1/1/04-03744

FINAL

Pilot Study Work Plan

Operable Unit No. 10 (Site 35)

Marine Corps Base

Camp Lejeune, North Carolina

Prepared for

Department of the Navy

Atlantic Division

Naval Facilities Engineering Command

Norfolk, Virginia

Contract No. N62470-95-D-6007

CTO-0253

LANTDIV Clean II Program

January 2004

Prepared by

CH2MHILL

TABLE OF CONTENTS

APPENDICES

FIGURES

Abbreviations and Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
AM	Activity Manager
ASTs	Above ground Storage Tanks
Baker	Baker Environmental, Inc.
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-Dichloroethene
CLEAN	Comprehensive Long-Term Environmental Action Navy
cm^3	Cubic Centimeter
COC	Contaminants of Concern
CSA	Comprehensive Site Assessment
CTO	Contract Task Order
cVOCs	Chlorinated Volatile Organic Compounds
DCE	Dichloroethene
DEB	Dry Enzyme Breaker
DI	Distilled
DNAPL	Dense Non-Aqueous Phase Liquids
DoN	United States Department of the Navy
DPT	Direct Push Technology
ERH	Electric Resistive Heating
ECTFE	Ethylene Chlorotrifluoroethylene
EISOPQAM	Environmental Investigations Standard Operating Procedures and Quality Assurance Manual
EMR	Experience Modification Rate
EPA	Environmental Protection Agency
Fe(II)	Iron II Ion
Fe(III)	Iron III Ion
FFA	Federal Facilities Agreement
FFS	Focused Feasibility Study
FID	Flame Ionization Detector
Ft	Foot or Feet
FTL	Field Team Leader
gpm	Gallons per Minute

HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HRC	Hydrogen Releasing Compound
HSP	Health and Safety Plan
H_2O_2	Hydrogen Peroxide
I.D.	Inner Diameter
IDW	Investigative-Derived Waste
IR	Installation Restoration
ISOTEC	In-Situ Oxidative Technologies, Inc.
kg	Kilogram
L	Liters
LANTDIV	Atlantic Division, Naval Facilities Engineering Command
LEB	Liquid Enzyme Breaker
Lb or lbs.	pound or pounds
LNAPL	Light Non-Aqueous Phase Liquid
LTM	Long Term Monitoring
M	Million
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
MH	Silt of High Plasticity, Elastic Silt
ML	Silt
MSDSs	Material Safety Data Sheets
MSL	Mean Sea Level
MTBE	Methyl-tert butyl ether
NCDENR	North Carolina Department of Environment and Natural Resources
NCDOT	North Carolina Department of Transportation
NIOSH	National Institute for Occupational Safety and Health
NOD	Natural Oxidant Demand
NOM	Natural Organic Matter
NPL	National Priorities List
O.D.	Outer Diameter
O&M	Operations and Maintenance
ORC	Oxygen Releasing Compound
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
OU	Operational Unit
PCE	Tetrachloroethene

P.E.	Professional Engineer
P.G.	Professional Geologist
pH	Hydrogen Ion Concentration of a Solution
PHSM	Project Health and Safety Manager
PM	Project Manager
PPE	Personal Protective Equipment
ppm_v	Parts per Million (by volume)
psi	Pounds per Square Inch
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl Chloride
PVDF	Polyvinylidene fluoride
PVSA	Pressure-Vacuum-Swing-Adsorption
QA/QC	Quality Assurance/ Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
ROI	Radius of Influence
SAP	Sampling and Analysis Plan
scfh	Standard Cubic Feet per Hour
scfm	Standard Cubic Feet per Minute
SDR	Standard Dimension Ratio
SHSP	Site-Specific Health and Safety Plan
SM	Silty Sand
SOD	Soil Oxidant Demand
SOW	Scope of Work
SP	Poorly Graded Sand
SSC	Site Safety Coordinator
SVE	Soil Vapor Extraction
TCE	Trichloroethene
TCE_d	Dissolved Phase TCE
TCE_s	Sorbed Phase TCE
TCLP	Toxicity Characteristic Leaching Procedure
TE	Technology Evaluation
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TWA	Time-weighted Average
UIC	Underground Injection Control
USCG	United States Coast Guard
USCS	Unified Soil Classification System
USGS	United States Geological Survey
USEPA	United States Environmental Protection Agency

V	Volt
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds
WP	Work Plan
WQS	Water Quality Standards
ZVI	Zero Valence Iron

Executive Summary

This work plan describes the objectives and activities for a pilot study that will be conducted at Site 35. The pilot study will evaluate the performance and effectiveness of modified Fenton's reagent and potassium permanganate injections for the purpose of groundwater contaminant removal. Groundwater at Site 35 is impacted by chlorinated volatile organic compounds (cVOCs), primarily trichloroethylene (TCE).

The target area for pilot testing was selected based on a minimum concentration of 200 µg/L TCE in groundwater. The highest TCE concentration is located beneath the median and northbound lanes of the Highway 17 Bypass at a depth of approximately 15 to 25 feet below mean seal level, 32 to 42 feet below ground surface. The target area is approximately 250 feet long and approximately 100 feet wide.

The selected remedial technology, injection of Modified Fenton's reagent followed by potassium permanganate, is a potentially effective approach for remediation of TCE and associated dissolved chlorinated solvent contamination at Site 35. The first injection event will inject Modified Fenton's reagent to aggressively address the highest TCE concentration areas. Within one month of the Fenton's work, there will be a second injection event to inject potassium permanganate to provide a more persistent oxidant.

The scope of work for the pilot test will consist of three phases:

- Installation and development of five new monitoring wells and eighteen injection wells
- Injection of oxidants
- Performance monitoring

The monitoring plan for the Modified Fenton's reagent and potassium permanganate pilot study at Site 35 will address groundwater at the following project stages: baseline, injection, and post injection. Reports will be prepared to summarize installation and monitoring results. A pilot study report will be prepared after completion of the test.

The effectiveness of the test will be evaluated according to the following criteria:

1. 80% contaminant mass removal from groundwater, as quantified by pre- and post-treatment groundwater samples.
2. Minimization of contaminant "rebound" to upgradient background levels, as quantified by post-treatment groundwater samples, to be collected quarterly for a period of one year.

Depending on the results of the pilot test and subsequent evaluation of the technology per the above criteria, injection of Modified Fenton's reagent and potassium permanganate may be used on a larger scale to address other areas of Site 35. A decision to use either technology in other areas of the site will be subject to the approval of the Partnering Team.

1.0 Introduction

This plan describes the objectives and activities for a pilot study that will be conducted at Operable Unit 10, Site 35, Marine Corps Base (MCB) Camp Lejeune, Jacksonville, North Carolina. The purpose of this plan is to serve as the work plan for the pilot study that will evaluate the performance and effectiveness of ISOTEC's Modified Fenton's Reagent (Modified Fenton's) and potassium permanganate injection for the purpose of groundwater contaminant removal. Groundwater at Site 35 is impacted by chlorinated volatile organic compounds (cVOCs), primarily trichloroethylene (TCE).

This is a pilot study for modified Fenton's reagent and permanganate injection. The goal of this pilot study is to gain information about the technologies being tested. This pilot test is not intended as a final remedy. The Camp Lejeune Installation Restoration (IR) program is in the process of testing multiple technologies across the Base. Currently, Electric Resistive Heating (ERH), Oxygen Releasing Compound (ORC), Hydrogen Releasing Compound (HRC), Modified Fenton's Reagent injection, permanganate injection, ozone sparging using a horizontal well, and hydrogen sparging using horizontal wells are being tried or are in the planning stages at various sites across the Base. The Site 35 project is part of this program. Depending on the results of this pilot test and subsequent evaluation of the technology, a decision will be made whether to use the Modified Fenton's and/or potassium permanganate on a larger scale at Site 35 or at other sites across the Base.

1.1 Project Overview

In an effort to evaluate remedial options for the groundwater contamination at Site 35, a target area has been selected to pilot test Modified Fenton's and potassium permanganate injections using a series of vertical injection wells. Activities associated with this pilot test include the installation of permanent monitoring wells and injection wells, baseline sampling, injection of Modified Fenton's and potassium permanganate, and mid- and post-pilot test groundwater sampling. The pilot test objectives, implementation, and monitoring activities are discussed in Sections 3.0, 4.0, and 5.0 of this work plan.

1.2 Contractual Setting

MCB Camp Lejeune was added to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) effective November 4, 1989. Consequently, the United States Environmental Protection Agency (USEPA) Region IV, North Carolina Department of Environment and Natural Resources (NCDENR), the United States Department of the Navy (DoN) and the Marine Corps entered into a Federal Facilities Agreement (FFA) for Camp Lejeune to address environmental concerns present on the Base. The Installation Restoration (IR) Program is responsible for addressing these concerns and managing responses as appropriate to CERCLA and Resource Conservation and Recovery Act (RCRA). Site 35 was added to the list of IR Program sites in 1992.

1.3 Work Plan Organization

This work plan consists of eleven sections. Brief descriptions of the sections and appendices are presented as follows:

1.0 Introduction – Presents an overview of the project and work plan.

2.0 Site Background – Presents the site background, conditions, and test area information.

3.0 Pilot Study Design – Presents an overview of Modified Fenton's and potassium permanganate technology, and a conceptual technical approach for the pilot test.

4.0 Pilot Study Implementation – Discusses how the pilot study will be conducted.

5.0 Pilot Study Monitoring – Describes the project sample collection locations, the frequency of sampling, and analysis of data.

6.0 Health and Safety Considerations - Outlines issues to be presented in the Site Health and Safety Plan for the project.

7.0 Site Activity Considerations – Outlines the site-specific requirements and constraints applicable during project implementation.

8.0 Submittal Requests - Outlines submittals that will be requested from prospective bidders to complete the scope of work (SOW).

9.0 Reporting - Provides the reporting that will occur during the project.

10.0 Schedule - Provides the project schedule.

11.0 References – Provides the references used in this document.

Figures accompanying the main text of this plan are at the end of each section. Two appendices provide supplemental materials and information for the pilot study field teams:

- Appendix A contains the Field Sampling Plan (FSP), which sets forth procedures for field activities and the analysis of groundwater samples.
- Appendix B contains the Quality Assurance Project Plan (QAPP), which describes the data quality objectives, specific quality assurance (QA) and quality control (QC) activities, and laboratory activities necessary to achieve the data quality objectives (DQOs) of the project.
- Appendix C contains the Health and Safety Plan (HSP), which has been prepared to address specific health and safety issues related to conducting the pilot study field activities at the site.
- Appendix D contains the Work Plan prepared by ISOTEC, the contractor conducting the Modified Fenton's and permanganate injection.

2.0 Site Background

2.1 Site Description

Information concerning contaminant concentrations, plume distribution, and subsurface geology/hydrogeology is documented in the Final Remedial Investigation (RI), Operable Unit 10, Site 35, Camp Geiger Area Fuel Farm (Baker, 1995) and the Final Natural Attenuation Evaluation Report, Operable Unit 10, Site 35, Former Camp Geiger Fuel Farm (CH2M HILL, et al., 2003). This information was used to screen feasible remediation scenarios in the Site 35 Technical Evaluation (TE) Report (CH2M HILL, June 2003). This section, as well as Section 2.2, summarizes information contained in these documents.

Camp Geiger is located at the northwest corner of Marine Corps Base (MCB), Camp Lejeune (Figure 2-1). The main entrance to Camp Geiger is off U.S. Route 17, approximately 3.5 miles southeast of the City of Jacksonville, North Carolina. Site 35 is situated within Camp Geiger just north of the intersection of Fourth and "G" Streets. Site 35 is the former Camp Geiger Area Fuel Farm (Fuel Farm), and was previously occupied by five 15,000-gallon above ground storage tanks (ASTs), a pump house, a fuel unloading pad, and several underground petroleum distribution lines. The former ASTs previously held No. 6 fuel oil, unleaded gasoline, diesel fuel, and kerosene. The Fuel Farm was decommissioned and removed in 1995 to accommodate a six-lane divided highway (Highway 17 Bypass) proposed by the North Carolina Department of Transportation (NCDOT). At the time of this report the Highway 17 Bypass was under construction.

Results of previous investigations have expanded Site 35 beyond the confines of the former Fuel Farm. Site 35 is now bounded on the west by D Street, on the north by Second Street, on the east by Brinson Creek and on the south by Fifth Street and Building TC572. Roadways, buildings, former building foundations and several large parking areas are located within Site 35. The foundations of previously existing structures are scattered throughout the study area marking the former existence of a warehouse (TC460), a mess hall, a heating plant, a gas station, and an ice house. A pair of abandoned north/south railroad tracks is located near former warehouses TC462 and TC560. These tracks appear to have been used to supply three warehouses (two existing and one former), the ice house and the Fuel Farm.

Construction of the Highway 17 Bypass complicates the remedial process by imposing access constraints to the area. Construction cut and fill operations have also changed the local topography and drainage. The portion of the Bypass that runs through the site is situated approximately 17 feet above mean sea level (MSL). Construction activities have eliminated much of the vegetation, and additional drainage ditches have been dug to transport surface runoff to Brinson Creek. Figure 2-2 depicts a site plan for Site 35.

2.2 Site Geology and Hydrogeology

The RI Report (Baker, 1995) and Natural Attenuation Evaluation Report (CH2M HILL, et al., 2003) provide details regarding site-specific geology and hydrogeology at Site 35. The following briefly summarizes Baker's investigations.

2.2.1 Site Geology

The uppermost horizon is Quaternary age "undifferentiated" deposits composed of sand, silt, and clay (Figures 2-3 through 2-5). In the wetland area, the undifferentiated Quaternary deposits are composed of layers of peat and silt. Beneath the "undifferentiated" deposits is the River Bend Formation and underlying it is the Castle Hayne Formation. The River Bend Formation is composed of fine-to coarse sand containing varying amounts of silt (0-50%), shell and fossil fragments (0-35%), and clay (0-10%). The sand layers in both the Quaternary deposits and River Bend Formation have a relative density of loose to dense. According to field observations using the Unified Soil Classification System (USCS), the sand layers classify as silty sand (SM) and poorly graded sand (SP). Where present, fine-grained (silt and clay) lenses are plastic to non-plastic, contain various amounts of sand (0-50%) and clay (0-10%), and classify as ML or MH. Standard penetration tests indicate that these lenses have a relative density of loose to dense for the non-plastic, and soft to very stiff for the plastic.

The upper part of the River Bend Formation contains partially cemented, fine to coarse sand and some gravel. The thickness of this unit is not uniform and varies from approximately 4 to 20 feet. Underlying the sand is a very dense to dense, greenish gray, fine sand and silt layer that acts as a semi-confining unit for the Castle Hayne aquifer. The semi-confining unit is approximately 8 to 12 feet thick, and appears to thicken toward the east. The upper part of the Castle Hayne Formation is described as a partially cemented, gray, fine sand with occasional shell and limestone fragments.

2.2.2 Site Hydrogeology

The surficial aquifer occurs within the Quaternary deposits and the River Bend Formation. A potentiometric map is shown in Figure 2-6. Groundwater levels measured in October 2002 indicate flow in the surficial aquifer is toward Brinson Creek (northeast across Site 35) under a fairly consistent gradient of approximately 0.01 ft/ft. Tidal and seasonal changes in the water level of Brinson Creek affects wells in the wetlands along the banks of the creek. The October 2002 flow direction and gradient are consistent with historical Long Term Monitoring (LTM) data and previous investigations.

Underlying the surficial aquifer is the Castle Hayne aquifer. A potentiometric map is shown in Figure 2-7. Local groundwater flow in the Castle Hayne aquifer is divergent. Flow in the wetland/Highway 17 Bypass areas is similar in direction and gradient to the surficial aquifer. Groundwater flow south of 7th Street is to the southeast, towards Edwards Creek under a gradient of 0.004 ft/ft.

Hydraulic conductivities from slug tests of wells within the surficial aquifer indicate a range from <1 ft/day for the upper fine-grained units up to 100 ft/day in the lower, coarse sand and gravel units. Groundwater velocities in the surficial aquifer are variable. Based on local

gradient of 0.01 ft/ft, hydraulic conductivity of 1 ft/day (upper) and 100 ft/day (lower), and an assumed effective porosity of 0.28, calculated velocities range from 0.04 ft/day in the upper part to 3.6 ft/day in the lower part.

2.3 Site Environmental Conditions

2.3.1 Previous Investigations

Previous site investigations conducted at Site 35 include:

- UST investigations (various dates),
- Initial Assessment Study (Water and Air Resources, 1983),
- Confirmation Study (ESE, 1990),
- Focused Feasibility Study (NUS Corporation, 1990),
- Comprehensive Site Assessment (Law, 1992),
- Interim Remedial Action Remedial Investigation (Baker, 1994),
- Final Remedial Investigation (Baker, 1995),
- Long Term Monitoring (Baker, 1999 – present),
- Natural Attenuation Evaluation (Baker, 2003), and
- Hot Spot Characterization (Baker, 2003).

From 1984 to 1987, a Confirmation Study of the site revealed that oil and grease, as well as benzene, trans-1,2-DCE, and TCE were present in groundwater at the site.

In 1990, a Focused Feasibility Study (FFS) was conducted in the area north of the Fuel Farm. The results of this study were not available; however, in the Comprehensive Site Assessment (CSA) Report Law reported that, during the FFS, groundwater in one well and soil cuttings from two borings were contaminated with petroleum hydrocarbons (Law, 1992).

In 1991, a CSA was performed by Law. The CSA identified areas of contaminated soil and groundwater. Contamination consisted of chlorinated organic compounds (TCE, trans-1,2-DCE, and vinyl chloride) and petroleum hydrocarbons (total petroleum hydrocarbons [TPH], methyl-tert butyl ether [MTBE], and benzene, toluene, ethylbenzene, and xylenes [BTEX]). The contamination was found in both shallow and deep wells. Several shallow groundwater plumes were identified including two plumes consisting primarily of petroleum hydrocarbons and two plumes of chlorinated organic compounds. All of the plumes are located north of Fourth Street and east of E Street except for a portion of a TCE plume that extends southwest beyond the corner of Fourth and E Streets.

In December 1993, Baker conducted an Interim Remedial Action Remedial Investigation. During this investigation, seven more soil borings were made within and around the groundwater contaminant plume areas identified during the CSA. Thirteen shallow soil samples were taken near Brinson Creek to find the extent of contamination from Site 35. Benzene, toluene, ethylbenzene, xylenes, naphthalene, and 2-methylnaphthalene were detected in the soil samples. In addition, TPH (gasoline and diesel) and oil and grease were also detected. Some detections of lead, chromium, vanadium, and arsenic were found. These results confirmed results that contamination in the majority of the soil is associated with a dissolved petroleum hydrocarbon contaminant plume in shallow groundwater. It

was also concluded that the oil and grease detections were the result of naturally occurring organics in soils or an upgradient contamination source. On September 15, 1994, an Interim Record of Decision (ROD) was executed for the remediation of contaminated soil along and adjacent to the proposed highway right-of-way at Site 35.

In 1994, Baker conducted a comprehensive RI. Results of the RI (pertaining to the current pilot study area) indicated the presence of TCE and daughter products located in the surficial aquifer and the lower portion of the surficial aquifer, or intermediate zone. A detailed discussion of these results can be found in the RI report (Baker, 1994).

Long Term Monitoring of the site began in January 1999. Monitoring has been performed quarterly from the start to October 2000. Since October 2000, monitoring has been conducted semi-annually. During each sampling event, groundwater samples are collected from 39 monitoring wells, and surface water is collected from three locations along the portion of Brinson Creek that borders Site 35 to the northeast. A detailed discussion of analytical and sampling methods can be found in the Long-Term Monitoring and Natural Attenuation Monitoring Work Plan for MCB Camp Lejeune North Carolina (Baker, 2002).

The Natural Attenuation Evaluation (Baker, 2003) showed the distribution of TCE becomes broader and concentration increase with depth. The most widespread TCE contamination is between 15 and 25 feet below msl. This corresponds to depths of 40-50 feet bgs. The distribution of the TCE daughter products shows similar changes with depth. The study showed a BTEX "hot spot" just north of Building G480, and free phase LNAPL in 35-MW67A. After completion of the evaluation, it was concluded that natural attenuation processes are degrading and retarding the chlorinated solvent contamination as evidenced by:

- appearance of daughter products,
- stable to decreased concentrations of TCE over time, and
- no significant plume migration from 1998-2003.

However, the evaluation also concluded that natural attenuation is being slowed and the efficiency of natural attenuation is impacted. The lines of supporting evidence are as follows:

- It was estimated that the half lives for TCE, DCE, and VC are all less than one year, but observations do not support this. The presence of upgradient dissolve-phase source and sorbed phase contamination are providing a continuing supply of contaminants to the wetland aquifer.
- Complete degradation has not been observed; more cis-DCE has been generated than can be accounted for by TCE, the molar concentration of VC is also less than expected, and ethene and chloride concentrations are relatively low, given parent concentrations.

Baker conducted a Hot Spot Characterization at Site 35 to delineate and characterize suspected hot spot areas, and to identify and delineate any continuing sources associated with the hot spots. The field effort was conducted between October 7 and October 26, 2002, and consisted of soil and groundwater sampling of 30 Geoprobe borings. The Site 35 "Hot Spot" Characterization Letter Report (Baker, 2003) provides details regarding investigative

methods and results of the investigation. Some information from that report is summarized in Section 2.3.2.

2.3.2 Site Contamination

Baker performed groundwater sampling at Site 35 to delineate and characterize suspected hot spot areas, and to identify and delineate any continuing sources associated with the hot spots. The field effort was conducted between October 7 and October 26, 2002, and consisted of soil and groundwater sampling of 30 Geoprobe™ borings. Two hot spots were identified at Site 35. One shallow hot spot near Building G480 contains fuel contamination (BTEX). A second deeper (and larger) hot spot contains chlorinated solvents (primarily TCE and daughter products) and is located beneath the Highway 17 Bypass.

The TCE Hot Spot area consists of an area beneath the Highway 17 Bypass and surrounding monitoring well IR35-MW-72B that contains TCE concentrations greater than 100 times the 2L Standard of 2.8 µg/L, as shown in Figure 2-8. The most impacted study interval is the 15 ft to 25 ft below mean sea level interval, corresponding to a depth of 32 ft to 42 ft bgs, with TCE concentrations ranging up to 2,800 µg/L. Figures 2-9a through 2-9c, reproduced from Baker (2003), show the vertical distribution of TCE along transects A-A', B-B', and C-C' (from Figure 2-2). DNAPL was not observed in any of the monitoring wells.

2.4 Pilot Test Area

2.4.1 Rationale for Test Area Selection

The target area for pilot testing was selected based on a minimum concentration of 200 µg/L TCE in groundwater, which is two orders of magnitude higher than the regulatory standard. (The North Carolina groundwater standard for TCE is 2.8 µg/L.) The highest TCE concentration is located beneath the median and northbound lanes of the Highway 17 Bypass at a depth of approximately 15 to 25 feet below mean seal level, 32 ft to 42 ft bgs. Monitoring well MW-72B exhibited the highest TCE concentration at 2,800 µg/L.

2.4.2 Test Area Dimensions

The target area, indicated in Figure 2-10, is approximately 250 feet long and approximately 100 feet wide. The target depth is 37 to 47 feet bgs. This is the predominant depth with the greatest extent of TCE contamination.

2.4.3 Estimated Contaminant Mass

The contaminant mass of TCE in the target area is estimated to be 59.2 lbs as shown below. The target area is approximately 250 feet long by 100 feet wide with a thickness of 10 ft or a volume 250,000 ft^3 (7,080,000 L). The TCE mass is a combination of the dissolved phase and the sorbed phase. For the dissolved phase, an average TCE concentration of 1,750 µg/L was estimated from the average of the three monitoring wells in the target area.

Assuming a porosity of 28 percent, the dissolved phase TCE (TCE_d) mass concentration is calculated as follows:

Mass TCE_d = Porosity * TCE_d Concentration (µg/L) * Volume (ft^3) * 28.3 L/ft^3 * $2.2*10^{-9}$ lb/µg = 0.28 * 1,750 µg/L * 250,000 ft^3 * 28.3 L/ft^3 * $2.2*10^{-9}$ lb/µg.

Therefore, the Mass TCE_d = 7.6 lbs

The sorbed phase TCE (TCE_s) concentration is calculated as follows:

$TCE_s = K_{oc} * f_{oc} * C_w$; where log k_{oc} = 2.1 and k_{oc} = 125.9, f_{oc} = 0.01 (1% organic content), and C_w = 1,750 µg/L.

So, TCE_s = 125.9 * 0.01 * 1,750 µg/L = 2,203 µg/g.

The TCE_s mass concentration is calculated as follows:

Mass TCE_s = (TCE_s Concentration (µg/g) * Volume (L) * Soil Density (µg/cm^3) * 1000 cm^3/L * $2.2*10^{-9}$ lb/µg) / (1000 µg/g) = (2,203 µg/g * 7,080,000 L * 1.5 µg/cm^3 * 1000 cm^3/L* $2.2*10^{-9}$ lb/µg)/(1000 µg/g).

Therefore, the Mass TCE_s = 51.6 lbs.

Total Mass TCE = Mass TCE_d + Mass TCE_s = 7.6 lbs + 51.6 lbs = 59.2 lbs.

Figures

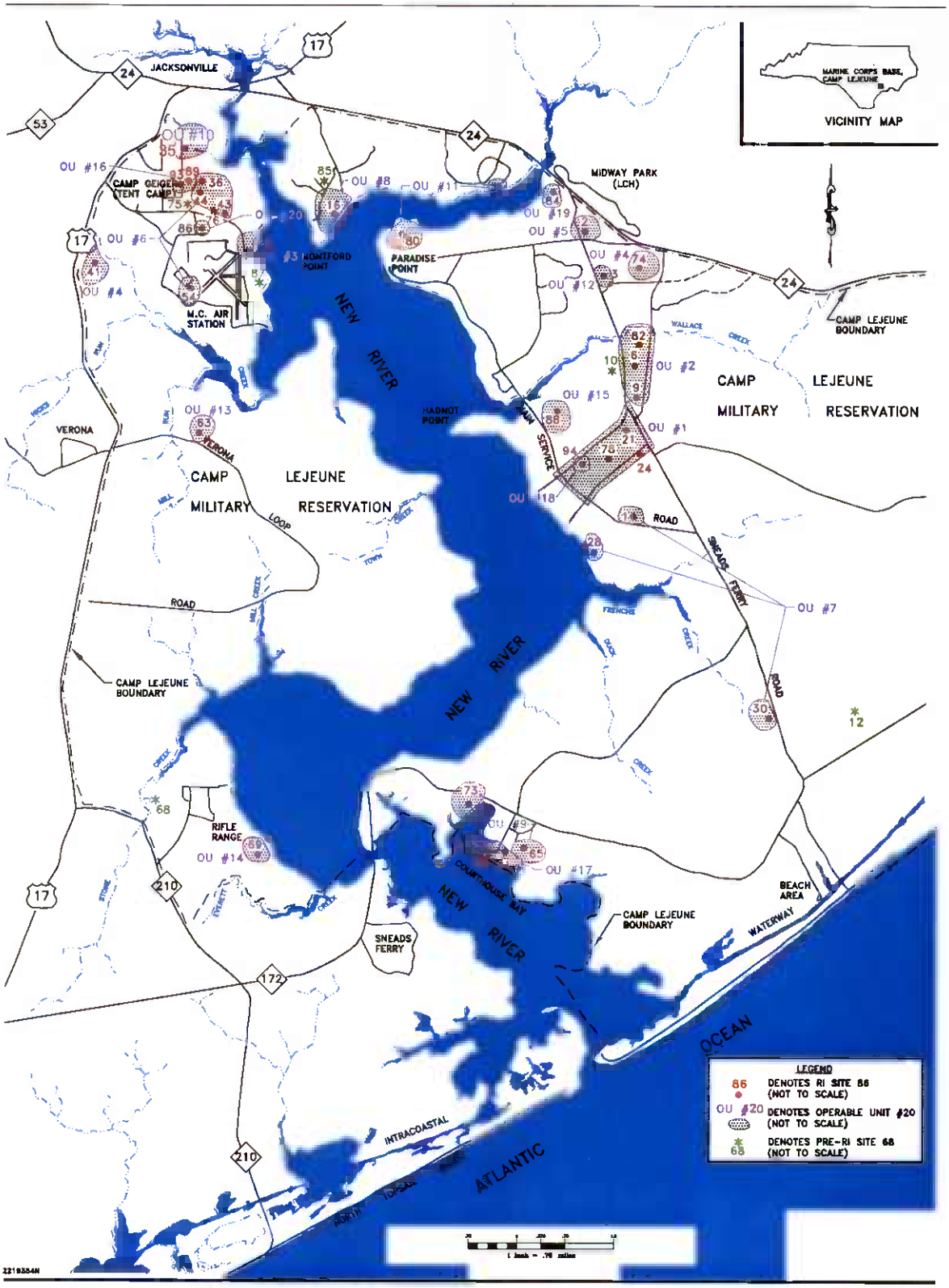


FIGURE 2-1
OPERABLE UNIT AND SITE LOCATION MAP
OPERABLE UNIT NO. 10 - SITE 35
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

APTED FROM BAKER FIGURE

2219335N

THIRD STREET
FOURTH STREET
FIFTH STREET
D STREET
E STREET
F STREET
6 STREET
NORTHBOUND LANES
SOUTHBOUND LANES
CREEK
RAMP

A
A'
B
B'
C
C'

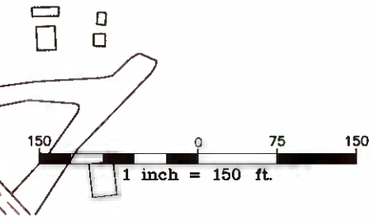
TC341
TC342
G480
TC462
TC470
TC572
TC576
G531
G532
G533
G534
G554
G560

MW-67A
MW-9A/B
MW-14A/B
MW-31A/B
MW-22
MW-26B
MW-10A/B
MW-37A/B
MW-29A/B
MW-30A/B
MW-38A/B
MW-32A/B
MW-76B
MW-63B
MW-47A/B
MW-64B
MW-55A/B
MW-65B
MW-74A/B
MW-68B
MW-66A
MW-34A/B

MP-03D
MP-06D
MP-05D
OP-1D
OP-2D

35-IS35
35-IS36
35-IS42
35-IS33
35-IS37
35-IS43
35-IS44
35-IS41
35-IS38
35-IS46
35-IS45
35-IS40
35-IS47
35-IS48
35-IS31
35-IS30
35-IS26
35-IS34
35-IS32
35-IS25
35-IS27
35-IS29
35-IS28
35-IS09
35-IS02
35-IS10
35-IS20
35-IS11
35-IS19
35-IS03
35-IS18
35-IS08
35-IS04
35-IS07
35-IS15
35-IS14
35-IS01
35-IS13
35-IS16
35-IS07
35-IS06
35-IS05
35-IS23

TW-62
TW-63
TW-64
TW-65
TW-66
TW-67
TW-68
TW-60
TW-61
TW-59
TW-53
TW-54
TW-56
TW-49
TW-50
TW-51
TW-52
TW-57
TW-58
TW-46B
TW-45B
TW-72
TW-73
TW-74
TW-75
TW-76
TW-71
TW-70
TW-69



LEGEND

MW-14B MONITORING WELL
GROUNDWATER SAMPLING BORING LOCATION
GROUNDWATER AND SOIL SAMPLING BORING LOCATION
IAS TRENCH
A — A' CROSS-SECTION TRAVERSE

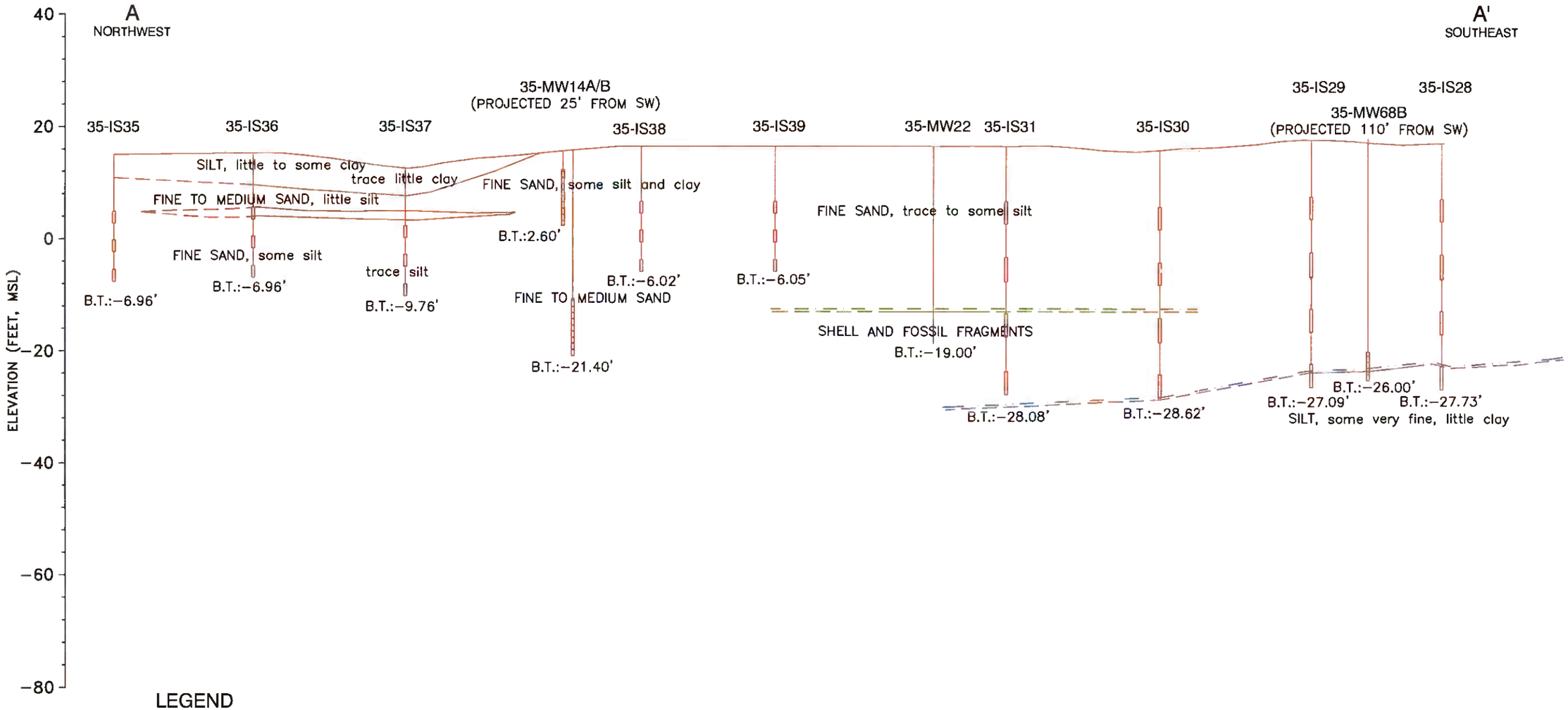
35-IS15 SUPPLEMENTAL IN-SITU GROUNDWATER SAMPLE BORING
35-IS01 INITIAL IN-SITU GROUNDWATER SAMPLE BORING
MW-72A NEW SHALLOW GROUNDWATER MONITORING WELL
MW-72B NEW INTERMEDIATE GROUNDWATER MONITORING WELL
TW-72 TEMPORARY WELL
US 17 JACKSONVILLE BYPASS RIGHT-OF-WAY LIMITS
US 17 JACKSONVILLE BYPASS EASEMENT LIMITS (APPROXIMATE FENCE LINE)

FIGURE 2-2
CROSS-SECTION LOCATION MAP
SITE 35, FORMER CAMP GEIGER FUEL FARM
TECHNOLOGY EVALUATION CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

EBL\NAVY CLEAN\CLEAN 2\CTO 253\SITE 35\SITE 35 WORKPLAN\FIGURES\FIGURE2-2.DWG

SOURCE: MCB CAMP LEJEUNE, 2000.

CH2MHILL



LEGEND

- SCREENED INTERVAL (GEOPROBE SAMPLER)
- SCREENED INTERVAL (PERMANENT AND TEMPORARY WELLS)
- GROUNDWATER ENCOUNTERED DURING DRILLING
- ESTIMATED CONTACT
- PROJECTED CONTACT
- TOP OF RIVER BEND FM (CASTLE HAYNE AQUIFER)
- TOP OF FIRST SEMI−CONFINING UNIT
- B.T.:−27.82' BORING TERMINATED (ELEVATION IN FEET MSL)

80 0 40 80 120
Horizontal Scale: 1 inch = 80 ft.

20 0 10 20 40
Vertical Scale: 1 inch = 20 ft.

THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

ADAPTED FROM BAKER FIGURE

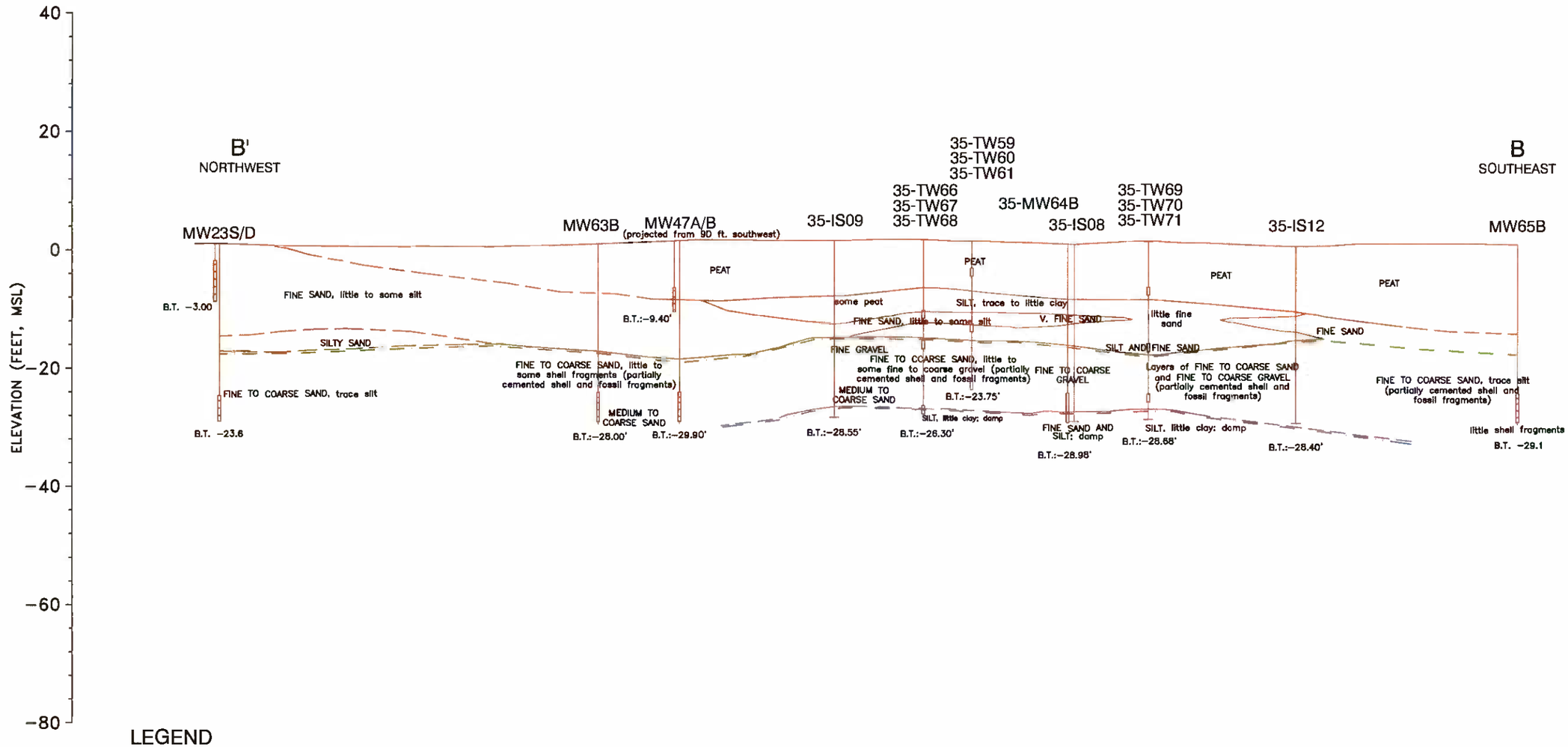
SOURCE: MCB CAMP LEJEUNE, 2000.

FIGURE 2−3
GEOLOGIC CROSS SECTION A - A'
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35/PILOT STUDY

2219301N



LEGEND

- SCREENED INTERVAL (GEOPROBE SAMPLER)
- SCREENED INTERVAL (PERMANENT AND TEMPORARY WELLS)
- GROUNDWATER ENCOUNTERED DURING DRILLING
- ESTIMATED CONTACT
- PROJECTED CONTACT
- TOP OF RIVER BEND FM (CASTLE HAYNE AQUIFER)
- TOP OF FIRST SEMI-CONFINING UNIT
- B.T.:-27.82' BORING TERMINATED (ELEVATION IN FEET MSL)

80 0 40 80 120
Horizontal Scale: 1 inch = 80 ft.

20 0 10 20 40
Vertical Scale: 1 inch = 20 ft.

THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

ADAPTED FROM BAKER FIGURE

SOURCE: MCB CAMP LEJEUNE, 2000.

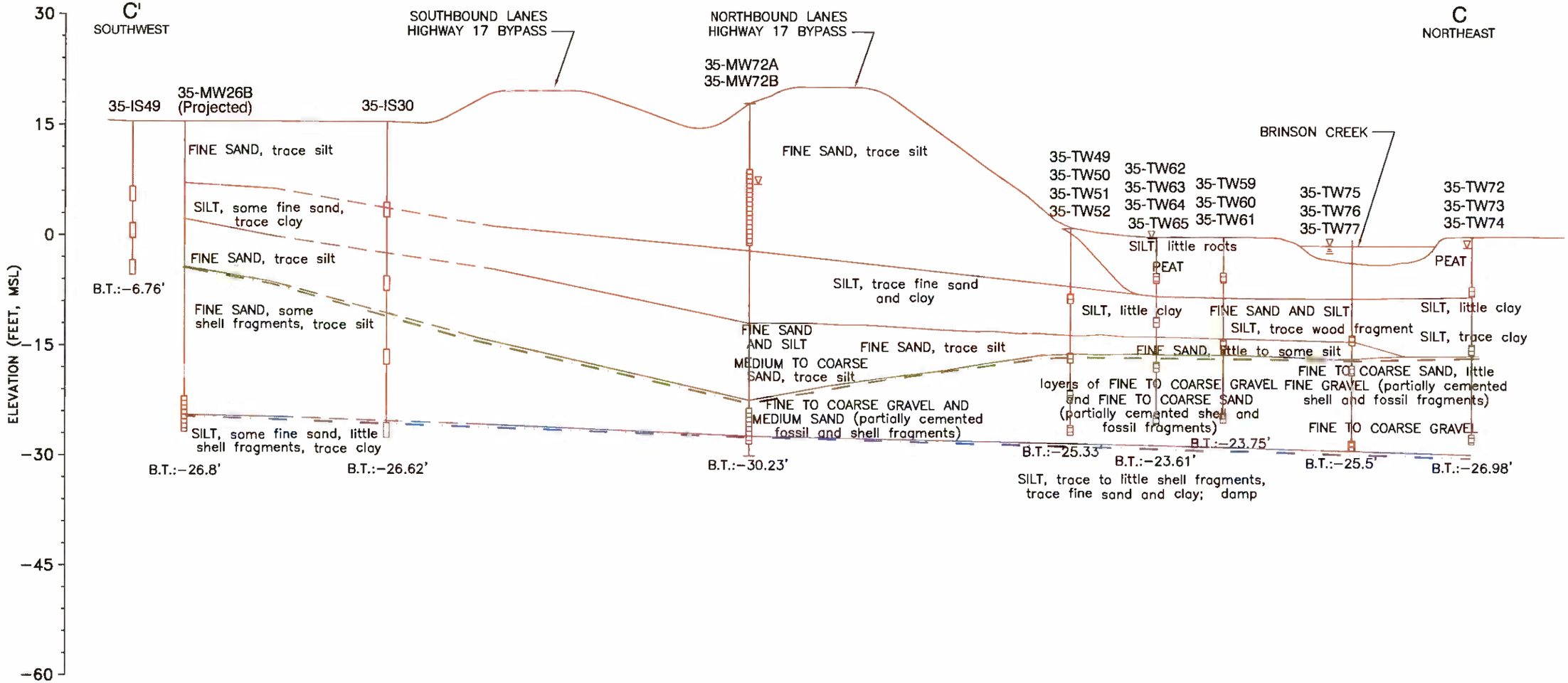
FIGURE 2-4
GEOLOGIC CROSS SECTION B-B'
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35/PILOT STUDY

2219300N

HIGHWAY 17 BYPASS



LEGEND

- SCREENED INTERVAL (GEOPROBE SAMPLER)
- SCREENED INTERVAL (PERMANENT AND TEMPORARY WELLS)
- GROUNDWATER ENCOUNTERED DURING DRILLING
- ESTIMATED CONTACT
- PROJECTED CONTACT
- TOP OF RIVER BEND FM (CASTLE HAYNE AQUIFER)
- TOP OF FIRST SEMI-CONFINING UNIT
- B.T.:−27.82' BORING TERMINATED (ELEVATION IN FEET MSL)

60 0 30 60 120

Horizontal Scale: 1 inch = 60 ft.

15 0 7.5 15 30

Vertical Scale: 1 inch = 15 ft.

THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

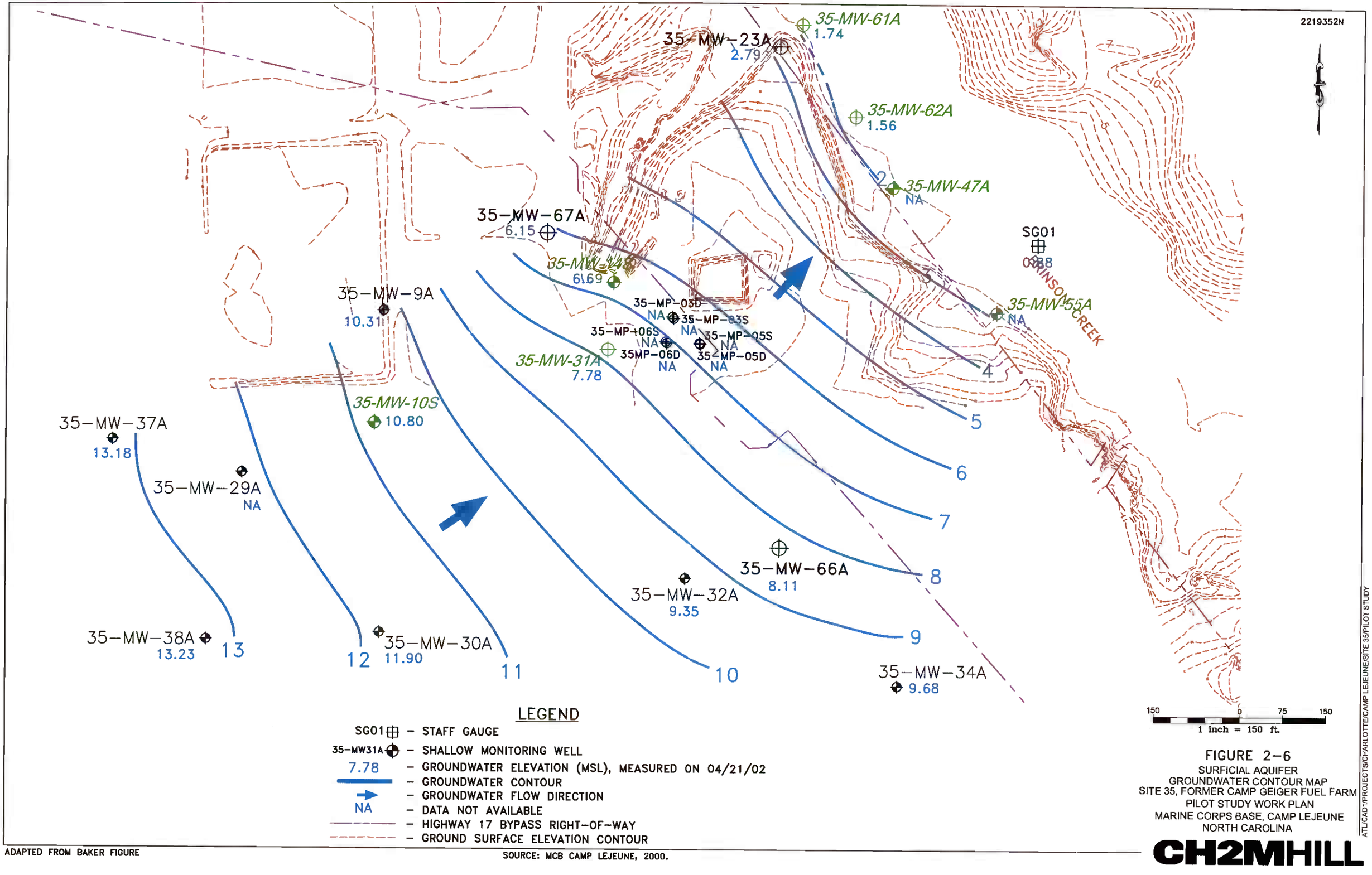
ADAPTED FROM BAKER FIGURE

SOURCE: MCB CAMP LEJEUNE, 2000.

FIGURE 2-5
CROSS SECTION C-C'
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35/PILOT STUDY



LEGEND

- SG01 ⊞ – STAFF GAUGE
- 35-MW31A ⊕ – SHALLOW MONITORING WELL
- 7.78 – GROUNDWATER ELEVATION (MSL), MEASURED ON 04/21/02
- ——— – GROUNDWATER CONTOUR
- → – GROUNDWATER FLOW DIRECTION
- NA – DATA NOT AVAILABLE
- – – – – – HIGHWAY 17 BYPASS RIGHT-OF-WAY
- – – – – – GROUND SURFACE ELEVATION CONTOUR

ADAPTED FROM BAKER FIGURE

SOURCE: MCB CAMP LEJEUNE, 2000.

FIGURE 2-6

SURFICIAL AQUIFER
GROUNDWATER CONTOUR MAP
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35/PILOT STUDY

2219353N

35-MW-23B 3.78
35-MW-63B 2.28
35-MW-47B NA
35-MW-64B 2.23
35-MW-55B NA
35-MW-65B 1.93
35-MW-9D 10.22
35-MW-14D 6.63
35-MW-31B 7.54
35-MW-10D 10.83
35-MW-37B 13.01
35-MW-29B NA
35-MW-68B 7.91
35-MW-32B 9.21
35-MW-30B 11.87
35-MW-38B 13.14
35-MW-34B 8.44
35-MW-70B 13.39
35-MW-39B 13.88
35-MW-40B 11.43
35-MW-41B NA
35-MW-69B 8.98

2
3
4
6
7
8
9
10
11
12
13

LEGEND

35-MW32B – INTERMEDIATE MONITORING WELL
9.21 – GROUNDWATER ELEVATION (MSL), MEASURED ON 04/21/02
– GROUNDWATER CONTOUR
– GROUNDWATER FLOW DIRECTION
NA – DATA NOT AVAILABLE
– HIGHWAY 17 BYPASS RIGHT-OF-WAY
– GROUND SURFACE ELEVATION CONTOUR

260 0 130 260
1 inch = 260 ft.

ADATED FROM BAKER FIGURE

SOURCE: MCB CAMP LEJEUNE, 2000.

FIGURE 2-7
UPPER CASTLE HAYNE AQUIFER
GROUNDWATER CONTOUR MAP
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35/PILOT STUDY

2219341N

THIRD STREET
FOURTH STREET
FIFTH STREET
C STREET
E STREET
F STREET
G STREET

35-IS35
35-IS36
35-IS42
35-IS33
35-IS37
35-IS43
35-IS44
35-IS41
35-IS46
35-IS45
35-IS47
35-IS48
35-IS34
35-IS26
35-IS25
35-IS32
35-IS38
35-IS40
35-IS39
35-IS23
35-IS27
35-IS28

MW-23A/B
MW-63B
MW-47A/B
MW-67A
MW-14A/B
MW-9A/B
MW-31A/B
MW-22
MW-10A/B
MW-37A/B
MW-29A/B
MW-26B
MW-38A/B
MW-30A/B
MW-32A/B
MW-66A
MW-68B
MW-34A/B
MW-39B
MW-40B
MW-41B
MW-65B

MP-03D
OP-1D
OP-2D
MP-05D
MP-06D
TW-46B
TW-45B

TW-66
TW-75
TW-76
TW-77
TW-72
TW-73
TW-74
TW-62
TW-63
TW-59
MW-64B
TW-35
TW-34
TW-55
TW-54
TW-53
TW-50
TW-51
TW-52
TW-69
TW-70
TW-71

TC341
TC342
TC470
TC462
TC572
TC576
TC575
TC562
TC569

G480
G520
G521
G522
G523
G524
G530
G531
G532
G533
G534
G540
G541
G542
G543
G544
G550
G551
G552
G553
G554
G560

10 ug/L CONTOUR INFERRED

NORTHBOUND LANES
SOUTHBOUND LANES

2,000 ug/L
1,000 ug/L
500 ug/L
250 ug/L
100 ug/L

200 0 100 200
1 inch = 200 ft.

LEGEND

- US 17 JACKSONVILLE BYPASS RIGHT-OF-WAY LIMITS
- US 17 JACKSONVILLE BYPASS EASEMENT LIMITS (APPROXIMATE FENCE LINE)
- MW-14B◆ MONITORING WELL
- TW-49 TEMPORARY WELL FROM FOCUSED NAE STUDY
- GROUNDWATER SAMPLING BORING LOCATION
- GROUNDWATER AND SOIL SAMPLING BORING LOCATION
- IAS TRENCH
- GROUNDWATER FLOW DIRECTION IN THE SURFICIAL AND CASTLE HAYNE AQUIFERS

SOURCE: MCB CAMP LEJEUNE, 2000.

