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NIROP FRIDLEY
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ACP Pilot-Scale Study Project Work Plan

for:

Southern Division (SOUTHDIV)
U.S. Naval Facilities Engineering Command
Prime Contract No. N62467-98-D-0995
Contract Task Order (CTO) #0024

at:

NIROP Fridley, Fridley, MN
EMR Project 5427-99

Prepared For:

CH2M Hill Constructors, Inc.
Atlanta, Georgia

Prepared By:

Environmental Management Resources, Inc.
Duluth, Minnesota

October 2001

EMR
INCORPORATED

ENVIRONMENTAL MANAGEMENT RESOURCES

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ABBREVIATIONS

ACP	Anoka County Riverfront Park
ASTM	American Society of Testing and Materials
bgs	Below Ground Surface
CAD	Corrective Active Design
CCI	CH2M HILL Constructors, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chain of Custody
DCE	Dichloroethylene
DNAPL	Dense Non-Aqueous Phase Liquid
EMR	Environmental Management Resources, Inc.
EPA	Environmental Protection Agency
FSM	Field Site Manager
GC	Gas Chromatograph
gpm	Gallons Per Minute
HASP	Health and Safety Plan
HBV	MDH Health Based Value
HRL	Health Risk Limit
IDW	Investigation-Derived Wastes
LOD	Limit of Detection
LOQ	Limit of Quantitation
MCL	Maximum Contaminant Level
MDH	Minnesota Department of Health
MDL	Method Detection Limit – laboratory specific analysis
MPCA	Minnesota Pollution Control Agency
NIROP	Naval Industrial Reserve Ordnance Plant
NAVD	National Vertical Datum
NPL	National Priorities List
OU	Operable Unit
OVM	Organic Vapor Monitor
ppm	Parts Per Million
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAL	MDH Recommended Allowable Limit
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RPD	Relative Percent Difference
SOPs	Standard Operating Procedures
SOUTHDIV	Southern Division, U.S. Naval Facilities Engineering Command
SRV	MPCA Draft Residential Human Health-Based Soil Reference Values
SLV	MPCA Soil Leaching Value
SVCLs	Soil Visual Classification Logs
TCE	Trichloroethylene
TOC	Total Organic Carbon
UDLP	United Defense Limited Partnership
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds
ya	years ago

1.0 INTRODUCTION

Environmental Management Resources, Inc. (EMR) has prepared the following work plan for submittal to CH2M HILL Constructors, Inc. (CCI) to outline the scope of work and project tasks involved in the implementation of a pilot-scale study involving the injection of food-grade vegetable oil into a chlorinated solvent plume (Investigation) originating from the U.S. Naval NIROP Facility in Fridley, Minnesota (Facility). CCI has been contracted by the Southern Division, U.S. Naval Facilities Engineering Command (SOUTHDIV) to perform remediation activities at the NIROP Facility and the adjoining Anoka County Riverfront Park (ACP) and has contracted with EMR to complete the scope of work described here. This document provides a discussion of the project site history and background, scope of work, project organization, schedule, and description of the tasks, resources and materials needed to complete the project.

1.1 Project Background And Setting

1.1.1 Regulatory Frame Work

NIROP has been listed on the Final Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) National Priorities List (NPL) since 1989. Groundwater remedial actions conducted at the NIROP Facility were initiated in response to the Record of Decision (ROD) signed in September 1990 by representatives of the U.S. Navy (Navy), the United States Environmental Protection Agency - Region V (USEPA), and the Minnesota Pollution Control Agency (MPCA).

1.1.2 Historical Investigations

Groundwater extraction wells began operating in September 1992 with two additional wells placed into operation in June 1995. Another upgrade of the extraction system was completed in June 2001. The goal of the system installation was to address requirements of the ROD that specified hydraulic containment and, to the extent feasible, recovery of down-gradient contamination.

The treatment of extracted groundwater was handled in a two-phase process. Phase II of the process, implemented in December 1998, involved construction and operation of a groundwater treatment system consisting of air-stripping units and located at the NIROP Facility. Currently, post-treatment water is discharged to the Mississippi River through outfall 020 (NPDES/SDS Permit MN0000710).

A five-year review of the groundwater extraction system, Operable Unit 1 (OU-1), resulted in the recommendation that the Navy determine what can be done to significantly reduce residual groundwater contamination at the ACP. The currently proposed ACP Pilot-Scale Study is a result of that recommendation.

1.1.3 Site Setting

The NIROP Facility and ACP are located just east of the Mississippi River in Fridley, Minnesota. The NIROP Facility is approximately 1,000 feet east of the Mississippi River and lies on a broad, flat outwash terrace. Pavement, structures, and other impermeable features largely cover the Facility, while the ACP is predominately wooded with areas of rough terrain. The NIROP Facility covers a total of 138 acres, of which the federal government owns 83 acres, which are operated by United Defense Limited Partnership (UDLP). The remaining 55 acres are owned and operated by UDLP. The ACP is a day-use recreational facility located between East River Road and the Mississippi River and consists of approximately 60 acres.

1.1.3.1 Hydrogeology

The hydrogeology within the vicinity of the NIROP Facility is consistent with the regional hydrogeology. There are four aquifers which govern groundwater flow; listed from shallow to deep they include: unconsolidated Quaternary aquifer zone, the Prairie du Chien/Jordan aquifer, the Franconia/Ironton/Galesville aquifer, and the Mount Simon/Hinckley/Fond du Lac aquifer.

The unconsolidated aquifer zone, proposed for remediation, consists of glacial outwash and till deposits overlain by glacial-fluvial deposits and is composed of two poorly defined aquifers: a shallow unconfined drift aquifer, and a deep confined or semi-confined drift aquifer. These aquifers consist of sand and gravel and are separated by a silt or clay layer that ranges in thickness from 0 to 47 feet in the vicinity of the 83-acre Facility. These two aquifers vary significantly in thickness (shallow from 41 to 93 feet; deep from 19 to 55 feet) and hydraulic connection throughout the site. Data from monitoring wells at the site have indicated no or very little hydraulic separation between these aquifers.

Under current pumping conditions the general horizontal groundwater flow direction across the NIROP site in the Quaternary aquifer zone is generally toward the southwest, with discharge into the Mississippi River and underlying alluvium estimated to be as much as 60 feet thick under the river (Lindgren 1990). Studies at the site have indicated that the Mississippi River is a gaining stream for groundwater flow at all times of the year. However, a groundwater ridge appears to be present near well MS-46S in the south end of ACP and western portion of the UDLP. Due to this ridge, groundwater appears to flow in an outward radial pattern in the ACP. A shutdown of the extraction system in December 1999 did not show a change in the overall flow direction during non-pumping conditions, indicating that the ridge is a result of natural conditions, accentuated by the groundwater extraction system.

1.1.3.2 Groundwater Quality

Groundwater samples collected from the site in Fall 1999 indicate that TCE, detected in 99 of 101 wells and ranging from 0.59 to 18,000 μg/L, is the most extensive contaminant

encountered in groundwater at the NIROP and adjacent ACP site. Dissolved TCE concentrations are generally higher (0.59 to 18,000 µg/L) in the shallow and intermediate monitoring intervals of the unconfined aquifer, compared to the deep semi-confined aquifer concentrations (1.8 to 5,200 µg/L). TCE in the Prairie du Chien aquifer is significantly lower and ranged in concentration from non-detected to 7.9 µg/L in fall 1999. Generally, TCE in groundwater at the shallow, intermediate and deep monitored intervals extends from north of the NIROP's northern boundary to the southwest, along the direction of groundwater flow to the Mississippi River.

Elevated levels of TCE in the shallow aquifer are generally present in the southwestern portion of the NIROP and ACP site. Concentrations are significantly lower northeast of East River Road. Concentrations in the central portion of the ACP are locally elevated, ranging from 1,100 to 18,000 µg/L at well MS-46S, in the vicinity of the proposed pilot study. Well MS-46S is screened in the shallow interval of the Quaternary aquifer system. This zone of elevated concentrations generally corresponds with the location of the groundwater ridge and may represent a stagnation zone allowing elevated concentrations to exist in this area.

2.0 PROJECT ORGANIZATION

2.1 Project Personnel and Staffing

EMR will have on-site at, a minimum, a two-person field crew consisting of a Field Site Manager (FSM) and an experienced field technician. The FSM will oversee and assist with all field activities and subcontractor oversight, in addition to management of investigation derived wastes (IDW), health and safety plan implementation, and direct communication with the CCI field team and designated NIROP representatives. The field technician will be responsible for site preparation, direct supervision of subcontractor activities, and soil and water data collection, completion of all the required field forms, groundwater and soil sample collection and oil injection activities. Periodic groundwater sampling and data collection will be conducted by members of the designated EMR Sampling Team under direct supervision of the FSM. Qualifications and certifications for each of the sampling team members are provided in Attachment C-1 of the EMR Quality Assurance Program Plan (Appendix C).

A flow chart of the EMR project team personnel who will be working on the ACP Pilot Scale Project, and there designated responsibilities is provided in Figure 1.1 of the EMR QAPP (Appendix C). EMR will provide investigation information to the CCI Project Manager who will be actively involved throughout each Investigation. EMR will only by direction of CCI have direct contact with any other agency or party.

2.2 Project Scheduling

A proposed schedule of project and field investigation activities is provided in Appendix A. All of EMR's on-site field activities will be scheduled and coordinated with the CCI project manager prior to implementation. Periodic groundwater sampling and data collection conducted post-system-installation will be implemented as outlined in the project schedule and by request of the CCI project manager.

2.3 Project Resources

A state-licensed well contractor who will work in accordance with Minnesota Department of Health (MDH) Rules, Chapter 4725, Wells and Borings, has been chosen to perform the installation of all new wells. Licensed disposal facilities capable of handling wastes classified in accordance with 40 Code of Federal Regulations (CFR) 261 regulations and currently in good regulatory standing have been selected to provide removal, pumping (liquid wastes only), transportation, temporary offsite storage, and treatment services. Analytical samples will be submitted to a state of Minnesota certified and licensed laboratory pre-selected by CCI. A list of subcontractor names and associated services is provided in Table 2.2.

A detailed list of anticipated equipment needs is provided in Appendix A

2.4 Reporting

Project reporting and submittals will take place during the full duration of the project implementation and is discussed in detail below.

2.4.1 Pre-Award Submittals

This work plan document constitutes one of three developed by EMR for submittal to and approval by CCI prior to implementation of the on-site field investigation. The two additional documents to be used in conjunction with this wok plan include the site-specific Health and Safety Plan (HASP) (Appendix B) and the Quality Assurance Project Plan (QAPP) (Appendix C). EMR's QAPP combines all quality control measures to be used on the project and includes requirements of the standard quality control plan, sampling and analysis plan, and waste management plan.

2.4.2 On-Site Deliverables and Reporting

EMR will provide the on-site CCI field manager with the following reports and project documentation within the time interval specified:

- Completed COC Forms (End of each workday as generated)
- Analytical Data Reports (Upon Receipt)

- Weigh Tickets (End of Workday)
- Disposal/Destruction Manifests and Certificates (End of work day or upon receipt)
- Geophysical Reports (Within 3 days)

In addition, EMR will provide the CCI field manager with the following reports in a format specified by CCI:

- Daily Field Log and Production Reports (End of workday)
- Field Test Reports (End of workday)
- Material Testing Reports (End of workday)

2.4.3 Post-Work Activity Reporting

Within 14 calendar days of completing fieldwork at the site to the satisfaction of CCI and SOUTHDIV, the Subcontractor shall provide CCI with all copies of pertinent project records not previously submitted, including but not limited to, analytical data, transportation and disposal records, as-built drawings, and air monitoring records. Geophysical gamma logging is requested by CCI within 3 days of completion.

The EMR project manager will provide the CCI project manager with a monthly update of the project schedule, completed tasks, expenditures, and budget. At the completion of each scheduled monitoring event, EMR will provide CCI with a letter report summarizing the fieldwork conducted, any problems or complications, a brief summary of applicable results.

3.0 MOBILIZATIONS AND SITE PREPARATORY WORK

All submittals required prior to work will be submitted to CCI prior to mobilization. Upon CCI approval of all required submittals, EMR will mobilize all resources necessary to efficiently and completely perform this scope of work task.

3.1 Temporary Facilities and Site Controls

The NIROP Facility will remain active during the scheduled work activities. EMR will set up designated areas and perform work in a manner that minimizes disruption of the ongoing plant activities and will be responsible for addressing traffic control at the work areas. Temporary barricades and caution signs will be provided around the work areas.

EMR will provide a project site trailer for use by EMR and CCI. The trailer will have at least two cellular telephone lines with local call access for CCI use. EMR will store equipment and tools not left in the field trailer in a portable locked trailer that will be removed from the site at the completion of each working day.

EMR will provide a portable toilet unit for CCI, EMR and lower-tier personnel use. EMR will make arrangements for a water cooler on site as a source of potable water and supply a gas-powered generator to provide electricity.

A decontamination pad to be used for the decontamination of heavy equipment will be constructed by the drilling subcontractor. The decontamination pad will be cleaned after each use. EMR will provide a boot wash/rinse area to be used to decontaminate reusable articles. The basins will be placed in a prefabricated containment berm constructed of a chemically resistant material. The floor of the berm will be equipped with a skid-resistant mat. A drum or other container will be designated to dispose of PPE that will not be reused. All equipment and personnel decontamination will be documented in the field-log books.

A temporary staging area will be constructed, consisting of a minimum of two plastic-lined, covered and sealed roll off boxes. One roll off box will be used for temporary storage of 55-gallon drums containing soil wastes, while the other will be used for temporary storage of water-filled drums. The roll off boxes will be lined with 6 mil reinforced plastic sheeting and will be equipped with water tight doors and retractable tarps to prevent the collection of precipitation. The roll off boxes will be locked at the end of each workday.

The temporary staging area will be equipped with the following equipment:

- drum labeling supplies
- fire extinguisher
- spill control and absorbent materials (spill control equipment and materials will also be provided in areas where liquids are transferred from one vessel to another – if the transfer takes place outside the staging area).
- overpack drums
- an alarm horn or direct access of site personnel to mobile phones or radios.
- drum repair materials and tools
- first aid kit
- 15-minute eyewash
- blood-borne pathogen kit

3.2 Permitting and Variances

Site preparatory work will also require the obtainment of appropriate permits and clearance requirements. Before any fieldwork is conducted, each proposed well location will be checked for underground utilities. Underground utilities clearances, as per State of Minnesota law, will be the responsibility of the drilling subcontractor. Utility clearances will be obtained through the Gopher State One Call program and clearance will be documented and provided to CCI on a daily basis.

CCI will be responsible for obtaining a variance related to well installation and oil injection for the Investigation. EMR will keep in close contact with CCI as to developments and potential scheduling delays related to variance approvals.

4.0 DESIGNATED TASKS AND SCOPE

Designated work phases to be completed for implementation of the Investigation include the following project tasks:

- Pilot-Scale System Installation and Soil Sampling
- Measurement of Baseline Geochemical Conditions and Contaminant Profiles
- Pre- and Post-Oil Injection Aquifer Testing
- Oil Injection
- Process Monitoring System Testing
- Waste Management, Transportation, and Disposal
- Site restoration and demobilization

All section references provided below refer to the Statement of Work in the CCI Request for Proposal #0024-439 dated June 21, 2001 and as amended by CCI in correspondence dated August 8,10, and 20, 2001 found in Appendix D of this report.

4.1 Pilot Scale System Installation and Soil Sampling

The pilot-scale system installation will consist of the installation of 16 monitoring, injection and contingency wells and tasks associated with their installation. The tasks are as follows:

Sub-Task 1 - Drilling, installation and completion of the following (Table 4.1) (Sections 6.2.3.3 and 6.2.3.4 Appendix D):

- one (1) 3-inch background monitoring well to a depth of 70 feet below ground surface (bgs) with a 10 foot long screen placed from 30-40 feet bgs;

- three (3) 3-inch injection wells to a depth of 70 feet bgs with 10 foot long screens placed from 30-40 feet bgs;
- five (5) 3-inch monitoring wells to a depth of 40 feet bgs with 10 foot long screens placed from 30-40 feet bgs;
- four (4) 3-inch diameter monitoring wells to a depth of 70 feet bgs with 10 foot long screens placed from 30-40 feet bgs; and,
- three (3) 2-inch contingency wells to a depth 40 feet bgs with 10-foot long screens placed from 30-40 feet bgs.

Sub-Task 2 - Continuous logging of all bore holes according to procedures outlined in Sections 6.2.2 of Appendix D, the site QAPP (Appendix C) and EMR Standard Operating Procedure (SOP) #1 (Appendix E). All information collected during the drilling will be entered on a *Visual Classification of Soils* form (Appendix C, Attachment C-2).

Sub-Task 3 - Collection of soil samples for volatile organic compounds (VOC), total organic carbon (TOC), bulk density, and microbial analyses near the vertical center of the screened interval according to procedures outlined in Section 6.2.2 Appendix D, site QAPP (Appendix C) and EMR SOP 2 (Appendix E).

Sub-Task 4 - Completion of a geophysical survey on all boring holes to specifications listed in Section 6.2.2 of Appendix D.

Sub-Task 5 - Surveying of elevations and locations of the completed wells to specifications in Section 6.2.3.7 of Appendix D.

4.1.1 Well Installation and Placement

The 3 injection wells will be located approximately 15 feet apart and centered 20 feet downgradient of existing monitoring well MS-46S. Monitoring wells will be located at distances of 15, 30, 50, 80 and 140 feet along the flowpath downgradient from injection well 2, and additional groundwater monitoring wells will be located downgradient from injection wells 1 and 3. Monitoring well locations are intended to monitor the groundwater system immediately downgradient of the injection zone over a period of 12 months. One upgradient well pair MS-46S is located to monitor background groundwater geochemistry. The three new contingency monitoring wells are to be located approximately 200 feet downgradient from the injection wells. In addition, two existing monitoring wells will be utilized as contingency monitoring wells (wells 27S and MS-47S).

Wells will be installed in stages, as directed by CCI, in order to collect water level elevation data from the first few wells installed to more accurately define the direction of groundwater flow and to better locate the remaining wells hydraulically downgradient.

All wells are to be completed with the top of the well screen located approximately 4 feet below the observed groundwater table. The drilling contractor will verify and record the total depth of the injection wells and monitoring wells, the lengths of all casing sections, and the depth to the top of all completion materials (filter pack, bentonite seal, etc.). All lengths and depths shall be measured to the nearest 0.1-foot.

All well installation and development activities are to be performed by Bergerson-Caswell, a Minnesota Licensed drilling company; under the direct supervision of EMR's FSM.

4.1.2 Soil Drilling and Sampling Procedures

Drilling in unconsolidated soils will be accomplished using the hollow stem auger drilling method to approximate depths specified in Table 4.1. Soil samples will be collected from drilling cores obtained by hollow stem auger drilling method using a 24-inch long, 2-inch diameter split spoon sampler. Soil samples will be observed and classified by EMR personnel per EMR SOP 1. All information will be recorded on a *Visual Classification of Soils* form (Appendix C, Attachment C-2). Soil samples for visual description will be collected at a frequency sufficient to identify the depths of significant stratigraphic contacts or other soil properties. Procedures will be modified, if necessary, to ensure good sample recovery.

4.1.3 Analytical Sample Collection

As each boring is advanced one soil sample shall be collected from close vertical proximity to the center of the screened interval to be installed. Aliquots of this soil sample from selected boring locations identified in Table 4.1 will be collected by EMR to submit for analysis of VOCs, bulk density, and total organic carbon (TOC) via methods specified in the QAPP (Appendix C) and SOP#2 (Appendix E). Samples will be shipped off-site, accompanied with a COC, for laboratory analysis by En Chem. Additional aliquots of soil samples will also be collected and provided to CCI for microbial analysis, soil isotherm sorption tests and bio-available iron analysis at another location.

4.1.4 Geophysical and Elevation Surveys

After drilling is complete, a gamma log geophysical survey will be conducted at each boring location on the total length of the boring. Summit Envirosolutions will conduct the geophysical survey under the direct supervision of the EMR FSM.

A registered surveyor will survey the locations and elevations of the newly installed background, injection and groundwater monitoring wells. Horizontal locations shall be measured relative to established coordinates. Horizontal coordinates shall be measured to the nearest 0.1-foot. The elevation of the ground surface adjacent to the well casing and the measurement datum (top of the casing) shall be measured relative to an existing

benchmark location. Vertical elevations will be measured with respect to the National Vertical Datum (NAVD) of 1998 to the nearest 0.01-foot.

4.2 Pre/Post Aquifer Testing

Aquifer characteristic testing (slug testing) will be conducted on three newly installed injection wells and seven monitoring/contingency wells to determine the hydraulic conductivity of the aquifer adjacent to the screened interval of the tested well. Both rising and falling head data will be collected and used to estimate the effects of oil injection. All slug testing will be performed after the completion of the baseline geochemical and contaminant sampling and prior to oil injection. The test data will be used to estimate the effects of oil injection. All slug testing will be performed after the completion of the baseline geochemical and contaminant sampling and prior to oil injection.

Slug testing will be repeated on the three previously tested injection wells after the oil injection process is complete. Aquifer testing procedures are outlined in EMR SOP 3 (Appendix E). Slug testing information will be recorded by the data-logging instrument and on the *Slug Test Report* form (Appendix C, Attachment C-2). A detailed description of slug test parameters and equipment needs is provided in Section 6.4 of Appendix D.

4.3 Baseline Groundwater Geochemical Condition and Contaminant Sampling

Groundwater sampling will be conducted on all newly installed injection, monitoring, and contingency wells and three previously installed monitoring wells (MS-46S, 27S and MS-47S) as outlined in Section 6.3 of Appendix D. This groundwater-sampling event will establish baseline conditions for comparison and monitoring of the effects of oil injection. Low flow sampling methods based on the MPCA *Superfund and Voluntary Investigation and Cleanup Programs - Sampling Protocol Template for Monitoring Wells* and outlined in EMR SOP 4 (Appendix E) will be employed during the groundwater-sampling event. A total of 18 wells will be sampled during this event for parameters outlined in Table 4.2. Standard protocol for analysis of the samples to be collected is outlined in Table 4.4. All information gathered during the groundwater-sampling event will be entered on the *Groundwater Collection Log* (Appendix C, Attachment C-2).

4.4 Oil Injection

The injection of vegetable oil into the subsurface aquifer will be conducted as per criteria outlined in Section 6.5 of Appendix D and according to procedures outlined in EMR SOP 5 (Appendix E). EMR will procure and mix 3,600 gallons of a food grade vegetable oil, 400 lbs of lecithin and 7,200 gallons of native groundwater for injection into the aquifer. The native groundwater will be extracted from an extraction well located close to the injection wells. Prior to injection, the system will be filled with native groundwater and pressurized to eliminate any air from the system. A total of 10, 800 gallons of the

oil/lecithin/water emulsion will be injected equally into three newly installed injection wells (3,600 gallons in each injection well). An additional 60 gallons of native water will be injected at a rate of 3 gpm into each injection well to flush the system and to enhance the distribution of the emulsion. The extraction of water from an on-site well, and the injection of the oil/water mixture may require special use permits. CCI will be responsible for the procurement of all special permits prior to beginning of injection. All data gathered during the oil injection process will be entered on the *Vegetable Oil Injection Form* (Appendix C, Attachment C-2).

4.5 Process Monitoring

Process monitoring sampling will be conducted at 2, 5, 8, and 12 months following the completion of the oil injection process. CCI may elect to extend the process-monitoring program to include sampling events at 16, 20, and 24 months. A total of 18 wells will be sampled during each event for parameters listed in Table 4.3 and in accordance to protocols listed in Table 4.4. The sampling events will be conducted according to procedures outlined in Section 6.5.2 of Appendix D and EMR SOP 4 (Appendix E).

4.6 Analytical Quality Assurance/Quality Control (QA/QC) Sampling Program

EMR will collect analytical quality assurance and quality control samples (QA/QC) to as discussed in Sections 5.5.2 and Section 11.1 of the QAPP. These samples will be collected to monitor sampling proficiency and laboratory performance, and will include trip blanks, equipment rinsate blanks, and field duplicate collected at a frequency detailed in Table 4.5.

4.7 Waste Management

All investigation-derived wastes (IDW) will be handled, containerized, transported and disposed of in accordance with Section 6.6 of Appendix D, and local, state and federal regulations. Pre-injection well development and purge water will be transported to and disposed at the NIROP water treatment facility. Soils and post-injection oil/water wastes will be transported by EMR to the temporary staging facility for scheduled pickup by the designated waste disposal contractor. Soils will be transported and disposed of by Onxy Environmental while post-injection oil/water wastes will be transported and disposed of by Special Waste Disposal, Inc. Wastes will only be disposed at facilities that have received prior approval from CCI. Waste storage and handling will be conducted according to procedures outlined in EMR SOP #6 (Appendix E). Conditions at the temporary storage areas will be inspected daily and observations will be noted on the *Temporary Staging Area Inspection Form* (Appendix C, Attachment C-2).

4.8 Site Restoration and Demobilization

Site demobilization activities will include the removal of all temporary structures and facilities, and disposal of all office, construction and investigation derived wastes. Site restoration will return the surfaces and areas disturbed by investigation activities back to their original grade and appearance. Demobilization and restoration activities will include those items outlined in Section 6.8 of Appendix D.

5.0 DECONTAMINATION

All Personnel and equipment working at the investigation site will be decontaminated prior to leaving the area of investigation to avoid the possibility of inadvertently spreading contamination. Equipment will be properly cleaned to remove all contamination that may adhere to the equipment components as a result of the Investigation. General decontamination procedures are outlined in Sections 1.0 and 2.0 of EMR's SOP #6. Decontamination of personnel and equipment will be performed in accordance with applicable provisions of 29 CFR 1910.120. A detailed outline of work zone and decontamination procedures is provided in Section 6.2 of the site HASP (Appendix B). All office wastes and general construction debris generated by EMR's demobilization activities will be properly disposed of offsite.

TABLES

TABLE 2.2
LOWER-TIER CONTRACTOR LISTING AND SERVICES
NIROP FRIDLEY, MINNESOTA
EMR PROJECT #5427-001

COMPANY NAME	SERVICES TO BE PROVIDED	COMPANY ADDRESS	COMPANY CONTACT PHONE NUMBER	% OF BID CONTRACTED WORK
Bergerson-Caswell Inc.	Well Installation	5115 Industrial Street, Maple Plain, MN 55359	(763) 479-3121	13.5%
En Chem	Analytical Testing	525 Scenic Drive, Madison, WI 53711	(608) 232-3300	30.2%
Microseeps	Hydrogen Analysis	220 William Pitt Way, Pittsburgh, PA 15238	(800) 659-2887	3.8%
Onyx Environmental Services	Soil Waste Disposal	3230 101st Avenue Northeast, Blaine, MN 55449	(763) 786-3660	0.2%
Special Waste Disposal, Inc.	Liquid Waste Disposal	3130 Excelsior Boulevard, Minneapolis, MN 55146	(612) 285-9865	1.0%
Summit Envirosolutions	Geophysical Surveying	1217 Bandana Boulevard North, St. Paul, MN 55108	(651) 644-8080	2.9%

TABLE 4.1
MONITORING WELL CONSTRUCTION SUMMARY
NIROP FRIDLEY, MINNESOTA
EMR PROJECT # 5427-001

Identification	Well Diameter (inches)	Total Depth (feet bgs)[a/]	Screened Interval (feet bgs)	Feet of Riser (feet)	Feet of Screen (feet)	Interval
New Background Well						
PES-BG-1	3.0	70	30-40	63	10	Shallow Drift
Injection Wells						
PES-INJ-1	3.0	70	30-40	63	10	Shallow Drift
PES-INJ-2	3.0	70	30-40	63	10	Shallow Drift
PES-INJ-3	3.0	70	30-40	63	10	Shallow Drift
Monitoring Wells						
PES-MW-1	3.0	70	30-40	63	10	Shallow Drift
PES-MW-2	3.0	70	30-40	63	10	Shallow Drift
PES-MW-3	3.0	40	30-40	33	10	Shallow Drift
PES-MW-4	3.0	40	30-40	33	10	Shallow Drift
PES-MW-5	3.0	40	30-40	33	10	Shallow Drift
PES-MW-6	3.0	70	30-40	63	10	Shallow Drift
PES-MW-7	3.0	70	30-40	63	10	Shallow Drift
PES-MW-8	3.0	40	30-40	33	10	Shallow Drift
PES-MW-9	3.0	40	30-40	33	10	Shallow Drift
Contingency Wells						
PES-CW-1	2.0	40	30-40	33	10	Shallow Drift
PES-CW-2	2.0	40	30-40	33	10	Shallow Drift
PES-CW-3	2.0	40	30-40	33	10	Shallow Drift

a/ feet bgs indicates approximate depth in feet below ground surface. All wells will be installed approximately 4 feet below the water table and have 3 feet of riser exposed above ground surface.

TABLE 4.2
SUMMARY OF PROPOSED INITIAL SITE ACTIVITIES (Pre Oil Injection)
NIROP FRIDLEY, MINNESOTA
EMR PROJECT # 5427-001

				Soil Analyses			Vegetable Oil Analyses [a]	Groundwater Analyses						
Location	**Well Installation**	**Slug Test Analysis**	**Water Level Measurement**	**Total Organic Carbon E415.1**	**Bulk Density ASTM - D2937**	**VOCs SW8260B**	**VOCs [b] (SW8260B)**	**VOCs (SW8260B)**	**Methane, Ethane, Ethene**	**Nitrate + Nitrite (E300.1)**	**TOC (SW9060)**	**Well Head Analyses [c]**	**Mobile Lab Analyses [d]**	**Hydrogen Analyses**
Existing Monitoring Wells														
MS-46S		X	X					1	1	1	1	1	1	1
New Monitoring Wells														
	X	X	X	1	1	1		1	1	1	1	1	1	
VG-MW-2	X		X					1	1	1	1	1	1	
VG-MW-3	X	X	X	1	1	1		1	1	1	1	1	1	
VG-MW-4	X	X	X	1	1	1		1	1	1	1	1	1	
VG-MW-5	X	X	X	1	1	1		1	1	1	1	1	1	
VG-MW-6	X		X					1	1	1	1	1	1	
VG-MW-7	X		X					1	1	1	1	1	1	
VG-MW-8	X	X	X					1	1	1	1	1	1	
VG-MW-9	X		X					1	1	1	1	1	1	
Existing Contingency Wells														
27S			X					1	1	1	1	1	1	
MS-47S			X					1	1	1	1	1	1	
New Contingency Wells														
VG-CW-1	X		X					1	1	1	1	1	1	
VG-CW-2	X	X	X					1	1	1	1	1	1	
VG-CW-3	X		X					1	1	1	1	1	1	
Injection Wells														
VG-INJ-1	X	X	X	1	1	1		1	1	1	1	1	1	
VG-INJ-2	X	X	X	1	1	1	1	1	1	1	1	1	1	
VG-INJ-3	X	X	X	1	1	1		1	1	1	1	1	1	
SUBTOTALS	**15**	**10**	**18**	**7**	**7**	**7**	**1**	**18**	**18**	**18**	**18**	**18**	**18**	**1**
QA/QC														
Duplicates						1	1	2	2	2	2		2	1
MS/MSD						1	1	1						
Trip Blanks						4		5						
Field Blank						1		1						1
Rinseates						4		5						
			TASK TOTAL:	**7**	**7**	**18**	**3**	**32**	**20**	**20**	**20**	**18**	**20**	**3**

[a] Baseline vegetable oil sample will be collected from oil delivered to the site, prior to injection.

[b] VOCs to include aromatic and chlorinated aliphatic hydrocarbons.

[c] Well head analyses include dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity.

[d] Mobile lab analyses include chloride, carbon dioxide, alkalinity, ammonia, ferrous iron, hydrogen sulfide, and manganese.

TABLE 4.3
SUMMARY OF POST-INJECTION PERFORMANCE MONITORING ACTIVITY (Per Sampling Event)
NIROP FRIDLEY, MINNESOTA
EMR PROJECT # 5427-001

			Oil Analyses	Groundwater Analyses						
Location	**Water Level Measurement**	**Slug Test Analysis**	**VOCs [a/] (SW8260B)**	**VOCs (SW8260B)**	**Methane, Ethane, Ethene**	**Nitrate + Nitrite (E300.1)**	**Total Organic Carbon (SW9060)**	**Well Head Analyses [b/]**	**Mobile Lab Analyses c/**	**Hydrogen Analyses**
Existing Monitoring Well										
MS-46S	X			1	1	1		1	1	1
New Monitoring Wells										
VG-MW-1	X			1	1	1	1	1	1	1
VG-MW-2	X			1	1	1	1	1	1	1
VG-MW-3	X			1	1	1	1	1	1	1
VG-MW-4	X			1	1	1	1	1	1	1
VG-MW-5	X			1	1	1	1	1	1	1
VG-MW-6	X				1	1	1	1	1	1
VG-MW-7	X				1	1	1	1	1	1
VG-MW-8	X				1	1	1	1	1	1
VG-MW-9	X			1	1	1	1	1	1	1
Existing Contingency Wells										
27S	X			1	1	1	1	1	1	1
MS-47S	X			1	1	1	1	1	1	1
New Contingency Wells										
VG-CW-1	X			1	1	1	1	1	1	1
VG-CW-2	X			1	1	1	1	1	1	1
VG-CW-3	X			1	1	1	1	1	1	1
Injection Wells										
VG-INJ-1	X	X	1	1	1	1	1	1	1	1
VG-INJ-2	X	X	1	1	1	1	1	1	1	1
VG-INJ-3	X	X	1	1	1	1	1	1	1	1
SUBTOTALS	**18**	**3**	**3**	**18**	**18**	**18**	**17**	**18**	**18**	**18**
QA/QC										
Duplicates			1	2	2	2	2		2	2
MS/MSD			1	1						
Trip Blanks				5						
Field Blanks				1						1
Rinseates				5						
SUBTOTAL PER EVENT:	**3**	**5**	**32**	**20**	**20**	**19**	**18**	**20**	**21**
TASK TOTAL:	**3**	**15**	**128**	**80**	**80**	**76**	**72**	**80**	**44**

[a/] VOCs to include aromatic and chlorinated apiphatic hydrocarbons. These samples will be collected only if vegetable oil is present in the injection well.

[b/] Well head analyses include dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity.

[c/] Mobile lab analyses include chloride, carbon dioxide, alkalinity, sulfate, ferrous iron, hydrogen sulfide, manganese, and hydrogen.

Note: Hydrogen will be sampled at MS-46S during all performance monitoring events, and during the 6 and 12 month events only in the remainder of the wells.

TABLE 4.4
STANDARD PROTOCOL FOR FIELD SAMPLES
NIROP FRIDLEY, MINNESOTA
EMR PROJECT # 5427-001

MATRIX Analyte	METHOD	FIELD (F) OR ANALYTICAL LABORATORY (L)
WATER		
Redox Potential	Direct-reading meter	F
Dissolved Oxygen	Direct-reading meter	F
pH	Direct-reading meter	F
Specific Conductance	Direct-reading meter	F
Temperature	Direct-reading meter	F
Ferrous Iron	Colorimetric, Hach Method 8146 (or similar)	F
Manganese	Colorimetric, Hach Method 8034 (or similar)	F
Hydrogen Sulfide	Colorimetric, Hach Method 8131 (or similar)	F
Sulfate	Colorimetric, Hach Method 8051 (or similar)	F
Ammonia	Colorimetric, Hach Method 8155 (or similar)	F
Alkalinity (Carbonate [CO_3^{2-}] and Bicarbonate [HCO_3^{1-}])	Titrimetric, Hach Method 8221 (or similar)	F
Chloride	Titrimetric, Hach Kit 8P (or similar)	F
Carbon Dioxide	Titrimetric, CHEMetrics Method 4500 (or similar)	F
Nitrate + Nitrite (as Nitrogen [N])	E300.1	L
Hydrogen	AM-20-GAX (modified SW8015)	L
Methane, Ethane, Ethene	SW5021	L
Total Organic Carbon	SW9060	L
VOCs[b/]	SW8260B	L
SOIL		
Total Organic Carbon	E415.1	L
Bulk Density	ASTM - D2937	L
VOCs	SW8260B	L
VEGETABLE OIL		
VOCs	SW8260B	L

[a/] RSKSOP = Robert S. Kerr Laboratory standard operating procedure.

[b/] VOCs = volatile organic compounds.

TABLE 4.5
QA/QC SAMPLING PROGRAM
NIROP FRIDLEY, MINNESOTA
EMR PROJECT # 5427-001

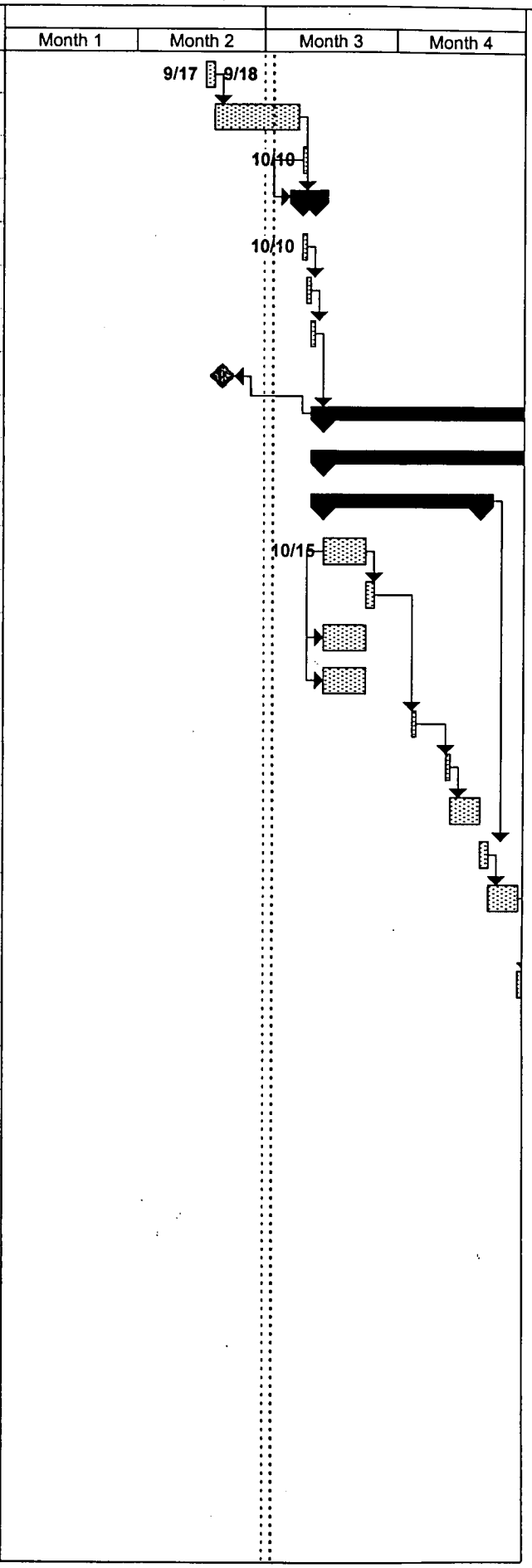
QA/QC Sample Type	Minimum Frequency to be Collected and Analyzed [a/]	Analytes
Duplicates/Replicates	1 every 10 or fewer samples of similar matrix	VOCs, methane, ethane, ethene, geochemical
Rinseate Blanks	1 per day on re- usable equipment	VOCs
Field Blank	1 every 20 or fewer groundwater samples	VOCs
Trip Blanks	One per sample shipment containing VOC smaples	VOCs
Matrix Spike Samples	5 percent of groundwater and soil samples	VOCs
Laboratory Control Sample	One per method per medium per analytical batch	Laboratory control charts (Method Specific)
Laboratory Method Blanks	One per method per medium per analytical batch	Laboratory control charts (Method Specific)

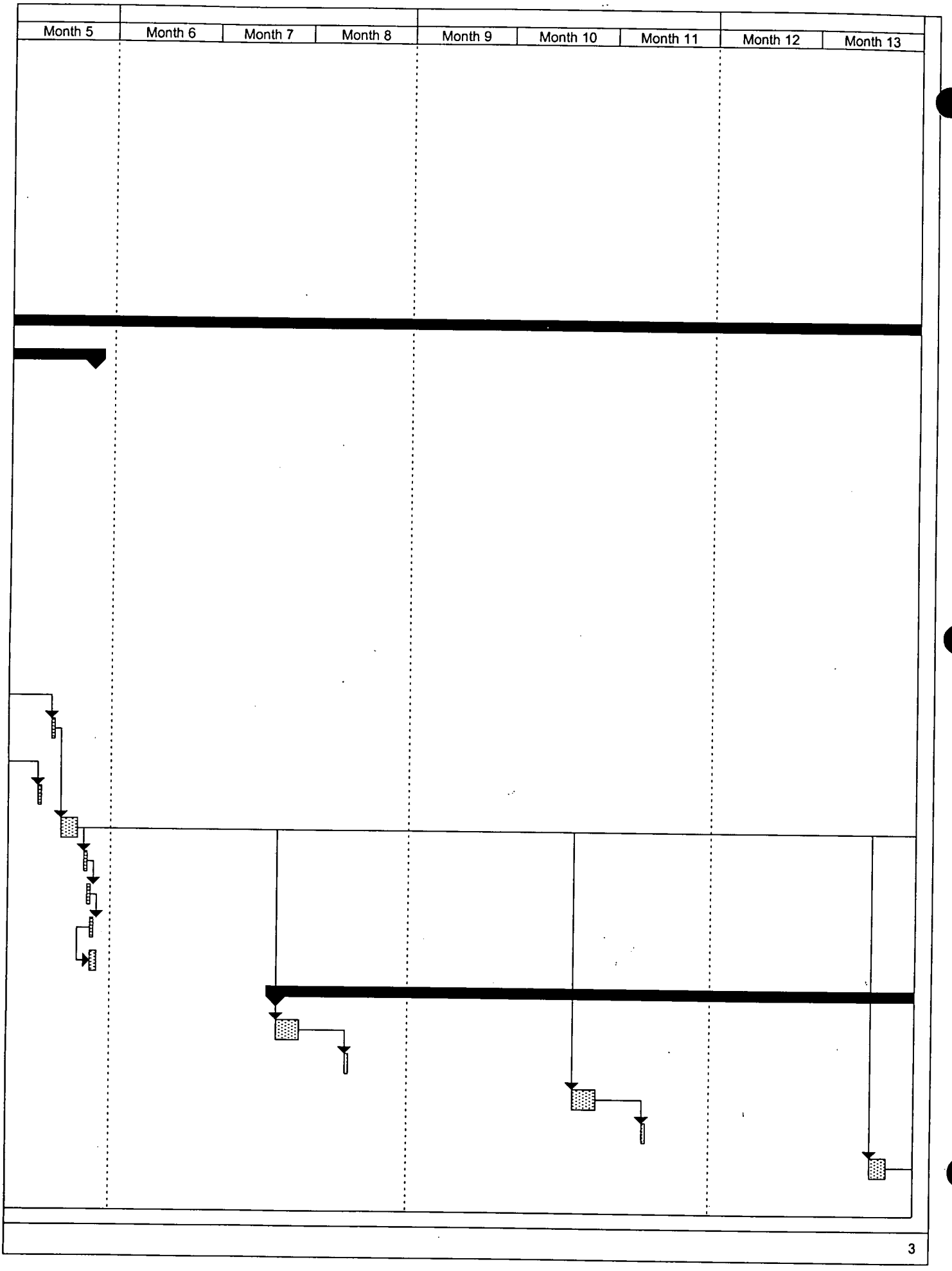
[a/] Actual frequency of QA/QC samples may be altered by the CCI field scientist, but will not be less than minimum QA/QC sampling frequency.

APPENDIX A

PROJECT SCHEDULE AND EQUIPMENT LIST

ID	Task Name	Duration
1	Prior-to-work submittals	2 days
2	Notice-to-Proceed (NTP)	14 days
3	Pre-construction Meeting	1 day
4	**Mobilization Period**	**3 days**
5	Mobilization	1 day
6	Site Preparation	1 day
7	Construction	1 day
8	Notification of off-site activities	1 day
9	**Execution Period**	**599 days**
10	**Field Work**	**52 days**
11	**Drilling/Well Construction**	**27 days**
12	Installation of Wells	8 days
13	Well Development	2 days
14	Geophysical Gamma Logging	8 days
15	Well Elevation Survey	8 days
16	Soil Disposal Characterization	1 day
17	Receive lab results/forward to CH2I	1 day
18	Soil transported/disposal facil.	5 days
19	Slug Tests	2 days
20	Baseline Groundwater Sampling	5 days
21	Analytical Received	1 day
22	Water Disposal Characterization	1 day
23	Analytical Received	1 day
24	Oil Injection	5 days
25	Slug Testing	1 day
26	Water Disposal	1 day
27	Office/construction waste removed	1 day
28	Demobilization/site restoration	2 days
29	**Post-Inj. Process Monitoring**	**494 days**
30	2 mo. after oil injection	5 days
31	Analytical Received	1 day
32	5 mo. after oil injection	5 days
33	Analytical Received	1 day
34	8 mo. after oil injection	5 days
35	Analytical Received	1 day




Month 5
Month 6
Month 7
Month 8
Month 9
Month 10
Month 11
Month 12
Month 13

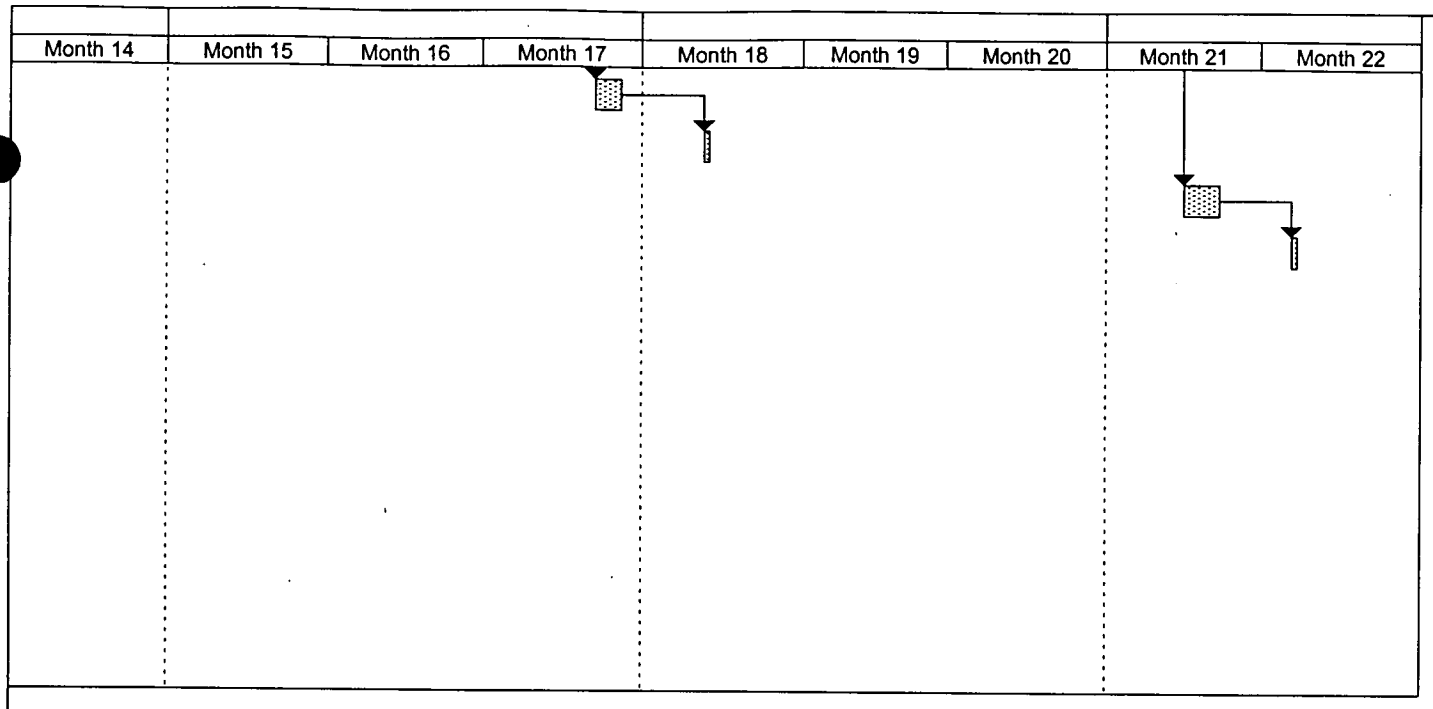
Month 14	Month 15	Month 16	Month 17	Month 18	Month 19	Month 20	Month 21	Month 22

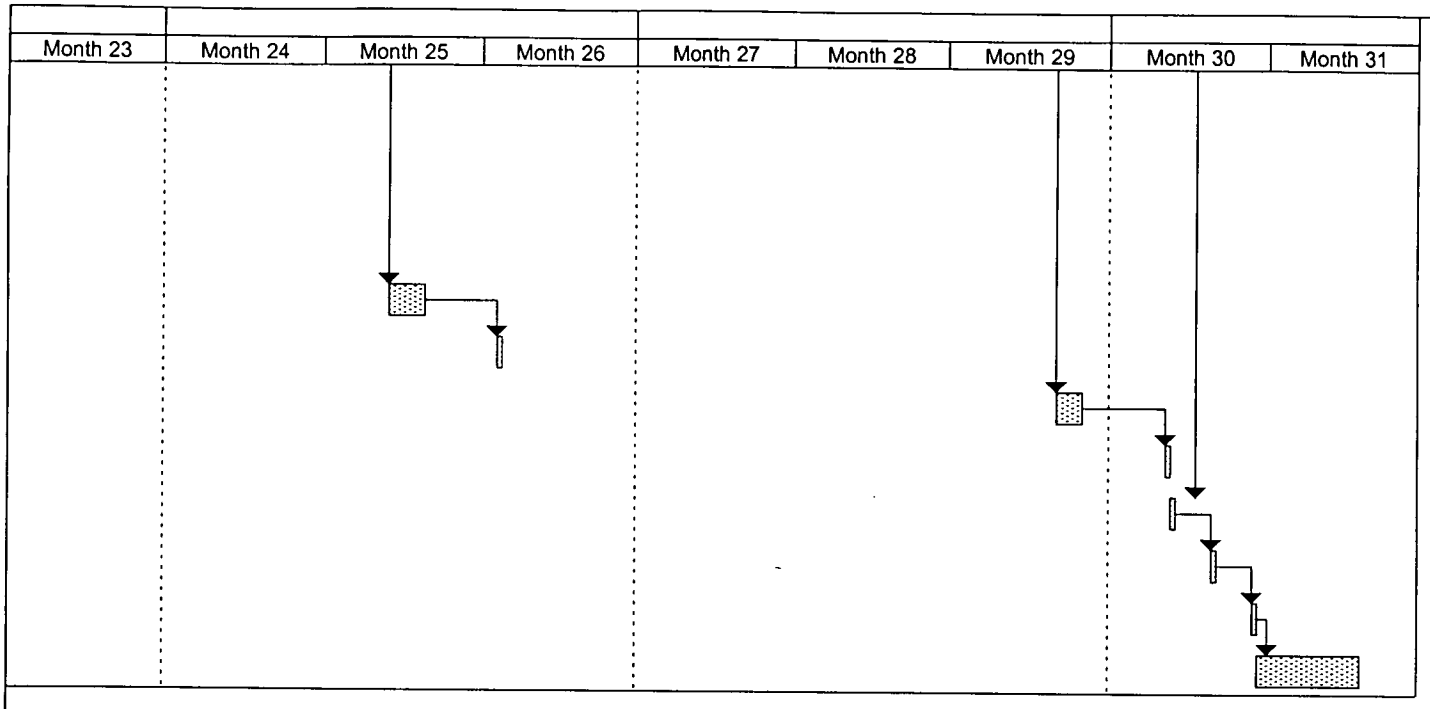
Month 23	Month 24	Month 25	Month 26	Month 27	Month 28	Month 29	Month 30	Month 31

ID		Task Name	Duration
36		12 mo. after oil injection	5 days
37		Analytical Received	1 day
38		16 mo. after oil injection	5 days
39		Analytical Received	1 day
40		20 mo. after oil injection	5 days
41		Analytical Received	1 day
42		24 mo. after oil injection	5 days
43		Analytical Received	1 day
44		Oil/water disposal characterization	1 day
45		Analytical received	1 day
46		Oil/water disposal	1 day
47		Closeout documentation	14 days

Month 1	Month 2	Month 3	Month 4

Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12	Month 13


Month 14
Month 15
Month 16
Month 17
Month 18
Month 19
Month 20
Month 21
Month 22


Month 23
Month 24
Month 25
Month 26
Month 27
Month 28
Month 29
Month 30
Month 31

Appendix 1 - Equipment List
NIROP Facility - Fridley, Minnesota
EMR Project # 5427-001.1

Task #	Related Equipment
2 Mobilzation and Site Preparation	
	Site Project Trailer - need
	2 cellular telephones
	EW5000 Honda Generator
	Potable Water Cooler with Extra bottle
	Portable Toilets
	Two way radios
	Miscellaneous Records and Manifests
	Profiles/Characterization Data
	Manifests, Bills of Lading
	Offsite facility waste reciepts
	Training Records
	Inspection Records
	MSDS
	IR 763 Skid Steer Loader
	Ford F-150 Pickup
	Tool/Equipment Storage Trailer
	Level D PPE
	12' x'12' Heavy Equipment Decontamination Pad
	8' x 8' Boot Decontamination Area
	Antislip decontamination area mat
	Boot area decontamination brushes and tubs
	(2) Sealed Door 30 yard Rolloff Containers
	Rolloff Container Liners
	120 Gallon Poly Tank
	Fire Extinguisher
	Spill Control Supplies (Overpack drums, compatable materials, hand tools)
	Site Emergency Equipment
	first aid kits
	15 minute eyewash
	bloodborne pathogen kit
	Decontamination Equipment
	Alarm System (Blow Horn)
	Tools for opening/closing drums
	Temporary Staging Area Inspection Forms
	Container Repair parts (Bungs, Covers, Seals)
	Haz/Non-Haz Labels
3 Well Installation and Development	
	ThermoEnvironmental 580B OVM/Calibration Gas
	Soil Visual Classification Logs
	Headspace Analysis Logs
	Soil Sampling Supplies (baggies, gloves, pens, etc)
	Soil Classification Information (USCS, Munsell, etc.)
	Table/Work Area
	Chevrolet Work Van
	300' Tape Measure
	Level D PPE
	Laboratory Sample Containers/Labels/Chain-of-Custody Forms
	Cooler/Ice

Appendix 1 - Equipment List
NIROP Facility - Fridley, Minnesota
EMR Project # 5427-001.1

IDW 55-gallon drums
Orion 1230 Groundwater Quality Meter with Probes
Turbidity Meter
Calibration Solutions
6 Port Flow Cell
purge Water 55-gallon drums
Level D PPE
Well Development Form
4. System Testing at Baseline
Orion 1230 Groundwater Quality Meter with Probes
Turbidity Meter
Calibration Solutions
Hach Field test kits
Colorimeter + accessories
Glasswear
Additional cells
Ferrous Iron
Manganese
Hydrogen Sulfide
Sulfate
Ammonia
Digital Titrator
Alkalinity
Chloride
Carbon Dioxide
Laboratory Sample Containers/Labels/Chain-of-Custody Forms
Laboratory QA/QC Sample Containers
Cooler with Ice
Groundwater Sampling Forms
Bladder Pump
Bladder Pump Controler
Pump Tubing
6 Port Flow Cell
Purge Water 55-gallon Drums
Gas powered air compressor
Water Level Indicator
Level D PPE
Chevrolet Work Van
Sampling Supplies
Decontamination Equipment
Well Keys
Gas Can
5. Geophysical Survey
Level D PPE
Bound Field Book
6. Aquifer Characteristic Testing
PVC Slug
Rope
Water level indicator

Appendix 1 - Equipment List
NIROP Facility - Fridley, Minnesota
EMR Project # 5427-001.1

Hermit data logger/transducer
Decontamination equipment
Well Keys
Slug Test form
7/8. Process Monitoring System Testing
* Same Equipment as Well Sampling (Task #5)
9. Injection of Soybean Oil, Lecithin and Native Water Emulsion
(2) 500-gallon poly tanks
(2) Warren Rupp Sandpiper air diaphragm pumps with 2-inch camcoupler connections
5 HP trash pump with 2-inch diameter camcouplers
185 cfm diesel powered air compressor
Compressed air hose with Chicago connections
Miscellaneous 2-inch diameter suction and discharge hoses with camcoupler connections
4 submersible pumps and associated hoses
Power supply for submersible pumps
3,600 gallons of Soybean Oil
400 pounds of Lecithin
Soybean Oil Storage Vessel
Native Groundwater Storage Vessel
Oil/Water Interface Probes
EMR Vehicle
Level D PPE
Oil Injection Forms
10. Addition of Lecithin
400 pounds of Lecithin
11. Storage, Transportation and Dispoal of Office, Construction, and PPE Wastes
Plastic Lined drums for PPE disposal
6 cubic yard dumpster
12. Storage, Transportation, and Disposal of Generated Liquids (to NIROP GWTF)
Drum Thieves
Laboratory Sample Containers/Labels/Chain-of-Custody Forms
Cooler with Ice
Sampling Supplies
Waste Disposal Log
Water Storage 55-gallon drums
13. Storage, Transportation and Disposal of Generated Liquids (to off-site TSDF)
Laboratory Sample Containers/Labels/Chain-of-Custody Forms
Cooler with Ice
Sampling Supplies
Oil/Water Storage Tanker
Vaccum Truck
14. Storage, Transportion and Disposal of Generated Soils
Stainless Steel Hand Auger
Stainless Steel Bowl

	Stainless Steel Spoon
	Laboratory Sample Containers/Labels/Chain-of-Custody Forms
	Cooler with Ice
	Sampling Supplies
	Waste Disposal Log
15	Site Restoration, Final Decontamination and Demobilization
	IR 763 Skid Steer Loader
	Top soil
	Grass Seed
	Potable Water
	Ford F-150 Pickup
	120 Gallon Water Tank

APPENDIX B

EMR SITE HEALTH AND SAFETY PLAN (HASP)

ACP PILOT-SCALE STUDY PROJECT HEALTH AND SAFETY PLAN

Prepared for:

CH2M HILL CONSTRUCTORS, INC.
115 PERIMETER CENTER PLACE NE, SUITE 700
ATLANTA, GEORGIA

Prepared by:

ENVIRONMENTAL MANAGEMENT RESOURCES, INC.
325 Lake Avenue South, Suite 603
Duluth, Minnesota

October 2001

ACP Pilot-Scale Study
Health and Safety Plan

Prepared for:

CH2M HILL CONSTRUCTORS, INC.
115 PERIMETER CENTER PLACE NE, SUITE 700
ATLANTA, GEORGIA

Prepared by:

ENVIRONMENTAL MANAGEMENT RESOURCES, INC.
325 Lake Avenue South, Suite 603
Duluth, MN

October 3, 2001

EMERGENCY REFERENCES

Key Telephone Numbers

OFF-BASE AMBULANCE	911 or (651) 222-0555
OFF-BASE POLICE	911 or (763) 427-1212
OFF-BASE FIRE	911 or (763) 427-1212
NATIONAL RESPONSE CENTER	1-800-424-8802
POISON CONTROL CENTER	1-800-332-6633
	(612) 347-3141
TOXLINE	1-301-496-1131
CHEMTREC	1-800-424-9300
EMR, DULUTH OFFICE	1-888-723-8140
EMR, MINNEAPOLIS OFFICE	1-877-319-8744
CCI PROJECT MANAGER	(216) 623-0326 ext. 13
	(216) 965-5605 (cell)

Nearest Hospital
Unity Hospital – 550 Osborn Road North East Fridley, MN 55432
(612) 780-6727 – Emergency Room

Directions to Hospital

Exit Site on to East River Road and proceed in a northerly direction. Continue along East River Road approximately 3.3 miles to Osborn road and turn right (East). Continue on Osborn Road approximately 0.75 miles to Unity Hospital, which will be on the right hand side of the road. The route to the hospital is shown on Figure A-1.

