

LONG-TERM MONITORING WORK PLAN

OPERABLE UNIT NO. 2 (SITES 6 AND 82)

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

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Prepared by:

**BAKER ENVIRONMENTAL, INC.
*Coraopolis, Pennsylvania***

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LIST OF ACRONYMS AND ABBREVIATIONS

MCB	Marine Corps Base
OU	Operable Unit
PCB	Polychlorinated Biphenyl
QA/QC	Quality Assurance/Quality Control
RI	Remedial Investigation
ROD	Record of Decision
SOP	Standard Operating Procedure
TCL	Target Compound List
VOC	Volatile Organic Compound
WQP	Water Quality Parameter

1.0 OBJECTIVE

The principal objective of this work plan is to describe groundwater monitoring activities which fulfill the requirements specified in the Record of Decision (ROD) for Operable Unit (OU) No. 2 (Sites 6, 9, and 82), Marine Corps Base (MCB) Camp Lejeune, North Carolina. The work plan describes groundwater monitoring activities to be performed at Sites 6 and 82. An alternate objective of this work plan is to provide a current listing of implemented actions regarding the selected remedy for OU No. 2. Documents which pertain to the accepted remedial alternatives for Sites 6, 9, and 82 are as follows:

- Final Remedial Investigation Report - August, 1993
- Final Feasibility Study - August, 1993
- Final Proposed Remedial Action Plan - August, 1993
- Final Record of Decision - September, 1993

The ROD for OU No. 2 stipulates that groundwater monitoring, coupled with institutional controls be implemented at Sites 6 and 82. The selected remedy includes periodic groundwater sampling of monitoring wells and restriction of groundwater use in the vicinity of Sites 6 and 82. In addition to monitoring and institutional controls, the ROD also stipulates that an active groundwater remediation system be installed, maintained, and operated at Sites 6 and 82. The selected remedy for Site 9 involves taking no further remedial action. The selected remedial alternative for Sites 6, 9, and 82 was approved by representatives of the following:

- Naval Facilities Engineering Command, Atlantic Division (LANTDIV)
- Marine Corps Base Camp Lejeune, North Carolina
- U.S. Environmental Protection Agency (USEPA) - Region IV
- North Carolina Department of Environment and Natural Resources (NC DENR)

In addition to agency approval, a public meeting was held to solicit concerns from the community regarding the selected remedial alternatives. A 30-day comment period followed the public meeting. The ROD was signed after a responsiveness summary and final version of the decision document had been prepared. The ROD was signed by MCB Camp Lejeune on September 24, 1993.

The selected remedy provided within the ROD for OU No. 2 is a permanent, long-term solution because groundwater contaminants are either being actively treated or permitted to naturally degrade and periodic sampling is a reliable means of monitoring contaminant persistence and migration. Monitoring and groundwater remediation activities were implemented at OU No. 2 during January of 1996. Based upon the limited amount of accumulated monitoring data, no modifications are currently recommended. Future modifications to the monitoring program will be recorded, once approved, and documented as amendments to this work plan.

2.0 BACKGROUND

During 1992, Baker Environmental, Inc. (Baker) conducted a Remedial Investigation (RI) of OU No. 2 to evaluate potential threats posed by the release or threatened release of hazardous substances, pollutants, and contaminants at Sites 6, 9, and 82. The investigation consisted of a preliminary site survey; a soil gas survey; a geophysical survey; an aquatic survey which included specie collection and identification; a soil investigation; a groundwater investigation which included monitoring well installation and sampling; and a surface water and sediment investigation. The initial phase of the RI commenced in August 1992 and concluded in November 1992. Supplemental groundwater investigations were conducted during 1993 and 1994. The Final RI Report was submitted in August 1994.

Based upon findings presented in the RI, the selected remedy for OU No. 2 was groundwater extraction and treatment, coupled with on-site treatment or off-site disposal of contaminated soil. The selected remedy specified that groundwater from the most highly contaminated portions of the shallow and deep aquifers be extracted via a series of recovery wells and then treated on-site. Potable water supply wells HP-637 and HP-651 were deactivated as a result of the aquifer use restrictions that had been established in the ROD. On-site treatment or off-site disposal of contaminated soil were also stipulated as part of the selected remedy for OU No. 2. Finally, a monitoring program was specified to continually evaluate the effectiveness of the selected groundwater remedy.