NOTES:
1.) LOCATIONS IN BROWN USED TO GENERATE PLUME MAP.
2.) MEAN SEA LEVEL (MSL) = 0.0 FEET

FIGURE 2-8

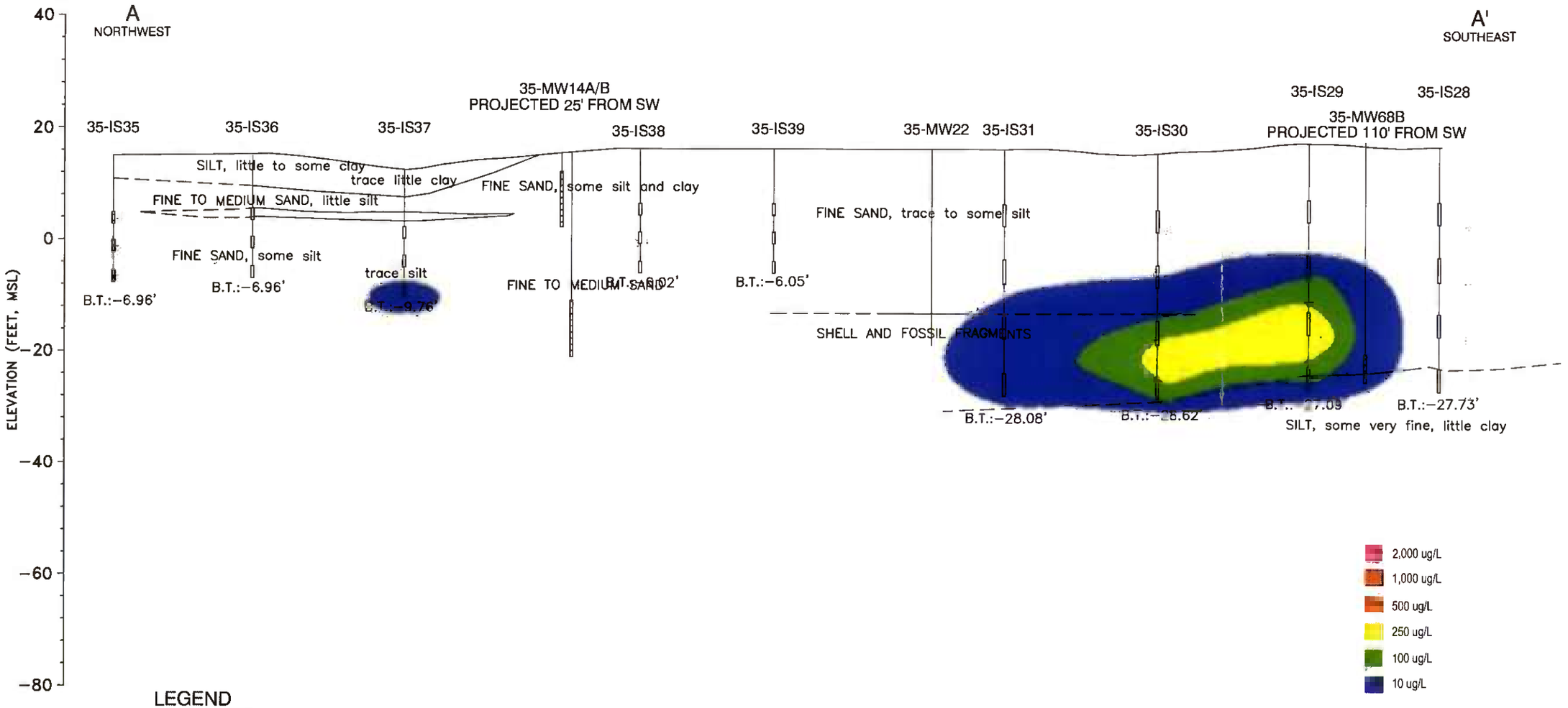
TCE IN GROUNDWATER 15-FT TO 25-FT BELOW MSL
SITE 35, FORMER CAMP GEIGER FUEL FARM
TECHNOLOGY EVALUATION CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

EBL\NAVY CLEAN\CLEAN2\CTO 253\SITE 35\SITE 35 WORK PLAN\FIGURES\FIGURE2-8.DWG

SOURCE: MCB CAMP LEJEUNE, 2000.

CH2MHILL

2219317N



LEGEND

- SCREENED INTERVAL (GEOPROBE SAMPLER)
- SCREENED INTERVAL (PERMANENT AND TEMPORARY WELLS)
- GROUNDWATER ENCOUNTERED DURING DRILLING
- ESTIMATED CONTACT
- PROJECTED CONTACT
- B.T.:−27.82' BORING TERMINATED (ELEVATION IN FEET MSL)

80 0 40 80 120

Horizontal Scale: 1 inch = 80 ft.

20 0 10 20 40

Vertical Scale: 1 inch = 20 ft.

THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

ADAPTED FROM BAKER FIGURE

SOURCE: MCB CAMP LEJEUNE, 2000.

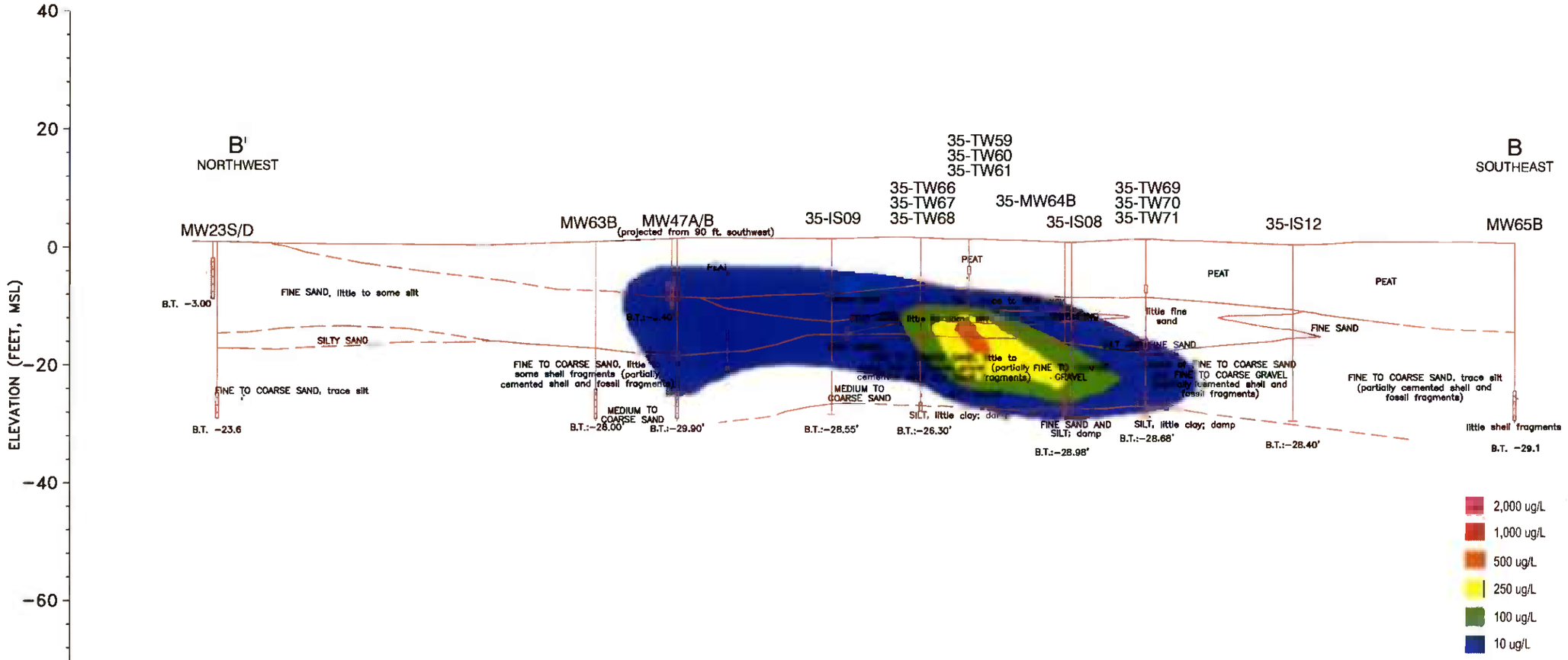
FIGURE 2−9a

VERTICAL DISTRIBUTION OF TCE
CROSS SECTION A-A'
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

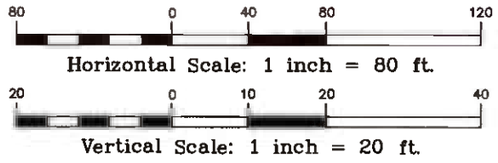
CH2MHILL

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35

2219314N



NOTE: GROUNDWATER FLOW IS INTO PAGE.



LEGEND

- SCREENED INTERVAL (GEOPROBE SAMPLER)
- SCREENED INTERVAL (PERMANENT AND TEMPORARY WELLS)
- ESTIMATED CONTACT
- PROJECTED CONTACT
- B.T.:-27.82' BORING TERMINATED (ELEVATION IN FEET MSL)

THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

ADAPTED FROM BAKER FIGURE

SOURCE: MCB CAMP LEJEUNE, 2000.

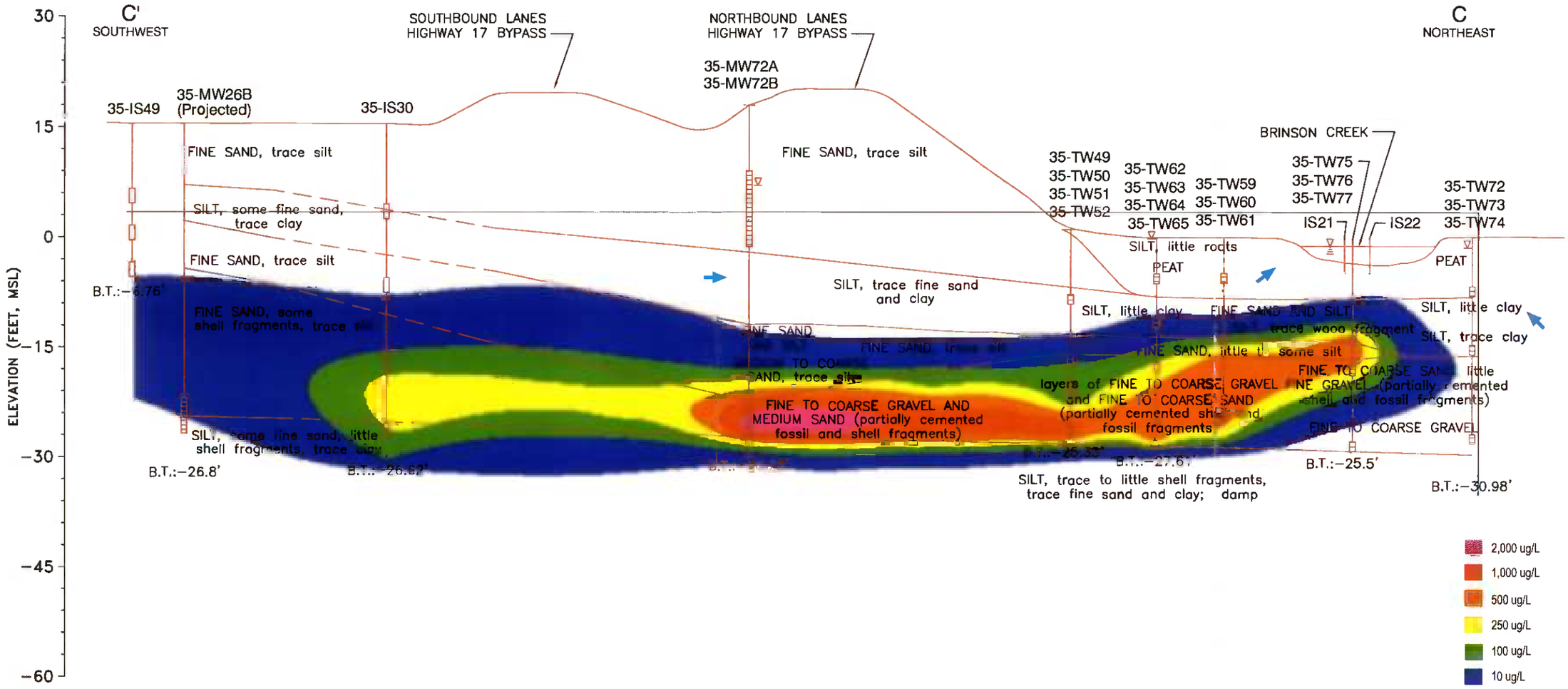
FIGURE 2-9b
VERTICAL DISTRIBUTION OF TCE
CROSS SECTION B-B'
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35/PILOT STUDY

2219340N

HIGHWAY 17 BYPASS



LEGEND

- SCREENED INTERVAL (GEOPROBE SAMPLER)
- SCREENED INTERVAL (PERMANENT AND TEMPORARY WELLS)
- GROUNDWATER ENCOUNTERED DURING DRILLING
- ESTIMATED CONTACT
- PROJECTED CONTACT
- B.T.:−27.82' BORING TERMINATED (ELEVATION IN FEET MSL)
- GROUNDWATER FLOW DIRECTION IN THE SURFICIAL AND CASTLE HAYNE AQUIFERS

NOTE: GROUNDWATER FLOW IS INTO THE PAGE.

60 0 30 60 120

Horizontal Scale: 1 inch = 60 ft.

15 0 7.5 15 30

Vertical Scale: 1 inch = 15 ft.

THE SOIL BORING INFORMATION IS CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS. SUBSURFACE CONDITIONS INTERPOLATED BETWEEN BORINGS ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND GEOLOGIC JUDGEMENT.

ADAPTED FORM BAKER FIGURE

SOURCE: MCB CAMP LEJEUNE, 2000.

FIGURE 2-9c
VERTICAL DISTRIBUTION OF TCE
CROSS SECTION C-C'
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

ATLCAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35/PILOT STUDY

2219339N

PILOT STUDY TREATMENT AREA

10 ug/L CONTOUR INFERRED

2,000 ug/L
1,000 ug/L
500 ug/L
250 ug/L
100 ug/L

200 0 100 200
1 inch = 200 ft.

LEGEND

- US 17 JACKSONVILLE BYPASS RIGHT-OF-WAY LIMITS
- US 17 JACKSONVILLE BYPASS EASEMENT LIMITS (APPROXIMATE FENCE LINE)
- MW-14B ◆ MONITORING WELL
- TW-49 ⓣ TEMPORARY WELL FROM FOCUSED NAE STUDY
- GROUNDWATER SAMPLING BORING LOCATION
- GROUNDWATER AND SOIL SAMPLING BORING LOCATION
- IAS TRENCH
- GROUNDWATER FLOW DIRECTION IN THE SURFICIAL AND CASTLE HAYNE AQUIFERS

NOTES:
1.) LOCATIONS IN BROWN USED TO GENERATE PLUME MAP.
2.) MEAN SEA LEVEL (MSL) = 0.0 FEET

SOURCE: MCB CAMP LEJEUNE, 2000.

FIGURE 2-10
TCE IN GROUNDWATER 15-FT TO 25-FT BELOW MSL
SITE 35, FORMER CAMP GEIGER FUEL FARM
TECHNOLOGY EVALUATION CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

CHARLETTE/PROJ/EB1/NAVY CLEAN/CLEAN 2CTO 250/SITE 88/FNAE.zip

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35

3.0 Pilot Study Design

The selected remedial technology, injection of Modified Fenton's followed by potassium permanganate, is a potentially effective approach for remediation of TCE and associated dissolved chlorinated solvent contamination at Site 35. This section presents a summary of the conceptual pilot scale design. Specific engineering details regarding chemical concentrations and volumes will be addressed in a separate document, to be prepared by the selected specialty vendor.

3.1 Pilot Study Overview, Objectives and Goals

3.1.1 Study Overview

For the target "hot spot" area, the Technology Evaluation (CH2M HILL, 2003) identified several options for a pilot study. These options were the BIOX process (hydrogen peroxide), potassium permanganate and ISOTEC's approach (Modified Fenton's followed by permanganate). All of the technologies are expected to be effective at removing contamination. However, combining the ISOTEC reagent with permanganate appears to be a very effective approach. Injecting the ISOTEC reagent provides an initial oxidant charge that should reduce both dissolved and adsorbed contaminant mass. A follow-up application of permanganate will reduce the potential for rebound of COC concentrations. The complete rationale for selection of chemical oxidation using Modified Fenton's and potassium permanganate is presented in the Technology Evaluation (CH2M HILL, 2003).

In summary, a series of oxidants will be introduced into the aquifer using eighteen injection wells. There will be one injection event to inject Modified Fenton's into the eighteen injection wells to aggressively address the highest TCE concentration areas. During this injection event, an attempt will be made to deliver a specified quantity of reagent to each well. Depending upon the injection pressures, flow rates and observed reactions, the reagent may be injected during one continuous injection or during multiple injections over several days. Within one month of the Fenton's work, there will be one injection event to inject potassium permanganate into all eighteen injection wells to provide a more persistent oxidant.

The scope of work for the pilot test will consist of three phases:

1. Installation and development of five new monitoring wells and eighteen injection wells
2. Injection of oxidants
3. Performance monitoring

3.1.2 Study Objectives and Goals

The primary objective of the pilot test is to evaluate the effectiveness of chemical oxidation for treating the target "hot spot" area and reducing TCE concentrations to low levels, where natural attenuation will complete the process of meeting regulatory standards within a reasonable time frame. The pilot test is not intended to be a final remedy. The Partnering

Team will determine low levels and a reasonable time frame. The work is regulatory driven as the state groundwater standards (2L Standards) are exceeded and VOCs are reaching the creek. The compliance point is both the groundwater concentration and the creek concentration. The use of multiple injections with multiple oxidants is intended to treat both adsorbed contamination and dissolved contamination.

The effectiveness of the test will be evaluated according to the following criteria:

1. 80% contaminant mass removal from groundwater, as quantified by pre- and post-treatment groundwater samples.
2. Minimization of contaminant "rebound" to upgradient background levels, as quantified by post-treatment groundwater samples, to be collected quarterly for a period of one year.

All new and existing monitoring wells will be gauged and sampled prior to initiation of the pilot test. The resulting laboratory analytical data and field geochemical data will be used to establish baseline conditions. Subsequent data will be compared to baseline conditions to evaluate performance during the test. A total of twelve monitoring wells will be in and around the test area. Three new monitoring wells will be considered upgradient. Five monitoring wells (3 existing and 2 new wells) will be considered in the test area and four wells will be considered downgradient. Numeric values will be based on averages of the specific wells (i.e., average of the 3 upgradient wells, average of the 5 test area wells, and average of the 3 down gradient wells).

Specific goals of the pilot study include:

- Reducing the mass of the plume,
- Gain information about the technologies being tested to evaluate whether to use the Modified Fenton's and /or potassium permanganate on a larger scale at the site or at other sites across the Base.

The pilot test is not intended to be the final remedy. Depending on the results of the pilot test and subsequent evaluation of the technology per the above criteria, chemical oxidation using Modified Fenton's and/or Potassium permanganate may be used on a larger scale at Site 35 or other sites across the Base. A decision to use either technology in other areas of the site sites across the base will be subject to the approval of the Partnering Team.

3.2 Technology Description

This section comprises a brief technical overview of the methodology associated with both technologies to be employed at Site 35: Modified Fenton's and potassium permanganate injections.

3.2.1 Modified Fenton's Reagent

In-Situ Oxidative Technologies, Inc. (ISOTEC) has a patented Modified Fenton's reagent that relies on a lower concentration of hydrogen peroxide combined with a chelated iron catalyst to produce hydroxyl radicals. The chelated iron catalyst provides two enhanced features over the introduction of the Fe(II) catalyst in a salt form: 1) the reaction is more controlled

and less exothermic; and 2) the process can be applied to a wider range of sites without pH adjustment of the groundwater. The Fenton's reaction is the same: hydroxyl radicals are generated which oxidize a multitude of organics. The ISOTEC reagent slows down the Fenton's reaction and allows it to occur at neutral pH conditions. This also improves the mobility of Fe(II)/Fe(III) ions, and the stability of the hydrogen peroxide. This ISOTEC reagent is specially formulated to enhance the subsurface mobility of injected reagents, thus achieving a larger radius of influence from each injection well. ISOTEC's catalysts have increased mobility compared to conventional Fenton's catalysts due to chelating components that prevent precipitation or fixation of iron to native soil, thereby promoting its availability for hydroxyl radical generation from peroxide.

ISOTEC's reagent has been shown to be effective in treating dissolved and adsorbed chlorinated ethenes. The ISOTEC reagent is more aggressive than permanganate and is effective at treating adsorbed contaminants, thus reducing the possibility of rebound. Also, the effectiveness of this reagent is less sensitive than standard Fenton's reagent to the requirement for thorough spreading within the plume at the time of injection.

Due to the short life of the ISOTEC reagent (although longer than Fenton's), the opportunity for treatment of COC at some distance from the injection well is limited. This makes effectiveness of the injection vital to the success of the remediation. Effectiveness is most directly measured by comparing pre-treatment and post-treatment groundwater concentrations (both short and long-term results). Due to the variable lithologies within the surficial aquifer at Site 35, it is difficult to assure that complete horizontal and vertical distribution of the ISOTEC reagent could be achieved within the plume. Therefore, a follow-up injection of permanganate will be used to complete the destruction of COC.

3.2.2 Potassium Permanganate

Permanganate is an oxidizing agent with a unique affinity for organic compounds containing carbon double bonds, such as PCE and TCE. The oxidation strength and specificity of the permanganate ion improves its longevity, relative to non-specific oxidizers, such as hydroxyl radicals and ozone.

The value of the permanganate treatment is that the oxidant life is much longer than the hydroxyl radicals formed from Fenton's reactions: permanganate is persistent for weeks to months versus minutes to hours for hydroxyl radicals. This allows the permanganate to have a higher probability of contacting remaining COCs after injection, because there is time for the reagent to spread within the plume via advection and dispersion. Permanganate reactions are also effective over a wide range of pH (3.5-12) conditions, and have been shown to be effective at reducing the TCE and daughter product concentrations. The permanganate solution will be injected into the subsurface using permanent injection wells.

3.3 Pre-Pilot Study Implementation Activities

Preliminary study activities associated with the implementation of the pilot studies include:

- Coordination with Camp Lejeune personnel on the location of utilities in the area;
- Pilot study monitoring and injection well installation;

- Gauging and baseline groundwater sampling event;
- Designation of areas for temporary storage of equipment and materials; and
- Site-specific security and safety concerns.

Applications will be submitted for any required drilling and underground injection permits. Injection of Modified Fenton's is considered to be the start of the pilot study test period.

3.3.1 Utility Location

The field engineer will mark the locations of five additional monitoring wells and eighteen injection wells at least 2 weeks prior to commencement of the activity. All utilities will be marked by a professional utilities locating service prior to the start of drilling. The preliminary monitoring and injection well locations are shown in Figure 3-1, but final locations will be determined based on results of utility locations and conditions encountered in the field.

3.3.2 Pilot Study Monitoring and Injection Well Installation

Groundwater monitoring will be performed to evaluate the changes in contaminant concentration and distribution over time as a result of the pilot study. Groundwater monitoring will be conducted prior to any oxidant injection, after injection of the modified Fenton's and then three quarterly rounds after injection of the permanganate.

Three new monitoring wells will be installed within the test area to serve as upgradient monitoring points from the injection zone and two new monitoring wells will be installed in the test area. The purpose of the upgradient wells is to monitor the conditions just upgradient of the test area. In addition, eighteen injection wells will be installed, as shown in (Figure 3-1). The vertical distribution of TCE with the proposed injection wells and monitoring wells are shown in (Figure 3-2). Each well will be installed using hollow stem auger drilling methods. The wells will be installed to a depth of 47 feet with 5-foot screens. The procedures and specifications that will be followed during well installation are presented in Appendix A.

3.3.3 Gauging and Baseline Groundwater Sampling Event

All new and existing monitoring wells will be gauged and sampled prior to the start of the pilot study. New monitoring wells that will be used for this study are IR-35-MW-75B, -76B,–77B, -78B, and –79B. Existing monitoring wells that will be used for this study are: IR35-MW-55B, -72B, -73B, -74B, IR35-TW-52, -55, and -57. Water level measurements will be used to develop site-wide potentiometric maps and to determine groundwater flow patterns. The results from sampling will provide a baseline for the pilot study. Samples from all monitoring wells will be analyzed for cVOCs, metals, ferrous iron, total iron, chloride, dissolved oxygen, conductivity, pH, temperature, turbidity, and oxidation/reduction potential.

3.3.4 Natural Oxidant Demand

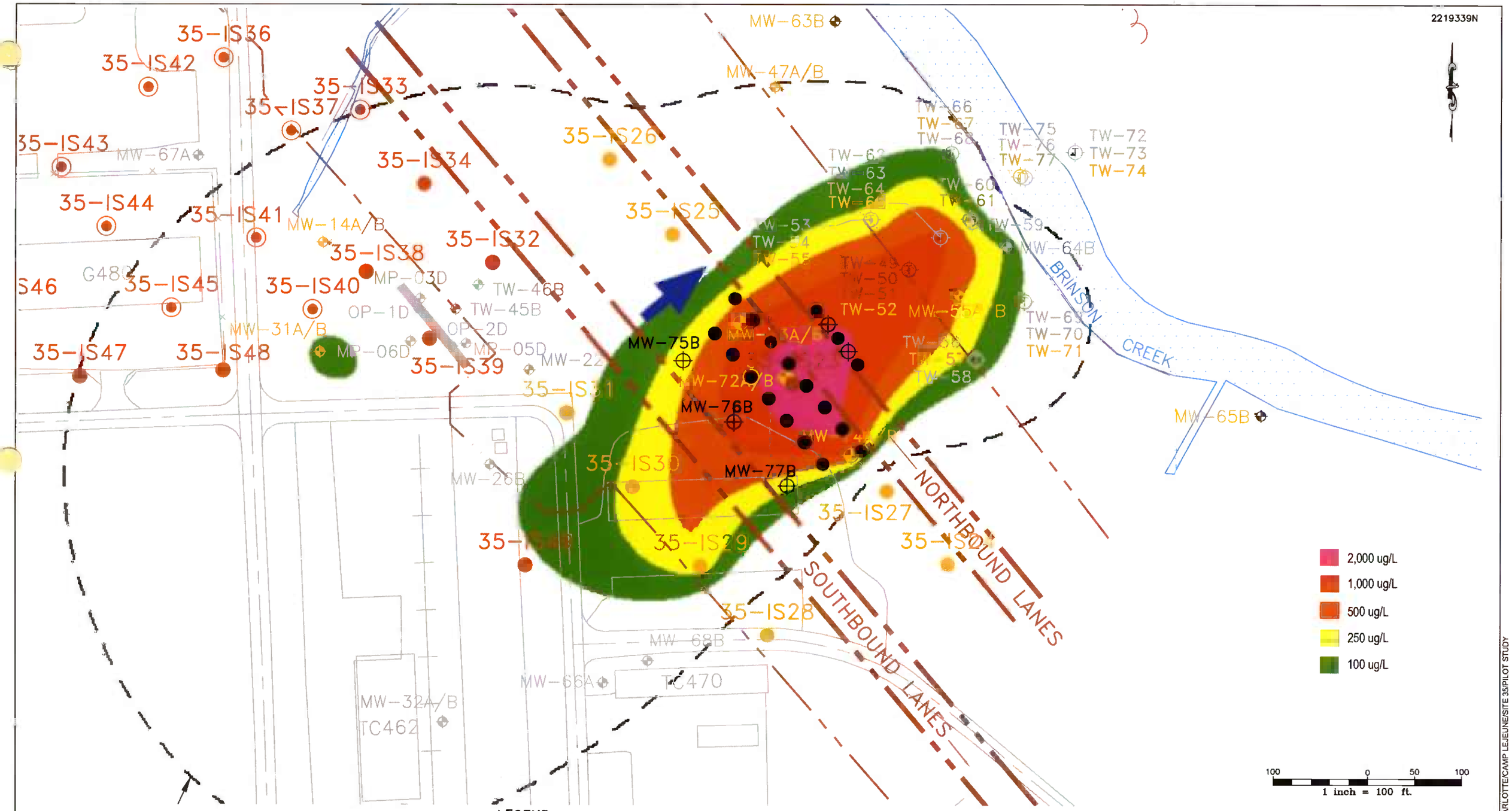
Natural organic matter (NOM) and reduced metal species in the subsurface can exert a significant oxidant demand. This natural oxidant demand (NOD) may directly affect the

oxidation of the target compounds. However, the test to determine NOD is a relatively new, inexact test with no agreed upon method. Yet, the test is still useful to assess the applicability of using an oxidant. The purpose of assessing NOD prior to injecting oxidant is to get a relative assessment of the organic demand of the system. In instances where the NOD results are extremely high, the application of the oxidation technology would need to be reconsidered. Likewise, if the results indicated an extremely low NOD, the mass of oxidant to be delivered would be reconsidered. With the NOD assessment performed for Site 35, these questions have been answered. The next step is to conduct the pilot study and assess the results of the injection. One result that will be evaluated is the longevity of the oxidant – which will help us determine the feasibility of applying the oxidation technology on a full-scale basis.

3.3.5 Other Preliminary Activities

Prior to commencement of field activities, CH2M HILL representatives will contact personnel at Camp Lejeune to locate temporary storage facilities that will be accessible during the entire 12 month testing period. The facilities will be used to store field equipment required for sampling activities. During discussions with Camp Lejeune personnel, site-specific security and safety of personnel and equipment will be reviewed.

Figures



LEGEND

- US 17 JACKSONVILLE BYPASS RIGHT-OF-WAY LIMITS
- US 17 JACKSONVILLE BYPASS EASEMENT LIMITS (APPROXIMATE FENCE LINE)
- MW-14B — MONITORING WELL
- TW-49 — TEMPORARY WELL FROM FOCUSED NAE STUDY
- GROUNDWATER SAMPLING BORING LOCATION
- GROUNDWATER AND SOIL SAMPLING BORING LOCATION
- IAS TRENCH
- GROUNDWATER FLOW DIRECTION IN THE SURFICIAL AND CASTLE HAYNE AQUIFERS
- PROPOSED CHEMICAL OXIDATION INJECTION WELL
- PROPOSED MONITORING WELL

NOTES:
1.) LOCATIONS IN BROWN USED TO GENERATE PLUME MAP.
2.) MEAN SEA LEVEL (MSL) = 0.0 FEET

ADAPTED FROM BAKER FIGURE

SOURCE: MCB CAMP LEJEUNE, 2000.

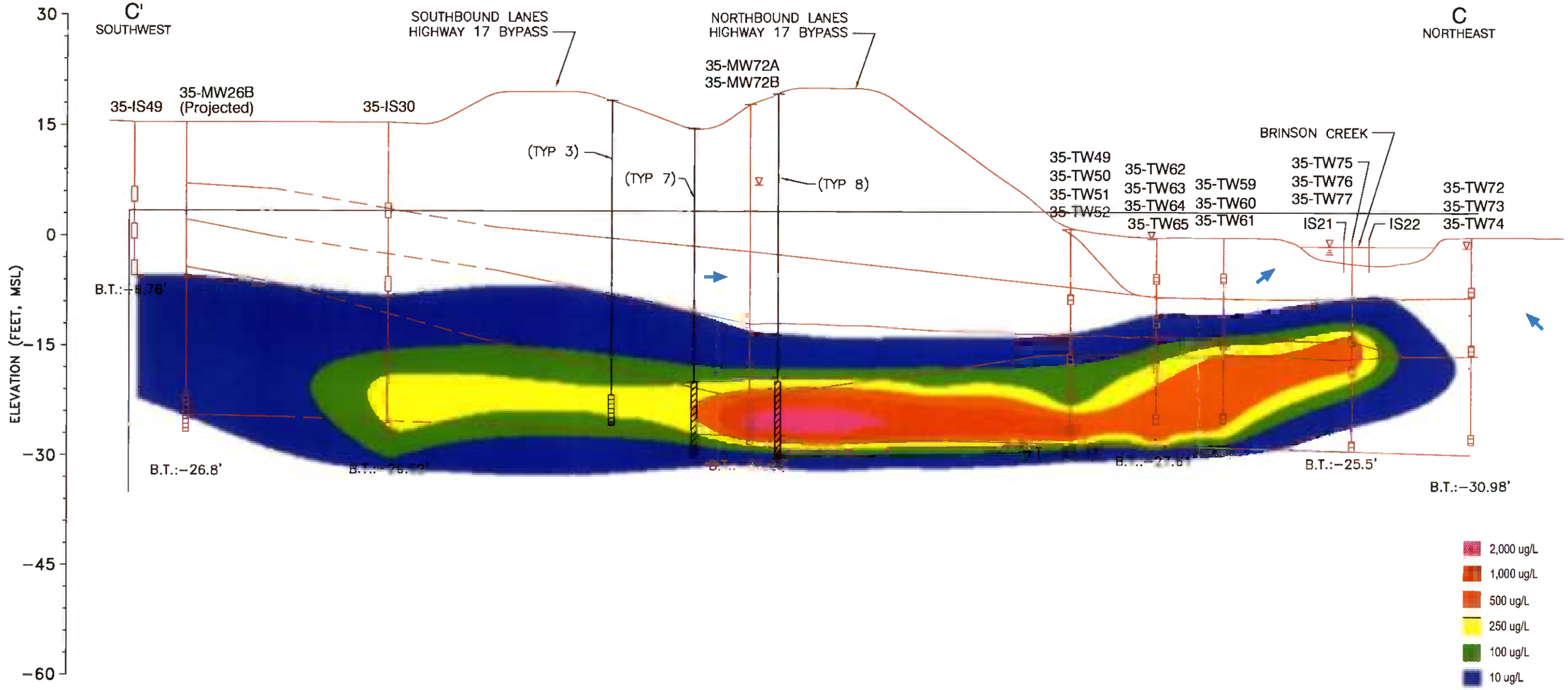
FIGURE 3-1
PROPOSED INJECTION WELL AND MONITORING WELL LAYOUT
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35/PILOT STUDY

2219340N

HIGHWAY 17 BYPASS



LEGEND

- SCREENED INTERVAL (GEOPROBE SAMPLER)
- SCREENED INTERVAL (PERMANENT AND TEMPORARY WELLS)
- GROUNDWATER ENCOUNTERED DURING DRILLING
- ESTIMATED CONTACT
- PROJECTED CONTACT
- B.T.:-27.82' BORING TERMINATED (ELEVATION IN FEET MSL)
- GROUNDWATER FLOW DIRECTION IN THE SURFICIAL AND CASTLE HAYNE AQUIFERS
- INJECTION WELL (PROPOSED)
- MONITORING WELL (PROPOSED)

60 0 30 60 120
Horizontal Scale: 1 inch = 60 ft.

15 0 7.5 15 30
Vertical Scale: 1 inch = 15 ft.

FIGURE 3-2

VERTICAL DISTRIBUTION OF TCE
CROSS SECTION C-C' WITH PROPOSED INJECTION WELLS AND MONITORING WELLS
SITE 35, FORMER CAMP GEIGER FUEL FARM
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

ADAPTED FROM BAKER FIGURE

SOURCE: MCB CAMP LEJEUNE, 2000.

ATL/CAD1/PROJECTS/CHARLOTTE/CAMP LEJEUNE/SITE 35/PLOT STUDY

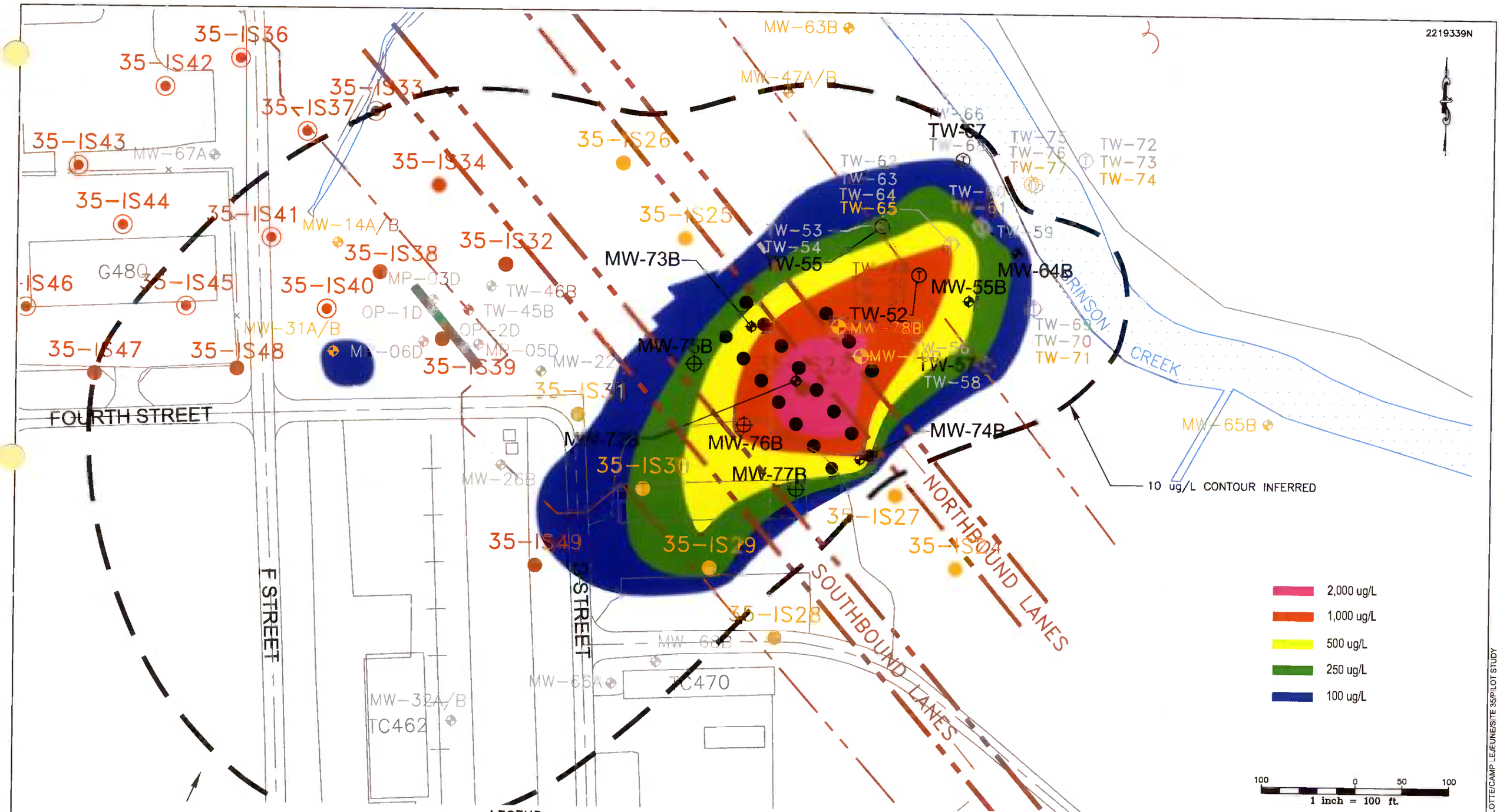


FIGURE 3-3
PROPOSED MONITORING LOCATIONS
PILOT STUDY WORK PLAN CTO-253
MARINE CORPS BASE, CAMP LEJEUNE
NORTH CAROLINA

CH2MHILL

4.0 Pilot Study Implementation

The scope of work will include, but is not limited to, the following tasks:

1. Monitoring Well Installation, Development, Surveying, and Sampling
2. Injection Well Installation and Development
3. Oxidant Demand Testing
4. Subcontractor Deliverables - Work Implementation Plan and Site-Specific Health and Safety Plan (SHSP)
5. Pre-Mobilization Meeting
6. Subcontractor Mobilization and Permits
7. Site Preparation
8. Series of Modified Fenton's injections followed by Potassium Permanganate injections
9. Groundwater Monitoring for One Year
10. Waste Management

Each of these tasks is described in the following sections.

Subcontractors shall furnish all labor, equipment, materials, lower-tier subcontractor(s), supplies and all else necessary to completely perform the Scope of Work identified herein. All work shall be completed in compliance with current federal, state and local regulations and in accordance with standard industry practice. The Subcontractor shall comply with all entry/exit, health and safety, permitting, work schedule, and any other requirements that may be set by Camp Lejeune that may impact the work specified herein.

During construction and operation of the pilot study, site operations will be implemented as presented in the Final Pilot Test Work Plan, the Site-Specific Health and Safety Plan (SHSP), and the Quality Assurance Plan. All activities will be conducted in accordance with these site-specific plans.

At the conclusion of the one-year post-injection groundwater sampling event, a Pilot Test Summary Report will be prepared and submitted to the Partnering Team. This report will outline the activities completed during the study period, results obtained, and recommendations with regard to possible Modified Fenton's and potassium permanganate implementation at other areas of Site 35. The pilot test is not intended to be the final remedy. The purpose of the pilot study is to evaluate in situ chemical oxidation using modified Fenton's and permanganate. The purpose of the study is not to design a full-scale system. The CERCLA process still applies to the site. At some point a feasibility study and remedial design will be performed that would take into consideration the results of the test (contaminant reduction, injection amounts, costs, etc.).

Several considerations related to the execution of the fieldwork at Site 35 are listed below. These considerations will include, but are not limited to, the following:

- Site entry and access authorizations
  - Camp Lejeune is an Active military base. All personnel working at the test site must check in with Camp Lejeune security and receive a vehicle pass, valid for the duration of the site work.
  - All personnel working at the test site must be U.S. citizens, or the Subcontractor shall provide proper and adequate escort as required by Camp Lejeune for all its foreign national workers.
  - Personnel should not enter a secured area without the proper training and key card access.
- Equipment, space, and utility requirements
  - Subcontractor shall be solely responsible for their equipment, instrumentation, materials, and supplies.
  - CH2M HILL will be responsible for obtaining the proper work permits (monitoring well, UIC, etc.).
  - Site access during the project will be limited to authorized personnel only.
- Site security, including securing of equipment
  - During working hours, the subcontractor or CH2M HILL will secure the working area (to be determined in the field).
  - During non-working hours, equipment will be secured.

4.1 Monitoring Well Installation and Sampling

Three new monitoring wells (35-MW75B, 35-MW76B, 35-MW77B) will be installed upgradient of the injection wells and two new monitoring wells. 35-MW78B, and 35-MW79B) will be installed within the proposed pilot study treatment zone injection wells, as shown in Figure 3-1. Well designations are similar to what has been used at the site in the past, with the "B" designation referring to the intermediate region of the Castle Hayne aquifer. The new monitoring wells will be screened from approximately –22.5 to –27.5 feet MSL. Prior to oxidant injection, groundwater samples will be collected from the monitoring wells in the target treatment area to establish the baseline groundwater quality and to delineate the TCE plume further.

All wells will be constructed of schedule 40 PVC with 0.010 inch slot screen and finished at grade with flush mounted 8.5 inch steel protective locking covers set in two foot square concrete aprons. Monitoring wells will be installed using hollow stem auger drilling methods. Appropriate sand filter pack and bentonite seal materials will be installed, and the annular space will be grouted to the land surface with Portland cement grout.

After construction activities are completed, wells will be developed to ensure good hydraulic connection with the water bearing zone or aquifer. Following a period of at least 24 hours to ensure equilibration with the surrounding water bearing zone, each well will be gauged, purged and sampled. Groundwater samples will be collected in accordance with the Region IV EISOPQAM, dated May 1996 (revised, 1997) and USEPA Region IV low-flow

with tape graduated in 0.01-foot increments. Measurements will be recorded as depth to water from the mark on the top of the well casing. Well number, date and time of measurement, and depth to water will be recorded in the field logbook.

Generation, characterization, and proper disposal of drilling and development fluids and well cuttings are discussed in Section 4.10 of this Work Plan.

All new well installations will be referenced both horizontally and vertically. Each new well will be surveyed relative to permanent land monuments or grid system (State plane coordinate system), and will be referenced to a USGS datum/benchmark. Elevation will be surveyed to the nearest 0.01 foot, while horizontal location will be established to the nearest 0.1 foot.

CH2M HILL will coordinate with Base personnel and a professional utility locator to define all subsurface structures that might be impacted by monitoring well drilling activity in the immediate area of the pilot test.

4.2 Injection Well Installation

Eighteen injection wells will be installed within the proposed pilot study area to deliver chemical oxidants to the treatment zone, as shown in Figure 3-1. The injection wells, designated IW-01 through IW-18, will be screened from approximately –20 to –30 feet MSL (approximately 37 to 47 feet BLS). The well spacing will be approximately 30 ft.

Each injection well will be drilled to a depth of 47 feet using 4-inch inside diameter hollow-stem augers. Injection wells will be constructed of 2-inch diameter schedule 40 polyvinyl chloride (PVC) flush thread casing, with 10 feet of 0.020-inch slotted PVC screen. Sections of solid 2-inch diameter PVC riser will complete the upper portion of the well. The riser casing will be installed to be approximately a few inches below the ground surface. A watertight, locking, expansion cap will be installed on top of the PVC well casing at the surface. The annulus of each well will be filled with 10-20 grade silica sand which will extend from the bottom of the borehole to approximately two feet above the top of the screen followed by hydrated bentonite chips or pellets to 5 feet below grade. The remainder of the borehole will be filled with concrete. The surface completion for each injection well will be constructed in a minimum 12-inch diameter steel traffic-box set in the concrete. Figure 4-1 illustrates a typical injection well design.

Generation, characterization, and proper disposal of drilling (and development) fluids and well cuttings are discussed in Section 4.10 of this Work Plan.

All new well installations will be referenced both horizontally and vertically. Each new well will be surveyed relative to permanent land monuments or grid system (State plane coordinate system), and will be referenced to a USGS datum/benchmark. Elevation will be surveyed to the nearest 0.01 foot, while horizontal location will be established to the nearest 0.1 foot.

CH2M HILL will coordinate with Base personnel and a professional utility locator to define all subsurface structures that might be impacted by monitoring well drilling activity in the immediate area of the pilot test.

4.3 Oxidant Demand Testing

4.3.1 Permanganate Demand Test

One permanganate demand test will be conducted with the objective to evaluate the native slurry (soil and groundwater mixture) and groundwater demand for the oxidant over a 7-day period. This information is useful to evaluate the excess permanganate that will need to be injected under field conditions to offset the natural organic demand. Based on ISOTEC's prior experience with oxidant demand testing, a separate Fenton's oxidant demand test will not be performed due to the fast reaction kinetics of the Fenton's reagent.

The natural oxidant demand (or soil oxidant demand) test (NOD) is an attempt to quantify the permanganate oxidant demand of the native soil. This is a relatively new test and there are no standard procedures (i.e., EPA or ASTM) for the test. The test is conducted by placing soil in several test tubes and adding varying concentrations of permanganate. The tubes are evaluated each day for color. When the permanganate is used up, the solution becomes clear. If the permanganate is not used up, the solution is pink or purple. At the seventh day, the initial permanganate concentrations of the clear tube and the next colored tube (pink or purple) are averaged and the theoretical demand is calculated in pounds of permanganate per volume of soil.

One consideration with using this test is that higher concentrations, as well as longer contact times, result in a higher oxidant demand. So when a NOD test is performed, it is important that the contact time, oxidant strengths, and contact method be clearly understood.

The test needs to be viewed as qualitative rather than quantitative and will only provide a prospective on the relative organic demand of the system to be treated. In instances where the NOD results are extremely high, the application of the oxidation technology would need to be reconsidered. Likewise, if the results indicated an extremely low NOD, the mass of the oxidant to be delivered would be reconsidered.

There is no NOD test available for estimating the oxidant demand with Fenton's reagent. This is because modified Fenton's reacts quickly and more aggressively than permanganate. So, unlike the permanganate based test where the residual permanganate can be measured for days or even weeks, the hydroxyl radical (i.e., the reactant) exists for fractions of a second and can not be measured.

For this study, the oxidant demand will be used as a yardstick. The study will try to meet the oxidant demand using a mix of Modified Fenton's and permanganate. It is one more piece of the data that will be used in the overall study evaluation.

4.3.2 Slurry and Groundwater Demand

In order to evaluate the soil/groundwater permanganate demand, a qualitative visual experiment will be initially conducted on a slurry sample from the site followed by a quantitative experiment. A soil/groundwater slurry will be composited using site samples. The slurry used in the experiments will be prepared by purging the VOCs present for 3 hours under room temperature conditions. VOCs are purged by leaving the container of soil open in a laboratory hood for three hours to drive off the VOCs, so to only measure the oxidant demand associated with the soil matrix. A sample of purged slurry will be weighed

into each of ten different clear vials. To each vial, measured permanganate reagent and DI water will be added to achieve the desired theoretical permanganate load. Color changes in each vial will be observed on a daily basis for 7 days after inverting each vial ten times, allowing the slurry particles to settle, and recording the supernatant color. The results of the visual test will be used to set-up the quantitative test.

In order to quantify the actual demand, vials containing the theoretical permanganate concentration based on the visual test will be set up a second time and daily demand will be determined for 7 days by spectrophotometrically determining residual permanganate concentrations. The actual permanganate demand in the slurries will be determined after the 7-day test period and an average demand will be reported.

4.4 Subcontractor Deliverables

There will be two primary subcontractors for this project: The chemical oxidation subcontractor, and the drilling subcontractor. The Subcontractors will provide a Work Implementation Plan and Site Specific Health and Safety Plan (SHSP) for their respective portion of the work. The Work Implementation Plan will include technology specific technical information that will be incorporated into appropriate sections of the Final Pilot Test Work Plan (WP).

The Final WP will consist of an updated and expanded version of this document, including detailed design drawings and specifications associated with the injection well screens and details of the injection procedure. The Final WP will incorporate the subcontractors' site-specific health and safety plan and work implementation plan. A schedule of implementation is also provided.

ISOTEC's Work Implementation plan and Site Specific Health and Safety Plan for the chemical oxidation is provided in Appendix D.

4.3.1 Site Specific Health and Safety Plan

The Site Specific Health and Safety Plan (SHSP) shall be consistent, and the Subcontractors shall comply, with the requirements and guidelines of:

- Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29, Code of Federal Regulations, Parts 1910 and 1926 (29 CFR 1910 and 1926), including amendments as stated in Federal Regulations March 6, 1989: 9294-9336 Final Rule, 29 CFR 1910.120 "Hazardous Waste Operations and Emergency Response")
- United States Environmental Protection Agency (U.S. EPA) Standard Operating Guidelines Revised November 1984
- NIOSH/OSHA/USCG/EPA Occupational Safety and Health Guidance Manual for Hazardous Site Activities, October 1985, NIOSH Publ. No. 85-115
- Threshold Limit Values for Chemical Substances in the Work Environment adopted by American Conference of Governmental Industrial Hygienists (ACGIH), 1997 or most recent version
- Project Health and Safety Plan

The SHSP must include a detailed description of work with equipment, materials and personnel identified to perform subcontractor's scope of work. In addition, the SHSP must include an inventory of chemicals that will be used onsite, along with MSDSs for each. The SHSP shall specify chemical handling procedures and required personal protective equipment for each task involving potential chemical exposure during the subcontractor's work.

The SHSP shall also include, but not necessarily be limited to, the following components as required by OSHA 29 CFR 1910.120(i) (2):

- Site description and evaluation of site contaminants
- Names of key personnel and alternates responsible for site safety and health (responsibilities and chain of command)
- Safety and health hazard assessment and risk analysis for each site task and operator
- Safety training, name of person who will give the training and the topics covered
- Personnel protective equipment
- Medical surveillance
- Air monitoring plan (environmental and personnel)
- Site control measures (work zones, communications and security)
- Decontamination
- Emergency Response Plan
- Plans and dates for meetings with local community, including local, state, and federal agencies involved in the cleanup, as well as the local emergency squads and the local hospitals
- A list of first aid and medical facilities including location of first aid kits, names of personnel trained in first aid, a clearly marked map with the route to the nearest medical facility, all necessary emergency phone numbers conspicuously posted at the job site
- A Spill Control and Countermeasures Plan which shall include contingency measures for spills and discharges from materials handling and/or transportation; a description of the methods, means, and facilities to prevent contamination of soil, water, atmosphere, uncontaminated structures, equipment, or materials by spills or discharges; a description of the equipment and personnel necessary to perform emergency measures to contain any spillage and remove spillage; and a description of the equipment and personnel to perform decontamination measures that may be required.

4.3.2 Work Implementation Plan

The subcontractor, ISOTEC, selected for the Modified Fenton's and potassium permanganate injections has prepared an Implementation Plan to describe its approach, procedures, schedule, and resources to implement the respective portions of the treatability study at Site 35. ISOTEC's implementation plan is being submitted as Attachment 1. The implementation plan includes the following information:

- Project Organization
- Lines of Communication

- Resources (e.g. personnel, materials, equipment, etc.)
- Project Schedule
- Design Information
- Injection well specifications
- Completion of the schedule for injections and for the expected reaction period to achieve the desired level of clean-up
- Field Effort Design and Approach
- Mobilization
- Temporary facilities
- Permitting
- Site preparation
- Field monitoring
- Quality Assurance Plan
- References

4.5 Pre-Mobilization Meeting

A pre-mobilization meeting will be held at the site, to include representatives from the Navy, appropriate Base representatives, CH2M HILL, and the Subcontractors. The objectives of this meeting will be to finalize project objectives, review health and safety objectives, present lines of communication associated with project management, clarify any unresolved issues concerning implementation of the pilot study, and review the project schedule.

4.6 Contractor Mobilization and Demobilization

The subcontractor shall mobilize all resources necessary to efficiently and completely perform the scope of work tasks. These resources include, but are not limited to, personnel, equipment, materials, supplies, lower tier Subcontractor and support facilities.

The subcontractor shall be responsible for having all equipment properly decontaminated prior to mobilization to the Site. Personnel and equipment shall be satisfactorily decontaminated in accordance with Subcontractor's SHSP prior to being removed from the site. Any debris or rinsate generated during decontamination shall be properly collected and containerized. Subcontractor shall furnish all equipment to safely and legally collect and store water encountered during the performance of the scope of work described herein for off-site disposal.