EMR Representatives

PROJECT MANAGER – Zandra Zwiebel

FIELD SITE MANAGER – Scott Carney

ASSISTANT SITE HEALTH AND SAFETY OFFICER – Scott Carney

DIRECTOR, HEALTH AND SAFETY – Chuck Ferguson

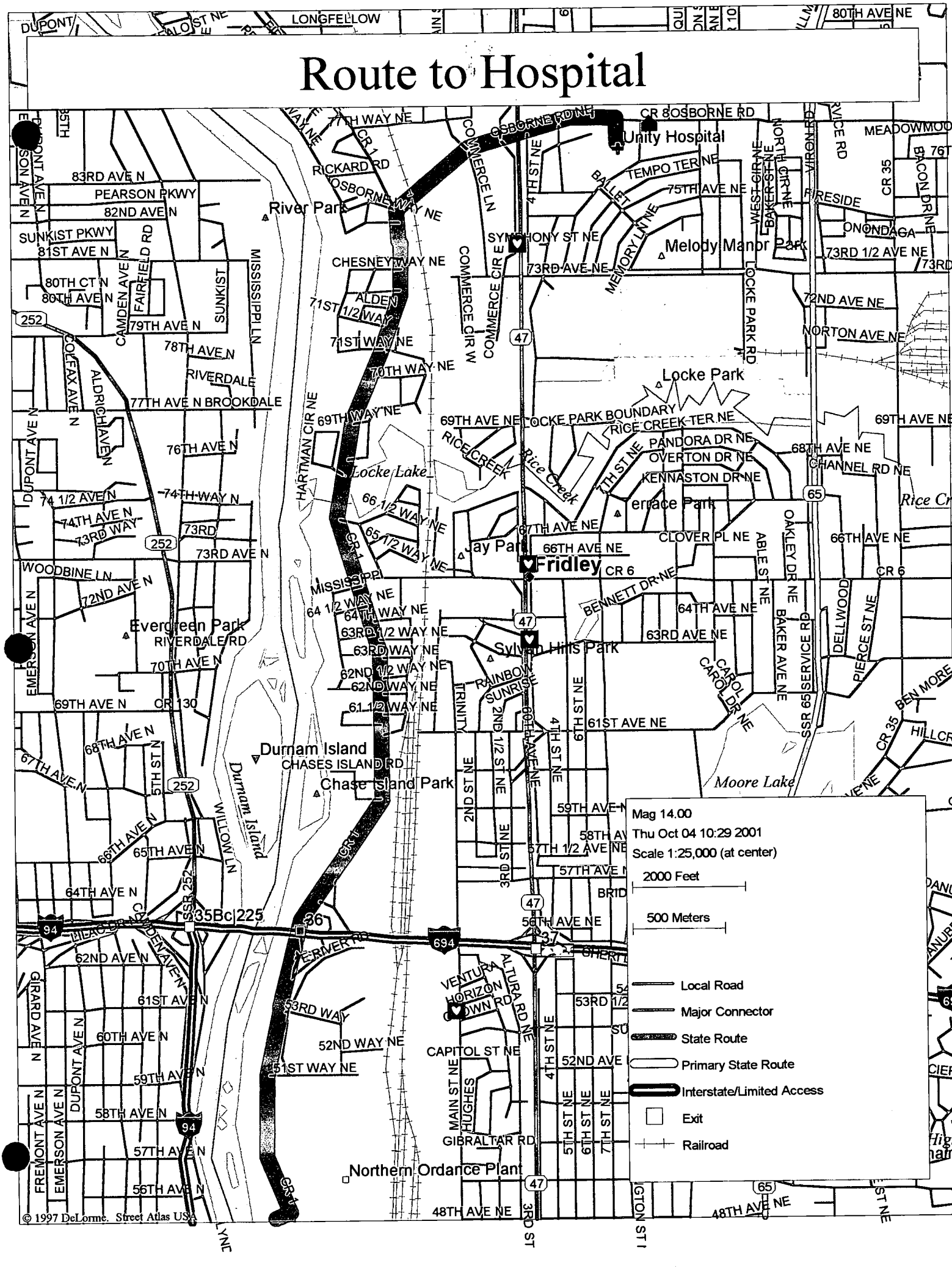
SAMPLING TEAM – Mike Goalen, Tracey Turner, Ryan Zick

Emergency Response Plan

In the event of an emergency, injured parties should not be moved unless there is an immediate threat to human health. A qualified individual with First Aid and CPR training shall be on site, and shall give first aid and stabilize any worker needing assistance. Life support techniques such as cardiopulmonary resuscitation and treatment of life-threatening problems such as bleeding, airway maintenance, and shock shall be given top priority. Professional medical assistance shall be obtained at the earliest possible opportunity. If assistance beyond first aid is required, phone 911 or contact the Unity Hospital Emergency Room at (612) 780-6727, and request emergency medical assistance.

If evacuation is necessary because of an immediate threat to human health, then the steps in Section 7.3 should be followed.

Route to Hospital



DISCLAIMERS AND LIMITATIONS ON USE

EMR Inc., ("EMR") developed the following Site Safety and Health Plan (the "SSHP") for use by EMR personnel and by EMR subcontractors (individually, an "EMR Contractor" and collectively, "EMR Contractors") in connection with soil and groundwater investigation, monitoring, and remediation activities designated under the ACP Pilot-Scale Study (the "Project") being performed by EMR for CH2M Hill Constructors, Inc (the "Client") at the Anoka County Riverfront Park (ACP) (the "Site"). Work is being conducted as part of a 1990 Record of Decision (ROD) involving the U.S. Naval NIROP Facility (the "Facility") in Fridley, MN. EMR personnel must adhere to the practices and procedures specified in the SSHP.

Each EMR Contractor must review the SSHP and agree to accept and abide by the SSHP, subject to any modifications to the SSHP (to address the EMR Contractor's more stringent practices and procedures) agreed upon in writing by EMR and the EMR Contractor. The EMR Contractor shall indicate such acceptance by executing a copy of this notice of disclaimers and limitations on use as indicated below and returning it to EMR's project manager for the Project prior to its commencing work at the Site. However, if any EMR Contractor commences work at the Site, the EMR Contractor shall be deemed to have accepted the SSHP and the terms hereof and the failure to execute and return to EMR a copy of this notice shall not be relevant to such interpretation.

If a contractor or a person other than the Client, EMR employees and EMR Contractors (individually, a "Third Party" and collectively, "Third Parties") receives a copy of the SSHP, such Third Party should not assume that the SSHP is appropriate for the activities being conducted by the Third Party. NO THIRD PARTY HAS THE RIGHT TO RELY ON THE SSHP. EACH THIRD PARTY SHOULD ABIDE BY ITS OWN SSHP IN ACCORDANCE WITH ITS OWN PROFESSIONAL JUDGMENT AND ESTABLISHED PRACTICES.

EMR shall not be responsible for the implementation of any Third Party's safety program(s), except to the extent otherwise expressly agreed upon by EMR and a Third Party in writing. The services performed by EMR for the Client and any right of the Client and/or an EMR Contractor to rely on the SSHP shall in no way inure to the benefit of any Third Party, including, but not limited to, employees, agents, or consultants and subcontractors of EMR Contractors, so as to give rise to any cause of action by such Third Party against EMR.

The SSHP generated by EMR in connection with the Project is for use on a specific site and in connection with a specific project. EMR makes no representation or warranty as to the suitability of the SSHP for reuse on another site or as to the suitability of the SSHP for reuse on another project or for modifications made by the Client or a Third Party to the SSHP.

EMR Contractors Only

Agreed and Accepted:

Contractor's Name:_____

By: _____

Title: _____

Date: _____

Contractor's Name:_____

By: _____

Title: _____

Date: _____

Contractor's Name:_____

By: _____

Title: _____

Date: _____

Contractor's Name:_____

By: _____

Title: _____

Date: _____

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1.0 INTRODUCTION

This Site Safety and Health Plan (SSHP) has been developed by EMR Inc., (EMR) to establish the safety and health procedures required to minimize potential hazards to personnel who will be involved in ACP Pilot-Scale Study at the ACP and NIROP Facility located in Fridley. The provisions of this SSHP directly apply to EMR personnel and contractors, if utilized, who will be potentially exposed to safety and/or health hazards related to the project. This SSHP does not directly apply to client personnel, although EMR will advise the client on the safety and health aspects of the work based upon the guidelines specified in this SSHP.

The procedures in this SSHP have been developed based upon current knowledge regarding the specific chemical and physical hazards that are known or anticipated for the operations to be conducted at the Site. This SSHP has been written to comply with the requirements of EMR safety and health policies. An Activity Hazard Analysis for tasks taking place on site is also included in the SSHP. It is EMR's policy that activities covered by this SSHP must be conducted in complete compliance with this SSHP and with all applicable Federal, State, and local safety and health regulations, including the Federal/Occupational Safety and Health Administration (OSHA) Construction Industry Standards in 29 Code of Federal Regulations (CFR) 1910.120. On-site personnel who cannot, or will not, comply with these requirements will be excluded from project activities. Prior to the commencement of field activities, all EMR and subcontractor personnel covered by this SSHP must review this document and return the sign-off form to the EMR Field Site Manager.

1.1 SITE DESCRIPTION AND HISTORY

This section discusses the general history and physiography of the Site. Site location and land use are described, hazardous chemicals associated with site activities and known releases are identified, and general site characteristics are presented.

1.1.1 Location

The NIROP Facility and ACP are located in Fridley, Minnesota in the southern most tip of Anoka County, just east of the Mississippi River. The NIROP Facility is approximately 1,000 feet east of the Mississippi River and less than one mile south of Interstate 694. The NIROP Facility covers 138 acres, of which 83 acres are government owned while the remaining 55 acres are owned by United Defense Limited Partnership.

Located between East River Road and the Mississippi River is the ACP. The ACP is a day-use recreational facility on the river's edge. ACP consists of approximately 60 acres.

1.2 PRIOR INVESTIGATIONS

The Record of Decision (ROD) for groundwater remediation at the NIROP Fridley site was signed in September 1990 by representatives of the U.S. Navy (Navy), the United States Environmental Protection Agency - Region V (USEPA), and the Minnesota Pollution Control Agency (MPCA). The ROD specified hydraulic containment and recovery of all future migration of groundwater from the NIROP facility and the recovery, to the extent feasible, of contamination downgradient of the NIROP Facility. To achieve this, groundwater extraction wells were installed. The initial extraction system began operating in September 1992. Two additional extraction wells were constructed and placed into operation in June 1995. Another upgrade of the extraction system was completed in June 2001.

Treatment of extracted groundwater involved a two-phased plan: Phase 1 involved discharging groundwater from the extraction system to an existing sanitary sewer with treatment provided at a local wastewater treatment facility; Phase II involved construction and operation of a groundwater treatment facility to provide long-term groundwater treatment. Groundwater treated by the Phase II treatment system is being discharged to the Mississippi River via a National Pollutant Discharge Elimination System (NPDES)/Metropolitan Council Environmental Services (MCES) State Disposal System (SDS) storm sewer discharge permit. The Phase II treatment system began operating in December 1998. Under Phase II, the combined discharge from the extraction system is fed through a feed system and air stripping units for treatment before the effluent is discharged to the Mississippi River through outfall 020 (NPDES/SDS Permit MN0000710).

At the time of the ROD, it was planned that contaminated groundwater located off-site and downgradient of the Facility in ACP would be naturally dissipated. Under a five-year review of the Operable Unit 1 (OU-1) groundwater extraction system in September 1998, it was recommended that the Navy determine what can be done to significantly reduce residual groundwater contamination in ACP.

1.3 INVESTIGATION WORK PLAN

The scope of work consists of the following work activities:

- Installation of 3 vegetable oil injection wells, 9 groundwater monitoring wells, and 3 contingency monitoring wells;
- Baseline (i.e., pre-injection) sampling of groundwater at the newly installed injection wells, groundwater monitoring wells, contingency monitoring wells, and existing wells MS-46S, 27S, and MS-47S;
- Pre-injection aquifer testing (hydraulic conductivity) of the 3 injection wells and 6 monitoring wells;

- Plumbing of the injection wells and injection of approximately 3,600 gallons of food-grade vegetable oil mixed with approximately 7,200 gallons of a water/emulsifier solution (estimated 3,600 gallons per well);

- Post-injection aquifer testing (hydraulic conductivity) of the previously-tested 3 injection wells;

- Surveying of the newly installed injection and monitoring wells;

- Post-injection sampling of groundwater and vegetable oil (if present) at the newly installed monitoring and injection wells at 2, 5, 8, and 12 months after injection; and

- Post-injection sampling of groundwater and vegetable oil (if present) at the newly installed monitoring and injection wells at 16, 20, and 24 months after injection.

2.0 KEY PERSONNEL

The organization and responsibilities for implementing safe project activities, and more specifically the requirements contained in this SSHP, are discussed in this section.

The key personnel for this project are:

- Field Site Manager – Scott Carney
- Project Manager/ Principal Geologist – Zandy Zwiebel
- Designated Safety Coordinator – Scott Carney
- Director, Internal Safety and Health – Chuck Ferguson
- Sampling Team –Mike Goalen, Tracey Turner, Ryan Zick

2.1 PROJECT MANAGER

The EMR Project Manager is, by designation, the individual who has the primary responsibility for ensuring the overall safety and health of field personnel working on this project. The Project Manager, therefore, has the primary responsibility for ensuring the implementation of the requirements of this SSHP. The Project Manager's specific responsibilities include:

- Ensuring that all project personnel have received a copy of and have read this SSHP and have completed the SSHP signature sheet;
- Ensuring that sufficient personal protective equipment (PPE), as required by this SSHP, is available during the project;
- Obtaining all subcontractor documentation of employee participation in a medical monitoring and training program;
- Maintaining a high level of safety and health consciousness among employees at the facility;
- Maintaining regular communications with the site Designated Safety Coordinator (DSC) and, if necessary to resolve safety and health conflicts, the Director, Internal Safety and Health (DISH); and
- Requiring the attendance of all site personnel to a tailgate briefing organized by the DSC, apprising them of the contents of this SSHP and specific hazards identified to be present at the facility prior to performing work.

2.2 DESIGNATED SAFETY COORDINATOR

The appointed DSC will be a member of the EMR project field team. The DSC responsibilities include enforcing the requirements of this SSHP once work begins. By design, the DSC has the authority to immediately correct all situations where noncompliance with this SSHP is noted and to immediately stop work in cases where an immediate danger is perceived. The DSC's specific responsibilities include:

- Procuring and distributing the PPE and air monitoring instrumentation needed for the project;
- Verifying that all PPE and safety and health equipment is in good working order;
- Setting up and maintenance of the personnel decontamination facility;
- Conducting a daily health and safety meeting prior to the start of work;
- Controlling site entry of unauthorized personnel;
- Supervising and monitoring the safety performance of all personnel to ensure that required safety and health procedures are followed, and correcting any deficiencies;
- Conducting accident/incident investigations and preparing investigation reports; and
- Initiating emergency response procedures.

2.3 DIRECTOR, INTERNAL SAFETY AND HEALTH

EMR's DISH is the individual responsible for the preparation, interpretation, and modification of this SSHP. Modifications to this SSHP which may result in less stringent precautions cannot be undertaken by the Project Manager or the DSC without the approval of the DISH. Specific responsibilities of the DISH include:

- Advising the Project Manager and DSC on matters relating to safety and health on this project;
- Recommending appropriate PPE and air monitoring instrumentation to protect personnel from potential hazards present on site;
- Performing field audits, when necessary, to monitor the effectiveness of the SSHP and to ensure compliance with it;
- Conducting or directing personal exposure monitoring where required and where deemed necessary to determine the adequacy of protective measures and PPE specified by this SSHP;

- Maintaining contact with the Project Manager to regularly evaluate project conditions and new information which might require modification to this SSHP;
- Working with the Project Manager to ensure that sufficient PPE is available at the site; and
- Conducting briefing meetings, when necessary, to apprise personnel of the contents of this SSHP and the project hazards.

2.4 FIELD PERSONNEL

All field and subcontractor personnel are responsible for following the safety and health procedures specified in this SSHP and for performing their work in a safe and responsible manner. Specific requirements include:

- Obtaining a copy of this SSHP and reading it, in its entirety, prior to the start of field activities;
- Signing the Safety and Health Signature Sheet acknowledging receipt and understanding of this SSHP;
- Providing current medical and OSHA training certificates to the DSC;
- Bringing forth any questions or concerns regarding the content of the SSHP to the DSC, Project Manager, or DISH prior to the start of work;
- Reporting accidents/incidents and the presence of potentially hazardous working situations to the DSC and Project Manager; and
- Complying with the requests of the appointed DSC.

3.0 PARTICIPANT QUALIFICATIONS

3.1 TRAINING REQUIREMENTS

All EMR personnel working on the Site soil and groundwater investigation, monitoring, and remediation activities will have completed an extensive training course and have previously worked at least three days at a hazardous waste site. The training course must be designed to meet the requirements of 29 CFR 1920.120. The training course must consist of a combination of 40 hours of classroom and field exercises plus an annual 8-hour refresher.

All site participants will be required to show proof of current training (less than one year since initial or refresher training) prior to field activities. Intended participants without current training documentation will be barred from site activities.

3.2 MEDICAL SURVEILLANCE

All on-site personnel, subcontractors, and visitors will be required to have a written statement from a licensed physician stating they have had a medical examination which meets the requirements of 29 CFR 1910.120. This examination must include pulmonary function testing as well as certification by the physician of the employee's ability to wear a negative-pressure respirator and perform strenuous work. If a person sustains an injury or contracts an illness related to work on site that results in lost work time, he/she must obtain written approval from a physician to regain access to the site.

3.3 RECORD KEEPING

Air monitoring via industrial hygiene monitoring or direct reading instrumentation will become part of the written record. Both medical and air monitoring data will be retained for 30 years. Training records shall be maintained in project files and are available for inspection at any time. A copy of current training records for all participants working on the Site will be kept on file at the field trailer. Subcontractor training and medical surveillance certification will also be maintained in project files.

3.4 TAILGATE MEETINGS

An initial tailgate meeting will be held to ensure that all field personnel meet the training and medical surveillance requirements for this project, and to review the procedures for the safety and health program. Daily tailgate meetings will be held prior to starting each day's work to discuss safety and health procedures for the specific tasks to be completed during that day.

4.0 HAZARD EVALUATION

This section summarizes chemical and physical hazards known or suspected at the Site.

4.1 CHEMICAL HAZARDS

Sited on previous data collected from groundwater beneath the Site and adjacent areas, the largest confirmed chemical hazard of concern at the Site is trichloroethylene (TCE). In addition, for the purpose of this document it is assumed that the decay products (1,2-dichloroethylene and vinyl chloride) of TCE are also present. These chemicals may exist in soil and/or groundwater.

In addition to those compounds potentially encountered during the site investigation, the following chemicals are anticipated to be used and stored at the site and will be stored in following locations:

CHEMICAL	PURPOSE	STORAGE LOCATION
Methanol	Sample Preservation	Individual Sample Container/ Project Trailer
Dilute Hydrochloric Acid	Sample Preservation	Individual Sample Container/ Project Trailer
Nitric Acid	Sample Preservation	Individual Sample Container/ Project Trailer
Sulfuric Acid	Sample Preservation	Individual Sample Container/ Project Trailer
Sodium Hydroxide	Sample Preservation	Individual Sample Containers
Alconox	Decontamination Detergent	Field Vehicles
Gasoline	Equipment Fueling	Equipment Storage Trailer
Diesel Fuel	Equipment Fueling	Equipment Storage Trailer
Silver Chloride	Instrument Reference Solution	Field Vehicle
Isobutylene	OVM Calibration Gas	Equipment Storage Trailer
Isopropyl Alcohol	Decontamination Solution	Equipment Storage Trailer

A Hazard Communication program will be maintained on-site at the project trailer. The Hazard Communication Program will contain MSDS sheets for all chemicals that are anticipated to be encountered during the investigation and for all chemicals to be used at the site.

The following sections describe potential health hazards associated with exposure to each of the contaminants of concern at the site.

4.1.1 Chlorinated Compounds

A summary of the hazards of the identified compounds of concern are listed separately below, additive effects of the mixture will be taken into consideration when determining established action levels.

Trichloroethylene is a colorless liquid with a chloroform-like odor and is a potential carcinogen. The main routes of exposure are inhalation, absorption, ingestion, and skin and eye contact. The OSHA time weighted average (TWA) is 100 ppm, and the concentration at which there is an immediate danger to life and health (IDLH) is 1,000 ppm. The primary target organs are the eyes, skin and respiratory system. Exposed skin should be washed promptly with soap and water, and eyes should be flushed immediately with eyewash solution for a minimum of 15 minutes. Ingestion warrants immediate medical attention.

1,2-dichloroethylene is a colorless liquid with a slightly acrid, chloroform-like odor. The OSHA TWA is 200 ppm and the IDLH concentration is 1,000 ppm. The main routes of exposure are inhalation, ingestion, and skin and eye contact. The primary target organs are the eyes and respiratory and central nervous systems.

Vinyl chloride is a colorless gas or liquid (below 7° F) with a pleasant odor at high concentrations and is a potential carcinogen. The OSHA TWA is 1 ppm, and the IDLH concentration has not been determined. The main routes of exposure are inhalation and skin and eye contact, and target organs include the liver and central nervous system. Exposed skin should be washed promptly with soap and water, and eyes should be flushed immediately with eyewash solution for a minimum of 15 minutes. Ingestion warrants immediate medical attention.

4.2 PHYSICAL HAZARDS

Physical hazards associated with site activities include slips, trips, falls, contact and crushing type injuries, eye abrasions, contusions, lacerations, flammability, and temperature stress concerns. The potential for such hazards necessitates the use of gloves, safety shoes or boots, safety glasses with side shields, and hard hats. Additionally, personnel engaged in strenuous physical labor are to wear sturdy work gloves.

4.2.1 Use of Equipment

Any equipment, including vehicles, winches or other machinery will be operated in strict compliance with the manufacturer's instructions, specifications, and limitations as well as any applicable regulations. The operator is responsible for inspecting the equipment daily to ensure that it is functioning properly and safely. This inspection will include all pins, pulleys, and connections subject to faster than normal wear and all lubrication points.

When equipment with moving booms, arms, or masts are operated in the vicinity of overhead hazards, the operator, with assistance from the designated signaling person, will ensure that the moving parts of the equipment maintain safe clearances to the hazards. Equipment will be kept at least 20 feet away from energized electrical lines.

All portable equipment and tools will be inspected prior to each day's use and as often as necessary to ensure that it is safe to use. Defective equipment and tools will be removed from service immediately. Examples of defective tools include:

- Hooks and chains stretched beyond allowable deformations;
- Cables and ropes with more than the allowable number of broken strands;
- Missing grounding prongs on power tools,
- Defective on/off switches;
- Mushroomed heads of impact tools;
- Sprung wrench jaws; and
- Missing or broken handles or guards as well as wooden handles which are cracked, splintered, or loose.
- All equipment and tools will be used within their rated capacities and capabilities.

4.2.2 Flammability Hazards

Due to the nature of this project, the hazards associated with flammability are expected to be low. However, the following good management practices shall apply at the site.

All electrical equipment used during the project will be inspected to ensure that it is in good repair and has no frayed or loose connections before use on site. Only approved, listed equipment and components will be used. All connections will be made in accordance with National Electric Code practices. All equipment and devices so designed will be properly grounded or bonded to an adequate grounding mechanism. Although explosive limits are not expected, only equipment listed as explosion proof will be used in areas where explosivity is sustained at or above 5 percent of the lower explosive limit.

4.2.3 Heat Stress Concerns

Heat stress is the combination of both environmental and physical work factors that contribute to the total heat load imposed on the body. Environmental factors that contribute to heat stress include air temperature, radiant heat exchange, air movement, and humidity. Although conditions that induce heat stress are not anticipated for this project, the following discussion is included.

The body's response to heat stress is reflected in the degree of symptoms. When the stress is excessive for the exposed individual, a feeling of discomfort or distress may result and a heat-related disorder may ensue. The severity of the response will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat stress is a general term used to describe one or more of the following heat-related disabilities and illnesses.

Heat Cramps. Painful, intermittent spasms of the voluntary muscles following hard physical work in a hot environment. Cramps usually occur after heavy sweating and often begin at the end of a work shift.

Heat Exhaustion. Profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat. Body temperature is normal or subnormal. Nausea, vomiting, and unconsciousness may occur.

Heat Stroke. Sweating is diminished or absent. The skin is hot, dry, and flushed. Increased body temperature, if uncontrolled, may lead to delirium, convulsions, coma, and even death. Medical attention is needed immediately.

Workers will be trained on the signs and symptoms of the forms of heat stress and will be encouraged to monitor themselves and others. In addition, experience has shown that the following work/rest regimen is appropriate for field workers performing various degrees of work while wearing Level D (no protective clothing). All values are given in °C Wet Bulb Globe Temperature (WBGT):

	Work Load		
Work/Rest Regimen	Light	Moderate	Heavy
Continuous Work	30.0	26.7	25.0
75% work/25% rest each hour	30.6	28.0	25.9
50% work/50% rest each hour	31.4	29.4	27.9
25% work/75% rest each hour	32.2	31.1	30.0

WBGT is defined according to the following formula (outdoors with solar load) where WB, GT, and DB are the wet bulb, globe, and dry bulb temperatures, respectively:

$$WBGT = 0.7WB + 0.2GT + 0.1DB$$

The workload classes are defined in The American Conference of Governmental Industrial Hygienists booklet, "Threshold Limit Values and Biological Exposure Indices for 1991-1992."

4.2.4 Cold Stress Concerns

Fatal exposures to cold among workers have almost always resulted from accidental exposures involving failure to escape from low environmental air temperatures or from immersion in low temperature water. Cold stress (hypothermia) and cold injury can be avoided by preventing a fall in the deep core temperature of the body.

Symptoms of hypothermia include increases in metabolic rate in an attempt to compensate for the heat loss and shivering. Workers should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (96.8°F). Lower body temperatures can result in reduced mental alertness, reduction in rational decision-making, or loss of consciousness with the threat of fatal consequences.

Pain in the extremities may be the first early warning of danger to cold stress. During exposure to cold, maximum severe shivering develops when the body's temperature has fallen to 35°C (95°F). Exposure to cold shall be immediately terminated for any worker when severe shivering becomes evident.

The body must be protected from exposure to cold air temperatures via whole body protection:

- Adequate-insulating clothing must be provided to workers if work is performed in air temperatures below 40°F.
- Older workers or workers with circulatory problems must be provided with extra insulating clothing and/or a reduction in the duration of exposure.
- Gloves shall be used by all workers if the air temperature falls below 40°F.

To prevent frostbite, workers should wear insulating gloves when contact with cold surfaces below 20°F is possible. Mittens are required if the air temperature falls below 0°F.

If insulating clothing is not adequate to prevent sensations of excessive cold or frostbite, auxiliary heaters or suspension of work is required.

5.0 EXPOSURE MONITORING PLAN

5.1 AREA AND PERSONAL MONITORING

Air monitoring will be conducted to determine the presence of on-site hazardous conditions and will help determine the level of personal protection required for personnel. Environmental monitoring equipment will include a photoionization detector (PID) or a flame ionization detector (FID) and a combustible gas indicator (CGI) with oxygen meter. Characterization with these instruments will determine airborne contaminants present and their concentrations in the workplace and will help assess worker safety.

5.1.1 General Area Monitoring

Area air monitoring will be conducted during all fieldwork. The intent is to utilize generic field instruments and action levels to assess the continuous exposure to field personnel during the investigation and upgrade or downgrade PPE in response to the monitoring. The general monitoring shall consist of daily breathing zone monitoring every 15 minutes using the PID or FID and CGI. A drägger tub will be used to monitor for vinyl chloride if there is reason to believe the compound may exist at targeted locations of subsurface drilling. During the groundwater sampling program, upon unlocking each monitoring well, the well headspace will be monitored using a PID or FID. Daily calibration and maintenance of the PID or FID will also be recorded and performed according to the manufacturer's recommendations. All breathing zone readings will be recorded in the field log book.

5.2 ACTION LEVELS

The DSC will establish daily background total organic vapor (TOV) levels prior to initiating site activities. Under most circumstances, this level can be determined by taking multiple readings at representative locations along the perimeter of the site and averaging the results of sustained measurements.

Decisions to upgrade or downgrade personal protection will be based on sustained breathing zone TOV levels that exceed background levels. Breathing zone refers to the area from the top of the shoulders to the top of the head. Specific criteria for upgrading or downgrading personal protection based on TOV levels is presented in the following table.

Sustained Breathing Zone TOV	Level of Protection
Background + 1 ppm	Level-D (no respiratory protection)
<1 ppm	Level-B (supplied air respirators)

If it is determined through targeted sampling that vinyl chloride is not a compound of concern (historical analytical data supports this) for the Site, the action level may be raised to above 1 ppm.

6.0 GENERAL SAFE WORK PROCEDURES

6.1 PERSONAL PROTECTION

In addition to the respiratory protection described above, initial protection shall also include Tyvek, hard hats, eye protection, both inner and outer layer of gloves, and safety boots. It is expected that the highest level of protection which may be needed during field investigation activities will be Level C. Level C protection consists of the following:

- Level C protection (required by all site personnel outside of those conducting strictly office work) consists of:
  - Full-length shirt and long pants;
  - Steel-toed boots or safety shoes;
  - Safety glasses with side shields; and
  - Hardhat.
- Air-purifying respirator equipped with appropriate filter cartridges;
- Chemical resistant clothing (i.e., Tyvek, polycoated Tyvek or Saranax Suits). Suits are to be one-piece with attached hoods and elastic wrist bands;
- Outer chemical resistant gloves and inner latex surgical gloves (Polyvinyl Alcohol gloves are recommended for the exterior layer); and
- Chemical resistant over boots.

6.2 WORK ZONES AND DECONTAMINATION PROCEDURES

Work zones and decontamination procedures will be established in accordance with guidance provided in Chapters 9 and 10 of the NIOSH/OSHA/USCG/USEPA document Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. Where applicable, the exclusion zones will be marked with yellow caution tape. The location of the zones may be modified to fit applicable field conditions; however, proposed modifications must be approved by the HSO.

If necessary, a minimum two-basin wash/rinse station will be placed in the contamination/reduction zone to facilitate cleaning and removal of PPE. The two wash/rinse stations will be used by workers to clean and rinse boots and gloves. The basins will be placed in a prefabricated containment berm constructed of a chemically

resistant material. The floor of the berm will be equipped with a skid-resistant mat. A drum or other container will be designated to dispose of PPE that will not be reused.

It is expected that the highest level of protection used during project investigation activities will be Level C. Sited on the level of expected exposure to chemical constituents, the following decontamination protocol will be used:

- Station 1: Equipment Drop - Deposit equipment used on site (e.g., tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool down station may be set up within this area.

- Station 2: Outer Garment, Boots, and Gloves Wash and Rinse - Scrub outer boots and gloves, and splash suit with decontaminating solution or detergent water. Rinse off using copious amounts of water.

- Station 3: Outer Boot and Glove Removal - Remove outer boots and gloves. Deposit in container with plastic liner.

- Station 4: Canister or Mask Change - If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers are donned, joints are taped, and worker returns to duty.

- Station 5: Boots, Gloves, and Outer Garment Removal - Boots, chemical-resistant splash suit, and inner gloves are removed and deposited in separate containers lined with plastic.

- Station 6: Face Piece Removal - Face piece is removed. Avoid touching face with fingers. Face piece is deposited on plastic sheet.

- Station 7: Field Wash - Hands and face are thoroughly washed. Shower if body contamination is suspected.

All personnel must follow the appropriate order for cleansing and removal during decontamination: boots, outer gloves, coveralls or protective suit, respirators, and inner gloves. Direct contact with contaminated PPE can be avoided by a proper decontamination sequence. Respirators, if used, are not to be removed before leaving the contaminated area to avoid a potential inhalation hazard during decontamination.

Water, soap, and paper towels will be available for cleaning of hands and face before breaks, eating, drinking, or smoking. On-site toilet facilities will also be available.

6.3 GENERAL SAFETY RULES

In addition to the specific requirements of this SSHP, common sense should prevail at all times. The following general safety rules and practices will be in effect at the site.

- The site will be suitably marked or barricaded as necessary to prevent unauthorized visitors, but will not hinder emergency services, if needed.

- All open holes, excavations, trenches, and obstacles will be properly barricaded in accordance with local site needs. These needs will be determined by proximity to traffic ways, both pedestrian and vehicular, and site of the hole, trench, or obstacle. If holes are required to be left open during nonworking hours, they will be adequately decked over or barricaded and sufficiently lighted.

- Prior to conducting any digging or boring operations, underground utility locations will be identified. The site representative and local utility authorities (or Underground Alert) will be contacted to provide locations of underground utility lines and product piping. All boring, excavation, and other site work will be planned and performed with consideration for underground lines.

- Smoking and ignition sources in the vicinity of flammable or contaminated material are prohibited. Designated smoking areas will be delineated.

- Drilling, boring, movement and use of cranes and drilling rigs, erection of towers, movement of vehicles, and equipment as well as other activities will be planned and performed with consideration for the location, height, and relative position of aboveground utilities and fixtures, including signs, lights, canopies, buildings, other structures, and construction as well as natural features such as trees, boulders, bodies of water, and terrain. The additional procedures for drilling and heavy equipment safety included in Attachment B-2 were taken from Bergerson-Caswell's Safety and Policy Manual, revised January 7, 1994.

- When working in areas where flammable vapors may be present, particular care must be exercised with tools and equipment that may be sources of ignition. All tools and equipment so provided must be properly bonded and/or grounded.

- Individuals with beards that interfere with respirator fit are not allowed within the exclusion zone. This is necessary because all site personnel may be called upon to use respirator protection in some situations, and beards do not allow for proper respirator fit.

- No smoking, eating, or drinking will be allowed in the contaminated areas.

- Tools and hands must be kept away from the face.

- Personnel must shower at the end of the shift or as soon as possible after leaving the site.
- Each sample must be treated and handled as though it were extremely toxic.
- Do not touch obvious contaminated materials. Avoiding contact with these materials will facilitate decontamination.
- Persons with long hair and/or loose-fitting clothing that could become entangled in power equipment are not permitted in the work area.
- Horseplay is prohibited in the work area. The DSC has the authority to discharge site personnel for horseplay.
- Work while under the influence of intoxicants, narcotics, or controlled substances is prohibited.

Prior to the commencement of each day's activities, the HSO will conduct a daily tailgate safety meeting outlining new or potential hazards that may be encountered during site operations. The daily tailgate safety meetings will be documented by completion of the appropriate form located in Attachment B-1 to this document.

7.0 EMERGENCY RESPONSE/ACCIDENT INVESTIGATION

The phone numbers of the police and fire departments, ambulance services, local hospital, and EMR representatives are provided in the reference sheet at the back of this SSHP. Directions to the hospital are also provided on the sheet.

In the event of a health or safety emergency at the site, appropriate emergency measures will immediately be taken to assist those who have been injured or exposed and to protect others from hazards. The HSO will be immediately notified and will respond according to the seriousness of the injury. Personnel trained in first aid will be present during site activities to provide appropriate treatment of injuries or illnesses incurred during operations. The EMR Project Manager will be immediately informed of any serious injuries.

Any accident/incident resulting in an OSHA recordable injury or illness, treatment at a hospital or physician's office, property damage or a near miss accident requires that an accident/incident report be completed and submitted to the EMR DISH. The investigation will be initiated as soon as emergency conditions are under control. The purpose of this investigation is not to attribute blame but to determine the pertinent facts so that repeat or similar occurrences can be avoided.

7.1 PLANNING

Prior to facility entrance, the DSC shall plan emergency actions and discuss them with personnel conducting project work. Initial planning includes establishing the best means for evacuation from the area in case of a catastrophe.

7.2 EMERGENCY SERVICES

A tested system must exist for rapid and clear distress communications, preferably voice, from all personnel to the DSC. The DSC shall ensure that all personnel working at the facility know how to communicate with the appropriate local emergency response units as well as provide adequate and clear directions between work locations and the locations of support personnel, prior to commencing any facility investigation or operations. Emergency response contacts and telephone numbers are included in the emergency reference sheet. A copy of this information must be posted in a visible location at the project site before operations commence.

7.3 GENERAL EVACUATION PLAN

In case of fire, explosion, or toxic vapor release, and a site evacuation is ordered by the DSC, the following procedures will apply:

- Announce the evacuation via radio/horn;
- Evaluate the immediate situation and downwind direction. All personnel will evacuate in the upwind direction;
- All personnel will assemble in an upwind area when the situation permits and a head count will be taken by the DSC; and
- Determine the extent of the problem and dispatch response teams in protective clothing and self-contained breathing apparatus on-site to evaluate any missing personnel and correct the problem.

7.4 FIRST AID

There will be two First Aid and CPR trained responders on the Site at all times. Qualified personnel designated daily during the tailgate safety meeting shall give first aid and stabilize any worker needing assistance. Life support techniques such as cardiopulmonary resuscitation and treatment of life-threatening problems such as bleeding, airway maintenance, and shock shall be given top priority. Professional medical assistance shall be obtained at the earliest possible opportunity. If assistance beyond first aid is required, phone 911 or contact the Unity Hospital Emergency Room at (612) 780-6727, and request emergency medical assistance.

A first aid kit and emergency 16-ounce eye wash station shall be maintained readily accessible to all workers. The portable eyewash shall be supplemented by a nearby continuous-flowing eyewash facility. Prior arrangements must be made to facilitate easy access (preferably within 10 seconds of the work area) to this continuous-flowing device.

Emergency first aid for organic compounds follows below.

7.4.1 Eyes

Flush eyes immediately with fresh water for at least 15 minutes while holding the eyelids open. If injury occurs or irritation persists, transport person to emergency room as soon as possible.

7.4.2 Skin

Wash skin thoroughly with soap and water. See a doctor if any unusual signs or symptoms or skin irritation occurs. Launder chemically impacted clothing.

7.4.3 Inhalation

Move exposed person to fresh air. If breathing has stopped, apply artificial respiration. Call 911 immediately.

7.4.4 Ingestion

If swallowed, DO NOT make person vomit. Call Poison Control Center immediately.

7.5 FIRE PROTECTION AND RESPONSE

To ensure that fire and explosion hazards are minimized, plans and procedures must be coordinated with the local Fire Department. A permit may be required before gasoline or other flammable liquids may be removed. Call 911 or (763) 427-1212 in the event of any fire at a work location. A minimum of one fire extinguisher with a minimum class rating of 20BC shall be provided within 50 feet of the site activities.

7.6 SITE CONTROL MEASURES

The site control measures listed below are to be followed to minimize the potential contamination of workers, protect the public form potential site hazards, and control site access.

Barricades and barricade tape will be used to delineate an exclusion zone around drilling areas. An opening in the barricades upwind of the equipment will serve as an entry and exit point. A personnel decontamination station will be established at this point. All access to the drilling location will be made at the entry and exit point.

The site will be barricaded or otherwise made secure at the end of each workday. Soils will be segregated and drummed and hauled to the staging area. Decontamination fluids will be drummed, properly labeled, and hauled to the staging area.

The DSC will log all site visitors in the field notebook and will ensure that all personnel entering the work zone are briefed on site activities and potential hazards.

7.7 SITE OPERATION ZONES

The following three Site Operation Zones will be established at each investigation site:

- Exclusion zone;
- Contamination reduction zone; and
- Support zone.

The exclusion zone includes areas of active investigation or cleanup. Prescribed levels of protection must be worn by all personnel within the exclusion zone. The boundary of the exclusion zone should be a well-defined physical or geographical barrier.

The contamination reduction zone serves to prevent the transfer of hazardous materials picked up on personnel or equipment in the exclusion zone.

The support zone is the outermost area and is considered a non-contaminated area. The field operations command post, first aid station, and any other investigation support activities are located in the support zone. Potentially contaminated equipment is not allowed in this area.

7.8 EMERGENCY OPERATION SHUTDOWN PROCEDURES

In the event an extremely hazardous situation develops on Site, the DSC may temporarily suspend operations until the situation is corrected or controlled. The DSC will have the authority to restart operations when the situation has been corrected and safe working conditions have been restored.

7.9 SPILL OR HAZARDOUS MATERIAL RELEASE

Spills or hazardous material releases resulting in human exposure or off-site environmental contamination are reported to the appropriate authorities by the DSC. Small spills are reported to the DSC and are taken care of per the chemical manufactures' recommended procedures.

7.10 COMMUNITY SAFETY

Release or off-site migration of contaminants during field operations is unlikely. However, in the event of a significant release of contaminants during field work, the proper state and local authorities will be immediately notified. Appropriate actions will be taken to protect the public and control the contaminant release or migration.

ATTACHMENT B-1

SAFETY AND HEALTH FORMS

The following signatures indicate that the Safety and Health Program has been read and accepted by EMR management and personnel as well as all contractors and subcontractors and their personnel.

NAME	TITLE	COMPANY	SIGNATURE	DATE

SUPERVISOR'S ACCIDENT/INCIDENT INVESTIGATION REPORT

Injured Employee:	Title:	
Date of Accident/Incident:	Dept.:	
Location:	Time on this Job:	
Engaged in what work when injured:		
Nature of accident/incident:		
How did accident/incident occur?		
What can be done to prevent recurrence of the accident?		
What has been done to prevent recurrence of the accident?		
Supervisor's Signature:	Dept.:	Date:
Reviewer's Signature:	Dept.:	Date:
NOTE: To be submitted to the Safety and Health Manager within 2 days of the accident/incident.		

EMR DAILY TAILGATE SAFETY MEETING FORM

DATE: TIME: JOB NUMBER:
PROJECT NAME:
SPECIFIC LOCATION:
TYPE OF WORK:
CHEMICALS PRESENT:

SAFETY TOPICS DISCUSSED

Protective Clothing/Equipment:

Hazards of Chemicals Present:

Physical Hazards:

Emergency Procedures:

Hospital/Clinic: Phone: Paramedics:
Hospital Address:

Special Hazards:

Other Topics:

ATTENDEES

Name (printed) Signature

ATTACHMENT B-2

DRILLING SAFETY PROCEDURES

8. HAND TOOL SAFETY

Five ways to prevent hand tool injury:

A. Use of right tool.

B. Use a tool in good condition.

C. Use a tool in the right way.

D. Keep tools in a safe place.

E. Keep tools properly maintained.

9. POWER TOOL SAFETY

A. All power tools must be operated with guards in place unless tagged otherwise and approved by management.

B. All power tools under repair will be tagged and locked out.

C. Keep tools properly maintained and report all defects.

10. LIFTING

The key to proper lifting is to bend your knees, but not your back, so that you let the more powerful leg muscles do the work. It's a simple technique, but it makes lifting easier and reduces the possibility of severe back strain.

Here is a fact that proves the point. When you bend your back and lift, there is almost five times more force acting on your lower back than is exerted when you lift the same object by bending your knees and "lifting with your legs".

Seven Points of Safe Lifting:

A. Get the center of the weight as high above the ground as possible. (Stand it up if it is a box)

B. Get the object as close as possible to the supporting column. (Your backbone)

C. Position your legs and feet firmly with your back as nearly vertical as possible.

D. Lift with the arms first, and roll the object onto your knee.

E. Pull the object as close to you as possible.

F. Stand up with the load, using the legs, thus placing little or no strain on the back.

G. Now turn your feet, not your hips or shoulders, if your assignment requires turning.

11. PERSONAL PROTECTIVE EQUIPMENT

If your work exposes you to potential hazards, Bergerson-Caswell, Inc. will make available appropriate equipment for your personal protection. Protective equipment used includes such items as safety glasses, goggles, hearing protection, gloves, and dust masks.

Your department safety rules will make available, and dictate when and what type of safety equipment must be worn. The company will provide special protection (tyvec, nitrile, gloves, etc.) for on sites requiring such articles. It is the employee's responsibility to provide every day protection such as gloves, coveralls, etc.

Hard hats and hearing protection are supplied by the company upon hiring, however proper care is the employee's responsibility. Return broken or worn out safety equipment to your supervisor for replacement before you need to use it. Each employee will be charged for lost equipment. You must take reasonable care of your protective equipment and use it only for the purpose intended.

HARD HATS: Must be worn by everyone working under overhead loads and around or near any unit with a mast or boom.

GOGGLES OR FACESHIELDS: Must always be worn when grinding, using power brush, and when using torches for cutting or welding.

FLOOR STANDS: It is forbidden for anybody to crawl under any vehicle held up only by a hydraulic jack. Use floor stands or properly placed blocking.

DRILL PRESS: All work must be clamped to the table. Operator to have one hand on switch and the other hand on the feed control.

ELECTRICAL: These hazards are frequently ignored. Example: Never use any metal tool (even those with insulated handles) without first turning off the power and testing (with voltage meter).

COLD CHISELS & BULL POINTS: Do not use any with "mushroomed" tops. Grind off smooth with taper first.

