community resulting from implementation of the RAA. RAAs 3 and 5 will likely present minimal risk of community exposure during implementation and operation because they are, in essence, closed loop systems. RAA 4 has the potential for releases of toxic vapors to the atmosphere because of close proximity of the groundwater surface to the ground surface will make efficient soil vapor extraction difficult.

Some disturbance of the wetlands is expected under RAAs 3, 4, and 5. The greatest disturbance will be associated with RAA 3.

**Implementability**

Aside from RAAs 1 and 2, which are essentially no action alternatives, RAA 3 (Groundwater Collection And On-Site Treatment) will present greater technical challenges during construction than RAA 4 (In Situ Air Sparging and Off-Gas Carbon Adsorption) and RAA 5 (In Well Aeration and Off-Gas Carbon Adsorption). This is because RAA 3 involves the construction of a two-foot wide by 30-foot deep by 1,080 foot long interceptor trench while RAAs 4 and 5 involve primarily well installation.

The interceptor trench under RAA 3 represents specialized technology that is available from a limited number of vendors, whereas, the air sparging technology of RAA 4 is relatively commonplace and in well aeration (RAA 5) is a relatively new technology offered by a few vendors in the United States. Two of these companies are IEG Technologies Corporation and EG&G Environmental.

The proposed groundwater monitoring plan coupled with routine system maintenance and monitoring should be sufficient to provide sufficient notice of a system failure under either RAA 3, 4 or 5. The purpose of the monitoring is to provide for system adjustments with sufficient time so that a significant contaminant release to the environment will not occur.

Because each system under RAA 3, 4, and 5 will require construction within a wetlands area and because air and water discharges are incorporated into the designs, federal and state agency interaction will be required.

**Cost**

The estimated total present worth costs of the alternatives, excluding RAA 1 - No Action, range from $299,800 for RAA 2 - No Action with Institutional Controls to $3,000,500 for RAA 3 - Groundwater Collection and On-Site Treatment. These costs are based on the assumption of 30 years of active use. The ranking of the alternatives in terms of costs is as follows:

| | | |
|---|---|---|
| RAA | 1 - No Action | $0 |
| RAA | 2 - No Action with Institutional Controls | $299,800 |
| RAA | 4 - In Situ Air Sparging and Off-Gas Carbon Adsorption | $2,459,600 |
| RAA | 5 - In Well Aeration and Off-Gas Carbon Adsorption | $2,519,700 |
| RAA | 3 - Groundwater Collection and On-Site Treatment | $3,000,500 |

Figure 12 graphically displays a comparison of costs for RAAs 2, 3, 4, and 5.

**USEPA/State Acceptance**

The USEPA and NC DEHNR are in favor of either RAA 3 or 5 since both alternatives involve treatment and containment of the plumes leading edge.

**Community Acceptance**

Community acceptance is difficult to evaluate since public interest in Site 35 is minimal. It can, however, be assumed that the community wouldnot object to interim treatment of a groundwater condition that is impacting Brinson Creek.

## 9.0 SELECTED REMEDY

The interim preferred remedial action alternative is RAA 5 (In Well Aeration and Off-Gas Carbon Adsorption). The following paragraphs describe the process by which RAA 5 was selected over RAAs 1, 2, 3, and 4. This process involved a comparison/contrast evaluation of the five RAAs based on seven criteria: overall protectiveness, compliance with ARARs, long-term effectiveness/ permanece, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementabilty, cost, USEPA/State acceptance, and community acceptance. (Table 3 presents a complete summary of the alternatives evaluation; Table 4 provides a glossary of the evaluation criteria).

RAA 1 (No Action) and RAA 2 (No Action With Institutional Controls) are no action alternatives; RAA 3 (Groundwater Collection and On-Site Treatment), RAA 4 (In Situ Air Sparging and Off-Gas Carbon Adsorption), and RAA 5 (In Well Aeration and Off-Gas Carbon Adsorption) are source control alternatives. RAAs 3, 4, and 5 are preferred over the no action alternatives because source control alternatives are more effective at complying with ARARs, achieving remediation goals, contributing to the overall protection of human health and the environment, and achieving a permanent reduction in toxicity, mobility, and volume of waste.

Of the three source control alternatives, RAA 3 is the most difficult to implement because it involves constructing a large permeable trench (approximately 2 feet wide, by 30 feet deep, by 1,080 feet long) in the soft ground of a wetlands area. RAA 4 and RAA 5, on the other hand, have similar implementability ratings because the major construction activity, in both cases, involves the drilling and installation of multiple vertical wells. Since well installation at OU No. 10 has been executed successfully in the past, RAAs 4 and 5 should be relatively easy to implement compared to RAA 3.

Despite its more difficult implementability, RAA 3 would likely be the easiest alternative to operate and maintain because it involves fewer operable components than RAAs 4 and 5. Additionally, under RAAs 4 and 5, high metals in the groundwater could precipitate and oxidize easily because these RAAs involve in situ aeration. The process could clog the well screens which would require frequent maintenance or even well replacement.

Both RAA 3 and RAA 5 performed well under the short-term and long-term effectiveness/ performance evaluation. RAA 4, however, did not perform well. When the groundwater surface is within several feet of the ground surface, like it is at OU No. 10, vapor extraction (a main component of RAA 4) is difficult to control and there is a risk of releasing toxic vapors to the atmosphere. Thus, RAA 4 could pose a risk to the community that RAAs 3 and 5 do not.

Under the final criterion, cost effectiveness, RAA 4 resulted in the lowest net present worth, $2,459,600, although the cost of RAA 5 is nearly the same, $2,519,700. RAA 3, however, requires $3,000,500 which is roughly $500,000 more than RAAs 4 and 5. RAAs 4 and 5 are nearly tied as the most cost effective alternatives with RAA 4 being slightly less expensive.

In conclusion, neither RAA 1 nor RAA 2 was selected to be the preferred alternative because of the potential environmental impacts associated with a no action alternative. RAA 3 was not selected because of its high cost and difficult implementability. Despite its similarities to RAA 5, RAA 4 was not selected because of the possible release of toxic vapors associated with vapor extraction at Operable Unit No. 10. Thus, RAA 5, which is nearly the most cost effective alternative, was selected as the interim preferred remedial action. Figure 10 presents a plan view of this interim proposed remedial action.

The viability of in well aeration technology (RAA 5) at Camp Lejeune will be determined by means of a field pilot test scheduled to be initiated in September 1995. A Draft Report of results will be available in February 1996. Additionally, the field pilot test will provide important design support data. If it is determined, based on the results of the field pilot test, that in well aeration cannot perform as required, RAA 3 (Groundwater Collection and On-Site Treatment) will be selected as the Interim Preferred Remedial Action.

**Remedy Description**

The major components of RAA 5 include:

- Six aeration wells spaced at approximately 180 feet (center to center). These wells would be installed in a line between the proposed highway and Brinson Creek.

- A submersible pump incorporated into each well. These pumps are placed near the bottom of the wells. They draw in contaminated groundwater and pump it to the stripping zone of the aeration system.

- An aeration system in each well. As water is pumped in from the bottom of the well, air is injected into the water allowing the VOCs to move from the dissolved phase to the vapor phase. As the water is aerated, it is forced back out into the formation.

- A header system that delivers pressurized air from the compressor/blowers at each well to the well heads.

- An air extraction header system that runs from the well heads to a carbon adsorption unit adjacent to the well. This system is equipped with a vacuum pump(s) that draw VOC laden air from the wellheads to a carbon adsorption unit.

- Carbon adsorption units that adsorb vapor phase VOCs from the contaminated air prior to discharge to the atmosphere. These units along with the blowers, vacuum pumps and controls will be housed in individual treatment buildings which will also enclose the in well aeration well heads.

- Each well head has an upper observation well (slightly above groundwater table) and a lower observation well below the groundwater table.

- Implementation of aquifer use restrictions.

- Long term groundwater monitoring.

**Estimated Costs**

The costs that will be incurred to implement RAA 5 are as follows:

| | | |
|---|---|---|
| Capital Cost | - | $1,248,300 |
| Annual O&M | - | $82,320 |

The total net present worth (over 30 years) of these costs is $2,519,700. It is important to note that the cost estimate was calculated for the FS evaluation and should not be considered a construction quality estimate. An FS cost estimate should have an accuracy of +50 or -30 percent (EPA, 1988).

## 10.0 STATUTORY DETERMINATIONS

A selected remedy should satisfy the statutory requirements of CERCLA Section 121 which include: (1) be protective of human health and the environment; (2) comply with ARARs; (3) be cost-effective; (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 RAA 5 satisfies these requirements for Site 35 is presented below.

**Protection of Human Health and the Environment**

RAA 5 provides protection to human health and the environment through the in-situ remediation of contaminated groundwater that exceeds state groundwater standard. The potential risks associated with exposure to surficial groundwater is eliminated under this alternative.

**Compliance With Applicable or Relevant and Appropriate Requirements**

RAA 5 will comply with ARARs identified in the FS. Chemical-specific ARARs include the Federal Maximum Contaminant Levels (MCLs) and North Carolina Water Quality Standards for Groundwater (NCWQS). Location-specific ARARs which are potentially applicable to OU No. 10 and therefore may require compliance from RAA 5 include: the Fish and Wild Life Coordination Act, the Federal Endangered Species Act, the North Carolina Endangered Species Act, Executive Order 11990 on Protection of Wetlands, Executive Order 11988 on Floodplain Management, and RCRA Location Requirements. Action-specific ARARs which may be applicable to OU No. 10 and RAA 5 are defined by the Resource Conservation Recovery Act, the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act, and the Department of Transportation.

**Cost-Effectiveness**

The selected remedy, RAA 5, has been evaluated to be the most cost-effective of the alternatives considered (exclusive of the no action alternatives).

**Utilization of Permanent Solutions and Alternative Treatment Technologies**

RAA 5 represents a permanent treatment solution. That is, it utilizes, a permanent solution and alternative treatment technology to the maximum extent practicable.

**Preference for Treatment as a Principal Element**

RAA 5 satisfies the preference for treatment as a principal element since the contaminated groundwater exceeding the remediation goals will be treated in-situ.

## 11.0 RESPONSIVENESS SUMMARY

### Overview

At the time of the public comment period (May 10 through June 10, 1995), the Department of the Navy/Marine Corps had already selected a preferred alternative for the remediation of contaminated groundwater at Operable Unit No. 10 (Site 35). The preferred alternative specified in the Interim ROD is in well aeration and off-gas carbon adsorption. This alternative involves the in-situ treatment of contaminated surficial groundwater in the area between the highway right-of-way and Brinson Creek.

No written comments were received during the public comment period or at the public meeting on May 10, 1995. In addition, the EPA Region IV and the NC DEHNR are in support of the preferred alternative. Based on the lack of public comments, it appears that there is no public opposition to the preferred alternative.

### 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 have been few expressed interests or concerns specific to the environmental sites (including Site 35). 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 Preliminary Draft Community Relations Plan, August 1993.

- Established two information repositories.

- Established the Administrative Record for all of the sites at the base.