As part of the groundwater monitoring program, a number of monitoring and potable supply wells were identified for periodic sampling. Volatile organic compounds (VOCs) were identified during the RI among a select number of groundwater samples obtained from monitoring wells at Sites 6 and 82. In addition to VOCs, metals were identified as a potential concern among groundwater samples. As a result, the ROD for OU No. 2 stipulates that groundwater samples from 21 monitoring wells and 3 potable supply wells collected quarterly for the following analyses:

- Target Compound List Volatile Organic Analyses
- Target Analyte List Inorganic Analyses
- Total Suspended Solid and Dissolved Solid Analyses

The monitoring program presented herein is based upon previous investigation findings, monitoring data, and decision documents. Monitoring activities at OU No. 2 were initiated in July 1997. As a result of analytical data generated during two quarterly sampling events, sampling locations have been selected within or immediately adjacent to portions of the study area with known contamination. Twelve shallow monitoring wells and sixteen deep monitoring wells have been selected to monitor the persistence and possible migration of known VOCs within Sites 6 and 82. Groundwater sampling will be conducted on a quarterly basis for selected analyses, as presented in Section 3.0 of this work plan. Section 3.0 of this work plan also provides a detailed discussion of sampling locations and procedures.

Additional background information pertaining to Sites 6, 9, and 82 is provided within the following reports:

- Baker Environmental, Inc. Remedial Investigation Report, Operable Unit No. 2 (Sites 6, 9, and 82) for MCB Camp Lejeune, North Carolina. Final. Prepared for the Department of the Navy, Naval Facilities Engineering Command, Atlantic Division, Norfolk, Virginia. August 1994.

- Environmental Science and Engineering, Inc. Site Summary Report. Final. Marine Corps Base, Camp Lejeune, North Carolina. Prepared for the Department of the Navy, Naval Facilities Engineering Command, Atlantic Division, Norfolk, Virginia. ESE Project No. 49-02036. 1990.
- Water and Air Research, Inc. Initial Assessment Study of Marine Corps Base Camp Lejeune, North Carolina. Prepared for Naval Energy and Environmental Support Activity. 1983.

2.1 Site History

Sites 6 and 82 have a history of various uses and activities, including the storage and disposal of wastes and supplies. The majority of Site 6 is comprised of two open storage areas, Lot 201 and Lot 203. A wooded area which lies to the east of Lot 201 has been used for temporary housing, open storage, and disposal of waste supplies. Site 82 is situated between Lot 203 and Wallace Creek, north of Lot 203.

Pesticides and transformers containing polychlorinated biphenyls (PCBs) were reportedly stored at Site 6 in the past; no information regarding spills or leaks is available. Additional reports which detail disposal activities at Site 6 are vague, little information regarding the types and quantities of material stored and disposed is available. Interviews from personnel that worked at Lot 203 suggest that chemicals including PCBs, cleaning solvents, electrolytes from used batteries, and waste oils may have been disposed.

3.0 MONITORING TASKS

Section 3.0 provides specific procedures for implementing the monitoring program at Sites 6 and 82. In addition, sampling locations, sample analyses, and sample designations are included within this section. The monitoring program has been developed based upon analytical data obtained during previous investigations. The sections which follow provide the number and location of groundwater samples to be obtained quarterly as part of the monitoring program for Sites 6 and 82.

3.1 Sampling

Twelve shallow wells and sixteen deep wells will be sampled quarterly as part of the monitoring program at Sites 6 and 82. As depicted in Figure 3-1, the majority of wells included in the monitoring program are located within or adjacent to Site 82. Groundwater samples obtained from the central portion of Site 82 have historically exhibited the highest concentrations of organic contaminants. The 12 shallow wells will be employed to monitor conditions within the uppermost portion of the surficial aquifer. Samples obtained from the 16 deep monitoring wells will be representative of conditions within the deeper, Castle Hayne, aquifer. Table 3-1 provides construction details for each of the 28 wells included in the monitoring program.

3.2 Sample Designations

In order to identify and accurately track all groundwater samples collected during the monitoring program, including quality assurance and quality control (QA/QC) samples, will be designated with a unique identification number. The sample number will serve to identify the investigation, the site, the sample media, sampling location, QA/QC samples, and the quarter and year in which the samples were collected.

The sample designation format is as follows:

Site Number - Media and Station Number or QA/QC - Year and Quarter of Event

An explanation of each of these identifiers is given below.

Site Number	Monitoring activities will be conducted at Installation Restoration Program Sites 6 and 82. However, only Site 6 will be used to identify the groundwater samples.
Media	GW = Groundwater
Station Number	Each sample location or monitoring well will be identified with a unique identification number. Single digit location numbers must be preceded by a zero (e.g., 06-GW03).
QA/QC	TB = Trip Blank
Year	The number will reference the calendar year in which the sample was obtained (e.g., 98 would represent 1998).