RACKING OR STACKING PIPE: Always rack, stack or pile pipe or similar items so that it ***cannot*** be dislodged, slide or fall in any way.

VERTICAL STACKING: If product must be stood on end, then the bottom should be at or below working level. If this is impossible, then the bottom must be held so it cannot be dislodged by building a solid, safe retainer. In any case, the top is to be laid or otherwise secured from falling sideways.

HORIZONTAL STACKING: Bottom (or single layer) must be solidly blocked so it cannot roll. If succeeding layers are separated by boards, then each layer must be solidly blocked. Pipe "clips" are best. Take extra care that no pile can collapse.

BAILERS: Never leave a bailer hanging with the bottom above the platform and rely on the brake to hold even for a few minutes. Always climb up and chain to the mast so it will not fall.

SLEDGES: If the handle cracks - do not "tape" up and use:

PLATFORM PLANKING: Take the time to build a platform so that no loose planks are hanging out over the timbers.

ROPE & ROPE HITCHES: Make sure the rope is stout enough for the job. Be sure the right knot is used (timber hitch or bowline), so that the load cannot slip. Use extreme caution with catheads so rope does not overwind (drillers should expecially instruct helpers on this).

SLINGS: Be sure that slings are stout enough for the job and are in good condition. Be sure the loops cannot slip off the lifting "ears". Tie them together with a small manila rope if any doubt. Always keep "ears" parallel to the ground when raising from or lowering float to a horizontal position on the ground.

CHAINS: Use of chains should be limited. Chains should only be used for situations such as needing boomer chains, hooking tool string to mast and chaining bailer to mast. Tow hook chains may be used for lifting light loads such as small motors. Cable slings are always preferable to chains. **DO NOT USE BOOMER CHAINS FOR ANYTHING ELSE, (i.e., do not remove from truck bed).**

BOTTLE GAS, OXYGEN & ACETYLENE: All tanks must be turned off ***at the tank*** when not in use. (It is not enough just to turn them off at night).

SMOKING: Absolutely no smoking around or near equipment when filling with gasoline or liquid propane.

OVERHEAD OBSTRUCTIONS: When using any equipment with mast or boom, especially "A-Frames" and boom truck, be careful of overhead clearance. First, to avoid electrocution and second so that equipment is not damaged.

HIGH TENSION WIRES: No mast may be set up within 10-feet of a high tension wire. If the high tension wire is rated at 50 kv or more, the rig mast must be at least 25-feet from the wires and properly grounded.

HOUSEKEEPING: Keep work area clean and free of loose boards, tools, etc. so that it will not invite injuries. Tools are to be returned to the proper place so that they can be found and also keeps the area clean.

12. EYE SAFETY

You are required to wear adequate eye protection when your work exposes you to risk of eye injury, or when you are in areas which present eye injury hazards.

13. USE OF EMERGENCY EYE WASH FOUNTAINS

If harmful chemicals come in contact with your eyes, the proper use of emergency eye wash fountain can significantly reduce the possibility of serious injury. Make sure you know the location of the nearest emergency eye wash fountain in your area.

Speed is essential. If you receive a chemical splash in your eyes or on your skin, IMMEDIATELY start flushing the area with lots of water. Remove any contaminated clothing as you rinse.

Continue flushing with lots of water for at least fifteen minutes. Even if a taxi or other emergency vehicle has arrived to transport you to a medical facility, continue flushing the area for at least fifteen minutes.

14. DRESS REQUIREMENTS

At Bergerson-Caswell, Inc. we are more concerned with your safety than fashion. Clothing and accessories which create potentially hazardous conditions may not be worn in the production or processing areas. Your supervisor and the Policy Administrator are authorized to use their discretion in disapproving clothing items considered potentially hazardous or otherwise inappropriate.

APPENDIX C

EMR QUALITY ASSURANCE PROJECT PLAN (QAPP)

ACP PILOT-SCALE STUDY PROJECT QUALITY ASSURANCE PROJECT PLAN

Prepared for:

CH2M HILL CONSTRUCTORS, INC.
115 PERIMETER CENTER PLACE NE, SUITE 700
ATLANTA, GEORGIA

Prepared by:

ENVIRONMENTAL MANAGEMENT RESOURCES, INC.
325 Lake Avenue South, Suite 603
Duluth, Minnesota

October 2001

ACP Pilot-Scale Study
Quality Assurance Project Plan

Prepared for:

CH2M HILL CONSTRUCTORS, INC.
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ATLANTA, GEORGIA

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October 3, 2001

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1.0 INTRODUCTION

Environmental Management Resources, Inc. (EMR) has prepared this Quality Assurance Project Plan (QAPP) for CH2M Hill Contractors, Inc. (CCI) to provide a detailed summary of all quality assurance (QA) and quality control (QC) measures to be taken in the implementation of a pilot-scale oil injection study (Investigation) to be conducted at Anoka County Park in Fridley, MN. The Investigation is being funded by the Southern Division of the U.S. Naval Facilities Engineering Command to address a chlorinated solvent release from the Naval Industrial Reserve Ordnance Plant in Fridley, MN. An outline of specific task requirements associated with the Investigation is provided in the *ACP PILOT-SCALE STUDY PROJECT WORK PLAN* (Work Plan) generated by EMR and dated September 18, 2001.

Included in this document are the details of EMR's quality control organization and commitment to the project, discussion of the site-specific field sampling plan, testing methods, and applicable specifications, the project specific waste management plan, and EMR's project specific sampling and analysis plan and related QC evaluation.

It is the goal of EMR to provide the greatest possible assurance that project objectives are acheived. EMR practices quality control procedures in every phase of operation to assure that all components of work are performed at the highest level of professional standards. Standard Operating Procedures (SOPs) provide the mechanism for generating and maintaining quality levels to provide meaningful accurate data and information.

1.1 EMR QUALITY CONTROL ORGANIZATION AND COMMITMENT

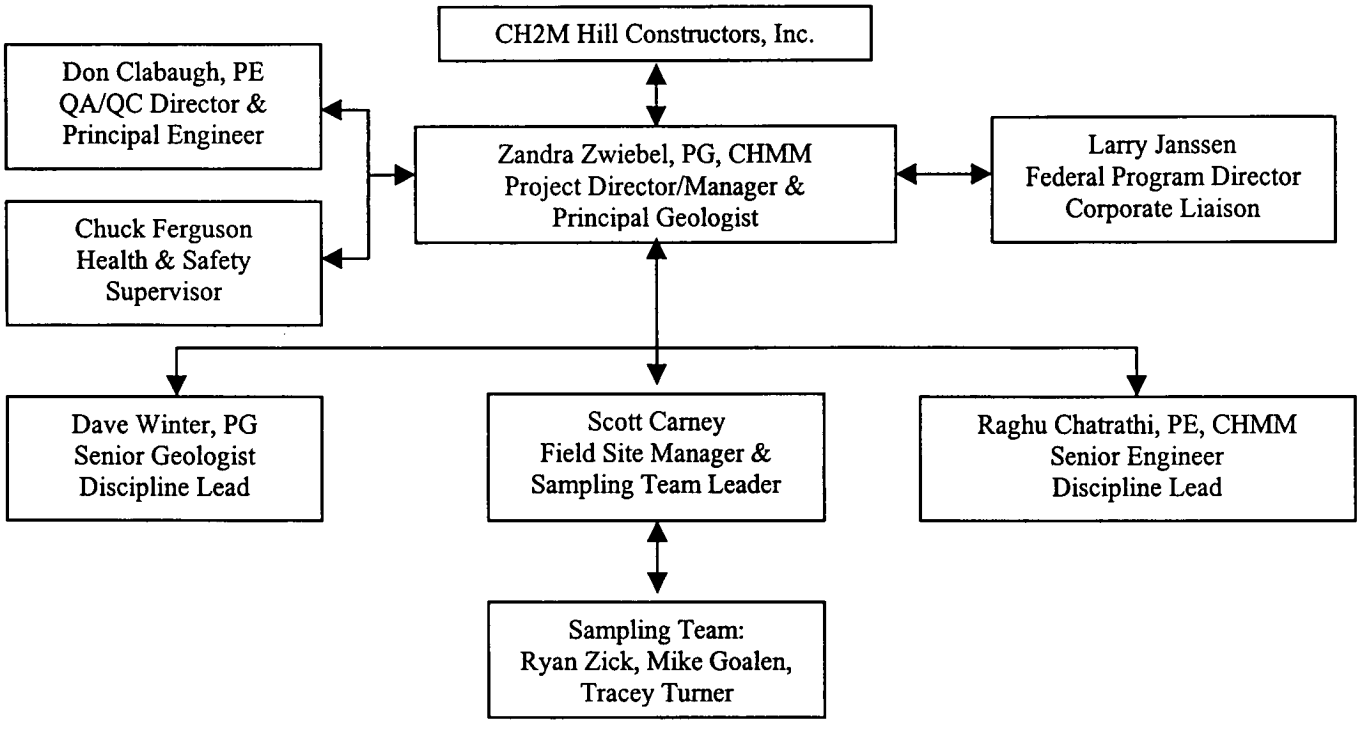
The project organization for the Investigation is illustrated in Figure 1-1 below. EMR will provide investigation information to the CCI Project Manager who will be actively involved throughout each Investigation. EMR will only by direction of CCI have direct contact with any other agency or party.

Table 2.2 of the Work Plan shows lower-tier contractors and a listing of services to be used by EMR for implementation of the Investigation.

1.1.2 Responsibilities

Work will be performed by qualified EMR engineers, geologists, specialists, and technicians. Project management will include quality assurance, scheduling, and budget control. It will also include preparation of monthly progress reports, attendance at meetings, and coordination of work with CCI. Project responsibilities for key personnel are as follows:

Figure 1-1. EMR Team Organization Chart
ACP Pilot-Scale Study, Fridley, MN



Project Director – Zandra Zwiebel

The Project Director (PD) is responsible to CCI for meeting the project quality requirements, and for providing project quality data to the EMR Quality Assurance Reviewer.

Quality Assurance Reviewer - Don Clabaugh, PE

The Quality Assurance Reviewer (QAR) will be responsible for review and approval of project documents and reports for conformance to the scope of work and technical adequacy.

Project Manager – Zandra Zwiebel

The Project Manager (PM) has the primary responsibility for fulfillment of the terms of the contract. The PM will be responsible for the following: meeting project plan requirements; adhering to project schedules; keeping the project within budget; reviewing and assessing the adequacy of the performance of the technical staff assigned to the project, the subsurface exploration contractor(s), the laboratory, and the surveying

subcontractor; maintaining project documentation; communication with CCI regarding progress toward the project's goals; and preparing technical reports.

Field Site Manager – Scott Carney

The Field Site Manager (FSM) has the responsibility for overall coordination of field operations including the subsurface exploration contracts and waste disposal contractor. The FSM will be responsible for adherence to the health and safety plans, project plans, QAPP, and documentation of field work.

Onsite QC Representative – Scott Carney

The onsite QC representative will coordinate field activities and implement the sampling and analysis plans according to EMR's SOPs, and the site-specfic QAPP.

Health and Safety Supervisor – Chuck Ferguson

The Health and Safety Supervisor (HSS) will be responsible for developing the requirements of the Health and Safety Plan, maintaining proper medical surveillance, providing hazard communication information, advising employees in safe operating procedures, and advising the PM and FSM on matters concerning the health and safety of field team employees.

Sampling Team Leader – Scott Carney

The Sampling Team Leader (STL) has the responsibility for coordinating the activities of the Sampling Team Members (STM). The STL will be responsible for the following: installing and calibrating the field instrumentation; conducting the sampling program; assuring the availability and maintenance of all sampling equipment and materials; equipment decontamination; providing for shipping and packaging materials; and supervising the accurate completion of all sampling paper work, e.g., chain-of-custody records and field log books.

Sampling Team Members – Ryan Zick, Mike Goalen, Tracey Turner

The Sampling Team Member (STM) will be responsible for observing field operations such as monitoring well boring and installation, and collecting environmental samples from the media of concern in accordance with the requirements and procedures specified in both the Work Plan, and Health and Safety Plan.

2.0 DEFINABLE FEATURES OF WORK

This QAPP describes methods and procedures for a number of subsurface investigative techniques. All of these techniques will not necessarily be utilized during the conduct of each portion of the Investigation. The site Work Plan will refer to the specific investigative techniques to be utilized.

- The following lists the definable features of work (DFOWs):
- Mobilization and site preparatory work
- Pilot-scale system installation and soil sampling
- Pre-injection sampling and aquifer testing
- Baseline sampling
- Injection of vegetable oil
- Post-injection aquifer testing
- Post-injection system sampling
- Site restoration and demobilization

A description of the individuals tasks associated with the DFOWs are found in the Work Plan. Below is a discussion of the project-specific field sampling plan, related waste management plan, and data collection and analysis quality assurance plan, which will be used to implement the associated tasks.

3.0 FIELD SAMPLING PLAN

3.1 DRILLING OF TEST BORINGS

The drilling program method for the Investigation tasks described in this section. Specifically addressed are the drilling and sampling methods. The program, as described, is based on CCI's Statement of Work. Specific items considered include the existing information on property and land use, existing boring logs, review of available records, geologic and hydrogeologic conditions at the site, and data collected during previous investigations. The program will be modified as additional information on subsurface conditions is obtained.

3.1.2 Equipment and Procedures

During all aspects of the drilling program, soil gas vapors and ambient air concentrations will be monitored to detect potential contamination and, if necessary, to implement contingency procedures of the health and safety plan. Procedures for the health and safety program are described in the *ACP PILOT-SCALE STUDY PROJECT HEALTH AND SAFETY PLAN.* Soil gas vapors will be measured in the headspace of soil samples to screen organic contamination. An OVM/DATALOGGER Model 580A will be used to measure the concentration of organic vapors.

Drilling procedures will be consistent with industry standards for hollow stem auger work. The practices outlined for ASTM D 1452 will be followed. Data and observations made during the drilling program will be recorded on a soil visual classification log (SVCL)(Appendix A).

3.1.3 Drilling and Drilling Supervision

Drilling services will be provided by a driller and helper familiar will all aspects of the drilling program. The drill rigs to be used are of the rotary hollow-stem auger type, equipped with 4-1/4", or larger, inside diameter (ID) hollow stem augers. The augers will be steam-cleaned prior to drilling, and following each boring.

EMR personnel will be on-site during all drilling activities and will provide the following services:

- provide professional field supervision for all aspects of the drilling program;
- to coordinate with CCI to select drilling sites, completion depths, and sampling intervals;
- describe soil samples and log each boring;
- select soil samples for laboratory analysis;

- measure and record water levels in all monitoring wells during the drilling program.
- Overall supervision of the drilling and monitoring well installation program will be provided by the FSM.

3.2 SOIL SAMPLING

Sampling of the deposits penetrated during drilling provides materials for examination at the surface and for analytical testing. Soil samples will be collected continuously at each location. Sampling devices will include a split-spoon sampler and a thin-wall Shelby tube sampler.

3.2.1 Methods for Describing and Handling of Soil Samples

Following collection, soil samples will be measured for amount recovered and organic vapor concentration. The lithology of the sample will be classified and recorded in the SVCL (Appendix A). Once the target sampling depth is reached soil samples will be collected for analysis by off site laboratories.

The ASTM standard methods for preserving and transporting soil samples will be followed (ASTM D4220). A chain of custody form (Appendix A) will be completed and will accompany soil samples designated for chemical analysis.

3.2.2 Laboratory Testing of Soil Samples

When the target sampling depth is reached soil samples will be submitted for laboratory analyses. Laboratory soil samples will be collected from near the vertical center of the anticipated screened interval, or approximately 35 feet below the ground surface (bgs).

Laboratory analysis to be conducted on soil samples consist of volatile organic compounds (VOC), total organic carbon (TOC), and bulk density (Tables 4.2 and 4.3 – Work Plan). Analytical sample collection methods and criteria are specified in SOP#2 (Appendix E of the Work Plan).

3.3 MONITORING WELL INSTALLATION PROGRAM

Preliminary location and purpose for each injection, contingency and monitoring well will is described in CCI's amended Statement of Work. The final well locations and screened depths will be chosen by the CCI field manager and implemented by the FSM.

3.3.1 Construction Details for Monitoring wells

Methods for monitoring well construction will follow those outlined in the "Green Book" (EPA 600/4-89/034) and CCI's amended Statement of Work. Construction of a monitoring well consists of the following steps: (a) advancing the hollow stem augers, while continuously collecting soil samples to a predetermined depth based on the purpose of the well; (b) installing the screen and risers through the augers; (c) concurrently removing the augers while adding a sand pack and above that, a cement and bentonite grout seal; (d) continuing to remove the augers while adding a cement and bentonite grout seal; (e) using an expansive cement seal to secure protective guard steel with

locking cap in place; and installation of protective bumper posts around the wellhead. Construction details for each monitoring well are summarized in CCI's amended Statement of Work and on Table 4.1 of the Work Plan.

PVC screen and casing will have been pre-cleaned by the manufacturer and sealed in shrink-wrap film to resist contamination during transport and storage. The casing will be constructed of schedule 40 PVC. The screens will be constructed of schedule 40 PVC in ten foot in lengths with 20-slot (0.020 inches) openings. The sand pack consisting of washed 10-20 silica sand will be added around the screen and brought to at least two feet above the top of screen. A pellet seal with a minimum thickness of 3 feet will be added above the sand pack. The seal will consist of sodium bentonite pellets, which will be hydrated with potable water.

The pellet seal will be overlain by neat cement grout (non-rapid setting cement) that will extend to within 2 feet bgs. A concrete surface collar will extend at least to the ground surface and will overlie the neat cement. The wellhead will be finished with a protective steel casing, locking well cap and three steel ballard posts.

All materials and well construction details will adhere to specifications found in CCI's amended Statement of Work.

3.3.2 Well Development

Following monitoring well completion, each monitoring well will be developed by pumping or bailing until the discharged water is relatively sediment free. Equipment to be used for development, and evacuation of water prior to sampling, includes a Centrifugal Pump, a bladder pump, disposable or dedicated bailers, or a low-volume peristaltic pump.

Effectiveness of the development measures will be closely monitored. Turbidity, specific conductance and temperature will be measured during the development process and used to determine when development is complete.

3.3.3 Water Level Monitoring

The STM will be responsible for measuring water levels during the drilling and development of test borings and monitoring wells. Procedures outlined in ASTM D4750 (See Attachment C-3) for measuring water levels will be followed. Following monitoring well installation and stabilization of water levels, static water levels will be measured so that potentiometric surface maps can be constructed.

3.3.4 Hydraulic Conductivity Testing

Hydraulic conductivity will be determined in the laboratory using rising- and falling-head slug tests as outlined in CCI's amended Statement of Work.

3.3.5 Top of Casing Survey

Top of casing of each monitoring well will be surveyed to the nearest 0.01 foot. This will allow for more accurate placement of downgradient wells and the construction of potentiometric surface maps of each water-bearing zone, and determination of flow direction and gradient, from water level measurements.

3.4 WATER SAMPLING AND ANALYSIS

3.4.1 Purpose and Scope

Water samples will be collected and analyzed for selected chemical constituents to determine water quality. Monitoring wells will be located where previous work has identified potential ground-water contamination, and where additional work identifies contamination. Monitoring wells will be located to determine water quality and to monitor the effects of oil injection.

3.4.2 Ground-water Monitoring Well Sampling Procedure

All sampling materials entering a monitoring well will be washed with a phosphate-free detergent, rinsed with potable water, rinsed with pesticide-grade isopropyl alcohol and rinsed with distilled water and allowed to air dry. Equipment blanks will be collected, and analyzed if anomalous results are obtained. In addition, replicate samples will be collected from selected wells to determine variance of analytical results.

Initially, upon approaching each monitoring well, it will be visually inspected for any indications of physical damage. The locking cap will be removed to allow for equalization and the protective top will be replaced. After all wells have been unlocked and sufficient time has elapsed for equalization the static water levels will be measured in all wells to be sampled. Following measurement of static water elevation, total volume of standing water in the wells will be calculated.

A minimum of three well volumes will be removed prior to the collection of laboratory samples. This ensures the removal of the stagnant water within the wells and that the sampled water is ground water from the formation. For wells that are completely evacuated, it may not be necessary to obtain several well volumes of water. In these instances, specific conductance, pH, turbidity, and temperature of pumped water will be measured until the parameters have stabilized. Monitoring of these parameters allows a determination of whether water is obtained from storage within the monitoring well and sand pack, or directly from the formation. Where possible, pumping rate will be minimized so that wells are not completely evacuated.

Ground-water samples will be collected so that physical alteration (pressure change and aeration) and chemical contamination (dirty sampling equipment) is minimized or avoided. Only stainless steel or fluorocarbon resin sampling devices will be used. Specific Conductance, pH, temperature, dissolved oxygen and turbidity will be measured before and after sample collection to confirm that a sample that is representative of formation water is obtained, and to provide a check for sample degradation between the field and laboratory.

Quality assurance and control will be determined through use of field blanks, trip blanks, duplicate samples, rinseate samples, and matrix spike samples. A summary of collection frequency and analysis to be performed on quality assurance/control samples is found in Table 4.5 of the Work Plan.

A chain-of-custody form, signed and dated by all personnel who handle the samples, will accompany the sample from the field through the laboratory. Sampling equipment will consist of stainless steel bladder pump. Methods and procedures will be consistent with those described in the *Superfund and Voluntary Investigation and Cleanup Programs – Sampling Protocol Template for Monitoring Wells.*

3.4.3 Chemical Parameters to be Monitored

Sampling and analysis of ground water will be conducted to assess and monitor groundwater quality both prior to and following oil injection. Groundwater chemical analysis will be conducted both in the field and at an analytical laboratory.

In-field analyses will consist of the groundwater water quality parameters discussed in section 3.4.2 and chloride, carbon dioxide, alkalinity, ammonia, ferrous iron, hydrogen sulfide, and manganese (Table 4.2 and 4.3 – Work Plan). Laboratory analyses will consist of VOC, methane/ethane/ethene, nitrate/nitrite, hydrogen (select wells) and TOC. The sampling procedures for hydrogen are included in SOP #7 (Appendix E Work Plan).

4.0 WASTE MANAGEMENT PLAN

4.1 WASTE STREAMS

The above discussed field activities will generate three distinct waste streams. These waste streams are as follows:

- Contaminated soil from drilling activities;
- Water from decontamination, well development and well sampling activities;
- Vegetable oil/water mixtures from post-injection well sampling;

Two additional waste streams are anticipated and consist of 1) miscellaneous and construction wastes; and 2) contaminated personal protective equipment (PPE). Miscellaneous and construction wastes will be placed in a job site dumpster and disposed at a municipal landfill. A determination will be made whether contaminated PPE will need special disposal requirements or can be handled by a municipal landfill. Pre-vegetable oil injection water wastes will be transported to NIROP for storage and disposal at the on-site water treatment facility. Certificates of disposal will be retained for all disposal activities related to the Site, and turned over to CCI at frequencies listed in Section 2.4.2 of the work plan.

4.2 WASTE CHARACTERIZATION

Two waste streams (contaminated soils and post-injection water) will be characterized prior to transportation and disposal to an off-site facility. These waste streams will be characterized through sampling and analyses of constituents listed on Table 4.1 of the Work Plan. Samples collection and waste handling procedures are described following sections.

It is assumed that all generated wastes will be classified as non-hazardous. If the laboratory results indicate that a waste stream is hazardous, EMR will contact a waste broker to determine the location of an acceptable disposal facility.

4.3 WASTE MANAGEMENT PRACTICES

All generated wastes will be containerized for both transportation and storage at the designated temporary staging areas. All containers, holding tanks, and roll-off boxes will be in good condition with no damage or other defects that could result in leakage.

A temporary staging area will constructed in an area designated by CCI. The temporary staging area will consist of at least two roll off boxes, which will be placed on bermed reinforced plastic sheeting. Both roll off boxes will be complete with plastic liners and

full coverage tarps. One roll off box will be used for the storage of liquid waste containers, while the other will be used for contaminated soil storage. Waste containers will be neatly arranged and stored in a secured onsite temporary staging area. Adequate aisle space will be provided between containers to allow the unobstructed movement of personnel and equipment. Containers will remain closed unless adding or removing material. Covers will be properly secured at the end of each workday.

The temporary staging area will contain emergency equipment equivalent to hazard posed by waste. At a minimum the temporary staging area emergency equipment will include:

- Fire extinguisher
- Spill control supplies and equipment
- Decontamination equipment
- Alarm Blow Horn
- Drum Repair Equipment and Tools

EMR personnel will be responsible for maintenance of the containment/storage area, including replacement of any worn or damaged containment materials. Daily inspections of the temporary storage area will be performed and documented to verify there are no ruptures to containers or other conditions that could result in a release. In addition, the daily inspections will ensure that all containers are properly labeled, with labels visible, and to maintain good housekeeping. An example of the temporary storage area inspection form is found in Appendix A.

Portable storage tanks for liquids will be provided with covers and secondary containment. Old labels will be removed. Any tank arriving onsite with contents will be rejected. Free liquids that have accumulated in the secondary containment will be pumped (or otherwise removed) and combined with tank contents.

The labeling of waste containers, tanks, and roll-off boxes will be in accordance with 49 CFR 172, 173 and 178 (and 40 CFR 262 for hazardous wastes).

Drums will be transported to the temporary staging areas on wood pallets and will be secured together with non-metallic bonding.

All generated wastes will be handled, stored, transported, and disposed of in accordance with all applicable federal, state and local regulations. All generated wastes will be disposed of within 60 days of the accumulation start date. All personnel handling hazardous waste will be trained in accordance with 49 CFR 172.704, 29 CFR 1910.120, and 40 CFR 262. All personnel responsible for hazardous waste labeling, inspecting, profiling and manifesting will be trained in accordance with 29 CFR 1910.120 and 49 CFR 172 as amended by HM-181 and HM-126. All vehicles carrying hazardous waste

will be placarded in accordance with 49 CFR 172. All vehicles will be adequately protected to prevent leakage or spillage during shipment.

EMR will coordinate with the on-site Navy O&M Contractor to schedule discharge of all generated water to the NIROP Ground Water Treatment Facility (GWTF).

4.3.1 Management of Soil

All soil generated during well installation will be stored in lined roll off containers or 55-gallon drums. Generated soil will be sampled and analyzed as specified in Table 4-5 of Appendix D of the Work Plan for disposal characterization. To the extent possible, samples will be collected using disposable sampling equipment. If required, decontamination of sampling equipment will be performed in accordance with Section 5.0 of the Work Plan.

Soil characterization samples will be collected from the material contained in roll offs or 55-gallon drums. One composite sample will be collected per roll-off or one per 4 drums or as required by the disposal facility. The samples will be collected as follows:

- Choose four points in the roll off (or four drums, if stored in drums) and place a marker (flag or stake) at each point.
- At each of the four points (or from each of the four drums, if stored in drums), collect grab samples by performing the following steps:
    - Remove the top 12 inches of the soil using a stainless steel auger
    - Auger down another 6 inches, remove the sampler, and place the sample in a stainless steel bowl.
- Homogenize the four grab samples by quartering techniques using a stainless steel spoon.
- Fill the appropriate sample jars with the homogenized sample
- Close the jars, label, and package the sample for shipment to the laboratory.

NOTE: Samples for volatile organic compounds (VOCs) analysis will not be composited and homogenized. They will be collected as discrete grab samples from the locations indicating highest field screening test results. Sample containers will be filled to capacity with the sampled soil so that no headspace remains in the container.

All analyses will be requested for a 14-calendar day turnaround time basis. The results of the analyses will be forwarded to CCI within one day following receipt of the analytical results. Analytical results will also be provided to CCI electronically in accordance with the specifications in the CCI amended Work Plan.

Based on analytical results, the soil will be disposed of offsite as hazardous waste (non-Toxic Substances Control Act (non-TSCA)) or non-hazardous special waste. Off site treatment or disposal facilities will use the waste profile and supporting documentation (e.g., analytical data) to determine if they will accept a waste. Hazardous wastes will be sent to the appropriate RCRA Subtitle C treatment or disposal facility. Non-hazardous wastes will be sent to Subtitle D facilities or municipal landfills, as appropriate. The treatment or disposal facility will be responsible for providing a copy of the final waste manifest and for providing a certificate of destruction or disposal for each load of waste received. Final waste manifests or destruction/disposal certificates will be forwarded to CCI upon receipt.

4.3.2 Management of Generated Water

All water generated from this work will be stored in portable holding tanks or 55-gallon drums. Purge water that is visibly contaminated with vegetable oil will be containerized separately and characterized prior to disposal off site to an approved waste disposal facility as hazardous (non-TSCA) or non-hazardous special waste based on analytical results. Water free of vegetable oil will be discharged at the NIROP GWTF for treatment and disposal.

Purge water containing free vegetable oil will be sampled and analyzed as specified in Table 4-5 of Appendix D of the Work Plan for disposal characterization. To the extent possible, samples will be collected using disposable sampling equipment. If required, decontamination of field sampling equipment will be performed in accordance with Section 6.3.2.1. Disposal characterization samples will be collected from the portable holding tanks or drums using either a dip jar or bailer. The sample containers for volatiles analyses will be filled first. The 40-ml vials will be filled so that there is no headspace in each vial. The sample containers for the remaining analyses will then be filled.

All analyses will be requested for a 14-calendar day turnaround time basis. The results of the analyses will be forwarded to CCI within one day following receipt of the analytical results. Analytical results will also be provided to CCI electronically in accordance with the specifications in Appendix C.

4.3.3 Management of Office Wastes, Construction Debris, and Personal Protective Equipment

All miscellaneous office waste and general construction debris (such as caution tapes, barricades, signs, and packing materials) will be containerized in accordance with all applicable rules and regulations until it is disposed of offsite. No waste material and/or debris will be buried or otherwise allowed to remain on the site.

Office wastes and general construction debris without any contamination is classified as non-hazardous construction debris and will be disposed at a landfill permitted to accept such wastes.

Used personal protective equipment (PPE) includes disposable Tyvek® suits, gloves, booties, and plastic sheeting. Contaminated PPE will be placed in a plastic-lined 55-gallon drum immediately after use; the drum will be labeled to identify its contents and

source of generation, and characterized using process knowledge. Contaminated PPE will be disposed as non-hazardous or hazardous waste, depending on characterization. Used uncontaminated PPE will be disposed of as non-hazardous wastes at a Subtitle D facility or municipal landfill, as appropriate.

4.4 WASTE TRANSPORTATION

Each transportation vehicle and load of waste will be inspected before leaving the site. The quantities of waste leaving the site will be recorded. Waste will be transported by licensed commercial transporters, in accordance with 49 CFR 171-179. A copy of the appropriate licenses and/or certificates will be provided to CCI prior to transport of any waste material.

The transporter is responsible for weighing loads at a certified scale. For each load of material, weight measurements will be obtained for each full and empty container, dump truck, or tanker truck. Disposal quantities will be based on the difference of weight measurements between the full and empty container, dump truck, or tanker truck. Weights will be recorded on the waste manifest. The Subcontractor will ensure that the transporter provides copies of weight tickets with the final manifest to CCI.

EMR will ensure that the transporter observes the following practices when hauling and transporting wastes offsite:

- Minimize impacts to general public traffic, repair road damage caused by construction and/or hauling traffic.
- Decontaminate vehicles prior to re-use offsite or for hauling non-contaminated material. The truck tires and exterior of the dump truck body will be swept clean of soil/sand prior to each truck leaving the excavation zone. All moist rags, poly-sheeting and PPE used during the decontamination process will be include with the contaminated soil and debris for disposal.
- No materials from other projects will be combined with materials from the site.
- Trucks transporting liquids will be sealed.

Care will be taken during loading operations to minimize the potential for spillage, tracking, or cross contamination. Contaminated soil which becomes spilled on the road, street, or other areas outside the limits of the excavation during loading operations, will be immediately cleaned up to the satisfaction of CCI. All personnel involved in offsite disposal activities will follow safety and spill response procedures outlined in the Health and Safety Plan.

4.4.1 Manifests/Shipping Documentation

Each load of waste material will be manifested prior to leaving the site. At a minimum, the manifest form will include the following information:

- Transporter information including name, address, contact and phone number
- Generator information including name, address, contact, and phone number
- Site name including street/mailing address
- Description of waste (e.g.: hazardous waste, liquid)
- Type of container
- Quantity of waste (volumetric estimate)

Additionally, each waste stream transported offsite will also have a waste profile, Land Disposal Restriction Notifications/Certifications (for hazardous wastes), and haul ticket. Copies of the shipping manifests will be returned to CCI within 24 hours of shipment.

4.4.2 Transportation and Disposal Log

Transportation of wastes will be inventoried the day of transportation from the site using the Transportation and Disposal Log. A carbon copy of the initial manifest form for each load will be retained on-site and attached to the Daily Production Report. All required transportation manifests will be prepared by EMR, approved by CCI, and signed by the Navy's site representative.

4.5 Disposal Facilities

EMR has selected three waste disposal companies to transport and dispose of the anticipated waste streams. The disposal responsibility of each company is as follows:

Waste Stream	Transportation/Disposal Company	Anticipated End Point
Contaminated Soil	Onyx Environmental Services	Superior FCR Landfill
Oil/Water Mixture	Special Waste Disposal , Inc	Metropolitan Council Environmental Services
Office/Construction Debris	Waste Management	Municiple Landfill

5.0 QUALITY ASSURANCE PROJECT PLAN (QAPP)

5.1 SAMPLING PROCEDURES

EMR STMs will be responsible for collecting samples in the field with the objective of obtaining samples that represent the environmental matrix at the site. Containers and preservatives will be supplied by EnChem Laboratory, Inc (EnChem). Preservatives required for each analysis will be added to the appropriate sample containers by EnChem before shipment to the project site.

The EMR QC representative will be responsible for assuring that an adequate volume of sample is collected, and that the samples are shipped, using proper chain-of-custody procedures. Upon receipt of samples, EnChem will complete the chain-of-custody documentation, and will consider any sample with a broken sample seal suspect.

A sample will be collected from the vegetable oil shipped to the Site prior to it being injected into the aquifer. A bailer or a drum thief will be used to collect an oil sample directly from the top opening of the tanker truck. The oil sample will then be transferred into sampling bottles provided by the Laboratory.

5.2 SAMPLE CUSTODY

Sample custody is a vital aspect of field investigation programs that generate data used as evidence in a court of law. The possession of samples must be traceable from the time the samples are collected until their ultimate disposal. To achieve the required documentation, several documents will be completed. These documents are described in the following sections.

5.2.1 Field Sample Logbook

All information concerning sample collection by EMR personnel will be entered either in a hardcover bound field book or on the appropriate field form (Appendix A). The recorded field data for each sample will include:

- project location;
- exact location of sampling point;
- sampling methodology;
- sample container numbers and volumes;
- date and time of collection;

- field sample identification number or designation;
- field observations or measurements;
- preservation and transport statement;
- name(s) and signature(s) of sampler(s);
- any deviation from the work plan will alos be noted and documented.

5.2.2 Sample Labels

Gummed laboratory sample labels will be used for proper identification and management of collected samples. These labels will be completed and affixed to each sample container at the time of collection. If a sample requires several containers for transport and analysis, each container will have a label. Entries on the sample label will include:

- Facility name;
- Sample station identification;
- Sample type;
- Sampling date;
- Sampling time;
- Preservative added;
- Sample collector's initials; and
- Analyses requested.
- All entries on the Sample Label will correspond with the Field Sample Logbook.

5.2.3 Chain-of-Custody Form

Samples submitted to EnChem will utilize chain-of-custody forms (Appendix A) to provide adequate documentation of sample possession. These forms will be completed and sealed within the sample transport container to be opened and examined by the EnChem Sample Custodian. All entries on the chain-of-custody form will correspond with the field sample logbook and sample labels.

To maintain and document sample custody, the chain-of-custody procedures described below will be strictly followed. A sample is in custody if:

a) it is in actual possession of the responsible person, or

b) it is in view, following physical possession, or

c) it was in possession of said personnel and is locked or sealed to prevent tampering, or

d) it is in a secure area.

Chain-of-custody procedures will continue after receipt of samples by the Subcontract Laboratory.

5.3 Calibration Procedures

A calibration procedure establishes the relationship between a known calibration standard and the measurement of that standard by an instrument or analytical procedure. Specific procedures are maintained by EnChem for the operation and calibration of all its analytical instruments. These procedures include proper operator training and supervision; mandatory instrument performance specifications; and systematic instrument calibration, verification, and monitoring schedules.

Equipment calibrated by EnChem includes major analytical instrumentation, measurement equipment, glassware, water, reagents, and industrial gases. Instrument calibration response criteria are based upon the manufacturer's or EPA's analytical method specifications.

5.4 Analytical Procedures

All samples designated for chemical analysis will be promptly packaged and delivered to EnChem. EnChem will then be required to submit results that are supported by sufficient backup data and quality assurance to enable reviewers to evaluate the quality of the data.

5.5 Data Reduction, Validation, and Reporting

The principal criteria for quality assurance of laboratory results are dependent on the data integrity during collection, analysis and reporting. The processes necessary for data reduction, validation, and reporting are described in the following sections.

5.5.1 Laboratory Data Reduction, Validation, and Reporting

EnChem utilizes a Laboratory Computerized Data Management System to record, document, and assimilate pertinent laboratory technical and administrative data. This data management system enhances efficient coordination among these component laboratory activities by providing a highly automated, standardized communication network for data transfer and correlation.

EnChem will provide QA/QC reports that contain information on instrument performance (initial and continuing instrument calibration and verification) and method performance (preparation blanks, laboratory control samples, spiked samples, duplicate samples) necessary to validate the integrity of the data. EnChem will adhere to the QA/QC and documentation procedures of the U.S. EPA's Contract Laboratory Program.

5.5.2 Analysis of Laboratory Results

The laboratory data report will be evaluated through an examination of "less than detection limit" values, missing data values, outliers, and units of measure.

Laboratory instrumentation is capable of recording values that may be "less than detection limit". Although these values may not be considered statistically accurate, they may, nevertheless, indicate certain trends in chemical constituents. Reported values that are less than the detection limit for that specific parameter will be considered suspect if the value appears to increase with time. Results that are increasing but still remain beneath the detection limit may indicate an increasing concentration trend. Analysis of a specific parameter will always be accompanied by the corresponding numerical value of the detection limit and by the actual amount detected.

A measured contaminant concentration value that is significantly different from the majority of other values in a data set are referred to as an "outlier". Outliers can be caused by a catastrophic unnatural occurrence such as a spill, inconsistent sampling or analytical chemistry methodology, errors in the transcription of data values or decimal points or a true value of an extreme contaminant concentration. Every effort should be made to determine the basis for outlier data. If no basis can be found for the outlier value, the value should be reported but deemed suspect.

The laboratory data report should be examined also for missing data and for the accuracy and reliability of the reported unit of measure.

5.5.2.1 Blank and Replicate Samples

Sampling techniques for quality assurance and quality control include the use of field blank samples, rinseate blank samples, trip blank samples, matrix spike samples and duplicate samples. A discussion of each is provided below:

Field blank samples are distilled water samples that are collected in field conditions to determine whether analytical samples are subject to sampling atmosphere conditions. At no time is the field blank sample exposed to site conditions. This sample is used to identify possible sources of laboratory error or the occurrence of contamination during the sample shipping process.

Rinseate blank samples are samples taken from water used to rinse sampling equipment. Laboratory analysis of equipment rinseate blank samples may indicate the effectiveness of cleaning and decontamination of sampling equipment.

Trip blank samples are samples that have been prepared by the laboratory, taken into the field, and returned to the laboratory for analysis.

Duplicate samples are collected from the identical sample matrix as a designated analytical sample but are not specifically labeled with sample location and time. Duplicate samples should be double blind to the lab meaning that neither sample should in any way indicate that it is part of a duplicate set. A sample ID and time of collection for one of the samples shall be created and it shall be recorded in the logbook and / or other appropriate forms, as to the actual identity of the sample. The results of a duplicate

sample are then compared to the associated analytical sample to check laboratory replication.

5.6 Internal Quality Control

Internal quality control checks are designed to evaluate the scientific and legal validity of all analytical results. The laboratory QA/QC Program consists primarily of a thorough, legal laboratory documentation network in combination with systematic inclusion of various analytical quality control practices into all component laboratory operations. These QC practices will provide constant documented evaluation and surveillance of acceptable sampling and analytical method performance.

5.7 Performance and Systems Audits

To verify the quality of the laboratory's measurement systems, an internal system of performance and systems audits is required. Performance audits require satisfactory blind analysis of unknown intra-laboratory performance evaluation samples. EnChem conducts these audits on a regular basis as a part of normal laboratory operations. EnChem also will submit to on-site external systems audits, which evaluate the adequacy of laboratory personnel, equipment, documentation, and QA/QC.

5.8 Data Assessment Procedures

Specific procedures to assess the precision and accuracy of analytical data will be required of the laboratory. These measures include data validation and internal quality control procedures. Specific procedures for assessing data accuracy and precision include calculation of percent recoveries and relative percent differences for all duplicate and spike sample analyses.

5.9 Corrective Action

To quickly identify and rectify problems in laboratory procedure, the laboratory will be required to routinely review its quality control data to assess the need for corrective action. Frequent review of data allows rapid identification of the source of analytical or sampling error and the implementation of corrective action.

5.10 Quality Assurance Reports

EnChem routinely prepares and submits internal QA reports to laboratory management. These reports include assessments of systems and performance audits, significant quality assurance problems and the outcome of any corrective actions undertaken. The laboratory also will submit a quality assurance report summarizing analytical results and those portions of the internal quality analysis report pertinent to this project.

6.0 QUALITY ASSURANCE OBJECTIVES FOR DATA EVALUATION

The principal objectives of the QA/QC procedures are to maintain the quality of operational activities in the field and in the laboratory, and to document the quality of data generated through established review and audit procedures so that all data and resulting decisions are technically sound, statistically valid, and properly documented. To provide analytical data that meet these objectives approved EPA analytical methods will be used. The methods to be used are summarized in Table 4.4 of the Work Plan, and in the attached Table 5.1 along with the preservation and holding time requirements.

To monitor progress towards achievement of the data quality objectives, the following QC parameters will be assessed: precision, accuracy, representativeness, completeness, and comparability (PARCC).

6.1 PRECISION AND ACCURACY

Precision and accuracy are quantitative measures of the reproducibility of the measurements or analytical results, and the bias of a specific measurement method, respectively.

Precision and accuracy of laboratory-generated data are assessed by evaluating spike, blank, and duplicate samples. The field QC samples are collected at a frequency equal to or greater than that specified in SW-846. The frequency of quality control samples is summarized in Table 4.5 of the Work Plan.

Precision of field measurements will be assessed by checking the reproducibility of measurements by taking multiple readings. Accuracy of field measurements will be addressed by calibration of instruments (where appropriate).

Detailed equations for evaluating precision and accuracy are presented in Chapter 14.0 of this QAPP.

6.2 REPRESENTATIVENESS

Representativeness is a qualitative evaluation that assesses whether the information obtained during the investigation accurately represents actual site conditions. Representativeness will be assessed after initial data validation and reduction, and will be based only on validated data. The determination of the representativeness of the data will be evaluated by:

- Comparing actual sampling procedures to those specified in the Work Plan.

- Examining the results of QC blanks for evidence of false-positive results.
- Examining the results of field duplicates to determine variance in site characteristics.
- Examining and comparing the results of successive sampling episodes.

6.3 COMPLETENESS

Completeness defines the percentage of completed measurements that are judged to be valid. Sufficient amounts of valid data must be generated to make technical decisions. Field completeness is assessed by comparing the number of samples collected to the number of samples planned. Overall completeness is assessed by comparing the number of samples having valid data to the number of samples planned. The equation used for evaluating completeness is presented in Chapter 14.0 of this QAPP.

6.4 COMPARABILITY

Comparability qualitatively expresses how data developed during the Investigation compares with applicable criteria and with data available from other scientific studies in the area. Both field and analytical procedures will follow standard methods as much as possible. Field sampling and measurement methods will follow procedures outlined in the SOPs and Work Plan Section 4.0. This allows comparison to previously collected data and to data sets, which will be collected in the future.

7.0 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

7.1 SAMPLE PACKAGING AND SHIPPING

Sample packaging and shipping procedures are based on U.S. EPA specifications as well as U.S. Department of Transportation (DOT) Regulations (49 CFR Parts 172 and 173). Samples will be packed and shipped according to requirements for low hazard level samples.

All sample bottles are to be supplied through a qualified sample bottle supplier or laboratory. EPA approved preparation, handling, and shipping guidelines are to be followed.

The steps outlined below will be followed to pack low hazard samples:

- Decontaminated sample containers will be arranged in groups by sample number.
- Containers will be arranged in front of the assigned coolers.
- Clear tape will be placed over the sample label to protect it.
- Each glass sample container will be wrapped with protective packing material.
- Approximately 2 inches of packing material will be placed in the bottom of the cooler for cushioning.
- The cooler will be lined with a large trash bag.
- Sample containers will be placed inside the trash bag in the cooler.
- The trash bag will be sealed with tape. Sample containers will not be allowed to be in direct contact with ice.
- Ice will be double packaged in sealed plastic bags and added in a quantity sufficient to maintain a required temperature control of 4 degrees C +/- 2 degrees C and temperature blanks will be included with each shipment.
- The remaining volume of the cooler will be filled with packing material.
- The chain-of-custody record will be signed; and the time and date the cooler is sealed or relinquished to an overnight delivery service will be indicated. The time will be recorded in the field log.

- Copies of forms will be separated. Proper copies will be sealed in a large sealable plastic bag and taped to the inside lid of cooler.
- The cooler drain will be taped shut.
- The lid will be closed and the cooler latched. The cooler will be taped shut on both ends, with several revolutions made with strapping tape. Labels or custody seals will not be covered.
- The airbill with contracted laboratory address will be placed on top of cooler.
- "This Side Up" labels will be put on both ends of cooler lid, "Environmental Samples" label will be placed on lower portion of cooler lid, and "Up Arrow" symbols will be put on all four sides of the cooler.
- Custody seals will be affixed over lid openings (front right and back left corners of cooler). Seals will be covered with clear plastic tape.
- The onsite QC representative will maintain a file of all sample documentation.
- All samples will be packaged and transported within one day of collection.

7.2 Documentation Procedures and Sample Custody

Each sample or field measurement will be properly documented to facilitate timely, correct, and complete analysis, and to support actions concerning a site. The documentation system provides the means to identify, track, and monitor each individual sample from the point of collection through final reporting of the data. All appropriate forms are included in Appendix A. Specific documentation requirements are described in the following sections.

7.2.1 General Documentation Procedures

A suitable work area will be established with sufficient space available for processing forms and packaging samples. After all the sample documentation has been completed and before the samples are prepared for shipping, another team member will cross check the data on all forms and labels and compare the data to the logbook entries.

The sample numbers, laboratory, date sampled, and date shipped will be recorded on the chain of custody for each sample. NOTE: If portions of a given sample are to shipped to different laboratories, two entries will be required for that sample number to accommodate the Chain-of-Custody Record number and shipping record number (if applicable) corresponding to each portion of the sample.

The number of shipping containers (coolers) required to accommodate the day's shipment will be determined. This will be based on the number of samples to be shipped, the number of containers per sample, and the number of laboratories to be used. (Note: A group of containers for a single sample should not be split between coolers except when

one portion of the sample is to be sent to one laboratory for one type of analysis, and the other portion is to be sent to another laboratory for another type of analysis.)

A shipping record (if applicable) will be completed for each laboratory address. (Note: Several coolers may be shipped to the same address.)

Shipping record numbers will be kept on file by the Field Site Manager.

A Chain-of-Custody Record will be preliminarily assigned to each cooler and the sample containers to be shipped in each will be determined. (Note: More than one Chain-of-Custody Record may be needed to accommodate the number of samples to be shipped in one cooler.)

Chain-of-Custody Record numbers will be assigned and recorded on the custody form.

The number of packing lists needed will be determined.

Chain-of-Custody Records will be completed, signed and reviewed.

Two Custody Seals will be assigned to each cooler. The serial numbers of the seals will be entered in the "REMARKS" section of each Chain-of-Custody Record and seals will be temporarily clipped to the form.

The paperwork associated with each cooler will be grouped with a separate clip.

Signatures of the onsite QC representative or his designates and initials of sampling team members will be obtained on the Sample Label and at the top of the Chain-of-Custody Records.

Samples will be prepared for shipment.

7.2.2 Field Logbook Record Documentation

No general rules can specify the exact information that must be entered in a logbook for a particular site. However, the logbook will contain sufficient information so that sampling activities can be reconstructed, if necessary. The bound logbook will have consecutively numbered pages. All entries in logbooks and on sample documentation forms will be made in waterproof ink and corrections will consist of line-out deletions that are initialed and dated. The person responsible for the entries will sign and date each page (or entry) after entering it in the logbook.

The logbooks will be kept in the field team member's possession or in a secure place during the investigation. Following the investigation, the logbooks will become a part of the final file. A listing of typical field logbook entries is as follows:

- Identification number of sample.
- Type of sample (soil, ground water, drilling water, etc.).

- Location of sample.
- Depth of sample (below ground).
- Sample withdrawal procedure/equipment.
- Date and time of collection.
- Types of sample containers and sample identification numbers.
- Parameters requested for analysis.
- Calibration record of field test equipment.
- Field test equipment analysis data and methods.
- Chemicals used for decontamination: manufacturer, product description, lot numbers, and dispenser description (type, construction, etc.).
- Sample shipment information - name of carrier, air bill number, and shipment date and time.
- Several numbers assigned to Chain-of-Custody Records and Custody Seals.
- Field observations on sampling event.
- Name of collector(s).
- Weather conditions both from the previous evening and prediction for the day, along with the current conditions at the time of sampling.
- Sample description (color, odor, etc.).
- Organic vapor detector reading.
- Identification of samples to hold for back-up analyses in the future.
- A cross check of information recorded in the logbooks by all members involved in sampling activities will be conducted daily and concurrence noted.

7.2.3 Corrections to Documentation

Unless prohibited by weather conditions, all original data recorded will be written with waterproof ink. No accountable serialized documents are to be destroyed or thrown away, 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 individual, the individual shall make corrections by marking a line through the error and entering the

correct information. The erroneous information should not be obliterated. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All subsequent corrections must be initialed and dated.

7.2.4 Chain-of-Custody Record

The Chain-of-Custody Record will be employed as physical evidence of sample custody. The sampler will complete a Chain-of-Custody Record to accompany each sample shipment from the field to the laboratory.

The custody record will be completed using waterproof ink. Corrections will be made by drawing a line through, initialing, and dating the error, and entering the correct information. Erasures will not be permissible. A typical Chain-of-Custody Record is shown in Appendix A. Typical information to be included on the Chain-of-Custody Record includes:

- Sample numbers.
- Signature of collector.
- Date and time of collection.
- Sample type (soil, etc.).
- Identification of sampling point (including depth).
- Number of containers.
- Signature of person(s) involved in the chain of possession.
- Inclusive dates and times of possession.
- Notations regarding compromise of sample integrity such as broken seals, bottles, etc.
- Any references to sample custody transferred to a laboratory Chain-of-Custody form.

After completion of the Chain-of-Custody Record by the above procedure, the original signature (top) copy of the Chain-of-Custody Record will be enclosed in a plastic bag (with any other sample documentation) and secured to the inside of the cooler lid. A copy of the custody record will be retained for the Field Site Manager's file.

7.2.5 Sample Labels

Each sample removed from a location and transferred to a laboratory for analysis will be identified by a Sample Label containing specific information regarding the sample. Each completed sample identification label will be securely fastened to the sample container.

7.2.6 Custody Seals

A Custody Seal will be used to preserve the integrity of the sample cooler from the time it is collected until it is opened in the laboratory. Seals must be attached so that it is necessary to break the seals to open the sealed container. All samples for the site will be shipped in coolers. Each cooler will usually be sealed on two opposite sides with custody seals.

Custody Seals will also be affixed to drums of materials stored temporarily on-site or on any other container or storage area, e.g., refrigerators, trailers, etc., where custody is to be maintained.

Shipping coolers are secured, and two Custody Seals are usually placed on opposite sides of cooler so that it cannot be opened without breaking a seal. As long as custody records are sealed inside the sample cooler and Custody Seals remain intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment will sign and date the Chain-of-Custody Record to acknowledge receipt of the samples, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and records that provide a custody record throughout sample preparation and analysis.

7.2.7 Laboratory Custody

Laboratory custody procedures will conform to those presented in the laboratory's QAPP. These procedures must include as a minimum:

Designation of a sample custodian authorized to sign for incoming field samples, obtain documents of shipments, and verify data entered in the field on Chain-of-Custody Record.

