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SITE SPECIFIC FIELD SAMPLING AND ANALYSIS PLAN RCRA FACILITY INVESTIGATION SOLID WASTE MANAGEMENT UNIT 474 (SWMU 474) MCB CAMP LEJEUNE NC

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CH2M HILL

Site Specific Field Sampling and Analysis Plan
RCRA Facility Investigation
SWMU 474

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Prepared for

Department of the Navy
Mid-Atlantic Division
Naval Facilities Engineering Command

Under the

CLEAN III Program
Contract N62470-02-D-3052

Contract Task Order 0134

February 2009

Prepared by

Raleigh, North Carolina

Sampling and Analysis Plan
RCRA Facility Investigation
RCRA Program, SWMU 474
(Field Sampling Plan and Quality Assurance Project Plan)

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Review Signatures: Daniel M Tomczak _____

Louise A. Palm _____

Approval Signatures _____

Other Approval Signatures: _____

Contents

Tables

Figures

Appendices

List of Acronyms and Abbreviations

CLEAN	Comprehensive Long-Term Environmental Action Navy
CSM	Conceptual Site Model
CTO	Contract Task Order
DoN	Department of Navy
DPT	Direct Push Technology
DQO	Data Quality Objective
ERA	Ecological Risk Assessment
HHRA	Human Health Risk Assessment
MCB	Marine Corps Base
MSL	Mean Sea Level
NAVFAC	Naval Facilities Engineering Command
NCDENR	North Carolina Department of Environment and Natural Resources
NEESA	Naval Energy and Environment Support Activity
PCB	polychlorinated biphenyls
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SLERA	Screening Level Ecological Risk Assessment
SOP	Standard Operating Procedures
SVOC	Semi-volatile Organic Compound
SWMU	Solid Waste Management Unit
TPH	Total Petroleum Hydrocarbons
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 Introduction

This Site-Specific Work Plan presents the strategy and technical approach for a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at Solid Waste Management Unit (SWMU) 474 – buried miscellaneous debris area near Building BB329 in Courthouse Bay at Marine Corps Base (MCB) Camp Lejeune, North Carolina (the Base). A Base map showing the location of SWMU 474 is provided as **Figure 1-1**.

This Site-Specific Work Plan was prepared by CH2M HILL under Contract Task Order (CTO) 0134 of the Department of the Navy's (DoN's) Comprehensive Long-Term Environmental Action Navy (CLEAN) Program. CH2M HILL is responsible for implementation of this project. It should be noted that this Site-Specific Work Plan is to be used in conjunction with the Master Project Plans, which include the Master Work Plan, Master Quality Assurance Project Plan (QAPP), and Master Health and Safety Plan (HASP) (CH2M HILL, 2008). The Master Project Plans will be referenced to the greatest extent possible.

1.1 RFI Objective

Specifically, the objectives of the RFI are as follows:

- Further evaluate the nature and extent of soil and groundwater contamination at SWMU 474.
- Assess the potential risks posed by site contaminants associated with the SWMU to human health and the environment.
- Provide recommendations for site management.

2.0 Background Information

Background information for the Base, including location, topography, geology, and regulatory history, is presented in the Master Project Plans and is not repeated herein. Site-specific background information for SWMU 474 is presented below.

2.1 SWMU Description and History

SWMU 474 has been identified as an area of buried debris encountered during construction activities near Building BB-329 in the Courthouse Bay area of MCB Camp Lejeune. The site is located east of D. A. Munro Street and north of Demo Range Road (**Figure 2-1**).

In 2005, during the construction of storm water utilities for the Joint Maritime Special Missions Maintenance Supply Building (Building BB329) contractors discovered buried debris consisting of numerous five-gallon motor oil and hydraulic fluid cans containing sludge material, spent vehicle oil filters, head light assemblies, and a vehicle tow bar. Stained soils were observed near all of the five-gallon cans. In response to this discovery, the Base Remedial Action Contractor, Shaw Group, excavated approximately 850 cubic yards of impacted soil for disposal. Analysis of samples collected from the excavated soils indicated the presence of Total Petroleum Hydrocarbons-Diesel Range Organics (TPH-DRO), while samples collected from the sludge material present in the five-gallon cans indicated the presence of polynuclear aromatic hydrocarbons (PAH). The excavation and subsequent sampling of the contaminated soil identified the following constituents of potential concern (COPCs):

- Total petroleum hydrocarbons (TPH) - Diesel range organics (DRO)
- Semi-volatile organic compounds (SVOCs)

The 2005 abatement activities focused solely upon removing debris from within the utility easement, and did not attempt to assess the nature and extent of the waste. In order to further assess the impacts to soil and potential impacts to groundwater at SWMU 474, a Confirmatory Sampling Investigation (CSI) was recommended for this site.

2.2 Confirmatory Sampling Investigation Activities

In November 2006, CH2M HILL conducted a CSI at SWMU 474 that involved the collection of samples of surface and subsurface soil, and groundwater using direct push technology (DPT). **Figure 2-2** illustrates the sampling locations used during the CSI**.** Based on the analytical results of samples collected from the excavated soils and the type of buried debris encountered in 2005, the CSI samples were analyzed for VOCs, SVOCs, and RCRA Metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) and the results were compared to screening values. The screening criteria included:

Soil

- Base background concentrations

- North Carolina Department of Environment and Natural Resources (NCDENR) Soil-to-Groundwater Screening Values
- United States Environmental Protection Agency (USEPA) Region IX Industrial Preliminary Remediation Goals (PRGs)

Groundwater

- Base background concentrations
- North Carolina Administrative Code (NCAC) 2L, Title 15A, Subchapter 2L, Groundwater Quality Standards Classification and Water Quality Standards Applicable to Groundwater of North Carolina (NCGWQS)

The findings of the CSI indicated that VOCs, SVOCs, and RCRA Metals did not exceed relevant screening criteria in surface or subsurface soils. However, it was reported that groundwater samples collected from three temporary wells exceeded the NCGWQS (and Base background concentrations for metals) for at least one of the following constituents: tetrachloroethene (PCE), 1,4-dichlorobenzene, arsenic, chromium, and lead. Since the CSI did not fully delineate the impacts to groundwater, a RFI was recommended in order to complete the evaluation and provide recommendations for future site management.

3.0 Preliminary Conceptual Site Model

The preliminary Conceptual Site Model (CSM) is an essential element of a results-based corrective action program. It is an important assessment tool that integrates the information needed to understand how COPCs move through the environment and potentially come in contact with human and ecological receptors. Development of a CSM is an iterative process; the model is refined as new information becomes available. The CSM is an effective tool in identifying additional data needs, and supporting management decisions regarding sampling strategies, project constraints, and regulatory compliance. Key elements of the CSM are grouped into major categories identifying potential sources, extent of contaminant migration, constituent fate and transport, as well as potential exposure pathways and receptors.

3.1 Source

The source of the VOCs and metals detected in groundwater samples collected from SWMU 474 is thought to be the buried miscellaneous debris and waste encountered during a utility corridor excavation near Building BB-329.

3.2 Fate and Transport Mechanisms

Fate and transport analysis can improve understanding of the distribution of observed constituents, support risk assessments, and aid in identifying potential remedial alternatives, if necessary. A transport pathway describes the mechanisms whereby SWMU-related constituents, once released, can be transported from a source to an exposure media.

3.2.1 Soil

Concentration gradients of metals and organics in surface and subsurface soil samples may be caused by outward migration from a source area. Different contaminants sorb to soil particles as a function of the soil characteristics (for example, organic content and clay percentage), as a function of soil conditions (such as pH and temperature), and as a function of the chemical properties of the contaminant (for example, solubility and partitioning coefficient). The extent of soil impacts both vertically and horizontally, relative to the source is a data need for this RFI. This work plan proposes the collection of soil data to identify a potential source that may be contributing to the groundwater impacts, which will also assist in the assessment of fate and transport mechanism likely operating at this SWMU.

Wind could serve as a constituent transport pathway agent by eroding exposed soil and blowing it across the site or even off-site. This process is influenced by wind velocity, the grain size/density of the soil particles, moisture conditions, and the amount of vegetative cover of the soil. However, paved areas present near the suspected source area at SWMU 474 and vegetated areas will minimize the likelihood of fugitive dust generation. Organic constituents in surface soils with high vapor pressures might volatilize to the atmosphere; however, the paved surface at SWMU 474 could minimize this effect. This process could be enhanced by excavation or erosional disturbances of the surface soils.

3.2.2 Groundwater

Currently, the primary transport mechanism for contaminants at SWMU 474 appears to be advection and dispersion in shallow groundwater. Shallow groundwater at SWMU 474 was encountered at depths of roughly 10 to 12 feet bgs, and was estimated to flow toward the New River in a south-southeasterly direction **Figure 3-1**. Groundwater has been impacted by PCE, 1,4-dichlorobenzene, arsenic, chromium, and lead, although the horizontal and vertical extents of these impacts have not been assessed.

3.3 Exposure Pathways and Receptors

An exposure pathway links a source of contamination with one or more receptors through exposure via one or more media and exposure routes. An exposure pathway must be complete for exposure to occur. The preliminary exposure pathways identified for this SWMU are described below.

3.3.1 Human Health Exposures

MCB Camp Lejeune is home to an active duty, dependent, retiree, and civilian population of approximately 150,000 personnel. Approximately 47,000 military personnel are stationed at MCB Camp Lejeune, including 39,000 Marines for resident formal school training and 8,000 Marines and DOD employees for job enhancement training. MCB Camp Lejeune provides housing, training facilities, logistical support, and administrative supplies for Fleet Marine Force (FMF) units and other assigned units. SWMU 474 and its vicinity are primarily covered with a mix of asphalt and gravel roadways, concrete, and buildings. The buildings within the vicinity of the site are primarily for industrial use.

Considering that the ground surface at SWMU 474 is mostly covered with asphalt or buildings, there is limited potential for casual exposure to surface soil. The shallow groundwater beneath the SWMU is not currently used as a source of drinking water, and therefore, there is no current exposure to groundwater. Consequently, there are no current potential human receptors at the SWMU. However, future construction workers engaged in excavation activities for utility work, landscaping, or construction of future industrial or residential buildings could potentially contact debris, soil and groundwater through ingestion, dermal contact, or inhalation of from these media. The construction worker/utility worker is considered to be the most likely future potentially exposed receptor for the SWMU. Additionally, any changes in landscaping that remove the current covering and expose soil would allow future industrial workers, maintenance workers, or residents to contact the soil through ingestion, dermal contact, and inhalation of particulate or volatile emissions from the soil.

State and federal governing policies assume that non-saline groundwater resources are to be maintained as potable. Potable water for MCB Camp Lejeune and the surrounding residential area is provided by water supply wells that pump groundwater from the Castle Hayne aquifer (approximately 50 to 200 feet bgs). Only two active water supply wells are located within a 1,500 feet search radius of SWMU 474 but neither are located between the SWMU and the groundwater discharge point of Courthouse Bay based on the groundwater flow direction; therefore, use of site groundwater for industrial or residential purposes is unlikely. Future residents could be exposed to groundwater used as a potable water supply through ingestion, dermal contact, and inhalation of volatile emissions.

3.3.2 Ecological Exposures

Given the extensive development of the site, there is minimal terrestrial habitat within SWMU 474. A small area (approximately 100 square feet) is landscaped with bermuda grass and surrounded by a parking lot and fencing. Potentially complete contaminant exposure pathways from soil to ecological receptors include direct contact, inhalation, and ingestion. Each are discussed below:

- During a site visit conducted by CH2M HILL ecologists in 2008, no animal burrows were observed in the landscaped area. This was not unexpected as the habitat area is small and the area is consistently mowed. As a result, the inhalation pathway via volatilization in burrows is not complete.

- Direct exposure to plants (root uptake) and soil invertebrates (dermal and ingestion) to contaminants in surface soil is insignificant based on the size of the grass area.

- Upper trophic level wildlife exposure to contaminants is minimal based on the small size of the grass area, its position relative to development, and because undeveloped areas located south and north of the SWMU provide more attractive habitat.

The CSI indicated that COPCs have impacted groundwater and could potentially migrate toward a discharge point, i.e. surface water and sediment in the nearest surface water body, Courthouse Bay. However, further assessment is necessary to evaluate whether this pathway is complete.

4.0 Data Quality and Sampling Objectives

The site-specific objectives presented in this section have been developed using the U.S. Environmental Protection Agency (USEPA) seven-step data quality objectives (DQOs) process, as presented in the USEPA Guidance for the Data Quality Objectives Process (USEPA, 2000a) and USEPA Data Quality Objectives Process for Hazardous Waste Site Investigations (USEPA, 2000b).

4.1 Data Quality Objectives Process

DQOs are qualitative and quantitative statements, developed using the USEPA DQO process, that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as a basis for establishing the quality and quantity of data needed to support decisions. DQOs define the performance criteria that limit the probabilities of making decision errors by considering the purpose of collecting data, defining the appropriate type of data needed, and specifying tolerable probabilities of making decision errors. The seven-step DQO process is as follows:

- Step 1 – State the Problem
- Step 2 – Identify the Decision
- Step 3 – Identify the Inputs to the Decision
- Step 4 – Define the Boundaries of the Study
- Step 5 – Develop a Decision Rule
- Step 6 – Specify Tolerable Limits on Decision Errors
- Step 7 – Optimize the Design for Obtaining Data

The following sections present the seven-step DQO process developed for the RFI at SWMU 474.

4.1.1 Step 1 – State the Problem

The first activity associated with this step is to establish the planning team. The planning team will include the North Carolina Department of Natural Resources (NC DENR), Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division, MCB, Camp Lejeune, and CH2M HILL. These team members are decision-makers for the DQO Process.

As the first step in the DQO process, the problem is to evaluate the extent to which soil and groundwater are impacted at SWMU 474. The planning team's primary goal is to address the problem through this investigation. Specifically, the objectives of the RFI are as follows:

- Collect supplemental information regarding the environmental setting at the SWMU, including hydrogeology, geology, hydrology, topography, aquifer characteristics, and any other anthropogenic influences that may affect contaminant fate and transport
- Characterize the extent of potentially contaminated soils via the collection and analysis of surface and subsurface soil samples

- Characterize the extent of impacted groundwater via the collection and analysis of groundwater samples from locations selected to provide horizontal and vertical delineation
- Evaluate the potential risks to human health and the environment posed by the identified COPCs
- Provide recommendations for site management.

The final activity associated with this step is to identify available resources, constraints, and deadlines. The project team organization and project schedule are presented in Sections 5.0 and 6.0 of this Site-Specific Work Plan, respectively. The schedule presents the anticipated completion and/or submittal dates for specific tasks or documents.

4.1.2 Step 2 – Identify the Decision

The principal study question identified is:

- What is the nature and extent of contaminated media related to historical wastes management practices at SWMU 474?

Before a decision statement can be formulated, a definition of "contaminated" must be clarified. For the RCRA program, soil and groundwater will be considered "contaminated" if concentrations of COPCs exceed the applicable North Carolina Groundwater Quality Standards (NCGWQS), NC DENR soil to groundwater screening criteria and/or USEPA Regional Screening Levels (RSLs) and the established background/secondary criteria (for metals only). Considering the principal study question and definition of "contaminated," the decision statement is as follows:

- Define the nature and extent of contamination in the vicinity of the SWMU by determining whether or not the concentration of a given COPC at any given sampling point exceeds the regulatory driven criteria.

4.1.3 Step 3 – Identify the Inputs to the Decision

Existing information regarding the nature of impacted media in the vicinity of SWMU 474 comes from analytical samples collected by CH2M HILL during the CSI in 2006. However, the extent of impacted soil and groundwater was not fully delineated. The type of data and sources used to resolve the decision statement include the following:

Kinds of Information	Sources of Information
Identification of potential up gradient source areas of groundwater contamination; nature and extent of contaminated soil	New analytical soil data
Delineation of the nature and extent of groundwater contamination.	New analytical groundwater data
Groundwater hydrology	New groundwater elevation data, aquifer testing (slug tests) and geotechnical testing

The criterion for evaluating the significance of contamination will be comparison of analytical results and applicable regulatory driven criteria as described in Section 4.1.2. Groundwater and soil samples will be analyzed by a fixed-based analytical laboratory for VOCs and RCRA Metals.

4.1.4 Step 4 – Define the Boundaries of the Study

The SWMU boundary was delineated based on the extent of the debris removal during the utility line excavations in 2005. **Figure 4-1**illustrates the proposed soil and groundwater sampling locations. Practical constraints to sample collection are minor to moderate. Weather conditions (such as heavy rain or lightning) can delay the field activities, but are not a serious constraint.

4.1.5 Step 5 – Develop a Decision Rule

The decision rule developed for the RFI at SWMU 474 is as follows:

- If a given concentration at a given sampling point exceeds the regulatory driven criteria for that contaminant, then that sampling point will be considered to be within the extent of contamination.

4.1.6 Step 6 – Specify Tolerable Limits on Decision Errors

Specification of tolerable limits on the decision errors will not be performed at this time. The sampling scheme is flexible and will include points inside and outside the suspected contaminated area so that the extent of contamination should be sufficiently defined. Specification of tolerable limits on the decision errors may be developed at a later date as determined by the planning team.

4.1.7 Step 7 – Optimize the Design for Obtaining Data

There are two fundamental goals for Step 7, and both rely on review of existing data and information:

- To evaluate the decision rule
- To design and optimize the sampling and analysis program

The decision rule developed in Step 5 has been shown to be valid following review of existing data. In this case, a simple statistical hypothesis test, broadly classified as a one-sample test was used. The test involved comparison of individual analytical data to a known value (regulatory driven criteria and established background/secondary criteria).

Existing information/data has been reviewed to evaluate and develop the data collection strategy for the field program. The development of alternate sampling plans is not practical given the nature of the RFI.

5.0 RFI Tasks and Responsibilities

5.1 Project Management

Project management activities include such items as daily technical support and oversight; budget and schedule review and tracking; preparation and review of invoices; personnel resource planning and allocation; and coordination with NAVFAC Mid-Atlantic, MCB, Camp Lejeune, and subcontractors.

5.2 Subcontractor Procurement

This task includes procurement, scheduling and coordination of subcontractors. The primary subcontractors required for the RFI include a utility locator, land surveyor, DPT sampling subcontractor, well driller, a fixed-base analytical laboratory, an independent data validator, and an IDW management subcontractor. Miscellaneous subcontractors may also be procured for various support services.

5.3 Field Activities

The field activities for the RFI at SWMU 474 will include the following subtasks:

- Mobilization/Demobilization
- Soil Sampling using DPT Macrocore, split-spoon, and Shelby Tubes
- Temporary Monitoring Well Installation, Groundwater Sampling, and Well abandonment
- Permanent Monitoring Well Installation, Groundwater Sampling, and Aquifer Testing
- Laboratory Analytical Program
- Quality Assurance/Quality Control (QA/QC)
- Sample Handling
- Investigative Derived Waste (IDW) Management
- Surveying

The following subsections present a discussion of the proposed field activities. A summary of the sampling program is provided in **Table 5-1**.

5.3.1 Mobilization/Demobilization

Mobilization/demobilization consists of securing equipment and supplies necessary for the field activities and shipping or transporting those items both to and from the field. Travel time to and from the Base, construction of decontamination areas, location of IDW storage areas, field establishment of sampling locations, and subsurface utility clearance are all included under this task. Activity personnel will be consulted during mobilization efforts.

5.3.2 Supplemental Soil Investigation

As part of the RFI field investigation, a surface soil sample will be collected from one soil boring (SWMU474-IS12) and subsurface soil samples will be collected from four (4) soil borings (SWMU474-IS09, SWMU474-IS10, SWMU474-IS12, and SWMU474-IS13) in order to identify an potential hydraulically upgradient (SWMU474-IS09, SWMU474-IS10) and side gradient (SWMU474-IS12 and SWMU474-IS13) source areas potentially contributing to the impacted groundwater. Surface samples will not be collected at locations within the paved areas since the surface soils would have been disturbed during the paving process. Continuous soil cores will be retrieved using a DPT soil sampler to a depth just below the water table, estimated to be approximately 10 to 12 feet below ground surface (bgs). Soil cores will be examined and logged by a CH2M HILL geologist to record lithology. The cores will also be screened for the presence of VOCs using a flame-ionization detector (FID) and photoionization detector. This information will be used to select subsurface soil samples for fixed-base laboratory analysis. Soil samples from these locations will be submitted for VOC (EPA SW-846 Method 8260B) and RCRA metal analysis (EPA SW-846 Method 6010/7000) with a standard 28 day turnaround time. Soil sampling procedures are described in the Master Field Sampling and Analysis Plan (FSAP) (CH2M HILL, 2008).

During the monitoring well installation activities, split-spoon samples will be conducted in accordance with CH2M HILL SOPs as well as the American Society for Testing and Materials (ASTM) Method D1586-08 at each monitoring well boring every 5 ft to characterize site lithology and screen for the presence of VOCs.

5.3.3 Geotechnical Testing

Three undisturbed soil samples will be collected using Shelby tubes within the vicinity of SWMU 474 for the determination of grain size and vertical permeability analyses in accordance with ASTM Method D1587. The geotechnical data will be used to assess site-specific fate and transport processes. The three samples will be collected above the water table at depths of 1-3 ft bgs, 4-6 ft bgs, and 7-9 ft bgs. Each of the three samples will be collected from a different monitoring well boring (refer to Section 5.3.4). Once collected, the undisturbed Shelby tube samples will be submitted to a fixed-base geotechnical laboratory for testing.

5.3.4 Supplemental Groundwater Investigation

Temporary Monitoring Well Installation

In order to evaluate the lateral extent of impacted groundwater at SWMU 474 groundwater samples will be taken from six (6) temporary well locations in the surficial aquifer and one (1) location in the deep aquifer (approximately 40 ft bgs) using a DPT screen point sampler (SP-15).

Each temporary well will consist of one-inch inner diameter (ID) Schedule 40 (Sch. 40) polyvinyl chloride (PVC) casing and riser. The well screens will be 10 ft in length of 0.010-inch machine slotted Sch. 40 PVC with a pre-packed sand filter and placed to bracket the water table. The wells will be constructed accordance with the *Temporary Well Installation* SOP in **Appendix A**. All temporary wells will be developed by surging and pumping. Surging will be completed manually by running a disposable weighted bailer across the screen in an up and down motion for 10 to 20 minutes to agitate and settle the filter pack material. The well will then be purged using a pump at an aggressive, but sustainable rate until water quality parameters are stabilized. At no time should

the well be pumped dry. Water quality data will be recorded during the purging and development process.

After a period of at least 24 hours following well development, water level measurements and groundwater samples will be collected from each temporary well using low-flow procedures in accordance with the *Master Project Plans, Marine Corps Base Camp Lejeune, Jacksonville, North Carolina* (CH2M HILL, 2005). Water level measurements will be used to determine groundwater flow direction within the vicinity of the SWMU. Groundwater samples will be submitted to a fixed based laboratory for VOC and RCRA metal analysis with a standard 28 day turnaround time.

Following sampling and surveying, five temporary wells (SWMU474-TW10, SWMU474-TW12, SWMU474-TW13, SWMU474-TW14, and SWMU474-TW15) will be removed from their boreholes. The DPT subcontractor will be abandon the boreholes following NCDENR guidelines (NCAC, 2001) by grouting from the bottom of the boring to the ground surface within 5 days of installation.

Conversion of a Temporary Well to a Permanent Well

The hydraulically upgradient temporary well SWMU474-TW09 will be converted to a permanent well. Bentonite chips will be placed in the annular space of the well borehole from the top of the sand pack around the well screen to 1 foot below ground surface and then hydrated with potable water to create a seal. A watertight, locking, expansion cap will be installed on top of the 1-inch diameter casing. The well will be completed at the surface with a 2 feet by 2-feet by 6-inch concrete pad and an 8-inch diameter steel flush manhole cover.

Permanent Monitoring Well Installation

Following critical evaluation of the laboratory analytical data derived from analysis of groundwater samples collected from the temporary wells, in addition to historical (November 2006 CSI) groundwater analytical data, CH2M HILL will, if necessary, make recommendations for the citing of additional permanent monitoring wells. The permanent wells will be cited based upon the groundwater flow direction within the vicinity of the SWMU as measured by the temporary wells.

The proposed permanent wells would be constructed during the second mobilization using hollow stem auger (HSA) drilling techniques. One permanent shallow well will be installed near the suspected VOC source area (near SWMU474-TW08), two permanent wells will be installed laterally from the suspected VOC source area, and one permanent well will be installed as a non-impacted well hydraulically downgradient from the suspected source area. In addition, temporary well SWMU474-TW09 will be converted to a permanent well to serve as a non-impacted, hydraulically upgradient well of the suspected source area.

The exact screened interval of each well will be based on the lithologic data collected during the borehole installations and depth to groundwater. Boring logs and well completion diagrams will be provided in the RFI Report.

The monitoring wells will be constructed within each borehole using 2-inch diameter, flush threaded, Schedule 40 polyvinyl chloride (PVC) riser and 10-feet of 0.010-inch machine-slotted PVC screen. A 30/40 silica sand filter pack will be placed in the annular space between the well screen and borehole wall, from the bottom of the borehole to approximately 2 feet above the top of the well screen. Bentonite pellets will be placed on top of the filter pack and hydrated (for at least 1 hour) to form a seal approximately 2 to 3 feet thick. After hydration of the bentonite pellets, the

remaining annular space of the borehole will be grouted to within a few inches of the ground surface. The grout shall be allowed to cure a minimum of 24 hours prior to well completion.

A watertight, expansion cap will be installed on top of the 2-inch diameter casing, and secured using a padlock. Each monitoring well will be completed at the surface with either an 8-inch diameter steel, manhole type, protective cover with concrete pad or a steel, stick-up protective cover with 2 feet by 2 feet concrete pad (depending on the location of the well). The drilling and well installation activities will be conducted by a North Carolina licensed well driller in accordance with the North Carolina Administrative Code, Title 15A, Subchapter 2C, Well Construction Standards, Criteria and Standards Applicable to Injection Wells.