- Released PRAP for public review in repositories, May 9, 1995 .

- Released public notice announcing public comment and document availability of the PRAP, April 29, 1995.

- Held Technical Review Committee meeting, May 10, 1995, to review PRAP and solicit comments.

- Held public meeting on May 10, 1995, to solicit comments and provide information. No members of the community attended the meeting, consequently no transcript was prepared.

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

No comments to this document were received during the public comment period. No representatives of the public at large attended the public meeting held on May 10, 1995.

## 12.0 REFERENCES

Baker. 1994a. Baker Environmental, Inc. Interim Remedial Action, Remedial Investigation, Operable Unit No. 10, Site 35 - Camp Geiger Fuel Farm. Marine Corps Base, Camp Lejeune, North Carolina.

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# TABLES

## TABLE 1

### SUMMARY OF COPCs IN ENVIRONMENTAL MEDIA OF CONCERN
### OPERABLE UNIT NO. 10 (SITE 35)
### INTERIM RECORD OF DECISION, CTO-0232
### MCB CAMP LEJEUNE, NORTH CAROLINA

| Contaminant | Surface Soil | Subsurface Soil | Ground-water | | Surface Water | | Sediment | | Fish |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,2-Trichloroethane | | | ● | | | | | | |
| 1,1-Dichloroethane | | | ● | | | | | | |
| 1,1-Dichloroethene | | | ● | | | | | | |
| Benzene | | | ● | X | | | | | |
| cis-1,2-Dichloroethene | | | ● | X | | | | | |
| Ethylbenzene | | | ● | X | | | | | |
| Heptachlor | | | ● | | | | | | X |
| Methyl Tertiary Butyl Ether | | | ● | X | | | | | |
| Naphthalene | | | | X | | | | | |
| Tetrachloroethane | | X | ● | | | | | | |
| Toluene | | | ● | X | | | | | |
| trans-1,2-Dichloroethene | | | ● | X | | | | | |
| Trichloroethene | | | ● | X | | | | | |
| Xylenes (Total) | | | ● | X | | | | | |
| Aluminum | | | | | | | | | X |
| Antimony | | | ● | X | ● | X | | | |
| Arsenic | | | ● | X | ● | | ● | X | |
| Barium | | | ● | X | | | | X | X |
| Beryllium | | | ● | X | | | | X | |
| Cadmium | | | ● | X | | | | | X |
| Cobalt | | | | X | | X | | X | |
| Copper | | | ● | X | | | ● | X | X |
| Lead | | | ● | X | ● | X | ● | X | |
| Manganese | | | ● | X | ● | X | | X | X |
| Mercury | | | ● | X | ● | X | ● | | X |
| Nickel | | | ● | X | | | ● | X | |
| Selenium | | | ● | X | | | | | X |
| Thallium | | | ● | X | ● | X | | | |
| Vanadium | | | | X | | X | | X | |
| Zinc | | | ● | X | | X | ● | X | X |
| Iron | | | | | ● | | | | |
| 2-Methylnaphthalene | | | | X | | | | | |
| 4,4'-DDE | X | | | | | | ● | X | X |
| 4,4'-DDT | X | | | | | | ● | X | X |
| 4,4'-DDD | X | | | | | | ● | X | X |

**TABLE 1 (Continued)**

**SUMMARY OF COPCs IN ENVIRONMENTAL MEDIA OF CONCERN**
**OPERABLE UNIT NO. 10 (SITE 35)**
**INTERIM RECORD OF DECISION, CTO-0232**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Contaminant | Surface Soil | Subsurface Soil | Ground-water | | Surface Water | | Sediment | | Fish |
|---|---|---|---|---|---|---|---|---|---|
| alpha-Chlordane | X | | | | | | ● | X | X |
| beta-BHC | | | | | | | | | X |
| Carbon disulfide | | | | | | | | | X |
| Chromium | | | | | | | ● | | |
| Dieldrin | X | | | | | | ● | X | X |
| Endosulfan II | | | | | | | | X | |
| Endrin Ketone | | | | | | | | | X |
| Endrin Aldehyde | | | | | | | | X | |
| Endrin | X | | | | | | ● | X | X |
| gamma-BHC | | | | | | | | | X |
| gamma-Chlordane | X | | | | | | ● | X | |
| Heptachlor Epoxide | | | | | | | | X | |
| Methoxychlor | | | | | | | | X | |

● Selected for comparison to existing criteria.
X Selected with respect to human health risk.

TABLE 2

TOTAL SITE RISK
OPERABLE UNIT NO. 10 (SITE 35)
INTERIM RECORD OF DECISION, CTO-0232
MCB CAMP LEJEUNE, NORTH CAROLINA

| Receptors | Soil | | Groundwater | | Surface Water | | Sediment | | Fish | | TOTALS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ICR | HI | ICR | HI | ICR | HI | ICR | HI | ICR | HI | ICR | HI |
| Future Child Resident | 4.1E-05 (<1) | 0.90 (<1) | 2.0E-03 | 64 (98) | NA | NA | NA | NA | NA | NA | 2.0E-03 | 65 |
| Future Adult Resident | 1.9E-05 (<1) | 0.10 (<1) | 4.3E-03 | 28 (99) | NA | NA | NA | NA | NA | NA | 4.3E-03 | 28 |
| Current Military Personnel | 3.2E-06 (100) | 0.10 (100) | NA | NA | NA | NA | NA | NA | NA | NA | 3.2E-06 | 0.10 |
| Future Construction Worker | 1.0E-07 (100) | 0.02 (100) | NA | NA | NA | NA | NA | NA | NA | NA | 1.0E-07 | 0.02 |
| Current Child Resident | NA | NA | NA | NA | ND | 0.02 (74) | 3.0E-07 (100) | <0.01 (26) | NA | NA | 3.0E-07 | 0.02 |
| Current Adult Resident | NA | NA | NA | NA | ND | 0.01 (<1) | 3.0E-07 (<1) | <0.01 (<1) | 1.35E-04 (99) | 3.56 (99) | 1.4E-04 | 3.57 |

Notes: ICR = Incremental Lifetime Cancer Risk
HI = Hazard Index
Total = Soil + Groundwater
ND = Not Determined
NA = Not Applicable

## TABLE 3

## SUMMARY OF ALTERNATIVES EVALUATION
## OPERABLE UNIT NO. 10 (SITE 35)
## INTERIM PROPOSED REMEIDAL ACTION PLAN, CTO-0232
## MCB CAMP LEJEUNE, NORTH CAROLINA

| Evaluation Criteria | RAA 1<br>No Action | RAA 2<br>No Action with Institutional Controls | RAA 3<br>Groundwater Collection and On-Site Treatment | RAA 4<br>In Situ Air Sparging and Off-Gas Carbon Adsorption | RAA 5<br>In Well Aeration and Off-Gas Carbon Adsorption |
|---|---|---|---|---|---|
| OVERALL PROTECTIVENESS | | | | | |
| • Human Health | Potential risks associated with groundwater exposure will remain. Some reduction in contaminant levels may result from natural attenuation. | Aquifer-use restrictions mitigate risks from direct groundwater exposure. | Active collection and treatment will reduce contaminant levels in groundwater within capture zone of interceptor trench (estimated at 100 feet upgradient maximum). Aquifer-use restrictions will also mitigate risks from direct groundwater exposure. | Active in situ volatilization and biodegradation will reduce contaminant levels in groundwater within radius of influence of wells (estimated at 25 feet). Aquifer-use restrictions will also mitigate risks from direct groundwater exposure. | Active in-well volatilization and in situ biodegradation will reduce contaminant levels in groundwater within radius of influence of wells (estimated at 45 to 60 feet). Aquifer-use restrictions will also mitigate risks from direct groundwater exposure. |
| • Environment | Contaminated groundwater will continue to be a source of future contamination to Brinson Creek. | Contaminated groundwater will continue to be a source of future contamination to Brinson Creek. | Interceptor trench serves as a barrier to contaminated groundwater discharge to Brinson Creek. | Air sparging wells and SVE wells serve as a barrier to contaminated groundwater discharge to Brinson Creek. | Aeration wells serve as a barrier to contaminated groundwater discharge to Brinson Creek. |
| COMPLIANCE WITH ARARs | | | | | |
| • Chemical-Specific | No active effort made to reduce groundwater contaminant levels to below federal or state ARARs. | No active effort made to reduce groundwater contaminant levels to below federal or state ARARs. | Reductions in groundwater contaminant levels to below federal or state ARARs can be expected within capture zone of interceptor trench. Reductions upgradient will be less substantial if at all. | Reductions in groundwater contaminant levels to below federal or state ARARs can be expected within radius of influence of wells. Reductions upgradient will be less substantial if at all. | Reductions in groundwater contaminant levels to below federal or state ARARs can be expected within radius of influence of wells. Reductions upgradient will be less substantial if at all. |
| • Location-Specific | Not Applicable. | Not Applicable. | Wetlands and alligators (endangered species) are concerns because of proposed location of interceptor trench. It is assumed that necessary approvals can be obtained. | Wetlands and alligators (endangered species) are concerns because of proposed location of interceptor trench. It is assumed that necessary approvals can be obtained. | Wetlands and alligators (endangered species) are concerns because of proposed location of interceptor trench. It is assumed that necessary approvals can be obtained. |

TABLE 3 (Continued)

SUMMARY OF ALTERNATIVES EVALUATION
OPERABLE UNIT NO. 10 (SITE 35)
INTERIM PROPOSED REMEDIAL ACTION PLAN, CTO-0232
MCB CAMP LEJEUNE, NORTH CAROLINA

| Evaluation Criteria | RAA 1<br>No Action | RAA 2<br>No Action with Institutional Controls | RAA 3<br>Groundwater Collection and On-Site Treatment | RAA 4<br>In Situ Air Sparging and Off-Gas Carbon Adsorption | RAA 5<br>In Well Aeration and Off-Gas Carbon Adsorption |
|---|---|---|---|---|---|
| • Action-Specific | Not Applicable. | Not Applicable. | Can be designed to meet these ARARs. | Can be designed to meet these ARARs. | Can be designed to meet these ARARs. |
| LONG-TERM EFFECTIVENESS AND PERFORMANCE | | | | | |
| • Magnitude of Residual Risk | Any long-term effect on contamination will be the result of natural attenuation processes only. | Any long-term effect on contamination will be the result of natural attenuation processes only.<br><br>Aquifer-use restrictions will provide a permanent means for protection against direct exposure to the contaminated surficial groundwater. | Provides an effective means of intercepting contaminated groundwater and blocking its discharge to Brinson Creek for as long as it remains in operation.<br><br>Aquifer-use restrictions will provide a permanent means for protection against direct exposure to the contaminated surficial groundwater. | Provides an effective means of intercepting and treating contaminated groundwater prior to its discharge to Brinson Creek for as long as it remains in operation.<br><br>Toxic vapors escaping to the air due to poor vapor extraction may increase risk to community.<br><br>Aquifer-use restrictions will provide a permanent means for protection against direct exposure to the contaminated surficial groundwater. | Provides an effective means of intercepting and treating contaminated groundwater prior to its discharge to Brinson Creek for as long as it remains in operation.<br><br>Aquifer-use restrictions will provide a permanent means for protection against direct exposure to the contaminated surficial groundwater. |