Completion by the custodian of the Chain-of-Custody Record, sample tag, and laboratory request sheet (including documentation of sample condition upon receipt).

Documentation of the processing steps through use of a laboratory sample custody log consisting of serially numbered standard laboratory sheets.

Conformity to sample custody procedures for sample handling, storage, and disbursement for analysis.

Completion of separate documentation to identify all laboratory quality control samples specific to each batch of samples.

Conformity to proper data logging and documentation procedures including custody of all original laboratory records.

7.3 PROJECT FILE

Upon completion of the project, the individual files will be assembled, organized, and securely stored as the final file for the project. This will be completed by the project team, maintained by the Project Manager, and supplied to CCI upon request.

8.0 CALIBRATION PROCEDURES AND FREQUENCY

All field and laboratory instruments will be calibrated prior to use. The calibration procedures will follow standard manufacturer and analytical requirements.

8.1 FIELD EQUIPMENT CALIBRATION PROCEDURES AND FREQUENCY

Field measurement and analytical equipment include pH, specific conductivity, dissolved oxygen, turbidity and temperature meter; static fluid elevation probes; and a photoionization detector (PID). The calibration procedures for field equipment will follow standard manufacturer's instructions to assure that the equipment is functioning within tolerances established by the manufacturer. The calibration of applicable equipment is detailed in SOP 2, which is found in Appendix E of the Work Plan.

Field analytical sampling kits will consist of the following Hach Test Kits and Methods:

Parameters	Method
Carbon Dioxide	8223
Alkalinity	8221
Sulfate	8051 with DR700 colorimeter
Ferrous Iron	8146 with DR700 colorimeter
Manganese	8034 with DR700 colorimeter
Chloride	8113
Ammonia	8155 with DR700 colorimeter
Hydrogen Sulfide	8131 with DR700 colorimeter

Manufacturer calibration and analysis procedures will be strictly followed for each method. Copies of the calibration and analysis procedures are found inside each test kit and are also found in Attachment C-4.

9.0 ANALYTICAL PROCEDURES

9.1 FIELD ANALYTICAL PROCEDURES

Field measurements made at the well head will include air monitoring, fluid level measurement, and determination of pH, specific conductivity, dissolved oxygen, redox potential, turbidity and temperature using a direct read instrument. Air monitoring procedures are detailed in Chapter 6 of the Site Health and Safety Plan. Field measurements for pH, specific conductivity and temperature are detailed in Appendix E of the Work Plan.

Field analysis of collected samples will include ferrous iron, manganese, hydrogen sulfide, sulfate, ammonia, alkalinity and bicarbonate, chloride, and carbon dioxide. These analyses will be conducted with the use of Hach or CHEMetrics colorimetric or titrimetric test kits as designated in Table 4.4 of the Work Plan. Each of the tests are to be conducted in strick adherence to the manufacture's specifications.

9.2 LABORATORY ANALYTICAL METHODS

To achieve the objectives of Quality Assurance/Quality Control, EnChem will perform all chemical analyses on environmental samples according to the procedures and requirements from either: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition (SW-846) or Methods for Chemical Analysis of Water and Wastes, revised March 1983 (EPA 600/4-79-020).

All physical analyses will be performed using either: Standard Methods for the Examination of Water and Wastewater, 17th Edition, or American Society for Testing and Materials (ASTM), current testing standards.

Specific analytical methods to be used are presented in the attached Table 5.1 and 4.4 of the Work Plan.

10.0 DATA REDUCTION, VALIDATION, AND EVALUATION

10.1 DATA REDUCTION

Analytical data generated during each Investigation will be compiled and organized into a database by SLWO for use in developing each Report of Investigation. All laboratory data are generated and reduced following guidelines specified in SWLO's QAPP.

All analytical reports will be submitted directly to CCI, unless otherwise requested.

10.2 DATA VALIDATION

Data validation procedures determine which data are usable, usable with qualifications, or unusable. Guidelines for performing validation of organic analytical data are provided in Laboratory Data Validation, Functional Guidelines for Evaluating Organics Analyses (U.S. EPA, 1988).

The following should be considered in the validation process:

- holding times;
- blanks;
- surrogate recovery;
- matrix spike/matrix spike duplicate;
- field duplicate;
- overall assessment of case data;
- quantitation limits; and,
- tentatively identified compounds.

Guidelines for performing validation of inorganic analytical data are provided in Laboratory Data Validation, Functional Guidelines for Evaluating Inorganics Analyses (U.S. EPA 1988). As above, EMR will validate the inorganic analytical data in accordance with the document.

The following should be considered in the validation process:

- Holding times
- Blanks
- Duplicate sample analysis
- Matrix spike sample analysis
- Field duplicates
- Detection limits

11.0 INTERNAL QUALITY CONTROL CHECKS

11.1 INTERNAL QUALITY CONTROL CHECKS FOR FIELD SAMPLES

To monitor sampling proficiency and laboratory performance, QC samples including trip blanks, equipment rinsate blanks, and field duplicate samples are collected and submitted with the samples collected in the field. The combined laboratory and field QC sample results will provide an adequate database for evaluation of analytical data. Unless noted otherwise, the QA/QC samples will be collected and analyzed for the same constituents as all the other samples of the particular matrix. The frequency of QA/QC sample collection is detailed in Table 4.5 of the Work Plan.

11.1.1 Trip Blanks

Trip Volatile Organic Compound (VOC) blanks will be prepared by the laboratory using distilled water and will be shipped with the other sample bottles. The trip blanks will be shipped to the laboratory with the field VOC samples as a check on possible contamination during sample storage and shipment. Trip blanks are to be collected for VOC samples only, and at a rate of one per each shipping container containing VOCs.

11.1.2 Rinsate Blanks

Rinsate blanks are prepared by collecting distilled water used to rinse decontaminated sampling equipment. Analysis of this water checks for cross-contamination from non-dedicated sampling equipment. Rinsate blanks are to be collected from re-usable sampling equipment and analyzed for VOC, at a rate of one per day.

11.1.3 Field Duplicate Samples

Two samples of soil or ground water collected at the same time and location, and analyzed in the same manner are called duplicates. One sample is referred to as the original while the other is the duplicate, or co-located sample. Duplicate samples will be collected for VOCs, methane, ethane, ethene, and geochemical parameters at a rate of at least 1 per every 10 samples collected.

Soil field duplicate samples will be collected as replicates by longitudinally splitting the soil core or sample into two equal portions with the soil knife and placing the portions in different sample bottles. Ground-water duplicate samples will require collecting separate bailers of water from the same well, and individually analyzing the samples collected from each one.

Soil duplicate samples, when collected, processed, and analyzed by the same organization, provide precision information for the entire measurement system including sample acquisition, matrix homogeneity, handling, shipping, storage, preparation, and analysis.

11.2 INTERNAL QUALITY CONTROL CHECKS FOR FIELD MEASUREMENTS

Field measurements are performed on-site and do not involve samples that are collected and retained, therefore quality control checks are limited to calibration and checking the reproducibility of measurements by taking multiple readings.

11.3 INTERNAL QUALITY CONTROL CHECKS FOR LABORATORY ANALYSIS

The laboratory prepares and analyzes a variety of internal QA/QC samples including blanks, reagent blanks, matrix spikes, matrix spike duplicates, calibration check samples, performance check samples, etc. The frequency of their analyses are detailed in Table 4.5 of the Work Plan. The laboratory's QAPP contains detailed information concerning the number and frequency of analysis of these types of samples.

Matrix spikes and duplicates are collected in the field and will be completed on 5 percent of samples. Soil will be collected as part of the original sample. Four ground-water triplicate samples will be collected. Matrix spike and duplicates will be completed for the same constituents as the actual sample. For organic parameters (VOCs) a matrix spike and matrix spike duplicate will be completed. For inorganic parameters a duplicate and matrix spike will be completed. Matrix spikes and duplicates will not be completed for pH.

12.0 PERFORMANCE AND SYSTEM AUDITS

12.1 FIELD PERFORMANCE AND SYSTEM AUDITS

The EMR Quality Assurance Manager (QAM) may schedule audits of field activities at various times to evaluate the execution of sample identification, sample control, chain-of-custody procedures, field documentation, and sampling and field measurement operations. Audits are conducted as appropriate throughout the duration of the project, and are scheduled with the Field Site Manager. The evaluation is based on the extent to which the applicable sampling procedures are followed during field operations. A minimum of one field audit will be scheduled by the EMR's QAM.

The person conducting the audit is normally a senior technical reviewer who is familiar with technical, procedural, and quality control requirements governing field sampling. The auditor keeps a record of his evaluation using field notes and checklists. Following the audit, the auditor reviews preliminary results with the person in charge of the sampling. The auditor also prepares an audit report containing the results of his evaluation and recommendations for corrective actions.

12.2 LABORATORY PERFORMANCE AND SYSTEM AUDITS

The laboratory periodically performs its own performance and system audits. The schedule for those audits are included in the laboratory's QAPP.

12.3 AUDIT PROCEDURE

This procedure provides requirements and guidance for performing internal and external audits to verify compliance with the elements of this QAPP.

Audit Notification: The Project Director, Project Manager, and if appropriate, other audited entity (e.g., Field Site Manager and Laboratory Supervisor) shall be notified by the QAM of an audit at a reasonable time before the audit is performed. This notification shall be in writing and include such information as the general scope and schedule of the audit and the name of the audit team leader.

Pre-Audit Conference: A pre-audit conference shall be conducted at the audit site with the appropriate manager or designated representative. The purpose of the conference will be to confirm the audit scope, present the audit plan, discuss audit sequence, and plan for the post audit conference.

Audit. The audit is then implemented by the audit team as follows:

Checklists prepared by the audit team and approved by the CQAO will ensure depth and breadth of audits. The checklist is intended for use as a guide and will not restrict the

audit investigation when findings raise further questions that are not specifically included in the checklist.

Selected elements of the QAPP shall be audited to the depth necessary to determine whether they are being implemented effectively.

Conditions requiring immediate corrective action shall be reported immediately to the Project Manager.

Post-Audit Conference: At the conclusion of the audit, a post-audit conference shall be held with the Field Site Manager, Laboratory Supervisor or designated representative, to present audit findings, recommendations, observations, and clarify any misunderstandings. Audit findings shall be concisely stated by the audit team leader on the field audit checklist for Post-Audit Conference. The findings will be acknowledged by the Project Manager or designated representative by signing the field audit checklist.

Audit Report: An audit report will be prepared by the audit team leader. The report will include the following:

Description of the audit scope.

Identification of the audit team.

Persons contacted during pre-audit, audit, and post-audit activities.

Details of findings and program deficiencies will be reported on an Audit Findings Report. Each finding and program deficiency shall be identified and described in sufficient detail to assure that corrective action can be effectively carried out by the project organization.

Recommendations for correcting the findings or improving the QAPP.

The audit report shall be addressed to the Project Manager with a copy to the Project Director and others as appropriate.

12.4 RESPONSE

The Project Manager or designated representative shall respond to the Audit Findings Report by addressing the corrective action required. The response shall be completed within 20 days of receipt and shall clearly state the corrective action for each finding, including action to prevent recurrence and the date the corrective action will be completed.

12.5 FOLLOW-UP ACTION

Follow-up action shall be performed by the CQAO or designated representative to:

- Evaluate the adequacy of the response.

- Assure that corrective action is identified and scheduled for each finding.
- Confirm that corrective action is accomplished as scheduled.

Follow-up action may be accomplished through written communications, re-audit, or other appropriate means. When all corrective actions have been verified, a memo shall be sent to the Project Manager signifying the satisfactory closeout of the audit with copies to the Project Director and others as appropriate.

12.6 AUDIT RECORDS

Original records generated for all audits shall be retained within the central project files that are maintained at EMR. Records shall include audit reports, written replies, the record of completion of corrective actions, and documents associated with the conduct of audits, which support audit findings and corrective actions as appropriate.

13.0 PREVENTIVE MAINTENANCE

13.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE

Preventive maintenance of equipment is essential if project resources are to be used in a cost-effective manner. Preventive maintenance will take two forms: (1) a schedule of preventive maintenance activities as detailed in the manufacturer's manual to minimize downtime and ensure accuracy of measurement systems and (2) availability of critical spare parts, and backup systems and equipment. Field instruments will be checked and calibrated prior to their use and batteries will be charged daily, where applicable.

Contract agreements with firms providing services will specify that any and all equipment used at the site will be maintained in safe working order. Any equipment or device determined not to be in safe working order by EMR field personnel or the Site Health and Safety Supervisor will be replaced, repaired, or corrected at the subcontractor's expense.

13.2 LABORATORY EQUIPMENT PREVENTIVE MAINTENANCE

Preventive maintenance of laboratory equipment is performed according to equipment specifications. Complete details concerning preventive maintenance is presented in the laboratory QAPP.

14.0 DATA ASSESSMENT PROCEDURES

The precision, accuracy, completeness parameters are indicators of data quality. EMR will review the calculated accuracy and precision results as reported by the laboratory for method analytical quality control samples. Outliers identified will be considered in the completeness assessment.

14.1 PRECISION

Precision is a measure of the reproducibility of the measurements made under a set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average value. Standard deviation, coefficient of variation, range, and relative range are terms often used to express precision. For duplicate sample measurements, precision can be expressed as the relative percent difference (RPD). The RPD is expressed as follows:

RPD = (D1 - D2) x 100/(D1 + D2)/2

Where:

RPD = Relative Percent Different

D1 = First Duplicate Value (as percent recovery)

D2 = Second Duplicate Value (as percent recovery)

If there is no variability of a group of measurements compared to their average value then the RPD = 0. Specific precision objectives are addressed in the laboratory's QAPP.

14.2 ACCURACY

Accuracy measures the bias of a measurement system. Sources of error introduced into the measurement system will be accounted for by using lab/field/trip blanks, surrogates, and matrix spikes. Possible sources of error include the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques.

Accuracy of chemical test results is assessed by establishing the average recovery. The recovery is determined by splitting a series of samples into two portions, spiking one of the portions (adding a known quantity of the constituent of interest), and submitting both portions for laboratory analysis as independent samples. The percent recovery is then calculated as follows:

% Recovery = SSR-SR x 100/SA

Where:

SSR = Spike Sample Results

SR = Sample Results

SA = Spike Added from Spiking Mix

Perfect accuracy would be defined by 100 percent recovery. Specific accuracy objectives are addressed for routine analyses in the laboratory's QAPP.

14.3 COMPLETENESS

Field completeness is assessed by comparing the number of samples obtained to the number of samples planned. Laboratory completeness is assessed by comparing the number of samples yielding valid data to the number of samples overall completeness is assessed by comparing the number of samples yielding valid data to the number of samples planned. The completeness is calculated following data reduction and data validation. The percent completeness is calculated as follows:

% Completeness = Number of Samples Having Acceptable Data x 100%

Number of Samples Planned

15.0 CORRECTIVE ACTION

15.1 FIELD CORRECTIVE ACTION

If quality control audits of data result in detection of unacceptable data, the EMR QC representative will be responsible for developing and initiating corrective action. The CQAO will be notified if nonconformance is of program significance or requires special expertise not normally available to the project team. Corrective action for field measurements may include:

- Repeating the measurement to check the error.
- Checking for all proper adjustments for ambient conditions such as temperature.
- Checking the batteries.
- Checking the calibration.
- Replacing the instrument or measurement device.
- Corrective action for sampling procedures may include:
- Evaluating and amending sampling procedures.
- Re-sampling.
- Renumbering samples.

15.2 LABORATORY CORRECTIVE ACTION

If a condition in the laboratory is discovered which compromises analytical data, EMR or CCI will be contacted immediately. The laboratory QA officer and the EMR QAM or his representative will address the situation immediately. Any action taken will be recorded and eventually included the final QA report.

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TABLE 5.1

SUMMARY OF ANALYTICAL METHODS, PRESERVATION AND HOLD TIMES

TABLE 5.1
SUMMARY OF ANALYTICAL METHODS, PRESERVATION, AND HOLD TIMES
NIROP FRIDLEY, MINNESOTA
EMR PROJECT # 5427-001

Sample Task	Sample Point	Matrix	Sampling Frequency	Approx Sample Nos.	Approx QC Sample Nos.	Sampling Method	Sampling Equipment	Turn Around Time	DQO Level/ Data Package Requirement	Required Analysis	Analytical Method	Holding Time	Sample Preservation	Containers/ Laboratory
Product Oil Injection Sampling	Designated Well Locations[1]	Water	One sample per well (18 total)	18 water	2 Duplicate 1 MS/MSD[3] 1 Field Blank 5 Trip Blanks 5 Rinseate	Grab	Bladder Pump	7 days	DQO Level III CCI Level A	VOCs	SW8260B	14 days	pH<2, Cool to 4°C	40 ml glass vials - 3 total
				18 water	2 Duplicate					Methane, Ethane, Ethene	Modified SW5021/ SW8015	14 days	pH<2, Cool to 4°C	40 ml glass vials - 3 total
					2 Duplicate					Nitrate+ Nitrite	E300.1	28 days	Cool to 4°C	250 ml glass bottle
					2 Duplicate					Total Organic Carbon	SW9060	28 days	pH<2, Cool to 4°C	250 ml glass bottle
				1 water	1 Duplicate 1 Field Blank		Hydrogen Sampler			Hydrogen	AM-20-GAX	14 days	Room Temperature	22 cc glass vial
	Designated New Well Installations[2]	Soil	One sample per well (7 total)	7 Soil	1 Duplicate 1 MS/MSD 1 Field Blank 4 Trip Blanks 4 Rinseate	Grab	Split Spoon Sampler			VOCs	SW8260B	14 days	Cool to 4°C	4 oz amber glass - 1 total
					None					Total Organic Carbon	E415.1	14 days	Cool to 4oC	4 oz amber glass - 1 total
					None					Bulk Density	ASTM - D2937	None	None	Shelby Tube Blow Count
	Oil Storage Container	Oil	One per oil batch	1 oil	1 Duplicate 1 MS/MSD	Grab	Drum Thief Bailer			VOCs	SW8260B	14 days	pH<2, cool to 4°C	40 ml glass vials - 3 total
Product Monitoring Sampling	Designated Well Locations[1]	Water	One sample per well (18 total)	18 water	2 Duplicate 1 MS/MSD 1 Field Blank 5 Trip Blanks 5 Rinseate	Grab	Bladder Pump	7 days	DQO Level III CCI Level A	VOCs	SW8260B	14 days	pH<2, Cool to 4°C	40 ml glass vials - 3 total
				18 water	2 Duplicate					Methane, Ethane, Ethene	Modified SW5021/ SW8015	14 days	pH<2, Cool to 4oC	40 ml glass vials - 3 total
					2 Duplicate					Nitrate+ Nitrite	E300.1	28 days	Cool to 4°C	250 ml glass bottle
				18 water	2 Duplicate 1 Field Blank		Hydrogen Sampler			Hydrogen	AM-20-GAX	14 days	Room Temperature	22 cc glass vial
	VG-INJ -1 VG-INJ-2 VG-INJ-3	Oil	One sample per well (3 total)	3 oil/water	1 Duplicate 1 MS/MSD	Grab	Bladder Pump			VOCs	SW8260B	14 days	pH<2, Cool to 4°C	40 ml glass vials - 3 total

(1) Wells include MS-46S, VG-MW-1 thru VG-MW-9, 27S, MS-47S, VG-CW-1 thru VG-CW-3, and VG-INJ-1 thru VG-INJ-3.

(2) Wells include VG-MW-2 thru VG-MW-5, VG-INJ-1 thru VG-INJ-3.

(3) MS/MSD - Matrix Spike / Matrix Spike Duplicate

ATTACHMENT C-1

FIELD CREW REGISTRATIONS AND CERTIFICATIONS

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Annual Refresher Class

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Scott J. Carney

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in accordance with 29 CFR 1910.120.

on Thursday, February 22, 2001.

Training Director

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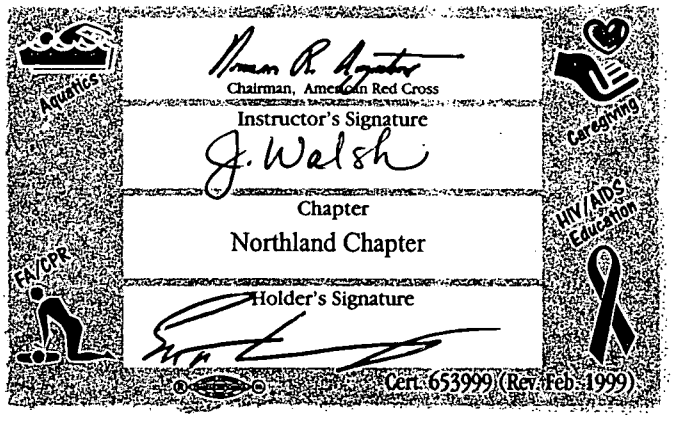
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29 CFR 1910.120(e)

Presented

Tuesday, September 25, 2001

Compliance Solutions Occupational Trainers, Inc.

Certificate Number: *37197*

Neval Gupta
Vice President

Jeffrey Kline
President/CEO

American Red Cross
We'll be there.

This recognizes that

Mike Goalen

has completed the requirements for

Adult CPR

conducted by

EMR

Date completed **04/20/2001**

The American Red Cross recognizes this certificate as valid for **1** year(s) from completion date.

Minnesota Safety Training Inc.

651-697-7315

Minnesota Safety Training, Inc.

P.O. Box 131752
St. Paul, MN 55113-0029

This training certificate has been issued for successful course completion:

Participant: Tracey Turner

Course Title: 8-Hour HAZWOPER Refresher (29 CFR 1910.120)

Course Completion Date: 9-14-01

Certificate Number: 1492

David J. Moline
Instructor

American Red Cross
We'll be there.

This recognizes that

Tracey Turner

has completed the requirements for

CPR for the Professional Rescuer

conducted by

White Bear Racquet & Swim

Date completed **02/15/2001**

The American Red Cross recognizes this certificate as valid for **1** year(s) from completion date.

Aquatics

Chairman, American Red Cross

Instructor's Signature

Kelly Erdman

Chapter

Caregiving

HIV/AIDS Education

FA/CPR

Holder's Signature

Tracey Turner

Cert. 653999 (Rev. Feb. 1999)

American Red Cross
We'll be there.

This recognizes that
Tracey Turner
has completed the requirements for
Lifeguard Training and Community First Aid & Safety
conducted by
White Bear Racquet & Swim
Date completed **03/10/2001**
The American Red Cross recognizes this certificate as valid for 3 year(s) from completion date.

ENVIRONMENTAL MANAGEMENT RESOURCES, INC.
1310 WAKARUSA, SUITE A
LAWRENCE, KS 66049

This is to Certify that

Ryan Zick

has successfully completed an 8-Hour Hazardous Waste Operations and Emergency Response Annual Refresher Course in compliance with 29 CFR 1910.120

12/22/00

Instructor – Raghu Chatrathi

CEO – Connie Cook

American Red Cross
We'll be there.

This recognizes that
Ryan Zick
has completed the requirements for
Workplace Training: First Aid
conducted by
EMR
Date completed **02/18/2000**
The American Red Cross recognizes this certificate as valid for **3** year(s) from completion date.

American Red Cross
We'll be there.

This recognizes that
Ryan Zick
has completed the requirements for
ADULT CPR
conducted by
EMR
Date completed **02/18/2000**
The American Red Cross recognizes this certificate as valid for **1** year(s) from completion date.

American Red Cross

This recognizes that
Daniel Field
has completed the requirements for
FIRST AID BASICS
conducted by
Theodor Beyer
Date completed January 15, 2001
The American Red Cross recognizes this certificate as valid for 3 year(s) from completion date.

American Red Cross

This recognizes that
Daniel Field
has completed the requirements for
ADULT CPR
conducted by
Theodor Beyer
Date completed January 15, 2001
The American Red Cross recognizes this certificate as valid for 1 year(s) from completion date.

American Red Cross

This recognizes that
David Lenzmeier
has completed the requirements for

FIRST AID BASICS

conducted by
Theodor Beyer

Date completed January 15, 2001

The American Red Cross recognizes this certificate as valid for 3 year(s) from completion date.

American Red Cross

This recognizes that
David Lenzmeier
has completed the requirements for

ADULT CPR

conducted by
Theodor Beyer

Date completed January 15, 2001

The American Red Cross recognizes this certificate as valid for 1 year(s) from completion date.

Bergerson-Caswell Inc.
GROUND WATER CONSULTANTS AND MEMBER OF GROUND WATER INSTITUTE
5115 Industrial Street
Maple Plain, Minnesota 55359
(612) 479-3121

_____, 1988

To Whom It May Concern:

I, Rob Cabo have received at least 40 hours of safety training qualifying me to work on Hazardous Waste Sites.

_____

Robert W. Cabo

American Red Cross

This recognizes that
Robert Caho

has completed the requirements for

ADULT CPR

conducted by
Theodor Beyer

Date completed January 15, 2001

The American Red Cross recognizes this certificate as valid for 1 year(s) from completion date.

American Red Cross

This recognizes that
Robert Caho

has completed the requirements for

FIRST AID BASICS

conducted by
Theodor Beyer

Date completed January 15, 2001

The American Red Cross recognizes this certificate as valid for 3 year(s) from completion date.

MEDICAL EXAMINER'S CERTIFICATE

I certify that I have examined

ROBERT W. CAHO

(Driver's name (Print))

In accordance with the Federal Motor Carrier Safety Regulations (49 CFR 391.41 through 391.49) and with knowledge of his/her duties, I find him/her qualified under the regulations. Expiration date of certificate: 7/8/03

Qualified only when wearing: ☐ Corrective Lens ☐ Hearing Aid

☐ Medically unqualified unless accompanied by a _____ waiver.

☐ Medically unqualified unless driving within an exempt intracity zone.

A complete examination form for this person is on file in my office.

C 52 0205 06 | 2-8-07 | MN

(Area Code/Phone No.) (License/Certificate No.) (State)

KEZOZA, N.P.-C

(Medical Examiner (Print Name and Title)) Signature

Robert W. Caho

(Signature of Driver)

1380 CO. ROAD 110N, MINNETRISTA MN 55364

(Address of Driver)

Form QE736 Text Printed by Occupational Medicine Consultants, Ltd.

Certificate of Completion

Hazardous Waste Operations and Emergency Response

January 15, 2001

This is to certify completion of
8 Hour HAZWOPER Refresher training
29 CFR 1910.120

Rob Caho

Environmental & Educational Consulting Services

Theodor J. Beyer

Onsite Occupational Training

This is to certify that

Daniel E. Field

has successfully completed Onsite's 40 hour HAZWOPER training and is in compliance with 29 CFR 1910.120(e). This also represents completion of training in Confined Spaces Level A, B, C, D Ensemble.

At

Minneapolis, MN

On

9/3/98

Expiration Date

9/2/99

ONSITE OCCUPATIONAL TRAINING

921 Elkridge Landing Road, Linthicum, MD 21090

Certificate Number: AMMN090398-011

Student SSN: 398-92-8618

Daniel A. Lewis

Training Director

MEDICAL EXAMINER'S CERTIFICATE

I certify that I have examined

DANIEL FIELD

(Driver's name (Print))

In accordance with the Federal Motor Carrier Safety Regulations (49 CFR 391.41 through 391.49) and with knowledge of his/her duties, I find him/her qualified under the regulations. Expiration date of certificate: 7/14/03

Qualified only when wearing: ☒ Corrective Lens ☐ Hearing Aid

☐ Medically unqualified unless accompanied by a _____ waiver.

☐ Medically unqualified unless driving within an exempt intracity zone.

A complete examination form for this person is on file in my office.

(952) 920-3663 (Area Code/Phone No.) 38557 (License/Certificate No.) MN (State)

EDUARDO R. YUPANGCO MD (Medical Examiner: (Print Name and Title)) (Signature)

X Daniel Earl Field (Signature of Driver) Daniel Field

X 350 74th Ave NE (Address of Driver) Fridley Mn 55432

Form 08738

TM Printed by Occupational Medical Consultants, Ltd.

Certificate of Completion

Hazardous Waste Operations and Emergency Response

January 15, 2001

This is to certify completion of
8 Hour HAZWOPER Refresher training
29 CFR 1910.120

Daniel Field

Environmental & Educational Consulting Services

Theodor J. Beyer

Certificate of Training

OSHA Hazardous Waste Operations Standard [29 CFR 1910.120]

Glenn A. Holmes has by Hazard Control Inc.

this 25th day of February 1988

American Red Cross

This recognizes that
Glenn Holmen
has completed the requirements for
FIRST AID BASICS
conducted by
Theodor Beyer
Date completed January 15, 2001
The American Red Cross recognizes this certificate as valid for 3 year(s) from completion date.

American Red Cross

This recognizes that
Glenn Holmen
has completed the requirements for
ADULT CPR
conducted by
Theodor Beyer
Date completed January 15, 2001
The American Red Cross recognizes this certificate as valid for 1 year(s) from completion date.

Certificate of Completion

Hazardous Waste Operations and Emergency Response

January 15, 2001

This is to certify completion of
8 Hour HAZWOPER Refresher training
29 CFR 1910.120

Glenn A. Holmen

Environmental & Educational Consulting Services

Theodor J. Beyer

MEDICAL EXAMINER'S CERTIFICATE

I certify that I have examined

Glenn Holmen

(Driver's name (Print)

In accordance with the Federal Motor Carrier Safety Regulations (49 CFR 391.41 through 391.49) and with knowledge of his/her duties, I find him/her qualified under the regulations. Expiration date of certificate: 5/14/03

Qualified only when wearing: ☒ Corrective Lens ☐ Hearing Aid

☐ Medically unqualified unless accompanied by a _____ waiver.

☐ Medically unqualified unless driving within an exempt intracity zone.

A completed examination form for this person is on file in my office.

952-930-5663 18686 MN

(Area Code/Phone No.) (License/Certificate No.) (State)

Richard F. Hirt Richard F. Hirt MD

(Medical Examiner: (Print Name and Title) Signature

Glenn E Holmen

(Signature of Driver)

4120 55th St Alexandria MN 56308

(Address of Driver)

Form CD700

7/98 Printed by Occupational Medicine Consultants, Ltd.

ONSITE ENVIRONMENTAL

This to certify that

David Lenzmeier

475-46-9861

has successfully completed Cardio 8 hour H.A.Z.W.O.P.E.R. training and is compliance with 29 C.F.R. 1910.120 (e). This also represents completion of the following training:

Confined Spaces Hearing Conservation Lockout/Tagout

Electrical Safety Level A, B, C, D Ensemble

at

Bloomington, MN

On

April 28, 1995

Expiration Date: April 27, 1996

Certificate Number: 40-5264

Greg Stannard

Health & Safety Director

Certificate of Completion

Hazardous Waste Operations and Emergency Response

January 15, 2001

This is to certify completion of
8-Hour HAZWOPER Refresher training
29 CFR 1910.120

David Lenzmeier

Environmental & Educational Consulting Services

Theodor J. Beyer

MEDICAL EXAMINER'S CERTIFICATE

I certify that I have examined DAVID L [illegible]

(Driver's name (Print))

In accordance with the Federal Motor Carrier Safety Regulations (49 CFR 391.41 through 391.49) and with knowledge of his/her duties, I find him/her qualified under the regulations. Expiration date of certificate: 1-12-02

Qualified only when wearing: ☐ Corrective Lens ☐ Hearing Aid

☐ Medically unqualified unless accompanied by a _____ waiver.

☐ Medically unqualified unless driving within an exempt intracity zone.

A complete examination form for this person is on file in my office.

952 9205665 32112 MN

(Area Code/Phone No.) (License/Certificate No.) (State)

Jetzer MD

(Medical Examiner: (Print Name and Title)) Signature

(Signature of Driver)

901 Heritage Trail, Jordan, MN 55352

(Address of Driver)

Form [illegible] 7/95 Printed by [illegible]

Certificate of Completion

Hazardous Waste Operations and Emergency Response

January 15, 2001

This is to certify completion of
8 Hour HAZWOPER Refresher training
29 CFR 1910.120

Jack Virnala

Environmental & Educational Consulting Services

Theodor J. Beyer

Onsite Occupational Training

This is to certify that

Jack V. Virnala

has successfully completed Onsite's 40 hour HAZWOPER training and is in compliance with 29 CFR 1910.120(e). This also represents completion of training in Confined Spaces and Level A, B, C, D Ensemble.

At

Minneapolis, MN

On

9/9/00

Expiration Date

9/8/01

ONSITE OCCUPATIONAL TRAINING

2555 Westside Pkwy, Ste 600, Alpharetta, GA 30004

Certificate Number: AMMN090900-010

Student SSN: 501-70-4867

Daniel A. Lewis

Training Director

American Red Cross

This recognizes that
Jack Virnala

has completed the requirements for

ADULT CPR

conducted by
Theodor Beyer

Date completed January 15, 2001

The American Red Cross recognizes this certificate as valid for 1 year(s) from completion date.

American Red Cross

This recognizes that
Jack Virnala

has completed the requirements for

FIRST AID BASICS

conducted by
Theodor Beyer

Date completed January 15, 2001

The American Red Cross recognizes this certificate as valid for 3 year(s) from completion date.

PHYSICAL EXAMINATION OF DRIVERS

Name: Jack Virnala
Address: RR3 Box 99 New York Mills MN 56567
Social Security No.: 501-70-2867 Date of Birth: 3·2·61 Age: 39

☐ New Certification ☒ Recertification

HEALTH HISTORY

Yes	No		Yes	No		Yes	No	
☐	☒	Head or spinal injuries.	☐	☒	Syphilis.	☐	☒	Kidney disease.
☐	☒	Seizures, fits, convulsions, or fainting.	☐	☒	Gonorrhea.	☐	☒	Muscular disease.
☐	☒	Extensive confinement by illness or injury.	☐	☒	Diabetes.	☐	☒	Suffering from any other disease.
☐	☒	Cardiovascular disease.	☐	☒	Gastrointestinal ulcer.	☐	☒	Permanent defect from illness, disease or injury.
☐	☒	Tuberculosis.	☐	☒	Nervous stomach.	☐	☒	Psychiatric disorder.
			☐	☒	Rheumatic fever.	☐	☒	Any other nervous disorder.
			☐	☒	Asthma.			

If answer to any of the above is yes, explain: _____

PHYSICAL EXAMINATION

GENERAL APPEARANCE AND DEVELOPMENT: Good: ✓ Fair: _____ Poor: _____

VISION: For distance: Right 20/ 30 Left 20/ 30 Both 20/ 30 ☐ Without corrective lenses ☒ With corrective lenses if worn

Evidence of disease or injury: Right: None Left: None

Color Test: Fail Horizontal field of vision: Right 85 ° Left 70 °

HEARING: Right ear nl Left ear nl Disease or injury _____

AUDIOMETRIC TEST (complete only if audiometer is used to test hearing) decibel loss at 500 Hz _____

at 1,000 Hz _____ at 2,000 Hz _____

THROAT nl

THORAX: Heart reg & R If organic disease is present, is it fully compensated? –

Blood pressure: Systolic 124 Diastolic 84

Pulse: Before exercise 90 Immediately after exercise 100 Lungs _____

ABDOMEN: Scars None Abnormal masses None Tenderness None

Hernia: Yes _____ No ✓ If so, where? – Is truss worn? –

GASTROINTESTINAL: Ulceration or other disease: Yes _____ No ✓

GENITO-URINARY: Scars None Urethral discharge None

REFLEXES: Romberg neg Pupillary nl Light R nl L nl

Accommodation Right nl Left nl

Knee Jerks: Right: Normal ✓ Increased _____ Absent _____

Left: Normal ✓ Increased _____ Absent _____

Remarks: _____

EXTREMITIES: Upper nl Lower nl Spine nl

LABORATORY AND OTHER SPECIAL FINDINGS: Urine: Spec. Gr. 1.025 Alb. 0 Sugar 0

Other laboratory data (serology, etc.) _____

Radiological data _____ Electrocardiograph _____

GENERAL COMMENTS normal exam

4/26/00 (Date of examination) 4960 Hwy (Address of Medical Examiner) Brian Henjum MD (Name of Medical Examiner) (Print)

MD (Title) 26247 (License or Certification No.) MN (State)

☐ CHECK HERE IF NOT QUALIFIED

(Signature of Medical Examiner)

NOTE: This section to be completed only when visual test is conducted by a licensed optometrist or ophthalmologist.

(Date of examination) (Address of examiner) (Name of examiner) (Print)

(Signature of examiner)

MEDICAL EXAMINER'S CERTIFICATE

I certify that I have examined Jack Virnala (Driver's name) (Print) in accordance with the Federal Motor Carrier Safety Regulations (49 CFR 391.41-391.49) and with knowledge of his/her duties, I find him/her qualified under the regulations.

☒ Qualified only when wearing corrective lenses.
☐ Qualified only when wearing a hearing aid.
☐ Qualified by operation of 49 CFR 391.64.
☐ Medically unqualified unless accompanied by a _____ waiver.
☐ Medically unqualified unless driving within an exempt intracity zone.

A completed examination form for this person is on file in my office. 612-495-2160 (Area Code & Telephone Number)

4/26/02 (Medical Certificate Expiration Date) Brian Henjum MD (Name of Medical Examiner) (Print) (Signature of Medical Examiner)

MD (Title) 26247 (License or Certificate No.) MN (State in Which Licensed)

Jack Virnala (Signature of driver) (Address of driver)

NOTE: Medical Examiner's Certificate must be retained in Driver's Qualification File.

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ATTACHMENT C-2

EMR FIELD FORMS

EMR FIELD FORMS INDEX

Visual Classification of Soils

Headspace Analysis Log

Well Development Form

Slug Test Report

Groundwater Collection Log

Vegetable Oil Injection Form

Temporary Staging Area Inspection Form

GROUNDWATER COLLECTION LOG

EMR INCORPORATED

DATE:	PROJECT NUMBER:
PROJECT NAME:	SAMPLE ID:
	PUMP TYPE :
SAMPLE LOCATION :	PURGE RATE:
SAMPLED BY :	

WELL DIMENSIONS		PURGE CALCULATIONS	
Static Water Level (ft):		Standing Water Column (ft):	0
Filter Pack Thickness (ft):	0	1 Casing Volume (gal):	0
Well Depth (ft:)		1 Well Volume (gal):	0
Well Diameter (in):	0	Filter Pack Saturated Thickness (ft):	0
Casing Diameter (in):		Filter Pack Volume (gal):	0
Screened Interval (in):	0	Recommended purged volume: (3 Well Volumes)	0

SAMPLING INFORMATION	WELL HEAD CONDITIONS
Analytical Parameters:	Protective Cover:
Previous Event	External Surface Seal:
Elevation:	Concrete Pad:
DO:	Cap:
Eh:	Datum Reference:
Cond.:	Internal Surface Seal:
pH:	

WATER QUALITY MEASUREMENTS

PURGED VOLUME (gal)	PH	SPECIFIC CONDUCTANCE (uMHOS/CM)	TEMP (C)	DISSOLVED OXYGEN (%)	DISSOLVED OXYGEN (mg/L)	OX-REDOX POTENTIAL EH (mV)	TURBIDITY (NTU)	TIME (MINUTES)	COMMENTS	INITIALS

Comments:

FIELD HEADSPACE ANALYSIS

PROJECT NAME: PROJECT #:

LOCATION:

AMBIENT OUTSIDE TEMPERATURE:

HOLDING TEMPERATURE:

WEATHER CONDITIONS:

INSTRUMENT MAKE AND MODEL:

DATE OF LAST FACTORY CALIBRATION:

FIELD CALIBRATION GAS USED AND CONCENTRATION:

DATE AND TIME OF LAST FIELD CALIBRATION:

LAMP ENERGY IN ELECTROVOLTS:

INSTRUMENT GAIN SETTING:

ERRATIC INSTRUMENT READINGS:

CLEANING OR REPAIRS PERFORMED IN THE FIELD:

DATE: PAGE OF

SAMPLE ID	HEADSPACE RESULT	MOISTURE CONTENT	ODOR

EMR INCORPORATED

VEGETABLE OIL INJECTION FORM

PROJECT NAME:	PROJECT #:
PROJECT NAME:	SAMPLING POINT:
LOCATION:	SAMPLE ID:

WELL INSTALLATION DATE	EMR SUPERVISOR:
WELL DEPTH (TOC)(FT):	FORM COMPLETED BY:
DEPTH TO WATER (FT):	CONTRACTOR:
CASING DIAMETER (ID) (FT):	CREW:
BORING DIAMETER (FT):	START DATE:
DEPTH TO BOTTOM OF WELL SEAL (FT):	END DATE:

DIAMETER FACTORS (GAL/FT)

DIAMETER (IN):	2	3	4	5	6	7	8	9
GALLONS/FT:	0.163	0.367	0.654	1.02	1.47	2	2.61	3.3

WELL VOLUME (IN CASING) = WATER COLUMN * WELL DIAMETER FACTOR (A) _____ GAL

STANDING WATER IN SAND PACK =
WATER COLUMN BELOW SEAL (FT) * (BORING DIAM. FACTOR - WELL DIAM. FACTOR) * 0.3
(B) _____ GAL

SINGLE STANDING WATER VOLUME = A + B
(A + B) _____ GAL

EVACUATION / STABILIZATION TEST DATA

ACTIVITY	START TIME	END TIME	ELAPSED TIME	INJECTION MATERIALS	VOLUME INJECTED (GAL) OIL	VOLUME INJECTED (GAL) WATER	INJECTION PRESSURE	INJECTION RATE	COMMENTS

PUMPING START TIME:	WATER LEVEL:
PUMPING STOP TIME:	WATER LEVEL:

COMMENTS:

Slug Test Report

EMR INCORPORATED

Date:	Tester Name(s):
Project:	Well ID:
Project Number:	Installation Date:
Drilling Method:	Development Date:

Well Information

Boring Diameter:	Depth to Top of Screen:	Total Well Depth (Installed):
Screen Diameter:	Depth to Bottom of Screen:	Total Well Depth (Measured):
TOC Elevation:	Static Water Level	Product Present (Y/N)
		Static Product Level:

Test Equipment

Data Recording Method:	Transducer Rating:
Instrument Brand/Model:	Slug/Bailer Dimensions:

Test Information

Type:	Time Interval:
Start Time:	End Static Water Level:
End Time:	Max/Min Water Level:
Data File Name:	Test Time - Max/Min:
	Transducer Depth:

Weather Conditions

Time	Temp (Approx)	Weather	Humidity (General)	Wind		Ground/Surface Conditions
				Velocity	Direction	

Manual Testing

Time (Sec)	Depth to Water (ft)	Drawdown	Time (Sec)	Depth to Water (ft)	Drawdown	Time (Sec)	Depth to Water (ft)	Drawdown

EMR INCORPORATED

VISUAL CLASSIFICATION OF SOILS

EMR Project Name:

EMR Project Number:

Note:

Drilling Information

Drilling Contractor:
Drilling Method:
Drillers Name:
Borehole Diameter:
Sampler Type:

Event Information

Logged by:
Boring Depth:
GW Encountered
Static GW Level:
Location:

Boring #:
MW #:
Surface Elevation:
Start time/date:
End time/date:

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Groundwater	PID/FID Readings	GC Reading	Graphic Log	USCS Classification	Soil Classification/ Description
0	0-4								
1									
2									
3									
4	4-8								
5									
6									
7									
8	8-12								
9									
10									
11									

Boring Number: 0 Project : Project #: 0

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Ground water	PID/FID Readings	GC Reading	Graphic Log	USCS Classification	Soil Classification/ Description
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									

EMR INCORPORATED

TEMPOARY STAGING AREA INSPECTION FORM

Inspection Date: Time of Inspection:
Inspector Name: Weather Conditions:

SOIL TEMPORARY STAGING AREA

Ground Cover Conditions Beneath/Adjacent to Rolloff Box:

Condition of Rolloff Box:

Condition of Rolloff Box Cover:

Condition of Rolloff Box Liner:

Percentage of Capasity

Signs of Spills:

Signs of Leaks:

Actions taken to remedy any observed problems:

LIQUID TEMPORARY STAGING AREA

Condition of Ground Cover Beneath/Adjacent to Rolloff Box

Condition of Rolloff Box:

Condition of Rolloff Box Cover:

Condition of Rolloff Box Liner:

Condition of Rolloff Box Door and Gasket

Percentage of Capasity

All Drums Properly Labeled and Sealed:

Condition of drums:

Signs of Leakage:

Signs of Spills:

Actions taken to remedy any observed problems:

EMR INCORPORATED

WELL DEVELOPMENT FORM

PROJECT NAME:	PROJECT #:
PROJECT NAME:	SAMPLING POINT:
LOCATION:	SAMPLE ID:

DRILLING METHOD:	SUPERVISOR	
PUMP METHOD(S):	CONTRACTOR	
SURGE METHOD(S):	CREW	
WELL INSTALLATION DATE	START DATE:	END DATE:
WELL DEPTH:	CASING DIAMETER:	
DEPTH TO WATER:	DATE:	TIME:
DISCHARGE RATE =	gpm x 0.00223 =	cfs.
PUMP INTAKE OR BAILER SET AT:	FT. BELOW MP	
SAMPLE APPEARANCE:	ODOR:	

DIAMETER FACTORS (GAL/FT)

DIAMETER (IN):	2	3	4	5	6	7
GALLONS/FT:	0.163	0.367	0.654	1.02	1.47	2

EVACUATION / STABILIZATION TEST DATA

TIME	pH	SPECIFIC CONDUCTANCE (umhos/cm)	TEMPERATURE (C)	WATER LEVEL (ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

PUMPING START TIME:	WATER LEVEL:
PUMPING STOP TIME:	WATER LEVEL:

COMMENTS:

FORM COMPLETED BY:

ATTACHMENT C-3

ASTM D 4750-87 DETERMINING SUBSURFACE LIQUID LEVELS IN A BOREHOLE OR MONITORING WELL

Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)[1]

This standard is issued under the fixed designation D 4750; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes the procedures for measuring the level of liquid in a borehole or well and determining the stabilized level of liquid in a borehole.

1.2 The test method applies to boreholes (cased or uncased) and monitoring wells (observation wells) that are vertical or sufficiently vertical so a flexible measuring device can be lowered into the hole.

1.3 Borehole liquid-level measurements obtained using this test method will not necessarily correspond to the level of the liquid in the vicinity of the borehole unless sufficient time has been allowed for the level to reach equilibrium position.

1.4 This test method generally is not applicable for the determination of pore-pressure changes due to changes in stress conditions of the earth material.

1.5 This test method is not applicable for the concurrent determination of multiple liquid levels in a borehole.

1.6 The values stated in inch-pound units are to be regarded as the standard.

1.7 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Document

2.1 *ASTM Standard:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

3. Terminology

3.1 *Descriptions of Terms Specific to This Standard:*

3.1.1 *borehole*—a hole of circular cross-section made in soil or rock to ascertain the nature of the subsurface materials. Normally, a borehole is advanced using an auger, a drill, or casing with or without drilling fluid.

3.1.2 *earth material*—soil, bedrock, or fill.

3.1.3 *ground-water level*—the level of the water table surrounding a borehole or well. The ground-water level can be represented as an elevation or as a depth below the ground surface.

3.1.4 *liquid level*—the level of liquid in a borehole or well at a particular time. The liquid level can be reported as an elevation or as a depth below the top of the land surface. If the liquid is ground water it is known as water level.

3.1.5 *monitoring well (observation well)*—a special well drilled in a selected location for observing parameters such as liquid level or pressure changes or for collecting liquid samples. The well may be cased or uncased, but if cased the casing should have openings to allow flow of borehole liquid into or out of the casing.

3.1.6 *stabilized borehole liquid level*—the borehole liquid level which remains essentially constant with time, that is, liquid does not flow into or out of the borehole.

3.1.7 *top of borehole*—the surface of the ground surrounding the borehole.

3.1.8 *water table (ground-water table)*—the surface of a ground-water body at which the water pressure equals atmospheric pressure. Earth material below the ground-water table is saturated with water.

3.2 *Definitions:*

3.2.1 For definitions of other terms used in this test method, see Terminology D 653.

4. Significance and Use

4.1 In geotechnical, hydrologic, and waste-management investigations, it is frequently desirable, or required, to obtain information concerning the presence of ground water or other liquids and the depths to the ground-water table or other liquid surface. Such investigations typically include drilling of exploratory boreholes, performing aquifer tests, and possibly completion as a monitoring or observation well. The opportunity exists to record the level of liquid in such boreholes or wells, as the boreholes are being advanced and after their completion.

4.2 Conceptually, a stabilized borehole liquid level reflects the pressure of ground water or other liquid in the earth material exposed along the sides of the borehole or well. Under suitable conditions, the borehole liquid level and the ground-water, or other liquid, level will be the same, and the former can be used to determine the latter. However, when earth materials are not exposed to a borehole, such as material which is sealed off with casing or drilling mud, the borehole water levels may not accurately reflect the ground-water level. Consequently, the user is cautioned that the liquid level in a borehole does not necessarily bear a relationship to the ground-water level at the site.

4.3 The user is cautioned that there are many factors which can influence borehole liquid levels and the interpretation of borehole liquid-level measurements. These factors are not described or discussed in this test method. The

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Nov. 27, 1987. Published January 1988.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

interpretation and application of borehole liquid-level information should be done by a trained specialist.

4.4 Installation of piezometers should be considered where complex ground-water conditions prevail or where changes in intergranular stress, other than those associated with fluctuation in water level, have occurred or are anticipated.

5. Apparatus

5.1 Apparatus conforming to one of the following shall be used for measuring borehole liquid levels:

5.1.1 *Weighted Measuring Tape*—A measuring tape with a weight attached to the end. The tape shall have graduations that can be read to the nearest 0.01 ft. The tape shall not stretch more than 0.05 % under normal use. Steel surveying tapes in lengths of 50, 100, 200, 300, and 500 ft (20, 30, 50 or 100 m) and widths of ¼ in. (6 mm) are commonly used. A black metal tape is better than a chromium-plated tape. Tapes are mounted on hand-cranked reels up to 500 ft (100 m) lengths. Mount a slender weight, made of lead, to the end of the tape to ensure plumbness and to permit some feel for obstructions. Attach the weight to the tape with wire strong enough to hold the weight but not as strong as the tape. This permits saving the tape in the event the weight becomes lodged in the well or borehole. The size of the weight shall be such that its displacement of water causes less than a 0.05-ft (15-mm) rise in the borehole water level, or a correction shall be made for the displacement. If the weight extends beyond the end of the tape, a length correction will be needed in measurement Procedure C (see 7.2.3).

5.1.2 *Electrical Measuring Device*—A cable or tape with electrical wire encased, equipped with a weighted sensing tip on one end and an electric meter at the other end. An electric circuit is completed when the tip contacts water; this is registered on the meter. The cable may be marked with graduations similar to a measuring tape (as described in 5.1.1).

5.1.3 *Other Measuring Devices*—A number of other recording and non-recording devices may be used. See Ref. **(1)** for more details.[3]

6. Calibration and Standardization

6.1 Calibrate measuring apparatus in accordance with the manufacturers' directions.

7. Procedure

7.1 Liquid-level measurements are made relative to a reference point. Establish and identify a reference point at or near the top of the borehole or a well casing. Determine and record the distance from the reference point to the top of the borehole (land surface). If the borehole liquid level is to be reported as an elevation, determine the elevation of the reference point or the top of borehole (land surface). Three alternative measurement procedures (A, B, and C) are described.

NOTE 1—In general, Procedure A allows for greater accuracy than B or C, and B allows for greater accuracy than C; other procedures have a variety of accuracies that must be determined from the referenced literature (2–5).

7.2 *Procedure A—Measuring Tape:*

7.2.1 Chalk the lower few feet of tape by drawing the tape across a piece of colored carpenter's chalk.

7.2.2 Lower a weighted measuring tape slowly into the borehole or well until the liquid surface is penetrated. Observe and record the reading on the tape at the reference point. Withdraw the tape from the borehole and observe the lower end of the tape. The demarcation between the wetted and unwetted portions of the chalked tape should be apparent. Observe and record the reading on the tape at that point. The difference between the two readings is the depth from the reference point to the liquid level.

NOTE 2—Submergence of the weight and tape may temporarily cause a liquid-level rise in wells or boreholes having very small diameters. This effect can be significant if the well is in materials of very low hydraulic conductivity.