Quarter

The last letter of the sample designation corresponds to the quarter of the calendar year in which the sample is collected.

- A = First quarter (January - March)
- B = Second quarter (April - June)
- C = Third quarter (July - September)
- D = Fourth quarter (October - November)

Under this sample designation format the sample number IR06-GW01D-98A refers to:

<u>IR</u> 06-GW01D-98A	Installation Restoration Program
IR <u>06</u> -GW01D-98A	Site 6
IR06- <u>GW</u> 01D-98A	Groundwater sample
IR06-GW <u>01</u> D-98A	Monitoring well number 01
IR06-GW01 <u>D</u> -98A	Deep monitoring well. A "DW" or "DWA" designation may also be employed in the case of more than one deep monitoring well.
IR06-GW01D- <u>98</u> A	Year 1998
IR06-GW01D-98 <u>A</u>	First quarter

Under this sample designation format the sample number IR06-TB01-98A

<u>IR</u> 06-TB01-98A	Installation Restoration Program
IR <u>06</u> -TB01-98A	Site 6
IR06- <u>TB</u> 01-98A	Trip Blank
IR06-TB <u>01</u> -98A	Sequential number, in order of collection. Trip blanks are included with every shipment to be analyzed for volatile organic compounds. The total number will depend upon how many trip blanks are required.
IR06-TB01- <u>98</u> A	Year 1998
IR06-TB01-98 <u>A</u>	First quarter

This sample designation format will be followed throughout the project. Table 3-2 provides sample identifications for each monitoring well. Additional details regarding sample naming conventions and data deliverable standards and procedures are provided within the standard operation procedures (SOPs) section, presented at the end of these work plans.

3.3 Sample Collection and Analyses

The following describes sample collection procedures and analytical requirements of the monitoring program. Periodic redevelopment of monitoring wells may be required prior to groundwater sample collection.

Groundwater samples will be collected from the identified monitoring wells at Sites 6 and 82. The following details the low-flow purge and sampling procedure used to obtain groundwater samples:

1. Remove well cap, measure escaping gases from well head using a Photoionization Detector (PID) or Flame Ionization Detector (FID). The results of this test will determine if respiratory protection is required.

2. Allow groundwater level to stabilize, if a vent hole was not installed in the well.
3. Measure and record the static water level. Record total well depth from well construction tables. Calculate volume of water in well.
4. Lower unused sample tubing (i.e., 1/4-inch internal diameter polypropylene or polyethylene tubing) slowly into well, until the intake is within the screened interval of the well. Place water level probe just above the water, in well.
5. Commence purging using a peristaltic-type pump. Record the flow rate using a stopwatch and a calibrated container. The flow rate will be adjusted to ambient flow conditions (i.e., do not permit groundwater to be drawn down). Flow rates of less than 1 liter per minute are expected.
6. Investigation derived waste (i.e., purge water) will be temporarily containerized in 55-gallon drums. The purge water will then be disposed of at the groundwater treatment facility at Site 82.
7. Record water quality parameters (WQPs) including temperature, dissolved oxygen, turbidity, pH, and specific conductance at regular intervals. These measurements must be recorded in a field notebook.
8. Purging will be completed when a minimum of three well volumes have been removed and three successive WQP readings have stabilized, or there is no further discernable upward or downward trend. At low values, certain WQPs (such as turbidity and dissolved oxygen) may vary more than 10 percent, but have reached a stable plateau. Stability of WQPs may be defined as having less than 10 nephelometric turbidity units, pH measurements which remain constant within 0.1 standard units, specific conductance varying no more than 10 percent, and a constant temperature for at least three consecutive readings.
9. Upon WQP stabilization, collect groundwater samples for volatile organic, metal, total dissolved solid, and total suspended solid analyses. Label and preserve containers prior to sample collection.
10. Store samples in a cooler with ice until they are shipped to the laboratory.

The SOP for collection and sampling is located in the SOP section of this document. Table 3-1 provides a summary of well construction details for each well included in the monitoring program. Table 3-2 provides the sampling and analysis program for groundwater samples obtained at Sites 6 and 82.

3.4 Quality Assurance and Quality Control

Quality assurance and quality control requirements for the monitoring program are limited to trip blanks.

- Trip blanks are defined as samples comprised of analyte-free water from the laboratory, which are shipped to the sampling site, kept with the investigative

samples throughout the sampling event, and returned to the laboratory with the VOC samples. The blanks will only be analyzed for volatile organics. The purpose of a trip blank is to determine if samples were contaminated during storage and transportation back to the laboratory. One trip blank will accompany each cooler containing samples for volatile analyses.