Subcontractor shall stage its equipment and temporary facilities within the areas designated by CH2M HILL and/or the Base.

The Base will provide a source of potable water, if needed. The subcontractor shall provide CH2M HILL with all appropriate MSDS documentation of the reagents prior to mobilization.

Mobilization and demobilization will occur in stages, as the drilling is completed. Final demobilization will occur after the final potassium permanganate injection event, as specified by Subcontractor. After completion of the pilot test, all above-grade components will be demobilized. The injection wells will be capped and left in place. Injection wells (IW-16, IW-17, and IW-18) and two monitoring wells located on the northeast side of the northbound lane will be abandoned in November 2004 as required by the DOT.

4.7 Site Preparation

The site preparation task will include the following activities:

- Identification and marking of subsurface utilities
- Establishment of work zones and equipment staging areas
- Establishment of operations area
- Establishment of equipment and personnel decontamination areas

CH2M HILL will coordinate with Base personnel and a professional utility locator to define all subsurface structures that might be impacted by drilling activity in the immediate area of the pilot test.

Work zones will be delineated at the site for the different types of project activities. Personnel and equipment access will be controlled during project activities. The establishment of the work zones will accomplish the following:

1. Properly protect personnel against the hazards that are present
2. Confine work activities and contamination to the designated areas
3. Locate and evacuate personnel in the event of an emergency

Three types of work zones will be established during site operation activities: the exclusion zone, the contamination reduction zone, and the support zone. The SHSP will specifically address these zones as well as PPE, ambient air monitoring, and health and safety hazard assessments.

4.8 Injections of Modified Fenton's Reagent and Potassium Permanganate

4.8.1 Reagent Preparation

ISOTEC reagents are comprised of a site-specific chelated iron catalyst and stabilized H_2O_2 oxidizer. The H_2O_2 oxidizer consists of a pre-determined concentration of H_2O_2 and water. For this pilot study, ISOTEC will use ISOTEC catalyst 4260 as the chelated iron catalyst and a H_2O_2 concentration of 12%. The ISOTEC catalyst 4260 consists of a chelated iron complex that is similar and at post-reaction concentrations comparable to that of naturally occurring

metals within the soil matrix (i.e., ppm range). The ISOTEC catalyst 4260 will be shipped to the site in dry form and mixed on-site with water in 300-gallon bulk tanks. H_2O_2 at a concentration of 35% will be shipped directly to the site prior to field injection activities and will be stored in DOT approved 55-gallon drums. Using water obtained on-site, the H_2O_2 will be diluted in 300-gallon bulk tanks to a concentration of 12%.

A 3% solution of potassium permanganate will be prepared on-site using dry potassium permanganate and water. The potassium permanganate will be shipped to the site in dry form and mixed on-site with water in 300-gallon bulk tanks.

4.8.2 Injection Procedure

ISOTEC reagents will be injected into the subsurface at the site using 2-inch injection wells. The ISOTEC modified Fenton's reagent injection is a four-step process. ISOTEC begins by injecting water into the subsurface, followed by the ISOTEC catalyst 4260 or the 12% stabilized H_2O_2 oxidizer. Water is then injected into the well to flush the reagent away from the borehole. Following the water flush, either the ISOTEC catalyst 4260 or the 12% stabilized H_2O_2 oxidizer, whichever was not injected first, is injected into the subsurface. A final water injection is completed to flush the reagent from the injection equipment. This process is repeated at each injection well throughout the injection event.

Permanganate injection is a three-step process. ISOTEC begins by injecting water into the subsurface, followed by injection of the potassium permanganate solution. Following the potassium permanganate injection, water is injected to complete the flush of the potassium permanganate from the injection equipment.

4.8.3 Injection Rates and Pressures

The ISOTEC process injection rate and pressure are dependent upon soil permeability and cannot be determined before the pilot study program. Based upon ISOTEC experience at sites with similar lithology, injection flow rates of between 3 and 8 gallons per minute and injection pressures of between 10 and 40 psi are expected.

4.8.4 Reagent Quantities

The injection goal for total reagent volume is between 24,000 and 36,000 gallons for each injection of the modified Fenton's reagent and potassium permanganate. The modified Fenton's reagent injection volumes will be 50% stabilized H_2O_2 oxidizer and 50% ISOTEC catalyst 4260. The goal for each injection well is to inject between 5% and 8% by volume of the pore space within the 15-foot ROI or 1,600 to 2,400 gallons of total reagent (for each modified Fenton's reagent and potassium permanganate injection). These volumes are based on review of the site data and ISOTEC's past field experience. ISOTEC field applications range from 3-8% by volume based on the ease of treatment observed in the bench study. Injections of greater than 8% in one injection event lead to difficulties such as increased injection pressures, decreased flow rates and reagents creating vertical pathways and exiting the subsurface onto the ground. The actual volume of reagents used will depend upon the injection flow rate, pressure and radial effects noted during injection. All

reagents will be either injected during the pilot study or removed from the site at the completion of the project.

4.8.5 Injection Plan

The pilot study will begin with the injection of modified Fenton's reagent into eighteen injection wells. The modified Fenton's reagent injection is proposed to begin on February 2, 2004. Groundwater monitoring will be conducted approximately two weeks following the Modified Fenton's injection.

The second phase of injections will consist of potassium permanganate being injected into all eighteen injection wells. This will occur approximately four weeks after the modified Fenton's reagent injection, on March 1, 2004.

Each injection event will include approximately eight days of field injection activities. CH2M Hill will conduct post-injection groundwater monitoring approximately four weeks following the potassium permanganate injection. This groundwater-monitoring event will serve as the first of four quarterly groundwater-monitoring events. The pilot study will conclude with the fourth and final groundwater-monitoring event.

4.8.6 ISOTEC Monitoring

In addition to monitoring performed by CH2M HILL, ISOTEC will perform site specific monitoring during the pilot test to obtain information related to the treatment process and subsurface characteristics. This site-specific monitoring includes measurement of groundwater concentrations of H_2O_2 and total iron in IR-35-MW-72B, MW-73B, MW-74B MW-78B, and MW-79B prior to the start of each injection event and daily during each injection event to evaluate subsurface reagent distribution.

4.9 Performance Monitoring

Performance monitoring will consist of sampling five new and seven existing monitoring wells. Details of the monitoring plan are described in Section 5.0.

4.10 Waste Management

Project accumulated-IDW will consist of waste generated by installation of the monitoring and injection wells. Liquid sources of IDW generated during project activities will consist of development water for the monitoring (and injection) wells and equipment and personnel decontamination water. Discarded PPE, general construction refuse, and general demolition debris will be placed in trash bags and placed in dumpsters temporarily staged on-site. Large amounts of construction debris, if accumulated, will be segregated, placed in a dumpster, and subsequently hauled to the Base landfill.

Accumulated soil cuttings will be temporarily placed on plastic sheeting adjacent to the boring locations. These soil cuttings will subsequently be relocated to a lined roll-off container staged at the site. To evaluate the proper treatment/disposal requirements, one grab sample will be collected from each roll-off container and analyzed for toxicity

characteristic leaching procedure (TCLP) EPA Method 1311. A composite sample will also be collected for every three to five grab samples collected and analyzed for TCLP.

Liquid IDW from monitoring (and injection) well development will be containerized on-site in 55 gallon drums. Sampling of the IDW water is not required prior to discharge to the Lot 203 treatment system as the contaminants of concern in the groundwater at Site 35 are known. If visual contamination is present in a container, it will not be pretreated before treatment and disposal at Lot 203. Visual contaminants will be confirmed to be VOCs using the FID screening instrument.

If analytical data from hazardous waste characterization methods (which are required to assess whether a material is considered a characteristic hazardous waste) indicate a contaminant at a concentration exceeding the regulatory limits established in 40 CFR 261, the waste will be segregated into a separate waste stream and managed in accordance with the regulations for generators of hazardous wastes outlined in 40 CFR 261-268. All required transportation manifests will be prepared by the Contractor and signed by a Base representative.

Wastes will be securely stored on site prior to offsite transportation and treatment/ disposal. Storage containers will be clearly labeled prior to placement of any waste. Labels will indicate the material to be "Non-Hazardous Waste," unless analytical results indicate that it is hazardous waste. The labels will include the date that the waste was initially placed, as well as a description of the waste material. Non-hazardous waste material will typically be stored in the following manner:

- Roll-off containers for solids and debris will be provided with covers and disposable liners. Roll-off containers will be inspected upon arrival at the site. Any roll-off container arriving on site with contents will be rejected. When not in use, securely fastened covers will be installed on all roll-off containers. Liners will be disposed of with the treated soil material. Roll-off containers will be inspected by the transporter after removal of the liner and decontaminated in the event of evidence of liner failure. Decontamination procedures will be completed by the transporter at the point of disposal or by returning the roll-off container to the site for decontamination.
- Drums containing liquids will be neatly arranged and stored in a single secure onsite location. Each drum will be provided with its own label. Drums will remain covered until the material is placed inside the containers. Covers will be properly secured at the end of each workday. Drums will be disposed of with the contents. If the contents are removed from the drums for offsite transportation and disposal or treatment, the drums will be decontaminated prior to re-use or before leaving the site.

Containers will be visually inspected on a weekly basis with prompt action taken in the event of any evidence of failure to contain the wastes. In the event that hazardous waste material is generated during specific project activities, it will not be stored on site for longer than 90 days as required by 40 CFR 262.

5.0 Pilot Test Monitoring

The monitoring plan for the Modified Fenton's and potassium permanganate pilot study at Site 35 will address groundwater at the following project stages: baseline, injection, and post injection.

During each sampling event, a groundwater sample will be collected from five new and seven existing monitoring wells located within the study area, as shown in Figure 3-1. New monitoring wells that will be used for this study are IR35-MW-75B, -76B, –77B, -78B, and –79B. Existing monitoring wells that will be used for this study are: IR35-MW-55B, -72B, -73B, -74B, IR35-TW-52, -55, and -57. Samples will be hand delivered or delivered via an overnight carrier to an offsite laboratory, and analyzed for: cVOCs by EPA Method 8260B; metals by SWWW 846 6010B, ferrous iron by SM3500-FeD, total iron by SW-846 6010B, and chloride by EPA Method 300. Geochemical parameters, including dissolved oxygen, conductivity, pH, temperature, turbidity, and oxidation/reduction potential will also be evaluated in the field.

5.1 Baseline Groundwater Monitoring

All new and existing monitoring wells will be gauged and sampled prior to initiation of the pilot test (the first injection). New monitoring wells that will be used for this study are IR-35-MW-75B, -76B,–77B, -78B, and –79B. Existing monitoring wells that will be used for this study are: IR35-MW-55B, -72B, -73B, -74B, IR35-TW-52, -55, and -57. The resulting laboratory analytical data and field geochemical data will be used to establish baseline conditions. Subsequent data will be compared to baseline conditions to evaluate performance during the test.

5.2 Injection Groundwater Monitoring

Groundwater samples will be collected following each phase of oxidant injections (i.e. approximately two weeks following the Modified Fenton's injection and approximately four weeks following the potassium permanganate injection). Sampling procedures are described in Appendix A. Groundwater potentiometric surface measurements will also be collected prior to each sampling event.

Without treating the entire plume, rebound will be significant in the test area over a one-year period. Concentrations up to 1,000 µg/l of dissolved phase contaminants exist 50 feet upgrade of the test area, which will re-equilibrate with the treated aquifer water and saturated soils over the course of a year. True rebound will be most accurately measured using the first quarter and possibly second quarter data.

5.3 Post-Injection Groundwater Monitoring

The groundwater monitoring event following the final potassium permanganate injection will also serve as the first of four quarterly post-injection monitoring events. Sampling procedures are described in Appendix A. Groundwater potentiometric surface measurements will also be collected prior to the final sampling event.

An 80% reduction in the groundwater contaminant mass is the goal of pilot study. This will be measured in the five wells in the test area. Results for individual wells and an average of the wells will be examined.

Groundwater samples will also be collected upgradient and downgradient of the test area to see if there is any affect from the test. The upgradient wells are approximately 40 feet from the test area and the downgradient wells are roughly 100 feet from the test area.

5.4 ISOTEC Monitoring

In addition to monitoring performed by CH2M HILL, ISOTEC will perform site specific monitoring during the pilot test to obtain information related to the treatment process and subsurface characteristics. This site-specific monitoring includes measurement of groundwater concentrations of H_2O_2 and total iron in IR-35-MW-72B, MW-73B, MW-74B MW-78B, and MW-79B prior to the start of each injection event and daily during each injection event to evaluate subsurface reagent distribution.

6.0 Health and Safety Considerations

Development of a comprehensive Site Health and Safety Plan (SHSP) will be the combined responsibility of CH2M HILL and Subcontractors. The Master SHSP will address the potential hazards associated with Modified Fenton's and potassium permanganate, and will be maintained on-site during all field activities.

As project activities become better defined over time, addenda to the Master HSP will be prepared by the CH2M HILL Project Health and Safety Manager (PHSM) to address specific activities and the hazardous control measures associated with the specific projects. The addenda are submitted to the Partnering Team for review and approval prior to beginning site work. In this manner, the SHSP will be considered a "living document", to be reviewed and updated as necessary.

The Master SHSP does not address hazards associated with specialized remedial implementation tasks and equipment (such as operation of a drill rig). Accordingly, specialty subcontractors are responsible for health and safety procedures specific to their particular work components, and are required to develop and submit a HSP to CH2M HILL for review prior to the start of fieldwork. Subcontractors must comply with the established HSP. CH2M HILL must monitor and enforce compliance with the established HSP.

Inclement weather conditions may occur without warning and are a concern during drilling activity. It will be the responsibility of the Site Safety Coordinator (SSC) to halt work in the case of eminent danger. In the event that extreme weather conditions caused by high winds, hurricanes, etc., arise, site personnel will secure or remove all site facilities, materials, and equipment; secure temporary utilities where possible; verify equipment tiedowns; and cover all exposed openings in existing facilities to minimize potential wind and water damage. The SSC will also be responsible to commence work once the danger has passed.

Housekeeping and maintaining the cleanliness of the site will be a priority during well installation and injection activities to minimize the potential of foreign object debris dangers to personnel and equipment during inclement weather conditions.

The hurricane season in the immediate area surrounding Camp Lejeune begins on June 1 and continues through November 30. Storms of non-tropical origins such as frontal passages, local thunderstorms, and tornadoes are much more frequent and can occur year-round. The Contractor will review all Navy notification procedures and local readiness plans concerning inclement weather once they are made available.

7.0 Site Activity Considerations

Several considerations related to the execution of the pilot test at Site 35 include, but are not limited to, the following:

1. **Equipment, space, and utility requirements**

   - Subcontractors will be solely responsible for their equipment, instrumentation, materials, and supplies.
   - Underground utilities will be identified and labeled by Camp Lejeune staff and/or a professional utility location subcontractor.
   - The Drilling Subcontractors will be responsible for providing an equipment and materials storage area in a designated area of the project during the well installation phase.

2. **Site security**
   - During working hours, the Drilling Subcontractor will secure the working area.
   - Site access during the project will be limited to authorized personnel only.

3. **Waste management**
   - Subsurface media excavated during well drilling operations will be placed in roll-off boxes (with water-resistant tarps or other suitable covers maintained in place) provided by the subcontractor and located in the project work area.
   - The subcontractor will provide separate roll-offs for collection of normal waste materials, trash and debris generated during injection.
   - Larger water supplies for well installation and oxidant injection are available at Camp Lejeune but the subcontractor will need to provide the appropriate water tanker or storage system to collect the water and transport it to the work area.

8.0 Submittal Requests

This section provides an overview of the information to be included in the transmittal memorandum to prospective Subcontractors:

8.1 Project Related Information

- The Subcontractor's technical approach;
- An estimate as to the expected duration to complete the chemical injection phase, including the set-up period and demobilization from this project phase;
- An approximation as to the expected sizing of the equipment and materials storage area related to injection;
- Electrical service requirements for injections (as applicable);
- An estimate as to the prescribed period of time for the injected chemicals to meet performance standards;
- Warranties that may be offered related to the performance of the injected chemicals;
- Identification of any separate utility evaluation measures considered necessary by the subcontractor to implement the remedial system using the prescribed technology.

8.2 Firm Related Information

- A listing of all firms proposed as part of the prime technology subcontractor's team to complete this project (included in the cost proposal form);
- Resumes of all key staff (with their company affiliation) that will have active involvement in executing the expected SOW for this project, and their primary roles in this regard;
- A summary of relevant experience of the subcontractors, and the listed key staff, in completing similar projects under similar conditions;
- A list of at least three references that may be contacted regarding performance of the subcontractor's team in completing similar projects;
- Documentation of the health and safety record of the prime technology subcontractor and each of the proposed companies on his team, including copies of the latest OSHA 200 logs; and
- The experience modification rate (EMR) of the prime technology subcontractor and each of the proposed companies on his team.

9.0 Reporting

9.1 Investigation/Installation Report

The pilot study involves installation of permanent monitoring wells and injection wells, baseline groundwater monitoring, and injection of Modified Fenton's and potassium permanganate in the TCE upgradient "hot spot". The results of these activities will be summarized in a report after their completion. The report will include:

- A discussion of well location selection and installation activities;
- Results of baseline groundwater sampling;
- A discussion of revisions to the pre-determined injection point configuration due to site conditions; and
- A summary of the chemical injection process including injection point surveyed locations and quantity of chemical injected.

This report will provide the basis for the final pilot study report; therefore, only a draft version will be issued. Comments received on the draft will be addressed in the final pilot study report.

9.2 Periodic Progress Reports

A periodic progress report will be submitted after each of the sampling events. The report for the last sampling event will be incorporated into the final pilot study report. The reports will be brief, letter-style documents that discuss project status, i.e. work completed and recent sampling results. The trend of contaminant concentration with respect to time will also be presented as the information becomes available.

9.3 Pilot Study Report

The pilot study report will present details of the pilot study from baseline investigations through the one-year sampling period after injection. The report will include:

- The Installation Report (with comments addressed as appropriate);
- Analytical data from pre-injection through the one year post-injection period;
- Analysis of the effectiveness of the remedial technology in reducing contaminant concentration and in removing contaminant mass; and
- Recommendations for future site activities.

A draft report will be issued to allow for a comment period. Any comments received will be addressed in the final version.

10.0 Schedule

10.1 Schedule

The proposed schedule for implementing the pilot study at Site 35 is presented in Figure 10-1. The tasks presented in the pilot study schedule correspond to the tasks identified in this work plan.

10.2 Project Organization

The project organization is presented in Figure 10-2. The Partnering team includes representatives from CH2M Hill, LANTDIV, MCB Camp Lejeune, North Carolina Department of Environmental and Natural Resources (NC DENR), EPA Region IV, Baker Environmental, and Shaw Group.

Christopher Bozzini, P.E. will serve as the Project Manager (PM) for the pilot study and as the primary CH2M HILL contact. The PM is responsible for overall project management and the overall quality assurance and quality control (QA/QC) of project deliverables.

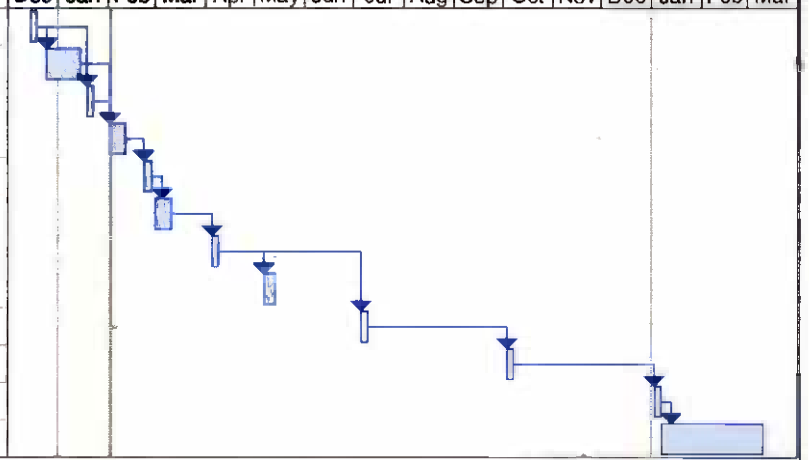
Senior engineers and a hydrogeologist will serve as the Senior Reviewers for the pilot study. The Senior Reviewers will be Sam Shannon, P.G., Tom Simpkin, P.E., and Paul Favara, P.E. The Senior Reviewers will review the technical aspects of the work from project scoping to project completion.

The project team will include: the Project Hydrogeologist, Field Team Leader (FTL), and Site Safety Coordinator (SSC). All field and subcontractor activity will be under the direction of the Field Team Leader.

Figures

Figure 10-1
Pilot Study Work Plan Schedule
Site 35, MCB Camp Lejeune

ID	Task Name	Duration	Start	Finish
1	MW Installation & Development (5 wells)	4 days	Mon 12/15/03	Thu 12/18/03
2	Injection Well Installation (18 wells)	15 days	Thu 12/25/03	Wed 01/14/04
3	Baseline Sampling	4 days	Mon 01/19/04	Thu 01/22/04
4	Modified Fenton's Reagent Injection	8 days	Mon 02/02/04	Wed 02/11/04
5	Post Modified Fenton's Sampling	5 days	Mon 02/23/04	Fri 02/27/04
6	Potassium Permanganate Injection	8 days	Mon 03/01/04	Wed 03/10/04
7	Post KMnO4 Injection / First Quarter Sampling	4 days	Mon 04/05/04	Thu 04/08/04
8	Investigation/Installation Report	5 days	Fri 05/07/04	Thu 05/13/04
9	Second Quarter Sampling	4 days	Tue 07/06/04	Fri 07/09/04
10	Third Quarter Sampling	4 days	Mon 10/04/04	Thu 10/07/04
11	Fourth Quarter Sampling	4 days	Mon 01/03/05	Thu 01/06/05
12	Pilot Study Report (Draft)	45 days	Fri 01/07/05	Thu 03/10/05



Project: Site 35 Final WP Schedule
Date: Mon 02/02/04

Task
Split
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Split
Rolled Up Milestone
Rolled Up Progress
External Tasks
Project Summary
External Milestone
External Milestone
Deadline

11.0 References

Baker Environmental, Inc. May 1995. Final Remedial Investigation (RI) at Operable Unit No. 10 (Site 35, Camp Geiger Area Fuel Farm).

Baker Environmental, Inc. 2002. Work Plans for Long Term Monitoring and Natural Attenuation Monitoring.

Baker Environmental, Inc. March 2003. Site 35 "Hot Spot" Characterization Letter Report.

CH2M HILL, Baker, CDM. April 2003. Final Natural Attenuation Evaluation Report, Operable Unit 10, Site 35, Former Camp Geiger Fuel Farm.

CH2M HILL. June 2003. Draft Technology Evaluation, Operable Unit No. 10 (Site 35).

U.S. Environmental Protection Agency. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual. EPA, Region IV, Environmental Services Division. 1996.

U.S. Environmental Protection Agency. Test Methods for Evaluating Solid Waste. EPA-SW-846, 3rd Revision. 1997.

Appendices

Appendix A: Field Sampling Plan (FSP)

Appendix B: Quality Assurance Project Plan (QAPP)

Appendix C: Health and Safety Plan (HSP)

Appendix D: Work Implementation Plan prepared by ISOTEC

Appendix A: Field Sampling Plan (FSP)

FINAL

Field Sampling and Analysis Plan

Operable Unit No. 10 (Site 35)

Marine Corps Base

Camp Lejeune, North Carolina

Prepared for

Department of the Navy

Atlantic Division

Naval Facilities Engineering Command

Norfolk, Virginia

Contract No. N62470-95-D-6007

CTO-0253

LANTDIV Clean II Program

January 2004

Prepared by

CH2MHILL

Table of Contents

List of Tables

List of Attachments

Acronyms and Abbreviations

ASTs	Aboveground Storage Tanks
BTEX	benzene, toluene, ethylbenzene, and xylenes
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
COC	Chain-of-Custody
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FSP	Field Sampling Plan
FTL	Field Team Leader
HSA	Hollow Stem Auger
IAS	In-situ Air Sparge
IDW	Investigation Derived Waste
MCB	Marine Corps Base
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NGVD	National Geodetic Vertical Datum
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control
SU	Standard Unit
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
VOA	Volatile Organic Analyte
VOCs	Volatile Organic Compounds

1.0 Introduction

This document has been prepared to serve as a Field Sampling Plan (FSP) for the remedial investigation at Operable Unit 10, Site 35 at the Marine Corps Base (MCB) Camp Lejeune in Onslow County, North Carolina. This FSP sets forth procedures for field activities and the analysis of groundwater samples.

Subcontractors will be furnished with copies of the project-specific FSP. Subcontractors will be expected to adhere to the procedures specified in this document. All field activities will be conducted by CH2M HILL or subcontractors under the direct supervision of CH2M HILL.

2.0 Site Background

This section provides a brief history of Site 35 and previous environmental investigations. Section 1 of the Work Plan provides a detailed project description. Section 2 describes the site background and environmental setting.

2.1 Site History and Contaminants

Construction of MCB Camp Lejeune began in 1941. Construction of Camp Geiger was completed in 1945. In 1945 the Fuel Farm's above ground storage tanks (ASTs) stored No. 6 fuel oil, but later stored other petroleum products such as gasoline, diesel fuel, and kerosene. The date of this switch is unknown.

The ASTs at Site 35 supplied fuel to an adjacent dispensing pump. Approximately 30 gallons of gasoline were reportedly lost per day from a leak in an underground line to the pump (Law, 1992). It is unknown how long this leak occurred, but when discovered, the leaking line was sealed and replaced. Other documented petroleum releases date back to 1957. A release of several thousand gallons of fuel from an underground distribution line occurred between 1957 and 1958. Fuel from this release reportedly migrated to the east and northeast toward Brinson Creek. Interceptor trenches were excavated to capture the fuel, and once captured, the fuel was burned (ESE, 1990).

In 1990, an unauthorized discharge from a tanker truck resulted in an unknown volume of diesel or jet fuel flowing along an unnamed drainage channel north of the Fuel Farm. This spill initiated an emergency clean up, which included the removal of about 20 cubic yards of soil. Other undocumented fuel and chlorinated solvent releases are suspected to have occurred at Site 35, as both fuel and chlorinated solvent contamination have been discovered in soil and groundwater.

In 1995, the Fuel Farm was demolished to clear the way for the Highway 17 Bypass. In 1995 and 1996, approximately 15,700 tons of contaminated soil was removed from the site.

An in-situ air sparge (IAS) system was installed and baseline groundwater sampling was conducted to determine the impact of the system on natural attenuative processes (Baker, 1999).

Two hot spots have been identified at Site 35. One shallow hot spot located in the vicinity of Building G480 contains fuel and solvent contamination (primarily BTEX). A second larger hot spot is located beneath the Highway 17 Bypass and contains chlorinated solvents (primarily TCE and daughter products). The focus of this pilot study is the TCE plume.

3.0 Sampling Objectives

The primary objective of the pilot test is to treat the "hot spot" and reduce TCE concentrations to low levels, so that natural attenuation can complete the process of reducing contaminant levels to below regulatory standards. Specific goals of the pilot study include:

- Minimize the size and migration potential of the plume,
- Cause little or no adverse effect on Highway 17 construction, and
- Protect potential receptors including nearby surface waters.

Collection of pre- and post- groundwater samples will be used to quantify contaminant mass removal from groundwater. Post-treatment groundwater samples will also be used to quantify the extent of "rebound" contamination.

Groundwater sampling will be conducted within, and immediately surrounding, Site 35. All analytical data will be collected, analyzed, and validated to provide a Level 3 data package. Data requirements are detailed in the site-specific *Quality Assurance Project Plan* (Appendix B).

4.0 Sampling Locations and Frequency

The pilot study at Site 35 includes the following field activities:

- Utility location,
- Surveying,
- Installation and development of groundwater monitoring and injection wells,
- Collection and analysis of groundwater samples,
- Modified Fenton's and Permanganate injection,
- Containerization and disposal of IDW.

Each activity is described in more detail below. Proposed sampling locations are shown in **Figure 3-1** of the Work Plan.

4.1 Utility Location

All utilities within 25 feet of any proposed soil boring or groundwater monitoring well location will require locating. Locations will be marked using maps, electronic devices, or any other means necessary to ensure the safety of drilling and sampling personnel. Preliminary monitoring and injection well locations are shown in Figure 3-1 of the Work Plan.

4.2 Surveying

A North Carolina-licensed land surveyor will survey each soil and groundwater sample location. The locations will be referenced both horizontally and vertically to permanent land monuments or a grid system. The survey controls will be tied to a benchmark and the National Geodetic Vertical Datum (NGVD) of 1929. Ground surface and top of casing vertical control will be to the nearest 0.01 foot, and the horizontal control will be to the nearest 0.10 foot. The top of casing will be notched or otherwise marked to identify a constant measuring point for measuring depths to groundwater, which is used to determine groundwater elevations.

4.3 Monitoring and Injection Well Installation

Eighteen injection wells and five monitoring wells will be installed. Monitoring wells will be used to monitor groundwater quality and to evaluate groundwater elevations and flow direction. Monitoring well installation procedures are described in Section 6.1. Injection well installation procedures are described in Section 6.2.

4.4 Groundwater Monitoring

4.4.1 Gauging and Baseline Sampling

Groundwater samples will be collected prior to treatment from the five new monitoring wells (35-MW75B, 35-MW76B, 35-MW77B, MW78B, and MW79B) and seven existing monitoring wells (35-MW55B, 35-MW72B, 35-MW73B, 35-MW74B, 35-TW52, 35-TW55, and 35-TW57). Samples will be submitted for laboratory analysis of cVOCs, metals, ferrous and total iron, and chloride.

Water level measurements will be used to develop site-wide potentiometric maps to determine groundwater flow patterns. Well purging and sampling procedures are described in Section 6.5.

4.4.2 Test Sampling

CH2M Hill will collect groundwater samples following each phase of oxidant injections (i.e. approximately two weeks following the modified Fenton's injection and approximately four weeks following the potassium permanganate injection). Post injection groundwater monitoring will be conducted approximately four weeks following the potassium permanganate injection. This will be the first of four quarterly groundwater monitoring events. The pilot study will conclude with the fourth and final groundwater monitoring event.

In addition to monitoring performed by CH2M HILL, ISOTEC will perform site specific monitoring during the pilot test to obtain information related to the treatment process and subsurface characteristics. This site-specific monitoring includes measurement of groundwater concentrations of H_2O_2 and total iron in MW-72B, MW-73B and MW-74B prior to the start of each injection event and daily during each injection event to evaluate subsurface reagent distribution.

4.4.3 Analytical Requirements

During drilling and sampling activities, the breathing zone will be monitored for potential health hazards to personnel performing these activities. This work will consist of monitoring the breathing zone for combustible gases using a combustible gas indicator (CGI), and monitoring VOCs and selected airborne inorganics using a flame ionization detector (FID). Both monitoring activities will be performed at the beginning of each task and at intervals as specified in the *Health and Safety Plan*.

During permanent monitoring well development and purging, water quality will be monitored for pH, temperature, specific conductance, and turbidity. The procedures for conducting these measurements are described in Sections 6.4 and 6.5.

Groundwater samples sent to the laboratory will be analyzed for cVOCs by EPA Method 8260B, ferrous iron by SM 3500-FeD, metals by SW-846 6010B, chloride by EPA Method 300.

4.5 Modified Fenton's and Permanganate Injection

A detailed description of the methods for injection of the reagents is included in Section 4 of the Work Plan. Modified Fenton's reagent will be injected into eighteen wells during one injection event. Following the modified Fenton's injection, permanganate will be injected into the same eighteen injection wells during one injection event.

4.6 Quality Assurance/Quality Control Samples

Trip blanks, field blanks, equipment blanks, duplicate samples, and matrix spike/matrix spike duplicate (MS/MSD) samples will be collected during the pilot study and submitted for laboratory analysis. Table 4-1 describes each QA/QC sample and the required frequency of collection.

TABLE 4-1
QA/QC Samples
Field Sampling Plan, Site 35, MCB Camp Lejeune

Sample Type	Description	Frequency	Analytes
Trip Blank	Designed to detect contamination of environmental samples during transport from the field to the laboratory. A trip blank is a VOC sample bottle filled with laboratory analyte-free water, transported to the site, handled like a sample, and returned to the laboratory for analysis. Trip blanks must not be opened in the field.	One per every cooler water samples sent to the laboratory for VOC analysis	VOCs only
Field Blank	Designed to detect contamination in the decontamination water. A field blank is decontamination water collected directly in the sample bottle. It shall be handled like a sample and transported to the laboratory for analysis.	One field blank from each source of decontamination water for each sampling event, where a sampling event is defined as one week	All laboratory analyses requested for the environmental samples collected at the site for that week
Equipment Blank	Designed to detect contamination of environmental samples caused by contamination of sampling equipment. An equipment blank is analyte-free water that is poured into or pumped through the sampling device, transferred to a sample bottle, and transported to the laboratory for analysis.	One per each day of sampling	All laboratory analyses requested for environmental samples collected at the site on that day
Field Duplicate	Designed to check precision of data in the laboratory. A field duplicate is a sample collected in addition to the native sample at the same sampling location during the same sampling event.	10%	Same parameters as native sample
MS/MSD	Designed to evaluate potential matrix interferences, accuracy, and precision. Three aliquots of a single sample – one native and two spiked with the same concentration of matrix spike compounds – are analyzed.	5%	Same parameters as native sample

5.0 Sample Designations

Each analytical sample will be assigned a unique number of the following format:

Site # - Media-Station # -QA/QC – Depth/Round

where

Site #	IR35, indicating Site 35 under the Installation Restoration Program
Media	GW = Groundwater
	IS = Soil boring (DPT, augered, etc.)
	MW = Monitoring well boring
Station	Unique identification number for each soil boring or monitoring well
QA/QC	FB = Field blank
	D = Duplicate sample (following sample type/number)
	TB = Trip blank
	ER = Equipment rinsate
	MS/MSD = Matrix spike/matrix spike duplicate
Round	Round indicators will be used for groundwater samples. Each round of sampling will have a distinct identification number. For example:
	PSB = Pilot study baseline sampling
	PSF = Pilot study sampling after modified Fenton's but before permanganate injection
	04A = Quarterly sampling during the 1st quarter of 2004
	04B = Quarterly sampling during the 2nd quarter of 2004
	04C = Quarterly sampling during the 3rd quarter of 2004
	04D = Quarterly sampling during the 4th quarter of 2004

Using this format, the sample designation IR35-GW50D-PSB refers to a duplicate groundwater sample, collected from monitoring well 50 during pilot study baseline sampling at Site 35. The sample designation IR35-ERGW-04D refers to the first equipment blank collected from groundwater sampling equipment at Site 35 during 4th quarter sampling in 2004.

6.0 Sampling Equipment and Procedures

6.1 Monitoring Well Installation

The monitoring well borehole will be bored, drilled, or augered as close to vertical as possible. Slanted boreholes are not acceptable unless specified in the Work Plan. The depth and volume of the borehole should be calculated and the appropriate materials procured before starting drilling activities. Field descriptions of the boring will be recorded on a boring log (Attachment 1) and in the field notebook.

The boreholes will be of sufficient diameter so that well construction can proceed without major difficulties. A minimum 2-inch annular space is required between the casing and the borehole wall to allow the filter pack, bentonite pellet seal, and the annular grout to be placed at the specified intervals at an acceptable thickness using a tremie tube. If the well string and casing are installed through HSAs, the augers will be slowly extracted as the filter pack, bentonite seal, and grout are tremied and/or poured into place. The gradual extraction of the augers will allow the materials being placed in the augers to flow gradually out of the bottom into the borehole without causing bridging problems.

Wells will be installed after discrete groundwater samples are collected and the boreholes have been drilled to the depths indicated by the FTL. For shallow wells, the screened interval will be placed to intersect the seasonal water table. For deep wells, the screened interval will be placed on the basis of lithology. Well construction details will be recorded on the Well Completion Form (Attachment 2) and in the field logbook.

6.1.1 Well Casing and Well Screen Assembly

Well casings and screens will be new and unused. Well casings, screens, and end caps will be assembled and installed to prevent damage to the sections and joints. No lubricating oils, solvents, grease, or pipe dope will be used on casing threads. Teflon® tape will be used to wrap the threads to ensure a tight fit and minimize leakage. No glue of any type will be used to secure casing joints. O-rings will not be used and will be removed prior to well assembly. A temporary well cap will be placed on top of the well casing and screen assembly during installation of the annular materials.

Well casings will consist of factory-made flush-threaded 2-inch-diameter, Schedule 40 PVC. Well screens will consist of 10 feet of factory-made flush-threaded machine-slotted 2-inch-diameter, Schedule 40 PVC. A well screen slot size appropriate for the geologic formation encountered (probably 0.010-inch) will be selected. A factory-made flush-threaded 2-inch-diameter, Schedule 40 PVC end cap will be placed on the bottom of each well screen. Flush-threaded joints will be compatible for monitoring well casings, screens, and end caps.

6.1.2 Sand Filter Pack Installation

A sand filter pack will be placed around the well screen using the positive displacement method, tremie method, or other approved method. Pouring of the filter pack materials is

acceptable in boreholes that are less than 50 feet deep. Before the well casing and screen assembly are placed on the bottom of the borehole, at least 6 inches of filter pack material will be placed at the bottom of the borehole to serve as a firm footing for the well. The well screen and casing will remain suspended and centered in the borehole until the annular materials have completely settled.

After the well casing and screen assembly are set at the appropriate depth, the sand filter pack will be placed into the borehole. The sand filter pack will consist of a thoroughly washed, sound, durable sand of an appropriate grain size, containing less than 5 percent silt or clay for the well screen slot size selected (commercially available 20/30-grain size or equivalent for 0.010-inch slot size). No organic material, anhydrite, gypsum, mica, or calcareous material will be allowed. The minimum specific gravity of the sand pack material will be 2.5. No water will be used to place the filter pack unless approved by the FTL. The filter pack will be installed in approximate 2-foot lifts to prevent bridging. The depth to the top of the sand filter pack will be measured periodically using a weighted measuring tape. The sand filter pack will be installed to a depth of at least 1-foot above the top of the well screen.

6.1.3 Bentonite Filter Pack Seal

A bentonite seal will be placed on top of the filter pack screen using the positive displacement method, tremie method, or other approved method. If the bentonite seal is installed above the saturated zone, the bentonite will be poured in as a slurry using the tremie pipe method, and if the bentonite seal is installed below the saturated zone, then the bentonite seal will be poured in as pellets. Pouring of the pellets is acceptable in boreholes that are less than 50 feet deep. The bentonite seal will consist of 30 percent solids in the form of bentonite pellets. Approximately 2 feet of bentonite pellets will be placed above the sand filter pack. The depth to the top of the bentonite seal will be measured and documented to ensure that the transition seal meets design requirements. The bentonite will be allowed to hydrate for 30 to 45 minutes prior to emplacement of the cement-bentonite grout.

6.1.4 Cement-Bentonite Grout Annular Seal

A cement-bentonite grout annular seal will be placed on top of the bentonite seal using the tremie method. The grout seal will extend from the top of the bentonite seal to within 2 feet of the ground surface. The grout seal will consist of Portland Type I cement conforming to ASTM C-150 standards. The cement-bentonite grout will be mixed using a maximum of 7 gallons of water per 94-pound bag of cement and a maximum of 2.7 pounds of bentonite per 94-pound bag of cement. The bentonite powder will either be mixed into the water prior to adding the cement or mixed into the cement powder prior to adding water. The grout will be mixed thoroughly before being placed in the borehole. The grout will be allowed to cure for a minimum of 24 hours before the concrete surface pad is installed.

6.1.5 Surface Completion

The type of flush mounted well completion depends on the location of the well. Surface pads will consist of concrete at least 4 inches thick and 2-feet square centered on the well. A

lockable, watertight cap or cover made specifically for the diameter of the well casing will be placed on each well. Locks will be made of brass and will be keyed alike.

For flush-mounted well completions in paved areas, concrete and asphalt will be removed from around the well to create a 2-foot-square opening in the pavement. The well will be centered in the opening. A concrete saw will be used to cut the opening. A jackhammer or similar tool may be required to remove the concrete pavement. Jagged-edged or out-of-square openings will not be permitted. The surface pad will be oriented with any cultural features located nearby. An 8-inch-diameter vault will be placed over the well 0.25-inch above the existing pavement surface. The surface of the concrete pad will slope gradually from the vault surface to the existing pavement surface at the edge of the pad. The vault will be centered in the 2-foot-square pavement opening. Each vault will have bolt-on traffic-bearing iron covers. The slab will be reinforced with four 20-inch-long steel reinforcing rods (#3 minimum size) placed uniformly around the vault within the concrete slab. The concrete surface will be finished smoothly, and a metal survey marker will be embedded in the fresh concrete.

For flush-mounted well completions in unpaved areas, soil will be removed and leveled around the well to create a 2-foot-square opening for a concrete form. The well will be centered in the opening and concrete form. A shovel or similar tool may be required to remove and level the soil. Jagged-edged or out-of-square openings will not be permitted. The surface pad will be oriented with any cultural features located nearby. An 8-inch-diameter vault will be placed over the well 0.50-inch above the existing ground surface. The surface of the concrete pad will slope gradually from the vault surface to the existing ground surface at the edge of the pad. The vault will be centered in the 2-foot-square concrete slab, with each vault having bolt-on traffic-bearing iron covers. The slab will be reinforced with four 20-inch-long steel reinforcing rods (#3 minimum size) placed uniformly around the vault within the concrete slab. The concrete surface will be finished smoothly, and a metal survey marker will be embedded in the fresh concrete.

6.2 Injection Well Installation

The installation of injection wells will be similar to the installation of monitoring wells. The installation well borehole will be bored, drilled, or augered as close to vertical as possible. Slanted boreholes are not acceptable unless specified in the Work Plan. The depth and volume of the borehole should be calculated and the appropriate materials procured before starting drilling activities. Field descriptions of the boring will be recorded on a boring log (Attachment 1) and in the field notebook.

Boreholes will be drilled using a 4-inch inside diameter hollow-stem auger to 47 feet bgs. A minimum 2-inch annular space is required between the casing and the borehole wall to allow the filter pack, bentonite pellet seal, and the annular grout to be placed at the specified intervals at an acceptable thickness using a tremie tube. The augers will be slowly extracted as the filter pack, bentonite seal, and grout are tremied and/or poured into place. The gradual extraction of the augers will allow the materials being placed in the augers to flow gradually out of the bottom into the borehole without causing bridging problems.

Wells will be installed after discrete groundwater samples are collected and the boreholes have been drilled to the depths indicated by the FTL. Well construction details will be recorded on the Well Completion Form (Attachment 2) and in the field logbook.

6.2.1 Well Casing and Well Screen Assembly

Well casings and screens will be new and unused. Well casings, screens, and end caps will be assembled and installed to prevent damage to the sections and joints. No lubricating oils, solvents, grease, or pipe dope will be used on casing threads. Teflon® tape will be used to wrap the threads to ensure a tight fit and minimize leakage. No glue of any type will be used to secure casing joints. O-rings will not be used and will be removed prior to well assembly. A temporary well cap will be placed on top of the well casing and screen assembly during installation of the annular materials.

The injection wells will be constructed of 2-inch diameter schedule 40 PVC flush thread blank casing and 10 feet of slotted well screen (0.020-inch machine slotted casing). Blank casing will be left 6 inches below the ground surface. The top of the casing will be completed with a 2-inch schedule 40 PVC slip-by-male pipe thread adapter and 2-inch threaded cap.

6.2.1 Sand Filter Pack Installation

A sand filter pack will be placed around the well screen using the positive displacement method, tremie method, or other approved method. Pouring of the filter pack materials is acceptable in boreholes that are less than 50 feet deep. Before the well casing and screen assembly are placed on the bottom of the borehole, at least 6 inches of filter pack material will be placed at the bottom of the borehole to serve as a firm footing for the well. The well screen and casing will remain suspended and centered in the borehole until the annular materials have completely settled.

After the well casing and screen assembly are set at the appropriate depth, the sand filter pack will be placed into the borehole. The sand filter pack will consist of a thoroughly washed, sound, durable sand. The annulus of each well will be filled with 10-20 grade silica sand which will extend from the bottom of the borehole to approximately two feet above the top of the screen. No organic material, anhydrite, gypsum, mica, or calcareous material will be allowed. The minimum specific gravity of the sand pack material will be 2.5. No water will be used to place the filter pack unless approved by the FTL. The filter pack will be installed in approximate 2-foot lifts to prevent bridging. The depth to the top of the sand filter pack will be measured periodically using a weighted measuring tape.

6.2.2 Bentonite Filter Pack Seal

A bentonite seal will be placed on top of the filter pack screen using the positive displacement method, tremie method, or other approved method. The seal will consist of hydrated bentonite chips. The seal will extend up to 5 feet bgs. The depth to the top of the bentonite seal will be measured and documented to ensure that the transition seal meets design requirements.

6.2.3 Concrete

The remainder of the annulus will be filled with 5 feet of concrete. Surface completion will be done by setting a 12-inch traffic box into the 5 feet of concrete

6.3 Monitoring and Injection Well Development

A new well will be developed within 48 hours after installation depending upon scheduled field activities. A new well will not be developed for at least 24 hours after the surface pad and outer protective casing or vault are installed to allow sufficient time for the well materials to cure before development procedures are initiated. Development equipment will be decontaminated as specified in this Work Plan. Development water will be containerized and disposed of in the Lot 203 treatment system.

The following procedure will be used to develop wells by surging, bailing, or pumping. If a well cannot be developed adequately with a bailer, then a submersible pump will be used.

1. Remove the well cap or cover and monitor for volatile organic vapors using the appropriate instrument listed in the *Health and Safety Plan* (Appendix C).
2. Measure the depth to water in the well and the total well depth with a clean electronic water level indicator. Calculate the volume of standing water in the well.
3. Lower the bailer or submersible pump into the well. If a submersible pump is used, turn the pump on as it is lowered into the water column and lower the pump slowly to develop the entire water column and avoid clogging the pump with sediment. Slowly surge the screened interval to draw sediment from the sand pack into the well. Alternately bail and surge or pump and surge the screened interval until the water is relatively clear and free of visible sediment.
4. After each well volume of water is removed, measure and record the pH, temperature, specific conductance, and turbidity of the water using the Well Development Form (Attachment 3).
5. Continue well development until the water is relatively clear and free of visible sediment. Well development will be considered complete after a minimum of three well volumes of water has been removed and the pH, specific conductance, temperature, and turbidity have stabilized. If the parameters have not stabilized within five volumes, it is at the discretion of the FTL whether or not to continue well development.

With respect to the volume of groundwater, adequate well development is normally achieved when the column of water in the well is free of visible sediment. Typically, several volumes of standing water in the well will be removed during well development.

With respect to groundwater chemistry, adequate development is achieved when the pH, specific conductance, and temperature of the groundwater have stabilized and the turbidity has either stabilized or is below 10 NTUs. Ten NTUs is twice the primary drinking water standard and is the goal for most groundwater sampling objectives. Stabilization occurs when pH measurements remain constant within 0.1 standard unit (SU), specific

conductance varies no more than 10 percent, and the temperature is constant for three consecutive readings.

6.4 Groundwater Sample Collection

6.4.1 Groundwater Monitoring Wells

The newly installed permanent monitoring wells will be sampled once. If necessary, confirmation samples will be collected a minimum of 2 days and a maximum of 2 weeks after the initial groundwater samples are collected.

Monitoring wells will be purged to remove standing water in the wells before groundwater samples are collected. Purge water will be containerized and transported to the Lot 203 treatment system for disposal.

Purging Procedures

The following groundwater purging procedure will be used.

1. For each well sampled, information on location, diameter(s), depth, and screened interval(s) will be recorded on the groundwater purging and sampling forms (Attachment 4).
2. Either a pump or bailer will be used to purge the well. A bailer will be used when the well does not yield sufficient water for pumping; otherwise, a pump is preferred.
3. Instruments will be calibrated according to manufacturers' instructions.
4. The well number, site, condition, and date will be recorded in the field logbook.
5. Plastic sheeting will be placed on the ground, and the well will be unlocked and opened.
6. Water level measurements will be collected, and the total well depth will be measured. The water level will be measured at the highest point on the inner PVC well casing or point to the nearest 0.01 foot.
7. The initial pH, specific conductance, temperature, and turbidity will be measured and recorded on the groundwater purging and sampling form.
8. The volume (in gallons) of water in the well casing will be calculated using the following method:

   $(\pi r^2 h)\ 7.48 = \text{gallons}$
   where: $\pi = 3.142$
   r = radius of the well pipe in feet
   h = linear feet of water in well
   7.48 = gallons per cubic foot of water

9. The volume of water in a typical 2-inch-diameter well casing will be calculated using the following method:

   gallons/feet x __ (linear feet of water) = total gallons

10. In productive wells, the well purging end point will be determined using field measurements of pH, specific conductance, temperature, and turbidity. A minimum of three to five well volumes will be removed prior to sampling. For non-productive wells, the well will be bailed dry and allowed to recover before sampling.

11. Field parameters will be measured at least once for each well volume of water removed while the well is being purged.

12. Well purging will be completed when field parameters have stabilized. With respect to the volume of groundwater, adequate well purging is normally achieved when the column of water in the well is free of visible sediment. A minimum of three well volumes will be removed from the well before groundwater samples are collected. With respect to groundwater chemistry, adequate purging is achieved when the pH, specific conductance, and temperature of the groundwater have stabilized and the turbidity has either stabilized or is below 10 NTUs. Ten NTUs is twice the primary drinking water standard and is the goal for most groundwater sampling objectives. Stabilization occurs when pH measurements remain constant within 0.1 SU, specific conductance varies no more than 10 percent, and the temperature is constant for three consecutive readings. If sufficient water is not present to yield required purge volumes, the well will be purged to dryness.

Groundwater samples will be collected when purging has been completed. The elapsed time between completion of well purging and groundwater sample collection will be minimized. Typically, the sample will be collected immediately after the well has been purged, but this will depend on well recovery.

6.4.2 Sampling Procedures

The following procedure will be used to collect groundwater samples from all permanently installed monitoring wells at Site 35:

1. Before samples are collected, the well will be purged as described above. This process includes placing plastic sheeting around the well, recording pertinent information in the field logbook, and collecting water level measurements. Additional information for sampling includes the sample identification number and the time of sampling.

2. As necessary, sampling equipment will be cleaned and decontaminated prior to sampling.

3. The person performing the sampling will wear clean, unused PVC or latex gloves. Gloves will be changed before each sample is collected.

4. If a bailer is to be used, it will be removed from either its protective covering or the well casing and attached, if necessary, to a cord that is compatible with the analytes and long enough to reach the bottom of the well. If a bladder pump is to be used, air, sample, and lifting lines will be attached to the pump. The lifting lines will bear the weight of the pump; the air and sample lines will be attached to the lifting lines at 10-foot intervals. If a peristaltic pump is to be used, new lines will be attached to the pump at each new sampling location.

5. The pump, bailer, or line will be lowered to the interval from which the sample is to be collected. If a bailer is used, it will be allowed to fill with a minimum of surface disturbance to prevent sample water aeration. When the bailer is raised, the bailer cord will not be allowed to touch the ground. For the bladder pump, the air lines from a regulated compressed gas source will be connected to a control box, and a power supply will be connected to the pump (if required). Air flow will be started and adjusted with the throttle knob on the control box. Discharge and refill knobs on the control box will be used to control the cycling rate of flow in the bladder. Equal length cycles are generally desired, but individual well conditions will be the controlling factor.
6. The cap will be removed from the sample bottle, and the bottle will be tilted slightly.
7. The sample will be poured slowly from the bailer line or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing.
8. Adequate space will be left in the bottle to allow for expansion, except for volatile organic analyte (VOA) vials, which will be filled to overflowing and capped.
9. The bottle will be capped, then labeled clearly and carefully. Label information will include laboratory, project name and number, sample ID, station ID, preservative, analysis, sampler's initials, date, and time.
10. Samples will be placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.

If the sampler (bailer) is dedicated, it will be returned to the well, and the well will be capped and locked. Non-dedicated samplers will be cleaned and decontaminated after use.

6.5 Decontamination

Decontamination procedures for well construction material and sampling equipment are described below. The decontamination area will be a temporary structure large enough to contain any well materials and the rear of the drilling rig. The area will be designed to collect, contain, and drain all fluids to a central point so that the collected fluids can be pumped and drummed. The decontamination area will be constructed of materials that preclude puncturing or leakage caused by decontamination activities. Racks will be provided to hold all equipment and well materials off the ground during decontamination. All equipment and well materials will remain racked and covered when not in use. All decontaminated well materials will be handled only with new, unused surgical gloves to avoid contamination prior to installation.

6.5.1 Well Construction Material

Before mobilizing to the site, the sampling tools will be cleaned with a high-pressure hot-water power washer or steam jenny, or hand washed with a brush using detergent to remove oil, grease, and hydraulic fluid from the exterior of the unit. The detergent does not have to be laboratory grade detergent. Degreasers will not be used. All sampling tools will be decontaminated prior to each monitoring well installation. All groundwater sampling equipment shall be decontaminated prior to each sample being collected within the same

borehole. All augers, water storage tanks, pumps, piping, drill pipe, and similar equipment will be flushed with potable water followed by cleaning with a hot-water pressure washer.

Decontamination of all equipment, tools, and well materials will consist of hot-water pressure washing to remove all visible evidence of soil, encrustations, or films. Well materials, augers, drill rods, and split-spoon samplers will be rinsed with de-ionized water after pressure washing and prior to use.

6.5.2 Sampling Equipment

The stainless-steel sampling equipment (such as split-spoon samplers) will be decontaminated to prevent the introduction of contaminants into the boring. This decontamination will be conducted according to the following procedure:

1. Wash equipment with a laboratory detergent (i.e., alconox, liquinox, or the equivalent) and hot water, using a brush to remove any particulate matter or surface film.
2. Rinse equipment thoroughly with tap water.
3. Rinse equipment thoroughly with de-ionized or organic-free water.
4. Rinse equipment twice with pesticide-grade isopropanol and allow to air dry.
5. Rinse equipment twice with ASTM Type II Water (ASTM 01193-77).
6. Wrap equipment in aluminum foil (dull side in) to prevent contamination during storage or transport to the field. Larger pieces of equipment, such as augers, may be wrapped in new visqueen or equivalent.