NOTE 3—Under dry surface conditions, it may be desirable to pull the tape from the well or borehole by hand, being careful not to allow it to become kinked, and reading the liquid mark before rewinding the tape onto the reel. In this way, the liquid mark on the chalked part of the tape is rapidly brought to the surface before the wetted part of the tape dries. In cold regions, rapid withdrawal of the tape from the well is necessary before the wet part freezes and becomes difficult to read. The tape must be protected if rain is falling during measurements.

NOTE 4—In some pumped wells, or in contaminated wells, a layer of oil may float on the water. If the oil layer is only a foot or less thick, read the tape at the top of the oil mark and use this reading for the water-level measurement. The measurement will not be greatly in error because the level of the oil surface in this case will differ only slightly from the level of the water surface that would be measured if no oil was present. If several feet of oil are present in the well, or if it is necessary to know the thickness of the oil layer, a water-detector paste for detecting water in oil and gasoline storage tanks is available commercially. The paste is applied to the lower end of the tape that is submerged in the well. It will show the top of the oil as a wet line and the top of the water as a distinct color change.

7.2.3 As a standard of good practice, the observer should make two measurements. If two measurements of static liquid level made within a few minutes do not agree within about 0.01 or 0.02 ft (generally regarded as the practical limit of precision) in boreholes or wells having a depth to liquid of less than a couple of hundred feet, continue to measure until the reason for the lack of agreement is determined or until the results are shown to be reliable. Where water is dripping into the hole or covering its wall, it may be impossible to get a good water mark on the chalked tape.

7.2.4 After each well measurement, in areas where polluted liquids or ground water is suspected, decontaminate that part of the tape measure that was wetted to avoid contamination of other wells.

7.3 *Procedure B—Electrical Measuring Device:*

7.3.1 Check proper operation of the instrument by inserting the tip into water and noting if the contact between the tip and the water surface is registered clearly.

NOTE 5—In pumped wells having a layer of oil floating on the water, the electric tape will not respond to the oil surface and, thus, the liquid level determined will be different than would be determined by a steel tape. The difference depends on how much oil is floating on the water. A miniature float-driven switch can be put on a two-conductor electric tape that permits detection of the surface of the uppermost fluid.

[3] The boldface numbers in parentheses refer to the list of references at the end of this standard.

BOREHOLE OR WELL SCHEDULE FORM

Date ..... 19..... Field No. .....
Record by ..... Office No. .....
Source of data .....

1. *Location:* State ..... County .....
Map .....
..... M ..... M sec. ..... T ..... N/S R ..... E/W
2. *Owner* ..... Address .....
Tenant ..... Address .....
Driller ..... Address .....
3. *Topography* .....
4. *Elevation* ..... ft. above/below .....
5. *Type.* Dug, drilled, driven, bored, jetted ..... 19.....
6. *Depth:* Rept. ..... ft. Meas. ..... ft.
7. *Casing:* Diam ..... in., to ..... in., Type .....
Depth ..... ft., Finish .....
8. *Chief Aquifer* ..... From ..... ft. to ..... ft.
Others .....
9. *Water level* ..... ft. rept./meas. ..... 19..... above/below .....
..... which is ..... ft. above/below surface
10. *Pump:* Type ..... Capacity ..... G. M. .....
Power: Kind ..... Horsepower .....
11. *Yield:* Flow ..... G. M., Pump ..... G. M., Meas., Rept. Est. .....
Drawdown ..... ft. after ..... hours pumping ..... G. M.
12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs. .....
Adequacy, permanence .....
13. *Quality* ..... Temp ..... °F.
Taste, odor, color ..... Sample Yes/No .....
Unfit for .....
14. *Remarks.* (Log, Analyses, etc.) .....

FIG. 1 Example of a Borehole or Well Schedule Form

LIQUID LEVEL MEASUREMENT FORM

Field No. .....
Owner ..... Office No. .....
Location ..... Project .....
Measuring Point .....
Elevation of Measuring Point .....

Date	Hour	Depth to Water	Elev. of Water Surface	Meas. by	Remarks (Nearby wells pumping, etc.)

FIG. 2 Example of a Liquid Level Measurement Form

7.3.2 Dry the tip. Slowly lower the tip into the borehole or well until the meter indicates that the tip has contacted the surface of the liquid.

7.3.3 For devices with measurement graduations on the cable, note the reading at the reference point. This is the liquid-level depth below the reference point of the borehole or well.

7.3.4 For measuring devices without graduations on the cable, mark the cable at the reference point. Withdraw the cable from the borehole or well. Stretch out the cable and measure and record the distance between the tip and the mark on the cable by use of a tape. This distance is the liquid-level depth below the reference point.

7.3.5 A second or third check reading should be taken before withdrawing the electric tape from the borehole or well.

7.3.6 Decontaminate the submerged end of the electric tape or cable after measurements in each well.

NOTE 6—The length of the electric line should be checked by measuring with a steel tape after the line has been used for a long time or after it has been pulled hard in attempting to free the line. Some electric lines, especially the single line wire, are subject to considerable permanent stretch. In addition, because the probe is usually larger in diameter than the wire, the probe can become lodged in a well. Sometimes the probe can be attached by twisting the wires together by hand and using only enough electrical tape to support the weight of the probe. In this manner, the point of probe attachment is the weakest point of the entire line. Should the probe become "hung in the hole," the line may be pulled and breakage will occur at the probe attachment point, allowing the line to be withdrawn.

7.4 *Procedure C—Measuring Tape and Sounding Weight:*

7.4.1 Lower a weighted measuring tape into the borehole or well until the liquid surface is reached. This is indicated by an audible splash and a noticeable decrease in the downward force on the tape. Observe and note the reading on the tape at the reference point. Repeat this process until the readings are consistent to the accuracy desired. Record the result as the liquid-level depth below the reference point.

NOTE 7—The splash can be made more audible by using a "plopper," a lead weight with a concave bottom surface.

7.4.2 If the liquid level is deep, or if the measuring tape adheres to the side of the borehole, or for other reasons, it may not be possible to detect the liquid surface using this method. If so, use Procedure A or Procedure B.

8. Determination of a Stabilized Liquid Level

8.1 As liquid flows into or out of the borehole or well, the liquid level will approach, and may reach, a stabilized level. The liquid level then will remain essentially constant with time.

SITE NO.

BOREHOLE OR WELL SCHEDULE FORM

Recorded by _____ Date _____

Check One ___ English ___ Metric Units

GENERAL SITE DATA (0)

Site Ident No. | RO Number R-0 | Transaction T- A D M V

Site Type 2- C D E H I M P R S T W X | Date Reliability 2- C U | Reporting Agency 4-

Project No. 5- | District 6- | State 7- | County (or town) 8-

Latitude 9- (deg min sec) | Longitude 10- (deg min sec) | Lat Long Accuracy 11- S F T M

Local Number 12- | Land Net Loc 13- S T R

Location Map 14- | Scale 15-

Altitude 16- | Method of Measurement 17- A L M | Accuracy 18-

Topo Setting 19- A B C D E F G H K L M O P S T U V W | Hydrologic Unit (OA DC) 20-

Use of Site 23- A C D E G H M O P R S T U W X Z | Secondary Site Use 301- | Tertiary Site Use 302-

Use of Water 24- A B C D E F H I J K M N P O R S T U Y Z

Secondary Water Use 25- | Tertiary Use of Water 26- | Depth of Hole 27- | Depth of Well 28- | Source of Depth Data ① 29-

Water Level 30- | Date Measured 31- (month day year) | Source ① 33-

Method of Measurement 34- A B C F G H L M N R S T V Z

Site Status 37- D E F G H I J N O P R S T V W X Z

Source of Geohydrologic Data ① 38- | Pump Used 36- | Date of First Construction/Completion 21- (month day year)

OWNER IDENTIFICATION (1)

R-158 | T- A D M | Date of Ownership 159- (month day year)

Name: Last 161- | First 162- | Middle Initial 163-

OTHER SITE IDENTIFICATION NUMBERS (1)

R-165 | T- A D M | Ident 190- | Assigner 191-

New Card Same R & T | Ident 190- | Assigner 191-

SITE VISIT DATA (1)

R-186 | T- A D M | Date of Visit 187- (month day year) | Name of Person 188-

FIELD WATER QUALITY MEASUREMENTS (1)

R-192 | T- A D M | Date 193- (month day year) | Geohydrologic Unit 195-

New Card Same R/Ign 196

Temperature 194- 0 0 6 7 0 | Degrees C 197-

Conductance 196- 0 0 0 8 5 | µ Mhos 197-

Other (STORET) Parameter 196- | Value 197-

Other (STORET) Parameter 196- | Value 197-

FOOT NOTES

① Source of Data Codes

A D G L M O R S Z

FIG. 3 Example of a Borehole or Well Schedule Form

NOTE 8—The time required to reach equilibrium can be reduced by removing or adding liquid until the liquid level is close to the estimated stabilized level.

8.2 Use one of the following two procedures to determine the stabilized liquid level.

8.2.1 *Procedure 1*—Take a series of liquid-level measurements until the liquid level remains constant with time. As a minimum, two such constant readings are needed (more readings are preferred). The constant reading is the stabilized liquid level for the borehole or well.

NOTE 9—If desired, the time and level data could be plotted on graph paper in order to show when equilibrium is reached.

8.2.2 *Procedure 2*—Take at least three liquid-level measurements at approximately equal time intervals as the liquid level changes during the approach to a stabilized liquid level.

8.2.2.1 The approximate position of the stabilized liquid level in the well or borehole is calculated using the following equation:

$$h_o = \frac{y_1^2}{y_1 - y_2}$$

where:

h_o = distance the liquid level must change to reach the stabilized liquid level,

y_1 = distance the liquid level changed during the time interval between the first two liquid-level readings, and

y_2 = distance the liquid level changed during the time interval between the second and the third liquid level readings.

8.2.2.2 Repeat the above process using successive sets of three measurements until the h_o computed is consistent to the accuracy desired. Compute the stabilized liquid level in the well or borehole.

NOTE 10—The time span required between readings for Procedures 1 and 2 depends on the permeability of the earth material. In material with comparatively high permeability (such as sand), a few minutes may be sufficient. In materials with comparatively low permeability (such as clay), many hours or days may be needed. The user is cautioned that in clayey soils the liquid in the borehole or well may never reach a stabilized level equivalent to the liquid level in the earth materials surrounding the borehole or well.

9. Report

9.1 For borehole or well liquid-level measurements, report, as a minimum, the following information:

9.1.1 Borehole or well identification.

9.1.2 Description of reference point.

9.1.3 Distance between reference point and top of borehole or land surface.

9.1.4 Elevation of top of borehole or reference point (if the borehole or well liquid level is reported as an elevation).

9.1.5 Description of measuring device used, and graduation.

9.1.6 Procedure of measurement.

9.1.7 Date and time of reading.

9.1.8 Borehole or well liquid level.

9.1.9 Description of liquid in borehole or well.

9.1.10 State whether borehole is cased, uncased, or contains a monitoring (observation) well standpipe and give description of, and length below top of borehole of, casing or standpipe.

9.1.11 Drilled depth of borehole, if known.

9.2 For determination of stabilized liquid level, report:

9.2.1 All pertinent data and computations.

9.2.2 Procedure of determination.

9.2.3 The stabilized liquid level.

9.3 *Report Forms*—An example of a borehole or well-schedule form is shown in Fig. 1. An example of a liquid-level measurement form, for recording continuing measurements for a borehole or well, is shown in Fig. 2. An example of a borehole or well schedule form designed to facilitate computer data storage is shown in Fig. 3.

10. Precision and Bias

10.1 Borehole liquid levels shall be measured and recorded to the accuracy desired and consistent with the accuracy of the measuring device and procedures used. Procedure A multiple measurements by wetted tape should agree within 0.02 ft (6 mm). Procedure B multiple measurements by electrical tape should agree within 0.04 ft (12 mm). Procedure C multiple measurements by tape and sounding weight should agree within 0.04 ft (12 mm). Garber and Koopman (2) describe corrections that can be made for effects of thermal expansion of tapes or cables and of stretch due to the suspended weight of tape or cable and plumb weight when measuring liquid levels at depths greater than 500 ft (150 m).

REFERENCES

(1) "*National Handbook of Recommended Methods for Water Data Acquisition—Chapter 2—Ground Water*", Office of Water Data Coordination, Washington, DC, 1980.

(2) Garber, M. S., and Koopman, F. C., "Methods of Measuring Water Levels in Deep Wells," *U.S. Geologic Survey Techniques for Water Resources Investigations*, Book 8, Chapter A-1, 1968.

(3) Hvorslev, M. J., "Ground Water Observations," in *Subsurface Exploration and Sampling of Soils for Civil Engineering Purposes*, American Society Civil Engineers, New York, NY, 1949.

(4) Zegarra, E. J., "Suggested Method for Measuring Water Level in Boreholes," *Special Procedures for Testing Soil and Rock for Engineering Purposes, ASTM STP 479*, ASTM, 1970.

(5) "Determination of Water Level in a Borehole," CSA Standard A 119.6 - 1971, Canadian Standards Association, 1971.

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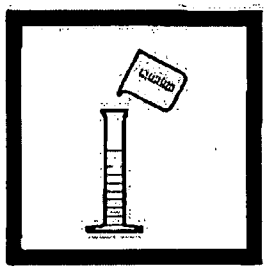
ATTACHMENT C-4

HACH TEST KIT CALIBRATION PROCEDURES

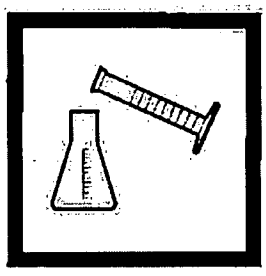
ALKALINITY

Buret Titration Method* ; USEPA Accepted



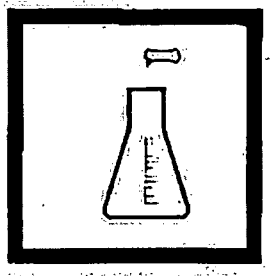
1. Select a sample size corresponding to the expected alkalinity concentration in mg/L as calcium carbonate ($CaCO_3$) from *Table 1*.

Note: If samples cannot be analyzed immediately, see Sampling and Storage following these steps.



2. Use a graduated cylinder or pipet to measure the sample volume from *Table 1*. Transfer the sample into a 250-mL erlenmeyer flask. If necessary, dilute to 50 mL with deionized water.

Note: For proof of accuracy, see Accuracy Check following this procedure.

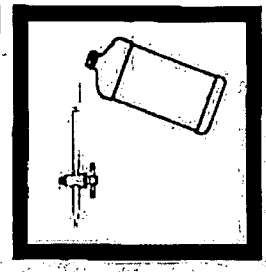


PHENOLPHTHALEIN ALKALINITY

3. Add the contents of one Phenolphthalein Indicator Powder Pillow. Swirl to mix.

Note: Six drops of Phenolphthalein Indicator Solution can be substituted for the Phenolphthalein Indicator Powder Pillow.

Note: Omit this step if a pH meter is used. A pH meter is required for NPDES reporting and is recommended for best results.

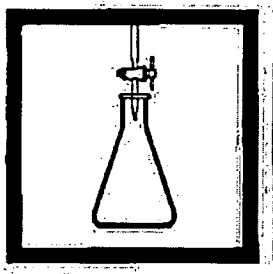


4. Fill a 25-mL buret to the zero mark with 0.020 N Sulfuric Acid Standard Solution.

Table 1

Range (mg/L as $CaCO_3$)	Sample Volume (mL)	Standard Titrant Solution (N)	Catalog Number	Multiplier
0-500	50	0.020	203-53	20
400-1000	25	0.020	203-53	40
1000-2500	10	0.020	203-53	100
2000-5000	5	0.020	203-53	200

* Adapted from *Standard Methods for the Examination of Water and Wastewater, 2320 B.*



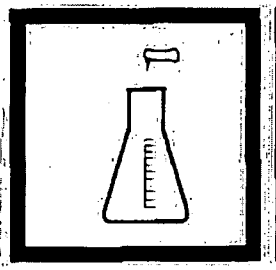
5. Titrate the sample while swirling the flask until the solution changes from pink to colorless.

Note: When using a pH meter, the end point is 8.3 pH.

mL Titrant Used x Multiplier = mg/L Phenolphthalein Alkalinity as $CaCO_3$

6. Calculate:

mL Titrant Used x Multiplier = mg/L Phenolphthalein Alkalinity as $CaCO_3$*



TOTAL ALKALINITY

7. Add the contents of one Bromcresol Green-Methyl Red Indicator Powder Pillow to the titrated sample. Swirl to mix.

Note: Six drops of Bromcresol Green-Methyl Red Indicator Solution can be substituted for the Bromcresol Green-Methyl Red Powder Pillow.

Note: See Total Alkalinity End Points, below, for alternate end points.

Note: Do not add indicator if a pH meter is used. A pH meter is required for NPDES reporting and is recommended for best results.

mL Titrant Used x Multiplier = mg/L Total Alkalinity as $CaCO_3$

8. Continue the titration until the appropriate end point is reached.

Calculate:

Total mL Titrant Used x Multiplier = mg/L Total Alkalinity as $CaCO_3$*

Sampling and Storage

Collect samples in plastic or glass bottles. Fill completely and cap tightly. Avoid excessive agitation and prolonged exposure to air. Samples should be analyzed as soon as possible after collection but can be stored at least 24 hours by cooling to 4 °C (39 °F) or below. Warm to room temperature before analyzing.

* mg/L value/17.12 = gr/gal equivalent

Total Alkalinity End Points

The following end points are recommended for determining total alkalinity in water samples of various compositions and alkalinity concentrations.

Table 2

Sample Trait	End Point	
	pH	Color
Alkalinity approx. 30 mg/L	5.1	light green blue-gray
Alkalinity approx. 150 mg/L	4.8	light violet gray
Alkalinity approx. 500 mg/L	4.5	light pink
Silicates or phosphates known present or suspected	4.5	light pink
Industrial waste or complex system	3.7	green*

* Use a Bromphenol Blue Indicator Powder Pillow instead of Bromcresol Green-Methyl Red.

Alkalinity Relationship Table

Total alkalinity primarily includes hydroxide, carbonate and bicarbonate alkalinities. The concentration of these types in a sample may be determined when the phenolphthalein and total alkalinities are known; see *Table 3*.

Table 3

	RESULT OF TITRATIONS	HYDROXIDE ALKALINITY IS EQUAL TO	CARBONATE ALKALINITY IS EQUAL TO	BICARBONATE ALKALINITY IS EQUAL TO
1	Phenolphthalein Alkalinity equal to zero	0	0	Total Alkalinity
2	Phenolphthalein Alkalinity equal to Total Alkalinity	Total Alkalinity	0	0
3	2 times the Phenolphthalein Alkalinity less than Total Alkalinity	0	2 times the Phenolphthalein Alkalinity	Total Alkalinity minus two times Phenolphthalein Alkalinity
4	2 times the Phenolphthalein Alkalinity equal to Total Alkalinity	0	Total Alkalinity	0
5	2 times the Phenolphthalein Alkalinity greater than Total Alkalinity	2 times the Phenolphthalein minus Total Alkalinity	2 times the difference between Total and Phenolphthalein Alkalinity	0

To use this table follow these steps:

a) Does the phenolphthalein alkalinity equal zero? If yes, use Row 1.

b) Does the phenolphthalein alkalinity equal total alkalinity? If yes, use Row 2.

c) Multiply the phenolphthalein alkalinity by 2.

d) Select Row 3, 4 or 5 based on comparing the result of Step c with the total alkalinity.

e) Perform the required calculations if any.

f) Check your results. The sum of the three alkalinity types will equal the total alkalinity.

For example:

A sample has 170 mg/L as $CaCO_3$ phenolphthalein alkalinity and 250 mg/L as $CaCO_3$ total alkalinity. What is the concentration of hydroxide, carbonate and bicarbonate alkalinities?

a) The phenolphthalein alkalinity does not equal zero but 170 mg/L.

b) The phenolphthalein alkalinity does not equal total alkalinity (17 mg/L vs 250 mg/L).

c) The phenolphthalein alkalinity multiplied by 2 equals 340 mg/L.

d) Because 340 mg/L is greater than 250 mg/L, select Row 5.

e) The hydroxide alkalinity is equal to:

$340 - 250 = 90$ mg/L hydroxide alkalinity

f) The carbonate alkalinity is equal to:

$250 - 170 = 80$

$80 \times 2 = 160$ mg/L carbonate alkalinity

The bicarbonate alkalinity is equal to zero mg/L.

g) Check:

```
  90 mg/L hydroxide alkalinity
 160 mg/L carbonate alkalinity
+  0 mg/L bicarbonate alkalinity
 250 mg/L
```

The answer is correct.
The sum of each type equals the total alkalinity (250 mg/L).

Accuracy Check

End Point Confirmation

- To accurately determine the phenolphthalein alkalinity end point, mix the contents of one Phenolphthalein Indicator Powder Pillow and the contents of one pH 8.3 Buffer Powder Pillow with 50 mL of deionized water in a 250 -mL Erlenmeyer flask. The resulting color is the end point. The buffer solution without the indicator can be used to standardize a pH meter.

- To accurately determine the total alkalinity end point, mix the contents of one pH 5.1 Buffer Powder Pillow and the contents of one Bromcresol Green-Methyl Red Indicator Powder Pillow with 50 mL of deionized water in a 250-mL Erlenmeyer flask. Repeat this preparation using pH 4.8 and pH 4.5 Buffer Powder Pillows. Titrate to the appropriate color change.

- For titration to pH 3.7, add one pH 3.7 Buffer Powder Pillow to 50 mL of deionized water in a 250-mL Erlenmeyer flask, but add the contents of one Bromphenol Blue Indicator Powder Pillow in place of Bromcresol Green-Methyl Red Indicator. The end point is a color change from purple, through blue, to pure green. The prepared buffer solutions without the indicators can be used to standardize the pH meter.

Standard Additions Method

The standard additions method check can be performed as follows:

a) Snap the neck off an Alkalinity Voluette Ampule Standard Solution, 0.500 N.

b) Use the TenSette Pipet to add 0.1 mL of standard to the sample titrated in Steps 5 or 8. Resume titration back to the same end point. Record the volume of titrant needed.

c) Repeat, using two more additions of 0.1 mL. Titrate to the end point after each addition.

d) The mL of titrant required should increase by 2.5 mL for each 0.1 mL increment of standard added.

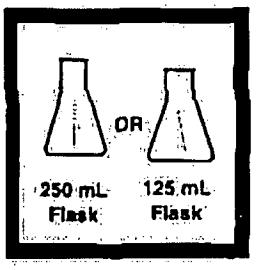
Interferences

Residual chlorine interference with the indicator may be removed by adding a drop of 0.1 N Sodium Thiosulfate Standard Solution.

Highly colored or turbid samples may mask the color change at the end point. Use a pH meter for these samples.

CARBON DIOXIDE

Buret Titration Method*



1. Select the sample volume and flask size that correspond to the expected carbon dioxide (CO_2) concentration; see *Table 1**.

Note: If samples cannot be analyzed immediately, see Sampling and Storage following these steps.

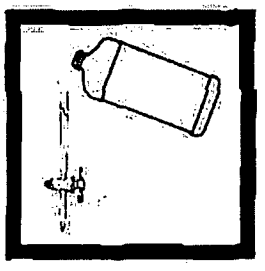
2. Fill a clean erlenmeyer flask to the appropriate mark (see *Table 1*). If possible, allow the water to overflow the flask several times; then pour off the excess until the appropriate level is reached.

Note: For more accurate results, check the calibration of the erlenmeyer flask with sample volume of demineralized water measured in a graduated cylinder. If the calibration is in error, mark the proper level with a wax pencil or other suitable permanent marker.

3. Add the contents of one Phenolphthalein Indicator Powder Pillow and mix gently. This solution is the prepared sample.

Note: For proof of accuracy, see the Accuracy Check following these steps.

Note: Four drops of Phenolphthalein Indicator Solution can be substituted for the Phenolphthalein Indicator Powder Pillow.

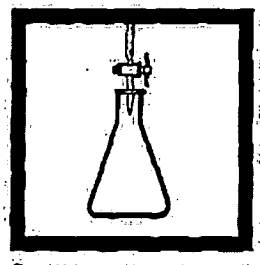


4. Fill a 25-mL buret to the zero mark with 0.0227 N Sodium Hydroxide Standard Solution.

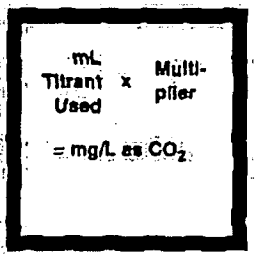
Table 1

Range (mg/L as CO_2)	Sample Volume (mL)	Flask Size (mL)	Multiplier
0-125	200	250	5
100-250	100	125	10

*Adapted from *Standard Methods for the Examination of Water and Wastewater.*



5. Titrate the prepared sample while gently swirling the flask until a light pink color forms and persists for 30 seconds.



6. Calculate:

mL Titrant Used x Multiplier = mgL as CO_2

Sampling and Storage

Collect samples in clean plastic or glass bottles. Fill completely and cap tightly. Avoid excessive agitation or prolonged exposure to air. Sample should be analyzed as soon as possible after collection but can be stored at least 24 hours by cooling to a temperature lower than that of the water source.

Accuracy Check

Sodium Hydroxide Standard Solution Check

Sodium Hydroxide Standard Solution sealed in plastic bottles will lose approximately 1% of its strength per year. When exposed to the air, the solution tends to slowly absorb carbon dioxide, causing a reduction in strength. For this reason, stock solutions of Sodium Hydroxide Standard Solution should be kept tightly sealed when not in use. In addition, the titration buret should be filled just prior to running the test or series of tests. Any solution left in the buret after the titration has been completed should be discarded.

The solution should be checked monthly by titrating a 50.0-mL sample of Potassium Acid Phthalate Standard Solution, 100 mg/L CO_2, using Phenolphthalein Indicator Solution. The titration should require 5.00 mL of titrant. To correct for any reduction in strength, divide 5.00 by the number of mL required for this titration. Multiply all results by this factor. If the volume of Sodium Hydroxide Standard Solution required for the titration is greater than 5.25 mL (5% error), the Sodium Hydroxide Standard Solution should be discarded and replaced with a fresh supply.

Standard Additions Method

The standard additions method check can be performed as follows:

a) Snap the neck off a Carbon Dioxide Voluette Ampule Standard Solution, 10,000 mg/L as CO_2.

b) Use a TenSette Pipet to add 0.1 mL of standard to the titrated prepared sample.

c) Swirl gently to mix and again titrate to the end point. Note the amount of additional titrant used.

d) Add 0.2-mL and 0.3-mL standard increments, titrating to the end point after each addition.

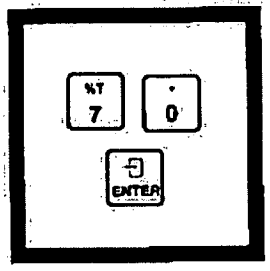
e) The volume of titrant required should increase 1.0 mL for each 0.1-mL increment of standard added. If these increases do not occur, see *"Standard Additions" on page 26(Section I)* for more information.

Summary of Method

The analysis for carbon dioxide is similar to that for acidity. A water sample is titrated to a phenolphthalein end point at pH 8.3 with a Sodium Hydroxide Standard Solution. Strong mineral acids are assumed to be absent or their effect to be negligible. Care must be taken during the analysis to minimize the loss of carbon dioxide from the water sample as a result of aeration when collecting and swirling the sample. For more information, see *Appendix A, Chemical Procedures Explained*.

CHLORIDE (0 to 20.0 mg/L Cl^-)

Mercuric Thiocyanate Method*



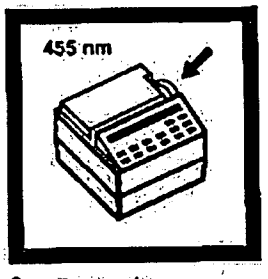
1. Enter the stored program number for Chloride (Cl^-).

Press: **7 0 ENTER**

The display will show:

Dial nm to 455

Note: The Pour-Thru cell can be used with this procedure. Collect the waste solution for proper disposal.



2. Rotate the wavelength dial until the small display shows:

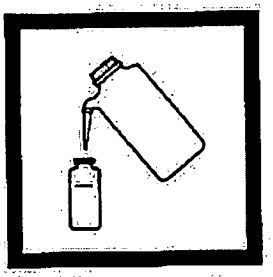
455 nm

When the correct wavelength is dialed in the display will quickly show: **Zero Sample**

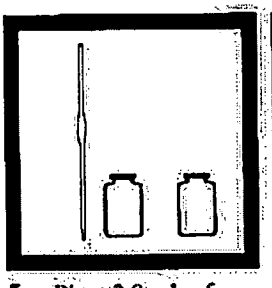
then: **mg/L Cl**

3. Fill a sample cell with 25 mL of sample.

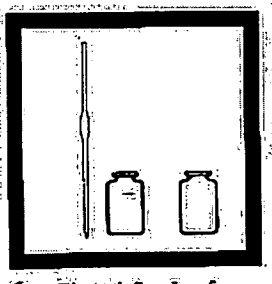
Note: Filter turbid samples.



4. Fill another cell with 25 mL of deionized water (the blank).



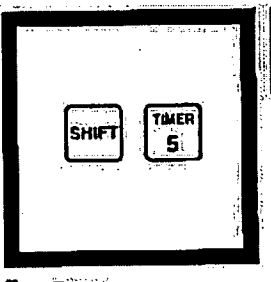
5. Pipet 2.0 mL of Mercuric Thiocyanate Solution into each cell. Swirl to mix.



6. Pipet 1.0 mL of Ferric Ion Solution into each sample cell.

Swirl to mix.

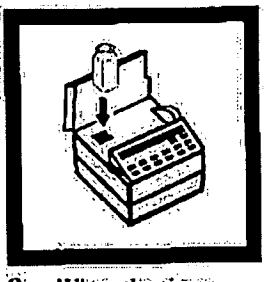
Note: An orange color will develop if chloride is present.



7. Press:

SHIFT TIMER

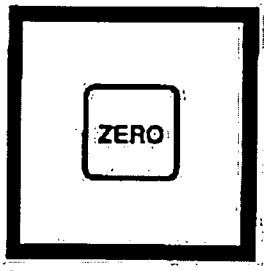
A two-minute reaction period will begin.

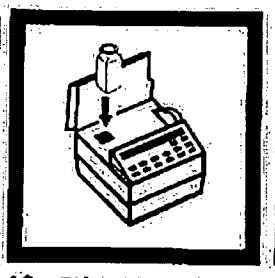


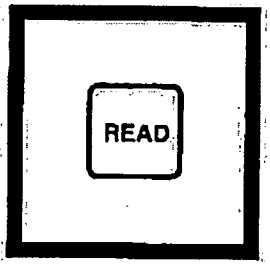
8. When the timer beeps, the display will show: **mg/L Cl**

Place the blank into the cell holder. Close the light shield.

* Adapted from Zall, et. al., Analytical Chemistry, 28 (11) 1665 (1956).







9. Press: **ZERO**

The display will show:

Zeroing. . .

then: **0.0 mg/L Cl⁻**

10. Place the prepared sample into the cell holder. Close the light shield.

11. Press: **READ**

The display will show:

Reading. . .

then the result in mg/L chloride (Cl^-) will be displayed.

Note: The prepared sample and blank contain mercury and must be disposed of according to current Federal, State, and local hazardous waste regulations.

Sampling and Storage

Samples can be stored for at least 28 days at room temperature in glass or plastic bottles.

Accuracy Check

Standard Additions Method

a) Use the TenSette Pipet to add 0.1 mL, 0.2 mL and 0.3 mL of Chloride Standard Solution, 1000 mg/L as Cl^-, to each of three 25-mL water samples. Mix each thoroughly.

b) Analyze each sample as described above.

c) The chloride concentration should increase 4.0 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see *"Standard Additions" on page 26* (*SECTION I*) for more information.

Standard Solution Method

Prepare a 10.0 mg/L chloride standard solution by diluting 5.00 mL of Chloride Standard Solution, 1000 mg/L to 500 mL with deionized water. Run the test using the 10.0 mg/L chloride standard in place of the sample. The results should be between 9.0 and 11.0 mg/L chloride.

Precision

In a single laboratory using a standard solution of 10 mg/L chloride and two lots of reagent with the DR/2010, a single operator obtained a standard deviation of ±0.3 mg/L chloride.

Interferences

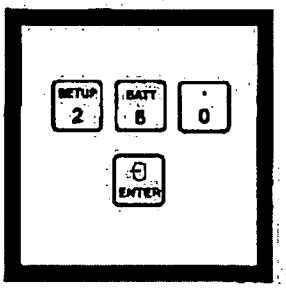
The pH of the sample after addition of reagents should be about 2. If the sample is strongly acid or alkaline, adjust a portion of sample before testing to a pH of about 7. Use either 5.0 N Sodium Hydroxide Standard Solution or a 1:5 dilution of perchloric acid. Use pH paper, as most pH electrodes will contaminate the sample with chloride.

Summary of Method

Chloride in the sample reacts with mercuric thiocyanate to form mercuric chloride and liberate thiocyanate ion. Thiocyanate ions react with the ferric ions to form an orange ferric thiocyanate complex. The amount of this complex is proportional to the chloride concentration. Chloride at these levels also can be determined directly using the Chloride Ion Selective Electrode (Cat. No. 50255-00).

IRON (0 to 1.300 mg/L)

FerroZine Method*



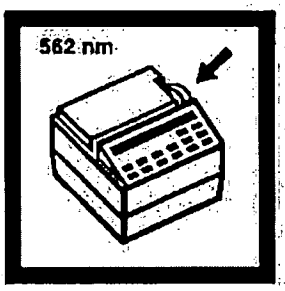
1. Enter the stored program number for total iron (Fe), FerroZine method.

Press: **2 6 0 ENTER**

The display will show:

Dial nm to 562

Note: The Pour-Thru Cell can be used with this procedure.



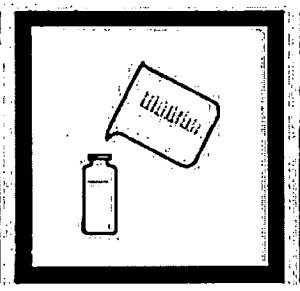
2. Rotate the wavelength dial until the small display shows:

562 nm

When the correct wavelength is dialed in the display will quickly show: **Zero Sample**

then: **mg/L Fe FZ**

Note: Total iron determinations need a prior digestion; use any of the three procedures given in Digestion (SECTION II).



3. Fill a sample cell to the 25-mL mark with sample.

Note: Rinse glassware with a 1:1 hydrochloric acid and deionized water before use to avoid errors due to iron deposits on the glass.

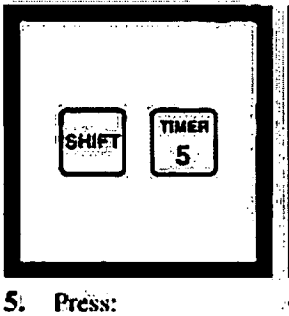
Note: For proof of accuracy, a 0.4 mg/L iron standard solution (preparation given in the Accuracy Check) can be used in place of the sample.

4. Add the contents of one FerroZine Iron Reagent Solution Pillow to the cell (the prepared sample). Swirl to mix.

Note: Do not allow the clippers to come into contact with the contents of the pillow.

Note: 0.5 mL of FerroZine Iron Reagent Solution can be used in place of the solution pillow if preferred.

Note: If the sample contains rust, see Interferences below.

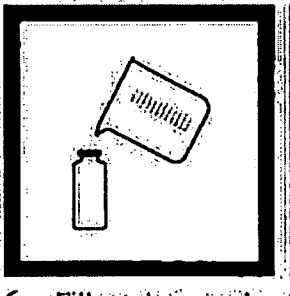


5. Press:

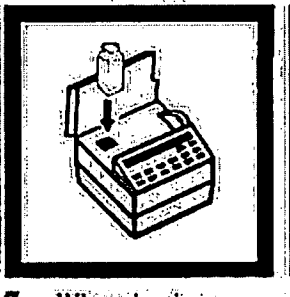
SHIFT TIMER

A five-minute reaction period will begin.

Note: A violet color will develop if iron is present.

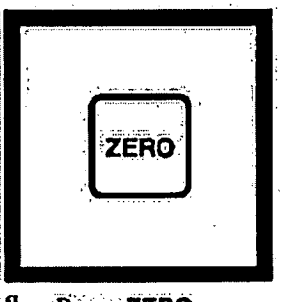


6. Fill another sample cell (the blank) with 25 mL of sample.



7. When the timer beeps, the display will show: **mg/L Fe FZ**

Insert the blank into the cell holder. Close the light shield.



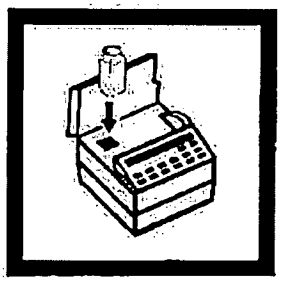
8. Press: **ZERO**

The display will show:

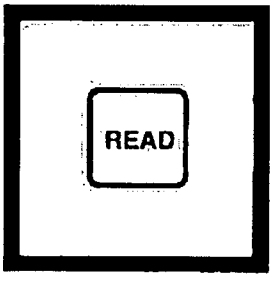
Zeroing...

then: **0.000 mg/L Fe FZ**

* Adapted from Stookey, L.L., Anal. Chem., 42 (7) 779 (1970).



9. Place the prepared sample into the cell holder. Close the light shield.



10. Press: **READ**

The display will show:

Reading. . .

then the result in mg/L iron will be displayed.

Sampling and Storage

Collect samples in acid-washed glass or plastic bottles. To preserve samples, adjust the sample pH to 2 or less with nitric acid (about 2 mL per liter). Samples preserved in this manner can be stored up to six months at room temperature. If only dissolved iron is to be reported, filter sample immediately after collection and before addition of nitric acid.

Before testing, adjust the sample pH to 3–5 with ammonium hydroxide, ACS. Do not exceed pH 5 as iron may precipitate. Correct test results for volume additions; see *"Correcting for Volume Additions" on page 56* in *SECTION I* for more detailed information.

Accuracy Check

Standard Additions Method

a) Snap the neck off an Iron Voluette Ampule Standard, 25 mg/L Fe.

b) Use the TenSette pipet to add 0.1 mL of standard to the prepared sample measured in Step 10.

c) Swirl to mix and allow another five-minute reaction period, then measure the iron concentration as in Step 10.

d) Add two additional 0.1 mL standard increments, taking a concentration reading after allowing the five-minute reaction period for each increment.

e) Each additional 0.1 mL increment of standard added should cause a 0.1 mg/L increase in the concentration reading.

f) If these increases do not occur, see *"Standard Additions" on page 26* in *SECTION I* for more information.

Standard Solution Method

Prepare a 0.4 mg/L iron working solution as follows:

a) Pipet 1.00 mL of iron standard solution, 100 mg/L Fe, into a 250 mL volumetric flask.

b) Dilute to volume with deionized water. This solution should be prepared daily. Analyze the working solution according to the above procedure.

Precision

In a single laboratory, using a standard solution of 0.80 mg/L iron and two representative lots of reagent with the DR/2010, a single operator obtained a standard deviation of ±0.0027 mg/L iron.

Interferences

Copper and cobalt may interfere to give slightly high results.

Strong chelates such as EDTA will interfere in the FerroZine method for determining iron. The FerroVer or TPTZ methods should be used for these samples. The TPTZ method is suggested for low concentrations.

Any of the three digestions given in *DIGESTION (SECTION II)* used in place of the treatments below will eliminate the following interferences.

If rust or hydroxides are present, the sample, with the FerroZine Iron Reagent added in Step 4, should be boiled for one minute in a boiling water bath then cooled to 24 °C (75 °F) before proceeding with Step 5. The reduced sample volume should be returned to 25 mL with deionized water.

If the sample contains magnetite (black iron oxide) or ferrites, perform the following procedure:

a) Fill a 25-mL graduated cylinder with 25 mL of sample.

b) Transfer the sample water into a 125-mL erlenmeyer flask.

Note: Do not allow to boil dry.

c) Add the contents of one FerroZine Iron Reagent Solution Pillow and swirl to mix.

d) Place the flask on a hot plate or over a flame and bring to a boil.

e) Continue boiling gently for 20 to 30 minutes.

Note: A purple color will develop if iron is present.

f) Return the boiled sample to the graduated cylinder. Rinse the erlenmeyer flask with small amounts of deionized water and empty into the graduated cylinder.

g) Return the sample volume to the 25-mL mark with deionized water.

h) Pour the solution into a sample cell and swirl to mix.

Summary of Method

The FerroZine Iron Reagent forms a purple colored complex with trace amounts of iron in samples that are buffered to a pH of 3.5. This method is applicable for determining trace levels of iron in chemical reagents and glycols and can be used to analyze samples containing magnetite (black iron oxide) or ferrites after treatment as described in *Interferences*.

REQUIRED REAGENTS AND APPARATUS

Description	Quantity Required Per Test	Unit	Cat. No.
FerroZine Iron Reagent Solution Pillows	1 pillow	50/pkg	2301-66
Clippers, for opening pillows	1	each	968-00
Sample Cell, 25-mL, matched pair		pair	20950-00

OPTIONAL REAGENTS

Ammonium Hydroxide, ACS	500 mL	106-49
Hydrochloric Acid Solution, 1:1 (6N)	500 mL	884-49
FerroZine Iron Reagent Solution	1000 mL	2301-53
Iron Standard Solution, 100 mg/L Fe	100 mL	14175-42
Iron Standard Solution, Voluette ampule, 25 mg/L Fe, 10 mL	16/pkg	14253-10
Nitric Acid, ACS	500 mL	152-49
Nitric Acid Solution, 1:1	500 mL	2540-49
Water, deionized	4 L	272-56

OPTIONAL APPARATUS

Ampule Breaker Kit	each	21968-00
Cylinder, graduated, 25 mL	each	508-40
Dropper, calibrated, 0.5-mL & 1.0-mL mark	6/pkg	23185-06
Flask, erlenmeyer, 125 mL	each	505-43
Flask, volumetric, 250 mL, Class B	each	547-46
Hot plate, 3 1/2" diameter, 120 Vac	each	12067-01
Hot plate, 3 1/2" diameter, 240 Vac	each	12067-02
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg	391-33
pH Meter, EC10, portable	each	50050-00
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-96
Pour-Thru Cell Assembly Kit	each	45215-00
Thermometer, -20 to 105 °C	each	1877-01
Water Bath, with sample cell rack	each	1955-55

For Technical Assistance, Price and Ordering

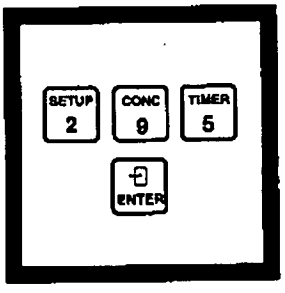
In the U.S.A. call 800-227-4224 to place an order.

Outside the U.S.A.—Contact the Hach office or distributor serving you.

MANGANESE, HR (0 to 20.0 mg/L)

For water and wastewater

Periodate Oxidation Method* ; USEPA Approved for reporting wastewater analysis (digestion is required; see Section II)**



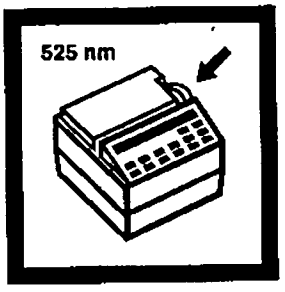
1. Enter the stored program number for manganese (Mn) periodate oxidation.

Press: **2 9 5 ENTER**

The display will show:

Dial nm to 525

Note: The Pour-Thru Cell can be used with 25-mL reagents only.



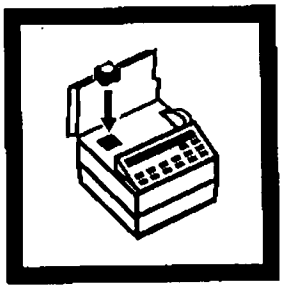
2. Rotate the wavelength dial until the small display shows:

525 nm

When the correct wavelength is dialed in, the display will quickly show:

Zero Sample

then: **mg/L Mn HR**

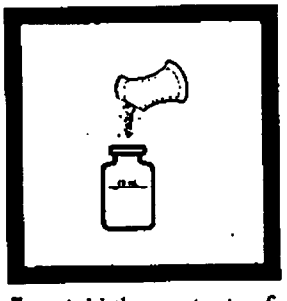


3. Place the 10-mL cell riser into the cell compartment.

4. Fill a sample cell with 10 mL of sample.

Note: Total manganese determination needs a prior digestion; use the mild digestion (Section II).

Note: Adjust pH of stored samples before analysis.

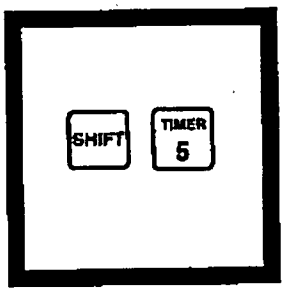


5. Add the contents of one Buffer Powder Pillow, citrate type. Swirl to mix.

6. Add the contents of one Sodium Periodate Powder Pillow to the sample cell (the prepared sample). Swirl to mix.

Note: A violet color will form if manganese is present.

Note: Accuracy is not affected by undissolved powder.



7. Press:

SHIFT TIMER

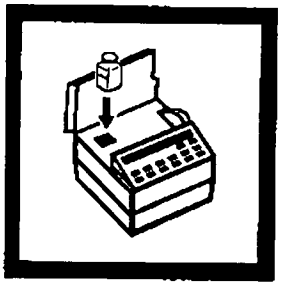
A two-minute reaction period will begin.

8. When the timer beeps, the display will show:

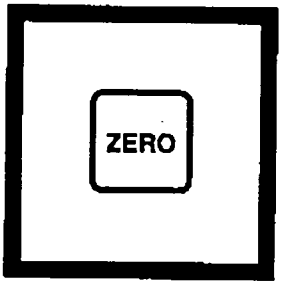
mg/L Mn HR

Fill another sample cell with 10 mL of sample (the blank).

* Adapted from *Standard Methods for the Examination of Water and Wastewater.*
** *Federal Register*, 44 (116) 34193 (June 14, 1979).



9. Place the blank into the cell holder. Close the light shield.

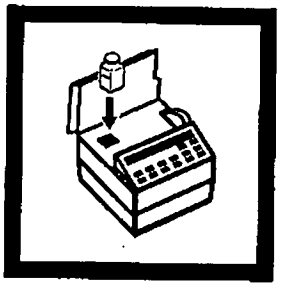


10. Press: **ZERO**

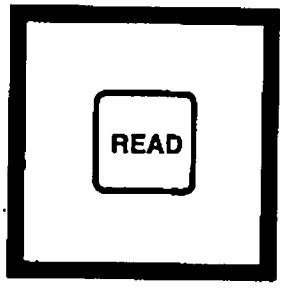
This display will show:

Zeroing...

then: **0.0 mg/L Mn HR**



11. Within eight minutes after the timer beeps, place the prepared sample into the cell holder. Close the light shield.



12. Press: **READ**

The display will show:

Reading...

then the result in mg/L Mn will be displayed.

Forms ▲▼ $KMnO_4$ Mn MnO_4^-

Sampling and Storage

Collect samples in acid-washed plastic bottles. Manganese may be lost by adsorption to glass container walls. Adjust the pH to less than 2 with nitric acid (about 2 mL per liter). Preserved samples may be stored up to six months at room temperature. Adjust the pH to 4 to 5 with 5.0 N sodium hydroxide before analysis. Do not exceed pH 5, as manganese may be lost as a precipitate. Correct the test result for volume additions; see *"Correcting for Volume Additions" on page 56* in *SECTION I* for more information. If only dissolved Mn is to be determined, filter before acid addition.

Accuracy Check

Standard Additions Method

a) Fill three 25-mL graduated mixing cylinders with 25-mL of sample.

b) Snap the neck off a Manganese Voluette Ampule Standard Solution, 250 mg/L Mn.

c) Use the TenSette Pipet to add 0.1, 0.2 and 0.3 mL of standard, respectively, to the three mixing cylinders. Stopper each and mix thoroughly.

d) Transfer only 10 mL of each solution to the 10-mL sample cells.

e) Analyze each standard addition sample as described in the procedure. The manganese concentration should increase 1.0 mg/L

. for each 0.1 mL of standard added.

f) If these increases do not occur, see *"Standard Additions" on page 26* in *SECTION I* for troubleshooting information.

Standard Solution Method

Prepare a 10.0 mg/L manganese standard solution by pipetting 5.00 mL of Manganese Standard Solution, 1000 mg/L Mn, into a 500-mL volumetric flask. Dilute to the mark with deionized water. Or, prepare this standard by diluting 4.00 mL of a High Range Manganese Standard Voluette Ampule, 250 mg/L, to 100 mL. Prepare these solutions daily. Run the test using the 10.0 mg/L Manganese Standard Solution. Results should be between 9.0 and 11.0 mg/L Mn.

Interferences

The following may interfere when present in concentrations exceeding those listed below:

Calcium	700 mg/L
Chloride	70,000 mg/L
Iron	5 mg/L
Magnesium	100,000 mg/L

Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment; see *pH Interferences* in *Section I*.

Precision

In a single laboratory using a standard solution of 10.00 mg/L manganese and two representative lots of reagent with the DR/2010, a single operator obtained a standard deviation of ±0.06 mg/L manganese.

Estimated Detection Limit (EDL)

The EDL for program 295 is 0.6 mg/L Mn. The EDL is the calculated lowest average concentration in deionized water matrix that is different from zero with a 99% level of confidence. For more information on derivation and use of Hach's estimated detection limit, see *SECTION I*.

Summary of Method

Manganese in the sample is oxidized to the purple permanganate state by sodium periodate, after buffering the sample with citrate. The purple color is directly proportional to the manganese concentration.

REQUIRED REAGENTS

	Cat. No.
High Range Manganese Reagent Set (100 tests) 10 mL	24300-00

Description	Quantity Required Per Test	Unit	Cat. No.
Buffer Powder Pillows, citrate type for manganese	1 pillow	100/pkg	21076-69
Sodium Periodate Powder Pillows for manganese	1 pillow	100/pkg	21077-69

REQUIRED APPARATUS

Clippers, for opening powder pillows	1	each	968-00
Sample Cell, 10 mL, matched pair	2	2/pkg	24954-02
Cell Riser, 10 mL sample cell	1	each	45282-00

OPTIONAL REAGENTS

Hydrochloric Acid, 6 N	500 mL	884-49
Manganese Standard Solution, 1000 mg/L Mn	100 mL	12791-42
Manganese Standard Solution, Voluette ampule, High Range, 250 mg/L Mn, 10 mL	16/pkg	14258-10
Nitric Acid, ACS	500 mL	152-49
Nitric Acid Solution 1:1	500 mL	2540-49
Sodium Hydroxide Solution, 5.0 N	100 mL MDB	2450-32
Water, deionized	4 L	272-56

OPTIONAL APPARATUS

Ampule Breaker Kit	each	21968-00
Mixing Cylinder, 25 mL	each	20886-40
Dropper, plastic, 0.5 and 1.0 mL marks	10/pkg	21247-10
Flask, erlenmeyer, 250 mL	each	505-46
Flask, volumetric, Class A, 500 mL	each	26366-49
Flask, volumetric, Class A, 100 mL	each	14574-42
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg	391-33
pH Meter, EC10, portable	each	50050-00
Pipet, 4.0 mL, Class A	each	14515-04
Pipet, serological, 5 mL	each	532-37
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-96
Pipet, volumetric, Class A, 5.00 mL	each	14515-37
Pipet Filler, safety bulb	each	14651-00

OPTIONAL 25 mL ANALYSIS ITEMS

High Range Manganese Reagent Set (100 tests) 25 mL	100/pkg	22432-00
Pour-Thru Cell Assembly Kit (for 25-mL reagents only)	each	45215-00
Sample Cell, 25 mL matched pair	pair	20950-00

For Technical Assistance, Price and Ordering

In the U.S.A. call 800-227-4224 to place an order.

Outside the U.S.A.—Contact the Hach office or distributor serving you.

SULFATE (0 to 70 mg/L)

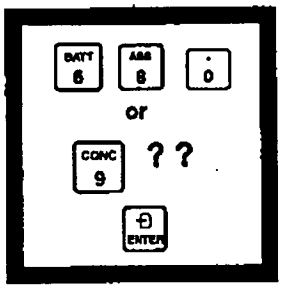
SulfaVer 4 Method* (Powder Pillows or AccuVac Ampuls,

USEPA Accepted for reporting wastewater analysis**

Using Powder Pillows

1. A User-Entered Calibration is necessary to obtain the most accurate results. See the *User Calibration* section at the back of this procedure. Program 680 can be used directly for process control or applications where a high degree of accuracy is not needed.