Equipment rinsates, field blanks, field duplicates, and matrix spike and matrix spike duplicates will not be collected during the monitoring program. The samples collected during the program will be considered confirmatory only; therefore, extraneous QA/QC samples have been eliminated from the program.

TABLES

TABLE 3-1

**SUMMARY OF WELL CONSTRUCTION DETAILS
LONG-TERM MONITORING PLAN
OPERABLE UNIT NO. 2 - SITES 6 AND 82
MCB, CAMP LEJEUNE, NORTH CAROLINA**

Well No.	Date Installed	Top of Casing Elevation (feet, msl)	Ground Surface Elevation (feet, msl)	Boring Depth (feet, bgs)	Well Depth (feet, bgs)	Screen Interval Depth (feet, bgs)	Sand Pack Interval Depth (feet, bgs)	Bentonite Interval Depth (feet, bgs)	Stick-Up (feet, ags)
06-GW01	10-21-86	35.18	32.7	25.0	25.0	5.0 - 25.0	3.0 - 25.0	2.0 - 3.0	2.48
06-GW01D	11-07-92	35.31	32.8	117.0	112.5	102.7 - 111.7	99.5 - 117.0	96.0 - 99.5	2.51
06-GW01DA	04-03-93	35.23	32.7	230.0	230.0	220.0 - 230.0	215.0 - 230.0	190.0 - 230.0	2.53
06-GW01DB	09-10-93	NA	NA	263.0	262.0	247.0 - 262.0	240.0 - 263.0	234.0 - 240.0	2.50
06-GW02DW	11-07-92	37.61	35.1	122.0	122.0	108.1 - 118.1	105.0 - 122.0	101.0 - 105.0	2.51
06-GW03	10-24-86	31.32	28.8	25.5	25.0	5.0 - 25.5	3.0 - 25.5	2.0 - 3.0	2.52
06-MW03D	03-31-93	35.18	34.2	201.5	118.0	97.6 - 117.6	94.0 - 118.0	898.0 - 94.0	0.98
06-GW15D	04-06-93	28.0	25.2	160.0	155.0	145.0 - 155.0	141.0 - 155.0	139.0 - 141.0	2.80
06-GW16	11-07-92	27.63	24.9	20.0	20.0	5.4 - 19.8	3.0 - 20.0	1.6 - 3.0	2.73
06-GW17	09-25-92	28.10	25.7	18.5	17.6	2.3 - 17.1	1.5 - 18.5	0.5 - 1.5	2.40
06-GW21	09-24-92	30.30	27.9	24.0	22.5	8.0 - 22.0	6.0 - 24.0	4.5 - 6.0	2.40
06-GW27DW	10-12-92	24.47	22.5	112.0	110.0	100.1 - 109.1	97.0 - 112.0	94.5 - 97.0	1.97
06-GW27DA	08-13-93	NA	NA	236.0	236.0	226.0 - 236.0	224.0 - 236.0	100.0 - 224.0	2.5
06-GW28	10-10-92	30.20	27.6	32.5	32.0	17.5 - 31.7	15.0 - 32.5	13.3 - 15.0	2.60
06-GW28DW	10-20-92	31.74	28.7	115.0	114.5	104.7 - 113.6	99.0 - 115.0	95.0 - 99.0	3.04
06-GW30	11-07-92	12.60	9.9	21.0	20.0	5.3 - 19.7	3.0 - 21.0	1.5 - 3.0	2.70
06-GW30DW	03-04-93	11.90	9.9	161.9	100.0	89.6 - 99.6	83.0 - 100.0	76.5 - 83.0	2.00
06-GW32	04-01-93	21.79	19.6	27.0	27.0	11.0 - 26.0	10.0 - 27.0	7.0 - 10.0	2.19
06-GW33	04-01-93	22.42	20.0	22.0	22.0	6.0 - 21.0	4.5 - 22.0	3.0 - 4.5	2.42
06-GW34	03-05-93	32.01	29.0	36.0	35.0	19.0 - 34.0	17.5 - 35.0	15.0 - 17.5	3.01
06-GW35D	03-07-93	14.29	12.0	201.0	105.0	95.0 - 105.0	90.0 - 105.0	87.0 - 90.0	2.29
06-GW36D	04-01-93	17.61	15.6	201.5	95.0	75.0 - 95.0	66.0 - 95.0	62.0 - 66.0	2.01
06-GW37D	04-01-93	15.96	14.0	111.5	95.0	75.0 - 95.0	73.0 - 95.0	70.0 - 73.0	1.96
06-GW38D	08-28-93	NA	NA	277.0	275.0	255.0 - 275.0	253.0 - 277.0	248.0 - 253.0	2.50