Teflon® and glass field sampling equipment decontamination will be conducted according to the following procedure:

1. Wash equipment with a laboratory detergent (i.e., alconox, liquinox, or the equivalent) and hot water, using a brush to remove any particulate matter or surface film.
2. Rinse equipment thoroughly with tap water.
3. Rinse equipment with 10 percent nitric acid solution.
4. Rinse equipment thoroughly with tap water.
5. Rinse equipment thoroughly with de-ionized water or organic-free water.
6. Rinse equipment twice with pesticide-grade isopropanol and allow to air dry.
7. Rinse equipment twice with ASTM Type II Water (ASTM 01193-77).
8. Wrap equipment in aluminum foil (dull side in) to prevent contamination during storage or transport to the field.

Well sounders or tapes (used to measure groundwater levels) and submersible pumps and hoses (used to purge monitoring wells) will be decontaminated according to the following procedure:

1. Wash equipment with a laboratory detergent and tap water, running solutions through the pumps and pump hoses.
2. Rinse equipment thoroughly with tap water.
3. Rinse equipment thoroughly with de-ionized or organic-free water.
4. Place the equipment in a polyethylene bag or wrap it with polyethylene film to prevent contamination during storage or transit.

Water sampling, water level measuring, and sample preparation equipment brought onsite will be cleaned prior to and after each use. During cleaning and decontamination operations, the substitution of a higher grade water for tap water is permitted and does not have to be noted as a variation. Personnel wearing Level D personal protective equipment (PPE) will decontaminate equipment in accordance with the site-specific *Health and Safety Plan* (Appendix C).

6.6 Investigation Derived Waste Handling

Wastes generated during the investigation of potentially contaminated sites are classified as IDW and will be containerized. Soil wastes will be placed in a 20-yard roll off and other wastes will be placed in 55-gallon drums that meet the packaging requirements of 49 *Code of Federal Regulations* (CFR) 173 and staged on wooden pallets. Water and personal protective equipment will be drummed separately. The FTL is responsible for labeling each drum with the boring number, date, contents, and contact information. The IDW will be drummed, labeled, sampled, and managed by Shaw Environmental.

All IDW will be characterized prior to completion of the field project. For this investigation, the IDW (soil and water) will be tested for reactivity, corrosivity, ignitability, and TCLP, VOCs, and metals (EPA Method 1311).

IDW will be managed and disposed of in accordance with federal, state, and local environmental rules and regulations. The drums containing IDW soil will be handled as follows:

- If the soil is not characterized as hazardous waste, it will be disposed of in the MCB Camp Lejeune landfill.
- If the soil is characterized as hazardous waste, it will be disposed of at a permitted off-site facility.

The drums containing IDW water will be transported to the Lot 203 treatment system for disposal. Other IDW will be managed as solid waste and disposed of at the MCB Camp Lejeune landfill.

7.0 Sample Handling and Analysis

7.1 Sample Preservation and Handling

Sample preservation occurs in the field immediately after collection. The containers supplied by the laboratory will contain applicable preservative. This will protect field personnel from transporting, handling, and measuring concentrated acids and bases. QA/QC samples, with the exception of trip blanks, will be collected in the same type of containers with preservatives as the field samples. The preservative and holding time for analysis is shown in Table 7-1.

TABLE 7-1
Sample Containers, Preservation, and Holding Times
Field Sampling Plan, Site 35, MCB Camp Lejeune

Analysis	Matrix	Method	Container	Preservation	Maximum Hold Time
VOCs	Aqueous	EPA Method 8260B	3 x 40 mL G-TLC	HCl to pH<2, Cool to 4°C	14 days
Total Iron	Aqueous	SW-846 6010B	1 x 500 mL plastic	HNO_3 to pH<2	180 days
Ferrous Iron	Aqueous	SM3500-FeD	1 x 125 mL plastic	HCl	48 hours
Total Metals	Aqueous	SW-846 6010B	1 x 500 mL plastic	HNO_3 to pH<2	180 days
Chloride	Aqueous	EPA Method 300	1 x 500 mL plastic	Cool to 4°C	28 days

G-TLC = Clear glass container with a Teflon-lined cap

Samples collected during the field activities will be shipped via an overnight courier to the analytical laboratory. A cooler of suitable strength for packaging and shipping of samples will be used and will be manifested to meet U.S. Department of Transportation regulations (dangerous goods, etc.). The bottom and sides of each cooler will be lined with bubble wrap or other cushioning material. Each sample jar or bottle will also be individually wrapped in bubble wrap to prevent breakage. All samples will be kept upright in the cooler. Once the samples are in the cooler, any voids will be filled with additional packaging material. Ice will be double-bagged in re-sealable bags and placed in the cooler with the samples. A sufficient amount of ice will be added to the coolers to ensure they arrive at the laboratory at a temperature of 4° C. The chain-of-custody (COC) record shall be placed in a watertight plastic bag and taped to the inside lid of the cooler. The cooler will be secured with strapping tape and custody seals will be affixed to the front and back of the cooler. The custody seals will be covered with wide, clear adhesive tape.

7.2 Chain-of-Custody

A COC form will be prepared for each shipment of samples to the laboratory. At minimum, the following will be recorded on the COC:

- Site name;
- Sampler name(s);
- Date and time of sample collection;
- Identification code unique to each sample;
- Number of containers with the same sample code;
- Analyses requested for each sample (including the analytical method numbers); and
- Signature of each individual who has custody of the sample(s).

All blank spaces (except for signature blocks) should be crossed out and initialed prior to shipment to the lab.

Upon receipt of samples at the laboratory, all samples will proceed through an orderly processing sequence specifically designed to ensure continuous integrity of both the sample and other pertinent information to the analysis. If no discrepancies are identified, the sample COC record will be signed, and the samples will be assigned a unique laboratory identification number by the laboratory for tracking and filing. The laboratory QA system and the use of an internal COC procedure will ensure that the samples are appropriately tracked from storage through the laboratory until the analytical process is complete.

Additional information regarding COC forms is contained in Section 6 of the *Quality Assurance Project Plan* (Appendix B). Attachment 5 provides an example COC form.

7.3 Field Logbook

A daily field log will be maintained, in a bound notebook. All the onsite field activities in real time, including the names of individuals onsite and sampling information, such as sample location, sample number, number of bottles collected, etc. will be recorded in this log. Recorded information will include, as a minimum, the following:

- Project name and number;
- Individuals onsite;
- Sample locations (well number) and depths;
- Current date, pertinent times (in military time), condition of the well, and ambient weather conditions;
- Sample numbers, number/type of containers, sample time and date;
- Analyses requested and laboratory assignments;
- Sampler's name and signature;
- Results of FID measurements;
- Type of sample collected; and
- Other notes and information, as required.

Notes will be written on sequentially numbered pages with indelible ink. At the end of each day, any unused space at the bottom of the last page will be "crossed" out, initialed, and dated by the FTL.

7.4 Corrections to Documentation

Corrections required in field logbooks or on any field forms must be completed by putting a single line through the incorrect entry and then initialing and dating the strikeout.

8.0 Site Management

CH2M HILL is responsible for the following activities during the pilot study at Site 35:

- Task order management;
- Quality assurance/quality control;
- Worker safety and health;
- Planning;
- Groundwater sampling and gauging;
- Data evaluation and reporting; and
- Subcontractor supervision.

CH2M HILL personnel responsible for the above aspects of the project are presented in Table 8-1.

TABLE 8-1
CH2M HILL Project Responsibilities
Field Sampling Plan, Site 35, MCB Camp Lejeune

Project Position	Responsible Personnel	Contact Information
Project Manager	Christopher Bozzini	(704) 329-0073 ext. 291
Senior Consultant/Review Team Leader	Tom Simpkin	(303) 771-0952 ext. 65394
Project Chemist	Ann West	(703) 471-1441 ext. 4643
Lead Data Manager	Adrienne Jones	(757) 460-3734 ext. 43
Field Team Leader	Mike Skeean	(704) 329-0073 ext. 219
Site Safety Coordinator	Mike Skeean	(704) 329-0073 ext. 219
Health and Safety Manager	Michael Goldman	(770) 604-9095 ext. 396

In addition to the above personnel, other Field Team Members will be used on the project. Field Team Members will be responsible for the collection of samples and the performance of field measurements under the supervision of the FTL in accordance with the procedures set forth in the pilot study Workplan, Quality Assurance Project Plan, and Health and Safety Plan.

Subcontractors will be used for the pilot study activities listed below:

- Utility location;
- Groundwater monitoring and injection well installation;
- Modified Fenton's and potassium permanganate injection;
- Analytical laboratory services;

- Transportation and disposal of IDW; and
- Survey of the location and elevation of groundwater monitoring wells and other sampling locations.

The project organizational structure is presented in Figure 6-1 of the Workplan.

Attachment 1

Sample Boring Log

Attachment 1

CH2MHILL

Boring Number:

Sheet: 1 of 1

Client:
Project:
Location:
Project Number:

Driller:
Drilling Method:
Sampling Method:
Logged by:
Start/Finish Date:

Depth (ft)	Sample Information: Sample	Sample Information: Sample Type	Sample Information: Recovery (%)	Sample Information: SPT (6"-6"-6")	Soil Log	Soil Description	Depth / Elev (ft)	Comments
0						Ground Surface	0 / 0	
5								
10								
15								
20								

Attachment 2

Well Completion Form

Attachment 2

CH2MHILL

PROJECT NUMBER	WELL NUMBER SHEET OF

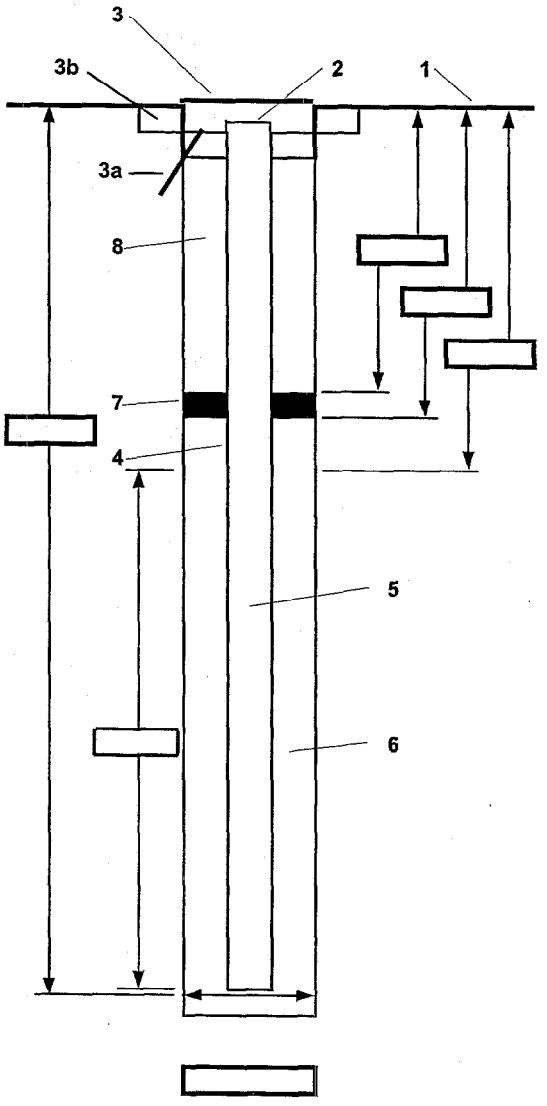
WELL COMPLETION DIAGRAM

PROJECT : LOCATION :

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED :

WATER LEVELS : START : END : LOGGER :



1- Ground elevation at well _____

2- Top of casing elevation _____

3- Wellhead protection cover type _____
a) drain tube? _____
b) concrete pad dimensions _____

4- Dia./type of well casing _____

5- Type/slot size of screen _____

6- Type screen filter _____
a) Quantity used _____

7- Type of seal _____
a) Quantity used _____

8- Grout
a) Grout mix used _____
b) Method of placement _____
c) Vol. of well casing grout _____

Development method _____

Development time _____

Estimated purge volume _____

Comments:

Attachment 3

Well Development Form

Attachment 3

CH2MHILL

Well Development Sheet

Project Site Name: ______________________________ **Well ID:** __________________________

Project No: __________________________ **Contractor:** ________________________

Development data								
	Time	pH SU	Cond. mS/cm	Temp. °C	Turbidity NTU	DO mg/L	ORP mV	Volume gallons
Date:								
Method:								
Pump setting:								
Well casing dia. (in.):								
Total well depth (TOC):								
Static water level (TOC):								
One purge volume (gals.):								
Start time:								
End time:								
Total dev. volume (gals.):								
Comments:								

Observations/Notes:

Attachment 4

Groundwater Purging and Sampling Form

Attachment 4

CH2MHILL	PROJECT NUMBER	PROJECT NAME

WELL PURGE AND SAMPLING FIELD SHEET

SITE:	DATE:
FIELD CREW:	WELL NUMBER:
WEATHER:	

PURGE VOLUME CALCULATION:

			CASING DIAMETER	GAL/FT OF CASING
WELL DEPTH (FT):				
DEPTH TO WATER (FT):	-		2 IN.	0.1632
WATER COLUMN (FT):	=	0	4 IN.	0.6528
GAL/FT OF CASING (from table at right):	x	0.1632	6 IN.	1.4688
CASING VOLUME (GALs):	=	0	8 IN.	2.611
NO. OF VOLUMES (min. 3):	x		10 IN.	4.0797
PURGE VOLUME (GAL):	=	0	12 IN.	5.8748

METHOD OF PURGING (circle one)

PUMP: SUB., CENT., PERIST.

TIME ON:

FLOW RATE (gpm):

PUMP TIME (min):

VOL. PURGED (gals):

OTHER:

BAILER : TEFLON, SS ,OTHER:

BAILER VOL.. (gal) .25 / .33 / .75

REQUIRED PULLS:

VOL. PURGED (gals):

OTHER:

FIELD PARAMETER MEASUREMENTS Field Equipment Used: Horiba U-22

No.	Time	Volume	pH	Temperature	Conductivity	Turbidity	Other (DO; ORP)
1							
2							
3							
4							
5							
6							
7							
8							

OBSERVATIONS (circle as appropriate)

COLOR: CLEAR , AMBER , TAN , BROWN , GREY , MILKY WHITE , OTHER:

ODOR: NONE , LOW , MEDIUM , HIGH , VERY STRONG , H2S , FUEL LIKE , CHEMICAL ?, UNKNOWN

TURBIDITY: NONE , LOW , MEDIUM , HIGH , VERY TURBID. HEAVY SILTS

COMMENTS:

Please use back of sheet for sketching maps, well location notes, etc. **See back of sheet? Y / N**

SAMPLE DATA:

Sample ID Number	No. and Types of Containers	Parameters Analyzed	Laboratory	QA/QC sample? Y /N

SIGNED/SAMPLER: _____

Attachment 5

COC Form

Attac..ent 5

Project #	Project Name						Number of Containers	Analyze For					Remarks
Samplers: (Signature)													
Sample #	Date	Time	Type	Comp	Grab	Sample Location							
Relinquished By:			Date:	Time:	Received By:		Relinquished By:				Date:	Time	Received By:
Relinquished By:			Date:	Time:	Received for Lab By:		Date	Time	Remarks				
Handling Instructions:													Turnaround Time:
Instructions													

Appendix B: Quality Assurance Project Plan (QAPP)

FINAL

Quality Assurance Project Plan

Operable Unit No. 10 (Site 35)

Marine Corps Base

Camp Lejeune, North Carolina

Prepared for

Department of the Navy

Atlantic Division

Naval Facilities Engineering Command

Norfolk, Virginia

Contract No. N62470-95-D-6007

CTO-0253

LANTDIV Clean II Program

January 2004

Prepared by

CH2MHILL

Table of Contents

List of Tables

List of Attachments

Acronyms and Abbreviations

ASTs	Aboveground Storage Tanks
BTEX	benzene, toluene, ethylbenzene, and xylenes
CA	Corrective Action
COC	Chain-of-Custody
cVOCs	Chlorinated Volatile Organic Compounds
DM	Database Manager
DQOs	Data Quality Objectives
EPA	Environmental Protection Agency
FTL	Field Team Leader
GC	Gas Chromatograph
HSM	Health and Safety Manager
IAS	In-situ Air Sparge
IDL	Instrument Detection Limit
IDW	Investigation Derived Waste
LDM	Lead Data Manager
MCB	Marine Corps Base
MDL	Method Detection Limit
MS	Mass Spectroscopy
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NIST	National Institute of Standards and Testing
ORP	Oxidation/Reduction Potential
PARCC	precision, accuracy, representativeness, comparability, and completeness
PC	Project Chemist
PPE	Personal Protective Equipment
PM	Project Manager
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD	Relative Percent Difference
RTL	Review Team Leader
SDGs	Sample Delivery Groups
SOPs	Standard Operating Procedures
SSC	Site Safety Coordinator
TCE	trichloroethene

1.0 Introduction

This document has been prepared to serve as a *Quality Assurance Project Plan* (QAPP) for the pilot study at Operable Unit 10, Site 35 at the Marine Corps Base (MCB) Camp Lejeune in Onslow County, North Carolina. This QAPP describes the data quality objectives, specific quality assurance (QA) and quality control (QC) activities, and laboratory activities necessary to achieve the data quality objectives (DQOs) of the project.

Subcontractors will be furnished with a copy of the project-specific QAPP, and will be expected to adhere to the procedures specified herein.

2.0 Project Description

This section provides a brief history of Site 35 and previous environmental investigations at Site 35. Section 1 of the Work Plan provides a detailed project description. Section 2 describes the site background and environmental setting.

2.1 Site History and Contaminants

Construction of MCB Camp Lejeune began in 1941. Construction of Camp Geiger was completed in 1945. In 1945 the Fuel Farm's aboveground storage tanks (ASTs) stored No. 6 fuel oil, but later stored other petroleum products such as gasoline, diesel fuel, and kerosene. The date of this switch is unknown.

The ASTs at Site 35 supplied fuel to an adjacent dispensing pump. Approximately 30 gallons of gasoline were reportedly lost per day from a leak in an underground line to the pump (Law, 1992). It is unknown how long this leak occurred, but when discovered, the leaking line was sealed and replaced. Other documented petroleum releases date back to 1957. A release of several thousand gallons of fuel from an underground distribution line occurred between 1957 and 1958. Fuel from this release reportedly migrated to the east and northeast toward Brinson Creek. Interceptor trenches were excavated to capture the fuel, and once captured, the fuel was burned (ESE, 1990).

In 1990, an unauthorized discharge from a tanker truck resulted in an unknown volume of diesel or jet fuel flowing along an unnamed drainage channel north of the Fuel Farm. This spill initiated an emergency clean up, which included the removal of about 20 cubic yards of soil. Other undocumented fuel and chlorinated solvent releases are suspected to have occurred at Site 35, as both fuel and chlorinated solvent contamination have been discovered in soil and groundwater.

In 1995, the Fuel Farm was demolished to clear the way for the Highway 17 Bypass. In 1995 and 1996, approximately 15,700 tons of contaminated soil was removed from the site.

An in-situ air sparge (IAS) system was installed and baseline groundwater sampling was conducted to determine the impact of the system on natural attenuative processes (Baker, 1999).

Two hot spots have been identified at Site 35. One shallow hot spot located in the vicinity of Building G480 contains fuel and solvent contamination (primarily BTEX). A second larger hot spot is located beneath the Highway 17 Bypass and contains chlorinated solvents (primarily TCE and daughter products). The focus of this pilot study is the TCE plume.

3.0 Project Organization and Responsibilities

This section identifies key project team members and lists the QA/QC responsibilities associated with each position; describes communication procedures that will be followed throughout the project; and summarizes the project schedule.

3.1 Project Team Members

The organizational structure (Work Plan, Figure 10-2) and responsibilities are designed to provide project QA/QC for the proposed pilot study at Site 35. Each position is described in the following paragraphs.

3.1.1 Project Manager (PM)

The PM is responsible for overall project activities, including cost control, schedule control, and technical quality. In addition, the PM develops the work plan and monitors task order activities to ensure compliance with project objectives and scope. The PM also communicates with MCB Camp Lejeune and other designated parties regarding project progress.

The PM has ultimate responsibility within the project team for producing deliverables that are technically adequate, satisfactory to the client, and cost-effective. To accomplish this, the PM develops an internal project review schedule, provides written instructions and frequent guidance to the project team, and monitors budgets and schedules. The PM will work with the project team to select an internal QA/QC review team, to coordinate review efforts, to address review comments, and to adjudicate technical issues.

3.1.2 Senior Consultant and Review Team Leader (RTL)

The RTL is a company-wide resource with significant experience in the various technical aspects involved in a complex project. The RTL coordinates all internal QA/QC review for technical validity and adherence to both internal CH2M HILL policy and MCB criteria. The review team is responsible for evaluating the technical merit of the work planning documents before field activities begin, and reviewing all deliverables before submittal to MCB Camp Lejeune. The RTL assists the PM in selecting an internal QA/QC review team, coordinating review efforts, addressing review comments, and resolving technical issues.

3.1.3 Project Chemist (PC)

The PC assists with the preparation of the project work planning documents, provides a point of communication between the laboratory and the project team, supervises the analytical data quality evaluation, and participates in preparing deliverables to the client. The PC coordinates with the project team and the analytical laboratory during the field activities. The PC is also responsible for monitoring project-specific laboratory activities, including checking laboratory invoices and reports, and may audit the laboratory or field operations at the PM's direction. The PC also monitors field and laboratory activities to

ensure that the QA/QC requirements described in this project-specific QAPP are met effectively.

3.1.4 Lead Data Manager (LDM)

The LDM is responsible for the structure, organization, format, implementation, and operation of the project database as described in the Work Plan. The lead data manager supervises the data management team and provides direction to the database manager.

3.1.5 Database Manager (DM)

The DM works with the database on a daily basis and provides data summaries and data queries to the project team.

3.1.6 Field Team Leader (FTL)

The FTL reports to the PM and is responsible for coordinating field efforts; providing and maintaining sampling equipment and materials; providing shipping and packing materials; and accurately completing the field logbook. The FTL will supervise the completion of all chain-of-custody (COC) records and the proper handling and shipping of samples. As the lead field representative, the FTL is also responsible for consistently implementing program QA/QC measures at the site and for performing field activities in accordance with approved work plans, policies, and field procedures.

3.1.7 Site Safety Coordinator (SSC)

The SSC develops and implements the project-specific *Health and Safety Plan* (Appendix C) in the field. The SSC will assist in conducting site briefings and perform all final safety checks. The SSC is responsible for stopping any investigation-related operation that threatens the health and safety of the field team or surrounding populace.

3.1.8 Health and Safety Manager (HSM)

The HSM reviews and approves the project-specific *Health and Safety Plan* as well as subcontractor *Health and Safety Plans*. The HSM serves as the point of contact for the SSC for any health- or safety-related issues, and may conduct project audits. The HSM is also responsible for investigating accidents should any occur during the course of the project.

3.1.9 Subcontractors

Subcontractors will be used for pilot study activities at Site 35. Subcontractors will provide the following services:

- Utility location
- Groundwater monitoring well installation
- Modified Fenton's and potassium permanganate injection
- Analytical laboratory services
- Geotechnical laboratory services
- Transportation and disposal of investigation-derived waste (IDW)

- Survey of the location and elevation of soil borings, groundwater monitoring wells, and other sampling locations

Procurement of subcontractors will be performed in accordance with AGVIQ procedures.

3.2 Project Communication

One of the most critical elements in performing any type of project is to establish and maintain lines of communication among all project personnel. At the beginning of the project or the start or end of major milestones, the PM will prepare written project instructions that will be distributed to all team members. These instructions will document project and task instructions, and each team member's responsibility in meeting the objectives, as well as a budget and schedule for successfully executing the work.

Before field activity begins, a project team meeting will be held to review the concept, assumptions, objectives of the field approach, and project objectives. Periodic meetings will be held to review data validity, technical evaluations, major decisions, and overall progress toward completing the project. Additionally, a team kickoff meeting will be held before work on each task is started. Senior personnel, including the RTL, will participate in the meetings to help focus the project approach and to define specific issues.

During the field investigation phase of projects, the field teams will meet daily to review the status of the project and to discuss technical and safety issues. When necessary, other meetings will be scheduled or the FTL will meet individually with field personnel or the subcontractors to resolve problems. During the field effort, the FTL will prepare a weekly report detailing project progress.

During the field effort, the FTL will be in regular telephone or face-to-face contact with the project team. When significant problems or decisions requiring additional authority occur, the FTL can immediately contact the PM for assistance. The PC, in consultation with the PM, will coordinate communication with the laboratory during sample collection, sample analysis, and data quality evaluation.

Daily and weekly reports, boring logs, QA reports, and other project information will be shared by the members of the project team as needed. All communications with MCB Camp Lejeune will be channeled through the PM for MCB Camp Lejeune, who will be informed of field activities being conducted on a daily basis.

3.3 Project Schedule

Figure 10-1 in the Work Plan presents the schedule for the pilot study at Site 35.

3.0 Quality Assurance Objectives

DQOs are qualitative and quantitative statements that specify the quality of data required from field and laboratory data collection activities to support decisions concerning risk and remediation. DQOs are established prior to data collection and describe what data are needed, why the data are needed, and how the data will be used to address the problems being investigated. DQOs help to ensure that all data collected are legally and scientifically defensible.

4.1 Background

The primary objective of the pilot test is to treat the "hot spot" and reduce TCE concentrations to low levels, so that natural attenuation can complete the process of reducing contaminant levels to below regulatory standards. Specific goals of the pilot study include:

- Minimize the size and migration potential of the plume,
- Cause little or no adverse effect on Highway 17 construction , and
- Protect potential receptors including nearby surface waters.

4.2 Levels of Data Quality

Three categories of data will be collected as part of the field effort, and each category has a different level of supporting QA/QC documentation. Level 1 includes field monitoring activities, such as pH, conductivity, dissolved oxygen, and turbidity. Level 2 includes the analyses associated with the characterization of the IDW samples. All other samples will be submitted to the laboratory for Level 3 analyses. For each QC level, the measures and methods to be used, as well as the applicable data package deliverables, are outlined below.

4.2.1 Level 1 – Field Surveys

Level 1 encompasses field monitoring or screening activities and does not require formal data package deliverables. Level 1 activities are focused on easily measured characteristics of a sample such as dissolved oxygen, pH, conductivity, oxidation/reduction potential (ORP), and turbidity. The data generated from field surveys are used to make decisions about the execution of the investigation or to provide general sample screening before laboratory analysis.

Monitoring results, as well as pertinent data concerning the sampling event, will be documented in the field logbook. Level 1 documentation will consist of the following:

- Instrument identification
- Calibration information (standards used and results)
- Date and time of calibration and field measurements
- Field measurement results

The logbooks will be reviewed daily by the FTL for completeness and correctness. No additional documentation or data quality evaluation is required.

4.2.2 Level 2 – Physical Parameters and IDW Analyses

Level 2 includes the samples submitted to the laboratories for physical parameter testing and IDW characterization. Samples submitted for analysis under Level 2 will require the delivery of an analytical data package. Level 2 documentation will consist of the following:

- Case narrative
- Sample results
- Selected QC information such as surrogate recovery
- Associated blank results
- Completed chain-of-custody form and sample receipt information

4.2.3 Level 3 – Laboratory Analyses

The purposes of Level 3 data include the following:

- To further define the nature and extent of groundwater contamination at Site 35
- To determine the effectiveness of the injected chemical oxidants
- To define the fate and transport mechanisms of site-related contaminants

Samples will be analyzed for cVOCs by EPA Method 8260B, ferrous iron by SM 3500-FeD, metals by SW-846 6010B, and chloride by EPA Method 300. EPA-approved methods from the current edition of *SW-846, Test Methods for Evaluating Solid Waste,* will be used to analyzed samples. Data package deliverables are summarized in Table 4-1.

TABLE 4-1
Level 3 Data Package Deliverables (Standard Deliverable Package)
Quality Assurance Project Plan, Site 35, MCB Camp Lejeune

All Analytical Fractions
Case Narrative
Sample ID Cross Reference Sheet (Lab IDs and Client IDs)
Completed COC form and any sample receipt information
Any analytical/procedural changes (copies of "Confirmation of Communication")
Copies of non-conformance memos and corrective actions
GC/MS Organic Analyses
Form 1 – Sample Results
Form 2 – Surrogate Recovery Summary
Form 3 – Matrix Spike and Matrix Spike Duplicate (MS/MSD) Accuracy and Precision Summary
Form 4 – Method Blank Summary
Form 5 – Instrument Tuning Summary
Form 6 - Initial Calibration Summary
Form 7 – Continuing Calibration Summary
Form 8 – Internal Standard Summary
General Chemistry
Includes potentiometric, gravimetric, colorimetric, and titrimetric analytical techniques. Examples, TRPH (418.1), TOC, etc. The following forms must be included (where applicable)
Form 1 – Sample Results
Form 2A – Initial and Continuing Calibration Summary
Form 3 - Initial and Continuing Calibration Blanks and Method Blanks Summary
Form 5A –MS/MSD Recoveries Summary
Form 6 – Native Duplicate and MS/MSD Precision Summary
Form 7 – Laboratory Control Sample Recovery Summary
Form 10 – Instrument or Method Detection Limit Summary
Form 13 – Preparation Log Summary

4.3 QA Objectives for Chemical Data Management

Analytical performance requirements are expressed in terms of precision, accuracy, representativeness, comparability, and completeness (PARCC). Brief definitions for each PARCC parameter are presented below.

4.3.1 Precision

Precision is a measure of the agreement or repeatability of a set of replicate results obtained from duplicate analyses made under identical conditions. Precision is estimated from analytical data and cannot be measured directly. The precision of a duplicate determination can be expressed as the relative percent difference (RPD).

4.3.2 Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. Accuracy is estimated through the use of known reference materials or matrix spikes. It is calculated from analytical data and is not measured directly. Spiking of reference materials into a sample matrix is the preferred technique because it provides a measure of the matrix effects on analytical accuracy. Accuracy is defined as percent recovery (P).

4.3.3 Representativeness

Representativeness is a qualitative measure of the degree to which sample data accurately and precisely represent a characteristic environmental condition. Representativeness will be assessed by reviewing the presence/absence of contaminants in method blanks, trip blanks, and equipment blanks; sample condition/integrity upon receipt and storage at the laboratory; and laboratory adherence to sample holding times. In addition, the effects of sample matrix interferences, if any, will be evaluated to determine possible data impact.

4.3.4 Comparability

Comparability is another qualitative measure designed to express the confidence with which one data set may be compared to another. Sample collection and handling techniques, sample matrix type, and analytical method all affect comparability. Comparability is limited by the other PARCC parameters because data sets can be compared with confidence only when precision and accuracy are known.

4.3.5 Completeness

Completeness is defined as the percentage of valid measurements compared to the total number of measurements made for a specific sample matrix and analysis. The completeness goal for analytical data is 90 percent. All validated data will be used. During the data validation process, an assessment will be made of whether the valid data are sufficient to meet project objectives. If sufficient valid data are not obtained, corrective action (CA) will be initiated by the PM.

5.0 Sampling Procedures

Sampling locations and procedures are discussed in Sections 4 and 5 of the Work Plan and Sections 4 and 6 of the *Field Sampling Plan* (Appendix A).

6.0 Sample and Document Custody Procedures

A sample is physical evidence collected from a hazardous waste site, the immediate environment, or another source. Because of the potential evidentiary nature of samples, the possession of samples must be traceable from the time the samples are collected until they are introduced as evidence in enforcement proceedings.

COC procedures are used to maintain and document sample possession for enforcement purposes. The principal documents used to identify samples and to document possession are:

- Packing Lists
- COC Records
- Air Bills (such as Federal Express, UPS)
- Field Logbooks
- Color photographs of the field activities

Sample custody and COC records will be maintained by the field team until delivered to the laboratory. Sample shipping information from each day will be maintained by the FTL and relayed to the laboratory as soon as possible after sample pickup. These documents may be introduced as evidence should a site investigation result in legal action. To document sample possession, COC procedures are followed.

6.1 Definition of Custody

A sample is under the field team's custody if one or more of the following criteria are met:

- It is in the field team's possession.
- It is in the field team's view, after being in the field team's possession.
- It was in the field team's possession and then the field team locked it up to prevent tampering.
- It is in a designated secure area.

6.2 Field Custody

In collecting samples, the amount collected should be only enough to provide a good representation of the media being sampled. To the extent possible, the quantity and types of samples and sample locations are determined before the actual field work begins.

The following procedures will be used to document, establish, and maintain custody of field samples:

- Labels will be completed for each sample with waterproof ink, making sure that the labels are legible and affixed firmly on the sample container.

- All sample-related information will be recorded in the site logbook.
- The field sampler will retain custody of the samples until they are transferred or properly dispatched.
- To simplify the COC record and minimize potential problems, as few people as possible will handle the samples or physical evidence. One individual from the field sampling team will be designated as the responsible individual for all sample transfer activities. This field investigator will be responsible for the care and custody of the samples until they are properly transferred to another person or facility.
- All samples will be accompanied by a COC record, which documents the transfer of custody of samples from the field investigator to another person, the laboratory, or other organizational elements. A signature for relinquishment and a signature of receipt of the samples must accompany each change of possession.
- Completed COC forms will be placed in a plastic cover, which is then placed inside the shipping container used for sample transport from the field to the laboratory.
- When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill or receipt will be recorded on the COC form or in the site logbook.
- Custody seals will be used on the shipping containers when samples are shipped to the laboratory to inhibit sample tampering during transportation.

6.3 Sample Labels

The sampling location identification and sample labeling, handling, and shipping must be performed using standardized and well-documented procedures, so that a sample can be tracked to its point of origination. Tracking will be performed from the time of sampling until the analytical data are released from the laboratory. The effectiveness of the tracking process will determine the integrity of the samples. Therefore, a sample numbering system with a tracking mechanism that allows the retrieval of sample information, including sampling locations, date, time, and analytical parameters must be used. Procedures for this system are provided in the project Work Plan. The method of sample identification to be used depends on the type of sample collected and the sample container type, as follows.

- Samples collected for in-situ field analysis are those collected for specific field analyses or measurements for which the data are recorded directly in the field logbooks or recorded on field data sheets, along with sample identity information, while in the custody of the sampling team. Examples are samples for measurement of field pH, specific conductance, and temperature.
- Samples other than those collected for in-situ field measurements or analyses are to be identified on a sample label affixed to the sample container by the FTL. The following information must be included on the label:
  - Laboratory
  - Project name (and number where appropriate)
  - Sample ID

- Station ID
- Date (for key to sampling round)
- Preservation
- Analysis
- Sampler's initials, date, and military time

6.4 Chain-of-Custody Record

Samples are accompanied by a COC record, which will contain the information described in Section 5.5.

6.5 Transfer-of-Custody and Shipment

When transferring samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the COC record. This record documents custody transfer from the sampler to the analyst at the laboratory.

Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate COC record accompanying each shipping container. Shipping containers will be sealed with custody seals for shipment to the laboratory. Courier name(s), and other pertinent information, will be entered in the '"Received By" section of the COC record.

When samples are split with a facility owner or agency, this information will be noted in the "Sample Remarks" section of the COC record and will be signed by both the sampler and the recipient. If the split is refused, the refusal will be noted and signed by both parties. The "Sample Remarks" section will also indicate if a representative is unavailable or refuses to sign. When appropriate, as in the case of the representative being unavailable, the COC record should contain a statement that the samples were delivered to the designated location at the designated time.

All shipments will be accompanied by the COC record identifying their contents. The original record and yellow copy will accompany the shipment to the laboratory, and the pink copy will be retained by the FTL.

If sent by mail, the package will be registered with return requested. If sent by common carrier, a bill of lading will be used. Freight bills, postal service receipts, and bills of lading will be retained as part of the permanent documentation.

6.6 Laboratory Chain-of-Custody Procedures

When samples are shipped to the laboratory, they will be placed in containers that are sealed on each side with at least one custody seal. A designated sample custodian will accept custody of the shipped samples following the procedure outlined below.

When sample analyses and necessary QA checks have been completed in the laboratory, the unused portion of the sample will be disposed of properly. All identifying stickers, data sheets, and laboratory records will be retained as part of the documentation. Sample

containers and remaining samples will be disposed in compliance with all federal, state, and local regulatory requirements.

6.6.1 Sample Receipt

A designated sample custodian will accept custody of the shipped samples and verify that the packing list sample numbers match those on the COC record. The custodian will enter pertinent information as to shipment, pickup, and courier in the "Sample Remarks" section of the COC record, and enter the sample numbers into a field logbook, which is arranged by project code and station number. Upon receipt of the samples, the custodian will check the original COC and request-for-analysis documents and compare them with the labeled contents of each sample container for corrections and traceability. The sample custodian will sign the COC and record the date and time received. The sample custodian also will assign a unique laboratory sample number to each sample. Cooler temperature (temperature vial) will be checked and recorded.

Care will be exercised to annotate any labeling or descriptive errors. If discrepancies occur in the documentation, the laboratory will immediately contact the FTL as part of the CA process. A qualitative assessment of each sample container will be performed to note anomalies, such as broken or leaking bottles. This assessment will be recorded as part of the incoming COC procedure.

6.6.2 Sample Storage

The laboratory custodian will use the sample identification number and assign a unique laboratory number to each sample, and is responsible for seeing that all samples are transferred to the proper analyst or stored in the appropriate secure area. The laboratory will send a sample acknowledgement letter to the PM or FTL as a record of the shipment's arrival and the condition of the containers. The laboratory custodian will identify any discrepancies and CAs will be performed. The project chemist may need to provide guidance concerning additional actions. A copy of the sample acknowledgement letter will be retained with the COC by the PM.

6.6.3 Data Recording

The custodian will distribute samples to the appropriate analysts. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian. The data from sample analyses are recorded on the laboratory report form.

6.7 Documentation Procedures

Field documentation for activities at MCB Camp Lejeune will consist of one or more site-specific field logbooks, field forms, sample logs/labels, and an equipment calibration log. Each logbook will be identified uniquely by project task and consecutively numbered. For extended field activities, logbooks will be maintained onsite until complete, then stored in the project files.

Photographs will be taken during key field activities. The photographs will be collected at the end of the field work and will be submitted to the MCB Camp Lejeune project manager within 2 weeks of the completion of field work.

6.7.1 Sample Identification

An electronic sample tracking program will be used to manage the flow of information from the field sampling team to the laboratory and to internal and external data users. The tracking program is used to produce sample labels and COC forms and to manage the entry of sampling-related data, such as station locations and field measurements.

The method of sample identification used depends on the type of sample collected and the sample container.

- The field analysis data are recorded in field logbooks or on data sheets, along with sample identity information, while in the custody of the sampling team.
- Labels for samples sent to a laboratory for analysis will be produced electronically. If they cannot be produced electronically, they must be written in indelible ink. The following information typically is included on the sample label:
  - Site name or identifier
  - Sample identification number
  - Date and time of sample collection
  - Sample matrix or matrix identifier
  - Type of analyses to be conducted

Each analytical sample will be assigned a unique number of the following format:

Site # - Media/Station # or QA/QC –Round

where

Site #	IR35, indicating Site 35 under the Installation Restoration Program
Media	MW = Monitoring well boring
	GW = Groundwater
	IS = In-situ sampled boring
Station #	Unique identification number for each soil boring or monitoring well
QA/QC	FB = Field blank
	D = Duplicate sample (following sample type/number)
	TB = Trip blank
	ER = Equipment rinsate
	MS/MSD = Matrix spike/matrix spike duplicate

Round	Round indicators will be used for groundwater samples. Each round of sampling will have a distinct identification number. For example: PSB = Pilot study baseline sampling PSF = Pilot study sampling after modified Fenton's but before permanganate injection 04A = Quarterly sampling during the 1st quarter of 2004 04B = Quarterly sampling during the 2nd quarter of 2004 04C = Quarterly sampling during the 3rd quarter of 2004 04D = Quarterly sampling during the 4th quarter of 2004

Using this format, the sample designation IR35-GW50D-PSB refers to a duplicate groundwater sample, collected from monitoring well 50 during pilot study baseline sampling at Site 35. The sample designation IR35-ERGW-04D refers to the first equipment blank collected from groundwater sampling equipment at Site 35 during 4th quarter sampling in 2004.

This sample designation format will be followed throughout the pilot study at Site 35. Required deviations to this format will be documented in the field logbook.

6.7.2 Field Logs

Field logs will consist of all associated field logbooks and field forms.

6.7.2.1 Site Logbook

The site logbook chronicles field investigation activities, but does not have the same level of detail as the field logbook. The site logbook delineates conditions and activities that occur on a given day and references the appropriate field logbooks and forms for specific information. The site logbook also is used to record field changes, along with supporting rationale (Attachment 1).

The responsible person for the field effort will complete the site logbook. Pages will not be removed from the document. Partially used pages will be lined out, dated, and initialed to prevent data entry at a later date.

The front cover or first page of the site logbook must list the project name, the project number, and dates of use. The following items are to be included, as appropriate to the work scope, in the site logbook:

- Date
- Weather conditions
- List of CH2M HILL personnel, subcontractor personnel, and site visitors by name, title, organization, and purpose, who entered the project area during the day
- Brief descriptions of activities conducted

- Field changes or variances with references to the appropriate documentation of these changes
- Specific comments related to peculiar problems that occurred during the day, if any, and their resolution

6.7.2.2 Field Logbook

Information required on the cover of the site logbook also must be provided on the cover of each field logbook. Entries in the field logbook must be continuous through the day. Field logbook pages, as well as the logbooks themselves, are numbered consecutively. The following information should be included in the field logbook:

- Date, time of specific activities, and physical location;
- Weather conditions;
- Names, titles, and organization of personnel onsite, names and titles of visitors, and times of visits;
- Field observations, including specific details on sampling activities (including type of sampling, time of sampling, and sample numbers), a description of any field tests and their results, and references to any field forms used and type of document generated;
- A detailed description of samples collected and any splits, duplicates, matrix spikes, or blanks that were prepared. A list of sample identification numbers, packaging numbers, and COC record numbers pertinent to each sample or referenced to the appropriate documentation should be noted;
- Specific problems, including equipment malfunctions and their resolutions;
- List of times, equipment types, and decontamination procedures (if different from those in the project Work Plan) or a reference to the appropriate documentation; and
- Photograph records.

Additional information may be recorded at the discretion of the logbook user. Information to be recorded may include the following:

- Identification of well
- Static water level, depth, and measurement technique
- Presence of immiscible layers and detection methods
- Collection method for immiscible layers and sample identification numbers
- Total depth of well
- Well yield
- Purge volume and pumping rate
- Well purging times and volumes
- Sample withdrawal procedure
- Date and time of collection
- Well sampling sequence
- Types of sample containers and sample identification numbers
- Preservatives used

- Laboratory analyses requested
- Field analysis data and methods
- Sample distribution and transporter

6.7.3 Corrections to Documentation

All original handwritten data recorded in field logbooks, sample identification tags, COC records, and receipts-for-sample forms will be written with black, waterproof ink. Corrections must be marked with a single line, dated, and initialed. Documents such as site, field, and calibration logbooks are not to be destroyed or discarded, even if illegible or inaccurate. None of these accountable control documents are to be destroyed or discarded, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on an accountable document assigned to one team member, the FTL may make corrections simply by drawing a single line through the error and entering the correct information. The erroneous information should not be obliterated. The person who made the entry should correct any subsequent error discovered on an accountable document. All subsequent corrections must be initialed and dated.

6.7.4 Final Evidence File Documentation

Documentation, including voided entries, must be maintained within project files.

7.0 Calibration Procedures and Frequency

Field and laboratory equipment must operate satisfactorily within specified operating limits before it can be expected to produce reliable and usable data for a project. Documentation concerning the calibration laboratory equipment should include instrument type, calibration frequency, reference standards used, calibration acceptance criteria, and calibration documentation procedures. Calibration applies to field and laboratory instruments, including balances, refrigerators, and ovens.

Instrument testing is primarily achieved by following the manufacturer's instructions with regard to proper voltages, carrier gas flow rates, temperatures, mass or retention time windows, and certified calibration standards. Practically all instruments come with manufacturer's instructions for initial setup, routine checks, CAs, and preventive maintenance.

7.1 Field Instruments

Field instruments will be calibrated at the beginning of each day using the method described by the manufacturer's instructions and then checked periodically during the day and at the end of the measurement period. Standards used to calibrate the field survey instruments will be traceable to National Institute of Standards and Testing (NIST) standards. All instrument calibration activities are documented in the field logbooks.

The water quality indicators will be decontaminated before each sample is measured. The probes will be rinsed three times with ASTM Type II water before storage each day. The meters will be checked for battery charge and physical damage each day. The meters and standard solutions will be stored in a cool, dry environment. Standard solutions will be discarded before they expire.

All field instruments will be set up and operated in strict accordance with the manufacturer's instructions. When the operation of these instruments needs modification because of specific site or sample conditions, such modification will be documented in the instrument logs and field logbooks.

7.2 Laboratory Equipment

Laboratory instruments will be calibrated in accordance with the manufacturer's directions and applicable method specifications. Laboratory instrument calibration procedures will be summarized in the laboratory QAP, which will be reviewed and approved by the PC or designee before samples are submitted for analysis.

8.0 Analytical Procedures

8.1 Field Testing and Screening

All field parameters will be analyzed in accordance with standard operating procedures (SOPs) for the individual equipment. Field parameters include temperature, dissolved oxygen, pH, conductivity, ORP, and turbidity.

8.2 Laboratory Methods

The parameters to be analyzed and the specific analytical methods to be used are listed in Section 4.2.3 of this QAPP.

9.0 Data Reduction, Validation, and Reporting

The data quality evaluation process is used to assess the effect of the overall analytical process on the usability of the data.

9.1 Level 1 – Field Survey Data

Field instruments used to collect field survey data (or bulk measurements, such as pH or conductivity) are direct readings, thus making field calculations and subsequent data reduction unnecessary. Field data will be recorded in the site logbooks by appropriately trained field personnel. Field data will include the following:

- Instrument identification
- Calibration information (standards used and results)
- Date and time of calibration and sample measurement
- Sample results
- Supporting information if appropriate

Data will be reviewed by the FTL, who is responsible for the collection and verification of all field data while in the field. Data initially will be accepted or rejected by the FTL before leaving the sampling site. Extreme readings (readings that appear significantly different from other readings at the same site) will be accepted only after the instrument has been checked for malfunction and the readings verified by re-testing.

Field documentation, sample data, instrument calibrations, and QC data will be reviewed by the PM (or a designee) before being included in the project files.

9.2 Level 2 – Screening Analyses

Level 2 data includes the samples submitted to the laboratories for physical parameter testing and IDW characterization. Samples submitted for Level 2 analysis will require the delivery of a limited data package, which includes:

- Case narrative
- Sample results
- Selected QC information, such as surrogate recovery
- Associated blank results
- Completed COC forms and sample receipt information

The PC will review the supporting information and will provide a summary report to the PM at the end of the field effort.

9.3 Laboratory Analyses

The PC or designee will perform data quality evaluation. The data quality evaluation process is used to assess the effect of the overall analytical process on the usability of the data. The two major categories of data evaluation are laboratory performance and matrix interferences. Evaluation of laboratory performance is a check for compliance with the method requirements and identifies whether the laboratory did, or did not, analyze the samples within the limits of the analytical method. Evaluation of the matrix interferences is more subtle and involves analysis of several results including surrogate spike recoveries, matrix spike recoveries, and duplicate sample results.

Before the analytical results are released by the laboratory, both the sample and QC data will be reviewed carefully to verify sample identify, instrument calibration, detection limits, dilution factors, numerical computations, accuracy of transcriptions, and chemical interpretations. Additionally, the QC data will be reduced and spike recoveries will be included in control charts, and the resulting data will be reviewed to ascertain whether they are within the laboratory-defined limits for accuracy and precision. Any non-conforming data will be discussed in the data package cover letter and case narrative. The laboratory will retain all of the analytical and QC documentation associated with each data package.

The data package will be reviewed by the PC using the process outlined in the following guidance documents:

- Control Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA, 1994)
- Contract Laboratory Program National Function Guidelines for Organic Data Review (EPA, 1994)

For non-CLP methods, the validation will be performed in a process analogous to the National Function Guidelines, but will use QC criteria established by the method.

The data review and validation process is independent of the laboratory's checks; it focuses on the usability of the data to support the project data interpretation and decision-making process. Areas of review include data package completeness, holding time compliance, initial and continuing calibration, spiked sample results, method blank results, and duplicate sample results. A data review worksheet will be completed for each data package. Acceptance criteria for each area of review are specified in the analytical method.

Sample results that do not meet the acceptance limit criteria will be indicated with a qualifying flag, which is a one- or two-letter abbreviation that indicates a possible problem with the data. Flags used in the text may include the following:

- U – Undetected. Samples were analyzed for this analyte, but it was not detected above the method detection limit (MDL) or instrument detection limit (IDL).
- UJ – Detection limit estimated. Samples were analyzed for this analyte, but the results were qualified as not detected. The results are estimated.
- J – Estimated. The analyte was present, but the reported value may not be accurate or precise.

- R – Rejected. The data are unusable. (Note: Analyte/compound may or may not be present.)

It is important to note that laboratory qualifying flags are included on the data summary forms that are submitted by the laboratory. However, during the data review and validation process, the laboratory qualifying flags are evaluated and replaced with the project-specific validation flags.

Once each of the data packages has been reviewed, and the data review worksheets completed, then the entire data set will be evaluated for overall trends in data quality and usability. Information summarized as part of the data quality evaluation may include chemical compound frequencies of detection, dilution factors that might affect data usability, and patterns of target compound distribution. The data set will also be evaluated to identify potential data limitations or uncertainties in the laboratory. Additional areas of review are listed below.

9.3.1 Field and Laboratory Blank Contamination

The appearance and concentration of target compounds in field and laboratory blanks as well as environmental samples will be reviewed. Common field sampling and laboratory contaminants detected in blanks include acetone, methylene chloride, and phthalates. Acetone and methylene chloride are used to extract samples in the laboratory, and hence, are common laboratory contaminants. Phthalates (such as bis(2-ethylhexyl)phthalate) are used as plasticizers and are often introduced during sample handling.

If these compounds are encountered in a method blank at a concentration greater than the practical quantitation limit (PQL), CAs will be taken in an attempt to eliminate these compounds. These compounds may also be detected in field blanks above the PQL. In either case, all analytical data above the PQL associated with these compounds will be flagged to indicate possible cross-contamination.

9.3.2 Surrogate Spike Recoveries

Surrogate spike compounds are added to each sample for the organic analytical methods. Surrogate spike compounds are structurally similar (but not identical) to target compounds and should behave in a similar manner during analysis. Surrogate spike recoveries are used to monitor both laboratory performance and matrix interferences. Surrogate spike recoveries from field and laboratory blanks are used to evaluate laboratory performance because these blanks represent an ideal sample matrix. Surrogate spike recoveries for field samples are used to evaluate the potential for matrix interferences.

When surrogate spike recoveries for field samples fall outside the method target acceptance windows, the samples are re-extracted if appropriate, then re-analyzed. If the surrogate spike recovery is still outside the acceptance window for the re-analyzed sample, then the sample results are qualified as affected by matrix interferences.

9.3.3 Matrix Spike Recoveries

For this QC measure, three aliquots of a single sample are analyzed – one normal and two spiked with the same concentration of matrix spike compounds. Unlike the surrogate spike compounds, matrix spike compounds are found on the method target compound list. Spike

recovery is used to evaluate potential matrix interferences, as well as accuracy. The duplicate spike results are compared to evaluate precision.

9.3.4 Laboratory Control Samples

An aliquot of ASTM Type II water or "Ottawa sand" for organic analyses is spiked with target analytes or compounds at concentrations in the middle of the linear calibration range, and then prepared and analyzed with a batch of samples. The laboratory control sample is used to ensure quality control for each preparation batch.

9.3.5 Duplicate Sample Results

Duplicate samples will be collected and submitted for laboratory analysis. Both the native and duplicate samples will be analyzed for the same parameters. Target compounds that are detected in both the native and duplicate samples will be compared and the precision estimated for the sample results calculated.

9.3.6 Laboratory Data Reporting

Laboratory data will be reported in Level 3 QC and validated for risk assessment. Level 3 reporting includes all QC and calibration summaries for a project-specific batch of samples as listed in Table 4-1. Matrix-specific QC is performed relative to project sample delivery groups (SDGs).

10.0 Field Measures

Field sampling QC procedures will include collecting trip blanks, field blanks, equipment blanks, field duplicates, and MS/MSD samples, as discussed in Appendix A. These QC samples will be submitted blind to the laboratory. Field measurement QC procedures will include the calibration requirements discussed in Section 6 of this QAPP.

Samples will be collected by personnel wearing Level D personal protective equipment (PPE).

10.1 Routine Analytical Services

Laboratory QC procedures will include the following:

- Analytical methodology according to the specific methods listed in Section 4.2.3 of this QAPP;
- Instrument calibrations and standards as defined in the specific methods listed in Section 4.2.3 of this QAPP;
- Laboratory blank measurements at a minimum frequency of 5 percent or 1-per-batch;
- Accuracy and precision measurements at a minimum frequency of 5 percent or 1-per-set;
- Data reduction and reporting according to the specific methods listed in Table 4-1 and the specifications outlined in Section 9 of this QAPP; and
- Laboratory documentation according to the specifications outlined in Section 9 of this QAPP.

11.0 Performance and System Audits

Performance and systems will be audited to verify documentation and implementation of the project-specific QAPP, to identify nonconformance, and to verify correction of identified deficiencies.

Assessment activities may include surveillance, inspections, peer review, management system review, readiness review, technical systems audit, performance evaluation, and data quality assessment. The Quality Assurance Control Manager (QACM) will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation.