TABLE 3 (Continued)

SUMMARY OF ALTERNATIVES EVALUATION
OPERABLE UNIT NO. 10 (SITE 35)
INTERIM PROPOSED REMEDIAL ACTION PLAN, CTO-0232
MCB CAMP LEJEUNE, NORTH CAROLINA

| Evaluation Criteria | RAA 1<br>No Action | RAA 2<br>No Action with Institutional Controls | RAA 3<br>Groundwater Collection and On-Site Treatment | RAA 4<br>In Situ Air Sparging and Off-Gas Carbon Adsorption | RAA 5<br>In Well Aeration and Off-Gas Carbon Adsorption |
|---|---|---|---|---|---|
| • Adequacy and Reliability of Controls | Not Applicable. | Aquifer-use restrictions are reliable if enforced. Enforcement is likely as Camp Geiger is a controlled military installation | Interceptor trench involves basic technology and should be adequate and reliable for an indefinite period. | Air sparging has a long track record of commercial use and should be able to be controlled adequately and reliably for an indefinite period. High levels of metals in groundwater could short circuit the system prompting frequent maintenance. Well replacement over several years may result. | In well aeration is a relatively new technology without a substantial commercial track record. High levels of metals could short circuit the system prompting frequent maintenance. Well replacement over several years may result. |
| • Estimated Period of Operation | 30 Years | 30 Years | 30 years unless additional active treatment actions are implemented upgradient. | 30 years unless additional active treatment actions are implemented upgradient. | 30 years unless additional active treatment actions are implemented upgradient. |
| • Need for 5-Year Review | Review required because no active treatment is included | Review required because no active treatment is included. | Review required because area impacted by treatment will be limited. | Review required because area impacted by treatment will be limited. | Review required because area impacted by treatment will be limited. |
| REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT | | | | | |
| • Treatment Process Used | No active treatment process applied. | No active treatment process applied. | On-site groundwater treatment includes filtration, metals precipitation, air stripping, air and water carbon adsorption. | In situ volatilization and biodegradation. Off-gas carbon adsorption. | In situ volatilization and biodegradation. Off-gas carbon adsorption. |

TABLE 3 (Continued)

SUMMARY OF ALTERNATIVES EVALUATION
OPERABLE UNIT NO. 10 (SITE 35)
INTERIM PROPOSED REMEDIAL ACTION PLAN, CTO-0232
MCB CAMP LEJEUNE, NORTH CAROLINA

| Evaluation Criteria | RAA 1<br>No Action | RAA 2<br>No Action with Institutional Controls | RAA 3<br>Groundwater Collection and On-Site Treatment | RAA 4<br>In Situ Air Sparging and Off-Gas Carbon Adsorption | RAA 5<br>In Well Aeration and Off-Gas Carbon Adsorption |
|---|---|---|---|---|---|
| • Reduction of Toxicity, Mobility or Volume | No reduction except by natural attenuation. | No reduction except by natural attenuation. | Reduction of organic and inorganic contaminants expected within capture zone of trench. | Reduction of organic contaminants expected within radius of influence of wells. | Reduction of organic contaminants expected within radius of influence of wells. |
| • Residuals Remaining After Treatment | No active treatment process applied. | No active treatment process applied. | Residuals include metals sludge and spent carbon which would have to be disposed of properly. | Residuals requiring disposal include spent carbon and a small volume of condensed contaminated vapor (water). | Residuals requiring disposal include spent carbon and a small volume of condensed contaminated vapor (water). |
| • Statutory Preference for Treatment | Not satisfied. | Not satisfied. | Satisfied except that area impacted by treatment is limited and does not include entire plume of contaminated surficial groundwater. | Satisfied except that area impacted by treatment is limited and does not include entire plume of contaminated surficial groundwater. | Satisfied except that area impacted by treatment is limited and does not include entire plume of contaminated surficial groundwater. |
| SHORT-TERM EFFECTIVENESS | | | | | |
| • Community Protection | Risks to community not increased by remedy implementation. | Risks to community not increased by remedy implementation. | Minimal, if any, risks during collection and treatment. | Possible migration of toxic vapors through ground surface because vapor extraction is difficult to control when groundwater surface is within several feet of ground surface. | Minimal, if any, risks during operation and treatment. |
| • Worker Protection | None. | Protection required during well installation and sampling. | Trench installation procedure limits worker exposure by design. | Minimal potential for worker exposure. | Minimal potential for worker exposure. |

**TABLE 3 (Continued)**

**SUMMARY OF ALTERNATIVES EVALUATION**
**OPERABLE UNIT NO. 10 (SITE 35)**
**INTERIM PROPOSED REMEDIAL ACTION PLAN, CTO-0232**
**MCB CAMP LEJEUNE, NORTH CAROLINA**

| Evaluation Criteria | RAA 1 No Action | RAA 2 No Action with Institutional Controls | RAA 3 Groundwater Collection and On-Site Treatment | RAA 4 In Situ Air Sparging and Off-Gas Carbon Adsorption | RAA 5 In Well Aeration and Off-Gas Carbon Adsorption |
|---|---|---|---|---|---|
| • Environmental Impacts | Continued impacts from unchanged existing conditions. | Continued impacts from unchanged existing conditions. | Wetlands disturbance during installation could be significant. Trench will serve as a barrier for contaminated groundwater discharge to Brinson Creek. | Minimal wetlands disturbance. System will serve as a barrier for contaminated groundwater discharge to Brinson Creek. | Minimal wetlands disturbance. System will serve as a barrier for contaminated groundwater discharge to Brinson Creek. |
| • Installation Period | Not Applicable. | Less than 30 days required to install additional groundwater monitoring wells. | 60 to 90 days estimated to install trench and treatment system. | 60 to 90 days estimated to install sparging and SVE wells and treatment system. | 60 to 90 days estimated to install aeration wells and treatment system. |
| IMPLEMENTABILITY | | | | | |
| • Ability to Construct and Operate | No construction or operation activities. | Involves standard well installation and sampling only. | Soft ground in wetlands areas may hamper construction and result in delays. Once installed, operating is straight-forward using commercially proven technology. Approximately 2,000 to 3,000 cubic yards of potentially contaminated soil excavated from the trench will require disposal. Lack of access may be a significant lost factor. | Construction of activities involve primarily well installation which has been previously executed successfully in this area. Disposal of drill cuttings required.<br><br>Thin vadose zone may hamper effective vapor extraction which could result in the release of toxic vapors to atmosphere.<br><br>High metals in groundwater could clog well screens which would require frequent maintenance or well replacement. | Construction of activities involve primarily well installation which has been previously executed successfully in this area. Disposal of drill cuttings required.<br><br>High metals in groundwater could clog well screens which would require frequent maintenance or well replacement. |

TABLE 3 (Continued)

SUMMARY OF ALTERNATIVES EVALUATION
OPERABLE UNIT NO. 10 (SITE 35)
INTERIM PROPOSED REMEDIAL ACTION PLAN, CTO-0232
MCB CAMP LEJEUNE, NORTH CAROLINA

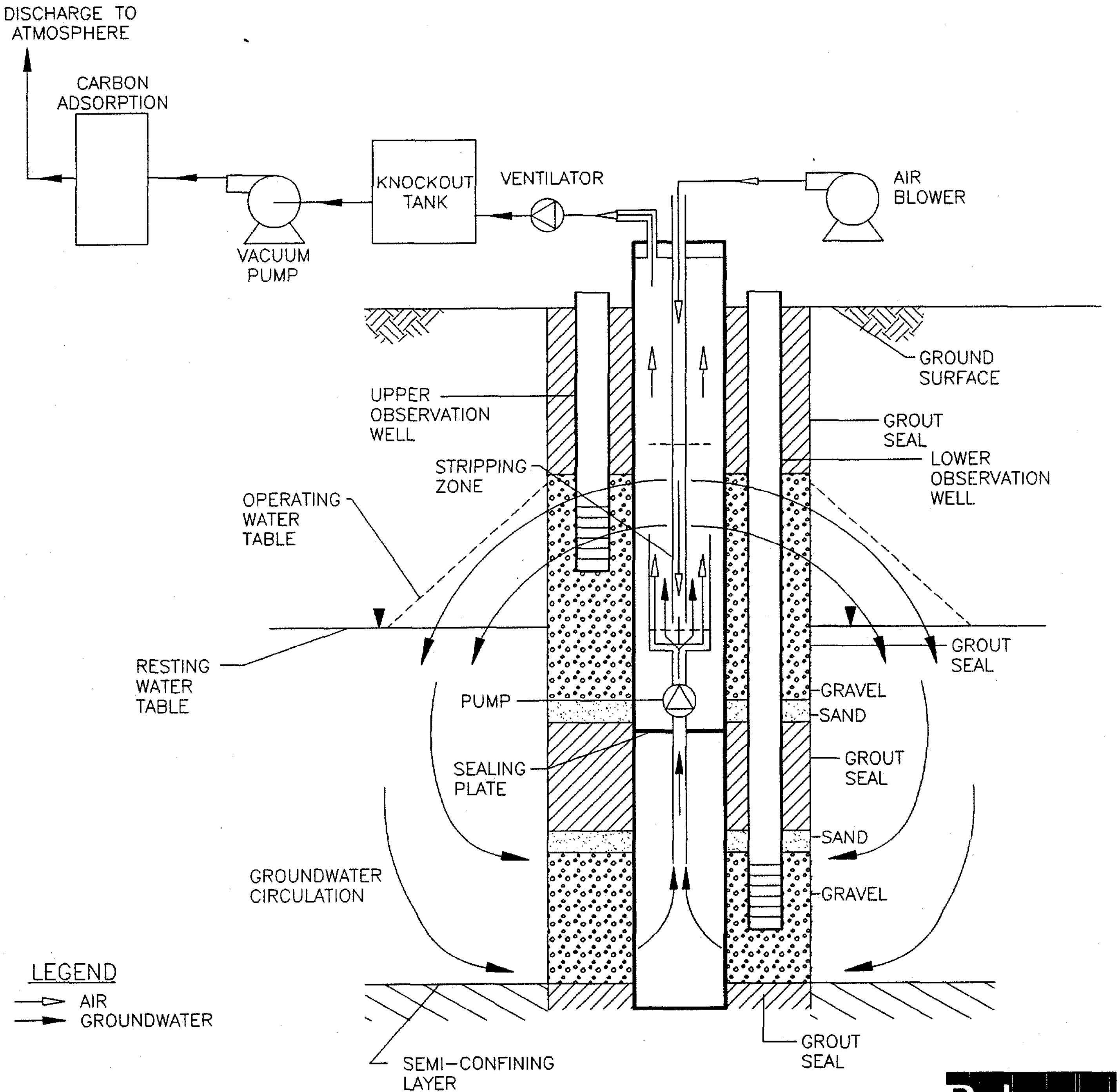
| Evaluation Criteria | RAA 1<br>No Action | RAA 2<br>No Action with Institutional Controls | RAA 3<br>Groundwater Collection and On-Site Treatment | RAA 4<br>In Situ Air Sparging and Off-Gas Carbon Adsorption | RAA 5<br>In Well Aeration and Off-Gas Carbon Adsorption |
|---|---|---|---|---|---|
| • Ability to Monitor Effectiveness | No monitoring. | Proposed monitoring will provide an indication of effects of natural attenuation and progress of contaminants migration. | Proposed monitoring will give notice of failure so that system can be adjusted before a significant contaminant release occurs. | Proposed monitoring will give notice of failure so that system can be adjusted before a significant contaminant release occurs. | Proposed monitoring will give notice of failure so that system can be adjusted before a significant contaminant release occurs. |
| • Availability of Services and Equipment | None required. | Well installation and sampling services available from multiple vendors. | Biopolymer trench technology available from a limited number of vendors. | Air sparging technology is available from multiple vendors. | In well aeration is a patented priority technology currently available from only one vendor. |
| • Requirements for Agency Coordination | None required. | Must submit semi-annual reports to document sampling reports. | Special permit to perform construction in wetlands may be required. Air and water discharge permits required. | Special permit to perform construction in wetlands may be required. Air and water discharge permits required. | Special permit to perform construction in wetlands may be required. Air and water discharge permits required. |
| COSTS<br>• Net Present Worth (30 years) | $0 | $299,800 | $3,225,000 | $2,810,800 | $2,625,100 |
| USEPA/State Acceptance | Not preferred because impact to Brinson Creek would be unabated. | Not preferred because impact to Brinson Creek would be unabated. | Acceptable because impact to Brinson Creek would be controlled. In addition, EPA/State prefer treatment alternatives. | EPA/State prefer treatment alternatives. Acceptance likely if off-gas discharges do not present health hazards. | Acceptable because impact to Brinson Creek would be controlled. In addition, EPA/State prefer treatment alternatives. |
| Community Acceptance | Not preferred because impact to Brinson Creek would be unabated. | Not preferred because impact to Brinson Creek would be unabated. | Acceptance likely because impact to Brinson Creek would be controlled. | Acceptance likely if off-gas discharges do not impact the neighboring populace. | Acceptance likely because impact to Brinson Creek would be controlled. |