TABLE 3-1 (Continued)

SUMMARY OF WELL CONSTRUCTION DETAILS
 LONG-TERM MONITORING PLAN
 OPERABLE UNIT NO. 2 - SITES 6 AND 82
 MCB, CAMP LEJEUNE, NORTH CAROLINA

Well No.	Date Installed	Top of Casing Elevation (feet, msl)	Ground Surface Elevation (feet, msl)	Boring Depth (feet, bgs)	Well Depth (feet, bgs)	Screen Interval Depth (feet, bgs)	Sand Pack Interval Depth (feet, bgs)	Bentonite Interval Depth (feet, bgs)	Stick-Up (feet, ags)
06-GW40DW	12-04-94	NA	NA	250.0	246.0	230.0 - 245.0	225.0 - 250.0	198.0 - 225.0	2.50
06-GW40DWA	12-06-94	NA	NA	120.0	116.0	100.0 - 115.0	92.0 - 120.0	87.0 - 92.0	2.50
82-MW02	06-17-91	6.28	3.71	13.2	13.0	3.0 - 13.0	2.0 - 13.0	2.0 - 1.0	2.57
82-MW03	06-18-91	24.57	21.98	21.5	21.0	11.0 - 21.0	9.0 - 21.5	7.0 - 9.0	2.59

Notes:

- ags = above ground surface
- bgs = below ground surface
- msl = mean sea level
- NA = Information not available

TABLE 3-2

**SAMPLING SUMMARY
LONG-TERM MONITORING PLAN
OPERABLE UNIT NO. 2 - SITES 6 AND 82
MCB, CAMP LEJEUNE, NORTH CAROLINA**

Location	Media	TCL Volatiles ⁽¹⁾	CLP Metals ⁽²⁾	Total Dissolved Solids ⁽³⁾	Total Suspended Solids ⁽³⁾	Laboratory Sample Identification
06-GW01	Groundwater	X	X	X	X	IR06-GW01-**
06-GW01D	Groundwater	X	X	X	X	IR06-GW01D-**
06-GW01DA	Groundwater	X	X	X	X	IR06-GW01DA-**
06-GW01DB	Groundwater	X	X	X	X	IR06-GW01DB-**
06-GW02DW	Groundwater	X	X	X	X	IR06-GW02DW-**
06-GW03	Groundwater	X	X	X	X	IR06-GW03-**
06-MW03D	Groundwater	X	X	X	X	IR06-GW03D-**
06-GW15D	Groundwater	X	X	X	X	IR06-GW15D-**
06-GW16	Groundwater	X	X	X	X	IR06-GW16-**
06-GW17	Groundwater	X	X	X	X	IR06-GW17-**
06-GW21	Groundwater	X	X	X	X	IR06-GW21-**
06-GW27DW	Groundwater	X	X	X	X	IR06-GW27DW-**
06-GW27DA	Groundwater	X	X	X	X	IR06-GW27DA-**
06-GW28	Groundwater	X	X	X	X	IR06-GW28S-**
06-GW28DW	Groundwater	X	X	X	X	IR06-GW28DW-**
06-GW30	Groundwater	X	X	X	X	IR06-GW30-**
06-GW30DW	Groundwater	X	X	X	X	IR06-GW30DW-**
06-GW32	Groundwater	X	X	X	X	IR06-GW32-**
06-GW33	Groundwater	X	X	X	X	IR06-GW33-**
06-GW34	Groundwater	X	X	X	X	IR06-GW34-**
06-GW35D	Groundwater	X	X	X	X	IR06-GW35D-**
06-GW36D	Groundwater	X	X	X	X	IR06-GW36D-**
06-GW37D	Groundwater	X	X	X	X	IR06-GW37D-**
06-GW38D	Groundwater	X	X	X	X	IR06-GW38D-**
06-GW40DW	Groundwater	X	X	X	X	IR06-GW40DW-**
06-GW40DWA	Groundwater	X	X	X	X	IR06-GW40DWA-**
82-MW02	Groundwater	X	X	X	X	IR06-82GW02-**
82-MW03	Groundwater	X	X	X	X	IR06-82GW03-**

Notes:

- (1) Target Compound List Organics by Solid Waste Method 8260A.
(2) Metals by U.S. Environmental Protection Agency, Contract Laboratory Protocol, Statement of Work, Document Number ILM03.0.
(3) Total Suspended and Dissolved Solids by Solid Waste Method 160.1 and 160.2.

X = Requested analysis

** = Year (e.g., 98 for 1998) and Quarter (e.g., A for January through March) in which groundwater sample is obtained.

FIGURES