The QACM, or designee, in consultation with the PM, will evaluate the need for an independent audit. The client may also perform independent project audits. Performance audits are used to quantitatively assess the accuracy of analytical data through the use of performance evaluation and blind check samples. The QACM or a designee will audit laboratory performance.

11.1 Project Systems Audit

A systems surveillance of operations may be required by the project-specific Work Plan and would be used to review the total data generation process. This will include onsite review of the field operational system, physical facilities for sampling, and equipment calibrations. Informal document control surveillance will consist of checking each document for completeness, including such items as signatures, dates, and project numbers.

An audit report summarizing the results and corrections will be prepared and entered in the project files.

11.2 Technical Performance Audits

The FTL or a designated representative will conduct an informal surveillance of the field activities. Surveillance for completeness will include the following items:

- Sample labels
- COC records
- Field logbooks
- Sampling operations

The first three items above will be checked for completeness. Sampling operations will be reviewed to determine if they are being performed as stated in the project-specific Work Plan or as directed by the FTL. A performance surveillance may be conducted by the PM and the FTL during the first week of sampling if it is deemed necessary by the PM, FTL, or client. The surveillance may focus on verifying that proper procedures are followed so that subsequent sample data will be valid. Before the surveillance, a checklist will be prepared by the PM and the FTL to serve as a guide for the performance surveillance. The surveillance may verify the following:

- Collection of samples follows the available written procedures
- COC procedures are followed for traceability of sample origin
- Appropriate QC checks are being made in the field and documented in the field logbook
- Specified equipment is available, calibrated, and in proper working order
- Sampling crews are adequately trained
- Record-keeping procedures are being followed and appropriate documentation is maintained
- CA procedures are followed

An audit report summarizing the results and corrections will be prepared and entered in the project files.

11.3 Field Audits

Field audits are not currently anticipated during the pilot study at Site 35, but will be performed if necessary.

11.4 Laboratory Audits

The analytical laboratory will conduct both internal and external QC checks. External QC checks include participation in EPA's certification and performance evaluation programs. The results of quarterly performance evaluation samples will be made available to the PM upon request. Internal QC checks (duplicates, blanks, and spiked samples) will be performed in accordance with the approved methods.

Laboratory systems are audited annually and as required by specific projects. The laboratories are required to submit a laboratory QAP and relevant SOPs before the field effort begins. During data evaluation and data use, if any problems are noted, specific CAs will be implemented on a case-by-case basis. An additional systems audit may be requested if warranted.

The laboratory will be required to perform the following:

- Monthly project review of 10 percent of all projects done by the QA department
- Audits by the laboratory QA manager at a frequency greater than specified in the laboratory QAP
- Special audits by the QACM or corporate management when a problem is suspected
- Yearly audits by the corporate QACM

12.0 Preventative Maintenance

12.1 Field Equipment

The field personnel operating the field equipment and appropriate offsite laboratory chemists are responsible for the maintenance of their respective instruments. Preventive maintenance will be provided on a scheduled basis to minimize down time and the potential interruption of analytical work. All instruments will be maintained in accordance with the manufacturer's recommendations and normal approved laboratory practice.

Scheduled periodic calibration of testing equipment does not relieve field personnel of the responsibility of using properly functioning equipment. If a project team member suspects an equipment malfunction, the device will be removed from service, tagged so that it is not inadvertently used, and the appropriate personnel notified so that a recalibration can be performed or a substitute piece of equipment can be obtained.

12.2 Laboratory Equipment

Designated laboratory personnel will be trained in routine maintenance procedures for all major instrumentation. Repairs will be made by either trained staff or trained service engineers/technicians employed by the instrument manufacturer. The laboratory will have multiple instruments that will serve as backup to minimize the potential for downtime.

Preventive maintenance will be performed according to the procedures delineated in the manufacturer's instrument manuals, including lubrication, source cleaning, detector cleaning, and the frequency of such maintenance. Procedures should be listed in greater detail in the laboratory's QAP.

Chromatographic carrier gas purification traps, injector liners, and injector septa will be cleaned or replaced on a regular basis. Precision and accuracy data will be examined for trends and excursions beyond control limits to identify evidence of instrument malfunction. Maintenance will be performed when an instrument begins to degrade, as evidenced by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet one or more of the QC criteria.

Instrument downtime will be minimized by keeping adequate supplies of all expendable items (i.e., an expected lifetime of less than 1 year). Selected items include gas tanks, gasoline filters, syringes, septa, GC columns and packing, ferrules, printer paper and ribbons, pump oil, jet separators, open-split interfaces, and mass spectroscopy (MS) filaments.

12.3 Instrument Maintenance Logbooks

All maintenance will be documented in permanent logs that will be available for review by auditing personnel. Both scheduled and unscheduled maintenance required by operational

failures will be recorded. The designated laboratory operations coordinator will review maintenance records regularly to ensure that required maintenance is occurring.

Instrument maintenance logbooks are maintained in laboratories at all times. The logbooks, in general, contain a schedule of maintenance, as well as a complete history of past routine and nonroutine maintenance. Prior to the start of analyses, the project chemist will audit the laboratories.

13.0 Data Measurement Assessment Procedures

The final activity of the data quality evaluation is an assessment of whether the data meet the DQOs. The goal of this assessment is to demonstrate that a sufficient number of representative samples were collected and that the resulting analytical data can be used to support the project decision making process.

Data assessment will follow the data review and validation described in Section 9 of this QAPP. An assessment report will be prepared at the end of the project. The report will summarize the findings of the data review/validation as relevant to project usage. Data accuracy, precision, and completeness values will be summarized in the assessment report. The following sections describe the quantitative definition of accuracy, precision, and completeness.

13.1 Precision

Precision is a measure of the agreement or repeatability of a set of replicate results obtained from duplicate analyses made under identical conditions. Precision is estimated from analytical data and cannot be measured directly. The precision of a duplicate determination can be expressed as the relative percent difference (RPD) and is calculated as follows:

$$RPD = \{(|X_1 - X_2|)/(X_1 + X_2)/2\} \times 100 = \left\{\frac{|X_1 - X_2|}{\frac{(X_1 + X_2)}{2}}\right\} \times 100$$

X_1 = native sample
X_2 = duplicate sample

13.2 Accuracy

Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. Accuracy is estimated through the use of known reference materials or matrix spikes. It is calculated from analytical data and is not measured directly. Spiking of reference materials into a sample matrix is the preferred technique because it provides a measure of the matrix effects on analytical accuracy. Accuracy, defined as percent recovery (P), is calculated as follows:

$$P = \left[\frac{(SSR - SR)}{SA}\right] \times 100$$

[1] SSR=spiked sample result, SR=sample result (native), and SA=the spike concentration added to the spiked sample

13.3 Completeness

Completeness is defined as the percentage of measurements judged to be valid compared to the total number of measurements made for a specific sample matrix and analysis. Completeness is calculated using the following formula:

$$\text{Completeness} = \frac{\text{Valid Measurements}}{\text{Total Measurements}} \times 100$$

Experience on similar projects has shown that laboratories typically achieve about 90 percent completeness. All validated data will be used. During the data validation process, an assessment will be made of whether the valid data are sufficient to meet project objectives. If sufficient valid data are not obtained, CA will be initiated by the PM.

14.0 Corrective Action

14.1 Field Activities

The PM is responsible for initiating CAs, which include problem identification, investigation responsibility assignment, investigation, action to eliminate the problem, increased monitoring of the effectiveness of the CA, and verification that the problem has been eliminated.

Documentation of the problem is important to the overall management of the study. A CA request form for problems associated with sample collection is completed by the person discovering the QA problem (Attachment 2). This form identifies the problem, establishes possible causes, and designates the person responsible for action. The responsible person will be either the PM or the FTL.

The CA request form includes a description of the CA planned and has space for follow-up. The PM verifies that the initial action has been taken and appears to be effective, and at an appropriate later date, checks to see if the problem has been resolved fully. The PM receives a copy of all CA request forms and enters them into the CA log. This permanent record aids the PM in follow-up and assists in resolving the QA problems.

Examples of CA include, but are not limited to, correcting COC forms, analysis re-runs (if holding time criteria permit), re-calibration with fresh standards, replacement of sources of blank contamination, or additional training in sampling and analysis. Additional approaches may include the following:

- Re-sampling and re-analyzing
- Evaluating and amending sampling and analytical procedures
- Accepting the data and acknowledging the level of uncertainty or inaccuracy by flagging the validated data and providing an explanation for the qualification

14.2 Laboratory Activities

The laboratory department supervisor's review the data generated to verify that all QC samples have been run as specified in the protocol. Laboratory personnel will be alerted that CAs may be necessary if the following should occur:

- QC data are outside the warning or acceptable windows for precision and accuracy established for laboratory samples.
- Blanks contain contaminants at concentrations above the levels specified in the laboratory QAP for any target compound.
- Undesirable trends are detected in matrix spike recoveries or RPD between matrix spike duplicates.
- There are unusual changes in detection limits.

- Deficiencies are detected by the laboratory QA Director during internal or external audits, or from the results of performance evaluation samples.

If nonconformances including, but not limited to, analytical methodologies or QC sample results are identified by the bench analyst, CAs will be implemented immediately. CA procedures will be handled initially at the bench level by the analyst, who will review the preparation or extraction procedure for possible errors and check the instrument calibration, spike and calibration mixes, instrument sensitivity, etc. The analyst will immediately notify his/her supervisor of the problem and the investigation being made. If the problem persists or cannot be identified, the matter will be referred to the laboratory supervisor and QA/QC Officer for further investigation. Once resolved, full documentation of the CA procedure will be filed with the laboratory supervisor, and the QA/QC Officer will be provided a CA memorandum for inclusion in the project file if data are affected. CAs may include, but are not limited to, the following:

- Re-analyzing suspect samples
- Re-sampling and analyzing new samples
- Evaluating and amending sampling and/or analytical procedures
- Accepting data with an acknowledged level of uncertainty
- Recalibrating analytical instruments
- Qualifying or rejecting the data

Following the implementation of the required CA measures, data that are deemed unacceptable may not be accepted by the PM, and follow-up CAs may be explored. Details of laboratory CAs are provided in the laboratory QAP. CA requests will be documented with the form in Attachment 2.

15.0 Quality Assurance Reporting Procedures

The purpose of QA reports is to document implementation of the QAPP. These reports include periodic assessments of measurement data accuracy, precision, and completeness of the results of performance audits, the results of system audits, and the identification of significant QA problems and recommended solutions.

The analytical laboratory will be responsible for submitting monthly progress reports to the PM. The PM is responsible for submitting these reports to the client, as required.

The final QA report will be attached as an appendix to the project report and may include the following:

- Data quality assessment in terms of PARCC, and the method detection limits
- The degree to which DQOs were met
- Limitations of the measurement data and usability of the data
- Applicability of the data to site conditions
- Laboratory QC activities, including a summary of planned versus actual laboratory QC activities, explanations for deviations, and an evaluation of data quality for each analysis for each medium
- Field QC activities, including a summary of planned versus actual field QC activities, explanations for deviations, and evaluations of the data quality of field QC samples/activities and estimated effect on sample data
- Data presentation and evaluation, including an assessment of sampling and analysis techniques, data quality for each analysis and each medium, and data usability

A final report will be submitted to the client after comments from the client and regulatory agencies have been incorporated.

Attachment 1

Field Change Documentation

Field Change Documentation

Date: _____
Page _____ **of** _____

Project:

Project No.:

Applicable Document:

Change Description:

Reason for change:

Recommended disposition:

Impact on present and completed work:

Final disposition (MCB Camp Lejeune only)

Request by:
CH2M HILL Project Manager: _____ Date:_____
Approvals:
MCB Camp Lejeune Project Manager: _____ Date:_____

Attachment 2

Corrective Action Request Form

Corrective Action Request Form

Originator: _____ Date: _____

Person responsible for replying: _____

Description of problem and when identified: _____

_____

Sequence of Corrective Action (CA): (Note, if no responsible person is identified, submit this form directly to the PM)

State date, person, and action planned:

_____

_____

_____

_____

_____

CA initially approved by: _____ Date: _____

Follow-up date: _____

Final CA approval by: _____ Date: _____

Information copies to:

Responsible person:_____

Field Team Leader:_____

Project Manager: _____

Appendix C: Health and Safety Plan (HSP)

FINAL

Health & Safety Plan

Operable Unit No. 10 (Site 35)

Marine Corps Base

Camp Lejeune, North Carolina

Prepared for

Department of the Navy

Atlantic Division

Naval Facilities Engineering Command

Norfolk, Virginia

Contract No. N62470-95-D-6007

CTO-0253

LANTDIV Clean II Program

January 2004

Prepared by

CH2MHILL

CH2M HILL HEALTH AND SAFETY PLAN

This Health and Safety Plan (HSP) will be kept on the site during field activities and will be reviewed as necessary. The plan will be amended or revised as project activities or conditions change or when supplemental information becomes available. The plan adopts, by reference, the Standards of Practice (SOPs) in the CH2M HILL *Corporate Health and Safety Program, Program and Training Manual*, as appropriate. In addition, this plan adopts procedures in the project Work Plan. The Site Safety Coordinator (SSC) is to be familiar with these SOPs and the contents of this plan. CH2M HILL's personnel and subcontractors must sign Attachment 1.

Project Information and Description

PROJECT NO: 174057

CLIENT: LANTDIV

PROJECT/SITE NAME: Operable Unit 10, Site 35

SITE ADDRESS: MCB Camp Lejeune, North Carolina

CH2M HILL PROJECT MANAGER: Christopher Bozzini/CLT

CH2M HILL OFFICE: Charlotte, North Carolina

DATE HEALTH AND SAFETY PLAN PREPARED: August 8, 2003

DATE(S) OF SITE WORK: December 2003 – February 2004

SITE ACCESS: Access to the site is currently restricted. Site 35 is situated within Camp Geiger just north of the intersection of Fourth and "G" Streets.

SITE SIZE: ~5 acres

SITE TOPOGRAPHY: Construction of the Highway 17 Bypass (cut and fill operations) have changed the local topography and drainage. Construction activities have eliminated much of the vegetation, and additional drainage ditches have been dug to transport surface runoff to Brinson Creek.

PREVAILING WEATHER: High 70s-80s, Lows 40s-50s, humid (SE coastal plain)

SITE DESCRIPTION AND HISTORY:

MCB Camp Lejeune is located in Onslow County, North Carolina and covers approximately 236 square miles and includes 14 miles of coastline. The Base is bounded to the southeast by the

Atlantic Ocean and to the northeast by State Route 24. The town of Jacksonville, North Carolina is located north of the Base.

Camp Geiger is located at the northwest corner of Marine Corps Base (MCB), Camp Lejeune (Work Plan, Figure 2-1). The main entrance to Camp Geiger is off U.S. Route 17, approximately 3.5 miles southeast of the City of Jacksonville, North Carolina. Site 35 is situated within Camp Geiger just north of the intersection of Fourth and "G" Streets. Site 35 is the former Camp Geiger Area Fuel Farm (Fuel Farm), and was previously occupied by five 15,000-gallon above ground storage tanks (ASTs), a pump house, a fuel unloading pad, and several underground petroleum distribution lines. The former ASTs previously held No. 6 fuel oil, unleaded gasoline, diesel fuel, and kerosene. The Fuel Farm was decommissioned and removed in 1995 to accommodate a six-lane divided highway (Highway 17 Bypass) proposed by the North Carolina Department of Transportation (NCDOT). At the time of this report the Highway 17 Bypass was under construction.

Results of previous investigations have expanded Site 35 beyond the confines of the former Fuel Farm. Site 35 is now bounded on the west by D Street, on the north by Second Street, on the east by Brinson Creek and on the south by Fifth Street and Building TC572. Roadways, buildings, former building foundations and several large parking areas are located within Site 35. The foundations of previously existing structures are scattered throughout the study area marking the former existence of a warehouse (TC460), a mess hall, a heating plant, a gas station, and an ice house. A pair of abandoned north/south railroad tracks is located near former warehouses TC462 and TC560. These tracks appear to have been used to supply three warehouses (two existing and one former), the ice house and the Fuel Farm.

Construction of the Highway 17 Bypass complicates the remedial process by imposing access constraints to the area. Construction cut and fill operations have also changed the local topography and drainage. The portion of the Bypass that runs through the site is situated approximately 17 feet above mean sea level (MSL). Construction activities have eliminated much of the vegetation, and additional drainage ditches have been dug to transport surface runoff to Brinson Creek. **Figure 2-2 (Work Plan)** depicts a site plan for Site 35.

DESCRIPTION OF SPECIFIC TASKS TO BE PERFORMED:

The tasks to be performed for this field Investigation are:

- Base engineering drawings will be used to identify underground utility easements. A subsurface utility surveyor will be subcontracted to mark the locations around the Site 35 area where the drilling and boring activities will be taking place.
- Five new monitoring wells (35-MW75B, 35-MW76B, 35-MW77B, 35-MW78B, and 35-MWW79b) will be installed within the proposed pilot study treatment zone upgradient of the injection wells to monitor effects and distribution of the injected chemical oxidants. The new monitoring wells will be screened from approximately –22.5 to –27.5 feet MSL. Prior to oxidant injection, groundwater samples will be collected from the monitoring wells in the target treatment area to establish the baseline groundwater quality and to delineate the TCE plume further.
- Eighteen injection wells will be installed within the proposed pilot study area to deliver chemical oxidants to the treatment zone, as shown in Work Plan Figure 3-1. The injection

wells, designated IW-01 through IW-18, will be designed and installed based on specifications provided by the chemical oxidation subcontractor. Injection wells will be screened from approximately –20 to –30 feet MSL.

- The pilot study will begin with the injection of Modified Fenton's reagent only into eighteen injection wells surrounding MW-72B, as shown in Work Plan Figure 3-1. Groundwater monitoring will be conducted approximately two weeks following the Modified Fenton's injection.
- The second phase of injections will consist of potassium permanganate being injected into all 18 injection wells as shown in Figure 3-1. This will occur approximately four weeks after the Modified Fenton's injection. Post-injection groundwater monitoring will be conducted approximately four weeks following the potassium permanganate injection. This groundwater monitoring event will serve as the first of four quarterly groundwater monitoring events. The pilot study will conclude with the fourth and final groundwater monitoring event.
- Performance monitoring will consist of sampling five new and seven existing monitoring wells.
- Survey activities will include all newly installed groundwater monitoring well locations and 5% of existing well locations. The well locations will be located both horizontally and vertically to document their position at Site 35.

Site Map

This page is reserved for a Site Map.

Note locations of Support, Decontamination, and Exclusion Zones; site telephone; first aid station; evacuation routes; and assembly areas.

Table of Contents

C.1 Tasks to be Performed Under this Plan

C.1.1 Description of Tasks

(Reference Field Project Start-up Form)

Refer to project documents (i.e., Work Plan) for detailed task information. A health and safety risk analysis (Section 1.2) has been performed for each task and is incorporated in this plan through task-specific hazard controls and requirements for monitoring and protection. Tasks other than those listed below require an approved amendment or revision to this plan before tasks begin. Refer to Section 8.2 for procedures related to "clean" tasks that do not involve hazardous waste operations and emergency response (Hazwoper).

C.1.1.1 Hazwoper-Regulated Tasks

- Drilling
- Soil sampling
- Monitoring well installation
- Injection well installation
- Groundwater sampling
- Surveying
- Investigation-derived waste (drum) sampling and disposal
- Observation of material loading for offsite disposal
- Injection of Modified Fenton's and Permanganate

C.1.1.2 Non-Hazwoper-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of federal or state Hazwoper regulations are not applicable. It must be demonstrated that the tasks can be performed without the possibility of exposure in order to use non-Hazwoper-trained personnel. **Prior approval from the Health and Safety Manager (HSM) is required before these tasks are conducted on regulated hazardous waste sites.**

TASKS	CONTROLS
• Mechanical installations (treatment system, equipment, pumps, etc.)	• Brief on hazards, limits of access, and emergency procedures • Post contaminant areas as appropriate (refer to Section 8.2 for details) • Sample and monitor as appropriate (refer to Section 5.0)

POTENTIAL HAZARDS		Drilling and monitoring well installation	Injection well installation	Injection of Fenton's and Permanganate	Groundwater monitoring	Surveying	IDW drum disposal	Observation of loading material for offsite disposal	
Flying debris/objects		X	X				X	X	
Noise > 85dBA		X	X	X				X	
Electrical		X	X	X	X				
Suspended loads		X	X					X	
Buried utilities, drums, tanks		X	X						
Slip, trip, fall		X	X	X	X	X	X	X	
Back injury		X	X	X	X		X		
Confined space entry						X			
Trenches / excavations									
Visible lightning		X	X	X	X	X	X	X	
Vehicle traffic								X	
Elevated work areas/falls									
Fires		X	X	X			X		
Entanglement		X	X	X					
Drilling		X	X						
Heavy equipment		X	X					X	
Working near water									
Working from boat									
IDW Drum Sampling							X		

C.2 Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the site or the particular hazard. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the SSC for clarification.

In addition to the controls specified in this section, Project-Activity Self-Assessment Checklists are contained in Attachment 6. These checklists are to be used to assess the adequacy of CH2M HILL and subcontractor site-specific safety requirements. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. Self-assessment checklists should be completed early in the project, when tasks or conditions change, or when otherwise specified by the HSM. The self-assessment checklists, including documented corrective actions, should be made part of the permanent project records, and be promptly submitted to the HSM.

Project-specific frequency for completing self-assessments: **Weekly or at the beginning of each new phase of work.**

C.2.1 Project-Specific Hazards

C.2.1.1 Trichloroethylene (TCE)

- Do not enter regulated areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- TCE is considered a "Potential occupational carcinogen".
- An exposure limit of 50 ppm and an IDLH of 1,000 ppm exist for this material.
- Symptoms and effects of exposure include headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained by the competent person.

C.2.1.2 cis-1,2-Dichloroethene

- cis-1,2-dichloroethene is flammable.
- cis-1,2-dichloroethene is harmful by inhalation, in contact with skin and if swallowed.
- cis-1,2-dichloroethene is irritating to eyes, respiratory system and skin.
- Target organs include CNS and liver.

- Keep away from ignition source, and wear appropriate protective clothing.

C.2.1.3 trans-1,2-dichloroethene

- trans-1,2-dichloroethene is flammable, keep away from ignition source.
- trans-1,2-dichloroethene is harmful by inhalation, in contact with skin and if swallowed.
- trans-1,2-dichloroethene is irritating to eyes, respiratory system, and skin.
- Target organs include CNS, liver and kidneys.
- Wear appropriate protective clothing.

C.2.1.4 Vinyl Chloride

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met. The term "competent person" means a person who is capable of recognizing and evaluating employee exposure to hazardous substances or to other unsafe conditions and is capable of specifying the necessary protection and precautions to be taken to ensure the safety of employees as required by the particular regulation under the condition to which it applies.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Vinyl Chloride is considered a "Confirmed Human Carcinogen".
- A Short Term Exposure Limit (STEL: 15 minutes) exists for this material.
- Vinyl Chloride has a mild, sweet, chloroform-like odor.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

C.2.1.5 Drilling

(Reference CH2M HILL SOP HS-35, *Drilling*)

- Only authorized personnel are permitted to operate drill rigs.
- Stay clear of areas surrounding drill rigs during every startup.
- Stay clear of the rotating augers and other rotating components of drill rigs.
- Stay as clear as possible of all hoisting operations. Loads shall not be hoisted overhead of personnel.
- Do not wear loose-fitting clothing or other items such as rings or watches that could get caught in moving parts. Long hair should have it restrained.
- If equipment becomes electrically energized, personnel shall be instructed not to touch any part of the equipment or attempt to touch any person who may be in contact with the electrical current. The utility company or appropriate party shall be contacted to have line de-energized prior to approaching the equipment.

- Smoking around drilling operations is prohibited.

C.2.1.7 IDW Drum Disposal

Personnel are permitted to handle and/or sample drums containing investigation-derived waste (IDW) only; handling or sampling other drums requires a plan revision or amendment approved by the CH2M HILL HSM. The following control measures will be taken when sampling drums containing IDW:

- Minimize transportation of drums.
- Sample only labeled drums or drums known to contain IDW.
- Use caution when sampling bulging or swollen drums. Relieve pressure slowly.
- If drums contain, or potentially contain, flammable materials, use non-sparking tools to open.
- Picks, chisels, and firearms may not be used to open drums.
- Reseal bung holes or plugs whenever possible.
- Avoid mixing incompatible drum contents.
- Sample drums without leaning over the drum opening.
- Transfer the content of drums using a method that minimizes contact with material.
- PPE and air monitoring requirements specified in Sections 4 and 5 must address IDW drum sampling.
- Spill-containment procedures specified in Section 7 must be appropriate for the material to be handled.

C.2.1.8 Modified Fenton's and Permanganate Injections

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met. The term "competent person" means a person who is capable of recognizing and evaluating employee exposure to hazardous substances or to other unsafe conditions and is capable of specifying the necessary protection and precautions to be taken to ensure the safety of employees as required by the particular regulation under the condition to which it applies.
- Skin contact with oxidizing chemicals should be avoided, and special care should be taken to avoid breathing the chemicals in the form of a dust or mist.
- Inexperienced personnel should not work directly with the chemicals since this presents the greatest potential for injury. The primary toxicity risk associated with oxidizing chemicals is through direct inhalation of the chemicals. Inhalation of hydrogen peroxide mist or potassium permanganate dust can irritate the respiratory tract. Inhalation of large quantities of permanganate dust can result in pulmonary edema, which could develop several hours to several days after the exposure. Severe inhalation exposure could potentially result in death from oxidation of the lung tissue.

- Workers should handle the chemicals in a manner that minimizes the creation of mist or dust. Proper respiratory protection should always be worn when working directly with the chemical.
- As oxidizing chemicals, potassium permanganate and hydrogen peroxide are either potentially flammable or explosive when mixed with combustible chemicals. Oxidizing chemicals not only react violently with combustible materials, but they also release oxygen gas during decomposition, which could help fuel a fire or explosion. In addition, hydrogen peroxide can rapidly self-decompose when in contact with metals or combustible compounds at elevated temperatures.
- Potassium permanganate and hydrogen peroxide will cause burns to the skin, eyes, and mucous membranes upon contact.

C.2.2 General Hazards

C.2.2.1 General Practices and Housekeeping

(Reference CH2M HILL SOP HS-20, *General Practices*)

- Site work should be performed during daylight hours whenever possible. Work conducted during hours of darkness require enough illumination intensity to read a newspaper without difficulty.
- Good housekeeping must be maintained at all times in all project work areas.
- Common paths of travel should be established and kept free from the accumulation of materials.
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions.
- Provide slip-resistant surfaces, ropes, and/or other devices to be used.
- Specific areas should be designated for the proper storage of materials.
- Tools, equipment, materials, and supplies shall be stored in an orderly manner.
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area.
- Containers should be provided for collecting trash and other debris and shall be removed at regular intervals.
- All spills shall be quickly cleaned up. Oil and grease shall be cleaned from walking and working surfaces.

C.2.2.2 Hazard Communication

(Reference CH2M HILL SOP HS-05, *Hazard Communication)*

The SSC is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M HILL using Attachment 2.

- Confirm that an inventory of chemicals brought on site by CH2M HILL subcontractors is available.
- Request or confirm locations of Material Safety Data Sheets (MSDSs) from the client, contractors, and subcontractors for chemicals to which CH2M HILL employees potentially are exposed.
- Before or as the chemicals arrive on site, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Give employees required chemical-specific HAZCOM training using Attachment 3.
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

C.2.2.3 Shipping and Transportation of Chemical Products

(Reference CH2M HILL's *Procedures for Shipping and Transporting Dangerous Goods)*

Chemicals brought to the site might be defined as hazardous materials by the U.S. Department of Transportation (DOT). All staff who ship the materials or transport them by road must receive CH2M HILL training in shipping dangerous goods. All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the HSM or the Equipment Coordinator for additional information.

C.2.2.4 Lifting

(Reference CH2M HILL SOP HS-29, *Lifting*)

- Proper lifting techniques must be used when lifting any object.
  - Plan storage and staging to minimize lifting or carrying distances.
  - Split heavy loads into smaller loads.
  - Use mechanical lifting aids whenever possible.
  - Have someone assist with the lift -- especially for heavy or awkward loads.
  - Make sure the path of travel is clear prior to the lift.

C.2.2.5 Fire Prevention

(Reference CH2M HILL SOP HS-22, *Fire Prevention*)

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet. Extinguishers must:
  - be maintained in a fully charged and operable condition,
  - be visually inspected each month, and
  - undergo a maintenance check each year.

- The area in front of extinguishers must be kept clear.
- Post "Exit" signs over exiting doors, and post "Fire Extinguisher" signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.
- Flammable/combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.

C.2.2.6 Electrical

(Reference CH2M HILL SOP HS-23, *Electrical*)

- Only qualified personnel are permitted to work on unprotected energized electrical systems.
- Only authorized personnel are permitted to enter high-voltage areas.
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service.
- All temporary wiring, including extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed.
- Extension cords must be:
  - equipped with third-wire grounding.
  - covered, elevated, or protected from damage when passing through work areas.
  - protected from pinching if routed through doorways.
  - not fastened with staples, hung from nails, or suspended with wire.
- Electrical power tools and equipment must be effectively grounded or double-insulated UL approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet from overhead power lines for voltages of 50 kV or less, and 10 feet plus ½ inch for every 1 kV over 50 kV.
- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage.
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

C.2.2.7 Stairways and Ladders

(Reference CH2M HILL SOP HS-25, *Stairways and Ladders*)

- Stairway or ladder is generally required when a break in elevation of 19 inches or greater exists.
- Personnel should avoid using both hands to carry objects while on stairways; if unavoidable, use extra precautions.
- Personnel must not use pan and skeleton metal stairs until permanent or temporary treads and landings are provided the full width and depth of each step and landing.
- Ladders must be inspected by a competent person for visible defects prior to each day's use. Defective ladders must be tagged and removed from service.
- Ladders must be used only for the purpose for which they were designed and shall not be loaded beyond their rated capacity.
- Only one person at a time shall climb on or work from an individual ladder.
- User must face the ladder when climbing; keep belt buckle between side rails
- Ladders shall not be moved, shifted, or extended while in use.
- User must use both hands to climb; use rope to raise and lower equipment and materials
- Straight and extension ladders must be tied off to prevent displacement
- Ladders that may be displaced by work activities or traffic must be secured or barricaded
- Portable ladders must extend at least 3 feet above landing surface
- Straight and extension ladders must be positioned at such an angle that the ladder base to the wall is one-fourth of the working length of the ladder
- Stepladders are to be used in the fully opened and locked position
- Users are not to stand on the top two steps of a stepladder; nor are users to sit on top or straddle a stepladder
- Fixed ladders $\geq$ 24 feet in height must be provided with fall protection devices.
- Fall protection should be considered when working from extension, straight, or fixed ladders greater than six feet from lower levels and both hands are needed to perform the work, or when reaching or working outside of the plane of ladder side rails.

C.2.2.8 Heat Stress

(Reference CH2M HILL SOP HS-09, *Heat and Cold Stress*)

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°F to 60°F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other

nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.

- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SSC/DSC to avoid progression of heat-related illness.

SYMPTOMS AND TREATMENT OF HEAT STRESS					
	Heat Syncope	Heat Rash	Heat Cramps	Heat Exhaustion	Heat Stroke
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature.
Treatment	Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Cool rapidly by soaking in cool– but not cold–water. Call ambulance, and get medical attention immediately!

Monitoring Heat Stress

These procedures should be considered when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress. The heart rate (HR) should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

C.2.2.9 Cold Stress

(Reference CH2M HILL SOP HS-09, *Heat and Cold Stress*)

- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in cool weather.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC).
- Wind-Chill Index is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it should only be used as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- NSC Guidelines for Work and Warm-Up Schedules can be used with the wind-chill index to estimate work and warm-up schedules for fieldwork. The guidelines are not absolute;

workers should be monitored for symptoms of cold-related illnesses. If symptoms are not observed, the work duration can be increased.

- Persons who experience initial signs of immersion foot, frostbite, hypothermia should consult the SSC/DSC to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast – be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

SYMPTOMS AND TREATMENT OF COLD STRESS			
	Immersion (Trench) Foot	**Frostbite**	**Hypothermia**
Signs and Symptoms	Feet discolored and painful; infection and swelling present.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Treatment	Seek medical treatment immediately.	Remove victim to a warm place. Re-warm area quickly in warm–but **not** hot–water. Have victim drink warm fluids, but **not** coffee or alcohol. Do not break blisters. Elevate the injured area, and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids, but **not** coffee or alcohol. Get medical attention.

C.2.2.10 Compressed Gas Cylinders

- Valve caps must be in place when cylinders are transported, moved, or stored.
- Cylinder valves must be closed when cylinders are not being used and when cylinders are being moved.
- Cylinders must be secured in an upright position at all times.
- Cylinders must be shielded from welding and cutting operations and positioned to avoid being struck or knocked over; contacting electrical circuits; or exposed to extreme heat sources.
- Cylinders must be secured on a cradle, basket, or pallet when hoisted; they may not be hoisted by choker slings.

C.2.2.11 Procedures for Locating Buried Utilities

Local Utility Mark-Out Service

Name: NC Call One
Phone: 1-800-632-4949

- Where available, obtain utility diagrams for the facility.
- Review locations of sanitary and storm sewers, electrical conduits, water supply lines, natural gas lines, and fuel tanks and lines.
- Review proposed locations of intrusive work with facility personnel knowledgeable of locations of utilities. Check locations against information from utility mark-out service.

- Where necessary (e.g., uncertainty about utility locations), excavation or drilling of the upper depth interval should be performed manually
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change n advancement of auger or split spoon).
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the SSC should confirm that arrangement.

C.2.2.12 Confined Space Entry

(Reference CH2M HILL SOP HS-17, *Confined Space Entry*)

No confined space entry will be permitted. Confined space entry requires additional health and safety procedures, training, and a permit. If conditions change such that confined-space entry is necessary, contact the HSM to develop the required entry permit. When planned activities will not include confined-space entry, permit-required confined spaces accessible to CH2M HILL personnel are to be identified before the task begins. The SSC is to confirm that permit spaces are properly posted or that employees are informed of their locations and hazards.

C.2.3 Biological Hazards and Controls

C.2.3.1 Snakes

Snakes typically are found in underbrush and tall grassy areas. If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If a person is bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Seek medical attention immediately. **DO NOT** apply ice, cut the wound, or apply a tourniquet. Try to identify the type of snake: note color, size, patterns, and markings.

C.2.3.2 Poison Ivy and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Become familiar with the identity of these plants. Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

C.2.3.3 Ticks

Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch in size. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots; spray **only outside** of clothing with permethrin or permanone and spray skin with only DEET; and check yourself frequently for ticks.

If bitten by a tick, grasp it at the point of attachment and carefully remove it. After removing the tick, wash your hands and disinfect and press the bite areas. Save the removed tick. Report

the bite to human resources. Look for symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme: a rash might appear that looks like a bullseye with a small welt in the center. RMSF: a rash of red spots under the skin 3 to 10 days after the tick bite. In both cases, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, seek medical attention.

C.2.3.4 Bees and Other Stinging Insects

Bees and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic. Watch for and avoid nests. Keep exposed skin to a minimum. Carry a kit if you have had allergic reactions in the past, and inform the SSC and/or buddy. If a stinger is present, remove it carefully with tweezers. Wash and disinfect the wound, cover it, and apply ice. Watch for allergic reaction; seek medical attention if a reaction develops.

C.2.3.5 Bloodborne Pathogens

(Reference CH2M HILL SOP HS-36, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or CPR, or when coming into contact with landfill waste or waste streams containing potentially infectious material. Exposure controls and personal protective equipment (PPE) are required as specified in CH2M HILL SOP HS-36, *Bloodborne Pathogens*. Hepatitis B vaccination must be offered before the person participates in a task where exposure is a possibility.

C.2.3.6 Other Anticipated Biological Hazards

None are anticipated

C.2.4 Radiological Hazards and Controls

Refer to CH2M HILL's *Corporate Health and Safety Program, Program and Training Manual*, and *Corporate Health and Safety Program, Radiation Protection Program Manual*, for standards of practice in contaminated areas.

Hazards	Controls
None Known	None Required

2.5 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Trichloroethylene (TCE)	GW: 1.15 SB: SS:	50 ppm	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	11.10
Cis-1,2-Dichloroethene	GW: 1.16 SB: SS:	NA	NA	Irritating to eyes, respiratory system and skin. Target organs include CNS and liver.	9.65
Trans-1,2-Dichloroethene	GW: 0.12 SB: SS:	NA	NA	Irritating to eyes, respiratory system and skin. Target organs include CAN, liver, and kidneys.	9.65
Vinyl Chloride	GW: 0.1 SB: SS:	1 ppm	NL Ca	Weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities	9.32
Footnotes: [a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), S (Surface Soil), SL (Sludge), SW (Surface Water). [b] Appropriate value of PEL, REL, or TLV listed. [c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen. [d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.					9.32

2.6 Potential Routes of Exposure		
Dermal: Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 4.	**Inhalation:** Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and monitoring, as specified in Sections 4 and 5, respectively.	**Other:** Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking).

C.3 Project Organization and Personnel

C.3.1 CH2M HILL Employee Medical Surveillance and Training

(Reference CH2M HILL SOPs HS-01, *Medical Surveillance,* and HS-02, *Health and Safety Training)*

The employees listed below are enrolled in the CH2M HILL Comprehensive Health and Safety Program and meet state and federal hazardous waste operations requirements for 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training. Employees designated "SSC" have completed a 12-hour site safety coordinator course, and have documented requisite field experience. An SSC with a level designation (D, C, B) equal to or greater than the level of protection being used must be present during all tasks performed in exclusion or decontamination zones. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. At least one FA-CPR designated employee must be present during all tasks performed in exclusion or decontamination zones. The employees listed below are currently active in a medical surveillance program that meets state and federal regulatory requirements for hazardous waste operations. Certain tasks (e.g., confined-space entry) and contaminants (e.g., lead) may require additional training and medical monitoring.

Pregnant employees are to be informed of and are to follow the procedures in CH2M HILL's SOP HS-04, *Reproduction Protection,* including obtaining a physician's statement of the employee's ability to perform hazardous activities before being assigned fieldwork.

Employee Name	Office	Responsibility	SSC/FA-CPR

C.3.2 Field Team Chain of Command and Communication Procedures

C.3.2.1 Client

Client Contact
Kirk Stevens, PE
LANTDIV
Code: EV23
1510 Gilbert St., Building N26
Norfolk, Virginia 23511-2699
757-322-8422
757-322-4805 fax
stevenska@efdlant.navfac.navy.mil

Base Contact
Rick Raines
Camp Lejeune - EMD
Building 58
Marine Corps Base
Camp Lejeune, NC 28542-0004
(910) 451-9461
(910) 451-5997
rainesrh@lejeune.usmc.mil

C.3.2.2 CH2M HILL

Project Manager: Chris Bozzini/CLT
Activity Manager: Chris Bozzini/CLT
Health and Safety Manager: Mike Goldman/ATL
Field Team Leader: Mike Skeean/CLT
Site Safety Coordinator: Mike Skeean/CLT
The SSC is responsible for contacting the Field Team Leader and Project Manager. In general, the Project Manager will contact the client. The Health and Safety Manager should be contacted as appropriate.

C.3.2.3 CH2M HILL Subcontractors

(Reference CH2M HILL SOP HS-55, *Subcontractor, Contractor, and Owner*)

Subcontractor: ISOTEC
Subcontractor Contact Name: Tim Elber
Telephone: 303/843-9079

The subcontractors listed above are covered by this HSP and must be provided a copy of this plan. However, this plan does not address hazards associated with the tasks and equipment that the subcontractor has expertise in (e.g., drilling, excavation work, electrical). Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit these procedures to CH2M HILL for review before the start of field work. Subcontractors must comply with the established health and safety plan(s). The CH2M HILL SSC should verify that subcontractor employee training, medical clearance, and fit test records are current and must monitor and enforce compliance with the established plan(s). CH2M HILL's oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

CH2M HILL should continuously endeavor to observe subcontractors' safety performance. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. In addition to this level of observation, the SSC is responsible for confirming CH2M HILL subcontractor performance against both the subcontractor's safety plan and applicable self-assessment checklists. Self-assessment checklists contained in Attachment 6 are to be used by the SSC to review subcontractor performance.

Health and safety related communications with CH2M HILL subcontractors should be conducted as follows:

- Brief subcontractors on the provisions of this plan, and require them to sign the Employee Signoff Form included in Attachment 1.
- Request subcontractor(s) to brief the project team on the hazards and precautions related to their work.
- When apparent non-compliance/unsafe conditions or practices are observed, notify the subcontractor safety representative and require corrective action – the subcontractor is responsible for determining and implementing necessary controls and corrective actions.
- When repeat non-compliance/unsafe conditions are observed, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented.

- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented. Notify the Project Manager and HSM as appropriate.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

C.3.2.4 Contractors

(Reference CH2M HILL SOP HS-55, *Subcontractor, Contractor, and Owner*)

Contractor: Shaw Group
Contractor Contact Name: TBD
Telephone: TBD

This plan does not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for the health and safety or means and methods of the contractor's work, and we must never assume such responsibility through our actions (e.g., advising on H&S issues). In addition to this plan, CH2M HILL staff should review contractor safety plans so that we remain aware of appropriate precautions that apply to us. Except in unusual situations when conducted by the HSM, CH2M HILL must never comment on or approve contractor safety procedures. Self-assessment checklists contained in Attachment 6 are to be used by the SSC to review the contractor's performance ONLY as it pertains to evaluating our exposure and safety.

Health and safety related communications with contractors should be conducted as follows:

- Request the contractor to brief CH2M HILL employees and subcontractors on the precautions related to the contractor's work.
- When an apparent contractor non-compliance/unsafe condition or practice poses a risk to CH2M HILL employees or subcontractors:
  - Notify the contractor safety representative
  - Request that the contractor determine and implement corrective actions
  - If needed, stop affected CH2M HILL work until contractor corrects the condition or practice. Notify the client, Project Manager, and HSM as appropriate.
- If apparent contractor non-compliance/unsafe conditions or practices are observed, inform the contractor safety representative. Our obligation is limited strictly to informing the contractor of our observation – the contractor is solely responsible for determining and implementing necessary controls and corrective actions.
- If an apparent imminent danger is observed, immediately warn the contractor employee(s) in danger and notify the contractor safety representative. Our obligation is limited strictly to immediately warning the affected individual(s) and informing the contractor of our observation – the contractor is solely responsible for determining and implementing necessary controls and corrective actions.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

C.4 Personal Protective Equipment (PPE)

(Reference CH2M HILL SOP HS-07, *Personal Protective Equipment*, HS-08, *Respiratory Protection*)

PPE Specifications [a]

Task	Level	Body	Head	Respirator [b]
General site entry System installation Surveying Observation of material loading for offsite disposal Oversight of remediation and construction	D	Work clothes; steel-toe, leather work boots; work glove., traffic vest with reflective strips	Hardhat [c] Safety glasses Ear protection [d]	None required
Surface water sampling Aquifer testing Surface soil sampling Hand augering Geoprobe boring	Modified D	Work clothes or cotton coveralls, traffic vest with reflective strips **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Safety glasses Ear protection [d]	None required
Monitoring well installation Injection well installation Modified Fenton's Reagent injection Potassium permanganate injection Horizontal Directional Drilling well installation Groundwater sampling Soil boring Investigation-derived waste (drum) sampling and disposal	Modified D	**Coveralls:** Uncoated Tyvek®, traffic vest with reflective strips **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Safety glasses Ear protection [d]	None required.
Tasks requiring upgrade	C	**Coveralls:** Polycoated Tyvek® **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Ear protection [d] Spectacle inserts	APR, full face, MSA Ultratwin or equivalent; with GME-H cartridges or equivalent[e].

Reasons for Upgrading or Downgrading Level of Protection

Upgrade[f]	Downgrade
• Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels (Section 5) exceeded.	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decrease the hazard. • Change in work task that will reduce contact with hazardous materials.

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.

[b] No facial hair that would interfere with respirator fit is permitted.

[c] Hardhat and splash-shield areas are to be determined by the SSC.

[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.

[e] Cartridge change-out schedule is at least every 8 hours (or one work day), except if relative humidity is > 85%, or if organic vapor measurements are > midpoint of Level C range (refer to Section 5)--then at least every 4 hours. If encountered conditions are different than those anticipated in this HSP, contact the HSM.

[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the HSM, and an SSC qualified at that level is present.

C.5 Air Monitoring/Sampling

(Reference CH2M HILL SOP HS-06, *Air Monitoring)*

C.5.1 Air Monitoring Specifications

Instrument	Tasks	Action Levels[a]		Frequency [b]	Calibration
FID: TVA model 1000 or equivalent	All intrusive work	>1 ppm 1 to 25 ppm 25 ppm	Level D Level C. Collect colorimetric tube samples for Vinyl Chloride Evacuate Site and contact HSM	Initially and periodically during task	Daily
PID: Mini-RAE with 11.7eV lamp or equivalent	All intrusive work	>1 ppm 1 to 25 ppm 25 ppm	Level D Level C. Collect colorimetric tube samples for Vinyl Chloride. Evacuate Site and contact HSM	Initially and periodically during task	Daily
CGI: MSA model 260 or 261 or equivalent	All intrusive work	0-10% : 10-25% LEL: >25% LEL:	No explosion hazard Potential explosion hazard Explosion hazard; evacuate or vent	Continuous during advancement of boring or trench	Daily
O_2Meter: MSA model 260 or 261 or equivalent	All intrusive work	>25%[c] O_2: 20.9%[c] O_2: <19.5%[c] O_2:	Explosion hazard; evacuate or vent Normal O_2 O_2 deficient; vent or use SCBA	Continuous during advancement of boring or trench	Daily
Colormetric Tube: Drager vinyl chloride specific (0.5 to 30 ppm range) with pre-tube, or equivalent and PCE specific (2 to 300 ppm range).	If PID/FID indicates readings above 1 ppm	<0.5 ppm 0.5 ppm	Level D Evacuate site and contact HSM	Initially and periodically when PID/FID >1 ppm	Not applicable

[a] Action levels apply to sustained breathing-zone measurements above background.

[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SSC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., "Breathing Zone/MW-3", "at surface/SB-2", etc.).

[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry (refer to Section 2).

[d] Refer to SOP HS-10 for instructions and documentation on radiation monitoring and screening.

[e] Noise monitoring and audiometric testing also required.

C.5.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Instrument	Gas	Span	Reading	Method
PID: OVM, 10.6 eV bulb	100 ppm isobutylene	RF = 1.0	100 ppm	1.5 lpm reg T-tubing
PID: MiniRAE, 10.6 or 11.7 eV bulb	100 ppm isobutylene	CF = 100	100 ppm	1.5 lpm reg T-tubing
PID: TVA 1000	100 ppm isobutylene	CF = 1.0	100 ppm	1.5 lpm reg T-tubing
FID: OVA	100 ppm methane	3.0 ± 1.5	100 ppm	1.5 lpm reg T-tubing
FID: TVA 1000	100 ppm methane	NA	100 ppm	2.5 lpm reg T-tubing
CGI: MSA 260, 261, 360, or 361	0.75% pentane	N/A	50% LEL ± 5% LEL	1.5 lpm reg direct tubing

C.5.3 Air Sampling

Sampling, in addition to real-time monitoring, may be required by other OSHA regulations where there may be exposure to certain contaminants. Air sampling typically is required when site contaminants include lead, cadmium, arsenic, asbestos, and certain volatile organic compounds. Contact the HSM immediately if these contaminants are encountered.

Method Description

Vinyl chloride – NIOSH Method #1015 may be utilized if elevated levels of vinyl chloride are found.

Personnel and Areas

Results must be sent immediately to the HSM. Regulations may require reporting to monitored personnel. Results reported to:

HSM: Michael Goldman/ATL

C.6 Decontamination

(Reference CH2M HILL SOP HS-13, *Decontamination*)

The SSC must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SSC. The SSC must ensure that procedures are established for disposing of materials generated on the site.

C.6.1 Decontamination Specifications

Personnel

- Boot wash/rinse
- Glove wash/rinse
- Outer-glove removal
- Body-suit removal
- Inner-glove removal
- Respirator removal
- Hand wash/rinse
- Face wash/rinse
- Shower ASAP
- Dispose of PPE in drums and contain for disposal
- Dispose of personnel rinse water in drums and contain for offsite disposal

Sample Equipment

- Wash/rinse equipment
- Solvent-rinse equipment
- Contain solvent waste for offsite disposal

Heavy Equipment

- Power wash
- Steam clean
- Dispose of equipment rinse water in drums and contain for offsite disposal

C.6.2 Diagram of Personnel-Decontamination Line

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SSC should establish areas for eating, drinking, and smoking. Contact lenses are not permitted in exclusion or decontamination zones.

Figure 6-1 illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SSC to accommodate task-specific requirements.

C.7 Spill-Containment Procedures

Sorbent material will be maintained in the support zone. Incidental spills will be contained with sorbent and disposed of properly.

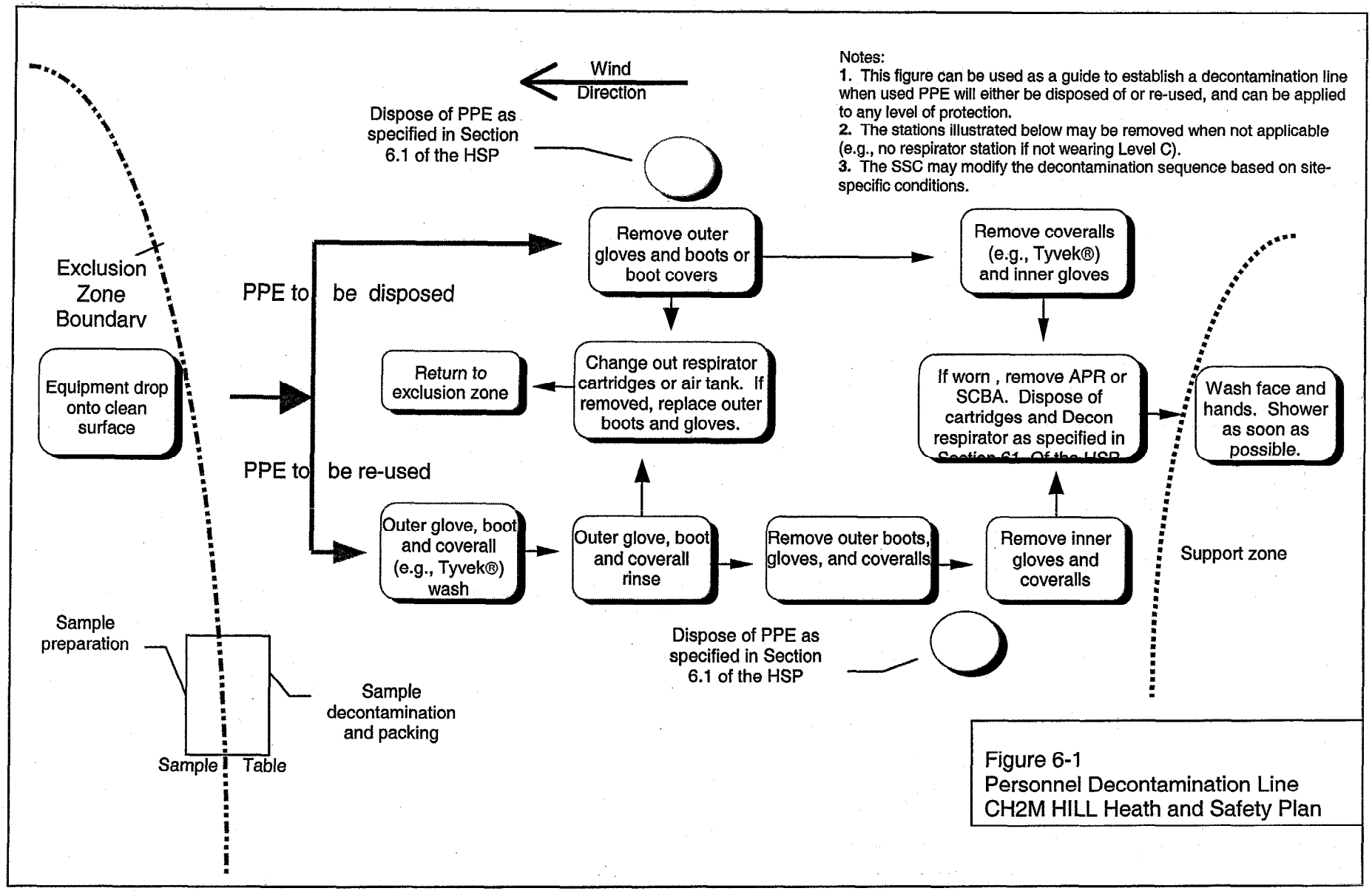


Figure 6-1
Personnel Decontamination Line
CH2M HILL Heath and Safety Plan

C.8 Site-Control Plan

C.8.1 Site-Control Procedures

(Reference CH2M HILL SOP HS-11, *Site Control)*

- The SSC will conduct a site safety briefing (see below) before starting field activities or as tasks and site conditions change.
- Topics for briefing on site safety: general discussion of Health and Safety Plan, site-specific hazards, locations of work zones, PPE requirements, equipment, special procedures, emergencies.
- The SSC records attendance at safety briefings in a logbook and documents the topics discussed.
- Post the OSHA job-site poster in a central and conspicuous location in accordance with CH2M HILL SOP HS-71, *OSHA Postings.*
- Establish support, decontamination, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals
  - Air horn
  - Two-way radio or cellular telephone if available
- Establish offsite communication.
- Establish and maintain the "buddy system."
- Initial air monitoring is conducted by the SSC in appropriate level of protection.
- The SCC is to conduct periodic inspections of work practices to determine the effectiveness of this plan – refer to Sections 2 and 3. Deficiencies are to be noted, reported to the HSM, and corrected.