Note: The nature of turbidimetric tests and reagent lot variation necessitate user calibration for best results.



2. Enter the appropriate stored program number for sulfate (SO_4^{2-}) powder pillows.

Press: **6 8 0 ENTER**

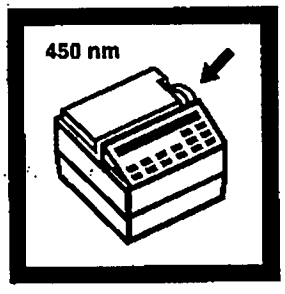
or

9 ? ? ENTER

The display will show:

Dial nm to 450

Note: The Pour-Thru cell cannot be used with this procedure.



3. Rotate the wavelength dial until the small display shows:

450 nm

When the correct wavelength is dialed in the display will quickly show: **Zero Sample**

then: **mg/L SO_4^{2-}**

Note: For greater accuracy, perform a user calibration for each new lot of SulfaVer 4 Sulfate Reagent Powder Pillows; see User Calibration following these steps.

4. Fill a clean sample cell with 25 mL of sample.

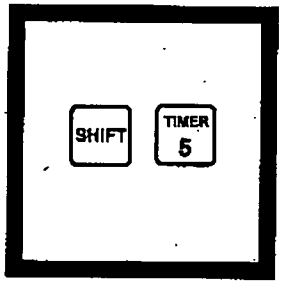
Note: Filter highly turbid or colored samples. Use filtered sample in this step and Step 7.

* Adapted from *Standard Methods for the Examination of Water and Wastewater.*
** Procedure is equivalent to USEPA method 375.4 for wastewater.

5. Add the contents of one SulfaVer 4 Sulfate Reagent Powder Pillow to the sample cell (the prepared sample). Swirl to dissolve.

Note: A white turbidity will develop if sulfate is present.

Note: Accuracy is not affected by undissolved powder.



6. Press:

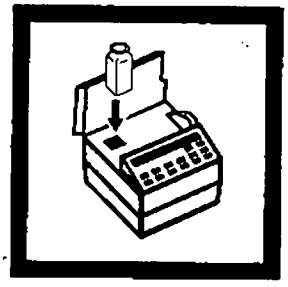
SHIFT TIMER

A 5-minute reaction period will begin.

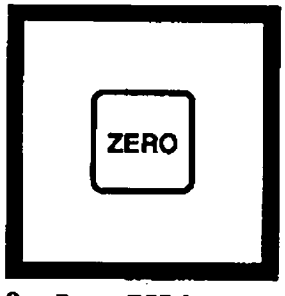
Note: Allow the cell to stand undisturbed.

7. When the timer beeps, the display will show: **mg/L SO_4^{2-}**

Fill a second sample cell with 25 mL of sample (the blank).



8. Place the blank into the cell holder. Close the light shield.

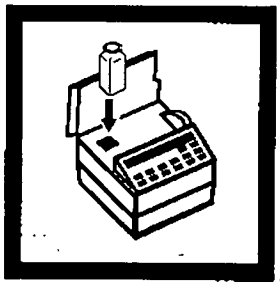


9. Press: **ZERO**

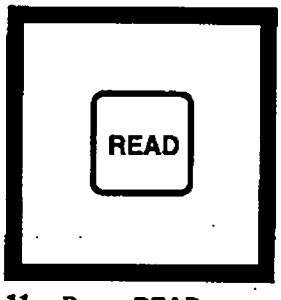
The display will show:

Zeroing...

then: **0. mg/L SO_4^{2-}**



10. Within five minutes after the timer beeps, place the prepared sample into the cell holder. Close the light shield.



11. Press: **READ**

The display will show:

Reading...

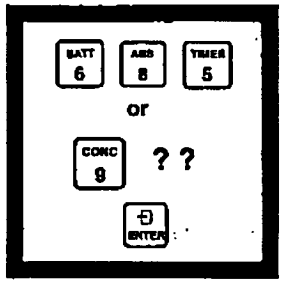
then the results in mg/L SO_4^{2-} will be displayed.

Note: Clean the sample cells with soap and a brush.

Using AccuVac Ampuls

1. A User-Entered Calibration is necessary to obtain the most accurate results. See User Calibration Section at the back of this procedure. Program 680 can be used directly for process control or applications where a high degree of accuracy is not needed.

Note: The nature of turbidimetric tests and reagent lot variation necessitate user calibration for best results.



2. Enter the appropriate stored program number for sulfate (SO_4^{2-}) powder pillows.

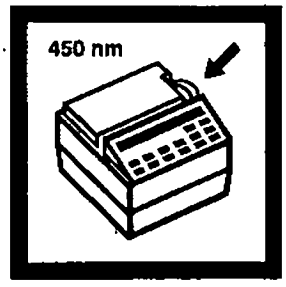
Press: **6 8 5 ENTER**

or

9 ? ? ENTER

The display will show:

Dial nm to 450

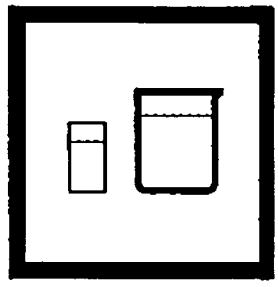


3. Rotate the wavelength dial until the small display shows:

450 nm

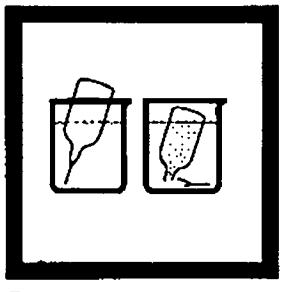
When the correct wavelength is dialed in the display will quickly show: **Zero Sample**

then: **mg/L SO_4^{2-} AV**



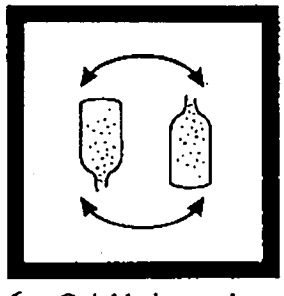
4. Fill a zeroing vial (the blank) with at least 10 mL of sample. Collect at least 40 mL of sample in a 50-mL beaker.

Note: Filter highly turbid or colored samples. Use filtered sample in this step and Step 5.



5. Fill a SulfaVer 4 Sulfate AccuVac ampul with sample.

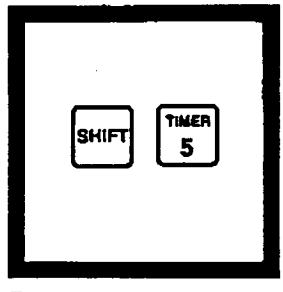
Note: Keep tip immersed until the ampul fills completely.



6. Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

Note: A white turbidity will develop if sulfate is present.

Note: Accuracy is not affected by undissolved powder.

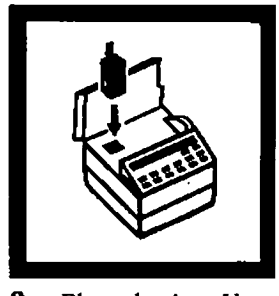


7. Press:

SHIFT TIMER

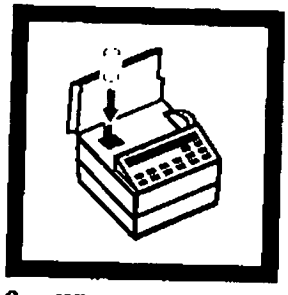
A 5-minute reaction period will begin.

Note: Allow the ampul to stand undisturbed.



8. Place the AccuVac Vial Adapter into the cell holder.

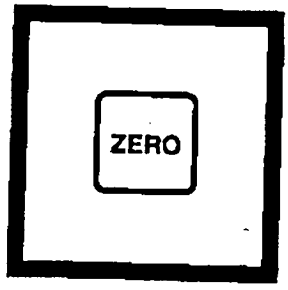
Note: Place the grip tab at the rear of the cell holder.



9. When the timer beeps, the display will show:

mg/L SO_4^{2-} AV

Place the blank into the cell holder. Close the light shield.

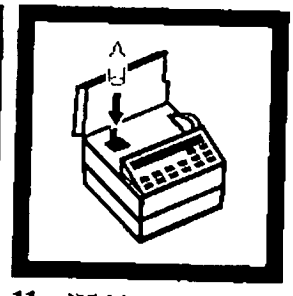


10. Press: **ZERO**

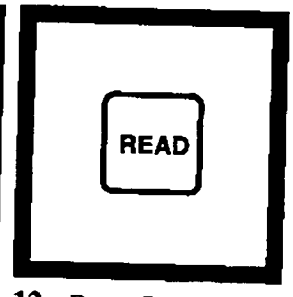
The display will show:

Zeroing...

then: **0. mg/L SO_4^{2-} AV**



11. Within five minutes after the timer beeps, place the AccuVac ampul into the cell holder. Close the light shield.



12. Press: **READ**

The display will show:

Reading...

then the results in mg/L SO_4^{2-} will be displayed.

Sampling and Storage

Collect samples in clean plastic or glass bottles. Samples may be stored up to 28 days by cooling to 4 °C (39 °F) or lower. Warm to room temperature before analysis.

Accuracy Check

Standard Additions Method

a) Fill three 25-mL graduated mixing cylinders with 25 mL of sample.

b) Snap the neck off a Sulfate Voluette Ampule Standard Solution, 2500 mg/L SO_4^{2-}.

c) Use a TenSette Pipet to add 0.1, 0.2 and 0.3 mL of standard to the three 25-mL samples. Mix thoroughly. For AccuVac Ampuls, transfer to clean, dry 50-mL beakers.

d) Analyze each sample as described above. The sulfate concentration should increase 10 mg/L for each 0.1 mL of standard added.

e) If these increases do not occur, see "Standard Additions" on page 26 for more information.

Standard Solution Method

Check the accuracy of the test by using the Sulfate Standard Solution, 50 mg/L, listed under Optional Reagents. Or, prepare this solution by pipetting 1.0 mL of the contents of a Voluette Ampule Standard for Sulfate (2500 mg/L) into a 50-mL volumetric flask. Dilute to volume with deionized water.

Substitute this standard for the sample and proceed with the test as described in the procedure. The mg/L SO_4^{2-} reading should be 50 mg/L.

User Calibration

For most accurate results, the use of a user-calibrated program is highly recommended. The Hach stored programs 680 and 685 are intended for process control samples or other applications where a high degree of accuracy is not necessary.

A one-time setup program for sulfate is required. A sulfate program template is pre-programmed into memory to make the process easier. After the setup is complete, the calibration can be entered for each new lot of reagents used or as necessary.

Standard Preparation

A new calibration should be performed for each new lot of SulfaVer 4 Sulfate Reagent as follows:

Prepare standards of 10, 20, 30, 40, 50, and 60 mg/L sulfate by pipetting 1, 2, 3, 4, 5, and 6 mL of a 1000-mg/L Sulfate Standard Solution into 100-mL volumetric flasks. Dilute to the mark with deionized water and mix well.

Initial Setup of Sulfate Program

The templates within User Program cannot be run directly. They must be copied into a usable program number (greater than 950) as in step c and d. Then, calibrate the program. The preprogrammed calibration (680 or 685) may be suitable for process control.

a) Press **SHIFT USER PRGM**. Use the **UP** arrow key to scroll to **Copy Program**. Press **ENTER**.

b) Scroll to or enter the template number for sulfate [906, 907 (AV)]. Press **ENTER**.

c) Scroll to or enter the desired user program number for sulfate (>950). Press **ENTER**. Record the program number for reference.

d) The display will show: **Program Copied.** Press **EXIT.** The program is now ready to be calibrated.

User Calibration of Sulfate Program

a) Use the test procedure to develop color in the standards just before recording the absorbance values for the calibration.

b) Press **SHIFT USER PRGM.** Use the **UP** arrow to scroll to **Edit Program.** Press **ENTER.**

c) Scroll to or enter the program number for sulfate (from step c in Setup). Press **ENTER.**

d) Use the **DOWN** arrow to scroll down to **Calib Table:X** (X= denotes a number which indicates the number of data points in the table). Press **ENTER.**

e) The instrument will prompt **Zero Sample.** Place the blank solution in the cell holder. Close the light shield. Press **ZERO.** The instrument will prompt you to adjust to the proper wavelength if necessary.

f) The first concentration point will be displayed. Press **ENTER** to display the stored absorbance value of the first concentration point.

g) Place the first developed standard solution (same concentration as the value displayed) in the cell holder. Close the light shield. Press **READ** to display the measured absorbance of the standard. Press **ENTER** to accept the displayed absorbance value.

h) The second concentration point will be displayed. Press **ENTER** to display the stored absorbance value of the second concentration. Place the second developed standard solution in the cell holder. Close the light shield. Press **READ** to display the measured absorbance value of the standard.

i) Press **ENTER** to accept the absorbance reading. The next concentration point will then be displayed.

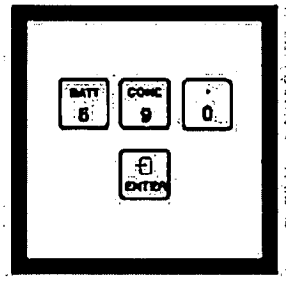
j) Repeat steps h and i as necessary for the remaining standards.

k) When finished reading the absorbance values of the standards, press **EXIT.** Scroll down to **Force Zero.** Press **ENTER** to change the setting. Change to **ON** by pressing the arrow key, then press **ENTER.**

l) Scroll down to **Calib Formula.** Press **ENTER** twice or until only the **0** in **F(0)** is flashing. Press **DOWN** arrow to select **F3** (cubic calibration). Press **ENTER** to select **F3.**

SULFIDE (0 to 0.600 mg/L S^{2-})

Methylene Blue Method * USEPA Accepted for reporting wastewater analysis*



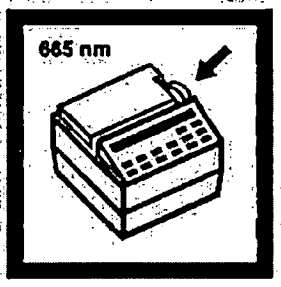
1. Enter the stored program for sulfide (S^{2-}).

Press: **6 9 0 ENTER**

The display will show:

Dial nm to 665

Note: The Pour-Thru Cell can be used with this procedure.



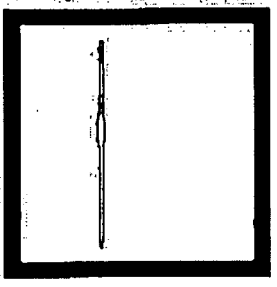
2. Rotate the wavelength dial until the small display shows:

665 nm

When the correct wavelength is dialed in, the display will quickly show:

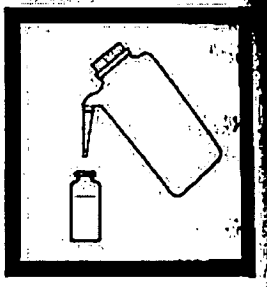
Zero Sample

then: **mg/L S^{2-}**

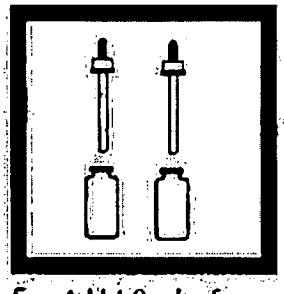


3. Pipet 25 mL of sample into a clean sample cell.

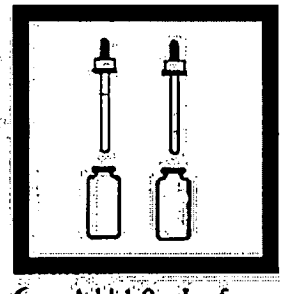
Note: Samples must be analyzed immediately and cannot be preserved for later analysis. Avoid excessive agitation it causes loss of sulfide. For turbid samples see Interferences.



4. Fill a second sample cell with 25 mL of deionized water (the blank).

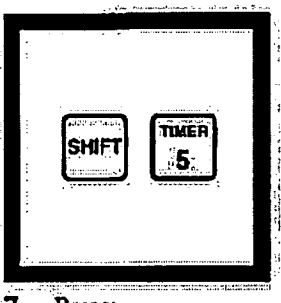


5. Add 1.0 mL of Sulfide 1 Reagent to each cell. Swirl to mix.



6. Add 1.0 mL of Sulfide 2 Reagent to each cell. Immediately swirl to mix.

Note: A pink color will develop, then the solution will turn blue if sulfide is present.



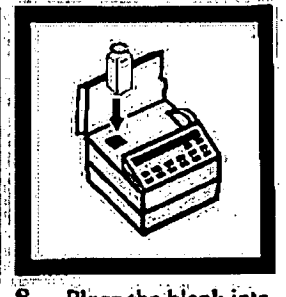
7. Press:

SHIFT TIMER

A 5-minute reaction period will begin.

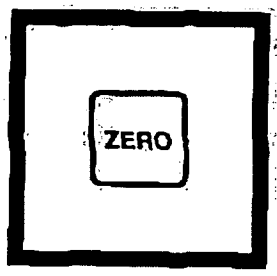
When the timer beeps, the display will show:

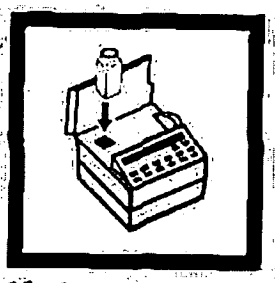
mg/L S^{2-}

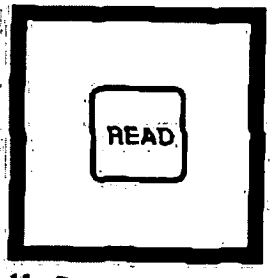


8. Place the blank into the cell holder. Close the light shield.

* Procedure is equivalent to USEPA method 376.2 or Standard Method 4500-S^{2-} D for wastewater.







9. Press

ZERO

The display will show:

Zeroing....

then: **0.000 mg/L S^{2-}**

10. Immediately place the prepared sample into the cell holder. Close the light shield.

11. Press:

READ

The display will show:

Reading....

then the result in mg/L sulfide (S^{2-}) will be displayed.

Sampling and Storage

Collect samples in clean plastic or glass bottles. Fill completely and cap tightly. Avoid excessive agitation or prolonged exposure to air. Analyze samples immediately.

Precision

In a single laboratory, using standard solutions of 0.250 mg/L sulfide an two representative lots of reagent with the DR/2010, a single operator obtained a standard deviation of ± 0.003 mg/L sulfide.

Estimated Detection Limit (EDL)

The EDL for program 690 is 0.01 mg/L S^{2-}.

The EDL is the calculated lowest average concentration in a deionized water matrix that is different from zero with a 99% level of confidence. For more information on derivation and use of Hach's estimated detection limit, see *Section I.*

Interferences

For turbid samples, prepare a sulfide-free blank as follows. Use it in place of the deionized water blank in the procedure.

a) Measure 25 mL of sample into a 50-mL erlenmeyer flask.

b) Add Bromine Water dropwise with constant swirling until a permanent yellow color just appears.

c) Add Phenol Solution dropwise until the yellow color just disappears. Use this solution in Step 5 in place of deionized water.

Strong reducing substances such as sulfite, thiosulfate and hydrosulfite interfere by reducing the blue color or preventing its development. High concentrations of sulfide may inhibit full color development and require sample dilution. Some sulfide loss may occur when the sample is diluted.

Soluble Sulfides

Determine soluble sulfides by centrifuging the sample in completely filled, capped tubes and analyzing the supernatant. Insoluble sulfides are then estimated by subtracting the soluble sulfide concentration from the total sulfide result.

Summary of Method

Hydrogen sulfide and acid-soluble metal sulfides react with N, N-dimethyl-p-phenylenediamine oxalate to form methylene blue. The intensity of the blue color is proportional to the sulfide concentration.

High sulfide levels in oil field waters may be determined after proper dilution.

APPENDIX D

CCI STATEMENT OF WORK

Appendix D: CCI Statement of Work

1.0 Introduction

CH2M HILL Constructors, Inc. (CCI) has been contracted by the Southern Division, U.S. Naval Facilities Engineering Command (SOUTHDIV) to perform remediation activities at Naval Industrial Reserve Ordnance Plant (NIROP) in Fridley, Minnesota and in the adjoining Anoka County Riverfront Park (ACP). In turn, CCI is planning to subcontract portions of the work to qualified Subcontractors.

This project is being conducted to document the enhanced bioremediation of chlorinated solvents dissolved in groundwater and sorbed to the aquifer matrix by injecting vegetable oil into the subsurface below the water table. Specifically, the objective of this field application is to determine if vegetable oil injection is a viable treatment option for volatile organic compounds (VOCs) in groundwater at the NIROP facility and adjacent areas including the ACP. The approximate location of the vegetable oil injection test is shown on Figure 1.1.

1.1 Site Setting

The NIROP Facility and ACP is located in Fridley, Minnesota in the southern most tip of Anoka County, just east of the Mississippi River. The NIROP Facility is approximately 1,000 feet east of the Mississippi River and less than one mile south of Interstate 694. It lies on a broad, flat outwash terrace, and is largely covered by pavement, structures, and other facilities. Out of the total plant size of 138 acres, the federal government owns 83 acres which are operated by United Defense Limited Partnership (UDLP). The remaining 55 acres are owned and operated by UDLP.

Located between East River Road and the Mississippi River is the ACP. The ACP is a day-use recreational facility on the river's edge, consisting of approximately 60 acres.

The NIROP Facility will remain active during the Subcontractor's work activities. Subcontractor shall set up work areas and perform work in a manner that minimizes disruption of the ongoing plant activities. Subcontractor work activities shall be temporarily stopped during facility emergencies that affect the work areas. All Subcontractor activities shall be coordinated with the CCI Site Superintendent.

Traffic control at work areas will be the responsibility of Subcontractor. Subcontractor shall coordinate with CCI to evaluate placement of equipment and traffic flow to minimize impact of this work to any ongoing operations.

1.2 Site Background

The Record of Decision (ROD) for groundwater remediation at the NIROP Fridley site was signed in September 1990 by representatives of the U.S. Navy (Navy), the United States Environmental Protection Agency - Region V (USEPA), and the Minnesota Pollution Control Agency (MPCA). The ROD specified hydraulic containment and recovery of all future migration of groundwater from the NIROP facility and the recovery, to the extent feasible, of contamination downgradient of the NIROP facility. To achieve this, groundwater extraction wells were installed. The initial extraction system began operating in September 1992. Two

additional extraction wells were constructed and placed into operation in June 1995. Another upgrade of the extraction system was completed in June 2001.

Treatment of extracted groundwater involved a two-phased plan: Phase 1 involved discharging groundwater from the extraction system to an existing sanitary sewer with treatment provided at a local wastewater treatment facility; Phase II involved construction and operation of a groundwater treatment facility to provide long-term groundwater treatment. Groundwater treated by the Phase II treatment system is being discharged to the Mississippi River via a National Pollutant Discharge Elimination System (NPDES)/Metropolitan Council Environmental Services (MCES) State Disposal System (SDS) storm sewer discharge permit. The Phase II treatment system began operating in December 1998. Under Phase II, the combined discharge from the extraction system is fed through a feed system and air stripping units for treatment before the effluent is discharged to the Mississippi River through outfall 020 (NPDES/SDS Permit MN0000710).

At the time of the ROD, it was planned that contaminated groundwater located off-site and downgradient of the NIROP in ACP would be naturally dissipated. Under a five-year review of the Operable Unit 1 (OU-1) groundwater extraction system in September 1998, it was recommended that the Navy determine what can be done to significantly reduce residual groundwater contamination in ACP.

1.3 Regulatory Framework

NIROP is currently listed on the Final Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) National Priorities List (NPL). It has been on the NPL since 1989. A ROD for implementation of a ground-water remediation system was signed in 1990 by representatives of the U.S. Navy, the United States Environmental Protection Agency (USEPA) - Region V, and the Minnesota Pollution Control Agency (MPCA).

A state-licensed well contractor shall perform installation of all new wells. All drilling and well installations shall conform to Minnesota Department of Health (MDH) Rules, Chapter 4725, Wells and Borings.

Based on generator knowledge of the materials and the waste characterization sample results, the wastes shall be classified in accordance with 40 Code of Federal Regulations (CFR) 261 regulations. Prior to waste shipment, the analytical data shall be supplied to the disposal facility. Characterization and disposal of generated wastes shall be in accordance with regulatory requirements identified in Section 6.6.

1.4 Site-Specific Data

1.4.1 Hydrogeology

This section provides a brief discussion of the hydrogeology and hydraulic monitoring data at the NIROP facility and ACP in the vicinity of well MS-46S. A summary of the local hydrogeology at the facility is discussed including a description of the groundwater flow and the interaction between the aquifer system and the adjacent Mississippi River.

The hydrogeology within the vicinity of the NIROP facility is consistent with the regional hydrogeology where four aquifers or aquifer zones govern groundwater movement through the subsurface. These aquifers are, from shallow to deep, the unconsolidated Quaternary aquifer

zone, the Prairie du Chien/Jordan aquifer (PC), the Franconia/Ironton/Galesville (FIG) aquifer, and the Mount Simon/Hinckley/Fond du Lac (MHF) aquifer.

Because the vegetable oil injection pilot test will be conducted near well MS-46S in the shallow interval of the Quaternary aquifer system, the remainder of this section will focus on this stratigraphic interval.

The unconsolidated Quaternary aquifer zone consists of glacial drift (i.e., glacial outwash and till deposits) overlain by glacial-fluvial deposits. It is referred to as an aquifer zone because it consists of two poorly defined aquifers, a shallow unconfined aquifer (shallow drift aquifer) and a deep confined or semi-confined aquifer (deep drift aquifer). These aquifers consist of sand and gravel and they are separated by a silt or clay layer that ranges in thickness from 0 to 47 feet in the NIROP area. These two aquifers vary significantly in thickness and hydraulic connection throughout the site. The shallow unconfined aquifer ranges in thickness from 41 to 93 feet, and the deep confined or semi-confined aquifer ranges in thickness from 19 to 55 feet across the site. Although monitoring wells at the site have been designated as shallow and intermediate there appears to be no or very little hydraulic separation between these monitored intervals. Hence, both of these zones make up the shallow unconfined aquifer at the site. Cross-Section A-A' (Figure 2.1) illustrates the stratigraphic relationship of the shallow drift and deep drift aquifers in the pilot-study area.

1.4.2 Groundwater Flow under Pumping Conditions

Under current pumping conditions the general horizontal groundwater flow direction across the NIROP site in the Quaternary aquifer zone is generally toward the southwest. Groundwater from the Quaternary aquifer zone discharges into the Mississippi River and underlying alluvium.

Groundwater flow in the far southwestern portion of the NIROP site (i.e., south end of ACP and western portion of the UDLP) does not follow these general trends in the Quaternary aquifer zone. A groundwater ridge is present near well MS-46S in ACP as shown on the potentiometric surface contour map for pumping conditions (November 30, 1999) for the shallow Quaternary aquifer (Figure 2.2). As a result of this ridge, groundwater flows in a radially outward pattern in the ACP.

1.4.3 Non-Pumping Conditions and Effect of Extraction Wells

The potentiometric surface contour map for non-pumping conditions (January 4, 2000) for the shallow Quaternary aquifers is presented in Figure 2.3. The entire extraction system was shutdown December 23, 1999. The aquifer system was allowed to recover for 13 days to reach static non-pumping water level conditions. Under static (i.e., non-pumping) conditions, the groundwater flow direction across the site is generally the same for the unconsolidated aquifers and the underlying PC bedrock aquifer as under pumping conditions.

As expected, water levels in the extraction wells recovered significantly (as much as 36.9 feet in well AT- 5B). The water level recovery in monitoring wells was much less ranging from 0.30 to 4.59 feet, 0.54 to 5.31 feet and 1.69 to 5.73 feet in the shallow, intermediate and deep monitored intervals. A visual comparison of the head differences under pumping and non-pumping conditions (Figures 2.2 and Figure 2.3) reveals that the groundwater ridge remained in the ACP

under static aquifer conditions indicating that the ridge is a result of natural conditions and is only accentuated by the groundwater extraction system.

1.4.4 Interaction between the Aquifer System and the Mississippi River

The Mississippi River borders Anoka County Park to the west. It is expected that the Mississippi River and the underlying alluvium are hydraulically connected. The alluvium consists of sand and gravel (Schoenberg, 1994) and is estimated to be as much as 60 feet thick under the river (Lindgren 1990). To evaluate the interaction between the unconsolidated aquifer system and the Mississippi River, pressure transducers and data loggers were installed to record the rise and fall of the water levels in the aquifers in relation to the rise and fall of the river stage of the Mississippi River.

The hydraulic heads in the aquifer were found to be higher in all wells within 500 feet of the river compared to the river stage even during rapid changes in the river level. This head difference indicates that throughout the entire year (i.e., during all seasons) water in the aquifer system flows towards and discharges into the Mississippi River. This indicates that there were no bank storage effects, even at high river stages, during the data collection period. Thus, the Mississippi River is a gaining stream at all times of the year.

1.4.5 Groundwater Quality

Groundwater samples were collected and analyzed in the Spring (April 19-22) and Fall (November 2-5) of 1999. Consistent with historical observations, TCE is the most extensive contaminant encountered in groundwater at the NIROP and adjacent ACP site. TCE was detected in 99 of 101 wells sampled in the fall 1999 sampling event. Detected concentrations of TCE ranged from 0.59 to 18,000 μg/L in the fall 1999 sampling round. Dissolved TCE is present at generally higher concentrations in the unconfined aquifer (concentrations range from 0.59 to 18,000 μg/L in the shallow and intermediate monitoring intervals) than the deep semi-confined aquifer (concentrations range from 1.8 to 5,200 μg/L). TCE in the PC aquifer is significantly lower than in shallow intervals (concentrations ranged from non-detect to 7.9 μg/L in 1999). Generally, TCE in groundwater extends from north of the NIROP's northern boundary to the southwest, along the direction of groundwater flow to the Mississippi River in the shallow, intermediate and deep monitored intervals.

Based upon the results of the NIROP/ACP field investigation results, TCE is present at elevated levels in the shallow aquifer in the southwestern portion of the NIROP and in ACP. A plan view isoconcentration map of the spatial distribution of TCE contamination in the shallow groundwater interval in the pilot study area near MS-46S is shown on Figure 2.4, based on groundwater samples collected in the fall of 1999. The concentrations are significantly lower northeast of East River Road (ranging from 170 to 730 μg/L) than the concentrations present in the ACP (42 to 18,000 μg/L). More specifically, the concentrations in the central portion of the ACP are locally elevated ranging from 1,100 to 18,000 μg/L at well MS-46S. This zone of elevated concentrations generally corresponds with the location of the groundwater ridge (Figure 2.2) which may represent a stagnation zone. This groundwater stagnation zone may allow elevated concentrations to exist in this area. The primary reason for implementing the pilot scale vegetable oil injection test near well MS-46S is because this well exhibited the highest TCE concentration in the Fall of 1999.

2.0 Scope of Work

The scope of work for this subcontract will consist of the following work activities:

- Installation of 1 new background monitoring well in the vicinity of existing monitoring well MS-46S, 3 vegetable oil injection wells, 9 groundwater monitoring wells, and 3 contingency monitoring wells;
- Baseline (i.e., pre-injection) sampling of groundwater at the newly installed injection wells, groundwater monitoring wells, contingency monitoring wells, and existing wells MS-46S, 27S, and MS-47S;
- Pre-injection aquifer testing (hydraulic conductivity) of the 3 injection wells and 6 monitoring wells;
- Plumbing of the injection wells and injection of approximately 3,600 gallons of food-grade vegetable oil (estimated 1,200 gallons per well);
- Post-injection aquifer testing (hydraulic conductivity) of the previously-tested 3 injection wells;
- Surveying of the newly installed injection and monitoring wells;
- Post-injection sampling of groundwater and vegetable oil (if present) at the newly installed monitoring and injection wells at 2, 5, 8, and 12 months after injection; and
- Post-injection sampling of groundwater and vegetable oil (if present) at the newly installed monitoring and injection wells at , , 16, 20, and 24 months after injection. **NOTE: This is an option item and will be executed only if required.**

The materials and methodologies to accomplish these activities are described in Section 6.0. The following lists the definable features of work (DFOWs) for the subcontractor's scope of work:

- Mobilization and site preparatory work
- Pilot-scale system installation and soil sampling
- Pre-injection sampling and aquifer testing
- Baseline sampling
- Injection of vegetable oil
- Post-injection aquifer testing
- Post-injection system sampling
- Site restoration and demobilization

3.0 Project Schedule

The following milestone schedule has been established for performance of this Subcontract.

A. Award Period: This period begins with Subcontract Award and includes all prior-to-work submittals. It is expected that the subcontract will be awarded within 14 calendar days of bid due date. Subcontractor shall submit all required prior-to-work submittals (bonds, insurance, and schedule) within 7 calendar days of Subcontract award. The Notice to Proceed (NTP) is expected to be made within 14 calendar days of Subcontract award, contingent upon review and approval of Subcontractor submittals.

B. Mobilization Period: This period begins with NTP and includes all work from mobilization up to the start of actual work execution. The mobilization period for this Subcontract shall not exceed more than 7 calendar days.

C. Execution Period: This period begins with the start of fieldwork and includes completion of all subcontract requirements including fieldwork activities (installation and development of wells, injection of oil, and baseline sampling), post-injection system sampling activities, closeout documentation and final demobilization. All fieldwork activities shall be completed within 60 calendar days of mobilization. Post-injection system sampling activities shall continue for the specified duration. Closeout documentation and final demobilization activities shall be completed within 14 calendar days of final sampling activity completion. All generated wastes shall be disposed of within 60 days of generation.

The defined work hours for construction activities under this Subcontract will be 7:00 A.M. to 4:00 P.M.; Monday through Friday, except federal holidays. Equipment, supplies and materials shall be received or shipped during the defined work hours.

Subcontractor shall decide what his normal work hours will be to achieve the work within specified milestone schedule guidelines and inform CCI Site Superintendent prior to commencement of work. Extended work hours or different work hours shall be coordinated and approved by CCI Site Superintendent, 48-hours prior to start of work.

Depending on the magnitude of adverse weather and its potential impact to the project schedule, time lost during the scheduled workweek may be made up on an accelerated schedule (including weekends) at the discretion of CCI Site Superintendent.

The Bidder is requested to state in his Bid the estimated duration of performing the various activities required to complete the work, including all submittals. This information shall be provided in the form of a project schedule using critical path method (CPM) logic.

4.0 Environmental Compliance

Subcontractor shall indicate whether their company or any of their employee(s) has/have been:

- Charged with violation or non-compliance with environmental regulations
- Subject to an enforcement action
- Fined or had a penalty imposed against them within the last 3 years related to a violation or environmental damage to persons, property, or natural resources.

Discuss the nature of violation or enforcement action taken against subcontractor and corrective actions taken by subcontractor (if applicable).

5.0 Meetings, Temporary Controls, and Submittals

5.1 Project Meetings

Subcontractor shall attend the following project meetings a pre-construction meeting, daily tailgate meetings, weekly progress meetings and quality control meetings, final post-construction meeting.

5.1.1 Pre-construction Meeting

Subcontractor shall attend a mandatory pre-construction meeting, which will be approximately one week prior to mobilization. The pre-construction meeting will be approximately four hours and held at the project site. The exact date and time will be notified at the time of Subcontract Award. Subcontractor shall discuss the following subjects, as a minimum:

- Required schedules
- Status of Bonds and insurance
- Sequencing of critical path work items
- Progress payment procedures
- Project changes and clarification procedures (including RFIs)
- Use of site, access, office and storage areas, security and temporary facilities
- Major product delivery and priorities
- Subcontractor's health & safety plan and representative (including required employee records)

5.1.2 Daily Tailgate Meetings

Daily tailgate meetings shall be conducted every workday morning at 7:00 am EST with CCI, Navy, and others as required. All Subcontractor's onsite personnel (including lower-tier Subcontractors) shall attend these meetings. Documentation of the meeting shall be provided to CCI by 9:00 a.m. that same day.

Daily tailgate meeting shall discuss the following subjects, as a minimum:

- The work planned for the day
- Changes in work assignment
- Health and safety issues
- Quality issues
- Review problems encountered the previous day
- Sign the safety task assignment form prior to beginning any work onsite

5.1.3 Weekly Progress Meetings

Subcontractor shall attend regular progress meetings at site, conducted weekly to review construction progress, progress schedule, sample collection and submissions schedule, contract modifications, and other matters that require discussion and resolution.

5.1.4 Quality Control Meetings

Subcontractor shall have at least one representative at QC meetings held onsite by CCI to review test and inspection reports, and other matters relating to quality control. The frequency of the meetings will be set by the pace of the work or as called by the CCI QC Manager.

5.1.5 Post-Construction Meeting

Subcontractor shall attend a mandatory post-construction inspection meeting, which will be scheduled after completion of field activities but prior to Subcontractor demobilization. The purpose of this final inspection/meeting is to close out any punchlist items, discuss schedule for demobilization, and delivery of all required submittals.

5.2 Temporary Controls

The proposed work may have adverse impacts on the environment. During the onsite work the Subcontractor shall implement temporary controls to minimize environmental impacts and meet the intent of federal, state, and local regulations designed to protect the environment. The temporary controls shall include, but are not limited to traffic control, site access control, erosion and sediment control, construction debris and waste control, water pollution control, dust control, and spill control. These temporary controls shall be described in detail in the Subcontractor's Work Plan.

5.3 Project Submittals

5.3.1 Prior to Work

Prior to the start of any onsite work, the Subcontractor shall submit the following to CCI for review and approval:

- Subcontractor Work Plan, which includes Site-Specific Health and Safety Plan (including employee training and medical clearance records). Refer to Appendix F for work plan requirements.
- Project CPM Schedule. Refer to Section 3.0.

Upon review, CCI may require revisions to the work plan and/or schedule in order to ensure the project schedule will be met and project objectives will be achieved in accordance with applicable rules and regulations and at an appropriate level of worker safety.

5.3.2 During the Work

During the execution of the work, CCI's Site Superintendent will be responsible for maintaining a daily field activity summary, which describes the work performed. To this end, the Subcontractor shall provide the following information to CCI on a daily basis, no later than 9:00 am the following business day:

- Contractor Quality Control Report
- Contractor Production Report
- Daily air monitoring logs and other relevant health and safety information
- Copy of hazardous waste profiles and manifests for hazardous wastes removed from the site
- Copy of non-hazardous waste manifests and bills of lading for non-hazardous wastes removed from the site
- Copy of haul tickets for all materials brought to the site or removed from the site
- Copy of all Certificates of Disposal for applicable wastes removed from the site
- Land Disposal Restriction (LDR) Notification/Certification (for hazardous wastes)

5.3.3 Following the Work

Within 14 calendar days of completing fieldwork at the site to the satisfaction of CCI and SOUTHDIV, the Subcontractor shall provide CCI with all copies of pertinent project records not previously submitted, including but not limited to, analytical data, transportation and disposal records, as-builts, and air monitoring records.

5.3.4 Requirements for Project Submittals/Reports

The requirements for the project submittals vary based upon the duration of the Bidder's work, the dollar value, scope of work requirements, and the type of compensation arrangement determined in the awarded subcontract. Further details will be provided about required reports at time of subcontract award. However, the Bidder should use the guidelines given in Appendix F to estimate the appropriate cost of the submittal requirements expected for this specific scope of work.

6.0 Technical Specifications

This section provides the technical approaches, and measurement and payment for each of the on-site activities included in the Scope of Work. Subcontractor shall furnish all labor, equipment, materials, lower-tier Subcontractors, 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.

6.1 Mobilization and Site Preparatory Work

All submittals required prior to work shall be submitted to CCI prior to mobilization. Upon CCI approval of all required submittals, Subcontractor shall mobilize all resources necessary to efficiently and completely perform this scope of work task. The resources include, but are not limited to, personnel, equipment, materials, supplies, lower-tier Subcontractors, and support facilities (e.g., project support trailer, decontamination facilities, waste containment facilities, material and equipment storage, cellular phones, water, portable sanitary facilities, etc.) to support the work activities at the site.

Site preparatory work is the first physical activity at the site and involves staging of material and equipment, demarcation of work zones, utility clearances and lockout/tagout of utilities, and providing run-on/runoff control devices as required. Onsite staging/lay down areas and waste storage areas will be as designated by CCI. Temporary barricades and caution signs shall be provided around the work areas.

Before any fieldwork is conducted, each proposed well location shall be checked for underground utilities. Underground utilities clearances shall be obtained through the Gopher State One Call program and clearance shall be documented and provided to CCI on a daily basis.

Subcontractor shall provide a project site trailer for use by Subcontractor and CCI. The trailer shall have at least two telephone lines with local call access for CCI use.

Subcontractor shall provide portable toilet units, as required, for CCI, Subcontractor and lower-tier personnel use. Subcontractor shall make arrangements for potable water and electricity. Subcontractor shall be responsible for storage of equipment and tools.

Subcontractor shall construct a decontamination pad for decontamination of heavy equipment. The decontamination pad shall be cleaned after each use. A boot wash/rinse area shall be used to decontaminate reusable articles. All equipment and personnel decontamination shall be documented in the field log books.

6.1.1 Measurement and Payment

Payment for this activity shall be lump sum to include full compensation to mobilize to the site and to set-up all labor, equipment, facilities, materials, lower-tier Subcontractors and supplies required to perform the scope of work.

6.2 Pilot-Scale System Installation and Soil Sampling

The procedures for installing the injection and monitoring wells for the pilot study are discussed in the following subsections.

6.2.1 Injection Well and Groundwater Monitoring Well Layout

The proposed well layout consists of 1 new background monitoring well in the vicinity of existing monitoring well MS-46S, 3 injection wells, 9 groundwater monitoring wells, and 3 contingency monitoring wells as shown in Figure 4.1. A cross-sectional view of the proposed wells also is shown in Figure 4.1. The 3 injection wells shall be located approximately 15 feet apart and centered 20 feet downgradient of existing monitoring well MS-46S. The final well layout may vary significantly from what is shown in Figure 4.1 as a result of information discovered during the field program.

The proposed well construction details and screened intervals are listed in Table 4.1 (EMR Work Plan). It is important to note that the total depths, screened intervals, and feet of riser listed in Table 4.1 (EMR Work Plan) are approximations. Actual depths and length specifications will be determined in the field. The most important completion detail is that the top of the screen for injection wells, groundwater monitoring wells, and contingency monitoring wells will be located 4 feet below the observed groundwater table. The volume of oil to be injected was calculated assuming an even distribution of vegetable oil over a vertical distance of 10 feet and a radius of 5 feet assuming isotropic, homogeneous conditions and an effective porosity of 20 percent. It is anticipated that the radius of influence of the injected vegetable oil will be somewhat greater than the assumed 5 feet (horizontally).

Monitoring wells will be located at distances of 15, 30, 50, 80 and 140 feet along the flowpath downgradient from injection well 2, and additional groundwater monitoring wells are located downgradient from injection wells 1 and 3 as shown in Figure 4.1. Monitoring well locations are intended to monitor the groundwater system immediately downgradient of the injection zone over a period of 12 months. One upgradient well pair MS-46S is located to monitor background groundwater geochemistry. The three new contingency monitoring wells are to be located approximately 200 feet downgradient from the injection wells. In addition two existing monitoring wells will be utilized as contingency monitoring wells (wells 27S and MS-47S); these wells and the proposed new wells are shown on the potentiometric map in Figure 2.2.

Subcontractor shall install the wells in stages, as directed by CCI, in order to collect water level elevation data from the first few wells installed to more accurately define the direction of groundwater flow and to better locate the remaining wells hydraulically downgradient.

All well installation and development activities shall be performed by a Minnesota Licensed driller.

6.2.2 Drilling and Soil Sampling Procedures

Drilling in unconsolidated soils will be accomplished using the hollow stem auger drilling method to approximate depths specified in Table 4.1 (EMR Work Plan). The drill rig shall be cleaned and decontaminated prior to delivery to the site. The rig shall not leak any fluids that may enter the borehole or contaminate equipment that is placed in the hole. The use of rags or absorbent materials to absorb leaking fluids is unacceptable.

All wells are to be completed with the top of the well screen located approximately 4 feet below the observed groundwater table. The well driller shall collect soil samples, maintain a detailed descriptive log of all subsurface materials recovered during drilling, and properly label and store all samples. During borehole advancement, soil samples for visual description shall be collected at a frequency sufficient to identify the depths of significant stratigraphic contacts or other soil properties. Soil samples shall be collected from drilling cores obtained by hollow stem auger drilling method using a 24-inch long, 2-inch diameter split spoon sampler. Procedures shall be modified, if necessary, to ensure good sample recovery.

As each boring is advanced one soil sample shall be collected from close vertical proximity to the center of the screened interval to be installed. Aliquots of this soil sample from selected boring locations identified in Table 4.2 (EMR Work Plan) shall be analyzed for VOCs, bulk density via ASTM Method D2937-94 , and total organic carbon (TOC) via method E415.1 (combustion/oxidation). Aliquots for VOCs, bulk density, and TOC shall be shipped to an off-site fixed-based laboratory for analysis at Subcontractor's cost. Additional aliquots of soil samples shall be collected and provided to CCI for microbial analysis, soil isotherm sorption tests and bio-available iron analysis for analysis by others.

After drilling is complete, gamma log geophysical data shall be collected from the entire boring at each location. Submit a complete report to CCI with graphs for each location within 3 days of gamma logging.

All drilling and soil sampling equipment shall be decontaminated in accordance with procedures discussed in Section 6.2.3.6.

6.2.3 Injection Well and Groundwater Monitoring Well Installation

This section describes the procedures to be used for installation of the injection and monitoring wells.

6.2.3.1 Pre-Installation Activities

All well installation permits shall be obtained prior to mobilizing to the field. In addition, all utility lines shall be located, and proposed drilling locations shall be cleared prior to any intrusive activities.

Water to be used in well installation and equipment cleaning shall be obtained by the well drilling Subcontractor from an off-site source. The CCI field scientist will make the final determination as to the suitability of water for these activities.

6.2.3.2 Materials Decontamination

All completion materials will be inspected by the CCI field scientist and determined to be clean and acceptable prior to use. If not factory sealed, casing, screen, end caps, and surface plugs

shall be cleaned prior to use with a high-pressure, steam/hot-water cleaner using approved water. Materials that cannot be cleaned to the satisfaction of the CCI field scientist shall not be used.

6.2.3.3 Screen and Casing

Injection and monitoring wells shall be installed through the drill rig drive casing using 2-inch or 3-inch-diameter PVC casing and screen. Injection and monitoring well screens shall be constructed of 10 feet of flush-threaded, Schedule 40 PVC with an ID of 2.0 or 3.0 inch as listed in Table 4.1 (EMR Work Plan). The screens shall be factory slotted with 0.020-inch openings. Screens shall be installed beneath the water table at the approximate intervals listed on Table 4.1 (EMR Work Plan). The casing at each well shall be fitted with a PVC bottom cap and a locking top cap.

Subcontractor shall verify and record the total depth of the injection wells and monitoring wells, the lengths of all casing sections, and the depth to the top of all completion materials (filter pack, bentonite seal, etc.). All lengths and depths shall be measured to the nearest 0.1-foot.

6.2.3.4 Injection and Monitoring Well Completion

One well shall be installed in each borehole. A graded sand filter pack shall be installed around the screened interval and will extend at least 2 feet above the top of the screen. The sand filter pack shall consist of clean 10-20 silica sand. A filter pack seal shall be installed above the filter pack using sodium bentonite pellets. The pellet seal shall be a minimum of 3 feet thick and shall be hydrated in place with potable water if the seal is installed above the water table. The pellet seal shall be overlain by a neat cement grout (non-rapid setting cement) that shall extend from the top of the pellet seal to approximately 2 feet below the ground surface. A concrete surface collar that will extend to the ground surface shall overlie the neat cement grout. Each injection and groundwater monitoring well casing shall be completed above grade, with a steel protective casing to protect the well. Three two-inch steel ballard posts shall be installed around each monitoring well completion to protect the well head.

6.2.3.5 Injection and Monitoring Well Development

The injection wells, groundwater monitoring, and contingency monitoring wells shall be developed prior to sampling. Development removes sediment from inside the well casing and flushes fines from the portion of the formation adjacent to the screen. Development shall be accomplished using a submersible pump. The pump shall be regularly raised and lowered through the screened interval while development is underway so that fines are agitated and removed from the entire screened interval.

Development shall continue until a minimum 10 casing volumes of water have been removed from the well and until pH, temperature, specific conductance, DO, and water clarity (turbidity) stabilize. If the water remains turbid, development shall continue until the turbidity of the water produced has been stable after the removal of several additional casing volumes.

Development water shall be collected in portable poly-tanks or 55-gallon drums. The tanks or drums shall be staged in a CCI-designated hazardous-waste collection area and disposed of in accordance with the Section 6.6. A development record shall be maintained for each injection and monitoring well on a form. Development records will include:

- Injection or groundwater monitoring well number;

- Date and time of development;
- Development method;
- Predevelopment water level and well depth;
- Volume of water produced;
- Description of water produced;
- Post development water level and well depth; and
- Field analytical measurements, including pH, specific conductance, turbidity, temperature, and DO.

6.2.3.6 Equipment Decontamination Procedures

Prior to arriving at the site, and between drilling of each borehole, drill bits, drill pipe, drill casing, instrumented probes, samplers, tools, and other downhole equipment shall be decontaminated using a high-pressure, steam/hot water wash. Only potable water shall be used for decontamination. All rinsate will be collected in portable tanks or 55-gallon drums and shall be staged in a CCI-designated location at NIROP Facility. The location for the storage of containerized waste at NIROP Facility will be identified by CCI.

Potable water to be used in equipment cleaning, decontamination, or grouting shall be obtained from an offsite water source by Subcontractor. Precautions shall be taken to minimize any impact to the surrounding area that might result from decontamination operations.

6.2.3.7 Datum Survey

A registered surveyor shall survey the locations and elevations of the newly installed background, injection and groundwater monitoring wells. Horizontal locations shall be measured relative to established coordinates. Horizontal coordinates shall be measured to the nearest 0.1-foot. The elevation of the ground surface adjacent to the well casing and the measurement datum (top of the casing) shall be measured relative to an existing benchmark location. Vertical elevations will be measured with respect to the National Vertical Datum (NAVD) of 1998 to the nearest 0.01-foot.

6.2.3.8 Measurement and Payment

Payment for this activity shall be on a linear feet (LF) basis to include HSA drilling; split spoon soil sampling and sample description; well construction; placement of screen, filter pack and pellet seal; well development; surface completion; and submittal of as-built survey drawing (CADD file and hard copy).

6.3 Measurement of Baseline Geochemical Conditions and Contaminant Profiles

After installation of the injection, groundwater monitoring, and contingency monitoring wells, each of these new wells and previously installed monitoring wells MS-46S, 27S, and MS-47S will be sampled and analyzed for parameters listed in Table 4.4 (EMR Work Plan) to characterize initial (baseline) site-specific geochemical and contaminant conditions to evaluate the potential for existing reductive dehalogenation, future enhanced reductive dehalogenation, and any expected changes in the above profile as a result of substrate addition.

Groundwater samples collected from the monitoring locations shall be analyzed for oxidation-reduction potential (ORP), DO, pH, specific conductance, temperature, ferrous iron, manganese,

hydrogen sulfide, sulfate, alkalinity, carbon dioxide, nitrate + nitrite (as nitrogen [N]), chloride, methane, ethane, ethene, total organic carbon (TOC), and VOCs (Table 4.4 (EMR Work Plan)).

6.3.1 Groundwater Sampling

Qualified scientists and technicians who are trained and experienced in the performance of groundwater sampling, records documentation, and chain-of-custody procedures shall conduct collection of groundwater quality samples. Groundwater samples shall be collected from previously installed monitoring wells MS-46S, 27S, and MS-47S and from all newly installed injection, monitoring, and contingency monitoring wells. Groundwater samples collected during this program shall be collected using established groundwater sampling techniques. Well locations that will be sampled during this program are shown on Figure 2.2. Prior to sampling, the injection and monitoring wells shall be developed as described in Section 6.2.3.5. In order to maintain a high degree of quality control (QC) during this sampling event, the procedures described in the following sections shall be followed.

6.3.2 Preparation for Sampling

All equipment to be used for sampling shall be assembled and properly cleaned and calibrated (if required) prior to arriving in the field. In addition, all record-keeping materials shall be gathered prior to mobilizing to the field.