TABLE 4

GLOSSARY OF EVALUATION CRITERIA
OPERABLE UNIT NO. 10 (SITE 35)
INTERIM RECORD OF DECISION, CTO-0232
MCB CAMP LEJEUNE, NORTH CAROLINA

- **Overall Protection of Human Health and Environmental** - 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** - addressed 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 statutes and/or provide grounds for invoking a waiver.
- **Long-term Effectiveness and Permanence** - refers to the magnitude of residual risk and the ability of an alternative to maintain reliable protection of human health and the environment over time once cleanup goals have been met.
- **Reduction of Toxicity, Mobility, or Volume through Treatment** - is 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 remedy's potential to create adverse impacts on human health and the environment that may result during the construction and implementation period.
- **Implementability** - is 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 costs. For comparative purposes, presents present worth values.
- **USEPA/State Acceptance** - indicates whether, based on review of the RI and FS reports and the PRAP, the USEPA and state concur with, oppose, or have no comments on the preferred alternative.
- **Community Acceptance** - assessed in the Record of Decision (ROD) following a review of the public comments received on the RI and FS reports on the PRAP.

# FIGURES



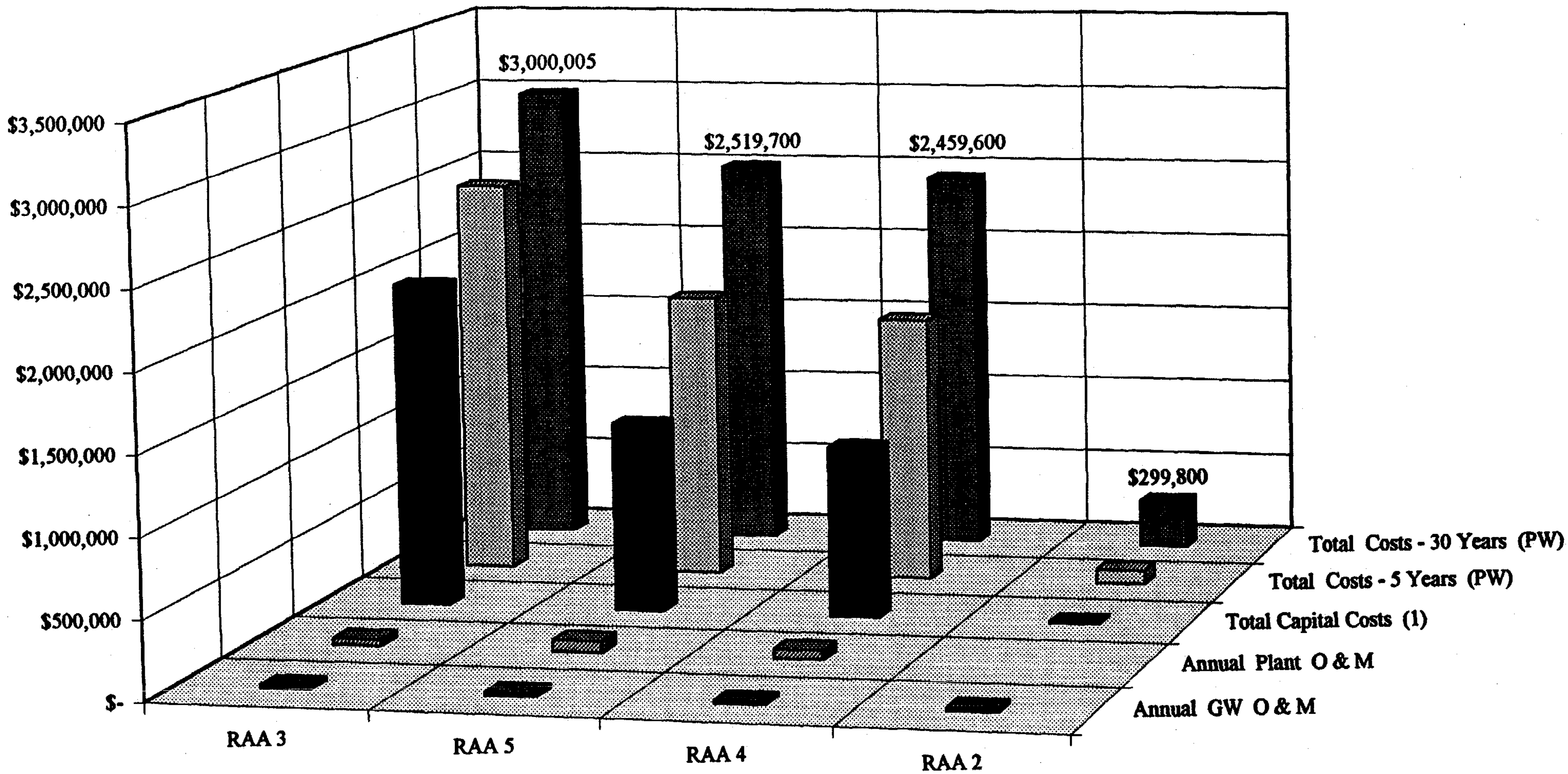

REFERENCE: HERRLING, B., ET AL., FIGURE 1.(a), P.59.
232208PR

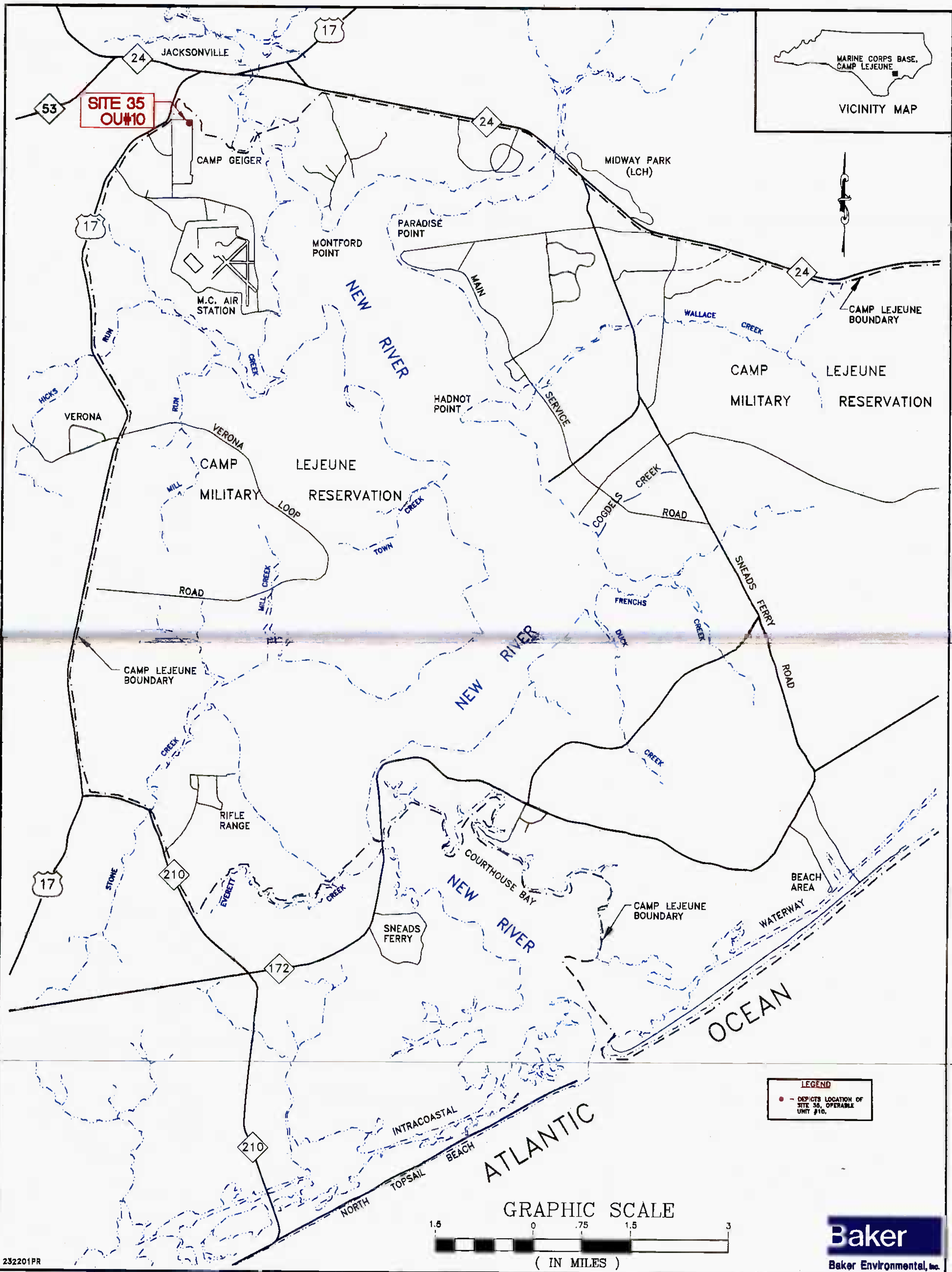
Baker
Baker Environmental, Inc.