C.8.2 Hazwoper Compliance Plan

(Reference CH2M HILL SOP HS-19, *Site-Specific Written Safety Plans)*

Certain parts of the site work are covered by state or federal Hazwoper standards and therefore require training and medical monitoring. Anticipated Hazwoper tasks (Section 1.1.1) might occur consecutively or concurrently with respect to non-Hazwoper tasks. This section outlines procedures to be followed when approved activities specified in Section 1.1.2 do not require 24- or 40-hour training. Non-Hazwoper-trained personnel also must be trained in accordance with all other state and federal OSHA requirements.

- In many cases, air sampling, in addition to real-time monitoring, must confirm that there is no exposure to gases or vapors before non-Hazwoper-trained personnel are allowed on the site, or while non-Hazwoper-trained staff are working in proximity to Hazwoper activities. Other data (e.g., soil) also must document that there is no potential for exposure. The HSM must approve the interpretation of these data. Refer to subsections 2.5 and 5.3 for contaminant data and air sampling requirements, respectively.

- When non-Hazwoper-trained personnel are at risk of exposure, the SSC must post the exclusion zone and inform non-Hazwoper-trained personnel of the:
  - nature of the existing contamination and its locations
  - limitations of their access
  - emergency action plan for the site
- Periodic air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-Hazwoper-trained personnel (e.g., in an adjacent area) are not exposed to airborne contaminants.
- When exposure is possible, non-Hazwoper-trained personnel must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.
- Remediation treatment system start-ups: Once a treatment system begins to pump and treat contaminated media, the site is, for the purposes of applying the Hazwoper standard, considered a treatment, storage, and disposal facility (TSDF). Therefore, once the system begins operation, only Hazwoper-trained personnel (minimum of 24 hour of training) will be permitted to enter the site. All non-Hazwoper-trained personnel must not enter the TSDF area of the site.

C.9 Emergency Response Plan

(Reference CH2M HILL, SOP HS-12, *Emergency Response*)

C.9.1 Pre-Emergency Planning

The SSC performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate.

- Review the facility emergency and contingency plans where applicable.
- Determine what onsite communication equipment is available (e.g., two-way radio, air horn).
- Determine what offsite communication equipment is needed (e.g., nearest telephone, cell phone).
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to onsite personnel.
- Field Trailers: Post "Exit" signs above exit doors, and post "Fire Extinguisher" signs above locations of extinguishers. Keep areas near exits and extinguishers clear.
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving route to hospital.
- Brief new workers on the emergency response plan.

The SSC will evaluate emergency response actions and initiate appropriate follow-up actions.

C.9.2 Emergency Equipment and Supplies

The SSC should mark the locations of emergency equipment on the site map and post the map.

Emergency Equipment and Supplies	Location
20 LB (or two 10-lb) fire extinguisher (A, B, and C classes)	Support Zone/Heavy Equipment
First aid kit	Support Zone/Field Vehicle
Eye Wash	Support & Decon Zone/Field Vehicle
Potable water	Support & Decon Zone/Field Vehicle
Bloodborne-pathogen kit	Support Zone/Field Vehicle
Additional equipment (specify):	

C.9.3 Incident Response

In fires, explosions, or chemical releases, actions to be taken include the following:

- Shut down CH2M HILL operations and evacuate the immediate work area.
- Notify appropriate response personnel.
- Account for personnel at the designated assembly area(s).
- Assess the need for site evacuation, and evacuate the site as warranted.

Instead of implementing a work-area evacuation, note that small fires or spills posing minimal safety or health hazards may be controlled.

C.9.4 Emergency Medical Treatment

The procedures listed below may also be applied to non-emergency incidents. Injuries and illnesses (including overexposure to contaminants) must be reported to Human Resources. If there is doubt about whether medical treatment is necessary, or if the injured person is reluctant to accept medical treatment, contact the CH2M HILL medical consultant. During non-emergencies, follow these procedures as appropriate.

- Notify appropriate emergency response authorities listed in Section 9.8 (e.g., 911).
- The SCC will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury.
- Initiate first aid and CPR where feasible.
- Get medical attention immediately.
- Perform decontamination where feasible; lifesaving and first aid or medical treatment take priority.
- Make certain that the injured person is accompanied to the emergency room.
- When contacting the medical consultant, state that the situation is a CH2M HILL matter, and give your name and telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.
- Report incident as outlined in Section 9.7.

C.9.5 Evacuation

- Evacuation routes and assembly areas (and alternative routes and assembly areas) are specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the SSC before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.

- The SSC and a "buddy" will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The SSC will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).
- The SSC will write up the incident as soon as possible after it occurs and submit a report to the Corporate Director of Health and Safety.

C.9.6 Evacuation Signals

Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

C.9.7 Incident Notification and Reporting

- Upon any project incident (fire, spill, injury, near miss, death, etc.), immediately notify the PM and HSM. Call emergency beeper number if HSM is unavailable.
- For CH2M HILL work-related injuries or illnesses, contact and help Human Resources administrator complete an Incident Report Form (IRF). IRF must be completed within 24 hours of incident.
- For CH2M HILL subcontractor incidents, complete the Subcontractor Accident/Illness Report Form and submit to the HSM.
- Notify and submit reports to client as required in contract.

C.10 Approval

This site-specific Health and Safety Plan has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

C.10.1 Original Plan

Written By: Jeremy Vaughan **Date: August 8, 2003**

Approved By: Michael Goldman **Date: December 15, 2003**

C.10.2 Revisions

Revisions Made By: **Date:**

Revisions to Plan:

Revisions Approved By: **Date:**

C.11 Attachments

Attachment 1: **Employee Signoff Form – Field Safety Instructions**

Attachment 2: **Project-Specific Chemical Product Hazard Communication Form**

Attachment 3: **Chemical-Specific Training Form**

Attachment 4: **Emergency Contacts**

Attachment 5: **Project H&S Forms/Permits**

Attachment 6: **Project Activity Self-Assessment Checklists**

Attachment 7: **Applicable Material Safety Data Sheets**

Attachment 8: **Incident Report Forms**

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 1

Employee Signoff Form – Field Safety Instructions

CH2MHILL

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

- The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this HSP, have read and understood it, and agree to abide by its provisions.

Project Name: Camp Lejeune, O.U. 10, Site 35 **Project Number:**

EMPLOYEE NAME (Please print)	EMPLOYEE SIGNATURE	COMPANY	DATE

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 2

Chemical-Specific Chemical Product Hazardous Communication Form

CH2MHILL

Project-Specific Chemical Product Hazard Communication Form

This form must be completed prior to performing activities that expose personnel to hazardous chemicals products. Upon completion of this form, the SSC shall verify that training is provided on the hazards associated with these chemicals and the control measures to be used to prevent exposure to CH2M HILL and subcontractor personnel. Labeling and MSDS systems will also be explained.

Project Name: Camp Lejeune, O.U. 10, Site 35 **Project Number:** 174057

MSDSs will be maintained at the following location(s):

Hazardous Chemical Products Inventory

Chemical	*Quantity*	Location	MSDS Available	*Container labels* Identity	Hazard
Methane	1 liter, compressed	Support Zone			
Isobutylene	1 liter, compressed	Support Zone			
Pentane	1 liter, compressed	Support Zone			
Hydrochloric acid	< 500 ml	Support Zone / sample bottles			
Nitric acid	< 500 ml	Support Zone / sample bottles			
Sulfuric Acid	< 500 ml	Support Zone / sample bottles			
Sodium hydroxide	< 500 ml	Support Zone / sample bottles			
Methanol	< 1 Gallon	Support/Decon Zones			
Hexane	< 1 Gallon	Support/Decon Zones			
pH buffers	< 500 ml	Support Zone			
MSA Sanitizer	< 1 liter	Support/Decon Zones			
Alconox/Liquinox	< 1liter	Support/Decon Zones			
Isopropanol	< 1 Gallon	Support/Decon Zones			
Hydrogen Peroxide	>55 Gallons	Support Zone/55 gallon drums			
Catalyst	>1 Gallon	Support Zone/Box Truck			
Potassium Permanganate	>1 Gallon	Support Zone/Box Truck			

Refer to SOP HS-05 *Hazard Communication* for more detailed information.

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 3

Chemical-Specific Training Form

CH2MHILL

CHEMICAL-SPECIFIC TRAINING FORM

Location:	Project # :
HCC:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC shall use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of MSDSs, chemical inventories, and CH2M HILL's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 4

Emergency Contacts

Emergency Contacts

24-hour CH2M HILL Emergency Beeper – 888/444-1226

Medical Emergency – 911

Hospital ER (On-Base) #: (910) 451-4840
(910) 451-4841
(910) 451-4842
Onslow County ER (Off-Base) #: (910) 577-2240
Ambulance (On-Base) #: (910) 451-3004
(910) 451-3005
Ambulance (Public) #: (910) 451-9111

CH2M HILL Medical Consultant

Dr. Peter Greaney
GMG WorkCare, Orange, CA
800/455-6155
(After hours calls will be returned within 20 minutes)

Fire/Spill Emergency -- 911

Base Fire Response #: (910) 451-9111

Local Occupational Physician

Security & Police – 911

Base Security #: (910) 451-2555

Corporate Director Health and Safety

Name: Mollie Netherland/SEA
Phone: 206/453-5005
24-hour emergency beeper: 888-444-1226

Utilities Emergency

Water:
Gas:
Electric:

Health and Safety Manager (HSM)

Name:
Phone:

Designated Safety Coordinator (DSC)

Name:
Phone:

Regional Human Resources Department

Name:
Phone:

Project Manager

Name: Chris Bozzini/CLT
Phone: (704) 329-0072 x251
Name: Chris Bozzini/CLT
Phone: (704) 329-0072 x291
Cell: (704) 819-6827

Corporate Human Resources Department

Name: John Monark/COR
Phone: 303/771-0900

Federal Express Dangerous Goods Shipping

Phone: 800/238-5355

CH2M HILL Emergency Number for Shipping Dangerous Goods

Phone: 800/255-3924

Worker's Compensation and Auto Claims

Sterling Administration Services
Phone: 800/420-8926 After hours: 800/497-4566

Report fatalities AND report vehicular accidents involving pedestrians, motorcycles, or more than two cars.

Contact the Project Manager. Generally, the Project Manager will contact relevant government agencies.

Facility Alarms:

Evacuation Assembly Area(s):

Facility/Site Evacuation Route(s):

Hospital Name/Address: Onslow County Memorial Hospital, 317 Western Boulevard, Jacksonville, North Carolina **Hospital Phone #:** (910) 577-2240

Directions to Hospital

From MCB Camp Lejeune

Directions to the Base Naval Hospital (Building NH100)
(nearest hospital; only to be used in an extreme emergency)

1. Proceed north to Holcomb Boulevard (towards Highway 24).
2. Turn left onto Brewster Boulevard (heading west)
3. Continue on Brewster Boulevard until intersection with the driveway to the Naval Hospital.
4. Turn onto Hospital driveway, and proceed to emergency room.

Directions to Onslow County Memorial Hospital :

1. From Holcomb Boulevard, exit Base through main gate.
2. Follow Highway 24 west until intersecting with Western Boulevard.
3. Turn right onto Western Boulevard.
4. The Onslow County Memorial Hospital is on the left, approximately 2 miles (fifth stop light) from Highway 24.
5. Follow the signs to the emergency room.

From Air Station and Camp Geiger

Directions to Onslow County Memorial Hospital:

1. Proceed through the main gate, turn right, and head north on Ocean Highway 17.
2. Follow Ocean Highway 17 north to Highway 24 and head east.
3. Travel east until Western Boulevard, turn left onto Western Boulevard.
4. The Onslow County Memorial Hospital is on the left, approximately 2 miles (fifth stop light) from Highway 24.
5. Follow the signs to the emergency room.

Attachment 5

Project H&S Forms and Permits

Attachment 6

Project Activity Self-Assessment Checklists

H&S Self-Assessment Checklist - DRILLING

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to hazards associated with drilling operations (complete Sections 1 and 3), and/or 2) CH2M HILL oversight of a drilling subcontractor is required (complete entire checklist).

SSC/DSC may consult with drilling subcontractors when completing this checklist, but shall not direct the means and methods of drilling operations nor direct the details of corrective actions. Drilling subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazard until corrected.

Completed checklists shall be sent to the health and safety manager for review.

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to drilling hazards
☐ Evaluate a CH2M HILL subcontractor's compliance with drilling H&S requirements
Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HS-35.

SECTION 1	Yes	No	N/A	N/O
PERSONNEL SAFE WORK PRACTICES (3.1)				
1. Only authorized personnel operating drill rig	☐	☐	☐	☐
2. Personnel cleared during rig startup	☐	☐	☐	☐
3. Personnel clear of rotating parts	☐	☐	☐	☐
4. Personnel not positioned under hoisted loads	☐	☐	☐	☐
5. Loose clothing and jewelry removed	☐	☐	☐	☐
6. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐
7. Smoking is prohibited around drilling operation	☐	☐	☐	☐
8. Personnel wearing appropriate PPE, per HSP/FSI	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (3.2.1)				
9. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
10. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
DRILL RIG PLACEMENT (3.2.2)				
11. Location of underground utilities identified	☐	☐	☐	☐
12. Safe clearance distance maintained from overhead powerlines	☐	☐	☐	☐
13. Drilling pad established, when necessary	☐	☐	☐	☐
14. Drill rig leveled and stabilized	☐	☐	☐	☐
DRILL RIG TRAVEL (3.2.3)				
15. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
16. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
17. Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
18. Safe clearance distance maintained while traveling under overhead powerlines	☐	☐	☐	☐
19. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
DRILL RIG OPERATION (3.2.4)				
20. Kill switch clearly identified and operational	☐	☐	☐	☐
21. All machine guards are in place	☐	☐	☐	☐
22. Rig ropes not wrapped around body parts	☐	☐	☐	☐
23. Pressurized lines and hoses secured from whipping hazards	☐	☐	☐	☐
24. Drill operation stopped during inclement weather	☐	☐	☐	☐
25. Air monitoring conducted per HSP/FSI for hazardous atmospheres	☐	☐	☐	☐
26. Rig placed in neutral when operator not at controls	☐	☐	☐	☐
DRILL RIG MAINTENANCE (3.2.5)				
27. Defective components repaired immediately	☐	☐	☐	☐
28. Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
29. Cathead in clean, sound condition	☐	☐	☐	☐
30. Drill rig ropes in clean, sound condition	☐	☐	☐	☐
31. Fall protection used for fall exposures of 6 feet or greater	☐	☐	☐	☐
32. Rig in neutral and augers stopped rotating before cleaning	☐	☐	☐	☐
33. Good housekeeping maintained on and around rig	☐	☐	☐	☐
DRILLING AT HAZARDOUS WASTE SITES (3.2.6)				
34. Waste disposed of according to HSP	☐	☐	☐	☐
35. Appropriate decontamination procedures being followed, per HSP	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked "No" in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 7

Applicable Material Safety Data Sheets

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 8

Incident Report Forms

CH2M HILL

Incident Report Form (Hardcopy)

Fax completed form to:
425.462.5957
CH2M HILL Seattle Office
Attention: Corporate HS&E Department

Type of Incident (Select at least one)

- ☐ Injury/Illness
- ☐ Environmental/Permit Issue
- ☐ Property Damage
- ☐ Near Miss
- ☐ Spill/Release
- ☐ Other

General Information (Complete for all incident types)

Preparer's Name: _____ Preparer's Employee Number: _____
Date of Report: _____ Date of Incident: _____ Time of Incident: _____ am/pm

Type of Activity (Provide activity being performed that resulted in the incident)

- ☐ Asbestos Work
- ☐ Confined Space Entry
- ☐ Construction Mgmt- Haz Waste
- ☐ Construction Mgmt - Non-Haz Waste
- ☐ Demolition
- ☐ Drilling-Haz Waste
- ☐ Drilling-Non Haz Waste
- ☐ Drum Handling
- ☐ Electrical Work
- ☐ Excavation Trench-Haz Waste
- ☐ Excavation Trench-Non Haz
- ☐ Facility Walk Through
- ☐ General Office Work
- ☐ Keyboard Work
- ☐ Laboratory
- ☐ Lead Abatement
- ☐ Motor Vehicle Operation
- ☐ Moving Heavy Object
- ☐ Other (Specify) _____
- ☐ Process Safety Management
- ☐ Tunneling
- ☐ Welding
- ☐ Wetlands Survey
- ☐ Working from Heights
- ☐ Working in Roadways
- ☐ WWTP Operation

Location of Incident (Select one)

- ☐ Company Premises (CH2M HILL Office: _____)
- ☐ Field (Project #: _____ Project/Site Name: _____ Client: _____)
- ☐ In Transit (Traveling from: _____ Traveling to: _____)
- ☐ At Home

Geographic Location of Incident (Select region where the incident occurred)

- ☐ Northeast
- ☐ Southeast
- ☐ Northwest
- ☐ Southwest
- ☐ Corporate
- ☐ Canadian
- ☐ Asia Pacific
- ☐ Europe Middle East
- ☐ Latin America

If a CH2M HILL subcontractor was involved in the incident, provide their company name and phone number: _____

Describe the Incident (Provide a brief description of the incident): _____

_____

_____

Injured Employee Data (Complete for Injury/Illness incidents only)

If CH2M HILL employee injured
Employee Name: _____ Employee Number: _____

If CH2M HILL Subcontractor employee injured
Employee Name: _____ Company: _____

Injury Type

- ☐ Allergic Reaction
- ☐ Amputation
- ☐ Asphyxia
- ☐ Bruise/Contusion/Abrasion
- ☐ Burn (Chemical)
- ☐ Burn/Scald (Heat)
- ☐ Cancer
- ☐ Carpal Tunnel
- ☐ Concussion
- ☐ Cut/Laceration
- ☐ Dermatitis
- ☐ Dislocation
- ☐ Electric Shock
- ☐ Foreign Body in eye
- ☐ Fracture
- ☐ Freezing/Frost Bite
- ☐ Headache
- ☐ Hearing Loss
- ☐ Heat Exhaustion
- ☐ Hernia
- ☐ Infection
- ☐ Irritation to eye
- ☐ Ligament Damage
- ☐ Multiple (Specify)

_____

- ☐ Muscle Spasms
- ☐ Other (Specify)

_____

- ☐ Poisoning (Systemic)
- ☐ Puncture
- ☐ Radiation Effects
- ☐ Strain/Sprain
- ☐ Tendonitits
- ☐ Wrist Pain

Part of Body Injured

- ☐ Abdomen
- ☐ Ankle(s)
- ☐ Arms (Multiple)
- ☐ Back
- ☐ Blood
- ☐ Body System
- ☐ Buttocks
- ☐ Chest/Ribs
- ☐ Ear(s)
- ☐ Elbow(s)
- ☐ Eye(s)
- ☐ Face
- ☐ Finger(s)
- ☐ Foot/Feet
- ☐ Hand(s)
- ☐ Head
- ☐ Hip(s)
- ☐ Kidney
- ☐ Knee(s)
- ☐ Leg(s)
- ☐ Liver
- ☐ Lower (arms)
- ☐ Lower (legs)
- ☐ Lung
- ☐ Mind
- ☐ Multiple (Specify)

_____

- ☐ Neck
- ☐ Nervous System
- ☐ Nose
- ☐ Other (Specify)

_____

- ☐ Reproductive System
- ☐ Shoulder(s)
- ☐ Throat
- ☐ Toe(s)
- ☐ Upper Arm(s)
- ☐ Upper Leg(s)
- ☐ Wrist(s)

Nature of Injury

- ☐ Absorption
- ☐ Bite/Sting/Scratch
- ☐ Cardio-Vascular/Respiratory System Failure
- ☐ Caught In or Between
- ☐ Fall (From Elevation)
- ☐ Fall (Same Level)
- ☐ Ingestion
- ☐ Inhalation
- ☐ Lifting
- ☐ Mental Stress
- ☐ Motor Vehicle Accident
- ☐ Multiple (Specify)

_____

- ☐ Other (Specify)

_____

- ☐ Overexertion
- ☐ Repeated Motion/Pressure
- ☐ Rubbed/Abraded
- ☐ Shock
- ☐ Struck Against
- ☐ Struck By
- ☐ Work Place Violence

Initial Diagnosis/Treatment Date: _____

Type of Treatment

- ☐ Admission to hospital/medical facility
- ☐ Application of bandages
- ☐ Cold/Heat Compression/Multiple Treatment
- ☐ Cold/Heat Compression/One Treatment
- ☐ First Degree Burn Treatment
- ☐ Heat Therapy/Multiple treatment
- ☐ Multiple (Specify)

_____

- ☐ Heat Therapy/One Treatment
- ☐ Non-Prescriptive medicine
- ☐ None
- ☐ Observation
- ☐ Other (Specify)

_____

- ☐ Prescription- Multiple dose
- ☐ Prescription- Single dose
- ☐ Removal of foreign bodies
- ☐ Skin Removal
- ☐ Soaking therapy- Multiple Treatment
- ☐ Soaking Therapy- One Treatment
- ☐ Stitches/Sutures
- ☐ Tetanus
- ☐ Treatment for infection
- ☐ Treatment of 2nd /3rd degree burns
- ☐ Use of Antiseptics – multiple treatment
- ☐ Use of Antiseptics – single treatment
- ☐ Whirlpool bath therapy/multiple treatment
- ☐ Whirlpool therapy/single treatment
- ☐ X-rays negative
- ☐ X-rays positive/treatment of fracture

Number of days doctor required employee to be off work: _____

Number of days doctor restricted employee's work activity: _____
Equipment Malfunction : Yes ☐ No ☐ Activity was a Routine Task: Yes ☐ No ☐
Describe how you may have prevented this injury: _____
_____

Physician Information
Name: _____
Address: _____
City: _____
Zip Code: _____
Phone: _____

Hospital Information
Name: _____
Address: _____
City: _____
Zip Code: _____
Phone: _____

Property Damage (Complete for Property Damage incidents only)

Property Damaged: _____ Property Owner: _____
Damage Description: _____
Estimated Amount: $ _____

Spill or Release (Complete for Spill/Release incidents only)

Substance (attach MSDS): _____ Estimated Quantity: _____
Facility Name, Address, Phone No.: _____
Did the spill/release move off the property where work was performed?: _____
Spill/Release From: _____ Spill/Release To: _____

Environmental/Permit Issue (Complete for Environmental/Permit Issue incidents only)

Describe Environmental or Permit Issue: _____
Permit Type: _____
Permitted Level or Criteria (e.g., discharge limit): _____
Permit Name and Number (e.g., NPDES No. ST1234): _____
Substance and Estimated Quantity: _____
Duration of Permit Exceedence: _____

Verbal Notification (Complete for all incident types)(Provide names, dates and times)

CH2M HILL Personnel Notified: _____
Client Notified: _____

Witnesses (Complete for all incident types)

Witness Information (First Witness)
Name: _____
Employee Number (CH2M HILL):_____
Address: _____
City: _____
Zip Code:_____
Phone: _____

Witness Information (Second Witness)
Name: _____
Employee Number (CH2M HILL: _____
Address: _____
City: _____
Zip Code:_____
Phone :_____

Additional Comments: _____
_____

Appendix D: Work Implementation Plan prepared by ISOTEC

FINAL

Work Implementation Plan

prepared by ISOTEC

Operable Unit No. 10 (Site 35)

Marine Corps Base

Camp Lejeune, North Carolina

Prepared for

Department of the Navy

Atlantic Division

Naval Facilities Engineering Command

Norfolk, Virginia

Contract No. N62470-95-D-6007

CTO-0253

LANTDIV Clean II Program

January 2004

Prepared by

CH2MHILL

WORK IMPLEMENTATION PLAN
PILOT STUDY

OPERABLE UNIT 10, SITE 35
MARINE CORPS BASE, CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

NOVEMBER 14, 2003

DRAFT

PREPARED FOR

CH2M HILL, INC.
4824 PARKWAY PLAZA BLVD.
CHARLOTTE, NC 28217

PREPARED BY

IN-SITU OXIDATIVE TECHNOLOGIES, INC.
5600 SOUTH QUEBEC ST., SUITE 320D
GREENWOOD VILLAGE, COLORADO 80111

ISOTEC PROJECT NO. 900085

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

In-Situ Oxidative Technologies, Inc. (ISOTEC) has been retained by CH2M Hill to conduct an in-situ chemical oxidation pilot study on soil and groundwater contamination at Operable Unit 10, Site 35 (Site 35), located at the Marine Corps Base (MCB), Camp Lejeune, in Jacksonville, North Carolina (**Figure 1**). The contaminants of concern (COC) at Site 35 include chlorinated volatile organic compounds, primarily trichloroethene (TCE). This implementation plan contains details on ISOTEC's approach for conducting the pilot study. Injection wells will be utilized to introduce chemical oxidation reagents, both modified Fenton's reagents and potassium permanganate.

Details about the site background, geology, hydrogeology and contaminant distribution can be found in the project Pilot Study Work Plan prepared by CH2M Hill dated August 2003.

1.1 PROJECT ORGANIZATION

ISOTEC will implement the pilot study using personnel and equipment from the Colorado Office. The Colorado office contact information is 5600 South Quebec Street, Suite 320 D, Greenwood Village, Colorado 80111, phone: (303) 843-9079, fax: (303) 843-9094. Key personnel on the project will include Mr. Chris Nelson, P.E., Mr. Stan Haskins, R.G., and Mr. Tim Eilber. Mr. Nelson will act as technical lead on the project with oversight responsibility for the project. Mr. Haskins will be the project manager responsible for day-to-day operations and communication with the Camp Lejuene project team. Mr. Eilber will be an on-site supervisor for the injection crew. Either Mr. Haskins or Mr. Eilber will be on-site at all time during injection.

2.0 TECHNOLOGY OVERVIEW

Two chemical oxidants will be used during the pilot study; a modified Fenton's reagent using a chelated iron catalyst at neutral pH (ISOTEC process) and permanganate.

2.1 THE ISOTEC PROCESS

The ISOTEC process is an in-situ chemical oxidation technology that destroys organic contamination using a modified Fenton's reagent oxidation chemistry. Fenton's chemistry was first documented by H.J.H. Fenton in 1894. It is characterized by the combination of soluble iron with low concentrations of hydrogen peroxide to produce hydroxyl radicals ($OH^{\bullet}$). These hydroxyl radicals are very powerful and short-lived oxidizers. Similar to the reaction of other oxidizers, the hydroxyl radicals attack the carbon double bonds of benzene and DCPD molecules. Under certain conditions reductive species can also be formed by Fenton's chemistry. This gives Fenton's reagent two separate pathways to attack a wide range of contaminants. The summary equation for Fenton's chemistry is shown below.

$$Fe^{+2} + H_2O_2 \rightarrow Fe^{+3} + OH^- + OH^{\bullet}$$

Where H_2O_2 is hydrogen peroxide, Fe^{+2} is ferrous iron, Fe^{+3} is ferric iron, $OH^{\bullet}$ is hydroxyl free radical and OH^- is hydroxide ion.

Iron is used to catalyze the reaction. Maintaining iron in solution is important for the process to be successful in an in-situ application. To eliminate the necessity of performing the reaction under low pH conditions, as is the case with traditional Fenton's chemistry, complexed iron is used in in-situ applications via the ISOTEC process. The hydrogen peroxide and dissolved iron solutions are injected through a site-specific delivery system providing sufficient distribution to selectively treat the area of concern. Reaction time is very fast, with oxidation capacity of the reagent being used up in a matter of a few days. Hydrogen peroxide breaks down into water and oxygen and the iron catalyst is oxidized and precipitates out of solution. It is important to note that the concentration of hydrogen peroxide will be relatively dilute, generally less than 15%, which eliminates the potential for significant exothermic reactions that are associated with higher concentrations of hydrogen peroxide. Experience with this process using low hydrogen peroxide concentrations and complexed iron has resulted in less than a 25° F temperature increase in field applications. Hydrogen peroxide not consumed in the above reaction will continue to oxidize the groundwater contaminants and will naturally degrade to oxygen and water.

ISOTEC's Fenton based oxidation process is effective on a wide range of contaminants including hard to treat recalcitrant compounds such as DCPD, gasoline additives including MTBE and BTEX, chlorinated solvents and pesticides. Hydroxyl radicals generated by the ISOTEC process will oxidize nearly all contaminants with carbon / carbon double bonds (i.e., benzene and DCPD).

The ISOTEC process consists of injecting stabilized hydrogen peroxide and complexed iron catalysts into contaminated aquifers or vadose zones. As compared to conventional

Fenton's Reagent that requires acidic conditions (pH ≤ 3), the ISOTEC process is effective at neutral (pH = 7) conditions. This is an important consideration in full-scale application since acidifying an aquifer is typically impractical. ISOTEC's oxidation method utilizes a site-specific delivery system(s) designed to treat organic contaminants within an area of concern. ISOTEC oxidants and catalysts generate hydroxyl radicals, which react with the organic contaminants within the subsurface producing innocuous by-products such as carbon dioxide and water (and chloride ions if chlorinated compounds are being treated).

Safety is a priority with the ISOTEC process. ISOTEC has not had a significant health and safety incident in over six years of field application. Most negative effects noted with in-situ oxidation occur with aggressive oxidation reactions utilizing high concentration reagents under pressurized conditions. These conditions can create a significant temperature rise and an enormous amount of carbon dioxide and/or oxygen off-gas, which can mobilize vapors and contaminants within the subsurface. ISOTEC does not utilize this approach. Reagents utilized by ISOTEC are stabilized and at low concentrations, with injection in a controlled manner to reduce the possibility of surface breakout or subsequent migration.

2.2 Permanganate

Permanganate is an oxidant historically shown to be effective against many chlorinated compounds. It varies from Modified Fenton's reagent in several that are critical to the Site 35 project. Permanganate:

- Is longer lived in the subsurface,
- Does not actively desorb contaminant from the sorbed or DNAPL phases,
- Does not produce gas during injection.

These differences from modified Fenton's reagent define a specific role for permanganate in this remediation program. Since it does not actively desorb contaminant, it is better suited for targeting dissolved phase contamination rather than source removal. The stability of the fluid can allow for larger injection volumes than modified Fenton's reagent since gas bubbles do not build up in the formation and limit permeability. These two characteristics along with the long-lived nature of the oxidant make it an excellent "polish" mechanism for oxidation projects.

3.0 PILOT STUDY

During the pilot study ISOTEC personnel will introduce ISOTEC's blend of modified Fenton's reagents and permanganate into the subsurface using 15 injection wells. The modified Fenton's treatment will desorb contamination adsorbed to soil and treat the majority of mass in groundwater. The permanganate will be injected following the ISOTEC reagents in order to treat remaining dissolved phase contamination.

3.1 REMEDIATION PROGRAM OBJECTIVES

The primary purpose of the remediation program is contaminant mass removal from the saturated soil and groundwater at the site. Specific objectives of the pilot study are to:

- Minimize the size and migration potential of the plume,
- Cause little or no impact to the Highway 17 Bypass construction,
- Protect potential migration pathways.

3.2 REMEDIATION PROGRAM DESIGN

The remediation program will include injection of ISOTEC reagents and permanganate into 15 injection wells across the pilot study area. The ISOTEC modified Fenton's reagents will be injected during the first week of the study followed by permanganate injection approximately four weeks later. The first injection is intended to aggressively desorb and then oxidize sorbed contamination as well as treat the majority of the dissolved phase. The follow up permanganate injection will address the remaining dissolved phase mass for several weeks or months after injection.

3.3 PERMITS AND APPROVAL

ISOTEC has assumed that CH2M Hill will obtain permission from property owners and complete public notification as necessary, prior to injection activities. CH2M Hill will also obtain the necessary injection permits from the applicable regulatory agencies as necessary.

3.4 UTILITY SURVEY

During the remediation program, steps will be taken to ensure that the integrity of the utilities located at or near the treatment area are not disturbed by field activities. Utility verification and marking will be performed in accordance with the standard industry utility verification procedures. ISOTEC has assumed that CH2M Hill will be responsible for utility identification and marking prior to the initiation of injection wells.

3.5 WATER SUPPLY

ISOTEC will use significant quantities of water during the remediation program. ISOTEC has assumed that CH2M Hill will obtain the necessary permits and/or permission from the applicable entities to use a water supply.

3.6 INJECTION WELL INSTALLATION AND COMPLETION

To effectively treat the saturated soil and groundwater contamination at Site 35, 15 injection wells will be installed at 30-foot centers, based on an estimated 15-foot radius of influence (ROI), across the site. The location of the injection wells is shown in **Figure 1.**

The 15 injection wells will have an approximate completion depth of 47 feet bgs, with 10 feet of screen. Boreholes will be drilled using a 4-inch inside diameter hollow-stem auger to 47 feet bgs. The injection wells will be constructed of 2-inch diameter schedule 40 polyvinyl-chloride (PVC) flush thread blank casing and 10 feet of slotted well screen (0.020-inch machine slotted casing). Blank casing will be left 6 inches below the ground surface. The top of the casing will be completed with a 2-inch schedule 40 PVC slip-by-male pipe thread adapter and 2-inch threaded cap. The annulus of each well will be filled with 10-20 grade silica sand which will extend from the bottom of the borehole to approximately two feet above the top of the screen followed by hydrated bentonite chips to 5 feet bgs. The remainder of the annulus will be filled with concrete. The exposed casing and a 12-inch traffic box are necessary for the installation of ISOTEC's injection equipment. An injection well design is shown in **Figure 2.**

3.6.1 WELL DEVELOPMENT

The injection wells will be developed by surging (using a surge block), bailing and/or pumping until five well volumes have been removed or purged water appears clear.

Produced water will be placed in designated storage containers and stored on-site for disposal at a later date. CH2M Hill will be responsible for well development and disposal of the purged water.

3.7 MOBILIZATION, DEMOBILIZATION AND STAGING AREA

Mobilization activities include transportation and staging of equipment, materials, instruments, personnel, and services required for implementing the remediation program at the site. The equipment to be transported to the site will include a box truck housing hoses, tanks, drums, gas powered air compressor and generator, electric mixers and pumps, and pneumatic pumps. The materials to be transported to the site will include hydrogen peroxide and dry catalyst required for reagent preparation. As discussed in **Section 3.5**, an on-site water supply will be required for reagent preparation.

Demobilization activities will include removal of all staged equipment, materials, instruments, personnel, and services from the site. In addition, the activities will include decontamination of all equipment, drums, tanks and instruments. Demobilization activities will take place at the conclusion of the remediation program when the staged equipment, materials, instruments, personnel, and services are no longer needed to perform or monitor the remediation. All waste and debris generated during demobilization activities will be removed. Any unused chemicals will be transported from the site within 30 days.

3.8 Reagent Preparation

ISOTEC reagents consist of a site-specific chelated iron catalyst and stabilized hydrogen peroxide (H_2O_2) oxidizer. The oxidizer consists of a pre-determined concentration of H_2O_2 and water. ISOTEC typically utilizes stabilized H_2O_2 at varying concentrations ranging from 5% to 17%. For this pilot study, ISOTEC will utilize a H_2O_2 concentration of 12% and ISOTEC catalyst 4260. The H_2O_2 will be shipped directly to the site immediately prior to field injection activities and stored in DOT approved 55-gallon drums with an initial concentration of 35%. The H_2O_2 will be diluted on-site to a 12% concentration. The H_2O_2 will be diluted in 300-gallon bulk tanks with water obtained on-site. The ISOTEC series catalysts consist of a chelated iron complex. The iron complex is similar and at post-reaction concentrations comparable to that of naturally occurring metals within a typical soil matrix (i.e., ppm range).

A 3% solution of potassium permanganate will be prepared with on-site water and dry potassium permanganate. The final permanganate concentration in groundwater is expected to be in the low 100's ppm range. The range will vary depending upon the total gallons injected and the volume of water into which the permanganate is diluted.

The catalyst and permanganate will be shipped to the site in dry form, stored in an ISOTEC box truck, and mixed on-site in 300-gallon bulk tanks with water obtained on-site. Safe management and handling procedures are described in the health and safety plan.

All reagents will be either injected during the remediation program or removed from the site at the completion of the project.

3.9 Injection Method

The ISOTEC modified Fenton's reagent injection is a four-step process. Water is first through the well into the subsurface, followed by catalyst or stabilized H_2O_2. Water is then injected into the well to flush the reagent away from the borehole. Following the water flush, either catalyst or stabilized H_2O_2, whichever was not injected first, is injected into the subsurface. A final water injection is completed to flush the reagent from the injection equipment. Depending upon injection flow rate and pressure variations during

the injection process, the total proposed reagent volume might be injected in one four-step cycle or several cycles spanning one or more days.

The permanganate injection is a three-step process. ISOTEC begins by injecting water into the subsurface, followed by the permanganate solution. Following the permanganate injection, a final water injection is completed to flush the permanganate from the injection equipment. An injection method schematic is shown in **Figure 3.**

3.9.1 Injection Equipment

Chemical application equipment consists of varying size storage containers, pneumatic double-diaphragm pumps, 3/4-inch diameter (3/4") reinforced tubing, valves and cam-lock connectors. Transfer of the reagents from the storage and/or mixing containers to the point of injection will be performed via a double-diaphragm pump. Reagents are conveyed through 3/4" reinforced tubing and connected to the probe rod with a PVC wellhead containing ball valves, fittings and a pressure gauge.

3.10 Injection Rates and Pressures

The ISOTEC pilot study has been designed by estimating subsurface conditions and past experience at similar sites. The injection rate and pressure are dependent upon soil permeability and cannot be determined before the pilot study. Based upon ISOTEC experience at sites with similar lithology, injection flow rates of between 3 and 8 gallons per minute and injection pressures of between 10 and 40 psi are expected.

3.11 Reagent Quantities

The injection goal for total ISOTEC modified Fenton's reagent volume ranges from 24,000 to 36,000 gallons. The goal for each injection screen is between 1,600 and 2,400 gallons of total reagent. These volumes are equivalent to approximately 5% to 8% of the pore space within the anticipated 15-foot ROI and the 10-foot injection screen length.

The injection goal for total permanganate and per screen volumes are equivalent to the Modified Fenton's volume; between 24,000 and 36,000 gallons total and between 1,600 and 2,400 gallons per well.

These volumes are based on review of applicable data and ISOTEC's past field experience. The actual volume of reagents and permanganate used will depend upon the injection flow rate, pressure and radial effects noted during injection.

4.0 PILOT STUDY FIELD MONITORING

Specific site monitoring will be performed during the pilot test to obtain information related to the treatment process and subsurface characteristics. Monitoring wells to be used for these purposes will be MW-72B, MW-73B and MW-74B. Field monitoring for groundwater concentrations of H_2O_2 and total iron will be measured by ISOTEC in the non-injection wells prior to the start of each injection event and daily during each injection event to evaluate subsurface reagent distribution.

5.0 PROJECT SCHEDULE

A proposed project schedule has been developed for the implementation of the tasks described in this report and to meet the project requirements as discussed with CH2M Hill.

EVENT	DATE
Modified Fenton's Reagent Injection	January 19, 2003
Permanganate Injection	February 23, 2003

Based on review of the subsurface characteristics, field activities for the site are estimated at eight (8) working days. Standard daily working hours on-site during the field activities will be during daylight hours, plus weekends as needed.

6.0 HEALTH AND SAFETY PLAN

A site-specific health and safety plan for this project has been prepared by ISOTEC and enclosed as **Appendix 1**. The ISOTEC HASP will be followed during the implementation of activities described herein. A typical ISOTEC injection team consists of a field supervisor, along with 1-2 field technicians. All members of the injection team will have completed health and safety training consistent with the Occupational Safety and Health Act (Title 29 of the Code of Federal Regulations 1910.120), with current certifications. The site supervisor will have completed an additional eight hours of OSHA training. The HASP shall be revised and/or updated to reflect site conditions and activities, as necessary. In addition to the ISOTEC HASP, personnel will also comply with any site-specific safety protocols.

ISOTEC personnel will create an exclusion zone around the injection pathway system and monitoring wells as part of their standard field operating procedures, with minimal site disturbance required. All injection and mixing activities will take place within this area, if possible. Reagents will be prepared on-site. Additional chemical storage precautions during non-working hours, such as an on-site lockable container (box truck) will be supplied to minimize any possible contact. Personnel protective equipment (PPE) will consist mostly of chemical splash attire, and items noted in the HASP. The site-specific HASP will be available on-site during all field operations.

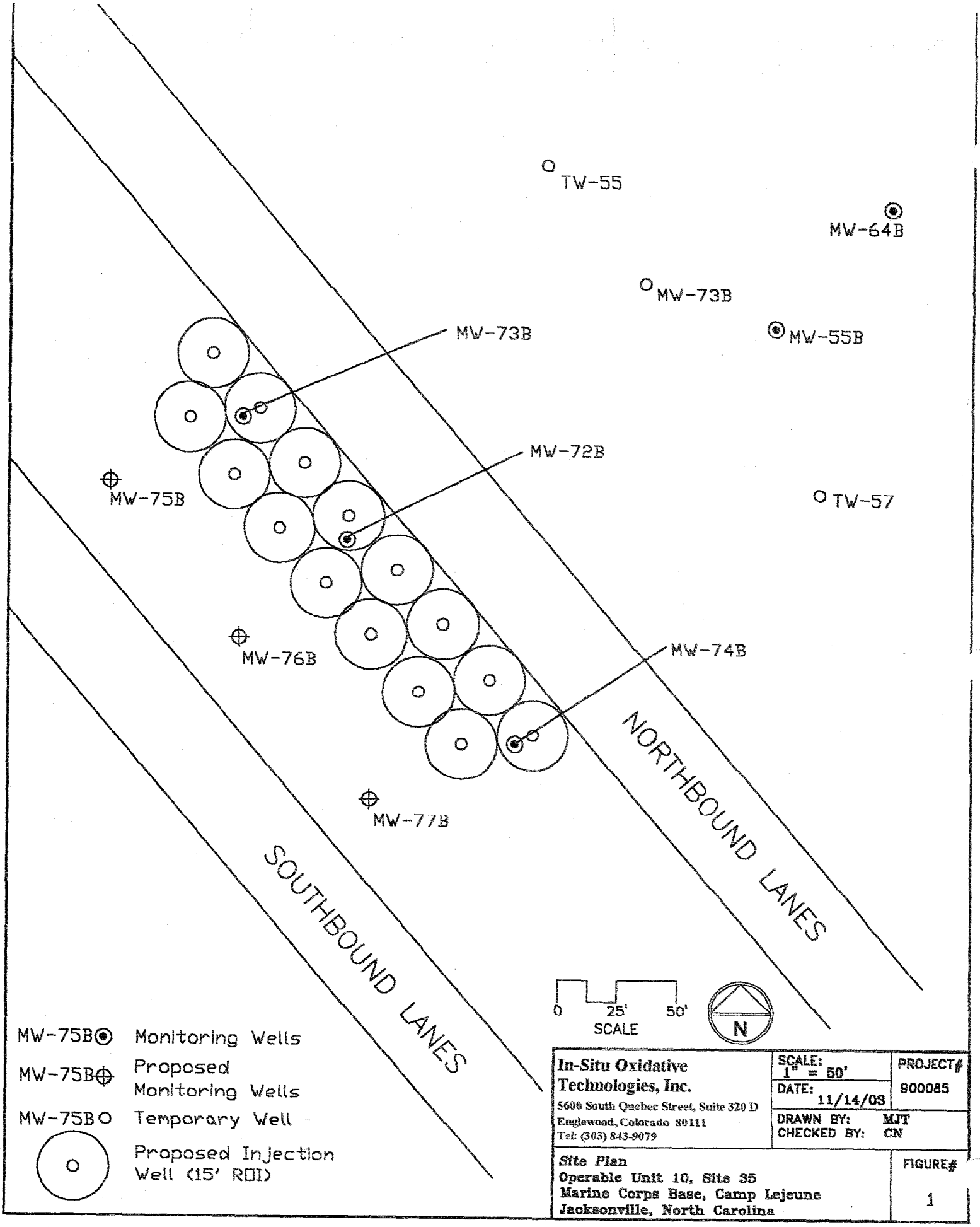
The ISOTEC process was created based on numerous years of both academic and private research in the chemical oxidation field. ISOTEC personnel understand the potential dangers associated with the oxidizers such as hydrogen peroxide, and have completed extensive safety training.

7.0 LESSONS LEARNED ON PREVIOUS ISOTEC PROJECTS

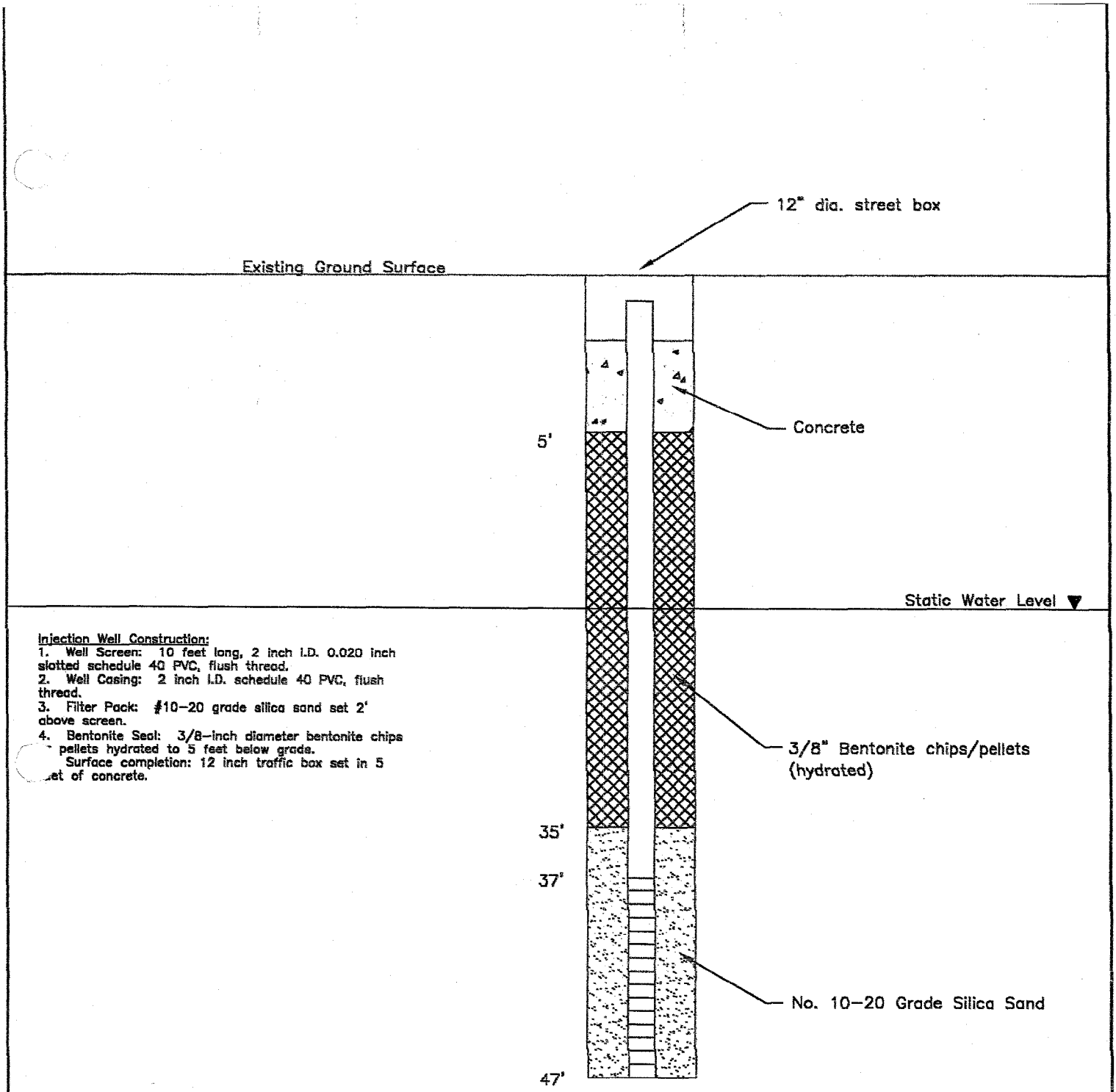
Past experience at similar sites suggests several lessons learned that should be considered during this pilot study.

- **Surfacing** – Subsurface reactions produce gases that migrate vertically. Any vertical permeability pathways or conduits can allow the gas to migrate to ground level and "surface". The gas can transport groundwater and reagent through the conduit as well; therefore liquid can bubble to surface. Conduits can be naturally occurring, i.e. fractures, or man made. Natural fractures are normally observed in clays and dry silts. Man made conduits include abandoned bore holes or probe holes, annular spaces of monitoring wells, monitoring well casings, and injection well annular spaces. All future bore and probe holes should be abandoned with hydrated bentonite to 6 inches below grade and a concrete plug to surface. Monitoring wells within 15 feet of an injection well should have a PVC threaded adapter glued on and a threaded cap with pressure gauge attached during injection. Annular spaces of monitoring wells should be observed during injection for liquid accumulation in the street box or surfacing around the street box.
- **Increasing Groundwater Concentrations** – The ISOTEC process causes contaminant desorption as well as dissolved phase oxidation. If sufficient contaminant mass is present in the adsorbed phase or as non-aqueous phase liquid (NAPL), more mass may be transferred to the dissolved phase than can be treated during one injection event. This can result in higher contaminant groundwater concentrations after injection than before injection. Total contaminant mass will still be reduced.
- **Variations in Permeability** – Permeability variations laterally can cause significantly different injection conditions. Pressures, flow rates and injection volumes can vary from well to well. Vertical permeability variations can cause poor distribution of reagent even in a relatively uniform lithology.
- **Estimated Volumes** – The estimated volumes for this remediation program are based on review of applicable data and ISOTEC's past field experience. The actual volume of reagents used will depend upon the injection flow rate, pressure and radial effects noted during injection.
- **Observed Reagent Distribution** – Field tests for reagent in nearby monitoring wells may or may not reflect the ROI of an injection well. Contaminant mass reduction is the primary method for evaluating an effective ROI.

FIGURES



In-Situ Oxidative Technologies, Inc. 5600 South Quebec Street, Suite 320 D Englewood, Colorado 80111 Tel: (303) 843-9079	SCALE: 1" = 50' DATE: 11/14/03 DRAWN BY: MJT CHECKED BY: CN	PROJECT# 900085
Site Plan **Operable Unit 10, Site 35** **Marine Corps Base, Camp Lejeune** **Jacksonville, North Carolina**		FIGURE# 1

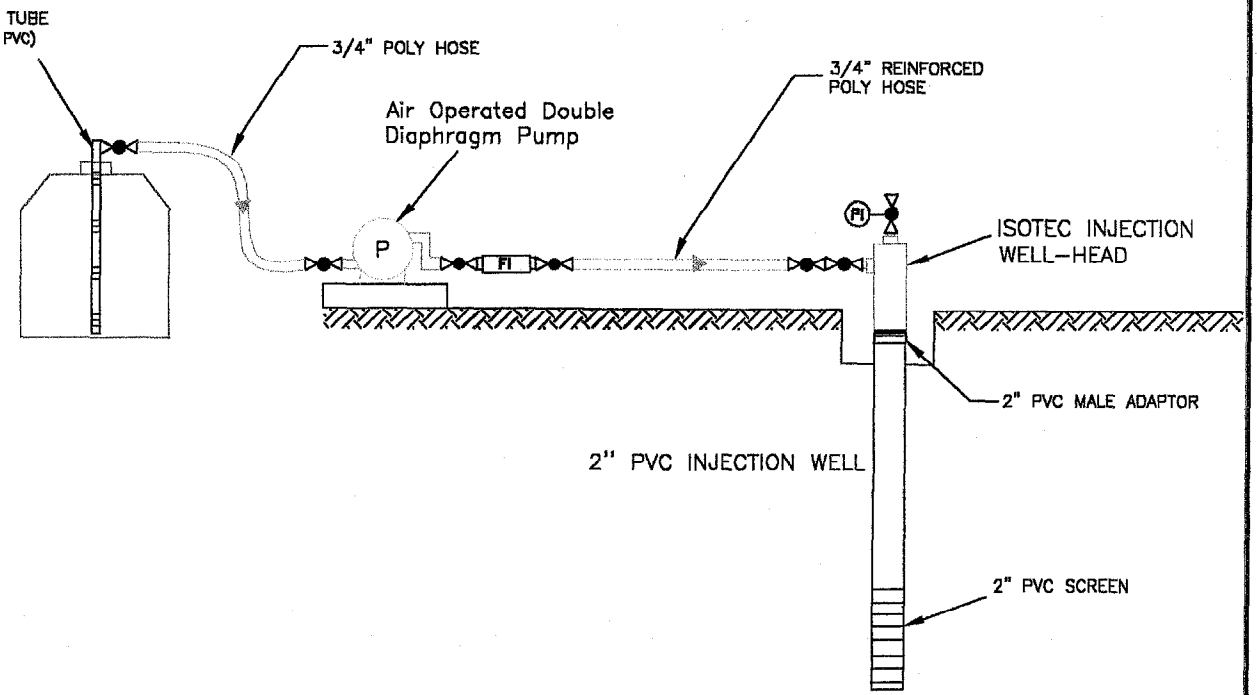


Injection Well Construction:
1. Well Screen: 10 feet long, 2 inch I.D. 0.020 inch slotted schedule 40 PVC, flush thread.
2. Well Casing: 2 inch I.D. schedule 40 PVC, flush thread.
3. Filter Pack: #10–20 grade silica sand set 2' above screen.
4. Bentonite Seal: 3/8–inch diameter bentonite chips pellets hydrated to 5 feet below grade.
Surface completion: 12 inch traffic box set in 5 set of concrete.