6.3.2.1 Equipment Cleaning

All portions of sampling and test equipment that will contact the sample matrix shall be thoroughly cleaned before each use. This includes the water-level probe and cable, test equipment for onsite use, and other equipment or portions thereof that will contact the samples. Based on the types of sample analyses to be conducted, the following cleaning protocol shall be used:

- Wash with potable water and phosphate-free laboratory detergent (Alconox®);
- Rinse with potable water;
- Rinse with isopropyl alcohol;
- Rinse with distilled or deionized water; and
- Air-dry the equipment prior to use (to the extent practical).

Any deviations from these procedures shall be documented in the field scientist's field notebook and on the groundwater sampling record.

Laboratory-supplied sample containers shall be cleaned and sealed by the laboratory. The type of container provided and the method of container decontamination shall be documented in the laboratory's permanent record of the sampling event.

6.3.2.2 Equipment Calibration

As required, field analytical equipment shall be calibrated according to the manufacturers' specifications prior to field use. This applies to equipment used for onsite measurements of DO, pH, specific conductance, ORP, sulfate, ferrous iron, and other field parameters listed in Table 4.4 (EMR Work Plan). All field calibration activities shall be documented and provided to CCI on a daily basis.

6.3.3 Groundwater Sampling Procedures

Special care shall be taken to prevent contamination of the groundwater and extracted samples. The primary way in which sample contamination can occur is through cross-contamination due to insufficient cleaning of equipment between wells. To prevent such contamination, the water-level probe and cable used to determine static water levels and total well depths shall be thoroughly cleaned before and after field use and between uses at different sampling locations according to the procedures presented in Section 6.3.2.1. A decontaminated submersible pump and/or bladder pumps shall be used for purging and sampling each groundwater sampling location.

Field personnel each time a different monitoring location is sampled shall wear a clean pair of new, disposable nitrile or latex gloves. The following paragraphs present the procedures to be followed for groundwater sample collection. These activities shall be performed in the order presented below. Exceptions to this procedure shall be noted in the sampler's field notebook and on the groundwater sampling form.

6.3.3.1 Preparation of Location

Prior to starting the sampling procedure, the area around the existing and new monitoring wells shall be cleared of foreign materials, such as brush, rocks, and debris. These procedures will prevent sampling equipment from inadvertently contacting debris and potentially becoming contaminated. In addition, the sampling location shall be inspected for the integrity of the protective cover, lock, external surface seal, concrete pad, cap, datum reference, and internal surface seal.

6.3.3.2 Water Level and Total Depth Measurements

Prior to removing any water from the sampling well, the static water level shall be measured. An electric water-level probe (or oil/water interface probe) shall be used to measure the depth to groundwater below the datum to the nearest 0.01-foot. After measuring the static water level, the water-level probe shall be slowly lowered to the bottom of the well if the well depth is not known, and the depth shall be measured to the nearest 0.01 foot. Based on these measurements, the volume of water to be purged from the monitoring well shall be calculated. Otherwise, previously recorded well depths shall be used to calculate purge volumes.

6.3.3.3 Purging Before Sampling

The volume of water contained within the monitoring well casing at the time of sampling shall be calculated. Groundwater shall be purged from the well until a minimum of 3 well casing volumes are removed and water quality parameters have stabilized. Sampling techniques specified in the attached site-specific MPCA Document shall be used for well purging. Water quality stabilization is defined in Section 6.3.4. Purge waters shall be handled in accordance with the procedures outlined in Section 6.6.

6.3.3.4 Sample Extraction

Sampling techniques specified in the attached site-specific MPCA Document shall be used for sample collection. A submersible and/or bladder pump shall be used to extract groundwater samples from the injection and monitoring wells. The sample shall be transferred directly into the appropriate sample container. The water shall be carefully poured down the inner walls of the sample bottle to minimize aeration of the sample.

Unless the analytical laboratory gives other instructions, sample containers shall be completely filled so that no air space remains in the container. Excess water collected during sampling shall be handled according to the procedures outlined in Section 6.6.

If a monitoring well is evacuated to a dry state during purging, the monitoring well shall be allowed to recharge, and the sample shall be collected as soon as sufficient water is present to obtain the necessary sample quantity. Sample compositing or sampling over a lengthy period by accumulating small volumes of water at different times to obtain a sample of sufficient volume will not be allowed.

6.3.4 Onsite Groundwater Parameter Measurement

As indicated on Table 4.4 (EMR Work Plan), many of the groundwater chemical parameters shall be measured onsite. Some of the measurements shall be made with direct-reading meters, while others shall be made using a Hach® or CHEMetrics® portable colorimeter or titration kit in accordance with manufacturer-specified procedures. These procedures are described in the following subsections.

Samples shall be collected after stable conditions have been reached. Stability shall be determined between successive purge volumes equal to one calculated saturated casing volume. Stability is obtained when the temperature, specific conductance, pH, dissolved oxygen, and turbidity fall within the following acceptable ranges: ±0.1 degrees Celsius (°C), ±5 %, ±0.1 pH units, ±2%, and less than 5 ntu respectively.

All glassware or plasticware used in the analyses shall have been cleaned prior to sample collection by thoroughly washing with a solution of Alconox® and water, and rinsing with distilled water and isopropyl alcohol to prevent interference or cross contamination between measurements. If concentrations of an analyte are greater than the range detectable by the titrimetric method, the analysis shall be repeated by diluting the groundwater sample with distilled water until the analyte concentration falls to a level within the range of the method. All rinsate and sample reagents accumulated during groundwater analysis shall be collected in glass containers fitted with screw caps. These waste containers shall be clearly labeled as to their contents and carefully stored for later transfer to the approved disposal facility.

6.3.4.1 Dissolved Oxygen Measurements

DO measurements shall be made using a meter with a sensor in a flow-through cell or a downhole oxygen sensor. Multiple measurements shall be taken before groundwater sample acquisition during well purging, with the final measurement made immediately prior to completion of the well purge. When DO measurements are taken in monitoring wells that have not yet been sampled, the existing monitoring wells shall be purged until DO levels stabilize. DO measurements shall be recorded on the groundwater sampling record.

6.3.4.2 pH, Temperature, and Specific Conductance

Because the pH, temperature, and specific conductance of a groundwater sample can change significantly within a short time following sample acquisition, these parameters shall be measured in the field in a flow-through cell during the purging process as described for DO in Section 6.3.4.1. The measured values shall be recorded in the groundwater sampling record.

6.3.4.3 Carbon Dioxide Measurements

Carbon dioxide is a byproduct of biological reactions and can be used to evaluate the bioactivity of the groundwater system. Carbon dioxide concentrations in groundwater shall be measured in the field via titrimetric analysis using CHEMetrics® Method 4500 [0 to 250 mg/L], or CCI approved equivalent.

6.3.4.4 Alkalinity Measurements

Alkalinity in groundwater helps buffer the groundwater system against acids generated through both aerobic and anaerobic biodegradation processes. Alkalinity of the groundwater sample shall be measured in the field via titrimetric analysis using USEPA-approved Hach® Method 8221 (0 to 5,000 mg/L as calcium carbonate), or CCI approved equivalent.

6.3.4.5 Nitrate + Nitrite (as Nitrogen) Measurements

Nitrate + nitrite (as N) concentrations are of interest because nitrate can act as an electron acceptor during hydrocarbon biodegradation under anaerobic soil or groundwater conditions. Nitrate is also a potential nitrogen source for hydrocarbon-degrading bacteria biomass formation. Nitrite is an intermediate byproduct in both ammonia nitrification and in nitrate reduction in anaerobic environments.

Nitrate + nitrite (as N) concentrations in groundwater shall be measured in the laboratory (Table 4.4 (EMR Work Plan)).

6.3.4.6 Sulfate and Hydrogen Sulfide Measurements

Sulfate in groundwater is a potential electron acceptor for fuel-hydrocarbon biodegradation in anaerobic environments, and sulfide is produced during sulfate reduction. Sulfate shall be measured in the laboratory (Table 4.4 (EMR Work Plan)), or measure sulfate and hydrogen sulfide concentrations in the filed via colorimetric analysis with a Hach® DR/700 Portable Colorimeter after appropriate sample preparation. USEPA-approved Hach® Methods 8051 (0 to 70.0 mg/L sulfate) and 8131 (0.60 mg/L hydrogen sulfide) or CCI approved equivalent shall be used to prepare samples and analyze sulfate and hydrogen sulfide concentrations, respectively.

6.3.4.7 Ferrous Iron Measurements

Iron is an important trace nutrient for bacterial growth, and different states of iron can affect the ORP of the groundwater and act as an electron acceptor for biological metabolism under anaerobic conditions. Ferrous iron concentrations shall be measured in the field via colorimetric analysis with a Hach® DR/700 Portable Colorimeter after appropriate sample preparation. Hach® Method 8146, or CCI approved equivalent, for ferrous iron (0 to 3.0 mg/L) shall be used to prepare and quantitate the samples.

6.3.4.8 Manganese Measurements

Manganese is a potential electron acceptor in anaerobic environments. Manganese concentrations shall be quantified in the field using colorimetric analysis with a Hach® DR/700 Portable Colorimeter. USEPA-approved Hach® Method 8034 (0 to 20.0 mg/L), or CCI approved equivalent, shall be used to prepare the samples for analysis of manganese concentrations.

6.3.4.9 Oxidation/Reduction Potential

The ORP of groundwater is an indicator of the relative tendency of a solution to accept or transfer electrons. Redox reactions in groundwater are usually biologically mediated; therefore, the ORP of a groundwater system depends upon and influences rates of biodegradation. ORPs can be used to provide real-time data on the location of the contaminant plume, especially in

areas undergoing anaerobic biodegradation. The ORP of a groundwater sample taken inside the contaminant plume should be somewhat lower than that of a sample taken in an upgradient location.

The ORP of a groundwater sample can change significantly within a short time following sample acquisition and exposure to atmospheric oxygen. Therefore, this parameter shall be measured in a flow-through cell as described for DO in Section 6.3.4.1.

6.3.4.10 Chloride Measurements

During biodegradation of chlorinated solvents dissolved in groundwater, chloride is released into the groundwater, resulting in accumulations of biogenic chloride. This results on chloride concentrations in groundwater in the contaminant plume that are elevated relative to background concentrations. In aquifers with relatively low background concentrations of inorganic constituents, the concentration of chloride in the aquifer can be seen to increase as chlorinated solvents are degraded. Chloride concentrations in groundwater shall be measured in the field via titrimetric analysis using USEPA-approved Hach Kit 8P or CCI approved equivalent.

6.3.4.11 Ammonia Measurements

The concentration of ammonia concentration is used as indicator of groundwater chemistry. Often a significant percentage of bioavailable nitrogen in a groundwater system is present as ammonia (NH_3). In addition, as discussed above (Section 6.3.4.5) nitrogen is an important reductive dechlorination byproduct. Nitrogen commonly in the form of ammonia is consumed during reductive dechlorination if the predominant groundwater geochemical conditions are such that denitrification is the dominant dechlorination process present. In the case where denitrification is occurring, nitrogen concentrations in groundwater in the source area will be significantly lower than background concentrations. Ammonia concentrations in groundwater shall be measured in the field using colorimetric analysis with a Hach® DR/700 Portable Colorimeter. USEPA-approved Hach® Method 8155 or CCI approved equivalent, shall be used to prepare the samples for analysis of ammonia concentrations.

6.3.5 Handling of Samples for Laboratory Analysis

This section describes the handling of samples from the time of sampling until the samples are delivered to the laboratory.

6.3.5.1 Sample Preservation

The laboratory shall add any necessary chemical preservatives prior to shipping the sample containers to the field. Samples shall be prepared for transportation to the analytical laboratory by placing the samples in a cooler containing ice to maintain a maximum shipping temperature of 4 °C.

6.3.5.2 Sample Container and Labels

Sample containers and appropriate container lids shall be provided by the laboratory. The sample containers shall be filled as described in Section 6.3.3.4, and the container lids shall be tightly closed. The sample label shall be firmly attached to the container side, and the following information shall be legibly and indelibly written on the label:

- Facility name;
- Sample station identification;
- Sample type (e.g., groundwater, soil, surface water, sediment);

- Sampling date;
- Sampling time;
- Preservatives added;
- Sample collector's initials; and
- Analyses requested.

6.3.5.3 Sample Shipment

After the samples are sealed and labeled, they shall be packaged for transport via an overnight carrier to the laboratory. The packaged samples shall be delivered to the laboratory as soon as possible (well within holding limits) after sample collection.

The following packaging and labeling procedures shall be followed:

- Package sample so that it shall not leak, spill, or vaporize from its container;
- Cushion samples to avoid breakage; and
- Add ice to container to keep samples cool for the duration of the trip to the laboratory.

6.3.5.4 Chain-of-Custody Control

Chain-of-custody (COC) documentation for the shipment of samples from the field to the laboratory shall be completed. Subcontractor shall submit copies of completed COC to the CCI Site Superintendent on a daily basis.

6.3.5.5 Sampling Records

In order to provide complete documentation of the sampling event, detailed records shall be maintained by the field scientist. At a minimum, these records shall include the following information:

- Sample location (facility name);
- Sample station identification;
- Date and time of sampling;
- Sampling method;
- Field observations of sample appearance and odor;
- Weather conditions;
- Water level prior to purging (groundwater samples only);
- Total monitoring well/well depth (groundwater samples only);
- Purge volume (groundwater samples only);
- Monitoring well/well condition (groundwater samples only);
- Sampler's identification;
- Field measurements of pH, temperature, DO, ORP, and specific conductance (groundwater samples only); and
- Any other relevant information.

Groundwater sampling information shall be recorded on a groundwater sampling form. Sample collection data such as collection location, sample identification number, collection time, and final collection field parameters shall be recorded in the project field book.

6.3.5.6 Laboratory Analyses

Laboratory analyses shall be performed on all groundwater and soil samples as well as the QA/QC samples described in Section 6.3.6. The analytical methods for these sampling events are listed in Table 4.4 (EMR Work Plan). Prior to sampling, the laboratory shall provide a sufficient number of analyte-specific sample containers for the samples to be collected. All containers, preservatives, and shipping requirements shall be consistent with USEPA protocol.

Laboratory personnel shall specify the necessary QC samples and prepare appropriate QC sample containers. For samples requiring chemical preservation, preservatives shall be added to containers by the laboratory.

All analyses shall be requested for a 7-calendar day turnaround time basis. The results of the analyses shall be forwarded to CCI within one day following receipt of the analytical results. Analytical results shall also be provided to CCI electronically in accordance with the specifications in Appendix C.

6.3.6 Sampling QA/QC

Quality assurance/quality control procedures are described in a site-specific QAPP that was developed to address the data needs of this project. The following is a brief discussion of the field QC samples to be collected and the laboratory QC samples required. A copy of the site-specific QAPP will be provided to Subcontractor upon award of subcontract.

6.3.6.1 Field QA/QC Procedures

Field QA/QC procedures shall include collection of field duplicates/replicates and rinsate, field, and trip blanks; decontamination of all equipment that contacts the sample medium before and after each use; use of analyte-appropriate containers; and chain-of-custody procedures for sample handling and tracking. All samples to be transferred to the laboratory for analysis shall be clearly labeled to indicate sample number, location, matrix (e.g., groundwater), and analyses requested. Samples shall be preserved in accordance with the analytical methods to be used, and water sample containers shall be packaged in coolers with ice to maintain a temperature of 4 degrees Celsius (°C) or less.

All field-sampling activities shall be recorded in a bound, sequentially paginated field notebook in permanent ink. All sample collection entries shall include the date, time, sample locations and numbers, notations of field observations, and the sampler's name and signature. Field QC samples shall be collected in accordance with the program described below, and as summarized in Table 4.5 (EMR Work Plan).

QA/QC sampling shall include collection and analysis of duplicate groundwater samples, rinsate blanks, field/trip blanks, and matrix spike samples. Internal laboratory QC procedures shall involve the analysis of laboratory control samples (LCSs) and laboratory method blanks (LMBs). QA/QC objectives for each of these samples, blanks, and spikes are described below.

Duplicate groundwater samples shall be collected at a frequency of one for every 10 or fewer samples of similar matrix. Each duplicate water sample shall be collected concurrently with, and by the same method as, the primary sample. Duplicate water samples shall be analyzed for VOCs and geochemical parameters.

One rinsate sample shall be collected for every 20 or fewer groundwater samples collected. The rinsate sample shall consist of a sample of distilled water poured into or through the sampling device and subsequently transferred into a sample container provided by the laboratory. If dedicated sampling equipment is used, then only one rinsate sample shall be collected per sampling device type to document the cleanliness of the dedicated equipment. Rinsate samples shall be analyzed for VOCs only.

One field blank shall be collected for every 20 or fewer groundwater samples to assess the effects of ambient conditions in the field. The field blank shall consist of a sample of distilled

water poured into a laboratory-supplied sample container at the well while sampling activities are underway. The field blank shall be analyzed for VOCs only.

A trip blank shall be analyzed to assess the effects of ambient conditions on sampling results during the transportation of samples. The trip blank shall be prepared by the laboratory, and shall be transported inside each sample shipment containing samples for VOC analysis. Trip blanks shall be analyzed for VOCs only.

6.3.6.2 Laboratory QC Procedures

Matrix spikes shall be prepared in the laboratory and used to establish matrix effects for samples analyzed for VOCs. Sufficient extra sample volume shall be submitted to the laboratory to allow matrix spike preparation and analysis. LCSs and LMBs shall be prepared internally by the laboratory and shall be analyzed each day samples from the sites are analyzed. Samples shall be reanalyzed in cases where the LCS or LMB are out of the control limits. Control charts for LCSs and LMBs shall be developed by the laboratory and monitored for the analytical methods used (Table 4.4 (EMR Work Plan)).

6.3.7 Measurement and Payment

Payment for this activity shall be lumpsum for performing all required sampling and testing of soil and groundwater at baseline (prior to oil injection). Includes bulk density, volatile organic compounds, and total organic carbon testing of soil sample collected from center of screened interval from seven of newly installed wells. Cost shall include all required QA/QC sampling and analyses. Payment for this item will not be made until all required tests are completed and all data have been submitted to and accepted by CCI.

6.4 Pre-Oil Injection Aquifer Testing

Slug tests shall be conducted before and after oil injection on the three newly installed injection wells to estimate the hydraulic conductivity of unconsolidated deposits at the site and to estimate the impact of oil injection. In addition, slug tests shall be conducted prior to oil injection on seven monitoring wells. Slug testing shall be preformed after the baseline geochemical and contaminant sampling.

A slug test is a single-well hydraulic test used to determine the hydraulic conductivity of an aquifer in the immediate vicinity of screened interval of the tested well. Slug tests can be used for both confined and unconfined aquifers that have a transmissivity of less than 7,000 square feet per day (ft^2/day). Slug testing can be performed using either a rising head or a falling head test; at this site, both methods shall be used in sequence.

6.4.1 Definitions

- **Hydraulic Conductivity (K).** A quantitative measure of the ability of porous material to transmit water; defined as the volume of water that will flow through a unit cross-sectional area of porous or fractured material per unit time under a unit hydraulic gradient.
- **Transmissivity (T).** A quantitative measure of the ability of an aquifer to transmit water. It is the product of the hydraulic conductivity and the saturated thickness of the water-bearing zone.
- **Slug Test.** Two types of tests are possible: rising head and falling head. A slug test consists of adding a slug of water or a solid cylinder of known volume to the well to be tested or removing a known volume of water or cylinder and measuring the rate of

recovery of water level inside the well. The slug of a known volume acts to raise or lower the water level in the well.

- **Rising Head Test**. A test used in an individual well within the saturated zone to estimate the hydraulic conductivity of the surrounding formation adjacent to the screened interval by lowering the water level in the well and measuring the rate of recovery of the water level. The water level may be lowered by pumping, bailing, or removing a submerged slug from the well.
- **Falling Head Test**. A test used in an individual well to estimate the hydraulic conductivity of the surrounding formation adjacent to the screened interval by raising the water level in the well by insertion of a slug or quantity of water, and then measuring the rate of drop in the water level.

6.4.2 Equipment

The following equipment shall be used to conduct a slug test:

- Teflon®, PVC, or stainless steel slugs;
- Nylon or polypropylene rope;
- Electric water-level indicator;
- Pressure transducer/sensor;
- Field logbook/forms; and
- Automatic data recording instrument (such as the Hermit Environmental Data Logger®, In-Situ, Inc. Model SE3000, or CCI approved equivalent).

6.4.3 General Test Methods

Aquifer hydraulic conductivity tests (slug tests) are accomplished by either removal of a slug or quantity of water (rising head) or introduction of a slug (falling head), and then allowing the water level to stabilize while taking water-level measurements at closely spaced time intervals. Both rising and falling head slug tests shall be performed at each well by qualified and experienced personnel.

Because hydraulic testing will be completed on existing wells, it will be assumed that the wells were properly developed and that water levels have stabilized. Slug testing shall proceed only after multiple water-level measurements over time show that static water levels are in equilibrium. During the slug test, the water level change should be influenced only by the introduction (or removal) of the slug volume. Other factors, such as inadequate well development or extended pumping, may lead to inaccurate results; in addition, slug tests shall not be performed on wells with free product. The field scientist will determine when static equilibrium has been reached in the well. The pressure transducer, slugs, and any other downhole equipment shall be decontaminated prior to and immediately after the performance of each slug test using the procedures described in Section 6.3.2.1.

6.4.4 Falling Head Test

The falling head test is the first step in the two-step slug testing procedure. The following steps describe procedures to be followed during performance of the falling head test.

1. Decontaminate all downhole equipment prior to initiating the test.
2. Open the well. Where wells are equipped with watertight caps, the well should be unsealed at least 24 hours prior to testing to allow the water level to stabilize. The protective casing shall remain locked during this time to prevent vandalism.
3. Prepare the aquifer slug test data form with entries for:

- Borehole/well number,
- Project number,
- Project name,
- Aquifer testing team,
- Climatic data,
- Top of well casing elevation,
- Identification of measuring equipment being used,
- Static water level, and
- Date.

4. Measure the static water level in the well to the nearest 0.01-foot.
5. Lower the decontaminated pressure transducer into the well and allow the displaced water to return to its static level. This can be determined by periodic water-level measurements until the static water level in the well is within 0.01 foot of the original static water level.
6. Lower the decontaminated slug into the well to just above the static water level in the well.
7. Turn on the data logger and quickly lower the slug below the water table, being careful not to disturb the pressure transducer. Follow the owner's manual for proper operation of the data logger.
8. Terminate data recording when water level stabilizes in the well. The well will be considered stabilized for termination purposes when it has recovered 80 to 90 percent from the initial displacement.

6.4.5 Rising Head Test

After completion of the falling head test, the rising head test shall be performed. The following steps describe the rising head slug test procedure:

1. Measure the water level in the well to the nearest 0.01-foot to ensure that it has returned to the static water level.
2. Initiate data recording and quickly withdraw the slug from the well. Follow the owner's manual for proper operation of the data logger.
3. Terminate data recording when the water level stabilizes in the well, and remove the pressure transducer from the well and decontaminate. The well will be considered stabilized for termination purposes when it has recovered 80 to 90 percent from the initial displacement.

6.4.6 Measurement and Payment

Payment for this activity shall be on a lumpsum basis to perform the slug tests (falling head and rising head) before and after oil injection at 3 injection wells; and at 7 monitoring/contingency wells prior to oil injection and submit data. Payment for this item will not be made until all required tests are completed and all data have been submitted to and accepted by CCI.

6.5 Oil Injection and Process Monitoring

6.5.1 Oil Injection

After the background geochemical and contaminant sampling and slug testing have been completed, an emulsion of 3,600 gallons of food-grade soybean oil/lecithin and 7,200 gallons (total) of native water shall be injected into the three new injection wells as specified by below.

The injection system and each injection point shall be filled with groundwater to remove entrapped air and to pressure-test the system. Water with similar geochemical characteristics (native) to the site groundwater shall be used for the injection to promote the development of a healthy microbial population and avoid adverse changes to site geochemistry. An in-line mixer shall be used to emulsify a total of 3,600 gallons of food grade vegetable oil/lecithin mixture with a total of 7,200 gallons of native groundwater previously extracted from a groundwater extraction well in close proximity to the newly installed injection wells. The oil-lecithin-water emulsion shall be pumped into the injection wells until a total of 10,800 gallons of emulsion have been injected into the shallow unconfined aquifer (i.e., 3,600 gallons of oil-lecithin-water emulsion into each well). The in-line mixer shall be operated with water for a period after injection is complete to flush that portion of the system. Native groundwater shall continue to be injected at ~3.0 gpm until ~60 gallons of native groundwater per well has been injected. This post injection water push will serve to distribute the emulsion further into the aquifer in the immediate vicinity of the injection wells. After the process has been completed, the presence of phase-separated oil emulsion in the injection points and the impact on the groundwater table elevation shall be measured with an oil-water interface probe.

NOTE: The vegetable/lecithin may be purchased from Central Soya Company (www.centralsoya.com; 800-348-0960) or other equivalent vendor. The quantity of lecithin added will be determined by CCI.

NOTE: Subcontractor shall install a temporary mechanical packer in the injection wells below the screened interval prior to injecting oil+lecithin+water emulsion. Remove packers after the emulsion is injected.

NOTE: Subcontractor shall allow access to CCI to the emulsifier for the purposes of adding magnetite or iron filings to the emulsion prior to injection.

6.5.1.1 Measurement and Payment

Payment for this activity shall be gallons of actual oil+lecithin+water emulsion injected as measured using a meter. This unit price for emulsion injection shall include full compensation for storage, transportation, required testing of vegetable oil ; cost of native water addition; emulsification; and injection of the emulsion. The cost of lecithin addition will be on a weight (pound) basis.

6.5.2 Process Monitoring

The 3 injection wells, the 9 newly installed groundwater monitoring wells, the 3 newly installed contingency monitoring wells and existing wells MS-46S, 27S, and MS-47S shall be sampled and analyzed for the parameters listed in Table 4.4 (EMR Work Plan) at 2, , 5, 8, and 12 months after oil injection. Based upon the results of the field application, continued monitoring and further injection of vegetable oil will be evaluated by CCI. The procedures listed in Section 6.3 shall be used for all sampling events.

Additionally, Subcontractor shall sample and analyze the 3 injection wells, the 9 newly installed groundwater monitoring wells, the 3 newly installed contingency monitoring wells and existing wells MS-46S, 27S, and MS-47S for the parameters listed in Table 4.4 (EMR Work Plan) at 16, 20, and 24 months after oil injection upon receipt of authorization from CCI. **NOTE: This is an option item and will be executed only if required.**

All analyses shall be requested for a 7-calendar day turnaround time basis. The results of the analyses shall be forwarded to CCI within one day following receipt of the analytical results. Analytical results shall also be provided to CCI electronically in accordance with the specifications in Appendix C.

6.5.2.1 Measurement and Payment

Payment for process monitoring system testing of 3 injection wells, 9 monitoring wells, 3 contingency wells, and wells MS-46S, 27S, and 47S will be lumpsum for each sampling event. The lump sum price shall include full compensation for sampling, handling and storage, shipment, and analyses for each matrix (soil/sediment and water). Cost shall include all required QA/QC sampling and analyses. Payment for this item will not be made until all associated QA/QC sampling has been completed and the required sample and QA/QC data have been submitted to and accepted by CCI.

6.6 Waste Management, Transportation, and Disposal

All generated wastes (soil from drilling, groundwater removed from monitoring and injection wells during development or purging, small quantities of solvent contaminated vegetable oil, water and solvents used for decontamination, and some personal protective equipment) shall be containerized (in approved containers in accordance with 49 CFR 178) and transported to CCI-designated temporary staging areas. All containers, holding tanks, and roll-off boxes must be in good condition with no leaks or damages. The temporary staging area shall be bermed and lined with a polyethylene liner. Containers of solid and liquid wastes shall be neatly arranged and stored in a secured onsite temporary staging area. Adequate aisle space shall be provided between containers to allow the unobstructed movement of personnel and equipment. Containers shall remain closed unless adding or removing material. Covers shall be properly secured at the end of each workday. Hazardous waste storage areas shall contain emergency equipment equivalent to hazard posed by waste. Typical items in a hazardous waste storage area include: fire extinguisher, spill control kits, decontamination equipment, and an alarm system (if radio equipment is not available to all staff working in storage area).

Subcontractor shall be responsible for maintenance of the containment/storage area, including replacement of any worn or damaged containment materials. Daily inspections of the containment/storage area shall be performed and documented to verify there are no ruptures to containers or other conditions that could result in a release, to make sure all containers are properly labeled, with labels visible, and to maintain good housekeeping.

Portable storage tanks for liquids shall be provided with covers and secondary containment. Old labels shall be removed. Any tank arriving onsite with contents shall be rejected. Free liquids that have accumulated in the secondary containment shall be pumped (or otherwise removed) and combined with tank contents.

The labeling of waste containers, tanks, and roll-off boxes shall be in accordance with 49 CFR 172, 173 and 178 (and 40 CFR 262 for hazardous wastes).

Drums shall be transported to the temporary staging areas on wood pallets and shall be secured together with non-metallic bonding.

All generated wastes shall be handled, stored, transported, and disposed of in accordance with all applicable federal, state and local regulations. All generated wastes shall be disposed of

within 60 days of the accumulation start date. All personnel handling hazardous waste shall be trained in accordance with 49 CFR 172.704, 29 CFR 1910.120, and 40 CFR 262. All personnel responsible for hazardous waste labeling, inspecting, profiling and manifesting shall be trained in accordance with 29 CFR 1910.120 and 49 CFR 172 as amended by HM-181 and HM-126. All vehicles carrying hazardous waste shall be placarded in accordance with 49 CFR 172. All vehicles shall be adequately protected to prevent leakage or spillage during shipment.

Subcontractor shall coordinate with the on-site Navy O&M Contractor to schedule discharge of all generated water to the NIROP Ground Water Treatment Facility (GWTF).

6.6.1 Management of Soil

All soil generated during well installation shall be stored in lined rolloff containers or 55-gallon drums for characterization and disposal. Generated soil shall be sampled and analyzed as specified in Table 4-5 for disposal characterization. To the extent possible, samples shall be collected using disposable sampling equipment. If required, decontamination of field sampling equipment shall be performed in accordance with Section 6.3.2.1.

Soil characterization samples shall be collected from the material contained in rolloffs or 55-gallon drums. One composite sample shall be collected per roll-off or one per 4 drums or as required by the disposal facility. The samples shall be collected as follows:

1. Choose four points in the rolloff (or four drums, if stored in drums) and place a marker (flag or stake) at each point.
2. At each of the four points (or from each of the four drums, if stored in drums), collect grab samples by performing the following steps:
   2.1. Remove the top 12 inches of the soil using a stainless steel auger
   2.2. Auger down another 6 inches, remove the sampler, and place the sample in a stainless steel bowl.
3. Homogenize the four grab samples by quartering techniques using a stainless steel spoon.
4. Fill the appropriate sample jars with the homogenized sample
5. Close the jars, label, and package the sample for shipment to the laboratory.

NOTE: Samples for volatile organic compounds (VOCs) analysis shall not be composited and homogenized. They shall be collected as discrete grab samples from the locations indicating highest field screening test results.

All analyses shall be requested for a 7-calendar day turnaround time basis. The results of the analyses shall be forwarded to CCI within one day following receipt of the analytical results. Analytical results shall also be provided to CCI electronically in accordance with the specifications in Appendix C.

Based on analytical results the soil shall be disposed of offsite as hazardous waste (non-Toxic Substances Control Act (non-TSCA)) or non-hazardous special waste. Off site treatment or disposal facilities shall use the waste profile and supporting documentation (e.g., analytical data) to determine if they shall accept a waste. Hazardous wastes shall be sent to the appropriate RCRA Subtitle C treatment, storage, or disposal facility. Non-hazardous wastes shall be sent to Subtitle D facilities or municipal landfills, as appropriate. The treatment or disposal facility shall be responsible for providing a copy of the final waste manifest and for providing a certificate of destruction or disposal for each load of waste received.

6.6.1.1 Measurement and Payment

This unit price for management of soil shall include full compensation to store, characterize, transport and dispose of all generated soil in accordance with all-applicable rules and regulations. This shall include all labor, equipment, containers, lower-tier Subcontractors, loading and transporting wastes using properly licensed waste hauling vehicles, and offsite disposal at CCI approved disposal facilities. Measurement will be made in pounds by quantities listed on manifests, verified by weight tickets from certified scales, and approved by the receiving facility. Payment will not be made until final signed manifests are received by CCI.

6.6.2 Management of Generated Water

All water generated from this work shall be stored in portable holding tanks or 55-gallon drums. Purge water that is visibly contaminated with vegetable oil shall be containerized separately and characterized prior to disposal off site to an approved waste disposal facility as hazardous (non-TSCA) or non-hazardous special waste based on analytical results. Water free of vegetable oil shall be discharged at the NIROP GWTF for treatment and disposal.

Purge water containing free vegetable oil shall be sampled and analyzed as specified in Table 4-5 for disposal characterization. To the extent possible, samples shall be collected using disposable sampling equipment. If required, decontamination of field sampling equipment shall be performed in accordance with Section 6.3.2.1. Disposal characterization samples shall be collected from the portable holding tanks or drums using either a dip jar or bailer. The sample containers for volatiles analyses shall be filled first. The 40-ml vials shall be filled so that there is no headspace in each vial. The sample containers for the remaining analyses shall then be filled.

All analyses shall be requested for a 7-calendar day turnaround time basis. The results of the analyses shall be forwarded to CCI within one day following receipt of the analytical results. Analytical results shall also be provided to CCI electronically in accordance with the specifications in Appendix C.

6.6.2.1 Measurement and Payment

This unit price for management of water shall include full compensation to store, characterize, transport and dispose of all generated decontamination water in accordance with all-applicable rules and regulations. This shall include all labor, equipment, containers, lower-tier Subcontractors, loading and transporting wastes using properly licensed waste hauling vehicles, and disposal onsite via NIROP GWTF or off-site at CCI approved recycling/disposal facilities. Measurement will be made in gallons by quantities measured in the flow meter for on-site discharge or as listed on manifests and approved by the receiving facility for off-site disposal. Payment will not be made until final signed manifests are received by CCI for off-site disposal.

6.6.3 Management of Office Wastes, Construction Debris, and Personal Protective Equipment

All miscellaneous office waste and general construction debris (such as caution tapes, barricades, signs, and packing materials) shall be containerized in accordance with all applicable rules and regulations until it is disposed of offsite. No waste material and/or debris shall be buried or otherwise allowed to remain on the site.

Office wastes and general construction debris without any contamination is classified as non-hazardous construction debris and shall be disposed at a landfill permitted to accept such wastes.

Used personal protective equipment (PPE) includes disposable Tyvek® suits, gloves, booties, and plastic sheeting. Contaminated PPE shall be placed in a plastic-lined 55-gallon drum immediately after use, the drum shall be labeled to identify its contents and source of generation, and characterized using process knowledge. Contaminated PPE shall be disposed as non-hazardous or hazardous waste, depending on characterization. Used uncontaminated PPE shall be disposed of as non-hazardous wastes at a Subtitle D facility or municipal landfill, as appropriate.

6.6.3.1 Measurement and Payment

Payment for this activity shall be lump sum to include full compensation to complete required the required storage, transportation, and disposal of all miscellaneous wastes indicated above.

6.7 Transportation and Disposal

Subcontractor shall identify transportation and disposal facilities. Upon award of Subcontract, Subcontractor must provide all information identified in Appendix E6 for those facilities identified in the initial bid at the time of submittal of pre-work submittals (see Section 2.0). This information shall be provided to CCI for their approval of the facilities.

6.7.1 Transportation

Each transportation vehicle and load of waste shall be inspected before leaving the site. The quantities of waste leaving the site shall be recorded. Transportation of non-hazardous wastes shall be completed by a transporter licensed for commercial transportation. In the event that wastes are hazardous, the transporter shall be licensed in accordance with 49 CFR 171-179. A copy of the documentation indicating that the selected transporter has appropriate licenses shall be received prior to transport of any waste material.

The transporter shall be responsible for weighing loads at a Department of Transportation certified scale. For each load of material, weight measurements shall be obtained for each full and empty container or dump truck. Disposal quantities shall be based on the difference of weight measurements between the full and empty container or dump truck. Tanker trucks, drums of liquids, and temporary storage tank volumes shall be measured on site. Weights and volumes shall be recorded on the waste manifest. Copies of weight tickets shall be provided with the final manifest.

The following procedures also shall be observed when transporting wastes off site:

- Minimize impacts to general public traffic
- Repair road damage caused by construction and/or hauling traffic
- Clean-up material spilled in transit
- Line and cover trucks/trailers used for hauling contaminated materials to prevent releases and contamination
- Decontaminate vehicles prior to re-use, other than hauling contaminated material
- All personnel involved in off site disposal activities shall follow safety and spill response procedures outlined in the SSHP
- No materials from other projects shall be combined with materials from NIROP Fridley
- Seal trucks transporting liquids

6.7.2 Manifests/Shipping Documentation

Each load of waste material shall be manifested prior to leaving the site. At a minimum, the manifest shall include the following information:

- Transporter information including name, address, contact and phone number
- Generator information including name, address, contact, and phone number
- Destination site name including street/mailing address
- Description of waste (e.g. petroleum contaminated waste)
- Appropriate waste codes (if applicable)
- Type of container
- Quantity of waste (volumetric estimate)
- LDR Notification/Certification (if applicable)

A carbon copy of the initial manifest form for each load shall be retained on site and attached to the Daily Production Report.

If the signed hazardous waste manifest from the designated offsite facility is not received within 35 days, the transporter or the designated facility shall be contacted to determine the status of the waste. If the signed hazardous waste manifest has not been received within 45 days, an "Exception Report" shall be prepared for the Navy and the Navy will submit it to the State of Minnesota, as required under 40 CFR 262.42.

6.7.3 Waste Disposal Log

A log of all generated wastes shall be maintained at the site. At a minimum, the log shall include the type of waste, source of waste, quantity of waste, waste accumulation start date, sampling data, and disposal information.

6.7.4 Disposal of Waste Streams

Off site treatment or disposal facilities shall use the waste profile and supporting documentation (e.g., analytical data) to determine if they will accept a waste. Hazardous wastes shall be sent to the appropriate RCRA Subtitle C treatment, storage, or disposal facility. Non-hazardous wastes shall be sent to Subtitle D facilities or municipal landfills, as appropriate. The treatment or disposal facility shall be responsible for providing a copy of the final waste manifest and for providing a certificate of treatment or disposal for each load of waste received.

Consistent with the CERCLA Offsite Policy (58 FR 49200, September 22, 1993), wastes shall be transported to and treated or disposed at an offsite facility determined acceptable by the EPA Regional Off-Site Contact. According to 40 CFR 300.400(b), the Regional Contact determines that the facility has no significant violations, and has no releases of hazardous substances (for RCRA Subtitle C facilities).

6.7.5 Records/Reporting

The following records and documents shall be maintained:

- Transportation and offsite disposal records, including:
  - Profiles and associated characterization data
  - Manifests, Land Disposal Restriction notifications/certifications, bills of lading, and other shipping records
  - Offsite facility waste receipts
- Training records
- Inspection records

Additionally, Material Data Safety Sheets (MSDSs) for al chemicals brought onsite shall be maintained at the site.

6.8 Site Restoration and Demobilization

Seeding/Mulching:
Areas to be seeded/mulched shall be prepared by placing six inches of topsoil to match existing grades and slopes. The topsoil for this work shall be uniform in quality and gradation, and shall be free of roots, sod, weeds, and stones larger than 2 inches.

After topsoil placement has been completed, areas to be seeded/mulched shall be raked or otherwise cleared of stones larger than 2 inches in any diameter, sticks, stumps, and other debris which might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of seeding/mulching, Subcontractor shall repair such damage. This may include filling gullies, smoothing irregularities, and repairing other incidental damage.

Native grass seed shall be applied at a rate sufficient to establish growth and the area shall be mulched and watered till growth is established.

Final Restoration of Areas
Upon completion of the work at each location, all field equipment, temporary facilities, and other miscellaneous items (e.g., barricades, caution tapes and signs) resulting from or used in the field operations shall be removed. All lockout/tagout equipment on utilities shall be removed.

Final Decontamination:
Personnel and equipment shall be decontaminated prior to leaving the area to avoid the possibility of inadvertently spreading contamination. Equipment shall be properly decontaminated to remove all contamination that may be adhering to the equipment components as a result of the remedial action. Decontamination of personnel and equipment shall be performed in accordance with the Site Health and Safety Plan and the applicable provisions of 29 CFR 1910.120.

The Subcontractor, solely at the Subcontractor's expense, shall restore any cross-contamination of Navy property or public thoroughfare. All office wastes and general construction debris generated by Subcontractor's demobilization activities shall be properly disposed of offsite.

Demobilization:
Following approval from CCI, all personnel, equipment, temporary facilities and utilities shall be demobilized from the site.

6.8.1 Measurement and Payment

Payment for this activity shall be lump sum to include full compensation to complete required site restoration and demobilization.

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1.1 Location of Vegetable Oil Injection Pilot Test

2.1 Cross-Section A-A'

2.2 Potentiometric Surface Map of Pumping Conditions

2.3 Potentiometric Surface Map of Non-Pumping Conditions

2.4 Trichloroethene (TCE) Concentrations

4.1 Vegetable Oil Injection Pilot Test System Layout

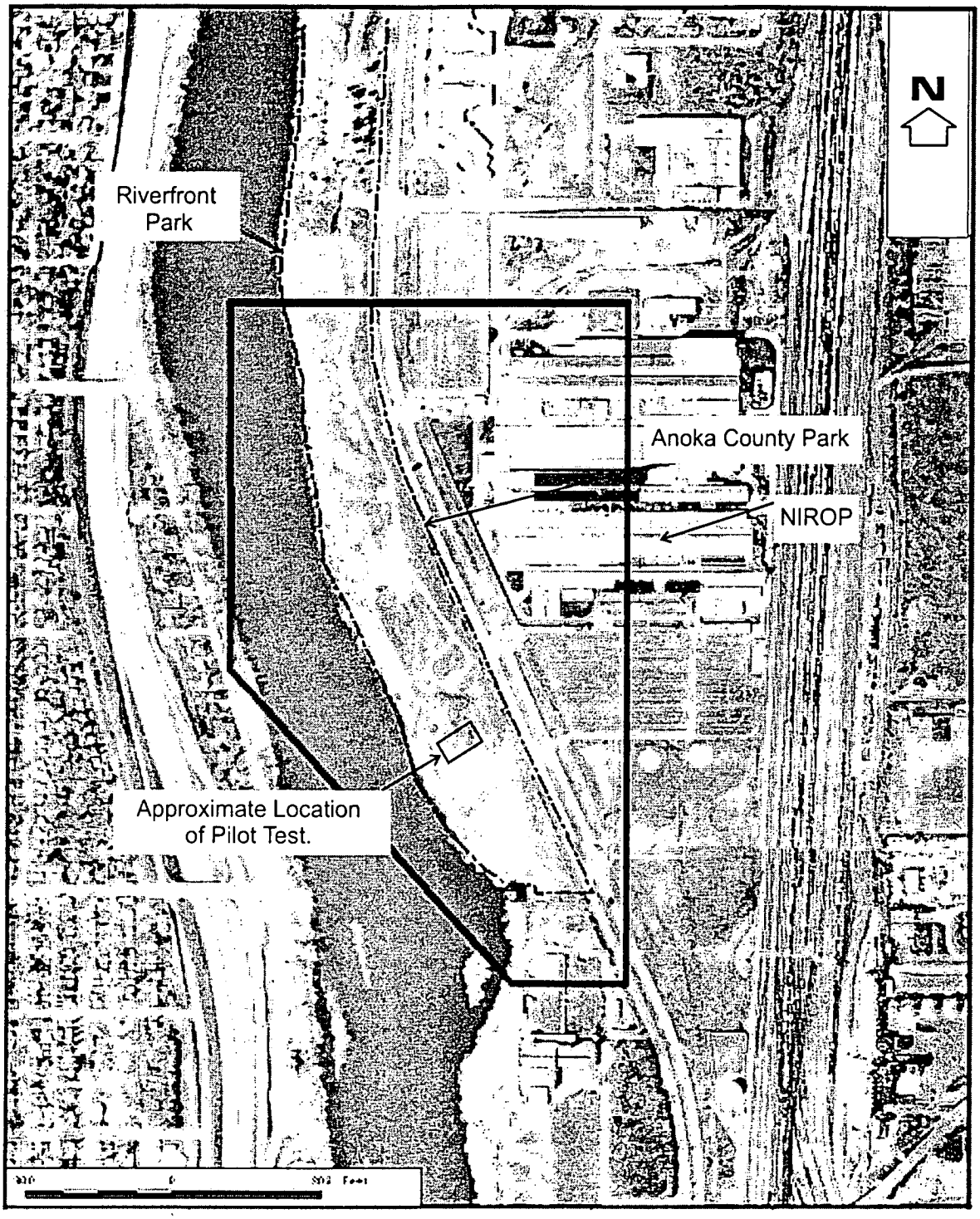

FIGURE 1.1

LOCATION OF VEGETABLE OIL INJECTION PILOT TEST

Vegetable Oil Injection Pilot-Scale Study
NIROP Fridley, Minnesota

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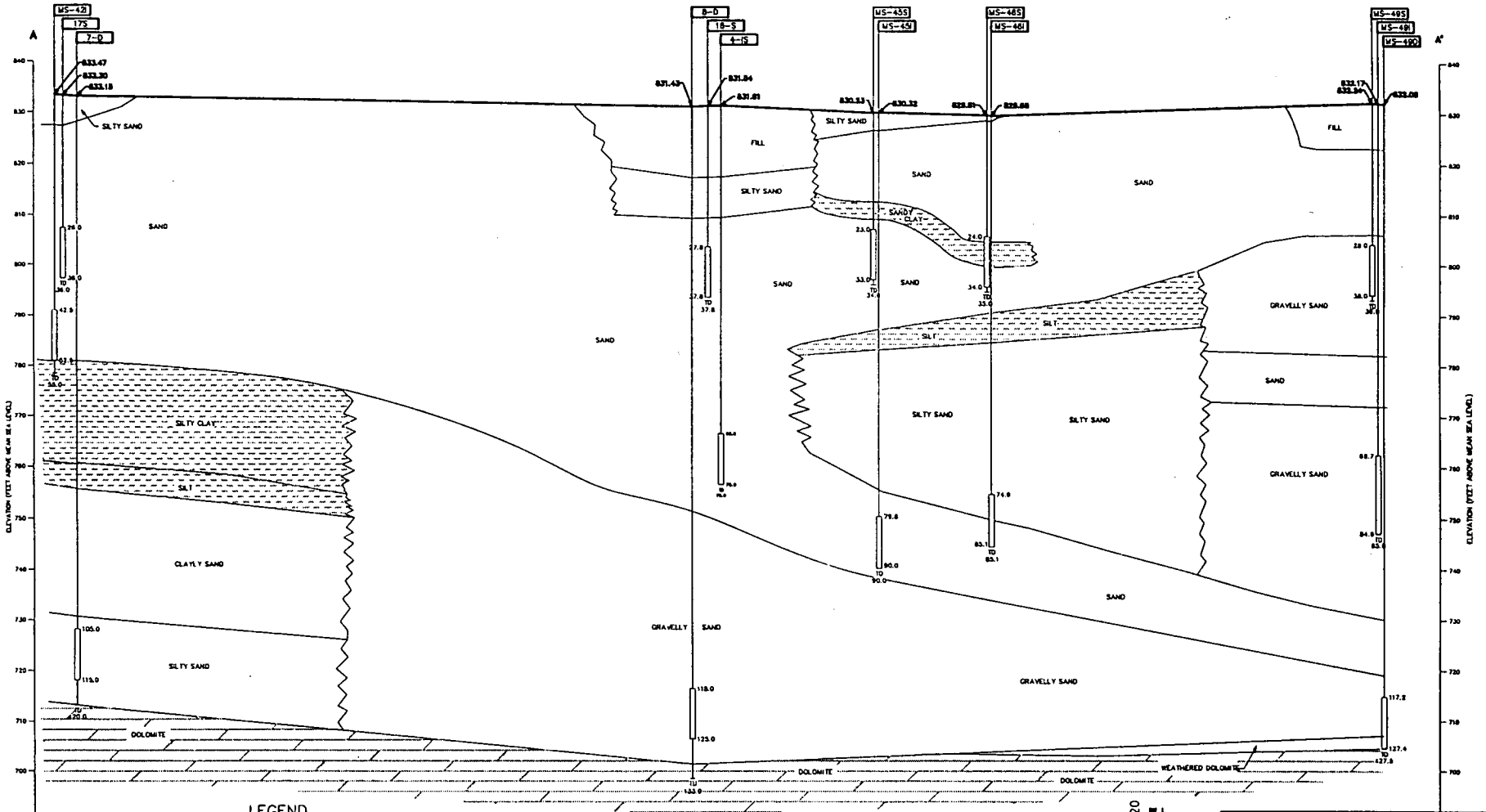

LEGEND

BORING OR WELL NUMBER — MS-421

GROUND SURFACE ELEVATION (ft.) — 833.47 — APPROXIMATE GROUND SURFACE

TOP OF MONITORED INTERVAL (ft bgs) — 42.5

BOTTOM OF MONITORED INTERVAL (ft bgs) — 52.5

LITHOLOGIC CONTACT

TOTAL DEPTH OF BORING OR WELL (ft bgs) — TD 55.0

NOTE: ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (FT AMSL)

UNCONSOLIDATED MATERIAL

CLAY, SILTY CLAY, SANDY CLAY, SILT, CLAYEY SILT AND SANDY SILT AS SHOWN ON THE CROSS-SECTION (UNCOLSOLIDATED MATERIAL HAVING A LOWER PERMEABILITY)

SAND, CLAYEY SAND, SILTY SAND, GRAVELY SAND, GRAVEL AND SANDY GRAVEL AS SHOWN ON CROSS-SECTION (UNCONSOLIDATED MATERIAL HAVING A HIGH PERMEABILITY)

BEDROCK

DOLOMITE BEDROCK (PRAIRIE DU CHIEN GROUP)

NOTES:

1. LITHOLOGY SHOWN BETWEEN BORINGS WAS INTERPOLATED BASED ON THE BORING LOGS.
2. SAND SHOWN IN CROSS-SECTION RANGES FROM FINE TO COARSE SAND.