FIGURE 11
RAA 5: IN WELL AERATION AND OFF-GAS CARBON ADSORPTION –
TYPICAL WELL DETAIL AND PROCESS FLOW DIAGRAM
SITE 35, CAMP GEIGER AREA FUEL FARM INTERIM ROD
CONTRACT TASK ORDER – 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

**FIGURE 12**

**COMPARISON OF COSTS**
**RAAs 2, 3, 4, and 5**
**SITE 35 - CAMP GEIGER FUEL FARM**
**MCB CAMP LEJEUNE, NC**



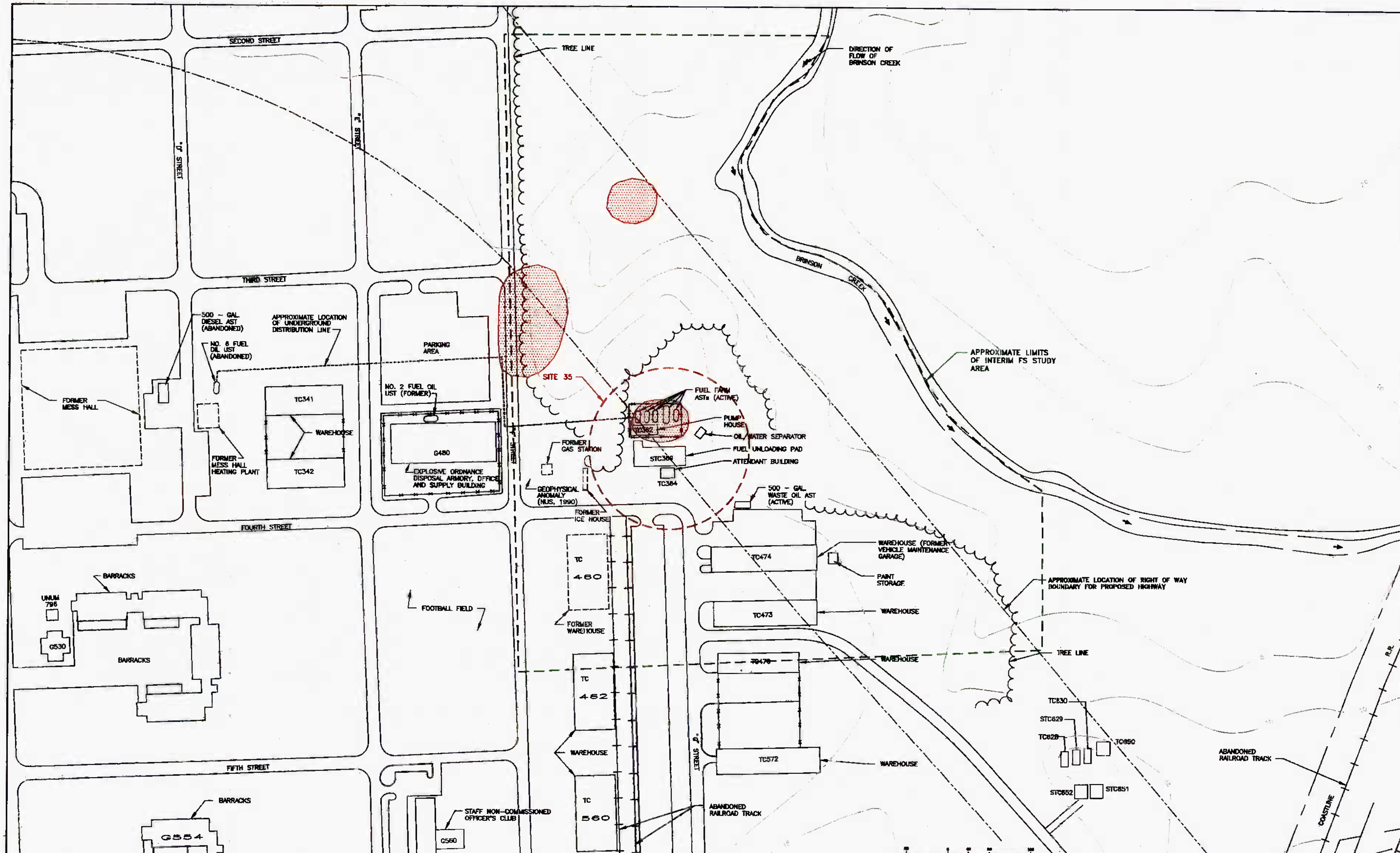



Baker
Baker Environmental, Inc.

FIGURE 1
CAMP LEJEUNE AND SITE 35
LOCATION MAP

MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01546JJB1Y




LEGEND

| | |
|---|---|
| -x-x- | FENCE LINE |
| —10— | CONTOUR LINES DEPICTING SURFICIAL RELIEF |
| - - - - | APPROXIMATE LOCATION OF THE UNDERGROUND DISTRIBUTION LINE |
| — — — | APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY |
| (shaded) | APPROXIMATE LIMITS OF SOIL CONTAMINATION SUBJECT TO REMEDIATION UNDER INTERIM ROD CTO-0160 DATED AUGUST 31, 1994. |

| | |
|---|---|
| DATE | MAY 1995 |
| SCALE | SEE BAR SCALE |
| DRAWN | REL |
| REVIEWED | JSC |
| S.O.# | 62470-232-0000-07000 |
| CADD# | 232202PR |

NORTH

INTERIM ROD FOR SURFICAL GROUNDWATER, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

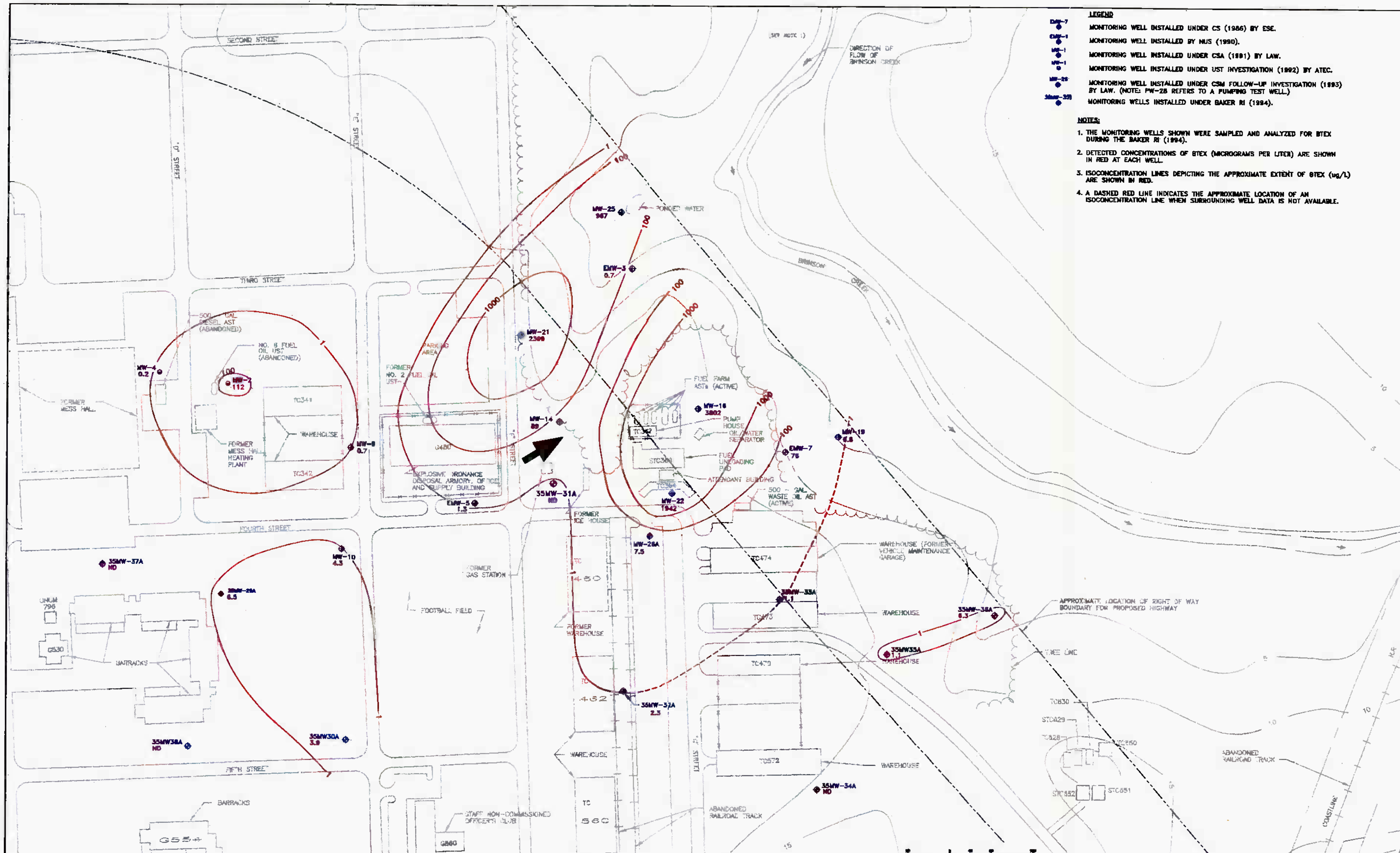
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

SITE PLAN
SITE 35 - CAMP GEIGER AREA FUEL FARM
CONTRACT TASK ORDER - 0232

SCALE SEE BAR SCALE
DATE MAY 1995

FIGURE No.
2




**LEGEND**

- FENCE LINE
- CONTOUR LINES DEPICTING SURFICIAL RELIEF
- ISOCONCENTRATION LIMITS OF COMBINED BTEX
- APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY
- APPROXIMATE GROUNDWATER FLOW DIRECTION

| | |
|---|---|
| DATE | NOVEMBER 1994 |
| SCALE | SEE BAR SCALE |
| DRAWN | REL |
| REVIEWED | JSC |
| S.O.# | 62470-232-0000-07000 |
| CADD# | 232203PH |

NORTH

INTERIM ROD FOR SURFICIAL GROUNDWATER, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