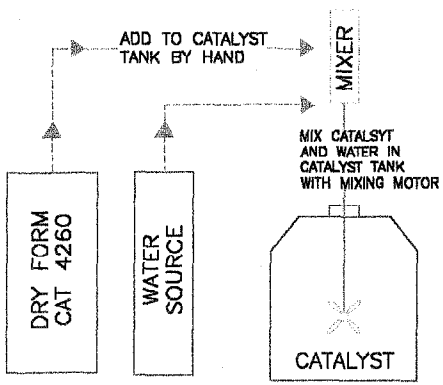
In-Situ Oxidative Technologies, Inc. 5600 S. Quebec, Suite 320 D Greenwood Village, Colorado 80111	SCALE: Not to Scale DATE: 11/14/03 DRAWN BY: TE CHECKED BY: SH FILE: S:\Projects\CH2 -Camp Lejeune\Inj well	PROJECT# 900085
Injection Well Design ***Operable Unit 10, Site 35*** ***Marine Corps Base, Camp Lejeune*** ***Jacksonville, North Carolina***		FIGURE# 2

ISOTEC REAGENT INJECTION PROCEDURE

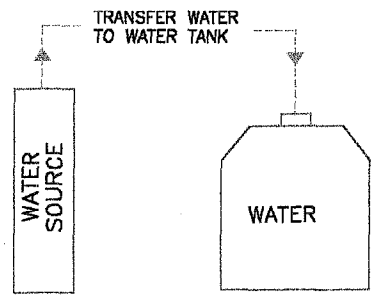
1.) DROP TUBE IS PLACED IN WATER TANK AND PUMP IS ACTIVATED.
2.) DROP TUBE THEN PLACED IN OXIDIZER TANK, CONTINUE INJECTIONS.
3.) WATER FLUSH IS INITIATED AT COMPLETION OF OXIDIZER INJECTIONS
4.) DROP TUBE IS MOVED TO CATALYST TANK, CONTINUE INJECTIONS
5.) FINAL WATER FLUSH IS COMPLETED



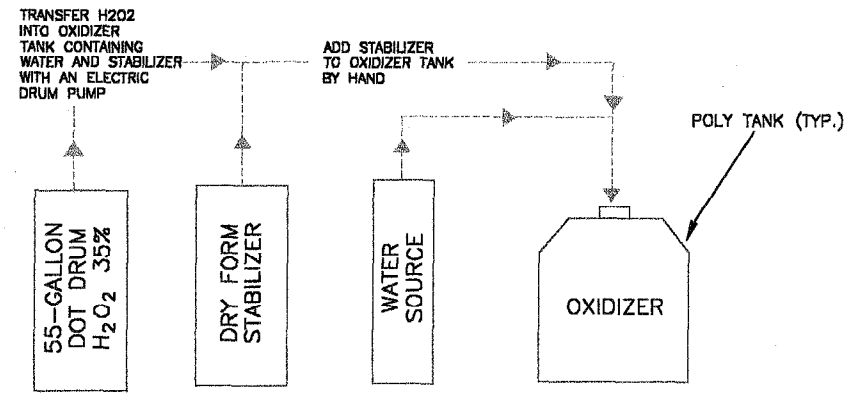
CATALYST TANK PROCEDURES



WATER TANK PROCEDURES



OXIDIZER TANK POCEDURES



LEGEND

FI — FLOW METER WITH TOTALIZER

3/4" BALL VALVE WITH CAM LOCK QUICK CONNECT

PI — 3/4" BALL VALVE WITH CAM LOCK QUICK CONNECT AND PRESSURE GAUGE

In-Situ Oxidative Technologies, Inc. 5600 S. Quebec Street, Suite 320D Englewood, Colorado 80111 Tel: (303) 843-9079	SCALE: N.T.S.	PROJECT# 900085
	DATE: 11/14/03	
	DRAWN BY: TE CHECKED BY: SH	
Injection Method Schematic **Operable Unit 10, Site 35** **Marine Corps Base, Camp Lejeune** **Jacksonville, North Carolina**		FIGURE# 3

HEALTH AND SAFETY PLAN
FOR
IN SITU CHEMICAL OXIDATION
PILOT STUDY

OPERABLE UNIT NO. 10 (SITE 35)
MARINE CORPS BASE
CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

DECEMBER 2003

PREPARED FOR:

CH2M HILL
4824 PARKWAY PLAZA BLVD.
CHARLOTTE, NC 28217

PREPARED BY:

IN-SITU OXIDATIVE TECHNOLOGIES, INC.
5600 SOUTH QUEBEC STREET
SUITE 320 D
ENGLEWOOD, COLORADO 80111

PROJECT NO. 900085

TABLE OF CONTENTS

ATTACHMENTS

ATTACHMENT A	Site Location Map
ATTACHMENT B	Emergency Route Map
ATTACHMENT C	ISOTEC Health & Safety Incident Report
ATTACHMENT D	ISOTEC Safety Log
ATTACHMENT E	OSHA Poster
ATTACHMENT F	Heat and Cold Stress Guidelines
ATTACHMENT G	Emergency Procedures
ATTACHMENT H	MSDS Sheets

Section 1 PROJECT IDENTIFICATION

CLIENT NAME:	CH2M Hill
CLIENT ADDRESS:	4824 Parkway Plaza Blvd. Charlotte, NC 28217
ISOTEC PROJECT No.:	900085
PROJECT NAME:	MCB, Camp Lejeune
LOCATION/ADDRESS:	MCB, Camp Lejeune Jacksonville, North Carolina
ISOTEC PROJECT MANAGER:	Stan Haskins
ISOTEC SITE MANAGER:	Stan Haskins
ISOTEC SITE SAFETY OFFICER:	Stan Haskins
PLAN VALID FROM:	December 1, 2003
PLAN EXPIRES:	December 31, 2004

- End of Section –

Section 2 INTRODUCTION

The purpose of this Health and Safety Plan (HASP) is to identify, evaluate and control health and safety hazards, and to provide for emergency response during field activities. All employees of ISOTEC, as well as its contractors and subcontractors who have agreed to abide by this HASP and who are involved in field activities on this project, will be bound by these provisions. This HASP is intended to supplement the HASP in Appendix A of the "Work Implementation Plan – Pilot Study at Operable Unit 10, Site 35" (Work Plan) prepared by the IT Corporation.

This site-specific HASP is based on a review and evaluation of the potential hazards and risks associated with this project. It outlines the health and safety procedures, and the equipment required, needed to minimize the potential for harm to field personnel and site visitors. Since work activities, site conditions and exposures to various combinations of contaminants which may be present are variable, the potential for adverse health effects associated with field activities on this site cannot be predicted with confidence.

2.1 Site Description & History

The pilot test at Marine Corp Base (MCB), Camp Lejeune will take place in Operable Unit 10, Site 35. Site 35 is the former Camp Geiger Area Fuel Farm (Fuel Farm), which was decommissioned and removed in 1995. A six-lane divided highway was proposed by the North Carolina Department of Transportation (NCDOT) to intersect this site. Trichloroethene (TCE) and its associated dissolved chlorinated solvents are the contaminants of concern at Site 35. The contaminant mass dimensions are estimated to be approximately 400 feet long, 100 feet wide, and 10 feet thick (15 to 25 ft below msl). There will be one injection event in this pilot test, during which reagents will be injected into 15 injection wells.

2.2 Key Personnel

2.2.1 ISOTEC Project Manager: Stan Haskins

The ISOTEC Project Manager has the following responsibilities:

- To provide the ISOTEC Director of Health and Safety with project-related health and safety information.
- To have a site-specific Health & Safety Plan (HASP) prepared.
- To implement the HASP.
- To see that the project is performed in a manner consistent with applicable local, state and federal regulations.
- To monitor compliance with the HASP.

The ISOTEC Project Manager has the authority to take the following actions:

- To suspend field activities, if the health and safety of field personnel are endangered.
- To suspend an individual from field activities for infractions of the HASP, pending further consideration by the ISOTEC DHS.

2.2.2 ISOTEC Director of Health and Safety: Tom Andrews

The ISOTEC DHS has the following responsibilities, although he will not be on-site during the work:

- To consult with the ISOTEC Project Manager in project-related matters of health and safety.
- To monitor compliance with the HASP.
- To assist the ISOTEC Project Manager in complying with the terms of this HASP, and applicable regulations.
- To verify that on-site personnel are properly trained and medically qualified to carry out their duties.

The ISOTEC DHS has the authority to take the following actions:

- To suspend work or otherwise limit personnel exposure if a HASP appears to be unsuitable or inadequate.
- To direct personnel to modify any work practices that are deemed to be hazardous to health and safety.
- To remove field personnel from the project if their physical actions or mental condition endangers their own health and safety, or that of their coworkers.

2.2.3 ISOTEC Site Safety Officer: Stan Haskins

The ISOTEC Site Safety Officer (ISOTEC SSO) will be present on-site during work. The SSO and ISOTEC Alternate Site Safety Officer(s) (Alternate ISOTEC SSO) have the following responsibilities:

- To direct on-site health and safety activities.
- To report safety-related incidents to the ISOTEC Project Manager and ISOTEC DHS.
- To assist the ISOTEC Project Manager in all aspects of implementing the HASP.
- To maintain an adequate supply of health and safety equipment on-site, as specified in the HASP.
- To observe on-site health and safety activities, as specified in the HASP, and report results to the ISOTEC Project Manager and the ISOTEC DHS.

The ISOTEC SSO has the authority to take the following actions:

- To suspend field activities, if the health and safety of field personnel are endangered.
- To suspend an individual from field activities for infractions of the HASP, pending further consideration by the ISOTEC DHS.

2.2.4 ISOTEC Injection Technicians: Tim Eilber, Mike Tanner, Nathan Torres & Rachel Krabacher

The ISOTEC Injection Technicians have the following responsibilities:

- To report safety-related incidents to the ISOTEC SSO.
- To comply with the HASP while working.
- To communicate safety concerns and/or ideas for safety improvements.

The ISOTEC Injection Technicians have the authority to take the following actions:

- To suspend field activities, if the health and safety of field personnel are endangered.

Section 3 GENERAL HEALTH AND SAFETY REQUIREMENTS

3.1 Personnel Medical Clearance

Prior to working at this site, ISOTEC assigned employees must: 1) have been certified by a licensed, ISOTEC-approved physician as being physically able to perform their assigned field work, and to use the Personal Protective Equipment (PPE) which will be required for this project, in accordance with the provisions of OSHA Regulation 29 CFR 1910.120(f); 2) have successfully completed an ISOTEC 40-hour basic health and safety training course (Level C) for field personnel or its equivalent. Site managers and supervisors must have successfully completed an 8-hour managers' health and safety course, in addition to the other clearance requirements.

ISOTEC subcontractor employees must also have similar medical, training, and respirator fit clearances and they will be required to provide proof of clearance before beginning work.

3.2 Hazard Training

All personnel working on-site who have potential exposures to health or safety hazards shall be thoroughly trained as specified in OSHA Regulations 29 CFR 1910.120(e). This training will include: (1) Attendance at an initial 40-hour basic health and safety training course off the Site; (2) At least three days of actual field experience under the direct supervision of a trained, experienced supervisor; (3) On-site, site-specific training; and (4) an 8-hour annual update in the basic health and safety training course. ISOTEC personnel may also receive specific topic training throughout the year. This training may include blood-borne pathogen training, low-level radioactivity safety, ergonomics updates, and newsletters/bulletins with pertinent or applicable information.

In addition to the above, on-site Managers and supervisors who are directly responsible for, or who supervise employees engaged in hazardous waste operations must also receive: (1) 8-hours of site supervisor training; and (2) additional training at the time of job assignment on such topics as, but not limited to, the company's safety and health program and the associated employee training program; personal protective equipment program; spill containment program; air quality monitoring; emergency response; monitoring equipment usage and calibration; and, health hazard monitoring procedures and techniques.

At the time of job assignment, special training will be provided to on-site personnel who may be exposed to unique or special hazards not covered by the initial 40-hour basic health and safety course. If unique or special hazards are unexpectedly encountered, specialized training will be provided before work proceeds.

3.3 Incident Reporting

An ISOTEC Health & Safety Incident Report will be filed for any incident involving personnel working at this Site. Situations covered by this policy include, but are not limited to, fires, explosions, illnesses, injuries and motor vehicle collisions. These reports must be sent to the ISOTEC DHS within 24 hours of the incident. Worker's Compensation

and Insurance reports for ISOTEC employees must be filed within 48 hours of each incident or illness that results from work-related activities and requires medical attention. See Attachment C for a copy of the ISOTEC Health & Safety Incident Report. The ISOTEC SSO or Project Manager will complete this form if needed.

3.4 Illumination, Sanitation and Confined Space Entry

3.4.1 Illumination

All major work tasks will occur outside during daylight hours. The illumination requirements set forth by OSHA Regulations 29 CFR 1910.120 (m) will be met.

3.4.2 Sanitation

The sanitation requirements regarding potable and non-potable waters, toilet facilities and washing facilities will be followed as set forth in OSHA Regulations 29 CFR 1910.120(n).

3.4.3 Confined Space Entry

Confined Space Entries will not be conducted under this HASP.

3.5 Respirator Maintenance, Fitting and Decontamination

Respirators will only be used when deemed necessary by the ISOTEC SSO. In the event that respirators are used, the respirators will be cleaned daily according to procedures described below. Cartridges will be replaced when breakthrough is detected at any time while in use. An increased resistance to breathing will determine breakthrough for HEPA cartridges. The following checks will be performed daily, in addition to the above:

- Exhalation valve - pull off plastic cover and check valve for debris or for tears in the neoprene valve, which could cause leakage.
- Inhalation valves - screw off both cartridges and visually inspect neoprene valves for tears. Make sure that the inhalation valves and cartridge receptacle gaskets are in place.
- Make sure a protective lens cover is in place.
- Make sure you have the proper HEPA cartridges.
- Make sure that the face piece harness is not damaged. The serrated portion of the harness can fragment which will prevent proper face seal adjustment.
- Make sure the speaking diaphragm retainer ring is hand tight.

NOTE: <u>The respirator MUST be Leak-Tested before each use</u>.

Test the respirator for leakage by using both the positive- and the negative-pressure method. Lightly place your palm over the exhalation valve cover. Exhale gently. The body of the respirator should bulge slightly outward from your face. If any leakage is detected around the face seal, readjust the head harness straps and repeat the test until there is no leakage. If leakage is detected other than in the face seal, the condition must be investigated and corrected before another test is made. The negative pressure test must also be made. Lightly place your palms or some impervious material, like Saran Wrap® over the cartridges or filter holders. Inhale gently. The face-piece should collapse against the face. The respirator must pass these two tightness tests before the respirator is used. The respirator will not furnish protection unless all inhaled air is drawn through suitable cartridges or filters.

NOTE: Respirators provide no protection in oxygen-deficient atmospheres!

After use, follow these steps to clean your respirator:

- Wash with Alconox® solution and brush gently. (This step will remove any soil/solid particulate matter that may have been collected on the respirator during field activities.)
- Rinse with distilled/de-ionized water, making sure that the inhalation and exhalation valves are clean and unobstructed.
- Rinse with distilled/de-ionized water.
- Wipe with sanitizing solution. (This step will assure the sterility of the respirator.)
- Allow your respirator to air dry.
- Place the respirator inside a sealed bag or a clean area away from extreme heat or extreme cold.

3.6 ISOTEC Project Manager Notification

All field personnel must sign-in on a sheet maintained by the ISOTEC SSO or the Alternate ISOTEC SSO before entering the Site.

IF ANY PREVIOUSLY UNIDENTIFIED POTENTIAL HAZARDS ARE DISCOVERED DURING ANY FIELD WORK, LEAVE THAT AREA OF THE SITE IMMEDIATELY AND CONTACT THE ISOTEC SSO FOR FURTHER INSTRUCTIONS.

3.7 OSHA Information Poster

In accordance with the Occupational Safety and Health Act of 1970, a copy of the OSHA information poster must be present at the Site. It will be posted at full size (11" x 17") in a permanent structure or temporary field office, or will be communicated to on-site personnel via Attachment E.

3.8 Prohibitions

Smoking, eating, drinking, chewing tobacco or toothpicks, applying cosmetics, storing food or food containers, and having open fires will be permitted only in designated areas that will be established by the ISOTEC SSO. Under no circumstances will any of the above activities be permitted within the Exclusion or Contamination Reduction Zones. Good personal hygiene should be practiced by field personnel to avoid ingesting contaminants.

3.9 Initial Site Safety Meeting and Signing of Health and Safety Plan Compliance Agreement

The ISOTEC SSO will hold an initial site safety meeting with ISOTEC, subcontractor and contractor field personnel before work activities begin at the Site. At this meeting, it will be verified that all personnel have been provided with or have reviewed a HASP for the work activities to be performed at this Site. For ISOTEC personnel, its subcontractor's personnel, and contractor personnel whose employer(s) have adopted this HASP, the HASP shall be reviewed, discussed and questions will be answered. Signed Health and Safety Plan Compliance Agreement Forms of personnel who will be following this HASP will be collected by the ISOTEC SSO and filed. Individuals refusing to sign the Form will not be allowed to work on the Site.

3.10 Daily Site Safety Briefings

During field operations, site safety briefings will be held at the start of each day by the ISOTEC SSO to review and plan specific health and safety aspects of scheduled work. All field personnel who are following this HASP are required to attend these briefings. These meetings and their content shall be documented by the ISOTEC SSO or Project Manager. Each company will have a SSO. SSO's will meet each day to discuss accidents and relative risk and safety issues. Each SSO is responsible for their personnel. SSO's will agree on communication methods when health and safety actions occur. Potential subjects that may be discussed are presented below:

1. Preliminary
   - Medical clearances.
   - Training requirements.
   - Written HASP availability.
   - Designation of responsibilities for on-site personnel.
   - Identification of on-site personnel trained and certified to administer First Aid.
2. Training topics

   Review of HASP including: types of hazards; pathways of exposure; levels of protection; contamination avoidance; prohibitions; work procedures; work zones; emergency response procedures; and, specific on-site area/work tasks of concern.

   Decontamination.

   Personnel Protective Equipment.

   Air Quality Monitoring Program.

3.11 ISOTEC Material Handling and Storage

ISOTEC employees will handle and store potassium permanganate, hydrogen peroxide and catalyst to complete this project. Material Safety Data Sheets (MSDS) are included as Attachment H. These employees, the injection technicians and the SSO, have received training in the proper handling and storage of the chemicals. They have also received specific training in the PPE required to handle the chemicals safely. A fire extinguisher will be on-site in the truck at all times.

To mix potassium permanganate solution, potassium permanganate powder is added to the mixing tank followed by water and an electric mixer is turned on to mix the solution. The technician completing the mixing will wear a full-face air-purifying respirator to avoid inhalation of potassium permanganate dust.

Once the potassium permanganate is mixed, safety hazards associated with the reagents are minimal. Technicians will avoid contact with the liquids during injection and wear Modified Level D PPE. If contact occurs flush the affected area with water and follow the procedures outlined in the MSDS sheet.

In brief, the 35% hydrogen peroxide and the catalyst should be stored in such a way that if a spill were to occur the two would not come into contact with each other. To avoid this, the 35% peroxide is stored in a location separate from the catalyst. Specifically the peroxide is stored in 55 gallon polyethylene drums on the ground outside of the ISOTEC box trucks while dry and liquid catalyst are stored inside of the box truck. Diluting the peroxide is performed in a dilution tank. Water is added to the dilution tank along with dry stabilizer in a predetermined volume to create a 12% concentration after the addition of a predetermined volume of 35% hydrogen peroxide. An electric drum pump or an air operated double diaphragm pump is used to transfer the 35% hydrogen peroxide into the dilution tank. Two technicians are required to complete this process. One operates the pump and one holds the transfer wand in the dilution tank. Both technicians wear splash shields and gloves while completing the transfer.

To mix catalyst, Catalyst 4260 Component A is added to the mixing tank followed by a predetermined quantity of water and an electric mixer is turned on to mix the solution. Catalyst 4260 Component B is then added to the solution and mixing continues. Catalyst component C is then added to the solution and mixing continues. Although the mixing process is generally dust free, the technician completing the mixing will wear a dust mask as a precautionary measure.

Once the catalyst is mixed and the peroxide is diluted safety hazards associated with the reagents are minimal. Technicians should avoid contact with the liquids during injection. If contact occurs flush the affected area with water and follow the procedures outlined in the MSDS sheet.

Combustion issues associated with the presence of hydrogen peroxide, a strong oxidizer, are minimized since a maximum solution of 35% will be delivered to the site. The 35% peroxide is stored in DOT approved drums. Flammable materials, i.e., gasoline, will not be stored near the peroxide or in locations where a spill of peroxide could occur. If 35% peroxide does come in contact with organic materials, i.e., wood, asphalt or clothing, the areas should be rinsed with water, contained and cleaned up following the procedures in section 9.2.4 Spill Prevention Plan.

Hydrogen peroxide at a concentration of 35% is insufficient to cause instantaneous combustion of non-flammable organic materials. The ISOTEC reagents are not mixed at the surface. The peroxide and catalyst only come into contact with one another in the subsurface. Precautions are taken, by flushing all equipment with water, between separate injections of each reagent. The maximum temperature rise documented in the subsurface due to the ISOTEC process is 25°F.

- End of Section –

Section 4 HAZARD ASSESSMENT

An assessment of the known or suspected chemical, physical and biological hazards have been made for each of the activities specified below.

4.1 Approved Work Activities

Work activities, which may be performed under this HASP, are limited to the following:

- Mixing and injecting potassium permanganate, hydrogen peroxide and catalyst through injection wells.

This HASP does not cover any site activities beyond those specifically listed above. Work activities not described above may be conducted only after an appropriate Addendum to this HASP has been issued by the ISOTEC DHS.

4.2 Hazards

Potential hazards associated with the project are discussed below. Specific hazards associated with ISOTEC reagent handling and storage are discussed in Section 3.11.

4.2.1 Environmental Contaminants

The following chemical information presents the significant contaminants that have been previously identified or routinely encountered during groundwater sampling activities within the site boundaries.

4.2.1.1 Chemical Hazards

The following chemical hazards have been identified, based on documented prior site uses and/or initial site investigations:

1. Trichloroethene (TCE)
2. Potassium Permanganate 2-6%
3. Hydrogen Peroxide (35%)
4. Catalyst (inorganic salts)

If inhaled, symptoms include eye irritation, headache, nausea, vomiting, dizziness, and drowsiness. Hydrogen peroxide has a PEL of 1 ppm and a vapor pressure of 18mm-Hg. Inhalation of hydrogen peroxide vapors causes irritation of the mucous membranes. Contact with skin causes bleaching and blistering. The catalyst contains iron. Inhalation of iron dust may cause irritation of mucous membranes

4.2.1.2 Chemical Exposure Controls

Contaminants usually enter the body through the mouth (ingestion), the lung (inhalation) or by absorption through the skin and mucous membranes. Chemical exposure through these routes will be controlled by limiting eating, drinking, and smoking to uncontaminated areas; through the use of hygiene practices and decontamination procedures; and by the use of appropriate engineering controls and personal protective equipment (PPE). There are four levels of personal protection (Levels A, B, C, and D), according to the degree of protection they afford, with Level A providing the greatest degree of protection. PPE is discussed in detail in Section 6. The initial level of personal protective equipment to be used while performing activities at the Site will be Modified Level D, based on the current site conditions without any known surface contamination.

The contaminants known to be present in the soils and groundwater at the site do not have the capacity to become airborne during the subsurface injection of reagents, due to their confined nature in the subsurface. Therefore, the monitoring program outlined in Section 5, if deemed necessary, is considered to be protective of the surrounding areas, outside of the work zone.

4.2.2 Physical Agents

Physical agents include noise, electro-magnetic fields, ionizing and non-ionizing radiation, thermal stress, street work and concrete trucks. There is also a risk of physical injury from slips, trips, falls, cuts, sprains, etc., when working in the field with sampling tools, and when near heavy equipment, operating machinery and vehicular traffic including railroad equipment and trains. Field personnel should be able to recognize these hazards and take steps to avoid injurious contact with them. The Following precautions must be observed whenever heavy equipment is in use:

- Personal protective equipment (PPE) such as steel-toed shoes, safety glasses or goggles, traffic safety vests, and hard hats must be worn at all times.
- Personnel must at all times be aware of the location and operation of heavy equipment, and take precautions to avoid getting in the way of its operation. Never assume that the equipment operator sees you; make eye contact and use hand signals to inform the operator of your intent, particularly if you intend to work near or approach the equipment.
- Never walk directly in back of or to the side of, heavy equipment without the operator's acknowledgment.
- When an equipment operator must operate in tight quarters, the equipment subcontractor should provide a person to assist in guiding the operator's movements.
- Keep all non-essential personnel out of the work area.
- Any heavy equipment that is used in the exclusion zone should remain in that zone until its task is completed. The equipment subcontractor should completely decontaminate such equipment in the designated equipment decontamination area as required prior to moving the equipment outside of the Exclusion Zone.
- Be aware of and yield to all railroad traffic.

Noise Exposure

Work at the site may be conducted with high noise levels from equipment such as excavators, pumps and drill rigs. ISOTEC standards require that hearing protection be used when noise levels exceed 85 dBA, averaged over an 8-

hour day. Hearing protection will be required at this site for noise exposures greater than 85 dBA for **any** length of time. Hearing protection will be worn anytime a normal conversation cannot be heard. ISOTEC and subcontractor personnel shall have hearing protection on-site and available for use at all times.

Thermal Stress

Depending on the altitude, geographic location and the season, the use of required PPE may cause heat or cold related stress on the wearer. The Heat Stress Casualty Prevention Plan as specified in Attachment F will be referred to for dealing with this health hazard during warm weather. The Plan outlines heat stress identification, treatment, prevention and monitoring. Fluids will be provided at all times during work periods, in order to maintain adequate body fluid levels for field personnel.

Radiation Exposures

Radiation is used to mean ionizing and non-ionizing, laser and microwave emissions. No sources of these forms of radiation are known to exist on-site.

4.2.2.1 Controls for Physical Agents

No physical hazards, as defined, are known or believed to be present.

4.2.3 Biological Agents

Biological agents may be viral, fungal, bacterial, or of higher orders: insects (including ticks and stinging insects), wild animals (especially snakes) and domesticated animals. Any mammal encountered on-site should be considered potentially rabid. Field personnel are encouraged to use insect repellents before donning PPE. To avoid snake bites check for snakes before walking through grassy or debris strewn areas. The presence of medical waste suggests the possibility that pathogenic micro-organisms may be present. A fully-stocked first aid kit must be available for use in the field.

4.2.3.1 Biological Agent Controls

No biological agents, as defined, are known or believed to be present.

4.2.4 Safety Hazards

Use of steel-toed work boots, safety glasses or goggles will be required when in an Exclusion Zone. Personnel should be aware that when PPE such as respirators, gloves, and protective clothing are worn, visibility, hearing, and manual dexterity are impaired.

- End of Section –

Section 5 AIR QUALITY MONITORING AND MEASURES FOR THE CONTROL OF EMISSIONS

5.1 Air Quality Monitoring Instrument

Air quality will not be monitored by ISOTEC personnel during the pilot test. However, in the event that it is deemed necessary by the SSO, air quality may be measured to determine exposure potentials prior to the start of work and at various times during the course of the project. Instruments which may be used to monitor air quality, are discussed below:

- **Photoionization Detector**

  The HNu Systems Model PI-101 Photoionization Detector (PID) with a 10.7eV lamp or equivalent will be used to detect trace concentrations of certain organic gases and a few inorganic gases in the air. Methane, ethane, and the major components of air are not detected by the HNu PID. PID readings reflect total (readable) vapors in the air. PID readings must be given as "PID units", rather than "ppm". The PID detects mixtures of compounds simultaneously. PID readings do not measure concentrations of any individual compound when a mixture of compounds is present.

  The PID will be calibrated twice each day (before start of work and after the conclusion of work) using an isobutylene standard (molecular weight = 56.2) for calibration. Calibrations will be logged. PID readings should be measured in the breathing zone of the most highly exposed worker (i.e., the person who is closest to the source of known or suspected contamination).

- **Combustible Gas Indicator/Oxygen**

  An approved Combustible Gas Indicator/Oxygen Meter and/or a four gas meter will be used to measure the concentration of flammable vapors and gases and oxygen in the air during field activities. Flammable gas concentrations are measured as percentages of the Lower Explosive Limit (LEL). Oxygen content is measured as a percentage of air.

5.2 Air Quality Response Levels

In the event that air monitoring is required, the Site Safety Officer will decide when to change protection levels in response to air monitoring results. The ISOTEC DHS will be notified of any upgrades from initial protection levels, as soon as is practical. ISOTEC Action Levels for this project are described in detail in Table 5-1, at the end of this Section. These Action (Response) Levels apply to the work activities covered by this HASP.

5.3 Monitoring Guidelines

5.3.1 Background Organic Vapor Monitoring

In the event that air monitoring is required, background organic vapor and combustible gas readings may be taken at least twice daily: before the start and after the conclusion of work activities. Background levels will be taken at locations surrounding the site that are unaffected by on-site work. Once work at the site begins, reselection of the original background location may be required.

5.3.2 Air Monitoring Protocol

In the event that air monitoring is required, at least one series (series=PID and CGI) of readings will be taken every 15 minutes during intrusive work activities (i.e. drilling, excavation). If no increases in readings above action levels are observed after one hour of monitoring, the frequency will be reduced to once every 30 minutes. If no increases in readings above action levels are observed after two hours of monitoring, the frequency will be reduced to once each hour. During non-intrusive work activities, one series will be performed at the start of work, one series at some point during the work, and one near the conclusion of the work. This will be in addition to the background monitoring described in the previous section.

5.3.3 Documenting Monitoring Results

A calibration log will be kept for each of the monitoring instruments used, which describes the calibration method(s) used, and the readouts obtained. Should work at the site require respiratory protection, the need for a personal exposure-monitoring program will be evaluated by the ISOTEC DHS. Details of this program and any monitoring equipment required for its implementation will be specified in an Addendum to this HASP prepared by the ISOTEC DHS. Records of exposure measurements will be maintained in the Health and Safety file for this project.

TABLE 5-1

ISOTEC RESPONSE ACTIONS

ISOTEC Air Quality Measurements and Response Actions

Air Quality Measurement [1]	Frequency	Response Action
PID reading less than 1 unit above background (averaged over 1 minute) CGI reading less than 10% LEL (averaged over 1 minute) Oxygen Meter reading between 19.5% and 25% (averaged over 1 minute)	Every 15 minutes during injection for first 1 hour. If action levels not exceeded during first hour, then every 30 minutes for one hour. If action levels not exceeded during second hour, then every hour for the duration of the injection events.	Modified Level D Protection (at the discretion of the ISOTEC SSO)
PID reading greater than 1 unit and less the 3 units above background (averaged over 1 minute) CGI reading less than 10% LEL (averaged over 1 minute) Oxygen Meter reading between 19.5% and 25% (averaged over 1 minute)	Every 15 minutes during injection for first 1 hour. If action levels not exceeded during first hour, then every 30 minutes for the duration of the injection events.	Level C Protection (at the discretion of the ISOTEC SSO)

Section 6 PERSONAL PROTECTIVE EQUIPMENT

6.1 Description of Levels of Protection

The personal protection equipment specified in this HASP will be available to all ISOTEC field personnel. The following requirements will also be met, in accordance with OSHA regulations:

1. Facial hair may not interfere with the proper fit of respirators;
2. Contact lenses will not be worn on-site, without exception.
3. Eyeglasses that interfere with the proper fit of full-face respirators will not be worn.
4. No eating, drinking or smoking will be allowed in any area where respiratory protection is required.

Level D Personal Protective Equipment

- Safety glasses or goggles
- Steel-toed leather or rubber work boots
- Hearing protection (if warranted)
- Traffic vest with reflective strips.

Modified Level D Personal Protective Equipment

- Hard hat [1]
- Safety glasses or goggles
- Steel-toed leather work boots
- Rubber overboots, steel-toed rubber boots, or disposable "booties" [1]
- Nitrile-butadiene rubber outer gloves
- Nitrile surgical gloves (to be worn underneath outer gloves)
- Dust mask for catalyst mixing
- Face Shield for peroxide dilution
- Polyethylene coated or Saranex impregnated Tyvek coveralls [1] (taped at cuffs)
- Hearing protection (if warranted)
- Traffic vest with reflective strips.
- [1] Optional, at the discretion of ISOTEC SSO.

Level C Personal Protective Equipment (not called for under this plan)

- Hard hat
- Half-face Air-Purifying Respirator with applicable chemical cartridge combined with a HEPA filter
- Steel-toed leather work boots
- Rubber overboots, steel-toed rubber boots, or disposable "booties"
- Nitrile-butadiene rubber outer gloves
- Nitrile surgical gloves (to be worn underneath outer gloves)
- Polyethylene coated or Saranex impregnated Tyvek coveralls (taped at cuffs)

- Hearing protection if warranted.

A first aid kit, multi-purpose dry chemical UL Class 10A-10B-C fire extinguisher, eye wash station, and appropriate barricades will be present and maintained at the Site.

Selection of the PPE specified for this project is based on a review of known or suspected hazards, routes of potential exposure (inhalation, skin absorption, ingestion, and skin or eye contact) and the effectiveness of personal protective equipment in providing a barrier to these hazards. In addition, PPE has been selected to match the work requirements and task-specific conditions of the job, and to provide adequate protection without causing unnecessary discomfort or physical impairment to the worker.

6.2 Initial PPE Levels for Specific Work Tasks

The selection of Initial Levels-of-Protection takes into consideration the physical, biological and chemical hazards posed by the site as well as those posed by the various pieces of personnel protective clothing. Initial Levels-of-Protection are established so as to obtain acceptable levels of protection while not imposing an unacceptable level of physical stress on the wearer.

The following initial PPE levels have been established for the tasks described in Section 4.1, Approved Work Activities:

Work Activity	Level of Protection
Potassium permanganate preparation	Modified Level D with full-face air-purifying respirator
Potassium permanganate injection	Modified Level D
ISOTEC catalyst preparation and injection	Modified Level D
ISOTEC oxidizer preparation and injection	Modified Level D
Reagent injection	Modified Level D
Monitoring well sampling	Modified Level D

- End of Section -

Section 7 DESIGNATION OF WORK ZONES

This section of the Health & Safety Plan applies to excavation projects where contaminated soils are exposed and may release their contaminants to the air, or come in contact with field personnel. To minimize the migration of contaminant from the Site to uncontaminated areas, three work zones will be set up:

Zone 1: Exclusion Zone
Zone 2: Contamination Reduction Zone
Zone 3: Support Zone

The Exclusion Zone is the area where contamination occurs or could occur. Initially, the Exclusion Zone should extend a distance of 25 ft from the edge of intrusive activity unless conditions at the Site warrant either a larger or smaller distance as determined by the ISOTEC SSO. All persons entering the Exclusion Zone must wear the applicable level of protection as set forth in Section 6.1, Personal Protective Equipment and Section 6.2, Initial PPE Levels for Specific Work Tasks. It is anticipated that work zones will be established at each individual area of intrusive work rather than encompass the entire Site.

The Support Zone is the area of the Site where significant exposure to contamination is not expected to occur during non-intrusive activities. The Support Zone is considered to be the "clean area" of the Site.

Between the Exclusion Zone and Support Zone is the Contamination Reduction Zone, which provides a transition zone between the contaminated and clean areas of the Site. The Contamination Reduction Zone will be located directly outside of the Exclusion Zone. All personnel must decontaminate when leaving the Exclusion Zone. A Contamination Reduction Zone (decontamination area) will be established adjacent to each individual area of intrusive work.

- End of Section -

Section 8 DECONTAMINATION PROCEDURES

Contamination reduction procedures appropriate for the existing work area will be developed and specified by the SSO. Such procedures must be in place before site operations begin, and they must remain in place (modified as necessary) throughout the period of activity. Wherever possible, the need for decontamination should be reduced through work practices that minimize contact with contaminants. Personnel should avoid walking through heavily contaminated areas, should not kneel or directly touch contaminated materials, and should use remote handling and sampling techniques when feasible.

Decontamination will be performed only in designated areas. Separate areas may be set up for equipment and personnel.

8.1 Personnel Decontamination

Personnel who have been in contact with contaminated materials will decontaminate themselves in the following manner:

- Deposit contaminated equipment on plastic drop cloths.
- Stand in wash tub containing Alconox® and water, wash boots and outer gloves with long handled brush.
- Rinse boots and outer gloves with long handled brush in a wash tub containing clear water or use a sprayer to rinse off boots and gloves.
- Remove ankle and wrist tapes; place in disposal drum.
- Remove outer gloves and place in disposal drum.
- Remove Tyvek® suit and place in disposal drum.
- Remove respirator and place on table to be decontaminated.
- Remove inner gloves and place in disposal drum.
- Wash hands and face.

8.2 Equipment Decontamination

Equipment which might require decontamination includes heavy equipment, tools, monitoring equipment, sampling equipment, and sample containers; trucks and trailers; and the decontamination equipment itself when the decontamination is closed down. Before entering the site, all equipment will be cleaned to remove grease, oil, encrusted dirt, or other potential contaminants.

All tools or equipment which have been in contact with contaminated materials, must be decontaminated after leaving the Exclusion Zone. This decontamination is to be performed using a high pressure/hot water "steam type" cleaner or a spray/rinse decontamination sequence as described in Section 3.5, Respirator Maintenance, Fitting and Decontamination, as appropriate.

Contaminated liquids from the decontamination area and contaminated clothing will be disposed of in accordance with site protocols.

8.3 Disposal of Decontamination Wastes

Solid and liquid decontamination waste will be containerized. Solids may be double bagged, or placed in a sealed drum or similar container. Liquids will be collected during decontamination and placed in sealed containers or pumped into holding tanks for future testing and disposal. Containers must be clearly labeled for content, the operation from which they were filled, and the dates.

- End of Section -

Section 9 EMERGENCY RESPONSE PLAN

9.1 Emergency Response

Emergencies addressed by this plan include:

- Fire;
- Chemical over-exposures;
- Physical injuries to site personnel; and,
- Chemical spills.

The ISOTEC Health & Safety Officer and Project Manager must be notified as soon as possible of any on-site emergency or potential emergency including fire, explosive conditions or OSHA-recordable physical injury.

9.2 Emergency Recognition and Prevention

9.2.1 Fires

Fires are possible whenever oxygen and flammable gases or vapors are mixed together in proper proportions and an ignition source is present. Construction equipment provides an ignition source. To prevent fires and explosions, a CGI as specified in Section 5.0 will be used to detect flammable or explosive atmospheres. Ignition and other sources which produce electrical sparks will be turned off and the area evacuated if vapors or gases reach 25% of the Lower Explosion Limit (LEL) as measured by the CGI. Work will not resume until the ISOTEC SSO observes CGI readings below 25% of the LEL for at least 5 consecutive minutes.

9.2.2 Chemical Exposures

Work should always be performed in a manner that minimizes exposure to contaminants through skin or eye contact, inhalation or ingestion. Work practices to reduce the risk of chemical exposure include:

- PPE, as specified in Section 6.0, will be used by all field personnel covered by this HASP. A formal revision to the HASP must be made by the ISOTEC DHS to modify the PPE specifications.
- Keep hands away from face during work activities.
- Minimize all skin and eye contact with contaminants.

Early recognition of the signs and symptoms of chemical exposure is essential for the prevention of serious chemical exposure incidents. Symptoms of exposure to the compounds present at the Site include the following:

Irritation of eyes and mucous membranes, headache, nausea, incoordination (feeling "tipsy").

If a person experiences any of these acute symptoms, or recognizes any of them in a fellow worker, the person experiencing the symptoms will stop work immediately and report to the ISOTEC SSO. If the symptoms persist or affect performance in any way, the ISOTEC SSO will arrange for medical treatment. If the symptoms are serious, or affect several people, work activities in the exposure area will be discontinued until more is known about the cause(s). Incident reporting procedures as specified in Section 3.3 will be initiated.

9.2.3 Physical Injuries

Site personnel should be on the lookout for potential safety hazards such as holes or ditches; improperly positioned objects, such as drums or equipment that may fall; sharp objects, such as nails, metal shards, and broken glass; protruding objects at eye or head level; slippery surfaces; steep grades; unshored steep entrenchments, uneven terrain or unstable surfaces, such as walls that may cave in or flooring that may give way. Site personnel should inform the ISOTEC SSO of any potential hazards observed so that corrective action can be taken.

9.2.4 Spill Prevention

Site personnel should be aware of potential conditions that could cause a spill and take preventative measures before a spill occurs. Safe storage and handling procedures are discussed further in Section 3.11.

The tanks used to mix the potassium permanganate are oversized to prevent spillage from the tanks. If a small spill, less than 5 gallons, of potassium permanganate occurs it should be contained and soaked up with sorbent pads then placed in a poly drum. If a large spill of potassium permanganate occurs it will be contained and pumped into the storage tank with an air diaphragm pump. If a spill of potassium permanganate powder occurs it will be swept up and placed in a poly bag. A full-face air-purifying respirator will be used to prevent inhalation of potassium permanganate dust.

Hydrogen peroxide and catalyst will be stored in such a way that if a spill of either were to occur the two would not come into contact with each other. The tanks used to dilute the peroxide and to mix and store the catalyst are oversized to prevent spillage from the tanks. If a small spill, less than five gallons of peroxide occurs to the ground surface water will be used to dilute it further and actions taken to prevent the fluid from entering the any storm drains or drainage ditchs, while the fluid is soaked up with clay sorbent. If a larger spill of peroxide occurs the same procedure will be followed and any excess liquid will be pumped into a clean empty storage tank. If a small spill, less than 5 gallons, of catalyst occurs it should be contained and soaked up with sorbent pads then placed in a poly drum. If a large spill of catalyst occurs it will be contained and pumped into the storage tank with an air diaphragm pump. If a spill of dry catalyst occurs it will be swept up and placed in a poly bag.

If any spill occurs work will stop immediately until the spill is cleaned up and the cause of the spill is determined and corrected. All spilled materials will be disposed of properly. Refer to the appropriate MSDS sheet for proper disposal instructions.

9.3 Emergency Alerting Procedures

The ISOTEC SSO will alert the appropriate work groups when an emergency occurs. The appropriate phone numbers for key project personnel are listed below in Section 9.5. The ISOTEC SSO and any isolated work group will carry radios if direct contact cannot be maintained.

9.4 Evacuation Procedures and Routes

Normally, personnel should evacuate through the Contamination Reduction Zone, and from there, to the Support Zone. Evacuation from the Contamination Reduction Zone will proceed in an upwind direction from the emergency. If evacuation to the Support Zone does not provide sufficient protection from the emergency, personnel will be advised to evacuate the Site.

9.5 *Telephone Numbers for Emergency Services and Contacts*

The telephone numbers of local emergency services are given below:

Emergency Service		Telephone Number
Ambulance		911
Fire Department		911
Police Department		911
Hospital	Onslow Memorial Hospital	(910) 577-2345
Poison Control Center		(800) 962-1253
USEPA National Response Center		(800) 438-2427
CH2M Hill – Charlotte		(704) 329-0073
CH2M Hill PM	Christopher Bozzini	(704) 329-0073
ISOTEC CO Office		(303) 843-9079
ISOTEC PM	Stan Haskins – Cellular Phone	(303) 931-4257

These telephone numbers must be verified by the ISOTEC SSO before the start of field work.

9.6 *Emergency Response Personnel*

The ISOTEC SSO will have the primary role in responding to all emergencies at the Site. The ISOTEC SSO, or the Alternate ISOTEC SSO, will be present at the Site during all work activities. If any emergency such as a fire, chemical exposure, or physical injury occurs, the ISOTEC SSO shall be notified immediately. The ISOTEC SSO will direct all site personnel in cases of emergency.

After an emergency has occurred at the Site, the causes and responses to that emergency shall be thoroughly investigated, reviewed and documented by the ISOTEC Project Manager and ISOTEC SSO; this documentation is to be submitted to the ISOTEC DHS within 48 hours of the incident.

9.7 *Decontamination Procedures During an Emergency*

Decontamination of an injured or exposed worker or during a site emergency shall be performed only if decontamination does not interfere with essential treatment or evacuation.

If a worker has been injured or exposed and decontamination can be done: Wash, rinse, and/or cut off protective clothing and equipment.

If a worker has been injured or exposed and cannot be decontaminated:

- Wrap the victim in blankets, plastic or rubber to reduce contamination of other personnel;
- Alert emergency and off-site medical personnel to potential contamination; and,
- Have the ISOTEC SSO or other personnel familiar with the incident and contaminants at the Site accompany the victim to the hospital. If possible, send a copy of the appropriate MSDS(s) with the victim.

9.8 Emergency Medical Treatment and First Aid Procedures

Emergency medical treatment or First Aid may be administered at the Site by the ISOTEC SSO or other personnel who have been certified in First Aid.

General emergency medical and First Aid procedures are as follows:

- Remove the injured or exposed person(s) from immediate danger.
- Render First Aid as needed; decontaminate affected personnel, if necessary.
- Call an ambulance for transport to local hospital immediately. This procedure shall be followed even if there is no apparent serious injury.
- Evacuate other personnel at the Site to safe places until the ISOTEC SSO determines that it is safe for work to resume.
- Report the accident to the ISOTEC DHS immediately.

Emergency Medical Treatment and First Aid Procedures are presented in Attachment-G.

9.9 Directions to the Hospital from Site

The route and/or directions to the hospital from the Site are in Attachment B (Map to be completed for Final Draft). The directions to the hospital from the site must be verified by the ISOTEC SSO prior to the start of field work.

Section 10 PERSONNEL ASSIGNMENTS

10.1 Project Personnel

ISOTEC personnel authorized to enter the Site and work on this project, subject to compliance with provisions of the HASP, are:

ISOTEC Project Manager	Stan Haskins
ISOTEC Site Manager	Stan Haskins
ISOTEC Site Safety Officer	Stan Haskins
ISOTEC Director of Health and Safety	Tom Andrews
ISOTEC Injection Personnel	Tim Eilber, Mike Tanner, Nathan Torres, and Rachel Krabacher

Other personnel who meet HASP requirements, including training and participation in a medical surveillance program, may enter and work on the Site subject to compliance with provisions of the HASP.

10.2 Project Safety Responsibilities

Personnel responsible for implementing this Health and Safety Plan are the ISOTEC Project Manager and the ISOTEC Site Safety Officer. Their specific responsibilities and authority are described in the ISOTEC Health and Safety Manual.

Section 11 HEALTH AND SAFETY PLAN APPROVALS

The authorized signatures below verify that this Health and Safety Plan has been read and approved for the work to be performed at the subject site:

ISOTEC Case Name: MCB, Camp Lejeune

ISOTEC Case Number: 900085

Stan Haskins
ISOTEC Project Manager

Date

Tom Andrews
ISOTEC Director of Health and Safety

Date

Section 12 HEALTH AND SAFETY PLAN COMPLIANCE AGREEMENT

I have reviewed a copy of the Health and Safety Plan for _____, dated _____. I have read the HASP, understand it, and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the Health and Safety Plan.

Name	Company
Signature	Date
Name	Company
Signature	Date
Name	Company
Signature	Date
Name	Company
Signature	Date
Name	Company
Signature	Date

ATTACHMENT A

SITE LOCATION MAP

ATTACHMENT B

EMERGENCY ROUTE MAP

EMERGENCY ROUTE MAP TO BE COORIDINATED WITH CH2M HILL

ATTACHMENT C

HEALTH & SAFETY INCIDENT REPORT

IN-SITU OXIDATIVE TECHNOLOGIES, INC

HEALTH & SAFETY INCIDENT REPORT

Form HS-102

Project Number:_____ **Date/Time of Incident:** _____

Project Name:_____ **Project Location:**_____

DESCRIPTION OF INCIDENT (Describe what happened and possible cause, identify individuals involved, witnesses, and their affiliations, and describe emergency or corrective action taken.)

Reporter: _____ _____ _____

Print Name Signature Date

Reporter must deliver this report to the ISOTEC Director of Health and Safety within one day of the date of incident for medical treatment cases or vehicle accidents and within five days for other incidents.

Reviewed by:_____

Name **Signature** **Date**

ISOTEC Project Safety Log

ISOTEC SSO: _____ Date: _____
Weather: _____
Personnel Present: _____ Affiliation: _____
Work Activities: _____ Level of Protection: _____

PID (ppm)

Sample Location	Sample Time	Reading (ppm)

LEL

Sample Location	Sample Time	Reading (ppm)

O2%

Sample Location	Sample Time	Reading (ppm)

ATTACHMENT E

OSHA POSTER

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Provisions of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employers must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discriminatory action.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory civil penalties against employers of up to $7,000 for each serious violation and for optional penalties of up to $7,000 for each nonserious violation. Penalties of up to $7,000 per day may be proposed for failure to correct violations within the proposed time period and for each day the violation continues beyond the prescribed abatement date. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $70,000 for each such violation. A minimum penalty of $5,000 may be imposed for each willful violation. A violation of posting requirements can bring a penalty of up to $7,000.

There are also provisions for criminal penalties. Any willful violation resulting in the death of any employee, upon conviction, is punishable by a fine of up to $250,000 (or $500,000 if the employer is a corporation), or by imprisonment for up to six months, or both. A second conviction of an employer doubles the possible term of imprisonment. Falsifying records, reports, or applications is punishable by a fine of $10,000 or up to six months in jail or both.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

OSHA has published Safety and Health Program Management Guidelines to assist employers in establishing or perfecting programs to prevent or control employee exposure to workplace hazards. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

Consultation

Free assistance in identifying and correcting hazards and in improving safety and health management is available to employers, without citation or penalty, through OSHA-supported programs in each State. These programs are usually administered by the State Labor or Health department or a State university.

Posting Instructions

Employers in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or facsimile) in a conspicuous place where notices to employees are customarily posted.

More Information

Additional information and copies of the Act, OSHA safety and health standards, and other assistance materials may be obtained from your [illegible]

Atlanta, GA	(404) 562-2300
Boston, MA	(617) 565-8860
Chicago, [illegible]	(312) 353-2220
Dallas, TX	(214) 767-4731

Washington, DC
1997 (Reprinted)
OSHA 2203

ATTACHMENT F

HEAT AND COLD STRESS GUIDELINES

HEAT STRESS CASUALTY PREVENTION PLAN

Due to the increase in ambient air temperatures and the effects of protective outer wear decreasing body ventilation, there exists an increase in the potential for injury, specifically, heat casualties. Site personnel will be instructed in the identification of a heat stress victim, the first-aid treatment procedures for the victim and the prevention of heat stress casualties.

IDENTIFICATION AND TREATMENT

- **Heat Exhaustion**

Symptoms: Usually begins with muscular weakness, dizziness, nausea, and a staggering gait. Vomiting is frequent. The bowels may move involuntarily. The victim is very pale, skin is clammy, and may perspire profusely. The pulse is weak and fast, breathing is shallow. The victim may faint unless victim lies down. This may pass, but sometimes it remains and death could occur.

First Aid: Immediately remove the victim to the Contamination Reduction Zone in a shady or cool area with good air circulation. Remove all protective outerwear. Call a physician. Treat the victim for shock. (Make victim lie down, raise feet 6 to 12 inches and keep victim warm but loosen all clothing). If the victim is conscious, it may be helpful to ingest sips of a salt-water solution (1 teaspoon of salt to 1 glass of water). Transport victim to a medical facility as soon as possible.

- **Heat Stroke**

Symptoms: This is the most serious of heat casualties due to the fact that the body excessively overheats. Body temperatures often are between 107 degrees Fahrenheit to 110 degrees Fahrenheit. First there is often pain in the head, dizziness, nausea, oppression, and the skin is dry, red and hot. Unconsciousness follows quickly and death is imminent if exposure continues. The attack will usually occur suddenly.

First Aid: Immediately evacuate the victim to a cool and shady area in the Contamination Reduction Zone. Remove all protective outerwear and all personal clothing. Lay victim on back with the head and shoulders slightly elevated. It is imperative that the body temperature be lowered immediately. This can be accomplished by applying cold wet towels, ice bags, etc., to the head. Sponge off the bare skin with cool water or rubbing alcohol, if available, or even place victim in a tub of cool water. The main objective is to cool victim without chilling. Give no stimulants. Transport the victim to a medical facility as soon as possible.

PREVENTION OF HEAT STRESS

- One of the major causes of heat casualties is the depletion of body fluids. On the site there will be plenty of fluids available. Personnel should replace water and salts loss from sweating. Salts can be replaced by either a 0.1% salt solution, more heavily salted foods, or commercial mixes such as Gatorade. The commercial mixes are advised for personnel on low sodium diets.

- A work schedule should be established so that the majority of the work day will be during the morning hours of the day before ambient air temperature levels reach their highs.

- A work/rest guideline will be implemented for personnel at all anticipated PPE levels. This guideline is as follows:

Level D:

Ambient Temperatures	Maximum Work Period
Above 90°F	1 hours
80° to 90°F	2 hour
70° to 80°F	4 hours

Level B and C:

Ambient Temperatures	Maximum Work Period
Above 90°F	1/2 hour
80° to 90°F	1 hour
70° to 80°F	2 hours
60° to 70°F	3 hours
<60°F	4 hours

A sufficient period will be allowed for personnel to "cool down." This may require shifts of workers during operations.

HEAT STRESS MONITORING

For monitoring the body's recuperative ability to excess heat, one or more of the following techniques should be used as a screening mechanism. Monitoring of personnel wearing protective clothing should commence when the ambient temperature is 70 degrees Fahrenheit or above. Frequency of monitoring should increase as the ambient temperature increases or if slow recovery rates are indicated. When temperatures exceed 80 degrees Fahrenheit, workers must be monitored for heat stress after every work period.

- Heart rate (HR) should be measured by the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats per minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period stays the same. If the pulse rate is 100 beats per minute at the beginning of the next rest period, the following work cycle should be shortened by 33%.

- Body temperature should be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature (OT) at the beginning of the rest period should not exceed 99 degrees Fahrenheit. If it does, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period stays the same. However, if the OT exceeds 99.7 degrees Fahrenheit at the beginning of the next period, the following work cycle should be further shortened by 33%. OT should be measured again at the end of the rest period to make sure that it has dropped below 99 degrees Fahrenheit.

- Body water loss (BWL) due to sweating should be measured by weighing the worker in the morning and in the evening. The clothing worn should be similar at both weighings; preferably the worker should be nude. The scale should be accurate to plus or minus 1/4 pound. BWL should not exceed 1.5% of the total body weight. If it does, workers should be instructed to increase their daily intake of fluids by the weight lost.

Ideally, body fluids should be maintained at a constant level during the work day. This requires replacement of salt lost in sweat as well.