VERTICAL SCALE IN FEET: 0, 10, 20

HORIZONTAL SCALE IN FEET: 120, 60, 0

FIGURE 2.1

CROSS-SECTION A-A'

Workplan for Vegetable Oil Pilot-Scale Study
NIROP Fridley, Minnesota

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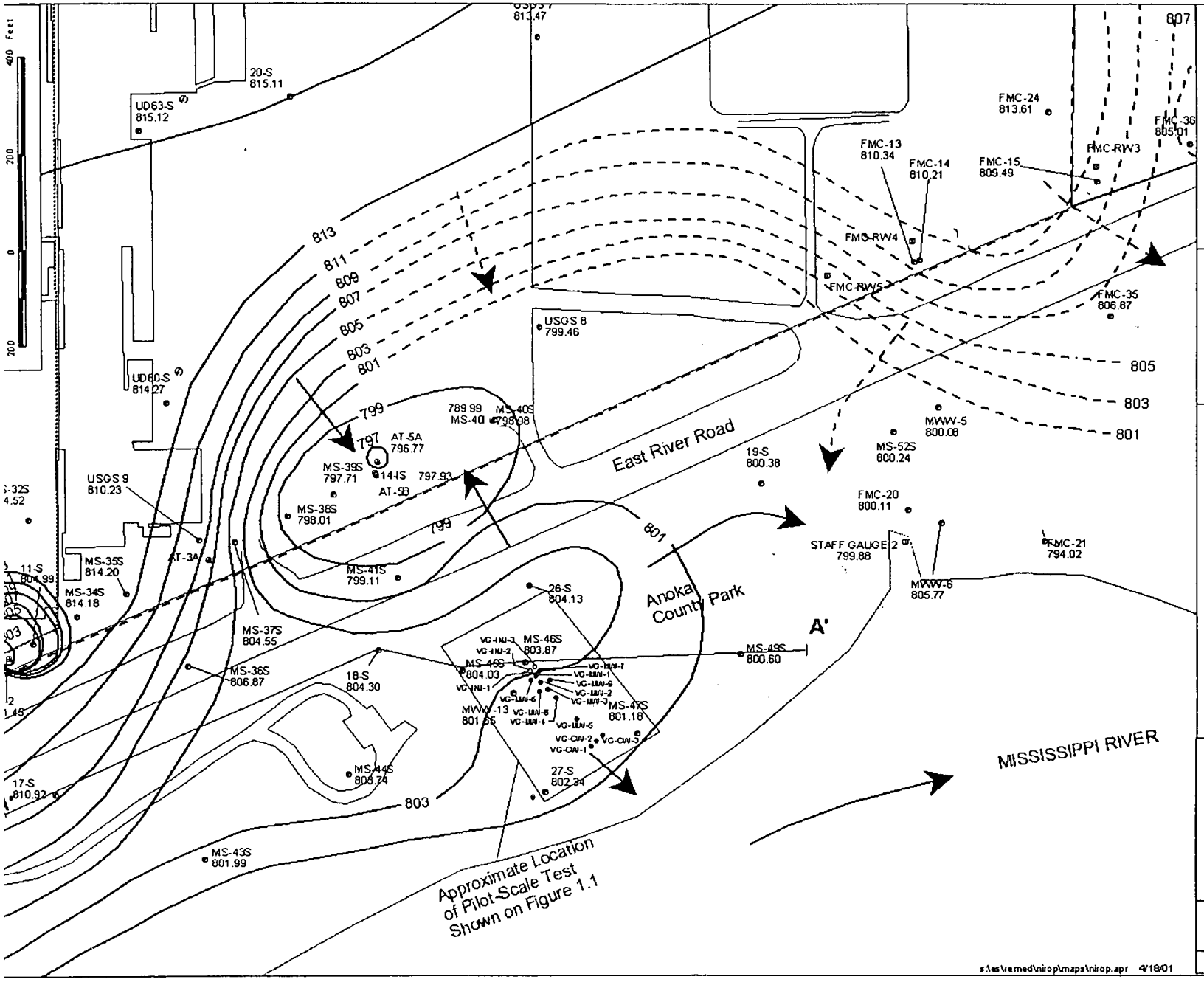
parsons engineering science, inc.
Denver, Colorado

From: Tetra Tech NUS (2001)



LEGEND

Existing Wells:
Shallow Monitoring Wells
MS-47S (NIROP)
26-S (NIROP)
FMC-20 (UDLP)
USGS 5 (USGS)
MWW-5 (USGS)

Extraction Wells
AT-3A (NIROP)

Recovery Well
RW-1 (UDLP)

Staff Gauge

Proposed Wells:
VG-INJ-1 Vegetable Injection Well
VG-MW-1 Groundwater Monitoring Well
VG-CW-1 Contingency Monitoring Well
A—A' Cross-Section Location

N

815 — Shallow Potentiometric Surface Contour (11/30/99) (Feet Above Mean Sea Level) (Dashed Where Inferred)

Groundwater Flow Direction (dashed where inferred)

MS-49S 800.60 Monitoring Well Potentiometric Surface (Feet Above Mean Sea Level)

Note:
(1)
--12-S water level measured on 3/21/00; Not measured on 11/30/99. Refer to text for water level correlation.
--MWW-6, FMC-21, FMC-24 and 13-S was not used in contouring. Groundwater elevation is suspect.
(2)
UD60-S, UD62-S, and UD63-S water levels measurd on 2/3/00; Not measured on 11/30/99. Refer to Tetra Tech (2001) for water level correlation.

Modified From: Tetra Tech NUS (2001)

FIGURE 2.2

POTENTIOMETRIC SURFACE MAP OF PUMPING CONDITIONS

Work Plan for Vegetable Oil Pilot-Scale Study
NIROP Fridley, Minnesota

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Denver, Colorado

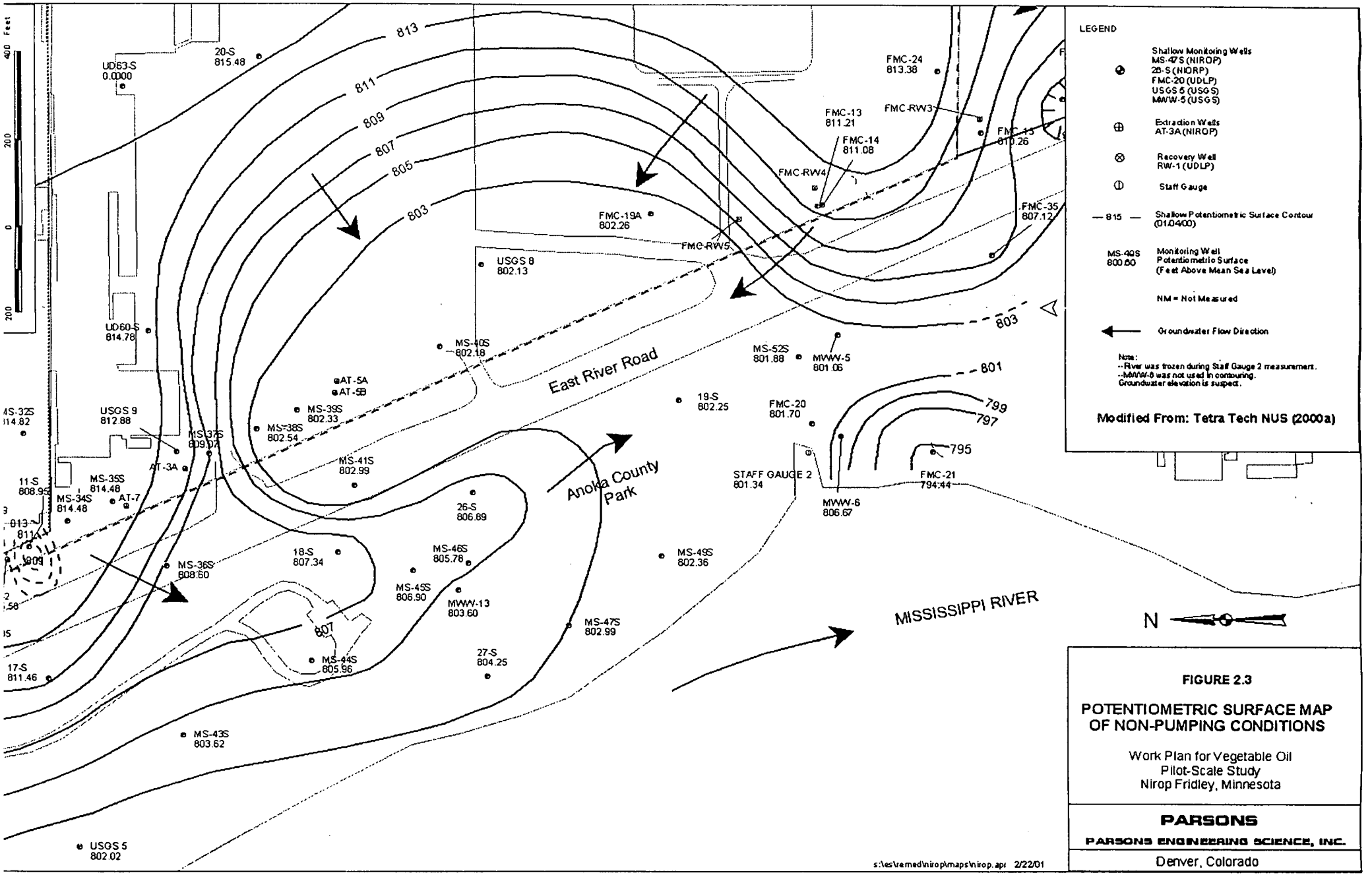

FIGURE 2.3

POTENTIOMETRIC SURFACE MAP OF NON-PUMPING CONDITIONS

Work Plan for Vegetable Oil
Pilot-Scale Study
Nirop Fridley, Minnesota

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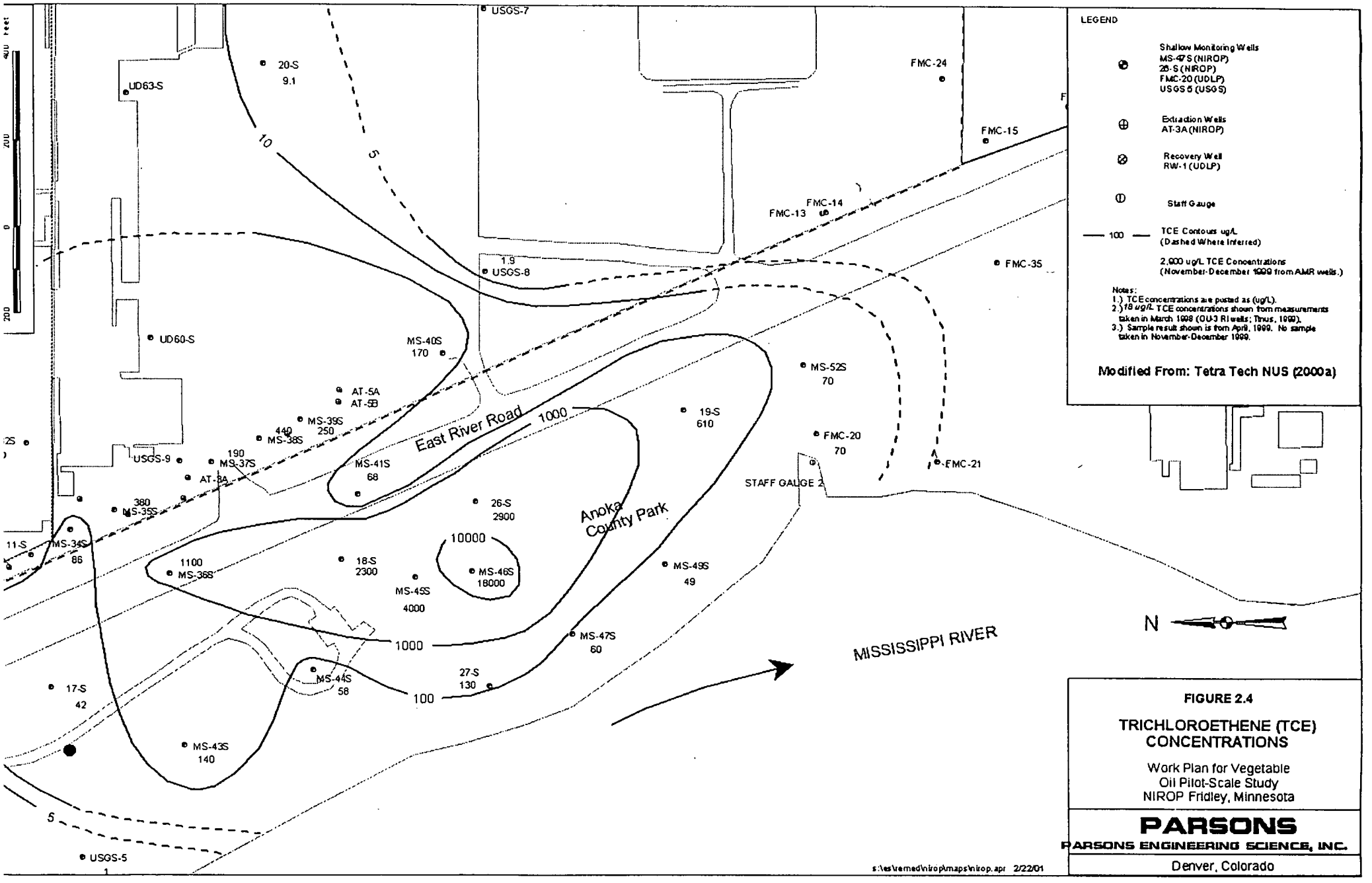

FIGURE 2.4

TRICHLOROETHENE (TCE) CONCENTRATIONS

Work Plan for Vegetable Oil Pilot-Scale Study
NIROP Fridley, Minnesota

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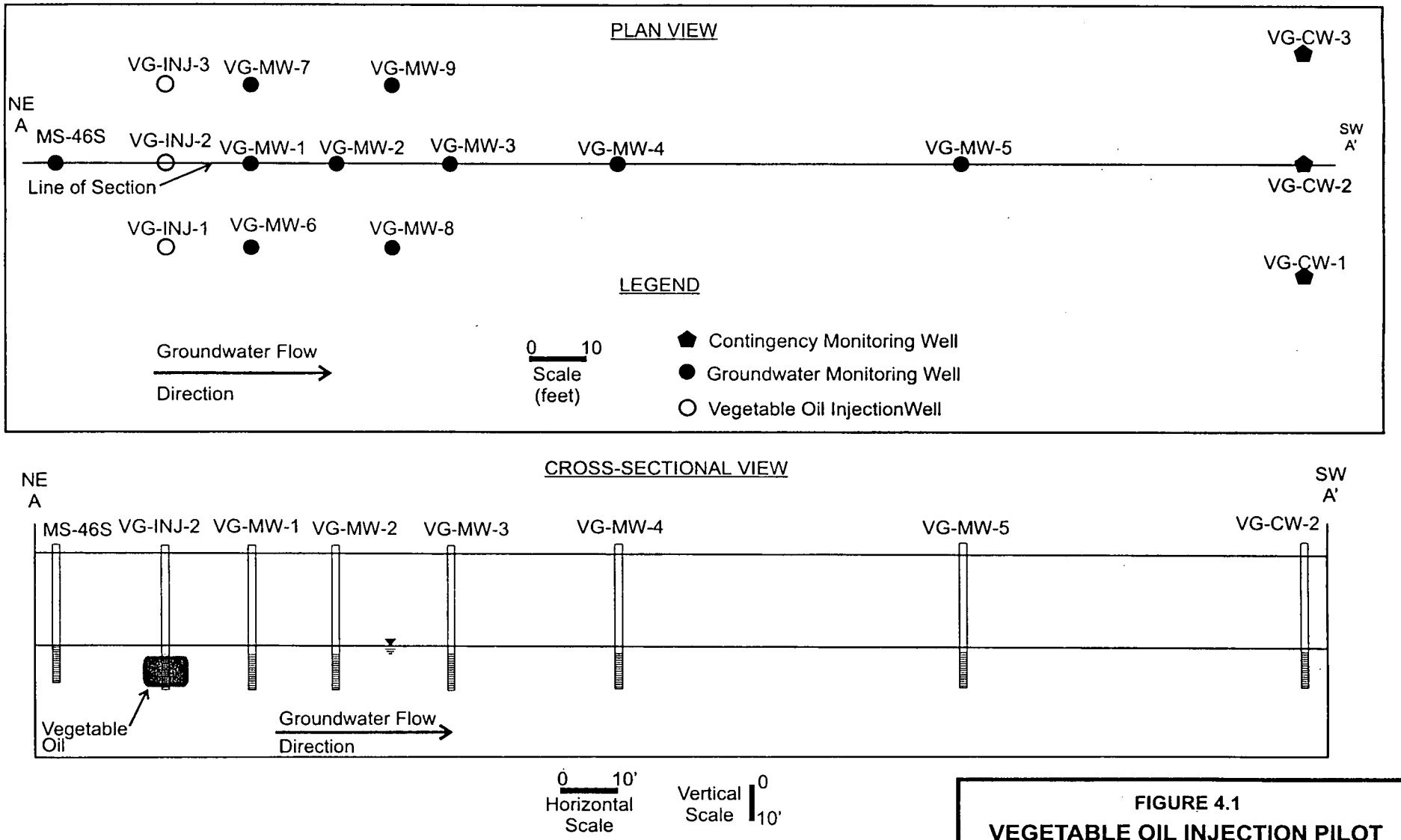

FIGURE 4.1

VEGETABLE OIL INJECTION PILOT TEST SYSTEM LAYOUT

Vegetable Oil Injection Pilot-Scale Study
NIROP Fridley, Minnesota

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APPENDIX E

EMR STANDARD OPERATING PROCEDURES

EMR STANDARD OPERATING PROCEDURES (SOP) INDEX

SOP 1: Soil Classification

SOP 2: Soil Sampling

SOP 3: Aquifer Characteristic Testing

SOP 4: Groundwater Sampling

SOP 5: Oil Injection and SPCC Plan

SOP 6: Decontamination and Investigation Derived Waste Handling, Storage, and Treatment

SOP 7: Hydrogen Sampling Procedure in Groundwater

EMR SOP 1: SOIL CLASSIFICATION

This Standard Operating Procedure (SOP) outlines the order of descriptive terms and parameters to be described in soil classification.

1.0 FIELD CLASSIFICATION OF SOILS

Soils will be classified in the following order for fine-grained soils: consistency, Munsell color (color name), structure, grain size, soil structure, soil classification name, moisture, and comments. Course-grained soils shall be described in the following order: relative density, color, structure, particle size angularity, group name, and moisture.

1.1 CONSISTENCY/DENSITY

For intact fine-grained soil, describe consistency as very soft, soft, medium stiff, stiff, very stiff or hard, based on blow counts per foot. For coarse-grained soils, describe density based on blows per foot (if available) as very loose, loose, medium dense, dense, and very dense.

1.2 CONSISTENCY/DENSITY BASED ON BLOW COUNTS

Term	1.4"ID	2.0"ID	2.5"ID	Term	1.4"D	2.0"D	2.5"D
Very Soft	0-2	0-2	0-2	Very Loose	0-4	0-5	0-7
Soft	2-4	2-4	2-4	Loose	4-10	5-12	7-18
Medium Stiff	4-8	4-9	4-9	Medium Dense	10-29	12-37	18-51
Stiff	8-15	9-17	9-18	Dense	29-47	37-60	51-86
Very Stiff	15-30	17-39	18-42	Very Dense	>47	>60	>86
Hard	30-60	39-78	42-85				
Very Hard	>60	>78	<85				

NOTE: 140 lb. hammer dropped 30 inches

If blow counts are not available, perform the field test described in the following table to determine consistency:

1.3 CRITERIA FOR DESCRIBING CONSISTENCY

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

2.0 COLOR

Use the Munsell Soil Color Chart. List in soil classification by Munsell designation and assigned color name in parentheses. Example: 10 YR 6/1 (gray).

3.0 SOIL STRUCTURE DESCRIPTIONS

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least six millimeters thick. Thickness should be recorded.
Laminated	Alternating layers of varying materials or color with layers less than six millimeters thick. Thickness should be recorded.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, e.g., small lenses of sand scattered through a mass of clay. Thickness should be recorded.
Homogeneous	Uniform color and/or appearance throughout.

4.0 GRAIN SIZE DEFINITIONS

Description	Criteria
Boulders	Particles of rock that will not pass a 12" square opening.
Cobbles	Particles of rock that will pass a 12" square opening & retained on a 3" sieve.
Gravel	Particles of rock that will pass a 3" sieve & retained on a No. 4 sieve with the following subdivisions: • Coarse Gravel: passes a 3" sieve & retained on a ¾" sieve • Fine Gravel: passes a ¾" sieve & retained on a No.4 sieve

Sand	Particles of rock that will pass a No. 4 sieve & retained on a No. 200 sieve with the following sub-divisions: • Coarse Sand: passes a No. 4 sieve & retained on a No. 10 sieve • Medium Sand: passes a No. 10 sieve & retained on a No. 40 sieve • Fine Sand: passes a No. 40 sieve & retained on a No. 200 sieve
Silt	Soil passing a No. 200 sieve that is non-plastic or very slightly plastic and that exhibits little or no strength when air-dried. Individual silt particles are not visible to the naked eye.
Clay	Soil passing a No. 200 sieve that can be made to exhibit plasticity within a range of water contents and that exhibits considerable strength when air-dried. Individual clay particles are not visible to the naked eye.

5.0 SOIL CLASSIFICATION NAME

Well Graded Gravel or Sand: If it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

Poorly Graded Gravel or Sand: If it consists predominantly of one-grain size (uniformly graded) or has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded)

Silty or Clayey Gravel or Sand: If the percentage of fines is estimated to be 15% or more.

"With Sand" or "With Gravel": If the soil is estimated to have 15% to 25% sand or gravel, or both, the words "with sand" or "with gravel" (whichever is predominant) shall be added to the group name. Example: "lean clay with sand (CL)".

"Sandy" or "Gravelly": If the soil is estimated to have more than 30% or more sand or gravel, or both, the words "sandy" or "gravelly" will be added to the group name. Example: "sandy silt (ML)"

Lean Clay (CL): Soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity.

Fat Clay (CH): Soil has high to very high dry strength, no dilatancy, and high toughness and plasticity.

Silt (ML): The soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity or is non-plastic.

Elastic Silt (MH): The soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity; will air dry more quickly than lean clay and have a smooth, silky feel when dry.

Organic Soil (OL or OH): The soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, from black to brown, when exposed to the air. Organic soils normally will not have a high toughness or plasticity.

6.0 MOISTURE

Describe the moisture condition of the soils as dry (absence of moisture, dusty, dry to the touch), moist (damp but no visible water), or wet (visible free water, saturated).

7.0 COMMENTS

ODOR

Due to health and safety concerns, NEVER intentionally smell the soil. This could result in exposure to volatile contaminants that may be present in the soil. If however, an odor is noticed, it should be described if organic or unusual.

PRODUCT OBSERVATION

The last comment of the visual description of soil should contain a description of any potential contaminant or anthropogenic material. Sites where petroleum hydrocarbons are investigated, note whether free product, hydrocarbon absorbed to soil or hydrocarbon odor was observed. Additionally, note whether the hydrocarbon is light (such as gasoline), medium (such as diesel) or heavy (such as waste oil).

CEMENTATION

Describe the cementation on intact coarse-grained soils as weak, moderate or strong, in accordance with the following criteria:

- Weak: Crumbles or breaks with handling or little finger pressure
- Moderate: Crumbles or breaks with considerable finger pressure
- Strong: Will not crumble or break with finger pressure

ANGULARITY

Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, sub-angular, sub-rounded or rounded in accordance with the following criteria:

- Angular: particles have sharp edges and relatively planar sides with unpolished surfaces.
- Sub-angular: particles are similar to angular description but have rounded edges.

- Sub-rounded: particles have nearly plane sides but have well-rounded corners and edges.
- Rounded: particles have smoothly curved sides and no edges.

8.0 PHYSICAL CHARACTERISTICS

8.1 CRITERIA FOR DESCRIBING DRY STRENGTH

Description	Criteria
None	The dry soil crumbles into powder with mere pressure of handling.
Low	The dry soil crumbles into powder with some finger pressure.
Medium	The dry soil breaks into pieces or crumbles with considerable finger pressure.
High	The dry soil cannot be broken with finger pressure. Soil will break into pieces between thumb and a hard surface.
Very High	The dry soil cannot be broken between the thumb and a hard surface

8.2 CRITERIA FOR DESCRIBING TOUGHNESS

Description	Criteria
Low	Only slight pressure is required to roll the soil into a thread (1/8" in diameter) near the plastic limit. The thread and the lump (after the thread crumbles, lump soils together until the lump crumbles) are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

8.3 CRITERIA FOR DESCRIBING PLASTICITY

Description	Criteria
Non-plastic	A 1/8" (3-mm) thread (soil rolled into a thread 1/8" in diameter) cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump (after the thread crumbles, lump soils together until the lump crumbles) cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

EMR SOP 2: SOIL SAMPLING

This standard operating procedure (SOP) outlines procedures for field screening, sample collection and laboratory analysis of contaminated soils.

1.0 EQUIPMENT CALIBRATION

Calibrate the PID according to the following process:

STEP 1: Set-up the calibration assembly as follows: Connect tubing to the pressure regulator and the regulator to the calibration standard cylinder (100 ppm Isobutylene). Connect the tubing from the regulator to the detector inlet of the PID.

STEP 2: Power-up the instrument by connecting the power plug on the back of the meter and follow these procedures:

PRESS THIS	OBSERVE THIS
ON/OFF	Sampling Pump On
MODE/STORE	LOG THIS VALUE?
+/CRSR 4 Times	RESET TO CALIBRATE
RESET	RESTORE BACKUP
-/CRSR	ZERO GAS RESET WHEN READY (Note: Make sure you are in a clean area.)
RESET	ZEROING then SPAN PPM= (Note: Value following "Span PPM" must equal PPM of calibration gas.)
+/INC	SPAN GAS RESET WHEN READY
*Open flow regulator	
RESET	CALIBRATING
MODE/STORE	Current PPM of gas

Storage: The power plug should be disconnected while in storage. The PID should be kept charged at all times. The calibration cylinder should be kept in the carrying case and maintain enough pressure to ensure enough gas for future calibrations.

2.0 FIELD SCREENING PROCEDURES

STEP 1: Half-fill a self-sealing quart size polyethylene freezer bag so the volume ratio of soil to air is equal and seal immediately. Break up any soil clumps in the bag.

STEP 2: Allow headspace to develop for at least 10 minutes. When temperatures reach below 32 degrees F, place the soil sample in an area where it can be

kept at or above 40 degrees F. Shake the bag for 15 seconds at the beginning and end of headspace development. A headspace reading should be collected within 20 minutes of sample collection. Record ambient temperature during headspace analysis.

STEP 3: Introduce the sampling probe through a small hole in the bag to a point one-half of the headspace depth. Keep the probe free of water and soil particles.

STEP 4: Record the highest meter response on the *Headspace Analysis Log* (Attachment C2 – EMR QAPP) or a different appropriate form.

3.0 SOIL SAMPLING PROCEDURES

STEP 1: To minimize cross-contamination, use dedicated or properly decontaminated sampling equipment. Wear clean sampling gloves at each sampling point.

STEP 2: When sampling soils from the sidewalls or floor of an excavation or soil pile, remove at least one foot of exposed soil to ensure a fresh sample is collected.

STEP 3: Label all sample containers prior to filling with the information including: company name, project name, sampling point, sampling interval, analysis, time, date, preservative used and initials of the person collecting sample.

STEP 4: When sampling from a split spoon sampler, collect the sample immediately after opening the sampler, to minimize losses due to volatilization.

STEP 5: Soil samples will be collected from the interval nearest the vertical center of the well screen location. Collect soil samples directly into the appropriate sample containers. VOC sample containers should be packed full to minimize volatilization. DO NOT USE soils previously used for soil screening.

STEP 6: Place in a covered cooler filled with ice. Secure cooler lid and place in a secure area until shipment.

STEP 7: Fill out chain-of-custody and place in a self-sealing bag.

EMR SOP 3: AQUIFER CHARACTERISTIC TESTING

This Standard Operating Procedure (SOP) outlines the procedures for conducting both rising and falling head methods of aquifer characteristic (slug) testing. Slug testing can be used on either confined or unconfined aquifers with a transmissivity less than 7,000 square feet per day (ft^2/day).

Slug tests will consist of two tests; rising head and falling head methods, and will be conducted only after the test well has been fully developed. The methods are described below:

1.0 FALLING HEAD TEST

STEP 1: Unlock and open the test well a minimum of 24 hours prior to the test. Replace and lock the protective top.

STEP 2: Decontaminate all downhole equipment according to procedures outlined in SOP 6.

STEP 3: Measure water level to within 0.01 feet with an electronic water level indicator.

STEP 4: Lower the Hermit datalogger pressure transducer to near the bottom of the well and determine the depth to the top of the transducer. Turn datalogger on.

STEP 5: Quickly lower the slug into the water. Be careful not to disturb the pressure transducer with the slug.

STEP 6: Record data including: test start time; test end time; beginning/ending static water level; data file name; and transducer depth on the *slug test report form* during the test (Attachment C2 – EMR QAPP).

STEP 7: Terminate the test when the water level has fallen to with 80 to 90 percent of the beginning static water.

STEP 8: Leave all equipment in the test well.

2.0 RISING HEAD TEST

Following the completion of the falling head test the rising head test will be performed.

STEP 1: With the Hermit datalogger on and the transducer in place, quickly remove the slug from the well.

STEP 2: Record data including: test start time; test end time; beginning/ending static water level; data file name; and transducer depth on the *slug test report form* during the test (Attachment C2 – EMR QAPP).

STEP 3: Terminate the test when the water level has fallen to within 80 to 90 percent of the beginning static water.

STEP 4: Decontaminate all downhole equipment following the completion of the rising head test.

STEP 5: Download data files from the Hermit datalogger.

STEP 6: Submit data files to the Contractor at the end of each day.

EMR SOP 4: GROUNDWATER SAMPLING

This standard operating procedure (SOP) outlines procedures for groundwater sample collection.

1.0 PREPARATION

STEP 1: Calibrate all instruments to be used.

STEP 2: Decontaminate all required equipment (See SOP 6).

STEP 3: Always measure water levels from least contaminated to most contaminated monitoring well.

STEP 4: Open all monitoring wells and allow enough time to ensure water stabilization. Take PID readings when opening a well, note any readings in field notebook. This only needs to be done at a new site with unknown levels of contaminants or at wells whose VOC concentration in air exceed standards set by the health and safety plan.

STEP 5: Take static water level readings of all wells on site within 1 hour of each other, after water levels have stabilized. Measurements are taken on the north side of the well or where marked by the surveyor. Make sure reading is stable for a minimum of two minutes. Measure to the nearest 0.01 foot. Take a total well depth reading (unless this information is previously known). At a minimum, decontaminate water level indicator between wells or more frequently as needed. Record readings on the *Groundwater Collection Form* (Attachment C2 – EMR QAPP).

STEP 6: Complete purge calculation.

2.0 PURGING PROCEDURES (BLADDER PUMP)

STEP 1: Always proceed in order from least contaminated to most contaminated when purging and sampling monitoring wells. When unknown, sample wells in an upgradient sequence. Sample the farthest downgradient well first and work towards the contamination source.

STEP 2: A clean pair of nitrile gloves will be worn whenever hands will be in contact with groundwater or whenever in contact with potentially contaminated sampling equipment. Gloves will be changed before the collection of groundwater samples and in between monitoring wells.

STEP 3: Lower the bladder pump to within 2 feet from the bottom of the well and begin to purge water within the well. Secure the pump lifting cable to ensure that the pump maintains the proper depth.

STEP 4: Make all connections between the air compressor, bladder pump controller and bladder pump. Check for air leakage and correct if necessary. Adjust controller for a discharge of approximately 500 ml/minute.

STEP 5: Connect the bladder pump discharge line to the flow cell. Record well head parameters consisting of pH, temperature, specific conductance, dissolved oxygen (DO), turbidity and oxidation/reduction potential measurements from water discharged through the flow cell. In order to obtain stable DO readings, the DO probe will be positioned so as to minimize aeration and to ensure water flow around the probe tip. Continue to collect data for these parameters at 1 gallon intervals.

STEP 6: A minimum of 3 well volumes is required for purging. If water quality parameters do not stabilize within 3 well volumes, a minimum of 5 well volumes are required to be purged. If a well is evacuated to a dry state during purging, the well will be allowed to recharge, and the sample will be collected as soon as sufficient water is present in the well to obtain the necessary sample quantity.

Water quality parameters are stabile when:

- pH +/- 0.1 units
- temperature +/- 0.1 degrees Celsius
- specific conductance +/- 5%
- dissolved oxygen +/- 2%
- turbidity </= to 5 NTU (10 NTU is acceptable for trace metals or trace organics)

STEP 7: Record all data on the *Groundwater Sampling Form* (Attachment C2 – EMR QAPP).

3.0 LABORATORY SAMPLE COLLECTION

STEP 1: Label all bottles before sample collection using an indelible marker to include the following

- Facility Name:
- Sample Station identification
- Sample Type
- Sampling Date;
- Sampling Time;
- Preservatives Added;
- Sample Collector's Initials;
- Analysis Requested;
- Company Name.

STEP 2: The pump intake will remain at the bottom of the well unless otherwise directed by CCI. Fill bottles directly from the bladder pump's discharge hose in a way that minimizes turbulence and overfilling. Samples will be collected into the appropriate sample container.

Fill VOC bottles in such a way that no air bubbles remain in the 40 ml vial. Open preserved bottles just prior to filling to minimize preservative volatilization. When sampling for compounds that are highly volatile, fill bottles with a positive meniscus. Otherwise, fill the bottle until it is 95% full. If the bladder pump discharge cycle is not sufficient to fill a specific container, the container will be tightly sealed between bladder pump cycles.

NOTE: Keep open bottles containing preservative away from the mouth and eyes to avoid inhalation of vapors.

STEP 3: For samples that require filtering, connect filter to the sampling pump discharge line, force sample water through filter for a minimum of three purge cycles before collecting samples.

STEP 4: Collect samples according to the following order:

- major and minor ions
- nitrates
- cyanide
- trace metals
- chromium VI
- "miscellaneous" parameters
- volatile organics (VOCs, BETX, DRO, GRO)
- semi-volatile organics (PAH, PCB)
- dioxin and dibenzo furans
- coliform bacteria
- total organic carbon
- total phosphorus
- sulfide
- radium, gross alpha, and gross beta
- containers for on-site analyses

STEP 5: Collect a QA/QC samples as directed by Table 4.5 of the EMR Work Plan.

STEP 6: Place all samples on ice immediately after collection. Place cooler in a secure location until shipment.

STEP 7: Fill out the Chain-of-Custody (COC) form (provided by CCI). Include instruction for 7-day turnaround time on COC form. Forward all submitted COC forms to CCI personnel within 24 hours.

4.0 MOBILE LABORATORY ANALYSIS

Samples will be collected directly from the pump discharge tube into a sample container appropriate for the desired analysis. The samples will be collected in such a way that water will be directed down the inner walls of the sample bottle to minimize aeration of the sample. The sample collection and procedure for each of the analytes to be analyzed in the field is provided below:

Carbon dioxide
Carbon dioxide concentrations in ground water will be measured in the field by titrimetric analysis using Hach ® Method 8223 (0 to 250 mg/L as CO_2).

Alkalinity
Alkalinity of the ground water sample will be measured in the field by titrimetric analysis using Hach ® Method 8221 (0 to 5,000 mg/L as calcium carbonate).

Sulfate
Sulfate and sulfide concentrations will be measured by colorimetric analysis with a portable colorimeter (Hach ® DR/700). The groundwater samples will be prepared for analysis using Hach ® Methods 8051 (0 to 70.0 mg/L sulfate) and 8131 (0.60 mg/L sulfide).

Ferrous Iron
Iron concentrations will be measured in the field by colorimetric analysis with a portable colorimeter (Hach ® DR/700) after appropriate groundwater sample preparation using Hach ® Method 8146 for ferrous iron (0 to 3.0 mg/L).

Manganese
Manganese concentrations will be measured in the field using colorimetric analysis with a portable colorimeter (Hach ® DR/700) after appropriate groundwater sample preparation using Hach ® Method 8034 (0 to 20.0 mg/L).

Chloride
Chloride concentrations in ground water will be measured in the field by titrimetric analysis using HACH ® Method 8113 (0 to 20 mg/L as Cl^-).

Ammonia
Ammonia concentrations will be measured in the field by colorimetric analysis with a portable colorimeter (Hach ® DR/700) after appropriate groundwater sample preparation using Hach ® Method 8155 for ammonia.

Hydrogen Sulfide
Hydrogen Sulfide concentrations will be measured in the field by colorimetric analysis with a portable colorimeter (Hach ® DR/700) after appropriate groundwater sample preparation using Hach ® Method 8131 for hydrogen sulfide.

EMR SOP 5: OIL INJECTION AND SPCC PLAN

This standard operating procedure (SOP) outlines procedures for the injection of soybean oil into 3-inch diameter injection wells and spill prevention and control guidelines.

1.0 GROUNDWATER EXTRACTION

STEP 1: Place storage tanker(s) in a location central to both the extraction and injection wellheads.

STEP 2: Connect discharge outlet from extraction well pump to storage tanker(s) and initiate removal of groundwater.

STEP 3: Frequently monitor water level in each chamber of the storage tanker to ensure that overfilling will not occur.

STEP 4: Stop pumping as necessary to switch chambers in the storage tanker(s). Repeat as necessary until a total of 7,200 gallons of water has been removed from the extraction well.

2.0 SYSTEM SETUP

STEP 1: Locate oil storage tanker near water storage tanker(s) in a central position near the injection wellheads.

STEP 2: Position mixing and injection and emulsifier/water tanks in a central position between the oil and water storage tankers and the injection wellheads.

STEP 3: Place and secure a decontaminated mechanical packer into well at a depth equivalent to the bottom of the well.

STEP 4: Using 2-inch diameter hoses equipped with camcouplers, connect the mixing tank to the storage tankers. Connect the intake side of the trash pump to the mixing tank with a 2-inch diameter cam-coupler equipped hose. The outlet of the trash pump will be connected to a 2-inch diameter hose with sufficient length to reach the fill-all on both the mixing and injection tank. Connect the inlet for the diaphragm pump to the injection tank and the air compressor with appropriate hoses. Place an inline flow meter between the air diaphragm pump and the wellhead. Make connections (including the flow meter) between the discharge side of the diaphragm pump and the injection well head.

STEP 5: Fill the injection tank with water. Start air diaphragm pump to fill the system while bleeding air off from the wellhead connection. Secure the wellhead connection once all air has been removed from the system.

Check system components and connections for leakage and correct if necessary.

3.0 OIL INJECTION

STEP 1: Pump or gravity feed appropriate volumes of the lecithin/water and vegetable oil into the mixing tank. The final ratio should be 2 part emulsifier/water to 1 part vegetable oil.

STEP 2: Mix emulsifier/water and soybean oil thoroughly by recirculating the solution with the trash pump.

STEP 3: Shut off the trash pump. Move the end of the discharge hose from the mixing tank fill-all to the injection pump. Start the trash pump to transfer the solution to the injection tank.

STEP 4: Start air compressor and begin pumping solution into the injection well. Note the injection start time, beginning injection tank volume, and well head pressure readings. Periodically monitor air flow and well head pressure.

STEP 5: Repeat steps 1 and 2 during the injection process to prepare the next injection solution batch. When injection tank is empty repeat step 3 to refill the injection tank.

STEP 6: Repeat steps 1 through 5 until approximately 3,600 gallon of solution has been pumped into the injection well.

STEP 7: When injection is complete, pump 60 gallons of extraction water into the injection tank at a rate of 3 gpm.

STEP 8: Check for presence of oil within well with oil/water interface probe. Document oil (if applicable) and water levels on the *oil injection form* (Attachment C2 – EMR QAPP).

STEP 9: At the end of each day or in between injection wells bleed off pressure from wellhead by slowly loosening the cam-coupler at the well head connection. When pressure has reached atmospheric levels, remove the hose and connections from the wellhead and run hose contents back into injection tank. Place end of hose into the injection tank fill all.

STEP 10: Remove mechanical packer from well and properly decontaminate.

4.0 SPILL PREVENTION AND CONTROL PLAN

The purpose of this is to outline procedures to prevent the discharge of oil and petroleum into the environment, especially to surface water. This type of discharge is specifically prohibited by law if:

- It affects water quality.
- It causes a film, sheen, or discoloration of the water, itself.
- It causes a film, sheen, or discoloration upon the water surface.
- It causes a film, sheen, or discoloration upon the adjoining shorelines.
- It causes a sludge or emulsion to be deposited beneath the surface of the water.
- It causes a sludge or emulsion to be deposited upon adjoining shorelines.

In addition, this plan creates mechanisms for response to discharges. The aim is to minimize any impact to human health, the environment, and employee safety.

Spill Prevention

General. This section summarizes the potential causes of releases and associated in-place preventive controls. Spills and releases are most likely to result from equipment failure or operator error:

1. Operator error during loading/unloading or refueling operations. Potential errors include overfilling, not disconnecting lines prior to vehicle departure, drain valves being left open, or fill valves being left open allowing precipitation to enter and cause tank overflow. Specific procedures have been developed to minimize this potential in line with the requirements of the Department of Transportation. These include regular periodic inspections, locking valves when not in use, and on-the-job training in correct procedures. If secondary containment is provided, a release is unlikely; however, operators still need to be instructed in proper procedures to prevent releases from secondary containment.

2. Rupture of piping, pressure fittings, or tanks, or another form of equipment failure. To minimize the potential for a significant release from equipment failure, regular inspections and maintenance need to be performed, and noted problems are addressed in a timely manner by repair, replacement, or removal of equipment from service.

3. Puncture of tank/containers or associated piping by heavy equipment. Operators of equipment and vehicles need to be well trained in operating large equipment on the facility. If a vehicle is of a size that could endanger aboveground piping, the driver is orally warned if the visual deterrents (e.g., size, signage, flagging to protective paint color) are not deemed sufficient. Where necessary, additional barriers, such as protective walls or posts, will be provided. In the event of night traffic, sufficient lighting is provided to make tanks and piping visible.

4. Small drips, leaks, and spills from lines or valves. Release rates would be negligible and are not likely to produce significant quantities or to have significant environmental effects. However, to minimize the potential for a release, equipment is inspected regularly, repaired in a timely manner when a problem is discovered, and released material is promptly cleaned up. Additionally, spill kits will be available at all oil or petroleum storage areas, or where oil/petroleum is transferred from one vessel to another.

Spill Prevention Procedures

Security. To prevent a spill or release from being caused by accidental or unknowing entry or vandalism, several security measures have been taken as noted below:

1. Locking of direct outward flow valves in the closed position when non-operating or in standby.

2. Adequate lighting for the detection of spills by both facility personnel and the general public.

Tank Loading and Unloading

1. Be sure the tank trailer is accurately spotted, brakes are set and wheels are blocked.

2. The driver must remain with the vehicle during the entire loading or unloading period.

3. Read the level indicator or visually inspect the receiving tank to be sure that sufficient space is available to receive material being transferred.

4. Place catch pans in position under tank trailer connections as needed to catch any liquid that may leak during the transfer.

5. Remove the tank trailer unloading line closure carefully. If significant leakage occurs, contact your supervisor for instructions.

6. Be sure connections between dispensing and receiving tanks are secured before opening the valves for liquid transfer.

7. Start pump and check to be sure there is no leakage at any of the connections or anywhere along the transfer lines. If a leak is present, immediately stop the pump, shut the valves, and repair the leak.

8. After liquid has been transferred, stop pump, close all valves, disconnect loading or unloading line, replace closures on valve lines, inspect the lowermost drain and all outlets of vehicle for leakage and correct as necessary, and release tank truck.

Spill Response

General Initial Response Measures. The following actions will be the initial response to any spill or release at the facility. These steps do not provide the necessary actions for remediation of a major release but they do provide guidance to minimize potential damage from a release. The intent of this plan is to provide appropriate guidance for response to oil and/or petroleum spills.

For small spills, leaks, or drips, the remedial action may be as simple as removing the contaminated material (whether dirt, booms, or other adsorbents) and placing it in an approved container for subsequent treatment or disposal. These guidelines should be followed to the extent possible and practical for any spill.

1. Stop spillage at the source, if possible, by closing valves, turning off pumps, plugging leaks, turning drums leak side up, etc.

2. Build berms of earth or waste materials or use booms to halt the spread of spill in the smallest possible area.

3. Plug appropriate inlets, culverts, and ditches.

5. Contact appropriate personnel as discussed below. Make every reasonable effort to keep spill contained to the site.

6. Monitor for runoff until one of the persons listed arrives on the scene to provide further guidance.

Spill Reporting

1. Contact the CCI Project Manager. If the CCI Project Manager unavailable, call one of the alternates listed below. If none of these are at the site, call the home numbers listed below. The CCI Project Manager (or alternate) will designate the appropriate personal safety equipment that must be worn when approaching releases.

CCI Project Manager:	Venky Venkatesh
Working Hours Phone Number:	216-623-0326, ext. 13
After Hours Phone Number:	216-965-5605 (cell phone)
First Alternate:	Rich Rathnow, Navy RAC HSM
Working Hours Phone Number:	865-483-9005, ext. 672
After Hours Phone Number:	865-607-6734

If safety is not an issue, call other nearby employees for assistance in stopping the release. Notify the area or shift supervisor as soon as possible.

2. The CCI Project Manager (or alternate) will determine the necessary response actions including whether evacuation of parts or all of the facility is necessary for employee safety.

   In general, CCI Project Manager (or alternate) will direct the containment of the release and decide on alternative source control if the source of the release was not controlled by the person(s) discovering it. The release should be confined to the smallest area possible.

   - Use booms or sandbags, dig small trenches, or place absorbent pads to stop the spread.
   - Take immediate action to prevent the spill from reaching offsite or surface waters.
     - Place booms or pads, dig a diversion ditch, or use soil to form a berm.
     - If the release reaches water, attempt to place booms to contain the release, or, if necessary, block drainage downstream of spill to prevent further discharge.

3. All spills of oil or petroleum products will be immediately reported to the CCI Project Manager.

4. If downstream surface water quality is likely to be affected by the spill, CCI shall notify the downstream water users.

5. If any of regulatory agencies are contacted, give them as much of the following information as possible. Under all circumstances, provide only factual information. DO NOT SPECULATE. Figure 1 at the end of this section is a blank form that can help you

collect and report the required information. This form should be kept with the records copy of this Plan.

Inspections

Tanks and Equipment

Equipment, tanks, and the temporary storage area shall be inspected daily. The temporary storage area inspections will be documented on the temporary storage area inspection form (Attachment C2 – EMR QAPP).

EMR SOP 6: DECONTAMINATION AND INVESTIGATION DERIVED WASTE HANDLING, STORAGE AND TREATMENT

This Standard Operating Procedure (SOP) outlines procedures for the decontamination of reusable equipment and the handling, storage, and treatment of investigation derived wastes.

1.0 SOIL SAMPLING/WELL INSTALLATION EQUIPMENT DECONTAMINATION

All drilling and soil sampling equipment will be decontaminated and in good working order prior to arriving on site. All well completion materials will be in factory sealed packaging otherwise materials will be cleaned to CCI's satisfaction.

STEP 1: The drilling subcontractor will provide all equipment necessary for complete decontamination of all drilling and soil sample collection equipment.

STEP 2: Setup a decontamination basin and high-pressure, steam cleaning unit. Obtain decontamination water from a CCI approved off-site potable source.

STEP 3: Thoroughly decontaminate and rinse all downhole equipment. Allow equipment to air dry.

STEP 4: Collect all decontamination fluids into 55-gallon drums or portable tank.

STEP 5: Label containers with appropriate information.

STEP 6: Place drums/tanks onto wooden pallets and secure with non-metallic bonding for transport to the temporary storage area.

2.0 WELL DEVELOPMENT/GROUNDWATER SAMPLING EQUIPMENT DECONTAMINATION

All portions of development, sampling and test equipment that will contact groundwater shall be thoroughly cleaned before each use and between each well.

STEP 1: Remove and dispose water discharge hose from bladder pump.

STEP 2: Wash equipment with potable water and a phosphate-free laboratory detergent (i.e. Alconox®).

STEP 3: Rinse equipment with potable water.

STEP 4: Rinse equipment with isopropyl alcohol.

STEP 5: Rinse equipment with distilled or deionized water.

STEP 6: Air-dry equipment prior to use.

STEP 7: Collect all decontamination fluids into 55-gallon drums or portable tank.

STEP 8: Label containers with appropriate information.

STEP 9: Place drums/tanks onto wooden pallets and secure with non-metallic bonding for transport to the temporary storage area.

3.0 WASTE HANDLING AND TRANSPORTATION

Generated wastes will be collected and transported to the temporary storage area at the end of each workday.

STEP 1: Collect palletized and bonded drums/tanks from the generation site and load into suitable vehicle. Check that all waste containers are sealed and properly labeled.

STEP 2: Transport drums/tanks to temporary staging area.

STEP 3: Move drums into temporary staging area.

STEP 4: Secure temporary staging area.

STEP 5: When the capacity of the temporary staging area is reached the water drums will be removed and transported to the NIROP frac tank or the wastewater treatment plant with a vacuum truck operated by a licensed waste hauler.

4.0 TEMPORARY STAGING AREA

A temporary staging area will be constructed, consisting of a minimum of two plastic-lined, covered and sealed roll off boxes. One roll off box will be used for temporary storage of 55-gallon drums containing soil wastes, while the other will be used for temporary storage of water-filled drums. The roll off boxes will be lined with 6 mil reinforced plastic sheeting and will be equipped with water tight doors and retractable tarps to prevent the collection of precipitation. The roll off boxes will be locked at the end of each work day.

The temporary staging area will be equipped with the following equipment:

- drum labeling supplies
- fire extinguisher

- spill control and absorbent materials
- overpack drums
- an alarm horn
- drum repair materials and tools
- first aid kit
- 15-minute eyewash
- bloodborne pathogen kit

The temporary staging area will be inspected daily for the following:

- signs of drum damage/deterioration
- leakage
- spills
- liner damage
- presence of precipitation within the roll-off box;
- damage to the roll-off box

A *temporary staging area inspection form* (Attachment C2 – EMR QAPP) will be completed following the daily inspection.

The water stored in the frac tank will be treated at a waste water treatment plant (WWTP) located on-site at the NIROP facility. Periodically, the oil/water mixture and soil wastes will be removed by a licensed waste hauler to be transported to and approved treatment or disposal facility.

5.0 IDW DISPOSAL/TREATMENT FACILITIES

The generation of the following waste types is anticipated during the completion of the EMR Work Plan:

- well installation soil cuttings;
- well installation decontamination water;
- pre-injection development/purge/decontamination water;
- post-injection purge water with oil;
- post-injection decontamination water;

Assuming that all the above-listed wastes will be classified as non-hazardous, the wastes will be disposed of at the following type of facility:

- well installation soil cuttings – special waste landfill
- well installation decontamination water – NIROP WWTP
- pre-injection development/purge/decontamination water – NIROP WWTP
- post-injection purge water with oil – off-site WWTP
- post-injection decontamination water – off-site WWTP

EMR SOP 7: HYDROGEN SAMPLING PROCEEDURE IN GROUNDWATER

This Standard Operating Procedure (SOP) outlines procedures for to be used when conducting sampling and analysis of hydrogen in groundwater. Please follow the following steps in order:

1. Remove one of the cell assemblies from the packing carton provided by Microseeps.

2. Connect the inlet tube of the cell to the outlet of your pump. The inlet tube is designed to connect to 1/4 O.D. hard tubing. Secure the connection using binder clips or cable ties.

3. Insert the drain tube of the cell into a waste container, keeping the end of the tube at the bottom of the container. Any waste container of suitable size may be used. A 2-Liter soda pop may be placed in the waste container to determine pumping flow rate.

4. Secure the cell assembly so that the housing cover (stopper) is above the glass housing (i.e. upright). A ring stand and clamp are recommended for this purpose.

5. Turn the pump on and check for leaks. If any leaks are found, seal them before proceeding.

6. Measure, in mL per minute, the flow rate of the pump. If a 2-Liter soda pop bottle is used, the flow rate can be determined by measuring how many minutes it takes to fill the bottle and substituting the measured time into the following equation:

$$\text{Flow} = 2000 \text{ mL/Time to fill (in minutes)}$$

Consult Table 1 to determine the equilibrium time needed to bubble strip at this flow rate.

Note: Use a flow rate between 100 mL/min. and 500 mL/min. Do not turn off the pump.

Table 1.

Flow rate (ml/min)	Sampling time (min)
100-120	30
130-150	25
160-200	20
210-300	15
>300	10

7. Unclamp the cell assembly, invert it, and re-secure the assembly in the inverted position. Make sure the drain tube is still in the waste container and the end of the drain tube is near the bottom of the bottle.

8. Connect the stopcock to the syringe and the needle to the stopcock. Place the stopcock in the open position (so that the stopcock handle is in-line with the syringe). Draw the plunger back on the syringe to the 20.0 mL mark pulling ambient air into the syringe.

9. Keeping the cell in the inverted position, insert the needle into the needle guide. Pierce the septum and inject the air into the cell creating the bubble. Withdraw the needle from the assembly and carefully place the needle into the cover. Do not discard the syringe apparatus.

10. Start timing and let the groundwater pump through the cell for time specified in Table 1 for your particular pumping speed. Meanwhile, be sure that the sample vial is properly labeled and that the flow rate and any other relevant field data are recorded in the field log.

Note: Be sure to keep the end of the drain tube at the bottom of the waste container. This will insure that outside air is not drawn into the cell. Failure to do this will invalidate the sample.

11. When equilibration time is up, turn off the pump, unclamp the cell, and re-clamp it in its upright position. Verify that the plunger of the syringe is pushed all the way in and that the stopcock is in the open position.

12. Insert the needle into the needle guide and pierce the septum. Withdraw 1 mL of gas by pulling back on the syringe plunger while holding the syringe body in place. Remove the syringe from the cell and expel the sample.

13. Immediately re-insert the needle into the needle guide and pierce the septum. Withdraw a 15 mL sample of gas (being careful not to pull any water into the syringe). With the needle still through the septum, close the stopcock and withdraw the needle from the septum.

14. Immediately insert the needle through the septum on the sample vial. Keeping the syringe and vial "in line", open the stopcock and completely depress the syringe plunger injecting the entire sample into the vial.

15. Keeping the plunger depressed, quickly remove the vial from the needle. Your sample is now ready to be packaged and shipped back to the laboratory for analysis. Do not cool the samples.

Note: Hydrogen sampling procedure provided here is a modified version located at the Microseeps Laboratory web site http://www.microseeps.com/ under the topic "Microseeps Gas Stripping Cell Instructions".