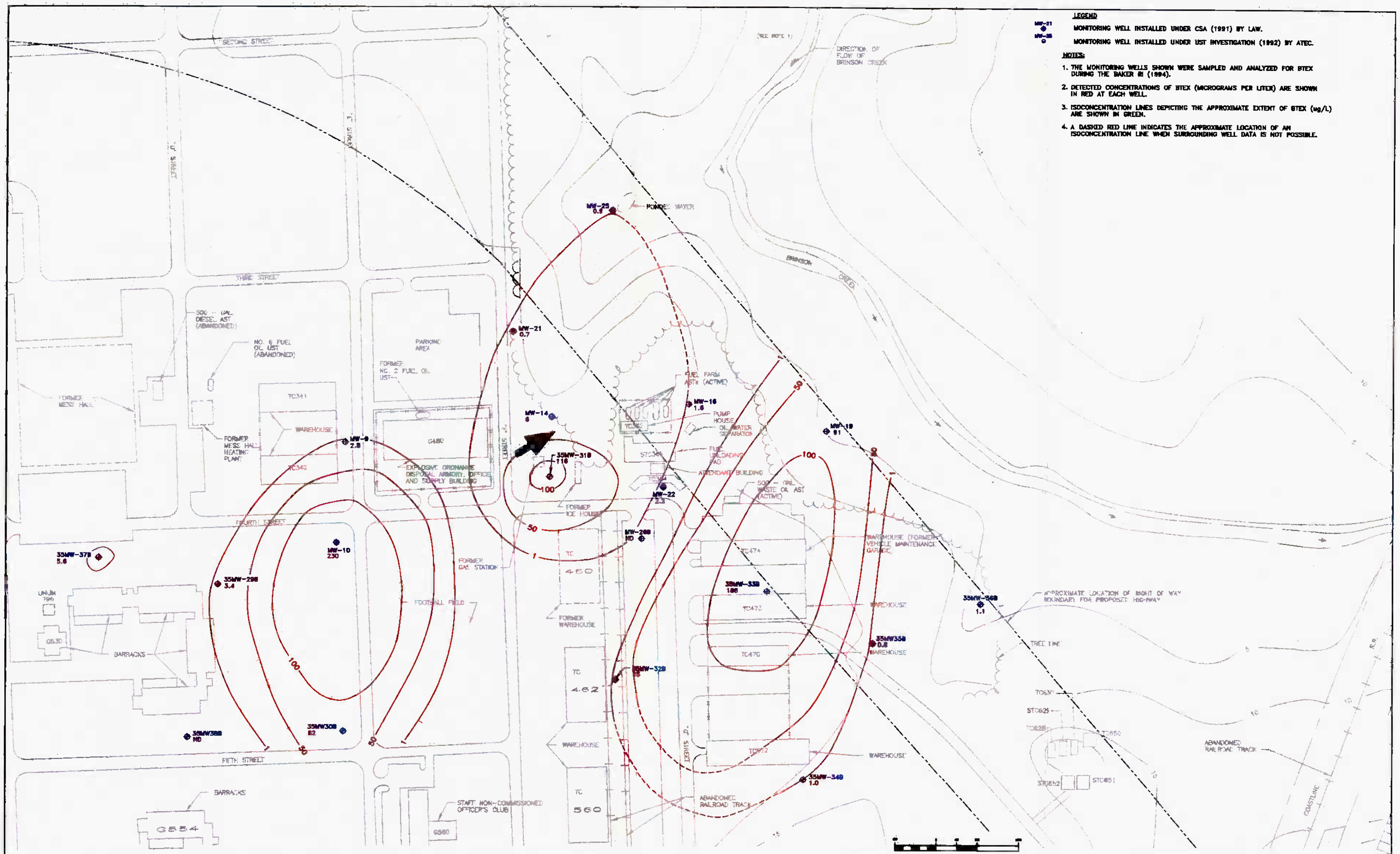
Baker
Baker Environmental, Inc.

LIMITS OF COMBINED BTEX IN THE UPPER PORTION OF THE SURFICIAL AQUIFER
SITE 35 – CAMP GEIGER AREA FUEL FARM

SCALE SEE BAR SCALE

DATE NOVEMBER 1994

FIGURE No. 3




| | |
|---|---|
| LEGEND | |
| FENCE LINE | |
| 15 | CONTOUR LINES DEPICTING SURFICIAL RELIEF |
| 50 | ISOCONCENTRATION LIMITS OF COMBINED BTEX |
| | APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY |
| | APPROXIMATE GROUNDWATER FLOW DIRECTION |

| | |
|---|---|
| DATE | DEC. 1994 |
| SCALE | SEE BAR SCALE |
| DRAWN | REL |
| REVIEWED | JSC |
| S.O.# | 62470-232-0000-07000 |
| CADD# | 232204PR |

NORTH

INTERIM ROD FOR SURFICIAL GROUNDWATER, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

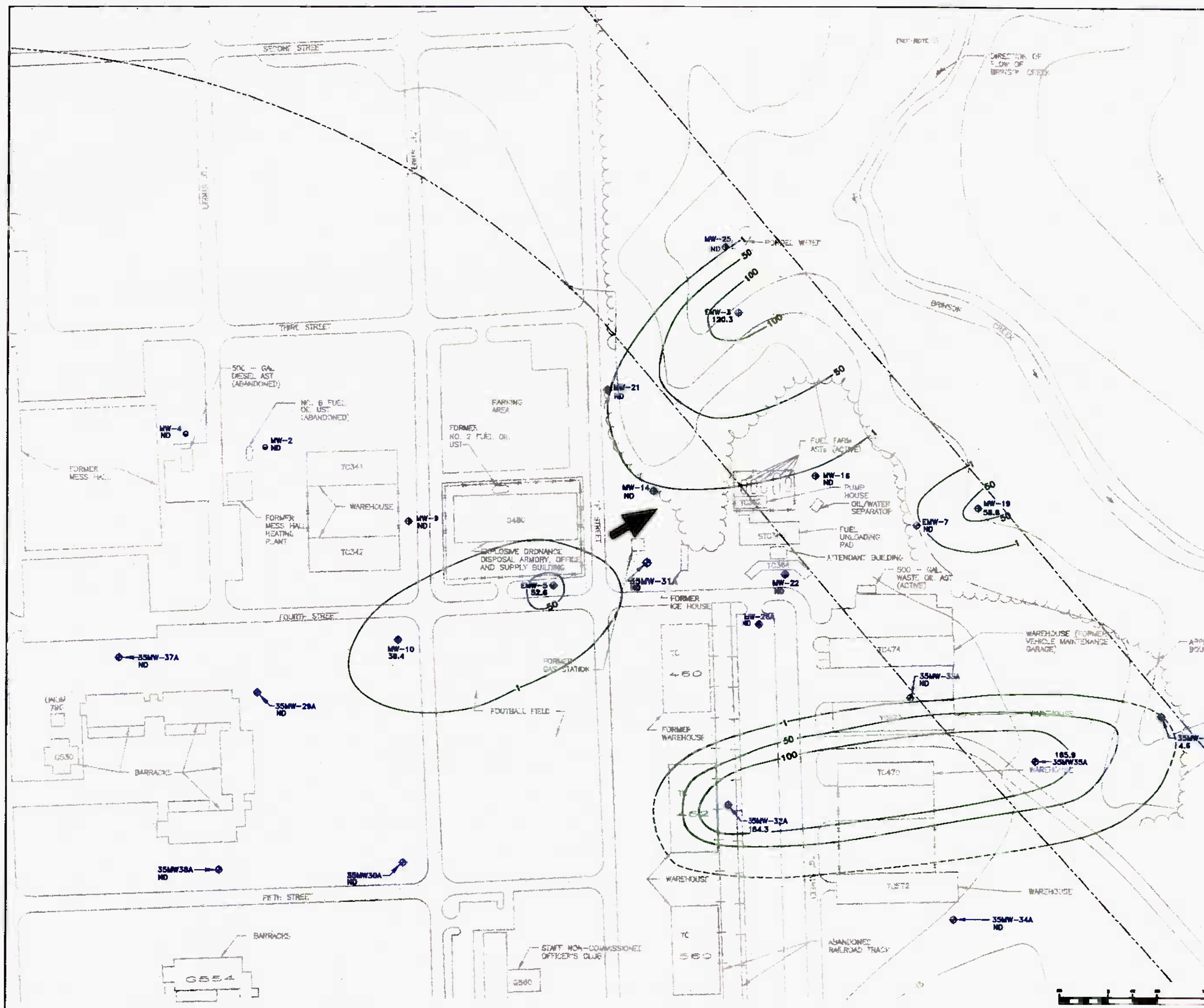
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

LIMITS OF COMBINED BTEX IN THE LOWER PORTION OF THE SURFICIAL AQUIFER
SITE 35 – CAMP GEIGER AREA FUEL FARM

SCALE SEE BAR SCALE | DATE DEC. 1994

FIGURE No. 4




LEGEND

- MONITORING WELL INSTALLED UNDER CS (1986) BY ESE.
- MONITORING WELL INSTALLED BY NUS (1990).
- MONITORING WELL INSTALLED UNDER CSA (1991) BY LAW.
- MONITORING WELL INSTALLED UNDER UST INVESTIGATION (1992) BY ATEC.
- MONITORING WELL INSTALLED UNDER CSM FOLLOW-UP INVESTIGATION (1993) BY LAW. (NOTE: PW-28 REFERS TO A PUMPING TEST WELL.)
- MONITORING WELLS INSTALLED UNDER BAKER RI (1994).

NOTES:

1. THE MONITORING WELLS SHOWN WERE SAMPLED AND ANALYZED FOR HALOGENATED ORGANIC COMPOUNDS DURING THE BAKER RI (1994).
2. DETECTED CONCENTRATIONS OF HALOGENATED ORGANIC COMPOUNDS (MICROGRAMS PER LITER) ARE SHOWN IN GREEN AT EACH WELL.
3. ISOCONCENTRATION LINES DEPICTING THE APPROXIMATE EXTENT OF HALOGENATED ORGANICS (ug/L) ARE SHOWN IN GREEN.
4. A DASHED GREEN LINE INDICATES THE APPROXIMATE LOCATION OF AN ISOCONCENTRATION LINE WHEN SURROUNDING WELL DATA IS NOT AVAILABLE.