Well development will not commence until the grout in the annular space of each well has had at least 24 hours to cure. Wells will be developed in accordance with Navy CLEAN SOPs, CH2M HILL SOPs, and the Master Plans (CH2M HILL, 2008). Well development will include surging and over pumping with a submersible pump across the length of the well screen. With respect to the volume of groundwater removed, adequate well development is normally achieved when the column of water in the well is free of visible sediment. With respect to groundwater geochemical parameters, adequate development is achieved when the pH, specific conductance, and temperature of the groundwater have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs). Stabilization occurs when pH measurements remain constant within 0.1 standard unit (SU), specific conductance varies no more than 10 percent, and the temperature is constant for three consecutive readings.

5.3.5 Monitoring Well Purging and Sampling

All four (4) new monitoring wells (SWMU474-MW01 through SWMU474-MW04) will be sampled. The wells will be purged and sampled using peristaltic pumps and low-flow purging/sampling methods in accordance with the *Low-Flow Groundwater Sampling from Monitoring Wells* SOP in **Appendix A**. New disposable tubing will be used for each monitoring well. SWMU474-MW01-MW04 groundwater samples will be submitted to a fixed-based laboratory for VOC and RCRA Metals analysis with a standard 28 day turnaround time. Specific sampling procedures are presented in **Appendix A** and summarized below:

- Remove the well cap or cover and monitor for volatile organic vapors using the appropriate instrument listed in the Health and Safety Plan.
- The static water level will be measured in each well; however, the total depth of the monitoring well will not be measured, as not to stir up any sediment. The total well depth will be obtained from the boring log or well construction record. The water volume in the well will then be calculated.
- The sampling device intake will be slowly lowered until the bottom end is two to three feet below the top of the well screen or the top of the water level, whichever is greater. Next, the water level probe will be placed into the monitoring well just above the water.
- Purging will begin. The pumping rate will be set to create a sustainable flow (approximately 0.3 liters/minute or less) without causing a significant drop in water level in the well. The static water level will be periodically measured throughout purging to verify that a significant drop in water level has not occurred.

- Water Quality Parameters (WQPs), including pH, specific conductance, temperature, oxidation-reduction potential (ORP), turbidity, and dissolved oxygen will be measured frequently.
- Purging will be complete when three successive readings of pH, specific conductance, and temperature have stabilized within 10 percent (0.1 Standard Units for pH), turbidity is less than 10 NTUs, or there is no further discernable upward or downward trend. However, a minimum of one well volume will be removed prior to sampling. If a well is purged dry, the well will be allowed to recharge (preferably to 70 percent of the static water level) prior to sampling.
- Upon WQP stabilization and removal of at least one well volume, groundwater samples will be collected and placed into the appropriate sample container(s).

5.3.6 Slug Testing

Rising head slug tests (bail-down or slug-out) will be performed on all four of the groundwater monitoring wells. The slug test will consist of submerging a poly bailer or solid cylinder (PVC or stainless-steel) of known volume (slug) in a test well, allowing the static water level time to equilibrate, rapidly removing the slug, and recording the changes in head over time. The test will be allowed to continue until the water level returns to within 10 percent of the original static water level.

Slug test equipment will be used in accordance with Navy CLEAN SOP (refer to Aquifer Slug testing SOP in Appendix A), CH2M HILL SOPs, and the Master Project Plans (CH2M HILL, 2008) and will include a data logger and pressure transducer, a nylon rope, and a bailer or solid PVC or stainless-steel slug. Prior to the initial slug test and between each well tested, all downhole equipment will be decontaminated according to the procedures described in this Work Plan.

Slug testing will be completed using the following procedure:

1. Remove the well cap or cover and monitor for volatile organic vapors using the appropriate instrument listed in the Health and Safety Plan.
2. Measure the depth to water in the well and the total well depth using a decontaminated electronic water level indicator. Calculate the length of the water column. If the pressure transducer and slug (e.g., bailer) cannot be fully submerged in the water column of the well, then the well should not be used to perform a slug test due to only having a limited amount of water being removed during the bail-down (< 1 liter if a standard bailer is used as the slug).
3. Lower the pressure transducer into the well and suspend in the water column in the screened interval.
4. Lower the slug into the well and suspend in the water column above the pressure transducer.
5. Enter the appropriate test parameters into the data logger and set the zero reference point after the water column has stabilized to near original static conditions. The transducers should be programmed to record water level data on a logarithmic time scale with the maximum time interval of 2 minutes (the minimum time interval should be automatically determined by the datalogger, but should not exceed 0.05 seconds).
6. Start the pressure transducer and **immediately** remove the slug from the water column. Be careful not to bump the pressure transducer.

7. Record the change in head over time until readings have stabilized. After the instantaneous extraction of water from the well during the bail-down slug test, groundwater stored in the filter pack around the well screen will drain rapidly into the well. Once the water level in the filter pack equals the water level in the well, the rise in the water level within the well becomes a function of the hydraulic conductivity of the aquifer formation around the well. Therefore, the water level should be allowed to recover a sufficient amount of time to allow the rate of inflow into the well to be controlled by the formation rather than by storage in the filter pack.

Reduce the data by plotting the change in head versus time on semi-logarithmic paper using the Bouwer and Rice method of analysis (Bouwer, 1989) or other appropriate data reduction method.

5.3.7 Field Quality Assurance/Quality Control

Specific Quality Assurance/Quality Control (QA/QC) requirements are presented in the Master QAPP, which is contained in the Master Project Plans (CH2M HILL, 2005). The Master QAPP describes the different levels of sample analysis and the associated QC procedures required with each. Adherence to established USEPA chain-of-custody (COC) procedures during the collection, transport, and analyses of the samples will be maintained throughout the project. Laboratory analyses of the samples will conform to accepted QA requirements.

The following QA/QC samples will be collected/prepared during the field activities to ensure precision, accuracy, representativeness, completeness, and comparability:

- Equipment rinsate blanks
- Trip blanks
- Field blanks
- Field duplicates
- Matrix Spike/Matrix Spike Duplicates (MS/MSDs)

Equipment rinsate blanks will be collected by running laboratory-supplied de-ionized water over/through the sampling equipment and placing it into the appropriate sample containers for laboratory analyses. Equipment rinsate blanks will be collected from selected disposable sampling equipment (i.e., roll of tubing, acetate liner, etc.); one equipment rinsate blank will be collected each day for reusable sampling equipment. The results will be used to verify that the sampling equipment has not contributed to contamination of the samples.

One field blank will be collected from each source of water used in decontamination. The field blanks will be collected by pouring the water from the original container or spigot directly into the sample bottle set. Field blanks will not be collected in dusty environments. The results will be used to verify that the water used for decontamination of re-usable equipment has not contributed to contamination of the samples.

Field duplicate samples will consist of one unique sample, split into two aliquots, and analyzed independently. Duplicate soil samples analyzed for parameters other than VOCs will be homogenized and split. Samples for VOC analyses will not be mixed, but select segments of the soil will be collected. Duplicate water samples will be collected simultaneously. The duplicate samples will be analyzed to verify the reproducibility of the laboratory results and degree of

variability of reported concentrations. Duplicate samples will be collected at a frequency of 10 percent; the samples will be taken from locations anticipated to be contaminated.

MS/MSD samples will be prepared in the field to address aliquoting reproducibility and to provide information on matrix reproducibility otherwise unobtainable from samples reported below analytically reproducible and statistically valid levels. MS/MSD samples will be prepared at a frequency of 5 percent for each group of samples of a similar matrix; the samples will be taken from locations anticipated to be contaminated.

5.3.8 Sample Handling and Analysis

Samples for chemical analyses will be placed into laboratory–prepared sample containers with the appropriate preservatives and stored on ice in a cooler at approximately 4° Celsius (or less) until shipped to the laboratory.

Sample preservation details are presented in the Master Project Plans. The type of container used for each sampling effort, as well as a summary of preservation requirements is described in the Master QAPP.

Proper COC documentation will be maintained for all samples from the time of collection until they are shipped to the analytical laboratory. The COC forms will contain the following information: project number, contract task order (CTO), sampler names, sample numbers, number of containers, methods of preservation, date and time of sample collection, analysis requested, date and time of transportation to the laboratory, method of transportation, and any other information pertinent to the samples. Specific COC procedures are presented in the Master Project Plans.

Samples will either be hand delivered to the laboratory via courier or shipped via overnight courier.

5.3.9 Investigation Derived Waste Management

IDW will be managed in accordance with the Base IDW Management Plan (CH2M HILL, 2008). IDW will consist of soil cuttings, personal protective equipment (PPE), decontamination fluids, and purged groundwater. PPE, such as sampling gloves, will be placed in plastic bags and disposed in an on-site dumpster. Soil and liquid IDW will be placed in 55 gallon drums, or, if low volumes are expected, in 5-gallon containers with lids. Samples will be collected from each waste stream for analysis of TCLP, reactivity, ignitability, and corrosivity in order to determine the appropriate method of disposal. The drums will be transported to and staged at a designated 90-day storage pending final disposition. A waste management subcontractor will assist with the removal of the IDW from the storage area and transportation to a permitted disposal facility.

5.3.10 Surveying

All soil boring locations and monitoring wells will be surveyed by a subcontractor licensed in the State of North Carolina for topographic elevation relative to mean sea level (MSL) and horizontal position within the North Carolina State Plane Coordinate System. The elevation point for the monitoring wells will be established at the top of the PVC well casing. The vertical accuracy of the survey will be within 0.01 feet and the horizontal accuracy will be within 0.1 feet. Surveying procedures are presented in the Master Project Plan.

5.4 Data Management and Validation

It is anticipated that data management activities will consist primarily of entering field and laboratory data onto computerized spreadsheets using database software and tabulating field and analytical results for preparation of the report.

An independent data validator will be subcontracted for data validation. The laboratory analytical results will be evaluated to assess the technical adequacy and usability of the data. The data will be technically reviewed based on specifications set forth in the Naval Energy and Environmental Support Activity (NEESA) and USEPA guidance documents.

5.5 Data Evaluation

The laboratory analytical results for soil and groundwater will be compared with the applicable North Carolina 2L Groundwater Quality Standards, NC DENR soil to groundwater screening criteria and/or USEPA Regional Screening Levels (RSLs) and the established background/secondary criteria (for metals only). Because the SWMU and its surroundings are not used for military housing, industrial RSLs will be used as comparison criteria.

5.6 Risk Assessment

An ecological risk assessment (ERA) and a Human Health Risk Assessment (HHRA) will be conducted after data evaluation. The HHRA and ERA will identify existing or potential risks that may be posed to human health and/or the environment and will serve to support the evaluation of the threats posed by a site with respect to current and future potential exposure scenarios. Only CSI and RFI data that has been validated will be used in the risk assessments.

5.6.1 Ecological Risk Assessment

The ERA task includes completing an ecological checklist and a screening-level ERA (SLERA). The checklist and SLERA documentation will be compliant with *Guidelines for Performing Screening Level Ecological Risk Assessments Within the North Carolina Division of Waste Management* (NC DENR, 2003). The SLERA will be completed and documented through Step 2 of the ERA process. Up to three conference calls with the NCDENR are anticipated to discuss the approach to the SLERA, the results at the conclusion of Step 2, and the initial comments on the SLERA portion of the RFI report. If Step 3a is required, based on the results of Step 2, then it will be conducted in accordance with current EPA guidance.

5.6.2 Human Health Risk Assessment

The baseline HHRA will be conducted in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (USEPA, 1990a). The primary guidance document for the HHRAs will be the *Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A) Interim Final* (USEPA, 1989). Additional guidance documents will be consulted, including the following:

- U.S. Environmental Protection Agency (USEPA). *Supplemental Guidance to RAGS: Region 4 Bulletins*, Human Health Risk Assessment Bulletins. EPA Region 4, originally published

November 1995, Website version last updated May 2000: http://www.epa.gov/region 4/waste/oftecser/healthbul.htm Office of Technical Services, USEPA Region 4. 2000.

- U.S. Environmental Protection Agency (USEPA). *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments*. Office of Solid Waste and Emergency Response. EPA 540-R-97-033. OSWER 9285.7-01D. December 2001.
- U.S. Environmental Protection Agency (USEPA). *Risk Assessment Guidance for Superfund, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final*. OSWER 9285.7-02EP. July 2004.

The primary objective of the baseline human health risk assessment is to assess the health risks associated with exposure to SWMU 474 soil and groundwater for human receptors under current and future site conditions. The risk assessment will be comprised of the following components:

- **Identification of Chemicals of Potential Concern**—Identification of the contaminants found onsite and selection of the COPCs. COPCs represent the subset of all chemicals detected at the site that provides the largest contribution to total site risks. COPCs in soil will be identified using USEPA RSLs. Groundwater data will also be compared to North Carolina 2L concentrations
- **Exposure Assessment**—Identification of the potential pathways of human exposure, and estimation of the magnitude, frequency, and duration of these exposures
- **Toxicity Assessment**—Assessment of the potential adverse effects of the COPCs and compilation of the toxicity values used for developing numerical risk estimates
- **Risk Characterization**—Integration of the results of the exposure and toxicity assessments to develop numerical estimates of health risks, and characterization of the potential health risks associated with potential exposure to site-related contamination
- **Uncertainty Assessment**—Identification and discussion of sources of uncertainty in the risk assessment.

5.7 Report Preparation

An RFI Report will be prepared detailing the new sampling results and evaluation of risk associated with the COPCs identified at the site. The report will include, but not be limited to, the following:

- Information to supplement and/or verify the environmental setting of the SWMU including geology and hydrogeology
- A summary of the investigation/sampling activities
- Characterization of the source(s)
- Evaluation of the nature and extent of contamination
- Human health risk assessment
- Ecological risk assessment

- Conclusions and recommendations

A draft RFI report will be submitted to MCB, Camp Lejeune and NC DENR for comments and approval. Response to comments and necessary revisions will be made to the draft report before issuing a final report.

6.0 Project Management and Staffing

The proposed management and staffing for the RFI at SMWU 474 is shown on **Figure 6-1**. CH2M Hill's primary participants for this project (CTO-0134) are as follows:

- Ms. Kim Henderson– Deputy Activity Coordinator
- Mr. Dan Tomczak – Project Manager
- Ms. Louise Palmer, PE – Senior Consultant
- Mr. Rick Powell, LG- Senior Consultant
- Task Managers

Mr. Tomczak and the Task Managers will have the overall responsibility for conducting the field activities and completing the reports associated with this CTO. They will be supported by geologists, engineers, scientists, biologists, and clerical personnel, as needed. The Task Managers will report to Mr. Tomczak and Ms. Henderson who will then relay pertinent issues and maintain close contact with NAVFAC Mid-Atlantic and the Base.

7.0 Project Schedule

The project schedule is presented in **Figure 7-1**. The schedule presents the anticipated completion and/or submittal dates for specific tasks or documents.

8.0 References

Bouwer, H., 1989. *The Bouwer and Rice Slug Test--an update, Ground Water, vol. 27, no. 3, pp. 304-309.*

CH2M HILL, 2007. *Final Confirmatory Sampling Investigation Report, Solid Waste Management Units (SWMUs) 470 and 474, Marine Corps Base Camp Lejeune, North Carolina.* August 2008.

CH2M HILL, 2008. *Master Project Plans, Marine Corps Base Camp Lejeune, North Carolina*. 2008.

CH2M HILL, 2008. *Waste Management Plan, Marine Corps Base Camp Lejeuene, North Carolina*. March 2008.

North Carolina Administrative Code (NCAC), 2001. Title 15A Environment and Natural Resources, Subchapter 2C – Well Construction Standards. April 1.

North Carolina Department of Natural Resources (NC DENR), 2003. Guidelines for Performing Screening Level Ecological Risk Assessments Within the North Carolina Division of Waste Management. October 2003.

United States Environmental Protection Agency. 1989. Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A) Interim Final. 1989.

United States Environmental Protection Agency. 1990a. National Oil and Hazardous Substances Pollution Contingency Plan (NCP). 1990.

United States Environmental Protection Agency. 2000a. Guidance *for Data Quality Objectives Process.* 2000.

United States Environmental Protection Agency. 2000b. *Data Quality Objectives Process for Hazardous Waste Site Investigations.* 2000.

Tables

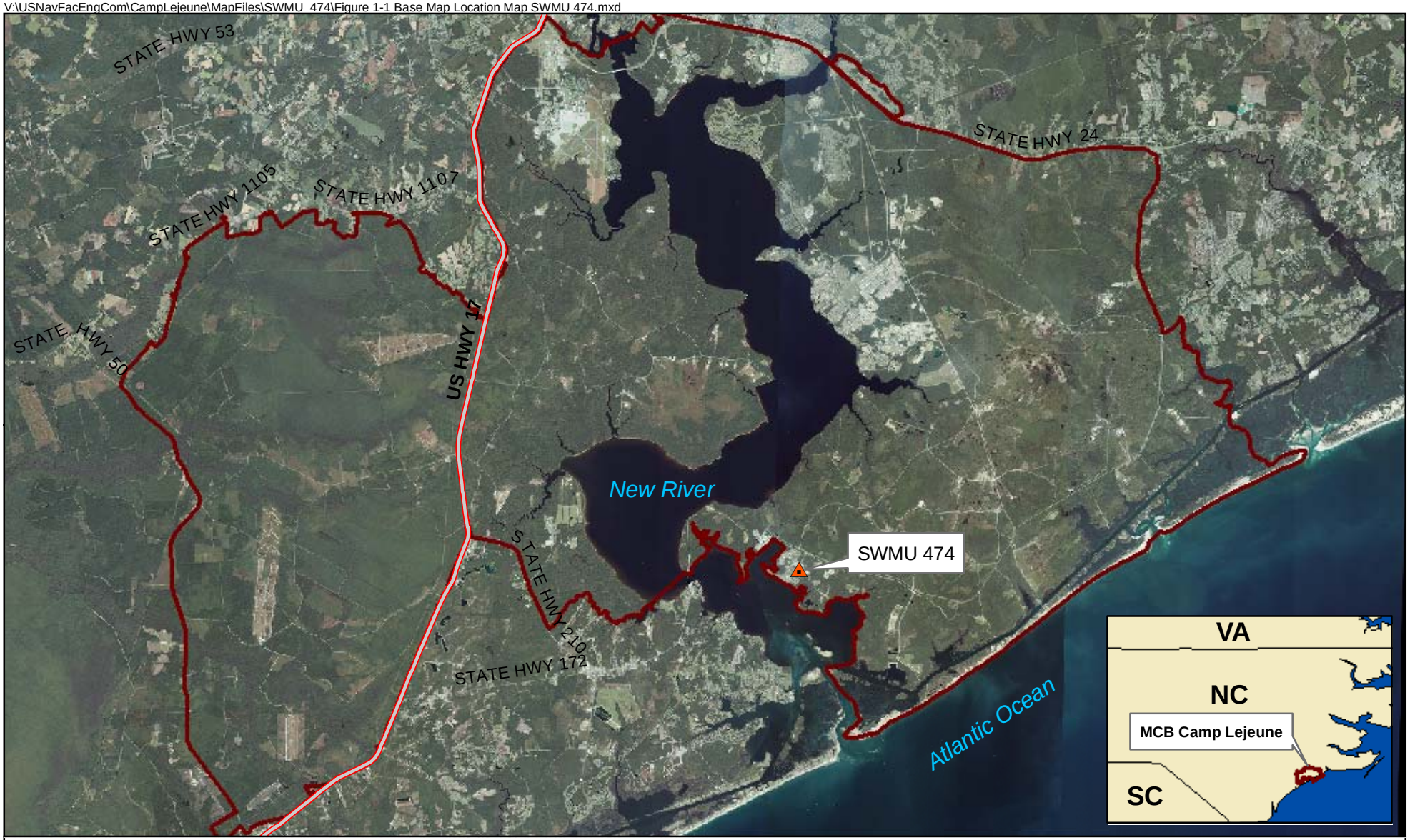
TABLE 5-1
Summary of Sampling Program
SWMU 474 RFI Work Plan
MCB Camp Lejeune
Jacksonville, North Carolina

Sample Media	Sample ID Number	Sample Depth/Location and Rationale	Analysis		
			VOCs	RCRA Metals (Total)	RCRA Metals (Dissolved)
Direct Push Surface Soil	SWMU474-IS12-0-1	Collected from an interval of 0 - 1 foot bgs as shown on Figure 4-1. Will evaluate the presence of impacted surface soil outside the SWMU boundary.	x	x	
Direct Push Subsurface Soil	SWMU474-IS09-T-B SWMU474-IS10-T-B SWMU474-IS12-T-B SWMU474-IS13-T-B	Collected from 1 ft interval within an impacted zone (as determined with PID/FID) or just above the water table at each location shown on Figure 4-1. Will evaluate the presence of impacted subsurface soil upgradient and side gradient of the SWMU.	x	x	
Temporary Groundwater Well	SWMU474-TW09 through SWMU474-TW15	Samples will be collected approximately 6-8 feet into the water table. TW-11 will be collected 40 ft bgs using a screen point sampler as shown on Figure 4-1. Will delineate the horizontal and vertical extent of impacted groundwater across the SWMU.	x	x	x
Permanent Groundwater Well	SWMU474-MW01 SWMU474-MW02 SWMU474-MW03 SWMU474-MW04	Locations and depths will be determined after the evaluation of the analytical results from the temporary well sampling. Will delineate the horizontal and vertical extent of impacted groundwater across the SWMU.	x	x	x

Notes and Abbreviations:
For Direct Push Soil Samples: "T-B" refers to the top depth and bottom depth of the sample interval

Figures

V:\USNavFacEngCom\CampLejeune\MapFiles\SWMU_474\Figure 1-1 Base Map Location Map SWMU 474.mxd



Legend

- Solid Waste Management Unit (SWMU)
- Highways
- Installation Boundary

N

0 7,500 15,000 30,000 Feet

1 inch equals 15,000 feet

Figure 1-1
Base Location Map
SWMU 474
MCB Camp Lejeune
North Carolina

CH2MHILL

\\aphrodite\proj\USNavFaceNGCom\CampLejeune\MapFiles\SWMU-474\RFI\Figure_2_1_SWMU474_Site_Map.mxd

Legend

- Manhole
- Approximate Boundary of SWMU 474

N

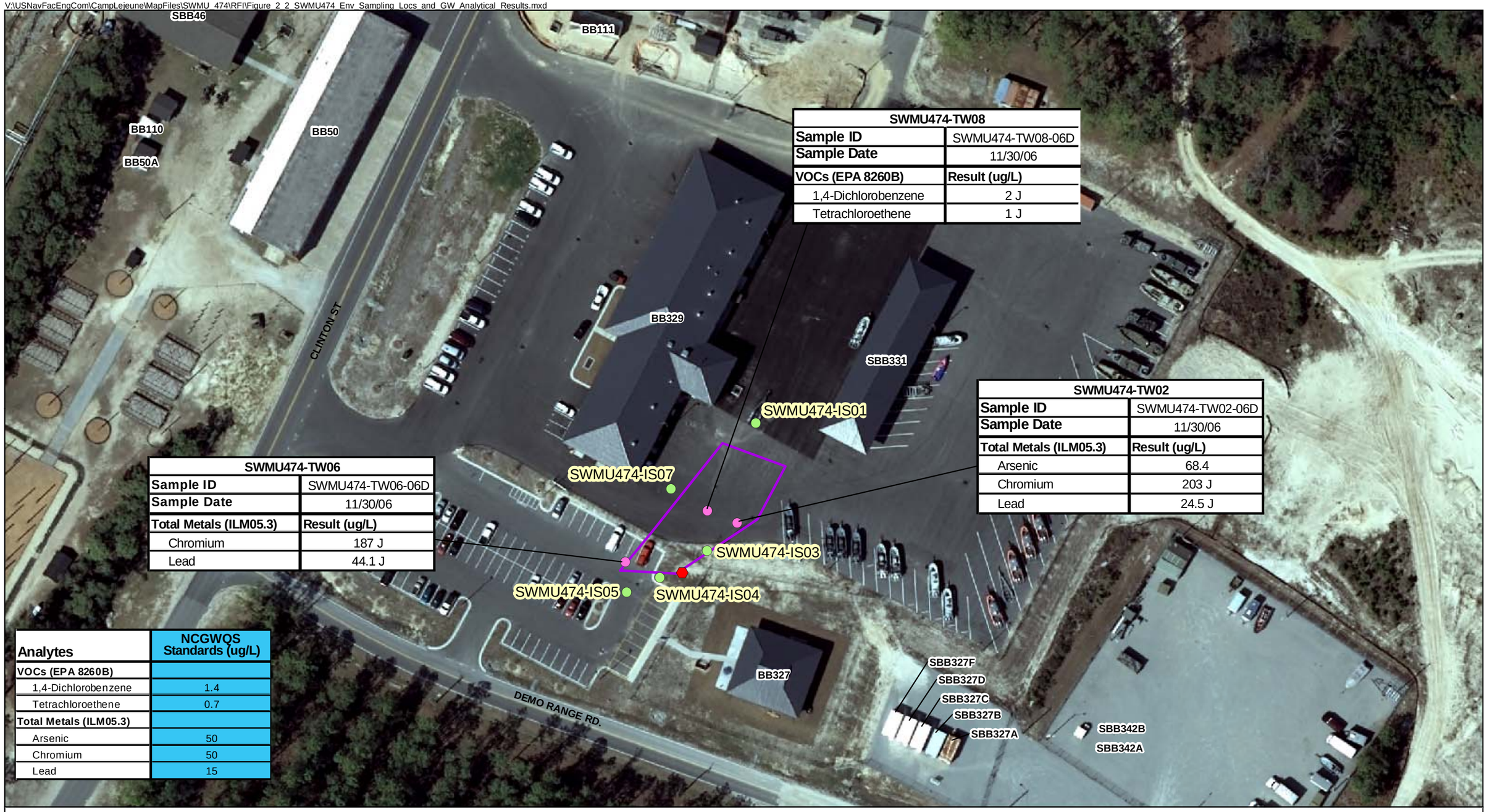
0 50 100 200 Feet

1 inch equals 100 feet

Figure 2-1
Site Map
SWMU 474 RFI
MCB Camp Lejeune
North Carolina

CH2MHILL

V:\USNavFacEngCom\CampLejeune\MapFiles\SWMU_474\RFI\Figure_2_2_SWMU474_Env_Sampling_Locs_and_GW_Analytical_Results.mxd