Good hygienic standards must be maintained by frequent change of clothing and daily showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

COLD EXPOSURE CASUALTY PREVENTION PLAN

Persons working outdoors in temperatures at or below freezing may be frostbitten. Extreme cold for a short time may cause severe injury to the surface of the body, or result in profound generalized cooling, causing death. Areas of the body which have high surface area-to-volume ratio such as fingers, toes, and ear, are the most susceptible.

EFFECTS OF COLD EXPOSURE

Two factors influence the development of a cold injury: ambient temperature and the velocity of the wind. Wind chill is used to describe the chilling effect of moving air in combination with low temperature. For instance, 10 degrees Fahrenheit with a wind of 15 mile per hour (mph) is equivalent in chilling effect to still air at -18 degrees Fahrenheit.

As a general rule, the greatest incremental increase in wind chill occurs when a wind of 5 mph increases to 10 mph. Additionally, water conducts heat 240 times faster than air. Thus, the body cools suddenly when chemical-protective equipment is removed if the clothing underneath is perspiration soaked.

Local injury resulting from cold is included in the generic term frostbite. There are severe degrees of damage. Frostbite of the extremities can be categorized into:

- **Frost nip or incipient frostbite:** characterized by suddenly blanching or whitening of skin.
- **Superficial frostbite:** skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- **Deep Frostbite:** tissues are cold, pale, and solid; extremely serious injury.

To administer first aid for frostbite, bring the victim indoors and rewarm the areas quickly in water between 102 degrees Fahrenheit and 105 degrees Fahrenheit. Give a warm drink not coffee, tea or alcohol. The victim should not smoke. Keep the frozen parts in warm water or covered with warm clothes for 30 minutes, even though the tissue will be very painful as it thaws. Then elevate the injured area and protect it from injury. Do not allow blisters to be broken. Use sterile, soft, dry material to cover the injured areas. Keep victim warm and get immediate medical care.

After thawing, the victim should try to move the injured areas a little, but no more than can be done alone, without help.

- Do not rub the frostbitten part (this may cause gangrene).
- Do not use ice, snow, gasoline or anything cold on frostbite.
- Do not use heat lamps or hot water bottles to rewarm the part.
- Do not place the part near a hot stove.

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature, it symptoms are usually exhibited in five stages; 1) shivering; 2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95 degrees Fahrenheit; 3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; 4) freezing of the extremities; and, finally, 5) death.

ATTACHMENT G

EMERGENCY PROCEDURES

EMERGENCY MEDICAL TREATMENT AND FIRST AID PROCEDURES

If an employee working at the Site is physically injured, emergency medical treatment and/or First Aid procedures will be followed. Depending on the severity of the injury, emergency medical response may be sought. If the employee can be moved, they will be taken to the edge of the work area (on a stretcher, if needed) where contaminated clothing will be removed (if possible), emergency first aid administered, and transportation to local emergency medical facility awaited.

If the injury to the worker is chemical in nature (e.g., overexposure), the following procedures are to be instituted as soon as possible:

- Eye Exposure - If contaminated solid or liquid gets into the eyes, wash eyes immediately at the emergency eyewash stations using large amounts of water and lifting the lower and upper lids occasionally. Obtain medical attention immediately. (Contact lenses are not permitted in the Exclusion Areas.)

- Skin Exposure - If contaminated solid or liquid gets on the skin, promptly wash contaminated skin using soap or mild detergent and water. If solids or liquid penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Obtain medial attention immediately if symptoms warrant.

- Breathing - If a person breathes in large amounts of organic vapor, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Obtain medical attention as soon as possible.

- Swallowing - If contaminated solid or liquid has been swallowed and the person is conscious, feed the person large quantities of salt water immediately and induce vomiting (unless the person is unconscious). Obtain medical attention immediately.

First Aid Procedures

- Remove the injured or exposed person(s) from immediate danger.

- Render first aid if necessary, decontaminate affected personnel, if necessary.

- Call an ambulance for transport to local hospital immediately. This procedure should be followed even if there is no apparent serious injury.

- Evacuate other personnel on-site to a safe place until the ISOTEC Site Safety Officer determines that it is safe for work to resume.

- Report the accident to the ISOTEC Director of Health and Safety immediately.

ATTACHMENT H

MSDS SHEETS

MATERIAL SAFETY DATA SHEET

Hydrogen Peroxide (40 to 60%)

MSDS Ref. No: 7722-84-1-4
Version: US/Canada
Date Approved: 06/10/2002
Revision No: 6

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: Hydrogen Peroxide (40 to 60%)
ALTERNATE TRADE NAME(S): Durox® Reg. & LR 50%, Hybrite® 50%, Oxypure® 50%, Semiconductor Reg & Seg 50%, Standard 50%, Technical 50%, Chlorate Grade 50%, Super D® 50%
GENERAL USE: Durox® 50% Reg. and LR - meets the Food Chemical Codex requirements for aseptic packaging and other food related applications.

Oxypure® 50% - certified by NSF to meet ANSI/NSF Std 60 requirements for drinking water treatment.

Standard 50% - most suitable for industrial bleaching, processing, pollution abatement and general oxidation reactions.

Semiconductor Reg. & Seg. 50% - conforms to ACS and Semi Specs., for water etching and cleaning, and applications requiring low residues.

Super D® 50% - meets US Pharmacopoeia specifications for 3% topical solutions when diluted with proper quality water. While manufactured to th eUSP standards or purity and to FMC's demanding ISO 9002 quality standards, FMC does not claim that its Hydrogen Peroxide is manufactured in accordance with all pharmaceutical cGMP conditions.

Technical 50% - essentially free of inorganic metals, suitable for chemical synthesis.

Chlorate Grade 50% - specially formulated for use in chlorate manufacture or processing.

MANUFACTURER

FMC of Canada Ltd.
Hydrogen Peroxide Division
PG Pulp Mill Road
Prince George, BC V2N2S6
General Information: 604-561-4200

FMC Corporation
Hydrogen Peroxide Division
1735 Market Street
Philadelphia, PA 19103
General Information: (215) 299-6000

Emergency Telephone Numbers:

CHEMTREC (U.S.): (800) 424-9300
Emergency Phone 613-996-6666 (Canutec)

Emergency Phone (303) 595-9048 (Medical) Call Collect
Emergency Phone (609) 924-6677 (Plant) Call Collect

2. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Wt.%
Hydrogen Peroxide	7722-84-1	40 - 60
Water	7732-18-5	40 - 60

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

IMMEDIATE CONCERNS: Oxidizer. Contact with combustibles may cause fire. Decomposes yielding oxygen that supports combustion of organic matters and can cause overpressure if confined.

POTENTIAL HEALTH EFFECTS: Corrosive to eyes, skin, nose, throat and lungs. May cause irreversible tissue damage to the eyes including blindness.

4. FIRST AID MEASURES

EYES: Immediately flush with water for at least 15 minutes, lifting the upper and lower eyelids intermittently. See a medical doctor or ophthalmologist immediately.

SKIN: Immediately flush with plenty of water while removing contaminated clothing and/or shoes, and thoroughly wash with soap and water. See a medical doctor immediately.

INGESTION: Rinse mouth with water. Dilute by giving 1 or 2 glasses of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. See a medical doctor immediately.

INHALATION: Remove to fresh air. If breathing difficulty or discomfort occurs and persists, contact a medical doctor.

NOTES TO MEDICAL DOCTOR: Hydrogen peroxide at these concentrations is a strong oxidant. Direct contact with the eye is likely to cause corneal damage especially if not washed immediately. Careful ophthalmologic evaluation is recommended and the possibility of local corticosteroid therapy should be considered. Because of the likelihood of corrosive effects on the gastrointestinal tract after ingestion, and the unlikelihood of systemic effects, attempts at evacuating the stomach via emesis induction or gastric lavage should be avoided. There is a remote possibility, however, that a nasogastric or orogastric tube may be required for the reduction of severe distension due to gas formation.

5. FIRE FIGHTING MEASURES

FLASH POINT AND METHOD: Non-combustible

FLAMMABLE LIMITS: Non-combustible

AUTOIGNITION TEMPERATURE: Non-combustible

EXTINGUISHING MEDIA: Flood with water.

FIRE / EXPLOSION HAZARDS: Product is non-combustible. On decomposition releases oxygen which may intensify fire.

FIRE FIGHTING PROCEDURES: Any tank or container surrounded by fire should be flooded with water for cooling. Wear full protective clothing and self-contained breathing apparatus.

SENSITIVITY TO STATIC DISCHARGE: No data available

SENSITIVITY TO IMPACT: No data available

HAZARDOUS DECOMPOSITION PRODUCTS: Oxygen which supports combustion.

---

6. ACCIDENTAL RELEASE MEASURES

RELEASE NOTES: Dilute with a large volume of water and hold in a pond or diked area until hydrogen peroxide decomposes. Hydrogen peroxide may be decomposed by adding sodium metabisulfite or sodium sulfite after diluting to about 5%. Dispose according to methods outlined for waste disposal.

Combustible materials exposed to hydrogen peroxide should be immediately submerged in or rinsed with large amounts of water to ensure that all hydrogen peroxide is removed. Residual hydrogen peroxide that is allowed to dry (upon evaporation hydrogen peroxide can concentrate) on organic materials such as paper, fabrics, cotton, leather, wood or other combustibles can cause the material to ignite and result in a fire.

---

7. HANDLING AND STORAGE

HANDLING: Wear cup type chemical safety goggles and full-face shield, impervious clothing, such as rubber, PVC, etc., and rubber or neoprene gloves and shoes. Avoid cotton, wool and leather. Avoid excessive heat and contamination. Contamination may cause decomposition and generation of oxygen gas which could result in high pressures and possible container rupture. Hydrogen peroxide should be stored only in vented containers and transferred only in a prescribed manner (see FMC Technical Bulletins). Never return unused hydrogen peroxide to original container, empty drums should be triple rinsed with water before discarding. Utensils used for handling hydrogen peroxide should only be made

of glass, stainless steel, aluminum or plastic.

STORAGE: Store drums in cool areas out of direct sunlight and away from combustibles. For bulk storage refer to FMC Technical Bulletins.

COMMENTS: VENTILATION:
Provide mechanical general and/or local exhaust ventilation to prevent release of vapor or mist into the work environment.

---

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMITS

Chemical Name	TWA (ACGIH)	STEL/Ceiling (ACGIH)	PEL (OSHA)	STEL/Ceiling (OSHA)
Hydrogen Peroxide	1 ppm		1 ppm	

ENGINEERING CONTROLS: Ventilation should be provided to minimize the release of hydrogen peroxide vapors and mists into the work environment. Spills should be minimized or confined immediately to prevent release into the work area. Remove contaminated clothing immediately and wash before reuse.

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Use cup type chemical goggles. Full face shield may be used.

RESPIRATORY: If concentrations in excess of 10 ppm are expected use approved self-contained breathing apparatus. Do not use oxidizable sorbants such as activated carbon.

PROTECTIVE CLOTHING: Liquid proof rubber or neoprene gloves. Rubber or neoprene footwear (avoid leather). Impervious clothing materials such as rubber, neoprene, nitrile or polyvinyl chloride (avoid cotton, wool and leather). Completely submerge hydrogen peroxide contaminated clothing or other materials in water prior to drying. Residual hydrogen peroxide, if allowed to dry on materials such as paper, fabrics, cotton, leather, wood or other combustibles can cause the material to ignite and result in a fire.

---

9. PHYSICAL AND CHEMICAL PROPERTIES

ODOR: Odorless

APPEARANCE: Clear, colorless liquid

pH: (as is) 1.0 to 3.0

PERCENT VOLATILE: 100%

VAPOR PRESSURE: 22 mmHg @ 30°C (40%); 18.3 mmHg @ 30°C (50%)

VAPOR DENSITY: (Air = 1): Not available

BOILING POINT: 110°C (229°F) (40%); 114°C (237°F) (50%)

FREEZING POINT: -41.4°C (-42.5°F) (40%); -52°C (-62°F) (50%)

SOLUBILITY IN WATER: (in H2O % by wt) 100%

EVAPORATION RATE: (Butyl Acetate = 1) Above 1

DENSITY: Not available

SPECIFIC GRAVITY: (H20 = 1) 1.15 @ 20°C/4°C (40%); 1.19 @ 20°C/4°C (50%)

COEFF. OIL/WATER: Not available

ODOR THRESHOLD: Not available

OXIDIZING PROPERTIES: Strong oxidizer

COMMENTS: pH (1% solution) : 5.0 - 6.0

---

10. STABILITY AND REACTIVITY

CONDITIONS TO AVOID: Excessive heat or contamination could cause product to become unstable.

STABILITY: Stable (heat and contamination could cause decomposition)

POLYMERIZATION: Will not occur

HAZARDOUS DECOMPOSITION PRODUCTS: Oxygen which supports combustion.

INCOMPATIBLE MATERIALS: Reducing agents, wood, paper and other combustibles, iron and other heavy metals, copper alloys and caustic.

COMMENTS: Materials to Avoid : Dirt, organics, cyanides and combustibles such as wood, paper, oils, etc.

---

11. TOXICOLOGICAL INFORMATION

EYE EFFECTS: Severe irritant (corrosive), (rabbit), (70% hydrogen peroxide) [FMC Study Number: ICG/T-79.027]

SKIN EFFECTS: Severe irritant (corrosive), (rabbit), (50% hydrogen peroxide) [FMC Study Number: I89-1079]

DERMAL LD_{50}: >6.5 g/kg (rabbit) (70% hydrogen peroxide) [FMC Study Number: ICG/T-79.027]

ORAL LD_{50}: >225 mg/kg (rat) (50% hydrogen peroxide) [FMC Study Number: I86-914]

INHALATION LC_{50}: >0.17 mg/L (rat) (50% hydrogen peroxide) [FMC Study Number: I89-1080]

TARGET ORGANS: Eye, skin, nose, throat, lungs

ACUTE EFFECTS FROM OVEREXPOSURE: Severe irritant/corrosive to eyes, skin and gastrointestinal tract. May cause irreversible tissue damage to the eyes including blindness. Inhalation of mist or vapors may be severely irritating to nose, throat and lungs.

CHRONIC EFFECTS FROM OVEREXPOSURE: There are reports of limited evidence of carcinogenicity of hydrogen peroxide to mice administered high concentrations in their drinking water (IARC Monograph 36, 1985). However, the International Agency For Research on Cancer concluded that hydrogen peroxide could not be classified as to its carcinogenicity to humans (Group III carcinogen).

CARCINOGENICITY

Chemical Name	NTP Status	IARC Status	OSHA Status	Other
Hydrogen Peroxide	Not listed	Not listed	Not listed	(ACGIH) Listed (A3, Animal Carcinogen)

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION: Channel catfish 96 hour LC50 = 37.4 mg/L
Fathead minnow 96 hour LC50 = 16.4 mg/L
Daphnia magna 24 hour EC50 = 7.7 mg/L
Daphnia pulex 48 hour LC50 = 2.4 mg/L
Freshwater snail 96 hour LC50 = 17.7 mg/L

For more information refer to ECETOC "Joint Assessment of Commodity Chemicals No. 22, Hydrogen Peroxide." ISSN-0773-6339, January 1993

CHEMICAL FATE INFORMATION: Hydrogen peroxide in the aquatic environment is subject to various reduction or oxidation processes and decomposes into water and oxygen. Hydrogen peroxide half-life in freshwater ranged from 8 hours to 20 days, in air from 10-20 hrs. and in soils from minutes hours depending upon microbiological activity and metal contaminants.

---

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: An acceptable method of disposal is to dilute with a large amount of water and allow the hydrogen peroxide to decompose followed by discharge into a suitable treatment system in accordance with all regulatory agencies. The appropriate regulatory agencies should be contacted prior to disposal.

---

14. TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

PROPER SHIPPING NAME: Hydrogen peroxide, aqueous solutions with more than 40% but not more than 60% hydrogen peroxide.

PRIMARY HAZARD CLASS/DIVISION: 5.1 (Oxidizer)

UN/NA NUMBER: UN 2014

PACKING GROUP: II

PLACARDS: 5.1 (Oxidizer)

LABEL: Oxidizer Corrosive

OTHER SHIPPING INFORMATION:
DOT Marking: Hydrogen Peroxide, aqueous solution with more than 40%, but not more than 60% Hydrogen Peroxide, UN 2014
Hazardous Substance/RQ: Not applicable
49 STCC Number : 4918776

Aluminum tanks, drum/DOT 42D

SPECIAL SHIPPING NOTES: IMDG: Hydrogen Peroxide, aqueous solutions with more than 40%, but not more than 60% hydrogen peroxide.

IATA: Hydrogen Peroxide (40 - 60%) is forbidden on Passenger and Cargo Aircraft, as well as Cargo Only Aircraft.

Protect from physical damage. Keep drums in upright position. Drums should not be stacked in transit. Do not

store drum on wooden pallets.

15. REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355):
Hydrogen Peroxide > 52%
RQ: 1000 lbs.
Planning Threshold: 1000 lbs.

SECTION 311 HAZARD CATEGORY (40 CFR 370):
Fire Hazard
Immediate (Acute) Health Hazard

SECTION 312 THRESHOLD PLANNING QUANTITY (40 CFR 370): 1000 lbs. (conc. >52%); 10000 lbs. (conc. <52%)

SECTION 313 REPORTABLE INGREDIENTS (40 CFR 372): Not listed

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT)

CERCLA REGULATORY (40 CFR 302.4): Unlisted (Hydrogen Peroxide); RQ = 100 lbs.; Ignitability, Corrosivity

TSCA (TOXIC SUBSTANCE CONTROL ACT)

TSCA STATUS (40 CFR 710): Listed

RCRA STATUS: Waste No. D001 Waste No. D002

CANADA

WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM):
Hazard Classification: Class C (Oxidizer), Class D, Div. 2 Subdiv. B, Class E (Corrosive)
Product Identification No. : 2014
Ingredient Disclosure List: Listed

16. OTHER INFORMATION

REVISION SUMMARY

This MSDS replaces Revision #5, dated September 29, 2000. Changes in information are as follows:

Section 16 (Other Information): HMIS Headings

HMIS RATING

HEALTH:	3
FLAMMABILITY	0
PHYSICAL HAZARD:	1
PERSONAL PROTECTION (PPE):	H

NFPA RATING

HEALTH:	3
FLAMMABILITY	0
REACTIVITY:	1
SPECIAL:	OX

Key
4 = Severe
3 = Serious
2 = Moderate
1 = Slight
0 = Minimal

HMIS RATINGS NOTES: Protection = H (Safety goggles, gloves, apron, the use of a supplied air or SCBA respirator is required in lieu of a vapor cartridge respirator)

GENERAL STATEMENTS: Note: NFPA - Reactivity is 3, when greater than 52%

The contents and format of this MSDS are in accordance with OSHA Hazard Communication Standard and Canada's Workplace Hazardous Information System (WHMIS).

National Fire Protection Association (NFPA)

SPECIAL = OX (Oxidizer)

Hazardous Materials Identification System (HMIS)

TMC CHEMICALS, INCORPORATED
P.O. BOX 5430
PARSIPPANY, NJ 07054
PHONE: 973-560-1400
FAX: 973-560-0400

MATERIAL SAFETY DATA SHEET

SECTION 1 - MATERIAL IDENTIFICATION

PRODUCT NAME	ISOTEC[SM] Stabilizer 0875

ISOTEC is a registered servicemark of In-Situ Oxidative Technologies, Inc.

MANUFACTURER	TMC Chemical, Inc. P.O. Box 5430 Parsippany, NJ 07054
EMERGENCY TELEPHONE NUMBER(S)	(973) 560-1400 (Northern NJ) (609) 275-8500 (Southern NJ)
DATE PREPARED:	JANUARY 1996 (Revised, 8/00)
C.A.S. CHEMICAL NAME	Not Applicable (Mixture)
SYNONYMS	None
CHEMICAL FAMILY	Not Applicable
EMPIRICAL FORMULA	MIXT
INTENDED USE	Stabilizing Agent

SECTION 2 - INGREDIENTS

CAS Number and Chemical Name	%	OSHA ACGIH PEL/TLV-TWA ppm - mg/M^3	ACGIH STEL-TWA ppm - mg/M^3
Stabilizer is a trade secret	100	Not established	Not established

This product is not listed as a known or suspect carcinogen by NTP or IARC

MATERIAL SAFETY DATA SHEET

SECTION 3 - HEALTH HAZARDS

EMERGENCY OVERVIEW

ROUTES OF EXPOSURE

Inhalation, Skin Contact, Ingestion

EXPOSURE STANDARDS

No exposure standards have been established

HEALTH HAZARDS

Amount of respirable dust is low in the product; however, it may cause skin or eye irritation upon prolonged exposure. May be harmful if swallowed.

TARGET ORGANS

Skin and mucous membranes

SIGNS AND SYMPTOMS OF EXPOSURE (Acute and Chronic effects)

No published data on skin absorption, contact, inhalation or ingestion. Human industrial experience has shown no significant inhalation hazard nor skin irritation for low level long term exposure. May be a moderate irritant to unirrigated eyes and mildly irritating after irrigating eyes following overexposure.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

None reported

IRRITATION EFFECTS DATA

No Data

ACUTE TOXICITY EFFECTS DATA

Oral LD50 - No Data

Dermal LD50 - No Data

OTHER ACUTE EFFECTS

No Data

CHRONIC/SUBCHRONIC DATA

No Data

MATERIAL SAFETY DATA SHEET

SECTION 4 - FIRST AID

EYE CONTACT

Hold eyelids apart and immediately flush eyes with plenty of water for at least 15 minutes. If irritation occurs and persists, call a physician.

SKIN CONTACT

Wash affected area immediately with soap and water.

INHALATION

In case of inhalation or suspected inhalation, move patient at once to fresh air.

INGESTION

Rinse mouth and dilute stomach contents with water or, preferably, with milk. Large doses may cause nausea, vomiting and diarrhea. Systematic oral toxicity is extremely rare and has consisted of acidosis and hypocalcemic tetany.

SECTION 5 - FIRE AND EXPLOSION DATA

CHARACTERISTICS:

Flash Point	None
Upper Explosive Limit (UEL)	None
Lower Explosive Limit (LEL)	None
Autoignition Temperature	No Data
Flash Point Method(s)	Not Applicable
Fire Hazard Classification (OSHA/NFPA)	None

EXTINGUISHING MEDIA

Product is noncombustible.

SPECIAL FIRE FIGHTING PROCEDURES

Not Applicable

UNUSUAL FIRE AND EXPLOSION HAZARDS

None

MATERIAL SAFETY DATA SHEET

SECTION 6 - REACTIVITY DATA

CHEMICAL STABILITY
Stable

INCOMPATIBILITIES
None

CONDITIONS TO AVOID
None

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
None

HAZARDOUS POLYMERIZATON
Will not occur

NFPA Reactivity Rating
None

SECTION 7 - SPILL, LEAK AND WASTE DISPOSAL INFORMATION

CLEAN-UP PROCEDURES
Material should be swept up for salvage or disposal.

OTHER EMERGENCY ADVISE
Avoid eye and skin contact. Wear appropriate protective clothing.

WASTE DISPOSAL
This product does not present a danger or hazard for disposal. May be disposed of in a properly designated landfill if needed.

ENVIRONMENTAL EFFECTS
Aquatic Toxicity unknown

SECTION 8 - PERSONAL PROTECTION/EXPOSURE CONTROLS

EYE PROTECTION

Wear chemical goggles when airborne dust is anticipated.

HAND PROTECTION

Impermeable gloves.

RESPIRATORY PROTECTION

Wear appropriate NIOSH/MSHA-approved respirator for dust protection if release of the product into the work area is expected.

PROTECTIVE CLOTHING

Long sleeved clothing to reduce exposed skin area.

ENGINEERING CONTROLS

Avoid drafts that may disperse material beyond the work area.

WORK AND HYGIENIC PRACTICES

Provide readily accessible eye wash stations. Wash at the end of each work shift and before eating, smoking or using the toilet.

SECTION 9 - STORAGE AND HANDLING

STORAGE

Keep container tightly closed and dry. Keep in a cool place.

HANDLING

Do not inhale. Avoid contact with skin and eyes.

OTHER PRECAUTIONS:

Carefully read instructions before handling this material. Be sure that all engineering and personal protective equipment is in working order.

MATERIAL SAFETY DATA SHEET

SECTION 10 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL FORM	Solid
COLOR	White
ODOR	None

TYPICAL PHYSICAL DATA

pH (1% solution)	4.6
VAPOR PRESSURE (mm Hg)	Non-Volatile
VAPOR DENSITY (Air = 1)	Non-Volatile
BOILING POINT	Not Applicable
FREEZING/MELTING POINT	253° C
SOLUBILITY IN WATER	20% by weight @ 25°C
SPECIFIC GRAVITY (Water = 1)	1.2
EVAPORATION RATE (Butylacetate = 1)	Non-Volatile
VISCOSITY (CPS)	No Data

SECTION 11 - TRANSPORTATION INFORMATION

UN No. 1481	
DOT SHIPPING NAME	No Data
IMO SHIPPING NAME	No Data
LATA SHIPPING NAME	No Data

The information set forth above is based upon information which TMC Chemical, Inc. believes to be accurate. No warranty, express or implied, is intended. The information is provided solely for your information and consideration and TMC Chemical, Inc. assumes no legal responsibility for use or reliance thereon.

TMC CHEMICALS, INCORPORATED
P.O. BOX 5430
PARSIPPANY, NJ 07054

PHONE: 973-560-1400
FAX: 973-560-0400

MATERIAL SAFETY DATA SHEET

SECTION 1 - MATERIAL IDENTIFICATION

PRODUCT NAME	ISOTEC[SM] Catalyst Series 4260 Component-A Powder Mix

ISOTEC[SM] is a registered servicemark of In-Situ Oxidative Technologies, Inc.

MANUFACTURER	TMC Chemicals, Inc. P.O. Box 5430 Parsippany, NJ 07054
EMERGENCY TELEPHONE NUMBER(S)	(973) 560-1400 (Northern NJ) (609) 275-8500 (Southern NJ)
DATE PREPARED:	May 2000 (Revised)
C.A.S. CHEMICAL NAME	Mixture
SYNONYMS	None
CHEMICAL FAMILY	Not Applicable
EMPIRICAL FORMULA	MIXT
INTENDED USE	Catalyst

SECTION 2 - INGREDIENTS

CAS Number and Chemical Name	%	OSHA ACGIH PEL/TLV-TWA ppm - mg/M^3	ACGIH STEL-TWA ppm - mg/M^3
Catalyst is a trade secret	100	Not established	Not established

SECTION 3 - HEALTH HAZARDS

EMERGENCY OVERVIEW

Applicable properties are relevant to the mixture when certain proprietary ingredients present at their highest concentrations. Please note that the effects are normally lower for a typical mixture with smaller concentrations of these ingredients present.

ROUTES OF EXPOSURE
Inhalation, Skin Contact, Ingestion

EXPOSURE STANDARDS
See Section 2 for exposure standards on ingredients

HEALTH HAZARDS
Eye and skin irritant, harmful if inhaled or swallowed

TARGET ORGANS
Eyes, respiratory tract

SIGNS AND SYMPTOMS OF EXPOSURE (Acute and Chronic effects)
Irritant to mucous membranes and upper respiratory tract; stinging of eyes, causes eye and skin irritation, stomach ache, breathing difficulty

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
Not Evaluated

IRRITATION EFFECTS DATA
Not Evaluated

ACUTE TOXICITY EFFECTS DATA
Oral LD50 - Not Evaluated
Dermal LD50 - Not Evaluated

OTHER ACUTE EFFECTS
Not Evaluated

CHRONIC/SUBCHRONIC DATA
Not Evaluated

SECTION 4 - FIRST AID

EYE CONTACT

Hold eyelids apart and immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

SKIN CONTACT

Wash affected area immediately with soap and water.

INHALATION

In case of inhalation or suspected inhalation, move patient at once to fresh air and call a physician. Keep patient absolutely quiet. If breathing has stopped or is labored, give assisted respiration (e.g., mouth-to-mouth). Supplemental oxygen may be indicated.

INGESTION

If swallowed, call a physician immediately. Induce vomiting or remove stomach contents by gastric suction only as directed by medical personnel. Wash mouth with plenty of water. Never give anything by mouth to an unconscious person.

SECTION 5 - FIRE AND EXPLOSION DATA

CHARACTERISTICS:

Flash Point	None
Upper Explosive Limit (UEL)	Not Applicable
Lower Explosive Limit (LEL)	Not Applicable
Autoignition Temperature	Not Applicable
Flash Point Method(s)	None
Unusual Fire & Explosion Hazards	None
Fire Hazard Classification (OSHA/NFPA)	None

EXTINGUISHING MEDIA

In case of fire, flood with water.

SPECIAL FIRE FIGHTING PROCEDURES

Firefighters should wear butyl rubber boots, gloves, body suit and self-containing breathing apparatus. Use water spray to cool all affected containers. Avoid skin contact. Contain runoff water in dikes. Prevent stream contamination. Expended liquids from fire fighting should be diverted to an active sanitary sewer line.

UNUSUAL FIRE AND EXPLOSION HAZARDS

May emit toxic fumes of sulfur oxides under burning conditions. See Section 6 for hazardous combustion products.

SECTION 6 - REACTIVITY DATA

CHEMICAL STABILITY
Stable

INCOMPATIBILITIES
Avoid mixing powder with strong oxidizing agents and alkalies

CONDITIONS TO AVOID
Contact with combustible materials, heat

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
Toxic fumes of Sulfur oxides i.e. SO_2 and SO_3

HAZARDOUS POLYMERIZATON
Will not occur

NFPA Reactivity Rating
None

SECTION 7 - SPILL, LEAK AND WASTE DISPOSAL INFORMATION

CLEAN-UP PROCEDURES
Sweep up and repackage or place in receptacle for future disposal.

OTHER EMERGENCY ADVISE
Avoid eye and skin contact. Wear protective clothing including gloves, safety goggles, breathing mask and coveralls when handling. Stored materials should be placed in a dry and reasonably temperature area, preferably below 75°F.

WASTE DISPOSAL
Remove to properly designated landfill. Observe all federal, state and local environmental regulations.

ENVIRONMENTAL EFFECTS
Data not yet available

SECTION 8 - PERSONAL PROTECTION/EXPOSURE CONTROLS

EYE PROTECTION

Splash proof goggles.

HAND PROTECTION

Impermeable gloves made of Nitrile or rubber.

RESPIRATORY PROTECTION

Wear appropriate NIOSH/MSHA-approved full-face respirator with HEPA cartridges for particulate matter/ dust.

PROTECTIVE CLOTHING

Long sleeved clothing (e.g. cotton coveralls or Tyvek).

ENGINEERING CONTROLS

Avoid drafts that may disperse material beyond the work area. Use light water spray for dust suppression.

WORK AND HYGIENIC PRACTICES

Provide readily accessible eye wash stations. Wash at the end of each work shift and before eating, smoking or using the toilet.

SECTION 9 - STORAGE AND HANDLING

STORAGE

Keep container tightly closed and dry. Keep in a cool place. Do not store next to strong oxidizers (e.g. hydrogen peroxide). Store approximately 10 feet away from oxidizers.

HANDLING

Do not inhale. Avoid contact with skin and eyes.

OTHER PRECAUTIONS:

Carefully read instructions before handling this material. Be sure that all engineering and personal protective equipment is in working order.

MATERIAL SAFETY DATA SHEET

SECTION 10 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL FORM	Powder
COLOR	Light Green
ODOR	None

TYPICAL PHYSICAL DATA

pH (10% aqueous)	3.5-3.9
VAPOR PRESSURE (mm Hg)	0
VAPOR DENSITY (Air = 1)	Not Applicable
BOILING POINT	Decomposition at 300°C
FREEZING/MELTING POINT	Not Applicable
SOLUBILITY IN WATER	57% by weight @ 158°
SPECIFIC GRAVITY (Water = 1)	1.899 @ 14°/ 8°C
EVAPORATION RATE (Butylacetate = 1)	Non Volatile
VISCOSITY (CPS)	Not Evaluated

SECTION 11 - TRANSPORTATION INFORMATION

UN No. 1481	
DOT SHIPPING NAME	No Data
IMO SHIPPING NAME	No Data
LATA SHIPPING NAME	No Data

The information set forth above is based upon information which TMC Chemicals, Inc. believes to be accurate. No warranty, express or implied, is intended. The information is provided solely for your information and consideration and TMC Chemical, Inc. assumes no legal responsibility for use or reliance thereon.

TMC CHEMICALS, INCORPORATED
P.O. BOX 5430
PARSIPPANY, NJ 07054
PHONE: 973-560-1400
FAX: 973-560-0400

MATERIAL SAFETY DATA SHEET

SECTION 1 - MATERIAL IDENTIFICATION

PRODUCT NAME	ISOTEC[SM] Catalyst-4260 Chelopolychempremox-B

ISOTEC is a registered servicemark of In-Situ Oxidative Technologies, Inc.

MANUFACTURER	TMC Chemicals, Inc. P.O. Box 5430 Parsippany, NJ 07054
EMERGENCY TELEPHONE NUMBER(S)	(973) 560-1400 (Northern NJ) (609) 275-8500 (Southern NJ)
DATE PREPARED:	May 2000 (revised)
C.A.S. CHEMICAL NAME	Mixture
SYNONYMS	None
CHEMICAL FAMILY	Not Applicable
EMPIRICAL FORMULA	MIXT
INTENDED USE	Catalyst

SECTION 2 - INGREDIENTS

CAS Number and Chemical Name	%	OSHA ACGIH PEL/TLV-TWA ppm - mg/M^3	ACGIH STEL-TWA ppm - mg/M^3
Catalyst is a trade secret	100	Not established	Not established

SECTION 3 - HEALTH HAZARDS

EMERGENCY OVERVIEW

Applicable properties are relevant to the mixture when certain proprietary ingredients present at their highest concentrations. Please note that the effects are normally lower for a typical mixture with smaller concentrations of these ingredients present.

ROUTES OF EXPOSURE
Inhalation, Skin Contact, Ingestion

EXPOSURE STANDARDS
See Section 2 for exposure standards on ingredients

HEALTH HAZARDS
Eye and skin irritant, may be harmful if inhaled or swallowed

TARGET ORGANS
Kidney, Ureter, Bladder

SIGNS AND SYMPTOMS OF EXPOSURE (Acute and Chronic effects)
Irritant to mucous membranes and upper respiratory tract; causes eye and skin irritation

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
Not Evaluated

IRRITATION EFFECTS DATA
Not Evaluated

ACUTE TOXICITY EFFECTS DATA
Oral LD50 - Not Evaluated
Dermal LD50 - Not Evaluated

OTHER ACUTE EFFECTS
Not Evaluated

CHRONIC/SUBCHRONIC DATA
Not Evaluated

SECTION 4 - FIRST AID

EYE CONTACT

Hold eyelids apart and immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

SKIN CONTACT

Wash affected area immediately with soap and water.

INHALATION

In case of inhalation or suspected inhalation, move patient at once to fresh air and call a physician. Keep patient absolutely quiet. If breathing has stopped or is labored, give assisted respiration (e.g., mouth-to-mouth). Supplemental oxygen may be indicated.

INGESTION

If swallowed, call a physician immediately. Induce vomiting or remove stomach contents by gastric suction only as directed by medical personnel. Wash mouth with plenty of water. Never give anything by mouth to an unconscious person.

SECTION 5 - FIRE AND EXPLOSION DATA

CHARACTERISTICS:

Flash Point	Not Evaluated
Upper Explosive Limit (UEL)	Not Applicable
Lower Explosive Limit (LEL)	Not Applicable
Autoignition Temperature	Not Evaluated
Flash Point Method(s)	Not Specified
Fire Hazard Classification (OSHA/NFPA)	None

EXTINGUISHING MEDIA

In case of fire, flood with water.

SPECIAL FIRE FIGHTING PROCEDURES

Firefighters should wear butyl rubber boots, gloves, body suit and self containing breathing apparatus. Use water spray to cool all affected containers. Avoid skin contact. Contain runoff water in dikes. Prevent stream contamination. Expended liquids from fire fighting should be diverted to an active sanitary sewer line.

UNUSUAL FIRE AND EXPLOSION HAZARDS

May emit oxides of carbon, nitrogen, and sulfur under burning conditions.

SECTION 6 - REACTIVITY DATA

CHEMICAL STABILITY
Stable

INCOMPATIBILITIES
Strong Oxidizing Agents. Do not mix with pure oxidizing agents

CONDITIONS TO AVOID
Contact with combustible materials, heat

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS
Oxides of carbon, nitrogen and sulfur.

HAZARDOUS POLYMERIZATON
Will not occur

NFPA Reactivity Rating
None

SECTION 7 - SPILL, LEAK AND WASTE DISPOSAL INFORMATION

CLEAN-UP PROCEDURES
Do not mix combustible substances (e.g., sawdust) with spilled material. Do not raise dust while sweeping.

OTHER EMERGENCY ADVISE
Avoid eye and skin contact. Wear protective clothing.

WASTE DISPOSAL
Sweep up, place in a bag and hold for waste disposal. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. Observe all federal, state and local environmental regulations.

ENVIRONMENTAL EFFECTS
Data not yet available

SECTION 8 - PERSONAL PROTECTION/EXPOSURE CONTROLS

EYE PROTECTION

Splash-proof goggles.

HAND PROTECTION

Impermeable gloves made of Nitrile or rubber.

RESPIRATORY PROTECTION

Wear appropriate NIOSH/MSHA-approved full-face respirator with HEPA cartridges for particulate matter/ dust.

PROTECTIVE CLOTHING

Long sleeved clothing such as cotton coveralls or Tyvek.

ENGINEERING CONTROLS

Avoid drafts that may disperse material beyond the work area. Use light water spray for dust suppression.

WORK AND HYGIENIC PRACTICES

Provide readily accessible eye wash stations. Wash at the end of each work shift and before eating, smoking or using the toilet.

SECTION 9 - STORAGE AND HANDLING

STORAGE

Keep container tightly closed and dry. Keep in a cool place. Do not store near strong oxidizers (e.g. hydrogen peroxide). Store at least 10 feet away.

HANDLING

Do not inhale. Avoid contact with skin and eyes.

OTHER PRECAUTIONS:

Carefully read instructions before handling this material. Be sure that all engineering and personal protective equipment is in working order.

MATERIAL SAFETY DATA SHEET

SECTION 10 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL FORM	Powder
COLOR	White
ODOR	None

TYPICAL PHYSICAL DATA

pH (10% aqueous solution)	7.9-8.5
VAPOR PRESSURE (mm Hg)	Non Volatile
VAPOR DENSITY (Air = 1)	Non Volatile
BOILING POINT	Not Applicable
FREEZING/MELTING POINT	> 300°C
SOLUBILITY IN WATER	Soluble
SPECIFIC GRAVITY (Water = 1)	Not Evaluated
EVAPORATION RATE (Butylacetate = 1)	Non Volatile
VISCOSITY (CPS)	Not Evaluated

SECTION 11 - TRANSPORTATION INFORMATION

UN No. 1481	
DOT SHIPPING NAME	No Data
IMO SHIPPING NAME	No Data
LATA SHIPPING NAME	No Data

The information set forth above is based upon information which TMC Chemicals, Inc. believes to be accurate. No warranty, express or implied, is intended. The information is provided solely for your information and consideration and TMC Chemical, Inc. assumes no legal responsibility for use or reliance thereon.

MATERIAL SAFETY DATA SHEET

CAIROX® Potassium Permanganate

Section 1 Chemical Product and Company Identification

PRODUCT NAME: CAIROX® potassium permanganate, $KMnO_4$
SYNONYMS: Permanganic acid potassium salt
Chameleon mineral
Condy's crystals
Permanganate of potash

MANUFACTURER'S NAME: CARUS CHEMICAL COMPANY

MANUFACTURER'S ADDRESS:
Carus Chemical Company
1500 Eighth Street
P. O. Box 1500
LaSalle, IL 61301

TRADE NAME: CAIROX® potassium permanganate

TELEPHONE NUMBER FOR INFORMATION: 815/223-1500

EMERGENCY TELEPHONE NO: 800/435-6856

AFTER HOURS NO. 815/223-1565
5:00 PM-8:00 AM Central Standard Time
Monday-Friday, Weekends and Holidays

CHEMTREC TELEPHONE NO.: 800/424-9300

Section 2 Composition/Information on Ingredients

Material or component	CAS No.	%	Hazard Data	
Potassium permanganate	7722-64-7	97% min. $KMnO_4$	PEL-C	5 mg Mn per cubic meter of air
			TLV-TWA	0.2 mg Mn per cubic meter of air

Section 3 Hazards Identification

1. Eye Contact
   Potassium permanganate is damaging to eye tissue on contact. It may cause severe burns that result in damage to the eye.

2. Skin Contact
   Contact of solutions at room temperature may be irritating to the skin, leaving brown stains. Concentrated solutions at elevated temperature and crystals are damaging to the skin.

3. Inhalation
   Acute inhalation toxicity data are not available. However, airborne concentrations of potassium permanganate in the form of dust or mist may cause damage to the respiratory tract.

4. Ingestion
   Potassium permanganate, if swallowed, may cause severe burns to mucous membranes of the mouth, throat, esophagus, and stomach.

Section 4 First Aid Measures

1. Eyes
   Immediately flush eyes with large amounts of water for at least 15 minutes holding lids apart to ensure flushing of the entire surface. Do not attempt to neutralize chemically. Seek medical attention immediately. Note to physician: Soluble decomposition products are alkaline. Insoluble decomposition product is brown manganese dioxide.

2. Skin
   Immediately wash contaminated areas with large amounts of water. Remove contaminated clothing and footwear. Wash clothing and decontaminate footwear before reuse. Seek medical attention immediately if irritation is severe or persistent.

3. Inhalation
   Remove person from contaminated area to fresh air. If breathing has stopped, resuscitate and administer oxygen if readily available. Seek medical attention immediately.

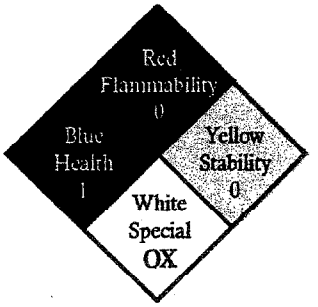
4. Ingestion
   Never give anything by mouth to an unconscious or convulsing person. If person is conscious, give large quantities of water. Seek medical attention immediately.

Section 5 Fire Fighting Measures

NFPA* HAZARD SIGNAL

Health Hazard (less than 1 hour exposure)	1	=	Materials which under fire conditions would give off irritating combustion products. Materials which on the skin could cause irritation.
Flammability Hazard	0	=	Materials that will not burn.
Reactivity Hazard	0	=	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.
Special Hazard	OX	=	Oxidizer

***National Fire Protection Association 704**



FIRST RESPONDERS:

Wear protective gloves, boots, goggles, and respirator. In case of fire, wear positive pressure breathing apparatus. Approach site of incident with caution. Use Emergency Response Guide NAERG 96 (RSPA P5800.7). Guide No. 140.

FLASHPOINT	None
FLAMMABLE OR EXPLOSIVE LIMITS	Lower: Nonflammable Upper: Nonflammable
EXTINGUISHING MEDIA	Use large quantities of water. Water will turn pink to purple if in contact with potassium permanganate. Dike to contain. Do not use dry chemicals, CO_2, Halon® or foams.
SPECIAL FIREFIGHTING PROCEDURES	If material is involved in fire, flood with water. Cool all affected containers with large quantities of water. Apply water from as far a distance as possible. Wear self-contained breathing apparatus and full protective clothing.

Section 6 Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
Clean up spills immediately by sweeping or shoveling up the material. Do not return spilled material to the original container. Transfer to a clean metal drum. EPA banned the land disposal of D001 ignitable waste oxidizers. These wastes must be deactivated by reduction. To clean floors, flush with abundant quantities of water into sewer, if permitted by Federal, State, and Local regulations. If not permitted, collect water and treat chemically (Section 13).

PERSONAL PRECAUTIONS
Personnel should wear protective clothing suitable for the task. Remove all ignition sources and incompatible materials before attempting clean-up.

Section 7 Handling and Storage

WORK/HYGENIC PRACTICES
Wash hands thoroughly with soap and water after handling potassium permanganate, and before eating or smoking. Wear proper protective equipment. Remove contaminated clothing.

VENTILATION REQUIREMENTS
Provide sufficient area or local exhaust to maintain exposure below the TLV-TWA.

CONDITIONS FOR SAFE STORAGE
Store in accordance with NFPA 430 requirements for Class II oxidizers. Protect containers from physical damage. Store in a cool, dry area in closed containers. Segregate from acids, peroxides, formaldehyde, and all combustible, organic or easily oxidizable materials including anti-freeze and hydraulic fluid.

Section 8 Exposure Controls/Personal Protection

RESPIRATORY PROTECTION
In the case where overexposure may exist, the use of an approved NIOSH-MSHA dust respirator or an air supplied respirator is advised. Engineering or administrative controls should be implemented to control dust.

EYE
Faceshield, goggles, or safety glasses with side shields should be worn. Provide eye wash in working area.

GLOVES
Rubber or plastic gloves should be worn.

OTHER PROTECTIVE EQUIPMENT
Normal work clothing covering arms and legs, and rubber or plastic apron should be worn.

Section 9 Physical and Chemical Properties

APPEARANCE AND ODOR	Dark purple solid with a metallic luster, odorless
BOILING POINT, 760 mm Hg	Not applicable
VAPOR PRESSURE (mm Hg)	Not applicable
SOLUBILITY IN WATER % BY SOLUTION	6% at 20°C (68°F), and 20% at 65°C (149°F)
PERCENT VOLATILE BY VOLUME	Not volatile
EVAPORATION RATE (BUTYL ACETATE=1)	Not applicable
MELTING POINT	Starts to decompose with evolution of oxygen (O_2) at temperatures above 150°C (302°F). Once initiated, the decomposition is exothermic and self-sustaining.
OXIDIZING PROPERTIES	Strong oxidizer
SPECIFIC GRAVITY	2.7 @ 20°C (68°F)
VAPOR DENSITY (AIR=1)	Not applicable

Section 10 Stability and Reactivity

STABILITY Under normal conditions, the material is stable.

CONDITIONS TO AVOID Contact with incompatible materials or heat (>150°C/302°F).

INCOMPATIBLE MATERIALS Acids, peroxides, formaldehyde, anti-freeze, hydraulic fluids, and all combustible organic or readily oxidizable inorganic materials including metal powders. With hydrochloric acid, toxic chlorine gas is liberated.

HAZARDOUS DECOMPOSITION PRODUCTS When involved in a fire, potassium permanganate may liberate corrosive fumes.

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION Material is not known to polymerize.

Section 11 Toxicological Information

Potassium permanganate: Acute oral LD_{50}(rat) = 780 mg/kg Male (14 days); 525 mg/kg Female (14 days)
The fatal adult human dose by ingestion is estimated to be 10 grams. (Ref. Handbook of Poisoning: Prevention, Diagnosis & Treatment, Twelfth Edition)

EFFECTS OF OVEREXPOSURE

1. Acute Overexposure
   Irritating to body tissue with which it comes into contact.

2. Chronic Overexposure
   No known cases of chronic poisoning due to potassium permanganate have been reported. Prolonged exposure, usually over many years, to heavy concentrations of manganese oxides in the form of dust and fumes, may lead to chronic manganese poisoning, chiefly involving the central nervous system.

3. Carcinogenicity
   Potassium permanganate has not been classified as a carcinogen by OSHA, NTP, IARC.

4. Medical Conditions Generally Aggravated by Exposure
   Potassium permanganate will cause further irritation of tissue, open wounds, burns or mucous membranes.

Registry of Toxic Effects of Chemical Substances
RTECS #SD6476000

Section 12 Ecological Information

Entry to the Environment

Potassium Permanganate has a low estimated lifetime in the environment, being readily converted by oxidizable materials to insoluble manganese dioxide (MnO_2).

Bioconcentration Potential

In non-reducing and non-acidic environments manganese dioxide (MnO_2) is insoluble and has a very low bioaccumulative potential.

Aquatic Toxicity

Rainbow trout, 96 hour LC_{50}: 1.8 mg/L
Bluegill sunfish, 96 hour LC_{50}: 2.3 mg/L

Section 13 Disposal Consideration

DEACTIVATION OF D001 IGNITABLE WASTE OXIDIZERS BY CHEMICAL REDUCTION

Reduce potassium permanganate in aqueous solutions with sodium thiosulfate (Hypo), or sodium bisulfite or ferrous salt solution. The thiosulfite or ferrous salt may require some dilute sulfuric acid to promote rapid reduction. If acid was used, neutralize with sodium bicarbonate to neutral pH. Decant or filter, and mix the sludge with sodium carbonate and deposit in an approved landfill. Where permitted, the sludge can be drained into sewer with large quantities of water. Use caution when reacting chemicals. Contact Carus Chemical Company for additional recommendations.

Section 14 Transport Information

U. S. DEPARTMENT OF TRANSPORTATION INFORMATION:

Proper Shipping Name:	49 CFR 172.101	Potassium Permanganate
ID Number:	49 CFR 172.101	UN 1490
Hazard Class:	49 CFR 172.101	Oxidizer
Division:	49 CFR 172.101	5.1
Packing Group:	49 CFR 172.101	II

Section 15 Regulatory Information

TSCA Listed in the TSCA Chemical Substance Inventory

CERCLA **Hazardous Substance**

Reportable Quantity: RQ - 100 lb 40 CFR 116.4; 40 CFR 302.4

RCRA Oxidizers such as potassium permanganate meet the criteria of ignitable waste. 40 CFR 261.21

SARA TITLE III Information

Section 302	Extremely hazardous substance: Not listed
Section 311/312	Hazard categories: Fire, acute and chronic toxicity
Section 313	CAIROX® potassium permanganate contains 97% Manganese Compound as part of the chemical structure (manganese compounds CAS Reg. No. N/A) and is subject to the reporting requirements of Section 313 of Title III, Superfund Amendments and Reauthorization Act of 1986 and 40 CFR 372.

Section 15 Regulatory Information (cont.)

STATE LISTS	Michigan Critical Materials Register:	Not listed
	California Proposition 65:	Not listed
	Massachusetts Substance List:	5 F8
	Pennsylvania Hazard Substance List:	E
FOREIGN LISTS	Canadian Domestic Substances List (DSL)	Listed
	Canadian Ingredient Disclosure List	Listed
	European Inventory of Existing Chemical Substances (EINECS)	2317603

Section 16 Other Information

NIOSH	National Institute for Occupational Safety and Health
MSHA	Mine Safety and Health Administration
OSHA	Occupational Safety and Health Administration
NTP	National Toxicology Program
IARC	International Agency for Research on Cancer
TSCA	Toxic Substances Control Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act of 1986
PEL-C	OSHA Permissible Exposure Limit-OSHA Ceiling Exposure Limit
TLV-TWA	Threshold Limit Value - Time Weighted Average (American Conference of Governmental Industrial Hygienists)

Kenneth Krogulski
May 2000

CARUS

Responsible Care®
A Public Commitment

QUALITY ASSURANCE PROJECT PLAN
PILOT STUDY

OPERABLE UNIT 10, SITE 35
MARINE CORPS BASE, CAMP LEJEUNE
JACKSONVILLE, NORTH CAROLINA

JANUARY14, 2004

PREPARED FOR

CH2M HILL, INC.
4824 PARKWAY PLAZA BLVD.
CHARLOTTE, NC 28217

PREPARED BY

IN-SITU OXIDATIVE TECHNOLOGIES, INC.
5600 SOUTH QUEBEC ST., SUITE 320D
GREENWOOD VILLAGE, COLORADO 80111

ISOTEC PROJECT NO. 900085

TABLE OF CONTENTS

1.0 INTRODUCTION

In-Situ Oxidative Technologies, Inc. (ISOTEC) has been retained by CH2M Hill to conduct an in-situ chemical oxidation pilot study on soil and groundwater contamination at Operable Unit 10, Site 35 (Site 35), located at the Marine Corps Base (MCB), Camp Lejeune, in Jacksonville, North Carolina (**Figure 1**). The contaminants of concern (COC) at Site 35 include chlorinated volatile organic compounds, primarily trichloroethene (TCE). This Quality Assurance Project Plan contains details on ISOTEC's approach for ensuring the quality of the pilot study program.

Details about the injection program specifics can be found in the ISOTEC Work Implementation Plan dated November 14, 2003. Information on the site background, geology, hydrogeology and contaminant distribution can be found in the project Pilot Study Work Plan prepared by CH2M Hill dated August 2003.

3.0 PILOT STUDY SCOPE

During the pilot study ISOTEC personnel will introduce ISOTEC's blend of modified Fenton's reagents and permanganate into the subsurface using 15 injection wells. The modified Fenton's treatment will desorb contamination adsorbed to soil and treat the majority of mass in groundwater. The permanganate will be injected following the ISOTEC reagents in order to treat remaining dissolved phase contamination.

3.1 OBJECTIVES

The primary purpose of the remediation program is contaminant mass removal from the saturated soil and groundwater at the site. Specific objectives of the pilot study are to:

- Test the effectiveness of the combination of Modified Fenton's reagent and permanganate on contaminants at the site.
- Minimize the size and migration potential of the plume.
- Cause little or no impact to the Highway 17 Bypass construction.
- Protect potential migration pathways.

3.2 DESIGN

The remediation program will include injection of ISOTEC reagents and permanganate into 15 injection wells across the pilot study area. The ISOTEC modified Fenton's reagents will be injected during the first week of the study followed by permanganate injection approximately four weeks later. The first injection is intended to aggressively desorb and then oxidize sorbed contamination as well as treat the majority of the dissolved phase. The follow up permanganate injection will address the remaining dissolved phase mass for several weeks or months after injection.

3.3 DATA COLLECTION

ISOTEC will collect field data to document the injection program. Chronological field logs will be kept that record the injection location, time, reagent type, injection pressures and flow rates. In addition, field parameter data sheets will be completed that document results of colorimetric field-test kit analysis for iron and peroxide measurements from groundwater samples collected from monitoring wells.