LEGEND

- FENCE LINE
- 45 - CONTOUR LINES DEPICTING SURFICIAL RELIEF
- 50 - ISOCONCENTRATION LIMITS OF COMBINED HALOGENATED ORGANICS.
- APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY
- APPROXIMATE GROUNDWATER FLOW DIRECTION

| | |
|---|---|
| DATE | DEC. 1994 |
| SCALE | SEE BAR SCALE |
| DRAWN | REL |
| REVIEWED | JSC |
| S.O.# | 62470-232-0000-07000 |
| CADD# | 232205PR |

NORTH

**INTERIM ROD FOR SURFICIAL GROUNDWATER, CTO-0232**
**MARINE CORPS BASE, CAMP LEJEUNE**
**NORTH CAROLINA**

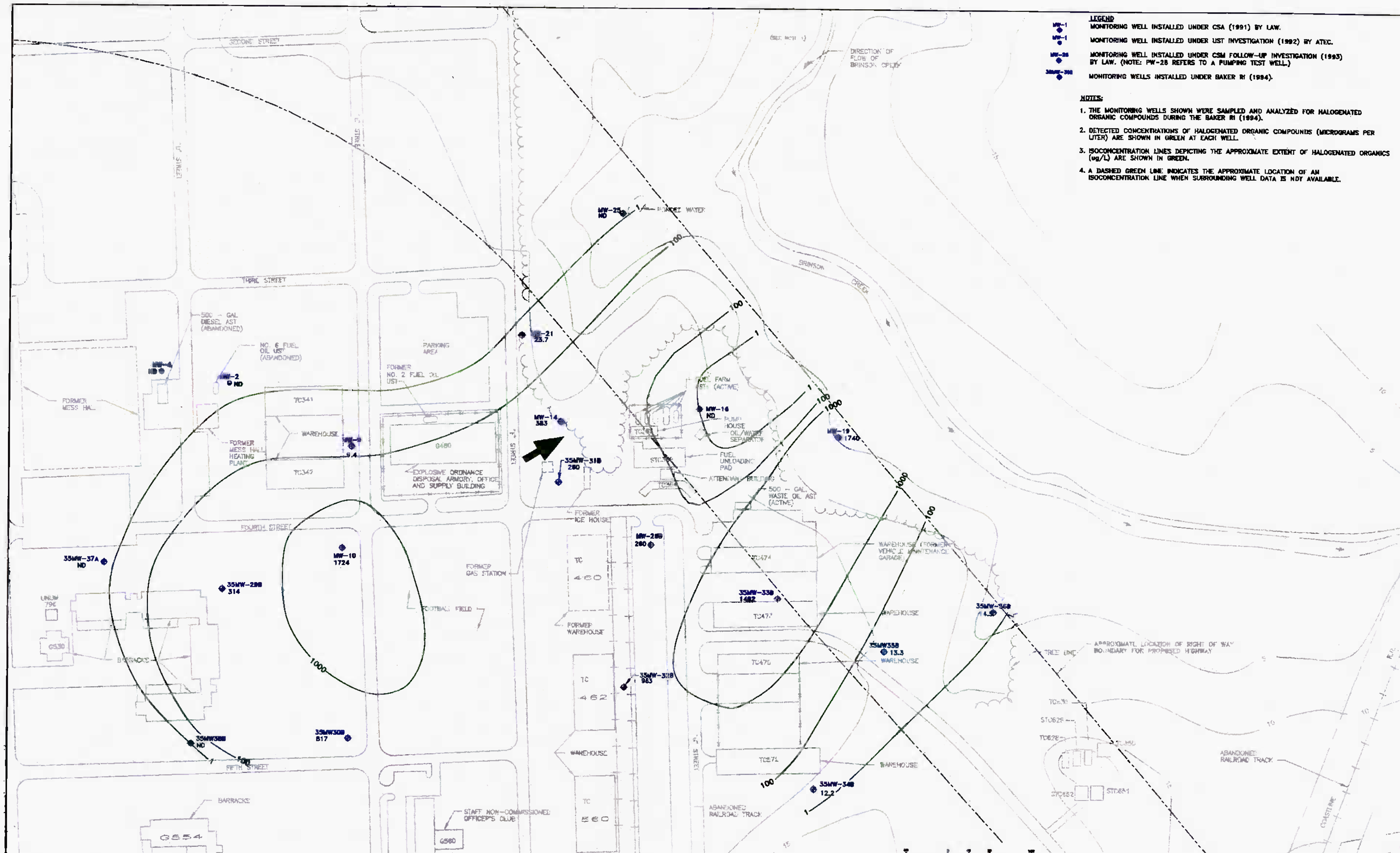
BAKER ENVIRONMENTAL,Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

LIMITS OF COMBINED HALOGENATED ORGANIC COMPOUNDS IN THE UPPER PORTION OF THE SURFICIAL AQUIFER
SITE 35 - CAMP GEIGER AREA FUEL FARM

SCALE SEE BAR SCALE
DATE DEC. 1994

FIGURE No.
5




| LEGEND | |
|---|---|
| — FENCE LINE | |
| —15— | — CONTOUR LINES DEPICTING SURFICIAL RELIEF |
| —100— | — ISOCONCENTRATION LIMITS OF COMBINED HALOGENATED ORGANICS. |
| | — APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY |
| | — APPROXIMATE GROUNDWATER FLOW DIRECTION |

| | |
|---|---|
| DATE | DEC. 1994 |
| SCALE | SEE BAR SCALE |
| DRAWN | REL |
| REVIEWED | JSC |
| S.O.# | 62470-232-0000-07000 |
| CADD# | 232206PR |

NORTH

INTERIM ROD FOR SURFICIAL GROUNDWATER, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

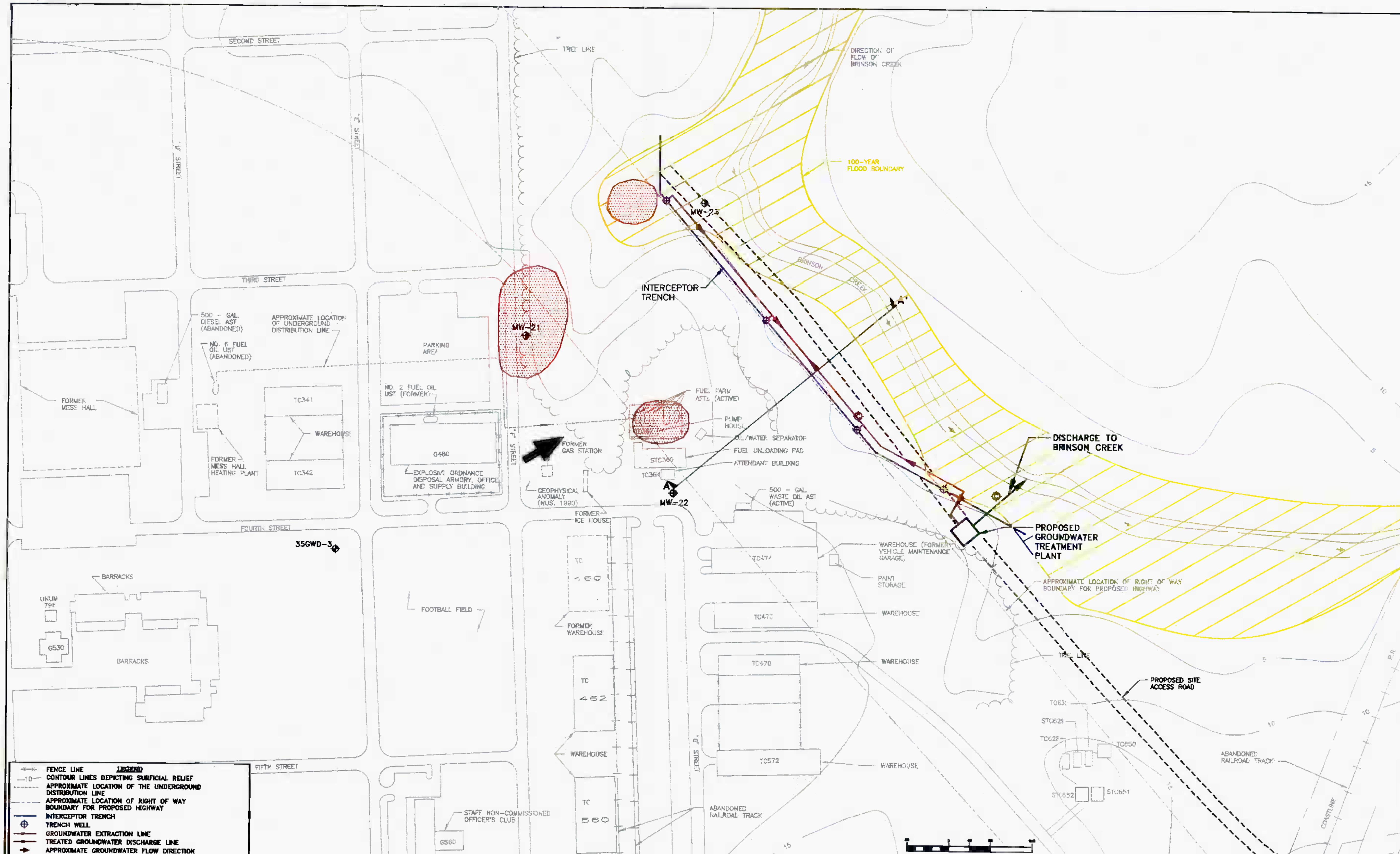
BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

LIMITS OF COMBINED HALOGENATED ORGANIC COMPOUNDS IN THE LOWER PORTION OF THE SURFICIAL AQUIFER
SITE 35 – CAMP GEIGER AREA FUEL FARM

SCALE SEE BAR SCALE | DATE DEC. 1994

FIGURE No. 6




**LEGEND**

- FENCE LINE
- CONTOUR LINES DEPICTING SURFICIAL RELIEF
- APPROXIMATE LOCATION OF THE UNDERGROUND DISTRIBUTION LINE
- APPROXIMATE LOCATION OF RIGHT OF WAY BOUNDARY FOR PROPOSED HIGHWAY
- INTERCEPTOR TRENCH
- TRENCH WELL
- GROUNDWATER EXTRACTION LINE
- TREATED GROUNDWATER DISCHARGE LINE
- APPROXIMATE GROUNDWATER FLOW DIRECTION
- APPROXIMATE LIMITS OF SOIL CONTAMINATION SUBJECT TO REMEDIATION UNDER INTERIM ROD CTO-0160 DATED AUGUST 31, 1994.
- 100 YEAR FLOOD BOUNDARY (ref. FIRM FLOOD INSURANCE RATE MAP, ONSLOW COUNTY, NORTH CAROLINA; FEMA COMMUNITY PANEL NUMBER 3 70340 0305C.
- PROPOSED LOCATION OF SITE ACCESS ROAD

PROPOSED LONG TERM MONITORING WELLS:

- MW-23 EXISTING WELL CLUSTER IN THE SURFICIAL AQUIFER
- EXISTING WELL IN THE DEEP AQUIFER
- PROPOSED WELL CLUSTER IN THE SURFICIAL AQUIFER

| | |
|---|---|
| DATE | MAY 1995 |
| SCALE | SEE BAR SCALE |
| DRAWN | REL |
| REVIEWED | JSC |
| S.O.# | 62470-232-0000-07000 |
| CADD# | 232219FS |