SWMU474-TW08	
Sample ID	SWMU474-TW08-06D
Sample Date	11/30/06
VOCs (EPA 8260B)	**Result (ug/L)**
1,4-Dichlorobenzene	2 J
Tetrachloroethene	1 J

SWMU474-TW02	
Sample ID	SWMU474-TW02-06D
Sample Date	11/30/06
Total Metals (ILM05.3)	**Result (ug/L)**
Arsenic	68.4
Chromium	203 J
Lead	24.5 J

SWMU474-TW06	
Sample ID	SWMU474-TW06-06D
Sample Date	11/30/06
Total Metals (ILM05.3)	**Result (ug/L)**
Chromium	187 J
Lead	44.1 J

Analytes	NCGWQS Standards (ug/L)
VOCs (EPA 8260B)	
1,4-Dichlorobenzene	1.4
Tetrachloroethene	0.7
Total Metals (ILM05.3)	
Arsenic	50
Chromium	50
Lead	15

Legend
- Temporary Well Sample
- Subsurface Soil Sample
- Manhole
- Approximate Boundary of SWMU 474

Notes:
J - Analyte present, value may or may not be accurate or precise
"D" identifier in sample ID indicates a duplicate sample

N

0 37.5 75 150 Feet

1 inch equals 75 feet

Figure 2-2
CSI Sampling
Locations and Groundwater Analytical Results
November 2006
SWMU 474 RFI
MCB Camp Lejeune
North Carolina

CH2MHILL

\\aphrodite\proj\USNavFaceNGCom\CampLejeune\MapFiles\SWMU_474\RFI\Figure 3_1_Nov_2006_CSI_Generalized.mxd

Legend

- Temporary Well Location
- Manhole
- Potentiometric Surface Contour (dashed where inferred)
- Groundwater Flow Arrow
- Approximate Boundary of SWMU 474

Notes:
-All water elevations are reported in feel above mean sea level.
-Potentiometric surface contours have been interpolated between monitoring well locations. Actual conditions may differ from those shown on this figure.
-Data collected November 30, 2006

N

0 25 50 100 Feet

1 inch equals 50 feet

Figure 3-1
Potentiometric Surface Map
November 2006
SWMU 474 RFI
MCB Camp Lejeune
North Carolina

CH2MHILL

\\aphrodite\proj\USNavFaceNGCom\CampLejeune\MapFiles\SWMU-474\RFI\Figure_4_1_SWMU474_Proposed_Sampling_locations.mxd

Legend

- Proposed Subsurface Soil Location and Deep DPT Groundwater Grab Sample Location
- Proposed Temporary Well Location, Surface and Subsurface Soil Location
- Proposed Temporary Well Location and Subsurface Soil Location
- Proposed Permanent Monitoring Well and Subsurface Soil Location
- CSI sampling location with reported groundwater exceeding criteria
- CSI sampling location with no soil detections exceeding criteria
- Manhole
- Approximate Boundary of SWMU 474

N

0 25 50 100 Feet

1 inch = 50 feet

Figure 4-1
Proposed Sampling Locations
SWMU 474 RFI
MCB Camp Lejeune
North Carolina

CH2MHILL

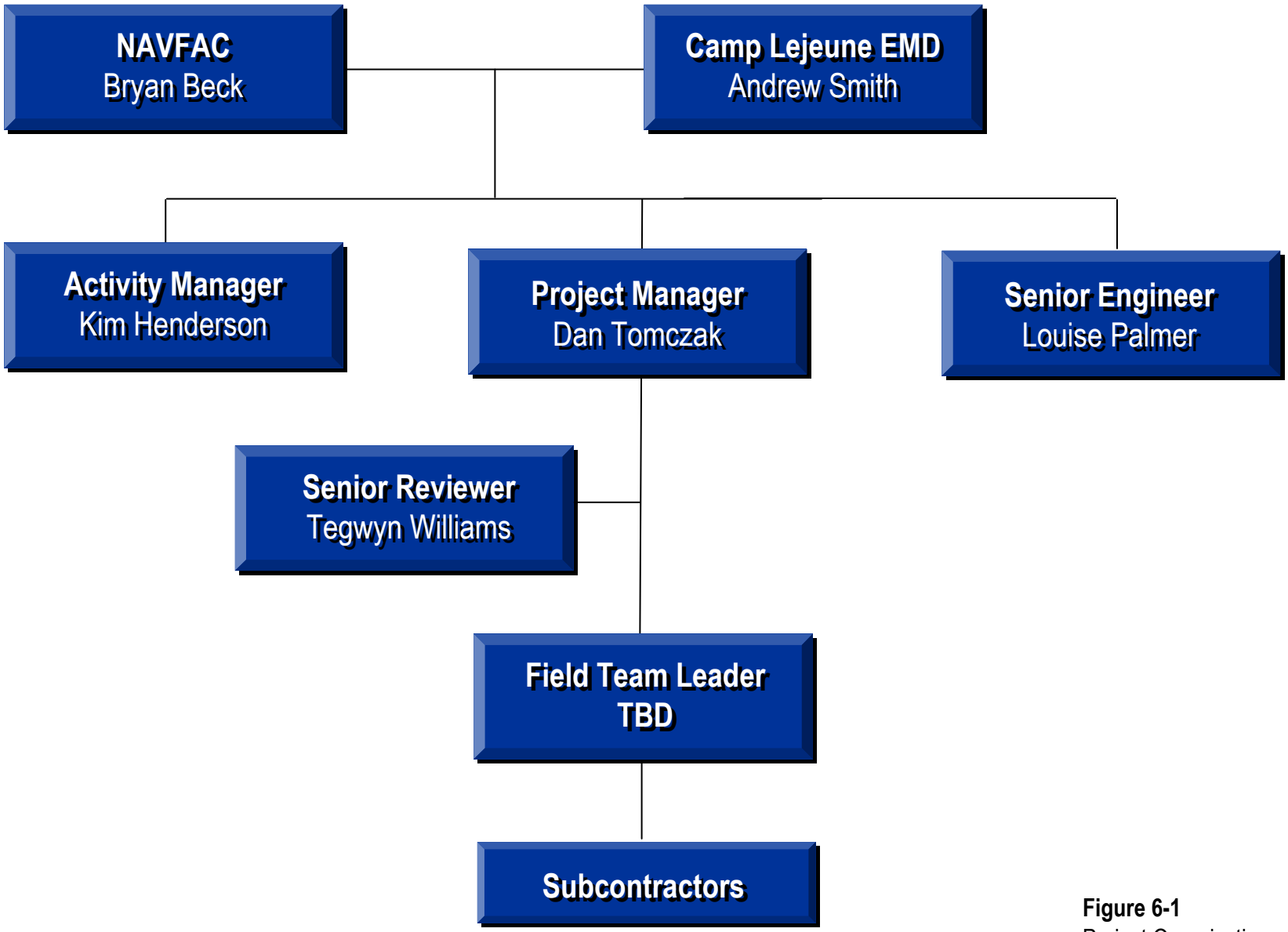


Figure 6-1
Project Organization
SWMU 474 RFI Work Plan
MCB Camp Lejeune

FIGURE 7-1
PROPOSED PROJECT SCHEDULE
SWMU 474 RFI
MCB CAMP LEJEUNE, NORTH CAROLINA

TASK NAME	DURATION (days)	Start Date
Draft RFI Work Plan	90	1 day after contract award
Final RFI Work Plan	60	1 day after comments received
RFI Field Work	30	1 day after Final Work Plan submittal
Laboratory Analysis/Data Validation	60	3 days after start of field work
Draft RFI Report	210	1 day after receiving validated data
Agency Review	40	1 day after Draft Report submittal
Final RFI Report	30	30 days after comments received

Appendices

Quality Assurance Project Plan

Sampling and Analysis Plan
RCRA Facility Investigation
RCRA Program, SWMU 474
(Field Sampling Plan and Quality Assurance Project Plan)

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

February 2009

Prepared for:
Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic Division

Prepared by:

CH2MHILL

Raleigh, North Carolina

Prepared under:
LANTDIV CLEAN III Program
Contract N62470-02-D-3052
Contract Task Order 134 Mod 5

Review Signatures: Daniel M Tomczak _____

Louise A. Palm _____

Approval Signatures _____

Other Approval Signatures: _____

Acronyms and Abbreviations

A2LA	American Association of Laboratory Accreditation
CLP	Contract Laboratory Program
CO	Consent Order
COC	Chain of Custody
CompQAP	Comprehensive Quality Assurance Plan
COPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
CTO	Contract Task Order
DI	Deionized
DoD	Department of Defense
DQE	Data Quality Evaluation
EDD	Electronic Data Deliverable
EIS	Environmental Information Specialist
EPA	Environmental Protection Agency
FTL	Field Team Leader
GC	Gas Chromatograph
GC/MS	Gas Chromatograph/Mass Spectrometer
GIS	Geographic Information System
GPS	Global Positioning System
GW	Ground Water
HPLC	High Performance Liquid Chromatography
HSM	Health and Safety Manager
HSP	Health and Safety Plan
ICP	Inductively Coupled Plasma
ICS	Interference Check Samples
IDL	Instrument Detection Limit
IDW	Investigation-Derived Waste
IS	Internal Standard
LCS	Laboratory Control Sample
LTM	Long Term Monitoring
MCB	Marine Corps Base
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
M&TE	Measuring and Test Equipment
MS/MSD	Matrix Spike/Matrix Spike Duplicate

NAVFAC	Atlantic Division, Naval Facilities Engineering Command
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NIST	National Institute of Standards and Technology
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PC	Project Chemist
PDF	Portable Document Format
PM	Project Manager
QA	Quality Assurance
QAM	Quality Assurance Manual
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation Limit
RAC	Remedial Action Contractor
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RL	Reporting Limit
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RSD	Relative Standard Deviation
RT	Retention Time
RTM	Remedial Technical Manager
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SOW	Statement of Work
SQL	Sample Quantitation Limit
STC	Senior Technical Consultant
SVOC	Semivolatile Organic Compound
SW	Surface Water
SWMU	Solid Waste Management Unit
TBD	To Be Determined
UFP	Uniform Federal Policy
VOA	Volatile Organic Analyte
VOC	Volatile Organic Compound
WP	Work Plan

Contents

Appendix

Tables

SAP Identifying Information

Site Name/Number: MCB Camp Lejeune SWMU 474
Contractor Name: CH2M HILL
Contract Number: N62470-02-D-3052
Contract Title: LANTDIV CLEAN III Program
Work Assignment Number (optional): CTO 134 Mod 5

1. This SAP was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (U.S. EPA 2005) and *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (U.S. EPA 2002)*. Identify any additional guidance used to prepare SAP: N/A

2. Regulatory program: RCRA

3. This SAP is a project specific SAP.

4. List dates of scoping sessions that were held: In February 2007, NAVFAC and Camp Lejeune informed CH2M HILL of work needed at SWMU 474. Formal scoping sessions were not used.

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation: September 11, 2006 a Site Specific Confirmatory Sampling Investigation Work Plan for SWMU 474 was submitted to NAVFAC and NC DENR. August 8, 2007 a Final Confirmatory Sampling Investigation Report for SWMU 474 was submitted to NAVFAC and NC DENR.

6. List organizational partners (stakeholders) and connection with lead organization: USEPA, NCDENR, MCB Camp Lejeune

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7. Lead organization: Department of the Navy

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

The crosswalk table below references the location of all 37 required elements of the UFP-SAP. They are either provided in the attached QAPP or in accompanying documents.

Crosswalk to Related Information

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	Page 1 of SAP
2	Table of Contents SAP Identifying Information	Pages 5 to 6 of SAP Page 7 of SAP
3	Distribution List	Page 14 of SAP
4	Project Personnel Sign-Off Sheet	Page 14 of SAP
Project Organization		
5	Project Organizational Chart	Figure 6.1 of Work Plan
6	Communication Pathways	Section 1.1.2 of SAP
7	Personnel Responsibilities and Qualifications Table	Section 1.1.2 of SAP
8	Special Personnel Training Requirements Table	Section 1.1.6 of SAP
Project Planning/ Problem Definition		
9	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet	NA
10	Problem Definition, Site History, and Background. Site Maps (historical and present)	See Work Plan for Site background and site maps.
11	Site-Specific Project Quality Objectives	Section 1.1.5 of SAP
12	Measurement Performance Criteria Table	Section 1.1.1 of SAP
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	No secondary data used in developing this SAP.
14	Summary of Project Tasks	Section 1.1.4 of SAP and Section 4 of Work Plan
15	Reference Limits/Evaluation Table	Tables 1-4 and 1-5 of Section 1.2.5 of SAP/ Tables 1-2 and 1-3 of Section 1.2.4
16	Project Schedule/Timeline Table	Section 6.0 of Work Plan
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale	Section 5.3 of Work Plan
18	Sampling Locations and Methods/ SOP Requirements Table Sample Location Map(s)	Figure 4-1 of Work Plan for Proposed Sample Locations and Map; Table 1-12 of SAP for SOP requirement
19	Analytical Methods/SOP Requirements Table	Table 1-6 of SAP
20	Field Quality Control Sample Summary Table	Section 1.2.3 of Table 1-1 of SAP
21	Project Sampling SOP References Table	Section 1.4 of Table 1-12 of SAP

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Section 1.2.9 of Table 1-9 of SAP
Analytical Tasks		
23	Analytical SOPs Analytical SOP References Table	Table 1-6 of SAP
24	Analytical Instrument Calibration Table	Section 1.2.10 of Table 1-10 of SAP
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Section 1.2.10 of SAP
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	Section 1.2.3 of SAP
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody Form and Seal	Section 1.2.3 of SAP Appendix A
Quality Control Samples		
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree	Table 1-1 of SAP
Data Management Tasks		
29	Project Documents and Records Table	Section 1.4.4 of Table 1-11 of SAP
30	Analytical Services Table Analytical and Data Management SOPs	Table 1-2 of SAP
C. Assessment Oversight		
31	Planned Project Assessments Table Audit Checklists	Section 1.3.1.2 of SAP
32	Assessment Findings and Corrective Action Responses Table	Section 1.2.6 of SAP
33	QA Management Reports Table	Section 1.3.2 of SAP
D. Data Review		
34	Verification (Step I) Process Table	Section 1.4 of SAP
35	Validation (Steps IIa and IIb) Process Table	Section 1.4 of SAP
36	Validation (Steps IIa and IIb) Summary Table	Section 1.4 of SAP
37	Usability Assessment	Section 1.4.4 of SAP

SECTION 1

Quality Assurance Project Plan

1.1 Project Management

This site-specific *Quality Assurance Project Plan* (QAPP) is meant to serve in conjunction with the Marine Corps Base (MCB) Camp Lejeune Master Project QAPP (CH2M HILL, 2008). The specific information contained in this site-specific QAPP supplements the general information contained in the Master QAPP. This document applies only to the RFI at SWMU 474. The QAPP describes the data quality objectives, specific quality assurance (QA) and quality control (QC) activities, and laboratory activities necessary to achieve the data quality objectives (DQOs) of the project. Subcontractors will be required to review both the Master QAPP and the site-specific QAPP, and will be expected to adhere to the procedures specified in these documents. All field activities will be conducted by CH2M HILL or subcontractors under the direct supervision of CH2M HILL.

1.1.1 Introduction

This QAPP provides QA/QC requirements for sampling activities, sample analyses, and other tests that will generate data as part of the activities performed during the RFI at SWMU 474. The RFI will further evaluate the presences of impacted soil and groundwater at SWMU 474. This QAPP is a component of the project work plan (WP) and has been prepared in accordance with the *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA QA/R-5, March 2001).

Quality Assurance involves all those planned and systematic actions necessary to provide adequate confidence that field activities will be performed satisfactorily and safely. The goal of QA is to ensure that activities are planned and performed according to accepted standards and practices so that the resulting data are valid and useable for the project decision-making process. QC is an integral part of the overall QA function and is comprised of all those actions necessary to control and verify that project activities and the resulting data meet established requirements.

The requirements of this document apply to contractors and subcontractors. Deviations from these procedures will be documented.

This section provides an overview of project management and addresses the following topics:

- Project organization and roles and responsibilities
- Project definition and background
- Project description
- Quality objectives and criteria for measurement data
- Documentation and records management

Section 1.2 describes the measurement and data acquisition procedures and the analytical methods to be performed in support of this monitoring. It addresses the following aspects of measurement and data acquisition:

- Sampling process design
- Sampling method requirements
- Sample handling and custody requirements
- Analytical method requirements
- QC requirements
- Instrument and equipment testing, inspection, and maintenance requirements
- Instrument calibration and frequency
- Inspection and acceptance requirements for supplies and consumables
- Data acquisition requirements

Section 1.3 describes the assessment and oversight activities that will be followed to determine whether the QC identified this QAPP is being implemented and documented as required.

Section 1.4 presents the data review, validation, and evaluation requirements.

1.1.2 Project Organization Roles and Responsibilities

This subsection identifies key project team members associated with the planned sampling work and lists the responsibilities associated with each position. The organizational structure and responsibilities are designed to provide project control and QA for the proposed sampling program.

Project Manager (PM). The PM for this project will be Mr. Dan Tomczak. The PM is responsible for overall activities for a specific project. The PM is responsible for cost and schedule control and for technical quality; in addition, he develops the WP and monitors task order activities to ensure compliance with project objectives and scope. The PM also communicates with the Agencies, and as appropriate, other designated parties regarding project progress.

The PM has ultimate responsibility within the project team for producing deliverables that are technically adequate, satisfactory to Mid-Atlantic Division, Naval Facilities Engineering Command (NAVFAC) for meeting Resource Conservation and Recovery Act (RCRA) requirements, and cost-effective. To accomplish this, the PM develops an internal project review schedule, provides written instructions and frequent guidance to the project team, and monitors budgets and schedules. The PM works with the project team to select an internal QA/QC review team and to coordinate review efforts, and works with the project team in addressing review comments and adjudicating technical disagreements.

Senior Technical Consultants (STCs). The STCs for this project will be Ms. Louise Palmer, PE, and Mr. Teg Williams, LG. The STCs have significant experience in the various technical aspects involved in a complex project. The STCs coordinate all internal QA/QC review for technical validity and adherence to NCDENR and USEPA criteria. The review team is responsible for evaluating the technical merit of the work planning documents before field activities begin, and for reviewing all deliverables before submittal to the Agencies. The STCs assist the PM in selecting an internal QA/QC review team and coordinating review

efforts, and work with the project team in addressing review comments and resolving technical issues.

Project Chemist (PC). The PC for this will be Ms. Anita Dodson. The PC assists with the preparation of the project work planning documents, provides a point of communication between the laboratory and the project team, supervises the analytical DQE, and participates in preparing deliverables to the client. The PC coordinates with the project team and the analytical laboratory during the field activities. The PC also is responsible for monitoring project-specific laboratory activities (including checking laboratory invoices and reports) and may audit the laboratory operations at the PM's direction. The PC also monitors field and laboratory activities such that QA/QC requirements described in this project-specific QAPP are coordinated effectively.

Environmental Information Specialist (EIS). The EIS for this project is Ms. Genevieve Moore. The EIS is responsible for tracking the data from sample collection, through submission to third party validator, through internal chemist review. She is also responsible for sending data to load into the database.

Field Team Leader (FTL). The FTL reports to the PM and is responsible for the coordination of field efforts, provides for the availability and maintenance of sampling equipment and materials, and provides shipping and packing materials. The FTL will supervise completion of all chain-of-custody records, supervise the proper handling and shipping of samples, and be responsible for accurate completion of the field notebooks. As the lead field representative, the FTL will be responsible for consistently implementing program QA/QC measures at the site and for performing field activities in accordance with approved work plans, policies, and field procedures.

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

Health and Safety Manager (HSM). The HSM is Mr. Mike Goldman. The HSM reviews and approves the project-specific HSP, as well as the subcontractor HSPs. The HSM serves as the point of contact for the SSC for any health- and safety-related issues, and may conduct project audits. The HSM also is responsible for investigating accidents should any occur during the course of the project.

Distribution List

This table identifies all recipients of the QAPP and work plan and is not exclusively for CH2M HILL personnel.

Name of SAP Recipients	Title/Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address
Bryan K. Beck	Remedial Project Manager-Camp Lejeune	NAVFAC Mid-Atlantic	(757) 322-4734	bryan.k.beck@navy.mil
Beth Hartzell	Environmental Engineer	NCDENR	(919) 508-8489	beth.hartzell@ncmail.net
Andrew Smith	Environmental Manager	MCB Camp Lejeune	(910) 451-9017	stephen.a.smith2@usmc.mil
Bob Lowder	Environmental Engineer	MCB Camp Lejeune-Environmental Management Division (EMD)	(910) 451-9607	robert.a.lowder@usmc.mil
Randy McElveen	Remedial Project Manager	NCDENR	(919) 508-8467	randy.mcelveen@ncmail.net
Louise Palmer	Senior Engineer	CH2M HILL	(704) 543-3276	louise.palmer@ch2m.com
Rick Powell	Senior Environmental Consultant	CH2M HILL	(704) 543-3275	rick.powell@ch2m.com

Project Personnel Signoff Sheet:

Name	Organization/Title / Role	Telephone Number (optional)	Signature/email receipt	SAP Section Reviewed	Date SAP Read
Bryan K. Beck	Remedial Project Manager-Camp Lejeune/ NAVFAC Mid-Atlantic	(757) 322-4734			
Mike Casalena	Senior Project Manager-Shealy Environmental Services, West Columbia, SC	(803) 791-9700			

Laboratory Work Group

The selected laboratory is responsible for analyzing samples collected during field activities, in accordance with the FSP and the laboratory comprehensive quality assurance plan (CompQAP). The laboratory PM or client service manager acts as a liaison between the PC and the field and laboratory operations and is responsible for the following:

- Receipt of sample custody from the field team members, verification of sample integrity, and transfer of sample fractions to the appropriate analytical departments
- Coordination of sample analyses to meet project objectives
- Preparation of analytical reports
- Review of laboratory data for compliance with method requirements
- Review of any QC deficiencies reported by the analytical department manager
- Coordination of any data changes resulting from review by the project QA supervisor or the PM
- Completion of data package deliverables
- Communication with the PC pertaining to analytical and QC issues
- Response to questions from the project team during the data quality evaluation (DQE) process

Project Communication

Effective communication among all project personnel will be established and maintained throughout the course of the project. At the beginning of the project, and/or at the start or end of major milestones, the PM will prepare written project instructions that will be distributed to all team members. These instructions will document project and task objectives and each team member's responsibility in meeting the objectives, as well as a budget and schedule for successfully executing the work.

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

During the field sampling phase of this project, the field team will meet daily to review the status of the project and to discuss technical and safety issues. When necessary, other meetings will be scheduled or the FTL will meet individually with field personnel or other stakeholders to resolve problems.

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

1.1.3 Problem Definition and Background

This RFI is taking place in response to the presence of contaminants in groundwater exceeding state and federal screening criteria at SWMU 474 located at MCB Camp Lejeune. Refer to the project WP for specifics of each site.

1.1.4 Project Description

The objective of the RFI sampling effort is as follows:

- Further evaluate the presence of groundwater contamination at SWMU 474.
- Further evaluate the presence of soil contamination at SWMU 474.
- Review the risk of contaminants associated with the SWMU to human health and ecological environment.

Project tasks include the soil sampling, installation of temporary monitoring wells and groundwater sampling at SWMU 474. CH2M HILL is responsible for the completion of work plans, soil sampling, monitoring reports, and overall project management, well installation, groundwater sampling and reports.

The project objective was used to develop specific DQOs, described in the next subsection. Additional information regarding the overall objective and general sampling approach is presented in the WP.

1.1.5 Quality Objectives and Criteria for Measurement Data

In order to ensure that minimum level of certainty regarding the quality of field data is being met, the following elements will be addressed to meet the requirements specified by the client and regulatory agencies:

- Field operations will be conducted in accordance with written standard operating procedures (SOPs).
- To maintain accuracy within necessary limits, measuring and test equipment (M&TE) used in field investigations will be calibrated against traceable standards at specific intervals, using approved SOPs or manufacturer's instructions.
- When M&TE is found to be out of specification, the previous inspection or test results will be evaluated for validity and acceptability. This evaluation will be documented.
- Before project field work begins, all project staff will be trained to ensure that they are familiar with project work plans and associated documents.
- Internal audits may be performed to assess the quality of project activities and to evaluate compliance with established QA requirements.
- QC samples will be collected to monitor the quality of field and laboratory techniques and resulting analytical data.

This subsection defines the levels of data and briefly outlines the DQO development process for this project. The level of data quality is dependent on the objective use of the results supported by the data. This subsection also provides the quantitative quality objectives and measurement performance criteria for the analytical data.

Levels of Data Quality

The data use determines the required levels of data quality. The two categories of data quality established by the EPA, ***screening*** and ***definitive***, are defined as follows:

Screening data are generated by rapid methods of analysis with less rigorous sample preparation, calibration and/or QC requirements as compared to the requirements for producing definitive data. Sample preparation steps commonly are restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data may provide analyte identification and quantitation, although the quantitation may be relatively imprecise, unless EPA reference methods are used. Physical test methods such as dissolved oxygen (DO) measurements, temperature and pH measurements, moisture content, turbidity, conductance, etc., have been designated by definition as screening techniques.

Depending on the DQOs, screening methods may require confirmation samples that generate definitive data. Confirmation samples will be selected to include both detected and nondetected results from the screening technique.

Definitive data are generated using rigorous analytical methods such as approved EPA reference methods. Data are analyte-specific, and both identification and quantitation are confirmed. These methods have standardized QC and documentation requirements. Definitive data are not restricted in their use unless quality problems require data qualification.

Four levels of data reporting may be performed as part of this field effort, with each level having different supporting QA/QC documentation. The four levels correspond to QC Levels I, II, III, and IV. Level I data reporting includes field monitoring activities such as measurements of pH, temperature, conductivity, DO, ORP, and turbidity. Level II data reporting may include screening activities, which are indicative of the nature of contamination, whereas Level III data reporting provides definitive or confirmation data. Level IV data reporting includes the highest level of QC with significant additional documentation.

Level IV data packages will be requested for this project.

Level I–Field Surveys. Level I includes field monitoring or screening activities and does not require formal data package deliverables. Level I activities are focused on easily measured bulk characteristics of a sample such as pH, conductivity, ORP, and DO. Monitoring results, as well as pertinent data concerning the sampling event, will be documented in the bound field book. Level I documentation will consist of the following:

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

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

Level II–Screening Activities, Physical Parameters, and Investigation-derived Waste Analyses. Level II includes the analyses submitted to the laboratories for screening, physical parameter testing, and analyses associated with the characterization of the IDW samples. Samples submitted for analysis under Level II will require the delivery of an analytical data package. Level II documentation will consist of the following:

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

Level III–Laboratory Analysis. Not applicable.

Level IV–Laboratory Analysis. The requirements for Level IV documentation also are described in **Table 1-8**. This level provides the most stringent level of documentation, and allows the data reviewer or data validator to recreate the analytical sequence and evaluate raw data such as quantitation reports generated from the instrumentation used in the analyses. The list of methods (presented in Table 1-8) and the corresponding target analytes have been designed to evaluate the potential for contamination at the site. Samples will be analyzed using EPA-approved methods, including methods from the following documents:

- SW-846–*Test Methods for Evaluating Solid Waste* (EPA, 1998)
- Annual Book of the American Society for Testing and Materials (ASTM) Standards (1993)
- *Methods for Chemical Analysis of Water and Wastes* (EPA, 1983)

Data Quality Objective Development

DQOs are both qualitative and quantitative statements that define the type, quality, and quantity of data necessary to support the decision-making process during project activities. The intended final use of the data determines the DQOs, which are developed before sampling and analysis plans.

The credibility of the data is strengthened by the level of the supporting QA/QC documentation. The greater the importance of the data or the resulting decision, the more QA/QC information is needed to validate the data. This reasoning must be applied to the data collected for any project. The DQO process used for this project follows the EPA QA/G-4 guidance (EPA, 2000) and uses the seven-step DQO development process below:

1. **State the problem.** Describe concisely the problem to be studied.
2. **Identify the decisions.** State the decisions to be made to solve the problem.
3. **Identify inputs to the decisions.** Identify information and supporting measurements needed to make the decisions and describe the source(s) of the information.
4. **Define the boundaries of the study.** Specify conditions (that is, time periods and spatial locations).
5. **Develop a decision rule.** Define the conditions by which a decision-maker will select alternatives, usually specified as "if/then" statements (for example, if average concentration in soil is less than cleanup level, then the site achieves remedial action goals).
6. **Specify tolerable limits on decision errors.** Define in statistical terms.

7. **Optimize the design for obtaining data.** Evaluate the results of the previous steps and develop the most resource-efficient design for data collection.

A detailed discussion of the development of the project-specific DQOs is presented in Section 4 of the project WP.

Method Performance Objectives

The sampling approach and rationale are based on the DQOs, and are presented in the WP. Site-specific DQOs are developed for each sampling event. One activity associated with developing the sampling approach and rationale is developing a list of samples to be collected, sample types, sampling intervals, analytical parameters, and required detection and quantification limits for each required parameter.

Once the number and type of samples and analytical parameters are determined, the method performance requirements are developed. The method performance requirements focus on determining the level of QA/QC and the data package deliverable requirements for all analyses.

Quality of Data

Analytical performance requirements are expressed in terms of precision, accuracy, representativeness, comparability, and completeness (PARCC). Summarized below are brief definitions for each PARCC parameter, and calculation equations as appropriate.

Precision. Precision is a measure of the agreement or repeatability of a set of replicate results obtained from duplicate analyses made under identical conditions. Precision can be estimated by comparing duplicate matrix spike concentrations and field duplicate sample results. The precision of a duplicate determination can be expressed as the relative percent difference (RPD), calculated as:

$$\text{RPD} = \left\{ \frac{|X_1 - X_2|}{\frac{(X_1 + X_2)}{2}} \right\} x\,100$$

where X_1 is the result from the native sample, and X_2 is the result from the duplicate sample.

Accuracy. Accuracy is a measure of the agreement between an experimental determination and the true value of the parameter being measured. Accuracy is estimated through the use of known reference materials and matrix spikes. It is calculated from analytical data and is not measured directly. Spiking of reference materials into a sample matrix provides a measure of the matrix effects on analytical accuracy. Spiking of reference materials into a "non-matrix", such as deionized (DI) water or Ottawa sand, provides a measure of the accuracy of the analytical method itself. Accuracy, defined as percent recovery (P), is calculated as:

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

where SSR is the spiked sample result, SR is the sample result (native), and SA is the spike concentration added to the spiked sample.

Representativeness. Representativeness is a measure of the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. Representativeness is demonstrated by providing full descriptions in the project planning documents of the sampling techniques and by making certain that the sampling locations are selected and the number of samples collected such that the accuracy and precision criteria are met.

Comparability. Comparability is another qualitative measure designed to express the confidence with which one data set may be compared to another. Sample collection and handling techniques, sample matrix type, and analytical method all affect comparability. Comparability is limited by the other PARCC parameters because data sets can be compared with confidence only when precision and accuracy are known. Data from one phase of an investigation can be compared to others when similar methods are used and similar data packages are obtained.

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

$$Completeness = \frac{Valid\ Measurements}{Total\ Measurements} x100$$

Experience on similar projects has shown that laboratories typically achieve approximately 95 percent completeness. All validated data will be used. During the data validation process, an assessment will be made of whether the valid data are sufficient to meet project objectives. If sufficient valid data are not obtained, the PM will initiate corrective action.

Project Quality/Systematic Planning Process Statements

Who will use the data?

The data will be used by the Navy, CH2M HILL, USEPA, and NCDENR. Within each organization the data will be used by staff scientists/engineers and project managers.

What are the Project Action Limits (PALs)?

- Concentrations of the groundwater contaminants of potential concern (COPCs) identified in the investigation will be compared to the North Carolina Groundwater Quality Standards and the established background/secondary criteria (for metals only).
- Concentrations of the soil COPCs identified in the investigation will be compared to NC DENR soil to groundwater screening criteria and/or Regional Screening Criteria and the established background/secondary criteria (for metals only).
- Wastes generated for offsite disposal/treatment will be compared to hazardous waste criteria and transport, storage and disposal facility acceptance criteria.

What will the data be used for?

- Data will be used to evaluate the presence and distribution of COPCs within soil and groundwater at SWMU 474.
- Data will be used to estimate the risk to human health and the environment.
- Laboratory analytical data from samples of the investigation derived waste (IDW) will be used to determine appropriate disposal methods.

What types of data are needed?

New analytical soil and groundwater data of VOCs and RCRA metals are needed in order to accomplish the RFI objectives.

How "good" must the data be to support the environmental decision?

- VOCs and RCRA metals should achieve laboratory analytical reporting limits at or lower than NC2L Groundwater Standards for groundwater samples.
- VOCs and RCRA metals should achieve laboratory analytical reporting limits lower than NC DENR soil to groundwater screening criteria and/or Regional Screening Criteria for soil samples.
- The laboratory data must also pass quality assurance and validation checks.

How much data should be collected (number of samples for each analytical group, matrix, and concentration)? Where, when, and how should the data be collected/ generated?

- Six groundwater samples will be collected from SWMU 474, and are shown on **Figure 4-1** of the WP. The sample locations were chosen based on previous CSI sampling locations in order to adequately delineate the extent of groundwater impacts at SWMU 474.
- Two soil samples will be collected from SWMU 474, and are shown on **Figure 4-1** of the WP. The sample locations were chosen in order to identify potential source areas for down gradient groundwater contamination and delineate impacted soils by VOCs and metals.
- Numbers of QA/QC samples for each chemical analysis are displayed on **Table 1-1**.
- The data will be collected following the Standard Operating Procedures (SOPs) presented in **Appendix A**.

Who will collect and generate the data? How will the data be reported?

- CH2M Hill will collect the soil and groundwater samples for chemical analyses.
- Chemical analyses will be performed by Shealy Environmental Services, a Navy-approved laboratory.
- All laboratory analytical data will be submitted to a Navy-approved third party data validator under subcontract to CH2M HILL for validation by National Functional Guidelines and USEPA Region IV modifications.

- CH2M HILL will receive validated analytical data and upload the data into a centralized electronic database used for Navy projects (EnDat).
- The analytical data will be reported in the RFI report following the fourth quarterly sampling event.

How will the data be archived?

Data will be archived according to procedures specified in the Navy CLEAN program/ contract. All analytical data will be uploaded into a centralized database developed and maintained by CH2M HILL (EnDat) and used for Navy projects. At the end of the project, hard copies of archived laboratory data and validation reports will be forwarded to the Navy.

PQOs listed in the form of if/then qualitative and quantitative statements.

Use of Reference Area Data PQOs

- If an NC2L Groundwater criterion, NC DENR soil to groundwater screening criteria and/or Regional Screening Criteria is exceeded, then further environmental sampling of the site will take place.
- If an NC2L Groundwater criterion, NC DENR soil to groundwater screening criteria and/or Regional Screening Criteria is not exceeded at a specific site, than that site will be given a No Further Action status.

1.1.6 Special Training, Requirements, and Certifications

The PM works with the Operations Leader, Regional Technology Manager, and Senior Technical Consultants to assemble a project team that has the necessary experience and technical skills. Part of the work planning process is to identify special training requirements or certifications necessary to execute the project successfully. Special training or certifications required beyond the normal routine requirements have not been identified for this project.

1.1.7 Documentation and Records

This subsection defines which records are critical to the project and what information needs to be included in reports, as well as the data reporting format and the document control procedures. It is imperative for the defensibility of critical decisions made at the site that proper documents and records be maintained for the field and offsite data gathering activities, so that specific events can be recreated or independently evaluated. The PM will be responsible for organizing, storing, and cataloging all project information. The PM also is responsible for collecting records and support data from all project team members. Individual project team members may maintain separate notebooks for individual tasks; any files necessary to be retained in the permanent file will be forwarded to the PM for real-time archiving upon preparation. Permanent files will not be retained in individual team member's possession, but will be forwarded to the PM at the close of the project. However, copies of permanent records may be retained in their individual files for use during the project and discarded at the close of the project. Personal copies of permanent records will not be forwarded to the PM at the close of the project; it is the individual's responsibility to ensure that records in their possession are archived real-time.

Surveying

The locations and elevations of all newly-installed monitoring wells will be surveyed by a NC-licensed professional land surveyor. Details of the surveying activities are provided in the SOPs (**Appendix A**).

Field Documentation

Field documentation includes:

- Soil boring logs
- Temporary monitoring well construction diagrams
- Well development logs
- Water level data sheets
- Field logbook to record data collection activities and observations (including date and time, sample locations, depth, health and safety measures, weather conditions, sampling personnel, analyses requested, field instrument calibration, maintenance logs, and sketches)
- Sample collection field sheets
- Chain-of-custody documentation
- Additionally, field QC and corrective action documents may be generated as a result of field audits

Field documentation will be stored with the project records.

Laboratory Documentation

Calculations to be used for data reduction are specified in the referenced analytical methods.

Whenever possible, analytical data will be transferred directly from the instrument to a computerized data system. Raw data will be stored electronically, and a hard copy file will be maintained. Laboratory data entered will be sufficient to document information used to arrive at reported values.

Electronic data storage will be utilized when possible. All electronic data will be maintained in a manner that prevents inadvertent loss, corruption, and inappropriate alteration.

Raw data will be examined to assess compliance with quality control guidelines. Surrogate, matrix spike, and QC check sample recoveries will be checked. In addition, samples and laboratory blanks will be checked for possible contamination or interferences. Chromatograms and concentrations will be checked to ensure that sample results are within the calibration range; if necessary, dilutions will be performed as defined by the initial calibration range.

Deviations from guidelines will call for corrective action. Deviations determined to be caused by factors outside the laboratory's control, such as matrix interference, will be noted

with an explanation in the report narrative. Calculations will be checked and the report reviewed for errors and oversights.

Upon completion, a report will be reviewed for discrepancies, errors, or omissions. Data will then be submitted to the laboratory Quality Assurance Manual (QAM) for review and approval. The laboratory QAM will review the package, ensure that any necessary corrections are made, and give the package to the laboratory project manager for review. A copy of the data package will be filed in the project file. Mailed data packages, along with applicable electronic data deliverables, will be sealed in an appropriate shipping container and logged into a document mailing log.

The laboratory data package deliverables are discussed in Section 1.2.4. The requested turn-around time for the majority of the definitive data will be 21 days from the time of sample receipt at the laboratory.

1.2 Measurement and Data Acquisition

This subsection describes the procedures for collection, handling, measurement, data acquisition, and management activities to be performed in support of the SWMU 474 RFI. It addresses the following aspects of measurement and data acquisition:

- Sampling process design
- Sampling method requirements
- Sample handling and custody requirements
- Analytical method requirements
- QC requirements
- Instrument and equipment testing, inspection, and maintenance requirements
- Instrument calibration and frequency
- Inspection and acceptance requirements for supplies and consumables
- Data acquisition requirements

1.2.1 Sampling Process Design

Refer to the WP for details on sampling design and rationale.

1.2.2 Sampling Method Requirements

This subsection includes instructions for the following procedures:

- Field parameter measurement
- Soil sample collection
- Groundwater sample collection
- QC sample collection
- Preservation of samples
- Decontamination and cleaning of sampling equipment

A separate area will be designated for the decontamination of the sampling equipment and the storage of IDW.

The analytical methods, sample containers, preservative requirements, and maximum holding times for common methods are specified in **Table 1-3**. The laboratory will provide pre-cleaned containers and shipping coolers.

1.2.3 Sample Handling and Custody Requirements

Proper sample handling, preservation, shipment, and maintenance of a chain of custody (COC) are key components to building the documentation and support for data within the evidentiary process in order that the data can be used for decision-making. It is essential that all sample handling and sample chain-of-custody requirements be performed in a complete, accurate, and consistent manner. Sample handling and custody requirements must be followed for all samples collected as part of the investigation.

The FTL is responsible for proper sampling, labeling, preserving, and shipping samples to the laboratory to meet the required holding times.

Sample Identification

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

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

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

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

Site # - Media-Station # or QA/QC # – Year/Round or Depth Interval

An explanation of each identifier is provided below:

Site #	SWMU 474
Media	GW – Groundwater SS- Surface Soil IS- Subsurface Soil WT – Water (rinsate, decontamination fluid, ambient potable water)
QA/QC	FB = Field blank
	DUP = Duplicate sample (following sample type/number)
	TB = Trip blank
	ER = Equipment rinsate
Depth/Round	The number will reference the depth interval of the sample. For example, "0-1" = 0 to 1 feet below ground surface (bgs), "1-2" = 1 to 2 feet bgs, "2-3" = 2 to 3 feet bgs, etc.

All matrix spike/matrix spike duplicate (MS/MSD) samples will be entered in the same line on the chain of custody as the field sample. The total number of sample containers submitted will be entered on the chain of custody and "MS/MSD" will be indicated in the comments section.

Using this sample designation format, the sample designation SWMU474-GW01-08C refers to:

SWMU474-GW01-08C	SWMU 474
SWMU474-GW01-08C	Groundwater sample collected from MW01
SWMU474-GW01-08C	Collected during the third quarter of 2008

For QA/QC samples that include TB, ER, and FB, the date of collection is included in the sample designation. For example, the sample designation SWMU474-TB012908 refers to:

SWMU474-TB012908	SWMU 474
SWMU474-TB012908	Trip blank for the day of January 29, 2008

Table 1-1 lists all of the QA/QC samples for the groundwater and soil sampling at SWMU 474. Required deviations to this format will be documented in the field logbook.

TABLE 1-1
QA/QC Sample Collection Frequencies
SWMU 474 RFI Work Plan
MCB Camp Lejeune
Jacksonville, North Carolina

Analysis	Sample Matrix	Field Samples	Field Duplicates	Equipment Blanks	Field Blanks	MS/MSDs
Direct Push Surface and Subsurface Soil Samples						
Volatile Organic Compounds	Solid	5	1	1 per day	1 per week	1
RCRA Metals		5	1	1 per day	1 per week	1
Temporary Well Groundwater Samples						
Volatile Organic Compounds	Aqueous	7	1	1 per day	1 per week	1
RCRA Metals		7	1	1 per day	1 per week	1
Dissolved RCRA Metals		7	1	1 per day	1 per week	1
Permanent Well Groundwater Samples						
Volatile Organic Compounds	Aqueous	4	1	1 per day	1 per week	1
RCRA Metals		4	1	1 per day	1 per week	1
Dissolved Metals		4	1	1 per day	1 per week	1

Notes:
MS/MSD = Matrix Spike and Matrix Spike Duplicate pair
Field duplicates are collected at the rate of 1 for every 10 environmental samples
Equipment rinsate blanks are typically collected at the rate of 1 per day per media
Field blanks are typically collected at the rate of 1 per week during sampling
MS/MSDs are collected at the rate of 1 for every 20 samples

Sample custody and COC records will be maintained in accordance with the MCB Camp Lejeune Master QAPP.

Sample Custody

The sample custody and documentation procedures described in this subsection will be followed throughout all sample collection activities. Components of sample custody procedures include the use of field logbooks, sample labels, custody seals, and chain of custody forms. Each person involved with sample handling must be trained in chain of custody procedures before the start of the field project. The chain of custody form must accompany the samples during shipment from the field to the laboratory.

A sample is under custody under the following conditions:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and that person locks it up to prevent tampering.
- It is in a designated and identified secure area.

Field Custody

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

- Sample labels must be completed for each sample with waterproof ink, ensuring that the labels are legible and affixed firmly on the sample container.
- All sample-related information must be recorded in the project logbook.
- The field sampler must retain custody of samples until they are transferred or properly dispatched.
- One individual from the field sampling team should be designated as the individual responsible for all sample transfer activities. This field investigator will be responsible for the care and custody of samples until they are properly transferred to another person or facility.
- All samples will be accompanied by a chain of custody record. This record documents the transfer of custody of samples from the field investigator to another person, to the laboratory, or to other organizational entities. Each change of possession must be accompanied by an authorized signature for relinquishment and receipt of the samples.
- Completed chain of custody forms will be enclosed in a "sealed" plastic "Zip-Lock ®" baggie (or its equivalent) and placed inside the shipping container used for sample transport from the field to the laboratory.
- When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill or receipt will be recorded on the chain of custody form.
- Custody seals must be affixed on shipping containers when samples are shipped to the laboratory to prevent sample tampering during transportation. If seals are numbered, record the numbers on the chain of custody and in the field log-book.

Laboratory Sample Custody

Each laboratory receiving samples must comply with the laboratory sample custody requirements outlined in the subcontract document and its own CompQAP. The FTL or PC will notify the laboratory of upcoming field sampling activities and the subsequent transfer of samples to the laboratory. This notification will include information concerning the number and type of samples to be shipped and the expected date of arrival.

The following procedures will be used by the laboratory sample custodian, once the samples have arrived at the laboratory:

- The laboratory will designate a sample custodian who will be responsible for maintaining custody of the samples and for maintaining all associated records documenting that custody.
- Upon receipt of the samples, the custodian will check the original chain of custody and request-for-analysis documents and compare them with the labeled contents of each sample container for corrections and traceability. The sample custodian will sign the chain of custody and record the date and time received. The sample custodian also will assign a unique laboratory sample number to each sample.
- Cooler temperature (temperature blank) will be checked and recorded.
- Care will be exercised to annotate any labeling or descriptive errors. If discrepancies occur in the documentation, the laboratory will immediately contact the FTL as part of the corrective action process. A qualitative assessment of each sample container will be performed to note anomalies, such as broken or leaking bottles. This assessment will be recorded as part of the incoming chain of custody procedure.
- If all data and samples are correct and there has been no tampering with the custody seals, the "Received by Laboratory" box will be signed and dated.
- Samples will be stored in a secured area and at a temperature of approximately 4 degrees Centigrade (°C), if necessary, until analyses are to begin.
- The laboratory will send a sample acknowledgment letter to the PC as a record that the shipment arrived and noting the conditions of the containers upon arrival. Any discrepancy will be identified and corrective actions performed. These remarks will be documented on a “sample receipt checklist” or its equivalent. The PC may need to be contacted to provide guidance concerning additional corrective actions or guidance. The PM and PC will retain copies of the sample acknowledgment with the chain-of-custody.
- All samples will be accompanied by a chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the field sampler to another person or to the laboratory. Overnight carriers will be treated as a single entity, and a single signature will be required when samples are delivered to the laboratory.
- A laboratory chain of custody form will accompany the sample or sample fraction through final analysis for control.
- Copies of the chain-of-custody and request-for-analysis forms will accompany the laboratory report and will become a permanent part of the project records.
- Samples must be properly packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate signed chain of custody form enclosed in each sample box or cooler.
- All packages must be accompanied by a chain of custody form identifying the contents. The original record must accompany the shipment, and the FTL must retain a copy. Additional details about laboratory sample custody will be included in the CompQAP.

Sample Packing and Shipping

Samples will be delivered to the designated laboratories by local courier or by a common carrier such as Federal Express. Hard plastic ice chests or coolers with similar durability will be used for shipping samples. The coolers must be able to withstand a 4-foot drop onto solid concrete in the position most likely to cause damage. The samples must be cushioned to cause the least amount of damage if such a fall occurs.

All aqueous VOC sample vials will be shipped in the same cooler on a given day. A trip blank will be included in each cooler with VOC samples (aqueous and soil). After packing is complete, the cooler will be taped with chain of custody seals affixed across the top and bottom joints. Each container will be clearly marked with a sticker containing the originator's address.

The following procedures must be used when transferring samples for shipment:

- All sample coolers and packages must be accompanied by a chain of custody form identifying the contents. When transferring possession of samples, the individuals relinquishing and receiving the sample must sign, date, and note the time on the record. This record documents the transfer of custody of samples from the field sampler to another person or to the laboratory. The original chain of custody record must accompany the shipment, and the FTL must retain a copy.
- Samples must be properly packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate signed chain of custody form enclosed in each sample box or cooler.

1.2.4 Analytical Method Requirements

This subsection summarizes the target analytes, analytical methods, reporting limits (RLs), and data package deliverables.

Samples will be analyzed using EPA-approved methods or other recognized standard methods (EPA, 1992). The three principal sources for analytical methods are as follows:

- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA SW-846, Third Edition, and its updates, 1998)
- *Methods for Chemical Analysis of Water and Wastes* (EPA, 1983)

Table 1-2 presents the analytical services to be performed during RFI.

TABLE 1-2
Analytical Services
SWMU 474 RFI Work Plan
MCB Camp Lejeune

Matrix	Analytical Group	Number of Samples	Analytical Method	Data Package Turnaround Time	Laboratory / Organization[1] (name and address, contact person, and telephone number)	Backup Laboratory / Organization (name and address, contact person, and telephone number)
GW	VOC	11	SW846 Method 8260B	Standard 28 Calendar-day TAT	Shealy Environmental Services 106 Vantage Point Drive West Columbia, SC 29172 Mike Casalena (803) 791-9700	TBD
GW	RCRA Metals	11	SW846 Method 6010B/ 7000			
Soil	VOC	5	SW846 Method 8260B			
Soil	RCRA Metals	5	SW846 Method 6010B/ 7000			

Table 1-3 presents the analytical methods to be used for the analysis of the target compounds. The requested turn-around time for the majority of the definitive data will be 21 days from the time of sample receipt at the laboratory. The laboratory will be notified of fast turn-around requirements.

TABLE 1-3
Required Analytical Method, Sample Containers, Preservation, and Holding Times
SWMU 474 RFI Work Plan
MCB Camp Lejeune

Analyses	Analytical Method	Sample Matrix[a]	Container[b]	Qty	Preservative[c]	Holding Time [d]
Volatile Organic Compounds	SW-846 5030B/8260B	W	40 mL, glass	3	HCL, pH<2, cool to 4 ºC	14 days
	SW-846 5035/8260B	S	Encores	3	Water, Cool 4°C	48 hours from collection to preservation, 14 days to analysis
RCRA Metals	SW-846 3010A/3020A-SW6010B /7000 Series	W	500-mL polyethylene	1	HNO_3, pH < 2Cool 4°C	6 months
	SW-846 3050-	S	8-oz glass	1	Cool 4°C,	

TABLE 1-3
Required Analytical Method, Sample Containers, Preservation, and Holding Times
SWMU 474 RFI Work Plan
MCB Camp Lejeune

Analyses	Analytical Method	Sample Matrix[a]	Container[b]	Qty	Preservative[c]	Holding Time [d]
	SW6010B /7000 Series					
TCLP–VOCs, and, RCRA Metals	SW-846 1311/8260B, 6010B, and 7470A	W S	1-L amber glass 8-oz glass	2 1	Cool 4°C Cool 4°C	14/7/40 days[h]
Reactivity[j]	SW-846 7.3.3.2/7.3.4.2	S	8-oz glass[j]	1	None	As soon as possible
Corrosivity[j]	SW-846 1110/9040	S	8-oz glass[j]	1	None	As soon as possible
Ignitability[j]	SW-846 1010/1020A	S	8-oz glass[j]	1	None	As soon as possible

Notes:
Sample container, and volume requirements will be specified by the analytical laboratory performing the tests.
Three times the required volume should be collected for samples designated as MS/MSD samples.
[a]Sample matrix: S = surface soil, subsurface soil, sediment; W = groundwater
[b]All containers will be sealed with Teflon®-lined screw caps.
[c]All samples will be stored promptly at 4°C in an insulated chest.
[d]Holding times are from the time of sample collection.
e 7 days to extraction for water, 40 days for analysis.
[f]14 days to extraction for soil, 40 days for analysis.
[j]Reactivity, Corrosivity, and Ignitability can be obtained from the same container
Source: SW-846, third edition, Update III (June 1997).