NORTH

INTERIM ROD FOR SURFICIAL GROUNDWATER, CTO - 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
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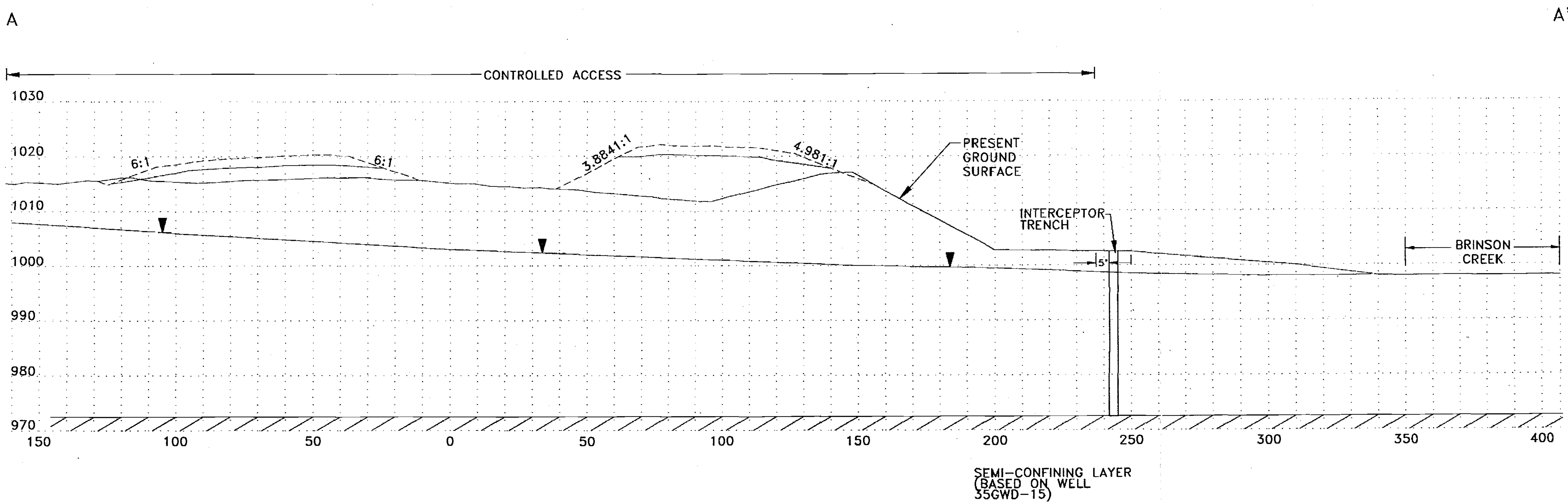
RAA 3: GROUNDWATER COLLECTION AND ON-SITE TREATMENT - PLAN VIEW
CONTRACT TASK ORDER - 0232

SCALE SEE BAR SCALE | DATE MAY 1995

FIGURE No. 7




232108FS

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LEGEND

▼ GROUNDWATER LEVEL IN THE SURFICIAL AQUIFER

- - - - SURFACE OF PROPOSED HIGHWAY

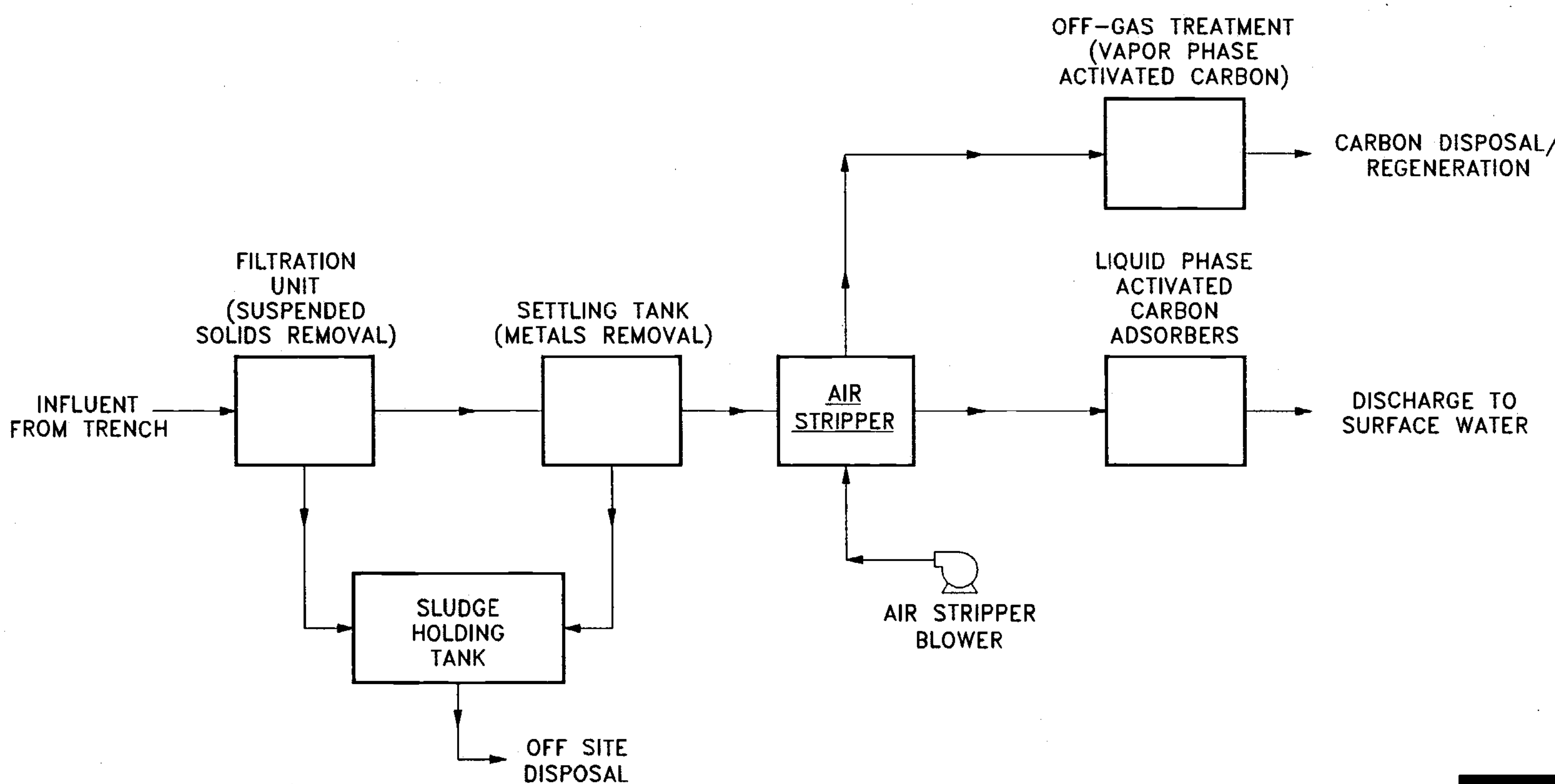
SOURCE: LANTDIV, FEB. 1992

Horizontal Scale: 1 inch = 40 ft.

Vertical Scale: 1 inch = 20 ft.

FIGURE 8
RAA 3: GROUNDWATER COLLECTION AND ON-SITE TREATMENT – CROSS-SECTION A–A'
SITE 35, CAMP GIEGER FUEL FARM INTERIM ROD
CONTRACT TASK ORDER – 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

01546JJ01Z

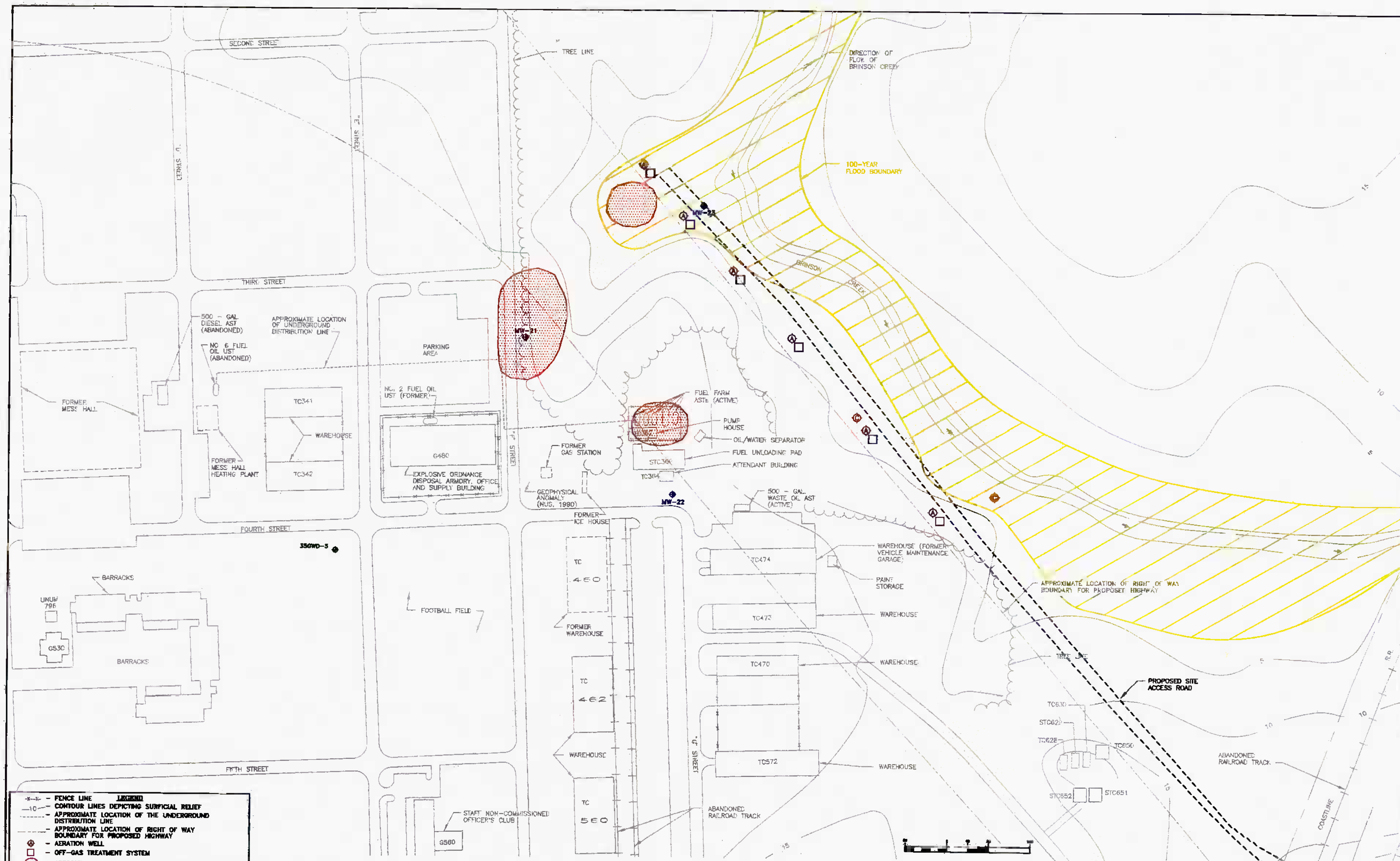



Baker

Baker Environmental, Inc.

FIGURE 9
RAA 3: GROUNDWATER COLLECTION AND ON-SITE TREATMENT-
PROCESS FLOW DIAGRAM
SITE 35, CAMP GEIGER AREA FUEL FARM INTERIM ROD
CONTRACT TASK ORDER - 0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

232109FS




| | |
|---|---|
| DATE | MARCH 1995 |
| SCALE | SEE BAR SCALE |
| DRAWN | REL |
| REVIEWED | JSC |
| S.O.# | 62470-232-0000-07000 |
| CADD# | 232207PR |

INTERIM ROD FOR GROUNDWATER REMEDIATION, CTO-0232
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

BAKER ENVIRONMENTAL, Inc.
Coraopolis, Pennsylvania

Baker
Baker Environmental, Inc.

RAA 5: IN WELL AERATION AND OFF-GAS CARBON ADSORPTION – PLAN VIEW
SITE 35 – CAMP GEIGER AREA FUEL FARM

SCALE SEE BAR SCALE
DATE MARCH 1995

FIGURE No.
10

01546JJ02Y