ºC = Degrees Centigrade
TCLP = Toxicity characteristic leaching procedure
mL = Milliliter
g = Gram
ASTM = American Society for Testing and Materials
NA = Not applicable
HCl = Hydrochloric acid
HNO_3 = Nitric acid
EPA = U.S. Environmental Protection Agency
L = Liter
oz = Ounce

1.2.5 Field Screening and Analysis Method Descriptions

This subsection describes the various field-screening and field-analysis methods expected to be used during the RFI field investigation.

EPA Method 120.1/SW846 9050 (Water)–Conductance. Standard conductivity meters, which also measure water temperature, should be used for this measurement. The person taking the measurement should follow the manufacturer's recommended instructions for instrument calibration, operation, and maintenance.

EPA 150.1/SW846 9040 (Water)–pH. Water samples will be measured for pH. Measurements are determined electrometrically using either a glass electrode in combination with a reference potential, or a combination electrode. The person taking the measurement should follow the manufacturer's recommended instructions for instrument calibration, operation, and maintenance.

EPA Method 170.1 (Water)–Temperature. Temperature measurements are made with a mercury-filled or dial-type centigrade thermometer, or a thermistor.

EPA Method 360.1 (Water)–Dissolved Oxygen. An instrumental probe, typically dependent on an electrochemical reaction, is used for the determination of DO in water. Under steady-state conditions, the current or potential can be correlated with DO concentrations. The person taking the measurement should follow the manufacturer's recommended instructions for instrument calibration, operation, and maintenance.

ASTM D1498-93 (Water)–Oxidation-reduction Potential. This method is designed to measure the ORP in water, which is defined as the electromotive force between a noble metal electrode and a reference electrode when immersed in a solution.

Hach Turbidimeter model–Turbidity. This method uses a turbidimeter measure the turbidity of the water. An aliquot of the water is placed into a cell and the light that is scattered is proportional to the amount of turbidity in the sample.

Analytical Methods for Organics and Inorganics

SW846 8260B–Volatile Organic Compounds. This method provides procedures for the detection and quantitative measurement of selected semivolatile compounds. The target parameters are "extracted" from the sample matrix using purge-and-trap technology. The analytical method calls for the use of gas chromatography/mass spectrometry (GC/MS) for the detection of the target parameters.

Table 1-4 refers to VOC reporting limits and evaluations.

SW846 6010B–RCRA Metals. Selected samples will be analyzed for the RCRA of metals.

Inductively coupled plasma emission spectrometry (ICPES) determines trace elements. All matrices–excluding filtered groundwater samples but including groundwater, aqueous samples, TCLP extracts, soils, sludges, sediments, and other solid wastes–require digestion

before analysis. Groundwater samples that have been prefiltered and acidified will not need acid digestion.

Table 1-5 presents the target analyte list and associated reporting limits.

TABLE 1-5
Reporting Limits
SWMU 474 RFI Work Plan
MCB Camp Lejeune

Analyte	CAS Number	Aqueous			Solid		
		Lab RL	MDL	units	Lab RL	MDL	units
VOCs							
Dichlorodifluoromethane	75-71-8	1	0.074	ug/L	10	0.6	ug/kg
Chloromethane	74-87-3	1	0.144	ug/L	10	0.64	ug/kg
Vinyl Chloride	75-01-4	1	0.043	ug/L	10	0.54	ug/kg
Bromomethane	74-83-9	1	0.132	ug/L	10	0.63	ug/kg
Chloroethane	75-00-3	1	0.132	ug/L	10	0.38	ug/kg
Trichlorofluoromethane	75-69-4	1	0.031	ug/L	10	0.36	ug/kg
1,1-Dichloroethene	75-35-4	1	0.125	ug/L	10	0.35	ug/kg
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1	0.14	ug/L	10	0.51	ug/kg
Acetone	67-64-1	10	0.775	ug/L	10	2.73	ug/kg
Carbon Disulfide	75-15-0	1	0.034	ug/L	10	0.31	ug/kg
Methyl Acetate	79-20-9	1	0.138	ug/L	10	0.67	ug/kg
Methylene Chloride	75-09-2	5	0.065	ug/L	10	0.49	ug/kg
trans-1,2-Dichloroethene	156-60-5	1	0.092	ug/L	10	0.36	ug/kg
Methyl tert-Butyl Ether	1634-04-4	1	0.067	ug/L	10	0.31	ug/kg
1,1-Dichloroethane	75-34-3	1	0.075	ug/L	10	0.53	ug/kg
cis-1,2-Dichloroethene	156-59-2	1	0.072	ug/L	10	0.45	ug/kg
2-Butanone	78-93-3	1	0.517	ug/L	10	1.28	ug/kg
Chloroform	67-66-3	1	0.064	ug/L	1	0.22	ug/kg
1,1,1-Trichloroethane	71-55-6	1	0.09	ug/L	10	0.39	ug/kg
Cyclohexane	110-82-7	1	0.24	ug/L	10	0.54	ug/kg
Carbon Tetrachloride	56-23-5	1	0.081	ug/L	10	0.46	ug/kg
Benzene	71-43-2	1	0.031	ug/L	10	0.19	ug/kg
1,2-Dichloroethane	107-06-2	1	0.064	ug/L	10	0.42	ug/kg
Trichloroethene	79-01-6	1	0.066	ug/L	1	0.47	ug/kg
Methylcyclohexane	108-87-2	1	0.042	ug/L	10	0.38	ug/kg
1,2-Dichloropropane	78-87-5	1	0.064	ug/L	10	0.45	ug/kg
Bromodichloromethane	75-27-4	1	0.054	ug/L	10	0.49	ug/kg
cis-1,3-Dichloropropene	10061-01-5	1	0.081	ug/L	10	0.36	ug/kg
4-Methyl-2-pentanone	108-10-1	1	0.062	ug/L	10	0.83	ug/kg
Toluene	108-88-3	1	0.038	ug/L	10	0.21	ug/kg
trans-1,3-Dichloropropene	10061-02-6	1	0.07	ug/L	10	0.36	ug/kg
1,1,2-Trichloroethane	79-00-5	1	0.072	ug/L	10	0.53	ug/kg
Tetrachloroethene	127-18-4	1	0.04	ug/L	10	0.33	ug/kg
2-Hexanone	591-78-6	1	0.084	ug/L	10	1.24	ug/kg
Dibromochloromethane	124-48-1	1	0.064	ug/L	10	0.14	ug/kg
1,2-Dibromoethane	106-93-4	1	0.062	ug/L	10	0.51	ug/kg

TABLE 1-5
Reporting Limits
SWMU 474 RFI Work Plan
MCB Camp Lejeune

Chlorobenzene	108-90-7	1	0.052	ug/L	10	0.23	ug/kg
Ethylbenzene	100-41-4	1	0.049	ug/L	10	0.39	ug/kg
Xylenes, total	1330-20-7	1	0.077	ug/L	10	0.45	ug/kg
Styrene	100-42-5	1	0.61	ug/L	10	0.25	ug/kg
Bromoform	75-25-2	1	0.72	ug/L	10	0.37	ug/kg
Isopropylbenzene	98-82-8	1	0.075	ug/L	10	0.32	ug/kg
1,1,2,2-Tetrachloroethane	79-34-5	1	0.025	ug/L	10	0.25	ug/kg
1,3-Dichlorobenzene	541-73-1	1	0.048	ug/L	10	0.38	ug/kg
1,4-Dichlorobenzene	106-46-7	1	0.077	ug/L	10	0.41	ug/kg
1,2-Dichlorobenzene	95-50-1	1	0.017	ug/L	10	0.37	ug/kg
1,2-Dibromo-3-chloropropane	96-12-8	1	0.11	ug/L	10	1.17	ug/kg
1,2,4-Trichlorobenzene	120-82-1	1	0.046	ug/L	10	0.4	ug/kg
RCRA Metals							
Arsenic	7440-38-2	10	3	ug/L	2000	162	ug/kg
Barium	7440-39-3	200	8	ug/L	40000	183	ug/kg
Cadmium	7440-43-9	5	0.6	ug/L	1000	18.5	ug/kg
Chromium	7440-47-3	10	1.6	ug/L	2000	25.7	ug/kg
Lead	7439-92-1	3	1.8	ug/L	600	159	ug/kg
Mercury	7439-97-6	0.2	0.0535	ug/L	200	6.09	ug/kg
Selenium	7782-49-2	5	2.8	ug/L	1000	115	ug/kg
Silver	7440-22-4	10	1.6	ug/L	2000	33	ug/kg

SW846 1010/1020–Ignitability; SW846 7.3.3.2/7.3.4.2–Reactivity; and SW846 1110/9040–Corrosivity. These methods are used to evaluate these three hazardous characteristics before land disposal.

Analytical Laboratory

The analytical laboratory contracted to perform the work is Shealy Environmental Services located in West Columbia, South Carolina.

The laboratory selected will undergo annual evaluations to determine if they are meeting project requirements. Laboratories may be added or deleted based on their performance.

Detection, Quantitation and Reporting Limits

The laboratory analytical reporting limits are listed in **Tables 1-4 and 1-5**.

The laboratory will supply analyte-specific quantification limits, with laboratory-specific MDL studies, as part of its laboratory CompQAP.

Method Detection Limits. The method detection limit (MDL) is the minimum amount of an analyte that can be routinely identified using a specific method and instrument measured and reported with 99 percent confidence that the analyte concentration is greater than zero. MDLs are operationally determined as three times the standard deviation of seven replicate spiked samples run according to the complete method. However, the evaluation is routinely

completed on reagent grade water. As a result, potentially significant matrix interferences that decrease analyte recoveries are not addressed.

Determine the MDL for each analyte as follows:

MDL = 3.14(s)

Note:

S - The standard deviation for each analyte from the seven replicate analyses.

3.14 - The one-sided t-statistic at the 99 percent confidence level appropriate for determining the MDL using seven replicates.

When the concentration of concern (or project-specific action level) is greater than the MDL, to the extent that the confidence limits of both the MDL and concentration of concern do not overlap, then both "non-detect" and "detect" results can be used with confidence. There will be a possibility of false positives and false negatives if the confidence limits of the MDL and the concentration of concern overlap. When the concentration of concern is sufficiently less than the MDL that the confidence limits do not overlap, then there is a strong possibility of false negatives and only "detect" results are useable.

The laboratory will establish MDLs for each method, matrix, and analyte for each instrument the laboratory plans to use for the project. The laboratory will revalidate these MDLs at least once per 12-month period. The laboratory will provide the MDL at the beginning of the project. Project and laboratory specific MDLs will be included in the project-specific addendum.

40 CFR 136, Appendix B, or Chapter 1 of SW846 Methods, has not set frequency requirements for revalidating the MDLs. The MDLs be validated once per 12-month period.

Where multiple instruments are used, the MDL used for reporting purposes will represent the least sensitive instrument.

Instrument Detection Limit. The instrument detection limit (IDL) includes only the instrument portion of the detection, not sample preparation, concentration/dilution factors, or method-specific parameters. The IDL is operationally defined as three times the standard deviation of seven replicate analyses at the lowest concentration that is statistically different from a blank. This represents 99 percent confidence that the signal identified is the result of the presence of the analyte, not random noise. The IDL is not the same as the MDL. There is no formal procedure for IDL outside the EPA Contract Laboratory Program (CLP) Statement of Work (SOW) for inorganic analysis.

Quantitation Limits. The quantitation limit (QL) as defined in SW-846 methods, is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The sample quantitation limit (SQL) is the QL adjusted to reflect sample-specific actions such as dilution or use of smaller aliquot sizes than prescribed in the method, or for percent moisture. These adjustments may be due to matrix effects or the high concentration of some analytes. The SQL is the more useful limit for data users such as risk assessors.

For the same chemical, the SQL in one sample may be higher than, lower than, or equal to the SQL values for other samples. In addition, preparation or analytical adjustments, such as dilution of the sample for quantitation high levels target and non-target analytes, could result in non-detects for other analytes included in the analysis, even though target analytes may have been present at trace quantities in the undiluted sample.

All results will be reported on a dry-weight basis.

Reporting Limits. The laboratories participating in this work effort will compare the results of the experimental MDLs to RLs for each analyte. The MDL may not be more than one-half the corresponding RL. The laboratories also will verify RLs by including a standard at the RL as the lowest point on the calibration curve. For methods that do not include the RL as the low point of the calibration curve, a RL verification standard will be analyzed immediately following calibration. The RL verification standard must include all target analytes. All results will be reported at or above the MDL values. No numerical results will be reported below the MDL; however, for those results falling between the MDL and the RL, a "J" flag will be applied to the results indicating the variability associated with the result.

Analytical SOPs. The laboratory has submitted a list of specific SOPs that will be used to perform off-site analysis of samples. Refer to **Table 1-6** for Analytical SOP References.

TABLE 1-6
Analytical SOP References

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?[1] (Y/N)
S-VO-002	GC/MS analysis based on EPA Methods 8260B and 624 Prepared by EPA Methods 5030B, 5035 and 3585	Both	Aqueous/Solid Waste VOA	GC/MS	SESI	N
S-SV-003	Gas chromatographic analysis Based on EPA 608 and SW-846, Method 8000B, 8081A, 8082 and 8151A	Both	Aqueous/Solid Waste SVGC	GC/ECD/ECD	SESI	N

[1] If yes, then specify the modification that has been made. Note that any analytical SOP modification made relative to project specific needs must be reviewed and approved by the Navy QAO.

Data Package Deliverables

There are no data package requirements for Level I (screening results). The FTL is responsible for reviewing the field logbooks, which will contain the following information for Level I field screening results.

QC data package deliverables are summarized in **Table 1-7** by analytical fraction and will include sample results and QC summary forms, but not unreduced instrument data. Level III data packages will contain sufficient information so that sample analysis can be reconstructed, calculations can be verified, and a data quality assessment can be made to evaluate whether the data meet project requirements.

In addition, the laboratory must have the capability of providing the data package on compact disk (CD) in a scanned .pdf format. At this time, it is anticipated that the laboratory will provide one hardcopy data package and one CD to the PC, and one CD to the PM.

Refer to **Table 1-7** for Data Package Deliverables.

TABLE 1-7
Data Package Deliverables
SWMU 474 RFI Work Plan

All Analytical Fractions				
Case Narrative – A detailed case narrative per analytical fraction is required and will include explanation of any non-compliance and/or exceptions and corrective action. Exceptions will be noted for receipt, holding times, methods, preparation, calibration, blanks, spikes, surrogates (if applicable), and sample exceptions.				•
Sample ID Cross Reference Sheet (Lab IDs and Client IDs)				•
Completed Chain of Custody and any sample receipt information				•
Sample preparation (extraction/digestion) logs				•
Copies of non-conformance memos and corrective actions				•
Form *	**GC/MS Organic Fractions**	**Level II**	**Level III**	**Level IV**
1	Sample results	•	N/A	• + raw
2	Surrogate Recovery Summary (w/ applicable control limits)	•		•
3	MS/MSD Accuracy & Precision Summary **	•		• + raw
3	LCS Accuracy Summary	•		• + raw
4	Method Blank Summary	•		• + raw
5	Instrument Tuning Summary (including tuning summary for applicable initial calibrations)			•
6	Initial Calibration Summary (including concentration levels of standards)			• + raw
7	Continuing Calibration Summary			• + raw
8	Internal Standard Summary (including applicable initial calibrations)			•
Form *	**GC/HPLC Organic Fractions**	**Level II**	**Level III**	**Level IV**
1	Sample results	•	N/A	• + raw
2	Surrogate Recovery Summary (w/ applicable control limits)	•		•
3	MS/MSD Accuracy & Precision Summary **	•		• + raw
3	LCS Accuracy Summary	•		• + raw
4	Method Blank Summary	•		• + raw
6	Initial Calibration Summary (including concentration levels of standards) ***			• + raw
7	Continuing Calibration Summary ***			• + raw
7	Degradation Summary (Organochlorine Pesticides only) ***			• + raw
8	Analytical Sequence (including internal standard area performance where applicable) ***			•
10	Compound Identification Summary (where confirmation required) ***			•
Form *	**Metals Inorganic Fractions**	**Level II**	**Level III**	**Level IV**
1	Sample Results	•	N/A	• + raw
2A	Initial and Continuing Calibration Summary			• + raw
3	Initial and Continuing Calibration Blanks and Method Blanks Summary	•		• + raw
4	Interference Check Standard Summary			• + raw
5A	Pre-digestion Matrix Spike Recoveries Summary	•		• + raw
5B	Post-digestion Spike Recoveries Summary			• + raw
6	Native Duplicate or MS/MSD Precision Summary **	•		• + raw
7	Laboratory Control Sample Recovery Summary	•		• + raw
8	Method of Standard Addition (if necessary)			• + raw
9	Serial Dilution			• + raw
10	Instrument or Method Detection Limit Summary			•
11	ICP Interelement Correction Factors			•
12	Linear Range Summary			•
13	Preparation Log Summary			• + raw
14	Analytical Run Sequence and GFAA Post-spike Recovery Summary		N/A	• + raw

TABLE 1-7
Data Package Deliverables
SWMU 474 RFI Work Plan

Form *	**General Chemistry Fractions:** (Includes potentiometric, gravimetric, colorimetric, and titrimetric analytical techniques. Examples, TPH (418.1), TOC, etc.)	Level II	Level III	Level IV
1	Sample Results	•	N/A	• + raw
2A	Initial and Continuing Calibration Summary			• + raw
3	Initial and Continuing Calibration Blanks and Method Blanks Summary	•		• + raw
5A	Pre-digestion Matrix Spike Recoveries Summary	•		• + raw
6	Native Duplicate or MS/MSD Precision Summary **	•		• + raw
7	Laboratory Control Sample Recovery Summary	•		• + raw
10	Instrument or Method Detection Limit Summary			•

* CLP Form or summary form with equivalent information
** with RPD calculated according to method specifications (CLP using % recovery, SW-846 using concentration)
*** including deliverables for primary and confirmation analysis (where applicable)

1.2.6 Quality Control Requirements

The following text describes this project's QC requirements.

Field QC Blank Samples and Duplicate Field Samples

The type and frequency of field QC samples should be evaluated as part of the project planning process. In the following subsections, typical field QC blank samples and duplicate field samples are defined.

Blank samples should not contain any target parameter of interest. There are certain organic compounds known to be common laboratory contaminants, such as acetone, methylene chloride, and the common phthalates. However, the laboratory must make all efforts to eliminate these compounds as contaminants. The concentration of all target compounds must be less than the RL, except for the common contaminants; the concentration of the common contaminants must be less than five times the RL.

Trip Blanks. TBs are used to monitor potential VOC contamination introduced during sample shipping and handling. Trip blanks are 40-mL VOC vials of ASTM Type II water, which are filled in the laboratory, transported to the sampling site, and returned to the laboratory with the VOC samples. TBs are prepared and analyzed for VOCs only; they should not be opened in the field. One TB will be included with each cooler containing samples for VOC analysis (aqueous and solid phase).

Equipment Rinsate Blank Samples. ERBs are samples of ASTM Type II water passed through and over the surface of decontaminated sampling equipment. The rinse water is collected in sample bottles, preserved, and handled in the same manner that is used when collecting aqueous samples, even if the ERBs are being collected for soil samples. ERBs are used to monitor the effectiveness of the decontamination process. One ERB will be collected per day, per type of sampling equipment and analyzed for the same parameters as the corresponding samples.

Field/Decontamination Source Water Blanks. FBs are samples of the source water used for decontamination and steam cleaning. This blank is used to monitor potential contaminants present in the source water during field decontamination procedures. One FB will be collected for each source of water used for decontamination and analyzed for the same

parameters as the corresponding samples. One FB will be collected per week while sampling.

Temperature Blanks. Temperature blanks are sent with each cooler shipped to the offsite laboratory containing samples requiring preservation at 4 °C. Temperature blanks consist of a non-preserved VOC vial, or similar laboratory container, filled with ASTM reagent grade water. Temperature blanks are measured at the laboratory upon receipt to verify the temperature of the samples contained in the cooler. One temperature blank will be shipped with each cooler to each offsite laboratory.

Duplicate Field Samples. Duplicate field samples are collected to monitor the precision of the field sampling process. The FTL will choose at least 10 percent (per matrix) of the total number of sample locations known or suspected to contain moderate contamination, and duplicate field samples will then be collected at these locations. The identity of the duplicate samples will be recorded in the field sampling logbook, and this information will be forwarded to the DQE team to aid in reviewing and evaluating the data. A control limit of ± 20 percent for the RPD will be used for original and duplicate concentrations greater than five times the RL in water matrices. A control limit of ± 35 percent for the RPD will be used for original and duplicate concentrations greater than five times the RL in soil matrices. A control limit of ± the RL will be used for waters and ± two times the RL for soils when concentrations are reported as less than five times the RL.

Laboratory QC Blank and Matrix Spike Samples

Laboratory Method/Preparation Blanks. Laboratory method blanks are blank matrices (such as ASTM Type II water or Ottawa sand) that are treated as environmental samples, being prepared and analyzed along with the field samples. Laboratory method blanks are used to monitor laboratory performance and to check for contamination introduced during the preparation and analytical procedures. A method blank is required for every 20 field samples or for each analytical batch, whichever is more frequent.

Blank samples should not contain any target parameter of interest. There are certain organic compounds known to be common laboratory contaminants, such as acetone, methylene chloride, and the common phthalates. However, the laboratory must make all efforts to eliminate these compounds as contaminants. The concentration of all target compounds must be less than the RL, except for the common contaminants; the concentration of the common contaminants must be less than five times the RL.

Matrix Spike/Matrix Spike Duplicate Samples. For MS/MSD samples, three aliquots of a single sample are analyzed: one native and two spiked with target compounds or metals. Spike recovery is used to evaluate potential matrix interferences, as well as accuracy. The duplicate spike results (MS and MSD) are compared to evaluate precision. MS/MSDs will be collected at a frequency of 5 percent (1 MS/MSD sample set for every 20 field samples) of the number of field samples. The MS/MSD accuracy limits are 75 to 125 percent for metals. The MS/MSD RPD limits for metals are 20 percent for waters and 35 percent for soils.

The laboratory MS/MSD accuracy and precision limits for the remaining analyses will be used as guidance when evaluating the data.

Surrogate Spikes. Surrogate spike compounds are added to each sample for the organic analytical methods. Surrogate spike compounds are structurally similar (but not identical) to target compounds and should behave in a similar manner during analysis. Surrogate spike recoveries are used to monitor both laboratory performance and matrix interferences. Surrogate spike recoveries from field and laboratory blanks are used to evaluate laboratory performance because these blanks represent an ideal sample matrix. Surrogate spike recoveries for field samples are used to evaluate the potential for matrix interferences. When surrogate spike recoveries for field samples fall outside the method target acceptance windows, the samples are re-extracted if appropriate, then re-analyzed. If the surrogate spike recovery is still outside the acceptance window for the re-analyzed sample, then the sample results are qualified as affected by matrix interferences.

Laboratory Control Spike Samples. The laboratory control samples (LCSs) are analyte-free water (for aqueous analyses) or Ottawa sand (for soil analyses) (except metals where glass beads of 1-millimeter (mm) diameter or smaller may be used) spiked with all target analytes. The appropriate spiking concentration will be spiked at a level less than or equal to the midpoint of the calibration curve for each analyte.

The LCS will be carried through the complete sample preparation and analysis procedure. The LCS is used to evaluate each preparation and analytical batch and to determine if the method is in control. The LCS cannot be used as the continuing calibration verification. One LCS will be included in every preparation and analytical batch. If more than on LCS is analyzed in an analytical batch, results from all LCSs analyzed will be reported.

Whenever an analyte in a LCS is outside the acceptance limit, corrective action will be performed. After the system problems have been resolved and system control has been reestablished, all samples in the analytical batch will be reanalyzed for the out-of-control analyte(s). When an analyte in a LCS exceeds the upper or lower control limit and no corrective action is performed or the corrective action was ineffective, the laboratory should discuss the issue with the PC or QAM personnel.

Interference Check Samples. The interference check sample (ICS), used in inductively coupled plasma (ICP) analyses only, contains both interfering and analyte elements of known concentrations. The ICS is used to verify background and interelement correction factors and is run at the beginning and end of each run sequence.

When the ICS results are outside of the acceptance limits as prescribed in the method, corrective action will be performed. After the system problems have been resolved and system control has been re-established, re-analyze the ICS. If the ICS result is acceptable, re-analyze all affected samples.

Internal Standards. Internal standards (ISs) are known amounts of certain compounds added after preparation or extraction of a sample. These compounds are used in an IS calibration method to correct sample results affected by column injection losses, purging losses, or viscosity effects. ISs will be added to environmental samples, control samples, and blanks in accordance with the method requirements.

When the IS results are outside of the acceptance limits, corrective actions will be performed. After the system problems have been resolved and system control has been reestablished, all samples analyzed while the system was malfunctioning will be reanalyzed.

Retention Time Windows

Retention time windows are established to compensate for minor shifts in absolute retention times resulting from normal chromatographic variability. Absolute retention times are used for analyte identification in all gas chromatography (GC) and high performance liquid chromatography (HPLC) methods that do not employ IS calibration. Retention time windows are used in GC and HPLC analysis for qualitative identification of analytes. They are calculated from replicate analyses of a standard on multiple days. If the analyte retention time is outside the established window, new retention windows must be established.

Confirmation of Identification

Quantitative confirmation of results at or above the RL for samples analyzed by GC or HPLC will be required and will be completed within the method-required holding times. For GC methods, a second column is used for confirmation. For HPLC methods, a second column or a different detector is used. The result from the lowest quantitation between the primary and secondary column/detector will be used for reporting purposes. The lowest quantitation will be reported to minimize the reporting of bias high results arising from co-elution of non-target analytes with the analyte of interest.

Standard Materials

Standard materials, including second source materials, used in calibration and to prepare samples will be traceable to National Institute of Standards and Testing (NIST), EPA, American Association of Laboratory Accreditation (A2LA) or other equivalent approved source, if available. If an NIST, EPA, or A2LA standard material is not available, the standard material proposed for use will be included in an addendum to the QAPP and approved before use. The standard materials will be current, and the following expiration policy will be followed: The expiration dates for ampulated solutions will not exceed the manufacturer's expiration date or 1 year from the date of receipt, whichever comes first. Expiration dates for laboratory-prepared stock and diluted standards will be no later than the expiration date of the stock solution or material or the date calculated from the holding time allowed by the applicable analytical method, whichever comes first. Expiration dates for pure chemicals will be established by the laboratory and be based on chemical stability, possibility of contamination, and environmental and storage conditions. Expired standard materials will be either revalidated prior to use or discarded. Revalidation may be performed through assignment of a true value and error window statistically derived from replicate analyses of the material as compared to an unexpired standard. The laboratory will label standard and QC materials with expiration dates.

A second source standard is used to independently confirm initial calibration. A second source standard is a standard purchased from a different vendor than the vendor supplying the material used in the initial calibration standards. The second source material can be used

for the continuing calibration standards or for the LCS (but will be used for one of the two). Two different lot numbers from the same vendor do not constitute a second source.

Table 1-8 has Laboratory QC Samples.

TABLE 1-8
Laboratory QC Samples
SWMU 474 RFI Work Plan

Matrix	All
Analytical Group	All
Analytical Method / SOP Reference	See Table 1-6

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1/20 Field samples or 1/analytical batch whichever is greater	This varies depending on client requirements; generally all analytes <PQL	Re-prep	Analyst		
LCS	1/20 Field samples or 1/analytical batch whichever is greater	This varies depending on client requirements	Re-prep	Analyst		
PT	2/year	Pass	New study	QA		
LFB	NA					

1.2.7 Field and Laboratory Corrective Action

The procedures that will be followed in identifying problems and performing corrective actions in the field and in the laboratory are described below.

Field Corrective Action

The task manager is responsible for overseeing the corrective action process, but any team member may initiate it. The corrective action process consists of identifying a problem, acting to eliminate the problem, monitoring the effectiveness of the corrective action, verifying that the problem has been eliminated, and documenting the corrective action.

Examples of corrective action are correcting chain-of-custody forms; problems associated with sample collection, packaging, shipping, or field record keeping; or additional training in sampling and analysis. Additional approaches may include re-sampling or evaluating and amending sampling procedures.

Laboratory Corrective Action

The laboratory department supervisors will review the data generated to verify that all QC samples have been run as specified in the procedure. Laboratory personnel are alerted that corrective actions may be necessary under the following conditions:

- QC data are outside the warning or acceptable windows for precision and accuracy established for laboratory samples.
- Blanks contain contaminants at concentrations above the levels specified in the laboratory QA plan for any target compound.
- Deficiencies are detected by the laboratory QA director during internal or external audits, or from the results of performance evaluation samples.

Corrective actions are implemented immediately when non-conformances in QC sample results are identified by the bench analyst. Corrective action procedures are handled initially at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors and checks such parameters as instrument calibration, spike and calibration mixes, and instrument sensitivity.

The analyst immediately notifies his or her supervisor of the problem and the investigation being conducted. If the problem persists or cannot be identified, the matter must be referred to the laboratory supervisor and the QA/QC officer for further investigation. At this point, the PC and the PM must be notified about the nonconformance. All laboratory QC problems that will affect the final data must be discussed with the PC as part of the corrective action process. Once resolved, full documentation of the corrective action procedure must be filed with the laboratory supervisor, and the QA/QC officer must be provided with a corrective action memorandum for inclusion in the project file if data are affected. A copy of the corrective action memorandum must be included in the laboratory data package deliverable.

Corrective actions may include the following:

- Reanalyzing suspect samples
- Recalibration with new standards
- Eliminating blank contamination
- Resampling and analyzing new samples
- Evaluating and amending sampling and analytical procedures
- Accepting data with an acknowledged level of uncertainty
- Recalibrating analytical instruments
- Qualifying or rejecting the data

After implementation of the required corrective action measures, data that are deemed unacceptable may not be accepted by the PM, and follow-up corrective actions may be explored. Details of laboratory corrective actions are provided in the laboratory CompQAM.

1.2.8 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

This subsection describes the inspection and acceptance of environmental sampling and measurement systems and components to ensure their intended use as specified by the design.

Field Instruments

All equipment used for field measurements will be maintained in accordance with the manufacturer's instructions. Routine maintenance and all equipment repairs will be documented in the site logbook. Whenever a piece of equipment fails to operate properly, the instrument either will be repaired in-house, if possible, or be sent out for repair, and another instrument equivalent to the original will be substituted, if possible. Other than solutions/standards for calibrating the equipment, the field team keeps only a limited amount of supplies on hand. Parts are ordered on an as-needed basis.

Data will be generated from field methods for pH, temperature, conductivity, and DO. QC procedures and calibration requirements for field methods are addressed in the following paragraphs. If procedures other than those listed below are to be used, or if modifications to approved procedures are proposed, a complete description will be submitted to the PM for approval before field use.

Temperature Meter. This method is applicable to groundwater and surface water. Temperature measurements may be made with an analog or digital readout device or conductivity and pH meters that are equipped with a thermometer.

Before using the equipment probe, it should be allowed sufficient time to equilibrate to the outside temperature when removed from a field vehicle. Insert the probe *in-situ* when possible or in a grab sample. Swirl the probe in the sample and take the temperature reading when the readout needle stops moving; record temperature to the nearest 0.5 °C. Routinely check the measurements device against a precision thermometer.

Analytical Laboratory Instruments

Preventive maintenance for laboratory instruments is discussed in greater detail in the laboratory's CompQAP.

It is required that designated laboratory personnel will be trained in routine maintenance procedures for all major instrumentation. Either trained staff or trained service engineers or technicians employed by the instrument manufacturer will make repairs. The laboratory should have multiple instruments that will serve as back-up to minimize potential downtime. All maintenance will be documented and kept in permanent logs. These logs will be available for review by auditing personnel.

Laboratory equipment testing, inspection, and maintenance will be in accordance with the laboratory's CompQAP. The laboratory CompQAP should discuss the schedule, procedures, criteria, and documentation for verifying that all analytical equipment is operating in an accurate and precise manner. To minimize instrument downtime, each laboratory should have an internal instrument repair department or have a contract with a local instrument repair company. The laboratory keeps an inventory of certain supplies and consumables, as described in the laboratory's CompQAP. Additional parts or supplies are ordered on an as-needed basis.

1.2.9 Instrument Calibration and Frequency

Calibration procedures for field instruments and laboratory equipment are discussed below.

Field Instruments

Because instruments used during field investigation activities may be of several models and manufacturers, it is not feasible to present instrument-specific details in this subsection. Instead, instrument-specific calibration will be performed in accordance with the manufacturer's instructions, as provided in the instrument's SOP.

Field instruments will be calibrated daily in accordance with manufacturers' specifications before the beginning of sampling activities. The calibration of all field equipment will be documented in the field notebook. Standards used to calibrate the field survey instruments will be traceable to NIST standards whenever possible. The method and frequency of calibration for the instruments used for each field activity are described in the manufacturer's instructions and summarized in **Table 1-9**. These procedures will be followed at a minimum.

The pH, DO, ORP, conductivity, and turbidimeters will be decontaminated before each sample is measured. The probes will be rinsed three times with ASTM Type II water before storage each day. The meters will be checked for battery charge and physical damage each day. The meters, pH standard solutions, and conductivity buffer solutions will be stored in a cool, dry environment. Standard solutions will be discarded on their expiration dates.

TABLE 1-9
Method and Frequency of Instrument Calibration
SWMU 474 RFI Work Plan

Instrument	Calibration Activity	Frequency
PID	Calibrate to isobutylene and zeroed to ambient air or background levels	Beginning of each sampling day
FID	Calibrate to 100 ppm methane	Beginning of each sampling day
pH meter	Calibrate against standard pH solutions (either 4.0 and 7.0 SU, or 7.0 and 10.0 SU)	Beginning of each sampling day. (Should verify calibration with a 7.0 buffer after each sampling location. If not 7.0 +/- 0.2, recalibrate pH meter)
Conductivity meter	Check conductivity reading with a solution of KCl at a known conductivity	Beginning of each sampling day
Turbidity meter	Calibrations will be preformed per manufactures specifications in the field	Calibrations will be preformed per manufactures specifications in the field
Dissolved oxygen meter	Calibrations will be preformed per manufactures specifications in the field	Calibrations will be preformed per manufactures specifications in the field

Notes:
PID = Photo-ionization detector
FID = Flame-ionization detectorppm = Parts per million
SU = Standard units

1.2.10 Laboratory Equipment

Laboratory instruments will be calibrated in accordance with the manufacturer's directions and applicable method specifications. Laboratory instrument calibration procedures will be summarized in the laboratory CompQAP, which will be reviewed and approved by the PM

or designee before samples are submitted for analysis. The calibration of all laboratory equipment will be documented in the specific maintenance logbook, or analytical logbook, as described in the laboratory's CompQAP.

Analytical instruments will be calibrated in accordance with the analytical methods (**Table 1-10**). All target analytes reported will be present in the initial and continuing calibrations. All results reported will be within the calibration range. Records of standard preparation and instrument calibration will be maintained. Records will unambiguously trace the preparation of standards and their use in calibration and quantitation of sample results. Calibration standards will be traceable to standard materials.

Instrument calibration will be checked using all of the target analytes. This applies equally to multi-response analytes. All calibration criteria will satisfy SW-846, Update III requirements at a minimum. The initial calibration will be checked at the frequency specified in the method using materials prepared independently of the calibration standards. Multipoint calibrations will contain the minimum number of calibration points specified in the applicable method including a standard at or below the corresponding RL. Analyte concentrations are determined with either calibration curves or response factors (RFs). For GC and GC/MS methods, when using RFs to determine analyte concentrations, the average RF from the initial five-point calibration will be used. The continuing calibration will not be used to update the RFs from the initial five-point calibration. The continuing calibration verification cannot be used as the LCS.

If more than the required minimum number of standard concentrations is used in the initial calibration, all standard concentrations must be included in calculating the acceptance of the initial curve. All results for field samples will be reported only within the calibration linearity range.

TABLE 1-10
Analytical Instrument Calibration

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[2]	SOP Reference[1]
GC/MS	Multi Point ICAL	As needed or after major maintenance	CCC, SPCC 15%RSD	Re-analyze	Analyst	S-VO-002,S-SV-002
GC/ECD/ECD	Multi Point ICAL	As needed or after major maintenance	20% RSD	Re-analyze	Analyst	S-SV-003
GC/MS	CCV	Per sequence	20%D FOR CCC	Re-analyze	Analyst	S-VO-002,S-SV-002
GC/ECD/ECD	CCV	Every 10 samples	20% D	Re-analyze	Analyst	S-SV-003

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #19).
[2] Name or title of responsible person may be used.

1.2.11 Inspection and Acceptance Requirements for Supplies and Consumables

All services, including subcontracted services and supplies received from vendors, must meet the project scope, specified levels of quality, and the submittal schedule. Field and

laboratory personnel must evaluate the vendor's ability to provide the services and specify acceptance requirements for supplies and consumables. For example, laboratories rely on suppliers for solvents, gases, consumables, and analytical equipment, including instrument maintenance. The laboratory should have and maintain adequate contracts with its vendors to receive uninterrupted supplies, parts, and services.

1.2.12 Data Acquisition Requirements

In addition to the electronic data, the laboratory provides hard-copy deliverables of the analytical results. Upon receipt, the data packages are prepared for data validation. After the data validation has been completed and a DQE report has been written, the hard-copy data packages are filed onsite until the project is completed. At that time, the data packages are sent to the PM for inclusion into the project files. Alternatively, the hard-copy data packages are stored at an offsite warehouse for a period of 10 years after the project close out.

1.3 Assessment and Oversight

Assessment and oversight activities are performed to determine whether the QC measures identified in the WP and in this QAPP are being implemented and documented as required. Audits and reviews are the tools used to implement this process. For example, during a review, the auditor may check that a monitoring well has been correctly sampled or that the field QC samples were collected at the appropriate frequency. During an audit or review, the auditor may check for:

- Adherence to the WP
- Documentation of the process or system
- Proper identification, resolution, and documentation of nonconformance with the process or system
- Correction of identified deficiencies

1.3.1 Assessments and Response Actions

The need for an audit can be determined independently by the PM. Assessment activities may include surveillance, inspection, peer review, management system review, readiness review, technical systems audit, performance evaluation, and data quality assessment. The PM will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation. For the fieldwork, a monthly audit will be conducted throughout the duration of sampling activities.

The laboratory will be audited in accordance with the laboratory subcontract. The PC or a designee will perform laboratory audits in compliance with the subcontract. One laboratory audit will be performed before the receipt of samples at the laboratory. A follow-up meeting will be held to address any deficiencies or issues identified during the audit.

Field audits will be conducted by a review team member as designated by the PM. One field audit, if requested, will be performed during the first week of sampling.

Laboratory Performance and System Audits

Laboratory systems will be audited in accordance with the project-specific requirements. Contracted laboratories must submit a laboratory CompQAP. The CompQAP must reference relevant SOPs and the laboratory's internal procurement policies and corrective action program.

The laboratory audit will address at least the following issues:

- Is the laboratory operation being performed as required by the subcontract?
- Are internal laboratory operations being conducted in accordance with the laboratory CompQAP?
- Are the laboratory analyses being performed in accordance with method requirements?

Any nonconformance noted during an audit will result in a corrective action.

Field Team Performance and System Audits

The PC or other member of the review team, as designated by the PM, will conduct an audit of the field activities in accordance with the program requirements. The audit will address at least the following issues:

- Are sampling operations being performed as stated in the WP?
- Are the sample labels being filled out completely and accurately?
- Are the chain-of-custody records complete and accurate?
- Are the field notebooks being filled out completely and accurately?
- Are the sampling activities being conducted in accordance with the WP and approved SOPs?
- Are the documents generated in association with the field effort being stored as described in the WP?

The generation and documentation of field data also will be audited. Audits will focus on verifying that proper procedures are followed so that subsequent sample data will be valid. Any nonconformance noted during an audit will result in a corrective action.

The results of the assessment and oversight activities will be reported back to the PM, who has ultimate responsibility for ensuring that the corrective action response is completed, verified, and documented.

1.3.2 Reports to Management

Reports to the PM include project status reports, the results of evaluation and system audits, data quality assessments, and significant QA problems and recommended solutions. The status reports, submitted in accordance with the requirements of the site-specific WP, will discuss at least current activities, problems encountered and their resolution, and planned work.

QA reports will be submitted in accordance with the site-specific WP. QA reports document implementation of the QAPP and the results of the site-specific QA/QC audits. A final QA report must be submitted as part of each project's final report. The topics to be covered are outlined in the site-specific WP, but each will include at least the following information:

- Identification of nonconformances that required corrective action and resolution of the nonconformance
- Data quality assessment in terms of precision and accuracy and how they affect the usability of the analytical results
- Limitations of the qualified results and a discussion of rejected results
- Discussion of the field and laboratory QA/QC sample results
- The results of external laboratory audits

The FTL will provide feedback to the PM discussing all field activities, changes to field procedures, problems encountered, and corrective actions taken.

1.4 Data Validation and Usability

This subsection addresses the QA activities that occur after the data collection has been completed. Implementation of these elements, which include data review, validation, and reconciliation to DQOs, will determine the extent to which the data conform to the specified criteria and satisfy the project objectives.

1.4.1 Data Review, Validation, and Verification Requirements

Data review and validation are processes whereby data generated in support of this project are reviewed against the QA/QC requirements. The data are evaluated for precision, accuracy, and completeness against the analytical protocol requirements. Non-conformances or deficiencies that could affect the usability of data are identified as noted. The types of data that will be validated are described further in the following subsections.

All analytical data will be supported by a data package. The data package will contain the supporting QC data for the associated field samples. Before the laboratory will release each data package, the laboratory QAM (or the analytical section supervisor) must carefully review the sample and laboratory performance QC data to verify sample identity, the completeness and accuracy of the sample and QC data, and compliance with method specifications.

Level I–Field Measurements

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

- Instrument identification
- Calibration information (standards used and results)

- Date and time of calibration and sample measurement
- Sample results
- Supporting information, if appropriate

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

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

Level II–Physical Parameters and Investigation Derived Wastes (IDW) Characterization

The data package deliverables associated with Level II data reporting consist of the components listed below (also described in **Table 1-7**). The data package will be reviewed by the PC for completeness and correctness. No further validation will be performed.

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

Level III–Laboratory Analyses

Not applicable.

Level IV–Laboratory Analyses

The data package deliverables associated with Level IV data reporting are listed in **Table 1-7**. Approximately 10 percent of data packages may be requested as Level IV, and a more in-depth validation performed, such as the re-creation of calculations.

Level IV contains the QC summary forms. Definitive data can be generated by a variety of measurements, ranging from onsite field analyses to laboratory analyses. In the evaluation of definitive data, not all data require the same effort for validation. One hundred percent of the laboratory and definitive data (Level III and IV) generated in support of this project will be validated.

1.4.2 Verification and Validation Methods

Data Verification

Before the analytical results are released by the laboratory, both the sample and QC data will be reviewed carefully to verify sample identity, instrument calibration, detection limits, dilution factors, numerical computations, accuracy of transcriptions, and chemical interpretations. Additionally, the QC data will be reduced and spike recoveries will be included in control charts, and the resulting data will be reviewed to ascertain whether they are within the laboratory-defined limits for accuracy and precision. Any non-conforming

data will be discussed in the data package cover letter and case narrative. The laboratory will retain all of the analytical and QC documentation associated with each data package.

As discussed previously, the data are also verified to assess whether the electronic data deliverables (EDDs) and the hard-copy data deliverables are consistent with one another to ensure an accurate database.

Data Validation

Data validation is at times based on professional judgment. To achieve consistent data validation, data worksheets will be completed for each data validation effort. A data validation worksheet is a summary form on which the data validator records data validation notes and conclusions specific to each analytical method. The worksheets will help the validator track and summarize the overall quality of the data. Sample results will then be assigned a degree of usability based upon the overall data quality.

One hundred percent of the laboratory Level III and Level IV data reporting packages will be validated.

The data package will be validated by the PC using a process analogous to that outlined in the guidance documents, *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA, 2002), *Contract Laboratory Program National Functional Guidelines for Organic Data Review* (EPA, 1999), and *Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review (*EPA, 2002) and will use QC criteria established in this QAPP or in the analytical method. The data review and validation process is independent of the laboratory's checks; it focuses on the usability of the data to support the project data interpretation and decision-making process.

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

- **U** Undetected. Samples were analyzed for this analyte, but it was not detected above the MDL or instrument detection limit (IDL).
- **UJ** Detection limit estimated. Samples were analyzed for this analyte, but the results were qualified as not detected. The result is estimated.
- **J** Estimated. The analyte was present, but the reported value may not be accurate or precise.
- **R** Rejected. The data are unusable. (Note: Analyte/compound may or may not be present.)

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

Data Quality Evaluation

The PC or designee will perform the DQE. The DQE process is used to assess the effect of the overall analytical process on the usability of the data. The two major categories of data

evaluation are laboratory performance and matrix interferences. Evaluation of laboratory performance is a check for compliance with the method requirements. It is a straight-forward examination–either the laboratory did, or did not, analyze the samples within the limits of the analytical method. Evaluation of the matrix interferences is more subtle and involves analysis of several results, including surrogate spike recoveries, matrix spike recoveries, and duplicate sample results. The project team will evaluate the data validation results. This evaluation will assess how the data, as qualified by the data validation, can be used on the project.

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

1.4.3 Reconciliation with Data Quality Objectives

The final activity of the data evaluation process is to assess whether the data meet the planned DQOs for the project. The final results, as adjusted for the findings of any data validation and data evaluation, will be checked against the DQOs, and an assessment will be made as to whether the data are of sufficient quality to support the DQOs. The decision as to data sufficiency may be affected by the overall precision, accuracy, and completeness of the data as demonstrated by the data validation process. The main project objective should be met assuming the 90 percent completeness goal is obtained after all of the data have undergone sufficient data validation. If the data, after validation and evaluation, are sufficient to achieve project objectives, the data quality and project managers will release the data and work may proceed.

1.4.4 Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

It is the joint responsibility of CH2M HILL's Project Chemist and the data validation subcontractor to ensure that the analytical data meet the method detection limits, reporting limits, and laboratory QC limits listed in this Work Plan, the laboratory SOW, and the various methods. During this assessment, non-conformances are documented, the data are qualified for use in decision making.

Non-detected site contaminants will be evaluated to ensure that project required quantitation limits in Worksheet #15 were achieved. If project quantitation limits were achieved and the verification and validation steps yielded acceptable data, then the data is considered usable. During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers represent minor QC deficiencies which will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases is not considered usable for project decisions. For statistical comparisons non-detect values will be represented by a concentration equal to one-half the sample reporting limit. For duplicate sample results, the most conservative value will be used for project decisions. Analytical data will be checked

to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data has been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately. Field and laboratory precision will be compared as relative percent difference (RPD) between the two results. Deviations from the SAP will be reviewed to assess whether corrective action is warranted and to assess impacts to achievement of project objectives.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

In-depth assessment occurs during the data validation process. The third-party validation contractor will follow the method performance criteria as outlined in the laboratory SOPs as for validation purposes. The findings of the data validation reports and the qualifiers applied to the data will be considered in context with field logs and corrective action reports to assess overall usability.

To assess whether a sufficient quantity of acceptable data are available for decision making, the data will be reconciled with measurement performance criteria following validation and review of data quality indicator. If significant biases are detected with laboratory QA/QC samples it will be evaluated to assess impact on decision making. Low biases will be described in greater detail as they represent a possible inability to detect compounds that may be present at the site. If significant deviations are noted between lab and field precision the cause will be further evaluated to assess impact on decision making.

Identify the personnel responsible for performing the usability assessment:

Project Chemist – Anita Dodson/CH2M HILL
Project Manager – Dan Tomczak/CH2M HILL

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

The data validation reports will identify precision and accuracy exceedances with respect to the laboratory performance for each batch of samples, as well as comparability of field and lab duplicates. All the results will be assembled and statistically reported for an overall quality assessment provided in the final project event report. Discussion will cover completeness and representativeness. Attachments supporting this report will include data validation narratives, CA forms, and field audit reports.

Data tables will be produced to reflect detected and non-detected site contaminants and geochemical parameters. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation. Figures will be produced representing concentrations of contamination.

Table 1-11 presents project documentation and records.

TABLE 1-11
Project Documents and Records
SWMU 474 RFI Work Plan

Document	Where Maintained
Field Notebooks	Electronic .pdf copies in the project file. Hardcopy (bound notebook) in the project file. Archived at project closeout.
Chain-of-Custody Records	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout.
Air Bills	Hardcopy in the project file. Archived at project closeout.
Telephone Logs	Hardcopy in the project file. Archived at project closeout.
Corrective Action Forms	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout.
PID/FID readings	Recorded in Field Notebook. Stored in EnDat.
Water quality parameters collected during sediment sampling	Recorded in Field Notebook. Stored in EnDat.
OVM/OVA readings	Recorded in Field Notebook. Stored in EnDat.
Various field measurements	Recorded in Field Notebook.
All equipment calibration information	Recorded in Field Notebook.
Pertinent telephone conversations	Recorded in Field Notebook.
Equipment maintenance records	Inspected by Field Team Leader. Not maintained.
Sample Receipt, Custody, and Tracking Records	Electronic .pdf copies in the project file. Hardcopy in the full data package.
Standard Traceability Logs	Hardcopy in the full data package. Archived at project closeout.
Equipment Calibration Logs	Hardcopy in the full data package. Archived at project closeout.
Sample Prep Logs	Hardcopy in the full data package. Archived at project closeout.
Run Logs	Hardcopy in the full data package. Archived at project closeout.
Equipment Maintenance, Testing, and Inspection Logs	Hardcopy in the full data package. Archived at project closeout.
Reported Field Sample Results	Electronic .pdf copies in the project file. Hardcopy in the data package. Archived at project closeout.
Reported Results for Standards, QC Checks, and QC Samples	Hardcopy in the full data package. Archived at project closeout.
Instrument Printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples	Hardcopy in the full data package. Archived at project closeout.
Data Package Completeness Checklists	Hardcopy in the data validation report. Archived at project closeout.
Sample Disposal Records	Maintained by the laboratory.
Extraction/Clean-up Records	Maintained by the laboratory.

TABLE 1-11
Project Documents and Records
SWMU 474 RFI Work Plan

Document	Where Maintained
Raw Data	Hardcopy in the full data package. Archived at project closeout.
Field Sampling Audit Checklists	Hardcopy in the project file. Archived at project closeout.
Fixed Laboratory Audit Checklists	If completed, hardcopy in the project file. Archived at project closeout.
Data Validation Reports	Electronic .pdf copies in the project file. Hardcopy stored with the data package. Archived at project closeout.

Table 1-12 presents field sampling SOPs.

TABLE 1-12
Field Sampling SOPs
SWMU 474 RFII Work Plan

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work?	Comments
Appendix A	Low-Flow Groundwater Sampling from Monitoring Wells, revised 1/21/01	CH2M HILL	Peristaltic pump	No	
Appendix A	Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature with Flow-through Cell; 1/08	CH2M HILL	Horiba U-22, In-Situ TROLL 9500, YSI 600XL, or equivalent	No	
Appendix A	Groundwater Sampling from Monitoring Wells; 1/30/97	CH2M HILL		No	
Appendix A	Temporary Well Installation	CH2M HILL		No	
Appendix A	Direct-Push Soil Sample Collection; 2/02/99	CH2M HILL	Truck-mounted hydraulic percussion hammer	No	
Appendix A	Water-Level Measurements; 1/11/99	CH2M HILL	Electronic water level meter	No	
Appendix A	Packaging and Shipping Procedures for Low-Concentration Samples; 1/08	CH2M HILL	Lab-supplied coolers	No	
Appendix A	Preparing Field Log Books; 1/08	CH2M HILL	n/a	No	
Appendix A	Utility Locating; 1/15/08	CH2M HILL		No	
Appendix A	Disposal of Waste Fluids and Solids; 2/2/99	CH2M HILL		No	

References

U.S.EPA, Intergovernmental Data Quality Task Force, 2005, *Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Part 1: UFP-QAPP Manual*, EPA-505-B-04-900A, March 2005.
U.S.EPA, 2002, *Guidance for Quality Assurance Project Plans EPA QA/G-5*, EPA/240/R-02/009, December 2002.

CH2M HILL, 2008. *Master Quality Assurance Project Plan, Marine Corps Base Camp Lejeune, North Carolina*.

U.S.EPA, 2001, *EPA Requirements for Quality Assurance Project Plans EPA QA/R-5*, EPA/240/B-01/003, March 2001.

U.S.EPA, 2007, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* SW-846 (online), Third ed., http://www.epa.gov/epaoswer/hazwaste/test/main.htm

U.S.EPA, 1983, *Methods for Chemical Analysis of Water and Wastes,* EPA-600-4-79-020, March 1983.

U.S.EPA, 2004, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* EPA 540-R-04-004, October 2004.

U.S.EPA, 1999, *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* EPA 540-R-99-008, October 1999.

U.S.EPA, 2005, *USEPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review* EPA 540-R-05-001, September 2005.

Appendix A
Standard Operating Procedures

STANDARD OPERATING PROCEDURE - 001

Preparing Field Log Books

I. Purpose

To provide general guidelines for entering field data into log books during site investigation and remediation field activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement of much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, orange-covered logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.

2. On the inside cover of the log book the following information should be included:

    - Company name and address
    - Log-holders name if log book was assigned specifically to that person

- Activity or location
- Project name
- Project manager's name
- Phone numbers of the company, supervisors, emergency response, etc.

3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."

4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

5. Daily entries will be made chronologically.

6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.

7. Each page of the log book will have the date of the work and the note takers initials.

8. The final page of each day's notes will include the note-takers signature as well as the date.

9. Only information relevant to the subject project will be added to the log book.

10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.

2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.

3. Scope: Describe the general scope of work to be performed each day.

4. Weather: Record the weather conditions and any significant changes in the weather during the day.

5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified, and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.

7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.

8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.

9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.

10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.

11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.

12. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data

obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

- Description of the general sampling area – site name, buildings and streets in the area, etc.
- Station/Location identifier
- Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
- Sample matrix and type
- Sample date and time
- Sample identifier
- Draw a box around the sample ID so that it stands out in the field notes
- Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples
- Number and type of sample containers collected
- Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)
- Parameters to be analyzed for, if appropriate
- Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).

2. Use tables to record sampling information and field data from multiple samples.

3. Sketch sampling locations and other pertinent information.

4. Sketch well construction diagrams.

V. Attachments

Example field notes.

STANDARD OPERATING PROCEDURE - 004

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using the Horiba® U-22 with Flow-through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using the Horiba® U-22 for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of groundwater samples. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Horiba® U-22 Water Quality Checker with flow-though cell
- Distilled water in squirt bottle
- Horiba® U-22 Auto-Calibration Standard Solution

III. Procedures and Guidelines

A. Parameters and Specifications:

Parameter	Range of measurement	Accuracy
pH	0 to 14 pH units	+/- 0.1 pH units
Specific conductance	0 to 9.99 S/m	+/- 3 % full scale
Turbidity	0 to 800 NTU	+/- 5 % full scale
Dissolved oxygen	0 to 19.99 mg/l	+/- 0.2 mg/l
Temperature	0 to 55 °C	+/- 1.0 °C
ORP	-999 to +999 mV	+/- 15 mV
Salinity	0 to 4 %	+/- 0.3 %

B. Calibration:

Prior to each day's use, clean the probe and flow-through cell using deionized water and calibrate using Horiba® Standard Solution. Calibration procedure:

1. Fill the calibration beaker to about 2/3 with the pH 4 standard solution.
2. Fit the probe into the beaker. All the parameter sensors will now be immersed in the standard solution except the D.O. sensor; the D.O. calibration is done using atmospheric air.
3. Turn power on.
4. Press CAL key to put the unit in the calibration mode.
5. Press the ENT key to start automatic calibration. Wait a moment, and the upper cursor will gradually move across the four auto-calibration parameters one by one: pH, COND, TURB, and DO. When the calibration is complete, the readout will briefly show END. The instrument is now calibrated.
6. If the unit is calibrated properly, pH will read 4.0 +/- 3%, conductivity will read 4.49 +/- 3%, and turbidity will read 0 +/- 3%

C. Sample Measurement:

As water passes through the flow-through Cell, press MEAS to obtain reading; record in the field notebook.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction.

STANDARD OPERATING PROCEDURE - 006

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV Responsibilities

Project Manager - The Project Manager is responsible for ensuring that project-specific plans are in accordance with these procedures, where applicable, or that other, approved procedures are developed. The Project Manager is responsible for development of documentation of procedures which deviate from those presented herein. The Project Manager is responsible for ensuring that chain-of-custody procedures are implemented. The Project Manager also is responsible for determining that custody procedures have been met by the analytical laboratory.

Field Team Leader - The Field Team Leader is responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper or laboratory. It is the responsibility of the Field Team Leader to ensure that these procedures are implemented in the field and to ensure that personnel performing sampling activities have been briefed and trained to execute these procedures.

Sample Personnel - It is the responsibility of the field sampling personnel to initiate chain-of-custody procedures, and maintain custody of samples until they are relinquished to another custodian, the sample shipper, or to a common carrier.

V Procedures

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

V.1 Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,

- Date and time of sample collection and/or measurement,
- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

V.1.1 Sample Label

Samples, other than for *in situ* measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project - CTO Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 01/21/08).
- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site). The field team should always follow the sample ID system prepared by the project EIS and reviewed by the Project Manager.

V.2 Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

V.2.1 Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify sample locations in photographs, an easily read sign with the appropriate sample/location number should be included.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

V.2.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below:

- Enter header information (CTO number, samplers, and project name).

- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).

- Sign, date, and enter the time under "Relinquished by" entry.

- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).

- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner;

- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.

- Sign and date the custody seal, a 1-inch by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.

- Place the seal across the shipping container opening (front and back) so that it would be broken if the container were to be opened.

- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

VI Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VII Attachments

A. Sample Label
B. Chain of Custody Form
C. Custody Seal

VIII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

STANDARD OPERATING PROCEDURE - 007

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped following procedures for dangerous-goods shipping specified by the intended shipper (e.g., Federal Express).

III. Equipment and Materials

- Coolers
- Clear tape
- "This Side Up" labels
- "Fragile" labels
- Vermiculite
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

A. Prepare coolers for shipment:

- Tape drains shut.
- Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
- Place mailing label with laboratory address on top of coolers.
- Fill bottom of coolers with about 3 inches of vermiculite or absorbent pads.

B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.

C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.

D. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.

E. Arrange sample bottles in coolers so that they do not touch.

F. If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.

G. Fill remaining spaces with vermiculite or absorbent pads.

H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.

J Close lid and latch.

K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.

L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Cover custody seals with tape to avoid seals being able to be peeled from the cooler.

M. Relinquish to Federal Express or to a courier arranged with the laboratory. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.

Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with several additional restrictions. The sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate vermiculite or other packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

STANDARD OPERATING PROCEDURE - 009

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized ("DI") water (specifically, ASTM Type II water or lab-grade DI water)
- Distilled water
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox® (or Alconox®)and water solution
- Concentrated (V/V) pesticide grade methanol (DO NOT USE ACETONE)
- Large plastic pails or tubs for Liquinox® and water, scrub brushes, squirt bottles for Liquinox® solution, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Phthalate-free gloves such as Nitrile
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in Liquinox® solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with Liquinox® solution, remove, and discard into DOT-approved 55-gallon drum.

2. Wash outer gloves in Liquinox® solution, rinse, remove, and discard into DOT-approved 55-gallon drum.

3. Remove disposable coveralls ("Tyveks") and discard into DOT-approved 55-gallon drum.

4. Remove respirator (if worn).

5. Remove inner gloves and discard.

6. At the end of the work day, shower entire body, including hair, either at the work site or at home.

7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.

2. Spread plastic on the ground to keep equipment from touching the ground

3. Turn off pump after sampling. Remove pump from well and remove and dispose of tubing. Place pump in decontamination tube.

4. Turn pump back on and pump 1 gallon of Liquinox® solution through the sampling pump.

5. Rinse with 1 gallon of 10% methanol solution pumped through the pump. (DO NOT USE ACETONE).

6. Rinse with 1 gallon of tap water.

7. Rinse with 1 gallon of deionized water.

8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.

9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.

10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Before entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox® solution.
5. Rinse with potable water.
6. Rinse with distilled or potable water and methanol solution (DO NOT USE ACETONE).
7. Air dry.
8. Rinse with deionized water.
9. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
10. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
11. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox® solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Liquinox® solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.

2. Dispose of all used paper towels in a DOT-approved 55-gallon drum.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Facility

2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox®, methanol, and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

STANDARD OPERATING PROCEDURE - 010

Disposal of Waste Fluids and Solids

I. Purpose and Scope

This SOP describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced. Also, the site investigation-derived waste management plan should be consulted for additional information and should take precedence over this SOP.

II. Equipment and Materials

A. Fluids

- DOT-approved 55-gallon steel drums or Baker® Tanks
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Paint Pens
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- DOT-approved 55-gallon steel drums or rolloffs
- Tools for securing drum lids
- Paint Pens
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. Procedures and Guidelines

A. Methodology

Clean, empty drums or rolloffs or Baker® Tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes, capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will

be labeled as they are filled in the field and labels indicating that the contents are potentially hazardous affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. The drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. The analysis will be used to determine if drilling wastes are covered by land disposal restrictions.

If rolloffs are used, compositing and sampling of soil will comply with applicable state and federal regulations.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended
- Generator Contact Information
- When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development and purging of the monitoring wells will be collected in 55-gallon, closed-top drums. When a drum is filled, the bung will be secured tightly. Fluids may also be transferred to Baker® Tanks after being temporarily contained in drums to minimize the amount of drums used.

When development and purging is completed, the water will be tested for appropriate hazardous waste constituents. Compositing and sampling of fluids will comply with applicable state and federal regulations.

D. Solids

The soil cuttings from well and boring drilling will constitute a large portion of the solids to be disposed of.

The solid waste stream also will include plastic sheeting used for decontamination pads, Tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the fenced drum storage area by the drilling services subcontractor. Drums should be stored on pallets on plastic sheeting to capture small spills.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste, and water quality regulations. Transport and disposal will be performed by a commercial firm under subcontract.

The liquid wastes meeting acceptable levels of discharge contamination may be disposed of through the sanitary sewer system at the site. Prior to disposal to the sanitary sewer system, contract arrangements will be made with the appropriate authorities. Wastes exceeding acceptable levels for disposal through the sanitary sewer system will be disposed of through contract with a commercial transport and disposal firm.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Check that representative samples of the containerized materials are obtained.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

STANDARD OPERATING PROCEDURE

Low-Flow Groundwater Sampling from Monitoring Wells

I. Purpose and Scope

This procedure presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Meters to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature (e.g., Horiba® U-22 or similar)
- Water-level indicator
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Generator
- Disposable polyethylene tubing
- Plastic sheeting
- Well-construction information
- Calibrated bucket or other container and watch with second indicator to determine flow rate
- Sample containers
- Shipping supplies (labels, coolers, and ice)
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. For the well to be sampled, information is obtained on well location, diameter(s), depth, and screened interval(s), and the method for disposal of purged water.

2. Instruments are calibrated according to manufacturer's instructions.

3. The well number, site, date, and condition are recorded in the field logbook.

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.

5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

6. Water level measurements are collected in accordance with SOP *Water Level Measurements*. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well installation log.

7. Attach and secure the polyethylene tubing to the low-flow pump. Lower the pump slowly into the well and set it at approximately the middle of the screen. Place the pump intake at least 2 feet above the bottom of the well to avoid mobilization of any sediment present in the bottom. Preferably, the pump should be in the middle of the screen.

8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.

9. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.

10. The water level should be monitored during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.5-foot). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1- to 0.2-liter per minute) to avoid affecting well drawdown.

11. During purging, the field parameters are measured frequently (every 3 to 5 minutes) until the parameters have stabilized. Field parameters are considered stabilized when measurements meet the following criteria:

    - pH: within 0.1 pH units

- Specific conductance: within 3 percent
- Dissolved oxygen: within 10 percent
- Turbidity: within 10 percent or as low as practicable given sampling conditions
- ORP: within 10 mV

B. Sample Collection

Once purging has been completed, the well is ready to be sampled. The elapsed time between completion of purging and collection of the groundwater sample from the well should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in bottles that are appropriate to the respective analysis and that have been cleaned to laboratory standards. Each bottle typically will have been previously prepared with the appropriate preservative, if any.

The following information, at a minimum, will be recorded in the logbook:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; whether the sample is filtered or not; time and date; sampler's identity)
2. Sample source and source description
3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservatives added; laboratory sent to, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Samples may be field filtered before transfer to the sample bottle. Filtration must occur in the field immediately upon collection. Inorganics, including metals, are to be collected and preserved in the filtered form as well as the unfiltered form. The recommended method is through the use of a disposable in-line filtration module (0.45-micron

filter) using the pressure provided by the pumping device for its operation.

4. Samples for analysis for volatile organic compounds should be collected first, if such samples are required.

5. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to overflowing and capped.

6. The bottle is capped, then labeled clearly and carefully following the procedures in SOP *Packaging and Shipping Procedures*.

7. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.

2. It may not be possible to prevent drawdown in the well if the water-bearing unit has sufficiently low permeability. If the water level was in the screen to start with, do not worry about it because there is no stagnant water in the riser above the screen to begin with.

   If the water level in the well is in the riser above the screen at the beginning of purging, then be sure you pump out sufficient volume from the well to remove the volume of water in the riser above the screen. For a 2-inch diameter well, each foot of riser contains 0.163 gallons; for a 4-inch riser, each foot of riser contains 0.653 gallons; for a 6-inch riser, each foot of riser contains 1.47 gallons.

   Alternatively, the water in the riser above the screen can be removed by lowering the pump into the well until the pump intake is just below the water level, starting the pump, running it at a low rate, and slowly lowering the pump as the water level in the riser declines. This approach can be terminated when the water level reaches the top of the screen, at which time the stagnant water in the riser has been removed. This may not be a practical approach for dedicated sampling equipment. As with typical low-flow sampling, the flow rate should be kept as low as practicable.

3. There may be circumstances where a positive-displacement or submersible pump cannot be used. An example is at isolated, hard-to-reach locations where the required power supply cannot be brought. In this case, a peristaltic pump may be used. Samples can be collected by the procedures described above for all but those for VOC analysis. The water to be placed in the vials for VOC analysis should not be run

through the peristaltic pump but instead should be collected by the following:

- Stop the pump when it is time to collect the VOC sample.
- Disconnect the tubing upstream from the pump (a connector must be installed in the line to do this).
- Pinching the tubing to keep the water in the tubing, remove the tubing from the well. Be sure that the tubing does not contact other than clean surfaces.
- Place the end of the tubing that was in the well into each VOC vial and fill the vial by removing the finger from the other end of the tube.
- Once the vials are filled, return the tubing to the well and collect any other samples required.

4. Nondedicated sampling equipment is removed from the well, cleaned, and decontaminated in accordance with SOP *Decontamination of Personnel and Equipment*. Disposable polyethylene tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.
- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
    - Inspect sampling pump regularly and replace as warranted

- Inspect quick-connects regularly and replace as warranted
- Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it's effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

STANDARD OPERATING PROCEDURE

Aquifer Slug Testing

I. Purpose and Scope

The purpose of this procedure is to outline the equipment and methods that will be used to perform variable-head tests ("slug" tests) on piezometers and monitoring wells. The guidance covers use of both air and solid displacement methods.

II. Equipment and Materials

- In-Situ data loggers or equivalent
- Well-testing assembly
  - packer
  - fittings for pressure transducers
  - fittings for air supply
  - release valve
- Compressed air
- Computer and associated equipment
- Solid displacement device with rope

III. Procedures and Guidelines

The tests to be performed are rising head tests. The tests are accomplished by lowering the head of water in the well and monitoring the recovery of the water level to the static water level. The water level will be lowered by one of two methods. One method is the use of an air displacement device. Alternatively, a solid displacement device removed from the well will be used.

The air displacement apparatus consists of a packer assembly, fittings to accommodate transducers and air pressurization, and a pressure-release valve. The packer is lowered into the upper portion of the monitoring well, secured in place and inflated, providing a seal between the apparatus and the inside of the well. Two fittings are provided for pressure transducers: one transducer is fed through the inside of the device and positioned below the water surface and the other is inserted to measure the air pressure inside the assembly. A third fitting is connected to the pressurized air supply, a compressed air tank.

The datalogger will be programmed to display the air pressure in units of head, the head measured by the submerged transducer, and the difference between the two. The difference between the two pressure transducers is the height of the water column on the submerged transducer. The readings are recorded in a field notebook, and then the assembly is pressurized. The air pressure applied will be equivalent to 3 to 7 feet of

head. The pressures are allowed to stabilize. The pressure of the air should not lower the water level to below the base of the bentonite seal installed in the well.

Each test is started by releasing the air pressure inside the assembly and allowing the water level to rise to the static water level. When the datalogger perceives a change in water level in the well above a preset trigger amount, it automatically begins to record the water levels and elapsed time. Each test will be terminated when the water level has recovered to at least 90 percent of the original equilibrium level before pressurization. Note that the test method cannot be used if the well is screened across or near the water table.

An alternate method of lowering using a solid displacement device to lower the water level. A single transducer will be installed in the well below the water table. A weighted solid displacement device is added to the well and the water level allowed to stabilize at the original static water level. The test is started by rapidly removing the displacement device, which causes a drop in the water level. The data logger begins recording the water level and elapsed time when the preset trigger amount is reached. Readings are taken as above, and the test stopped when the well has recovered to 90 percent of the original level.

At least two valid tests will be performed in each well. Additional tests will be required if there is some evidence that any of the tests were unacceptable.

At the end of each test, the test results will be transferred to a laptop and the data downloaded and checked for preliminary completeness.

IV. Attachments

None.

V. Key Checks and Preventive Maintenance

- Check that the packer assembly is in good condition and not leaking. Provide a repair kit including tape and clamps. Take additional packer assembly and other spare parts.
- Check the batteries for the datalogger and computer. Check that the computer disks containing the programs for the datalogger are packed.
- Check the datalogger calculation of the well hydraulic conductivity at the end of each test to determine if these are consistent with expectations.

STANDARD OPERATING PROCEDURE

Temporary Well Installation

Purpose

The purpose of this Standard Operating Procedure (SOP) is to give guidance on the installation of temporary wells that are intended for groundwater sampling.

Scope

Temporary well points will be used when sampling groundwater at stations that are not a groundwater well or direct-push groundwater sampling station. This procedure provides information on proper installation techniques for temporary well points. These wells are typically installed in direct-push locations, but may be installed in larger diameter boreholes, such as hollow stem auger locations. This information will facilitate planning of the field sampling effort by describing standard sampling techniques.

There are two primary situations when temporary well points would be installed:

- *Immediate Groundwater Sampling*: In this instance, the station produces enough water to collect the sample at the time of installation. The temporary well point provides protection of groundwater sampling equipment from soil contamination or fouling. It also protects the equipment and sample from partial or complete borehole collapse.
- *Delayed Groundwater Sampling*: In this instance, the borehole will not produce enough water within a 'reasonable' amount of time. The field team will install the well point and come back within 24 hours to complete the sampling. The ground surface at the well point must be sealed with sodium bentonite at the 24-hour groundwater sampling locations.

Equipment / Materials

The following pieces of equipment may be needed to install temporary well points.

- Decontaminated 1-or 2-inch diameter, threaded Schedule 40 PVC riser (supplied by the driller)
- Decontaminated 1- or 2-inch diameter, 2.5- or 5-foot long threaded Schedule 40 PVC screen (supplied by the driller)
- Decontaminated 1- or 2-inch diameter pointed screen base (supplied by the driller)
- Decontaminated 1- or 2-inch diameter PVC cap (supplied by the driller)
- Sodium bentonite pellets or chips (supplied by the driller)
- Inert, uncontaminated material, such as plastic sheeting or aluminum foil

Procedures / Guidelines

Temporary well points are to be installed in direct-push or hollow stem auger boreholes where groundwater samples could not be sampled using direct-push methods or at an installed monitoring well location.

Temporary wells points are sampled immediately after installation or within 24 hours of installation, so they do not have to be purged since there is no non-representative formation water to be purged.

Installation Procedure

- Ensure all well materials are decontaminated. Well point installers will wear clean gloves, as specified in the Health and Safety Plan.
- Attach the pointed well screen base to the base of the screen. Thread sections of riser onto the screen and lower the screen and riser through the direct-push rods or hollow-stem augers to the base of the boring
- Pull augers/rods out of the borehole, to a minimum of two feet above the top of the temporary piezometer screen, allowing direct contact with formation groundwater.
- Sample the wellpoint.
- If the sampling can not be completed immediately, then a temporary annular seal must be established.
  - If the formation does not collapse around the temporary well point screen, add filter pack to a depth of 2 feet above the top of the screen section. Complete the temporary annular seal by adding granular bentonite or bentonite pellets/chips to ground surface. Hydrate the granular bentonite or bentonite chips/pellets per manufacturers specifications. Attach the PVC cap prior to adding any materials to the borehole annulus.
  - Formation collapse to within 4 feet of ground surface is allowable as long as a single water-bearing unit is penetrated. If multiple water-bearing units are penetrated, then natural collapse to the top of the unit being sampled is allowable and granular bentonite or bentonite chips/pellets will be added from the top of the unit being sampled to ground-surface. Hydrate the granular bentonite or bentonite chips/pellets per manufacturers specifications. Attach the PVC cap prior to adding any materials to the borehole annulus.
- Return within 24 hours to complete well sampling. If the well is still not producing enough groundwater, consult with the FTL
- When complete, remove the temporary well point and either continue the boring and sampling or abandon the borehole.

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to CH2M HILL and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on CH2M HILL to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided

by the Navy do not meet the standards that we consider to be adequate, in that they often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from $500 to several $1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20 foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment B provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the Navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment C provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities /clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in Appendix C.

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by CH2M HILL and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These "dig permit" requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

CH2M HILL Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by CH2M HILL as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M HILL) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR),** which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF),** involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be

detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers,** are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions. ***The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.***
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the "Miss Utility" service and the CH2M HILL-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The CH2M HILL subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. ***This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.***

- Marking shall be done using the color coding presented in Attachment E. The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their sidewalks and streets. ***Any particular marking requirements need to be provided in the subcontractor SOW.***
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by CH2M HILL, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

A- Example SOW for Utility Location Subcontractor Procurement
B - Services Available for Identifying and Marking Underground Utilities
C – Equipment Used for Identifying Underground Utilities
D – Utility Clearance Documentation Form
E – Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site XX of <<insert name of base, city, and state>>. The subcontractor will need to be available beginning at <<insert time>> on <<insert date>>. It is estimated that the work can be completed within XX days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities (CHOOSE 1) that lie within a radius of 20 feet of each of XX sampling locations at Site XX shown on the attached Figure 1; (OR) that lie within the bounds of Site XX as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) (CHOOSE 1) can be found at <<insert specific department and address or phone number on the base>> and should be reviewed by the subcontractor and referenced as part of the utility locating. (OR), will be provided to the subcontractor by CH2M HILL upon the award of the subcontract. (OR), are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A CH2M HILL representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1)** ***a 20-ft radius of the XX proposed soil boring locations*** **(OR)** ***within the boundary of the site(s)*** as identified on the attached figure(s) will be marked using **paint** ***(some Bases such as the WNY may have restrictions on the use of permanent paint)*** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the ***Buried Utility Location Tracking Form*** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to CH2M HILL (field staff or project manager) within 24 hours of completing the utility locating activities.

(OPTIONAL) ***The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.***

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA and any required mapping. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of CH2M HILL.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified. Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. CH2M HILL will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to CH2M HILL, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the CH2M HILL Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the

Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and CH2M Hill representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by CH2M HILL)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWD should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss

Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "One Call" services are free to the public. Note that the "One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the "One Call" center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility "One Call" center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

A national listing of the "One Call" service centers for each state is presented on the web at http://www.underspace.com/refs/ocdir.htm. For the Mid-Atlantic region, the following "One Call" service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	not available	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

1. Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies.

   The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and

recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately $200 per day for a simple EM effort (usually one crew member and one instrument) to approximately $1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	Contact Name and Phone Number	Equipment[1]					Other Services[2]		
		1	2	3	4	5	A	B	C
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology. Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

[1]Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

[2]Other services include:

A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.

B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.

C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

CH2M HILL In-house Utility Location Experts

Tamir Klaff/WDC

Home Office Phone – 703-669-9611

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most new lines include a copper "locator" strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between "time-domain" and "frequency-domain" instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the "congestion" of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in "real time". This method is most commonly used by "dig-safe" contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the

receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects

ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Buried Utility Location Tracking Form

Project Location:
CH2M HILL Project No.:
CH2M HILL Project Manager:

(Submit to CH2M HILL PM within 24 hrs of location activities)

CH2M HILL Purchase Order:

CH2M HILL Field Team Leader:

Utility Location Contractor:
Dates of location activities:
Contractor POC:

	Check each box using an "X" if a buried utility is present within 20 feet of a marked Station ID, and indicate the color of the flag or paint used to identify each utility																
Station ID	**Gas**	**Electric**	**Fiber optic**	**Cable**	**Water**	**San. Sewer**	**Storm Sewer**	**Telephone**	**Petroleum**	**Compressed air**	**Steam**	**Other ____**	**Other ____**	**Other ____**	**Date completed**	**Technician initials**	Notes

The findings of the buried utility location activities summarized herein were conducted in strict accordance with the CH2M HILL scope of work.
Any exceptions to the scope of work are detailed below:

Contractor's Signature

Date

Exceptions:

APWA UNIFORM COLOR CODE

FOR MARKING
UNDERGROUND UTILITY LINES

PROPOSED EXCAVATION

TEMPORARY SURVEY MARKINGS

ELECTRIC POWER LINES, CABLES, CONDUIT AND LIGHTING CABLES

GAS, OIL, STEAM, PETROLEUM OR GASEOUS MATERIALS

COMMUNICATION, ALARM OR SIGNAL LINES, CABLES OR CONDUIT

POTABLE WATER

RECLAIMED WATER, IRRIGATION AND SLURRY LINES

SEWERS AND DRAIN LINES

STANDARD OPERATING PROCEDURE

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in piezometers and monitoring wells, even where a second phase of floating liquid (e.g., gasoline) is encountered, and on staff gages in surface-water bodies. This SOP includes guidelines for discrete measurements of static water levels and does not cover the use of continuously recording loggers (see SOP *Use of Data Loggers and Pressure Transducers)*.

II. Equipment and Materials

- Electronic water-level meter (Solinst® or equivalent) with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less
- Interface probe (Solinst® Model 122 Interface Meter or equivalent)

III. Procedures and Guidelines

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the piezometer or well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Note the depth from a reference point indicated on the piezometer or well riser. Typically this is the top of the protective casing. If no reference is clearly visible, measure the depth to water from the northern edge of the riser. If access to the top of the riser is difficult, sight across the top of the locking casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface.

Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the logbook. Water levels will be measured to the nearest 0.01-foot. Also measure and record the three following readings: (1) the depth of the piezometer or well; (2) the distance from the reference point to the top of the protective casing; and (3) the distance to the surface of the concrete pad or to ground. The depth of the piezometer or well may be measured using the water-level probe with the instrument turned off.

Free product light or dense nonaqueous phase liquid may be present in the piezometer or well. If the presence of free product is suspected, the thickness of the product should be determined using appropriate equipment (e.g., Solinst® Model 122 Interface Meter). The depth to water also is determined with this equipment and the water-level meter should not be used in the piezometer or well as long as product is present. Typically, a

constant sound is emitted from the device when free product is encountered and an alternating on/off beep sound is emitted when water is encountered.

The apparent elevation of the water level in the well or piezometer is determined by measuring both the apparent depth to water and the thickness of free product. The corrected water-level elevation is calculated by the following equation:

$$WL_c = Wl_a + (\text{Free-product thickness} \times 0.80)$$

Where WL_c = Corrected water-level elevation

Wl_a = Apparent water-level elevation

0.80 = Typical value for the density of petroleum hydrocarbon products.

If free product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gages may be installed in some surface-water bodies. These facilities typically are constructed by attaching a calibrated, marked staff gage to a wood or metal post, driving the post into the bottom of the surface-water body, and surveying the elevation of the top of the post to a resolution or 0.01-foot. The elevation of the water in the surface-water body then can be determined by reading off the distance the water level is from the top of the post. A shield or other protection may be needed to calm the fluctuations in water level if the gage is installed at a location exposed to wind or wave.

IV. Attachments

None.

V. Key Checks

- Before each use, verify that the battery is charged by pressing the test button on the water-level meter.
- Verify that the unit is operating correctly by testing the probe in distilled or de-ionized water. Leave the unit turned off when not in use.

SHEALY Chain of Custody Record

SHEALY ENVIRONMENTAL SERVICES, INC.
106 Vantage Point Drive
West Columbia, South Carolina 29172
Telephone No. (803) 791-9700 Fax No. (803) 791-9111

Number

Client	Report to Contact	Telephone No. / Fax No. / E-mail	Quote No.
Address	Sampler's Signature	Waybill No.	Page _____ of _____
City / State / Zip Code	X_____ Printed Name	Analysis (Attach list if more space is needed.)	
Project Name			
Project No.	P.O. No.		Lot No.

Sample ID / Description (Containers for each sample may be combined on one line.)	Date	Time	G=Grab C=Composite	Matrix: Aqueous	Solid	Non-Aqueous	No. of Containers by Preservative Type: Unpres.	H2SO4	HNO3	HCl	NaOH	5035 Kit											Remarks / Cooler I.D.

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison ☐ Unknown

Sample Disposal
☐ Return to Client ☐ Disposal by Lab

Note: All samples are retained for six weeks from receipt unless other arrangements are made.

Turn Around Time Required (Prior lab approval required for expedited TAT.)
☐ Standard ☐ Rush (Specify)

QC Requirements (Specify)

1. Relinquished by	Date	Time	1. Received by	Date	Time
2. Relinquished by	Date	Time	2. Received by	Date	Time
3. Relinquished by	Date	Time	3. Laboratory received by	Date	Time
Comments			LAB USE ONLY Received on ice (Circle) Yes No Ice Pack	Receipt Temp. _____ °C	

DISTRIBUTION: WHITE & YELLOW-Return to laboratory with Sample(s); PINK-Field/Client Copy

Site Specific Health and Safety Plan

Site Specific Health and Safety Plan
SWMU 474

Marine Corps Base
Camp Lejeune, North Carolina

Prepared for

Department of the Navy
Mid-Atlantic Division
Naval Facilities Engineering Command

Under the

CLEAN III Program
Contract N62470-02-D-3052
Contract Task Order 134 Mod 5

February 2009

Prepared by

Raleigh, North Carolina

Introduction

The health and safety of site personnel and the public are a primary concern during investigative and remedial activities at potentially hazardous sites. This Site Specific Health and Safety Plan (HASP) template is to be used in the formation of site specific HASP's.

CH2M HILL SITE SPECIFIC HEALTH AND SAFETY PLAN

(Reference CH2M HILL SOP 19, *Health and Safety Plans*)

This health and safety plan will be kept on the site during field activities and will be reviewed and updated as necessary. The plan adopts, by reference, the standards of practice (SOP) in the CH2M HILL *Corporate Health and Safety Program* as appropriate. The site safety coordinator (SC-HW) is to be familiar with these SOPs and the content of this plan. Site personnel must sign Attachment 1. In addition, this plan adopts procedures in the work plan for the project.

1.0 PROJECT INFORMATION AND DESCRIPTION

CLIENT OR OWNER: Department of the Navy
Mid-Atlantic Division
Naval Facilities Engineering Command

PROJECT NO: 347342

CH2M HILL PROJECT MANAGER: Dan Tomczak

OFFICE: RDU

SITE NAME: Marine Corps Base, Camp Lejeune; SWMU 474

SITE ADDRESS: Jacksonville, North Carolina

DATE HEALTH AND SAFETY PLAN PREPARED: June 16, 2006; revised June 2008

DATE(S) OF INITIAL VISIT:

DATE(S) OF SITE WORK: February 2009

SITE ACCESS: good.

SITE SIZE: The site is approximately one acre.

SITE TOPOGRAPHY: flat

SITE DESCRIPTION AND HISTORY:

SWMU 474 is located east of D. A. Munro Street and north of Demo Range Road in the Courthouse Bay area, MCB Camp Lejeune, and south of Buildings BB52 and newly constructed BB329. Building BB52 is the motor pool for the 2nd Combat Engineer Battalion while Building BB-329 is the Joint Maritime Special Missions Maintenance Supply. During the installation of storm water utilities for Building BB-329, discarded debris was uncovered in the utility corridor excavation. The debris encountered consisted of numerous five-gallon motor oil and hydraulic fluid cans, spent vehicle oil filters, head light assemblies, and a vehicle tow bar. Evidence of staining was present near all of the five-gallon cans and the surrounding soils. Analysis of the soils indicates Diesel Range Organics (DRO) contamination, while samples taken from the five-gallon cans identified polynuclear aromatic hydrocarbons (PAH) indicative of a heavy lubricant. Based on the information contained in the laboratory analysis, a Confirmatory Sampling Investigation (CSI) will be performed at the SWMU.

Soil and groundwater sampling and analysis were performed at this site during the Confirmatory Sampling Investigation (CSI) in November 2006. There were no exceedences of the standards reported in the surface and subsurface soil samples during the CSI activities; however, tetrachloroethene (PCE), 1,4-dichlorobenzene, arsenic, chromium, and lead were reported in groundwater in exceedance of the North Carolina 2L Groundwater Quality Standards.

2.0 PROJECT ORGANIZATION AND TASKS TO BE PERFORMED UNDER THIS PLAN

2.1 PROJECT ORGANIZATION

CLIENT: Bryan Beck
Department of the Navy
NAVFAC Mid-Atlantic Division
Naval Facilities Engineering Command

CH2M HILL: Activity Manager: Kim Henderson/ VBO
Project Manager: Dan Tomczak / RDU
Health and Safety Manager: Mike Goldman / ATL
Field Team Leader: Simon Kline / RDU
Field Staff: TBD

CONTRACTORS and SUBCONTRACTORS: Not Applicable
Utility Locating: Accumark
DPT Sampling: Columbia Technologies
Land Surveying: SEPI Engineering Group
Analytical Laboratory: Shealy Environmental Services

2.2 DESCRIPTION OF TASKS (Reference CH2M HILL SOP HS-19, *Written Plans*)

Refer to site-specific addenda (i.e., work plan, field sampling plan) for detailed task information. A health and safety risk analysis has been performed for each task and is incorporated into this HASP through task-specific hazard controls and requirements for monitoring and protection. Tasks in addition to those listed below and in the Master HASP require an approved amendment before additional work begins.

2.2.1 HAZWOPER-REGULATED TASKS

- DPT boring/drilling
- Temporary monitoring well installation
- Hand auguring
- Groundwater level measurement
- Groundwater sampling
- Surface and subsurface soil sampling
- Aquifer testing
- Investigation-derived waste (drum) sampling and disposal
- IDW Management Observation of material loading for offsite disposal

2.2.3 Drilling

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

- Only authorized personnel are permitted to operate drill rigs.
- Stay clear of areas surrounding drill rigs during every startup.
- Stay clear of the rotating augers and other rotating components of drill rigs.

- Stay as clear as possible of all hoisting operations. Loads shall not be hoisted overhead of personnel.
- Do not wear loose-fitting clothing or other items such as rings or watches that could get caught in moving parts. Long hair should have it restrained.
- If equipment becomes electrically energized, personnel shall be instructed not to touch any part of the equipment or attempt to touch any person who may be in contact with the electrical current. The utility company or appropriate party shall be contacted to have line de-energized prior to approaching the equipment.
- Smoking around drilling operations is prohibited.

2.2.4 NON-HAZWOPER-REGULATED TASKS

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

- Subsurface utility location
- Surveying
- Waste hauling

TABLE 2.3 TASK HAZARD ANALYSIS

Engineering and administrative controls are to be implemented by the party in control of the site or the hazard (i.e., CH2M HILL, subcontractor, or contractor). CH2M HILL employees and subcontractors must, at a minimum, remain aware of hazards affecting them regardless of who is responsible for controlling the hazards. Specialty subcontractors are responsible for the safe operation of their equipment (e.g., drill rig, heavy equipment). CH2M HILL employees are not to operate, or assist in the operation of, any subcontractor or contractor equipment.

Potential Hazard (Refer to SOP, or HSP Section)	Engineering Controls, Administrative Controls, and Work Practices	Drilling, Well Installation	Groundwater Monitoring	Surveying
Flying debris/objects	Wear safety eyewear and hardhat	X		
Noise > 85dBA	Wear ear plugs/muffs	X		
Electrical	Locate underground and overhead utilities prior to task	X	X	X
Suspended Loads	Wear hardhat, Be aware of location of overhead hazards	X		
Buried Utilities, drums, tanks	Locate underground utilities prior to task. Stop if object is encountered	X		
Slip, trip, fall	Be sure of footing, especially in wet or muddy conditions	X	X	X
Back injury	Be careful when lifting and use proper lifting techniques	X	X	
Visible lightning	Discontinue task if lightening is observed	X	X	X
Drilling (Geoprobe)	Be careful of equipment and pinch points	X		

3.1 HAZARDS POSED BY CHEMICALS BROUGHT ON THE SITE

This section discusses hazards posed by chemicals commonly used during RI/FS and other environmental investigation activities. Additional chemicals may be needed for future tasks.

3.1.1 HAZARD COMMUNICATION

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

The project manager is to request Material Safety Data Sheets (MSDSs) from the client or from the contractors and the subcontractors for chemicals to which CH2M HILL employees potentially are exposed. The SC-HW is to do the following:

- Give employees' required site-specific HAZCOM training.
- Confirm that the inventory of chemicals brought on the site by subcontractors is available.
- Before or as the chemicals arrive on the site, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, if any.

The chemical products listed below will be used on the site. Refer to Master HASP for MSDSs.

Chemical	Quantity	Location
Methane	1 liter, compressed	Support Zone
Isobutylene	1 liter, compressed	Support Zone
Pentane	1 liter, compressed	Support Zone
Hydrochloric Acid	<500 mL	Support Zone / sample bottles
Nitric Acid	<500 mL	Support Zone / sample bottles
Sulfuric Acid	<500 mL	Support Zone / sample bottles
Sodium Hydroxide	<500 mL	Support Zone / sample bottles
Methanol	< 1 Gallon	Support / Decon Zones
Isopropanol	< 1 Gallon	Support / Decon Zones
pH buffers	<500 mL	Support Zone
MSA sanitizer	< 1 Liter	Support / Decon Zones
Alconox/Liquinox	< 1 Liter	Support / Decon Zones

3.1.2 SHIPPING AND TRANSPORTATION OF CHEMICAL PRODUCTS

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

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

TABLE 3.2
CONTAMINANTS OF CONCERN

Contaminant	Location and Highest Concentration (ppm)	Exposure Limit[a]	IDLH[b]	Symptoms and Effects of Exposure	PIP[c] (eV)
Benzo[a]pyrene	SWMU 474 - 52.8	0.2 mg/m^3	80 mg/m^3	Dermatitis, bronchitis, [potential occupational carcinogen]	UK
Chrysene	SWMU 474 - 40	0.2 mg/m^3	80 mg/m^3	Dermatitis, bronchitis, [potential occupational carcinogen]	UK
2-Methylnaphthalene	SWMU 474 - 38.7	0.2 mg/m^3	80 mg/m^3	Dermatitis, bronchitis, [potential occupational carcinogen]	UK
Barium	SWMU 474 gw – 0.225	0.5 mg/m^3	50 mg/m^3	Irritation eyes, skin, upper respiratory system; skin burns; gastroenteritis; muscle spasm; slow pulse, extrasystoles; hypokalemia	NA
Lead	SWMU 474 gw – 0.0441	0.050 mg/m^3	100 mg/m^3	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypotension	NA
Chromium	SWMU 474 gw – 0.203	1 mg/m^3	250 mg/m^3	Irritation eyes, skin; lung fibrosis (histologic)	NA
Arsenic	SWMU 474 gw – 0.0684	0.010 mg/m^3	5 mg/m^3	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, [potential occupational carcinogen]	NA
Tetrachloroethene (PCE)	SWMU 474 gw - 0.001	25 ppm	300 ppm	Irritation to the eyes, skin and respiratory tract, metallic taste, ringing in the ears, nausea, vomiting, chest pain, difficulty breathing, irregular heartbeat, headache, drowsiness, symptoms of drunkenness, blurred vision, lung congestion.	9.32
1,2-dichlorobenzene	SWMU 474 gw – 0.001	75 ppm	250 ppm	Burning sensation. Cough. Drowsiness. Headache. Nausea. Shortness of breath. Vomiting.	8.94
1,4-dichlorobenzene	SWMU 474 gw - 0.002	75 ppm	250 ppm	Burning sensation. Cough. Drowsiness. Headache. Nausea. Shortness of breath. Vomiting.	8.94

Footnotes:
[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), S (Surface Soil), SL (Sludge), SW (Surface Water).
[b] Appropriate value of PEL, REL, or TLV listed.
[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.
[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.

3.3 POTENTIAL ROUTES OF EXPOSURE		
DERMAL: Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 5.	INHALATION: Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and monitoring, as specified in sections 5 and 6, respectively.	OTHER: Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before eating, drinking, or smoking).

4.0 PERSONNEL

4.1 FIELD TEAM CHAIN OF COMMAND AND COMMUNICATION PROCEDURES

4.1.1 CLIENT

Client Contact	Base Contact
NAVFAC Mid-Atlantic RPM	Camp Lejeune - EMD
Bryan Beck	Andrew Smith
Building LRA-C, Room 3011	Building 12
6506 Hampton Boulevard	Marine Corps Base
Norfolk, VA 23508-1278	Camp Lejeune, NC 28542-0004
(757) 322-4734	(910) 451-9017
Bryan.k.beck@navy.mil	Stephen.a.smith2@usmc.mil

4.1.2 CH2M HILL

Activity Manager/Phone: Kim Henderson / VBO (757) 671-6231
Project Manager/Phone: Dan Tomczak / RDU (919) 875-4311 ext 51776
Health and Safety Manager (HSM)/Phone: Mike Goldman (770) 604-9182 ext 396
Field Team Leader/Phone: Simon Kline/RDU (919) 946-1465
Site Safety Coordinator/Phone: Simon Kline/RDU (919) 946-1465

The SC-HW is responsible for contacting the field team leader and the project manager. In general, the project manager either will contact or will identify the client contact. The Health and Safety Manager (HSM) should be contacted as appropriate. The SC-HW or the project manager must notify the client and the HSM when a serious injury or a death occurs or when health and safety inspections by OSHA or other agencies are conducted. Refer to Master HASP sections 11 and 12 for emergency procedures and phone numbers.

4.1.3 SUBCONTRACTORS

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

When specified in the project documents (e.g., contract), this plan may cover CH2M HILL subcontractors. However, this plan does not address hazards associated with tasks and equipment that the subcontractor has expertise in (e.g., operation of drill rig). Specialty subcontractors are responsible for health and safety procedures and plans specific to their work. Specialty subcontractors are to submit plans to CH2M HILL for review and approval before the start of fieldwork. Subcontractors must comply with the established health and safety plan(s). CH2M HILL must monitor and enforce compliance with the established plan(s).

Subcontractor: Utility location, drilling, land surveying
Subcontractor Contact:
Telephone:

4.1.4 CONTRACTORS

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

This plan does not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for directing contractor personnel and is not to assume responsibility through their actions. When the contractor is in control of the site, ask the contractor to conduct a briefing of their health and safety practices and to describe how they apply to CH2M HILL's activities. Request a copy of the contractor's health and safety plan.

Contractor: None covered
Contact Name:
Telephone:

Table 5
PPE Specifications [a]

Task	Level	Required PPE	Head	Respirator [b]
General site entry Surveying	D	Work clothes; steel-toe, leather work boots; work glove.	Hardhat [c] Safety glasses Ear protection [d]	None required
Drilling Operations	Modified D	Work clothes or cotton coveralls Boots: Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers Gloves: Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Safety glasses Ear protection [d]	None required
Groundwater sampling Soil boring Investigation-derived waste (drum) sampling and disposal	Modified D	Coveralls: Uncoated Tyvek® Boots: Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers Gloves: Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Safety glasses Ear protection [d]	None required.
Tasks requiring upgrade	C	Coveralls: Polycoated Tyvek® Boots: Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers Gloves: Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Ear protection [d] Spectacle inserts	APR, full face, MSA Ultratwin or equivalent; with GME-H cartridges or equivalent[e].

Reasons for Upgrading or Downgrading Level of Protection

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

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SC.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.
[e] Cartridge change-out schedule is at least every 8 hours (or one work day), except if relative humidity is > 85%, or if organic vapor measurements are > midpoint of Level C range (refer to Section 5)-, then at least every 4 hours. If encountered conditions are different than those anticipated in this HSP, contact the HSM.
[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements[have been approved by the HSM, and an SC qualified at that level is present.

6.1 Air Monitoring Specifications

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

Instrument	Tasks	Action Levels[a]		Frequency [b]	Calibration
PID: OVM with 10.6eV lamp or equivalent	All intrusive work including excavation.	<1 ppm 1 to 10 ppm >10 ppm	Level D Level C Evacuate the work are and contact the HSM	Initially and periodically during task	Daily
CGI: MSA model 260 or 261 or equivalent	All intrusive work including excavation.	0-10% : 10-25% LEL: >25% LEL:	No explosion hazard Potential explosion hazard. Contact HSM in case the work area needs to be reclassified re Dow Hot Work Standard. Explosion hazard; evacuate or vent.	Continuous during advancement of boring or trench	Daily
O_2Meter: MSA model 260 or 261 or equivalent	All intrusive work including excavation.	>25%[c] O_2: 20.9%[c] O_2: <19.5%[c] O_2:	Explosion hazard; evacuate or vent Normal O_2 O_2 deficient; vent or use SCBA	Continuous during advancement of boring or trench	Daily

[a] Action levels apply to sustained breathing-zone measurements above background.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., "Breathing Zone/MW-3", "at surface/SB-2", etc.).
[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry (refer to Section 2).
[d] Refer to SOP HSE-10 for instructions and documentation on radiation monitoring and screening.
[e] Noise monitoring and audiometric testing also required.

6.2 Calibration Specifications

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

Instrument	Gas	Span	Reading	Method
PID: MiniRAE, 10.6 eV bulb	100 ppm isobutylene	CF = 100	100 ppm	1.5 lpm reg T-tubing
CGI: MSA 260, 261, 360, or 361	0.75% pentane	N/A	50% LEL ± 5% LEL	1.5 lpm reg direct tubing

6.3 Air Sampling

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

Method Description

None Anticipated

Personnel and Areas

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

HSM: Michael Goldman/ATL

7.0 APPROVAL

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

7.1 ORIGINAL PLAN

WRITTEN BY: Jonathan Burton **DATE:** 6/16/2006

APPROVED BY: Michael Goldman CIH, CSP, CHMM **DATE:** June 19, 2006

7.2 REVISIONS

REVISIONS MADE BY: David Seed **DATE: 5/8/2008**

REVISIONS TO PLAN: Updated Hazwoper regulated task and non-regulated task, client and base contact info, COPCs list, hazard communication table, and added MSDS sheets.

REVISIONS APPROVED BY: Michael Goldman **DATE: May 9, 2008**

8.0 ATTACHMENTS

Attachment 1: Emergency Contacts
Attachment 2: Employee Signoff
Attachment 3: Project H&S Forms/Permits
Attachment 4: Project Activity Self-Assessment Checklists
Attachment 5: Applicable Material Safety Data Sheets
Attachment 6: Behavior Based Loss Prevention System

CH2MHILL

Attachment 1

24-Hour CH2M HILL Emergency Contact – (800) 756-1130

Medical Emergency – 911 or

Hospital ER (On-Base)#:	(910) 451-4840
	(910) 451-4841
	(910) 451-4842
Onslow County ER (Off-Base)#:	(910) 577-2240
Ambulance (On-Base)#:	(910) 451-3004
	(910) 451-3005
Ambulance (Public) #:	(910) 451-9111
LEPC (Poison Control) #:	(800) 222-1222

CH2M HILL Medical Consultant
Dr. Jerry Berke
Health Resources, Woburn, MA
(888) 631-0129
(After hours calls will be returned within 20 minutes)

Fire/Spill Emergency – 911 or

Base Fire Response #: (910) 451-9111

Local Occupational Physician
Occupational Medicine Specialists
4815 Oleander Dr.
Wilmington, NC 28403
(910) 451-1111

Security & Police – **911 or**

Base Security #: (910) 451-2555

Corporate Director Health and Safety
Name: Angelo Liberatore
Phone: (770)604-9182

On-Scene Coordinator
Name: Fire Chief
Phone: (910) 451-5815

Environmental Management Division (EMD)
Name: Bob Lowder
Phone: (910) 451-9607

Utilities Emergency
Water
Gas: Contact Base EMD
Electric

Health and Safety Manager (EMD)
Name: Michael Goldman/ATL
Phone: (770) 604-9182 x54133
Cell: 770/331-3127

Designated Safety Coordinator (DSC) see Site-Specific HASP Name: David Seed
Phone: 919-875-4311

Regional Human Resources Department
Name: Mary Jo Jordan/GNV
Phone: (352) 355-2867

Project Manager see Site Specific HASP
Name: Dan Tomczak
Phone: 919-875-4311 x51776

Corporate Human Resources Department
Name: John Monark/COR
Phone: (303) 771-0900

Federal Express Dangerous Good Shipping
Phone: (800) 238-5355
CH2M HILL Emergency # for Shipping Dangerous Goods
Phone: (800) 255-3924

Workers' Compensation and Auto Claims
Sterling Administration Services
Phone: (800) 420-8926 After hours: (800) 497-4566
Report fatalities AND report vehicular accidents involving pedestrians, motorcycles, or more than two cars

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

Facility Alarms: TBD

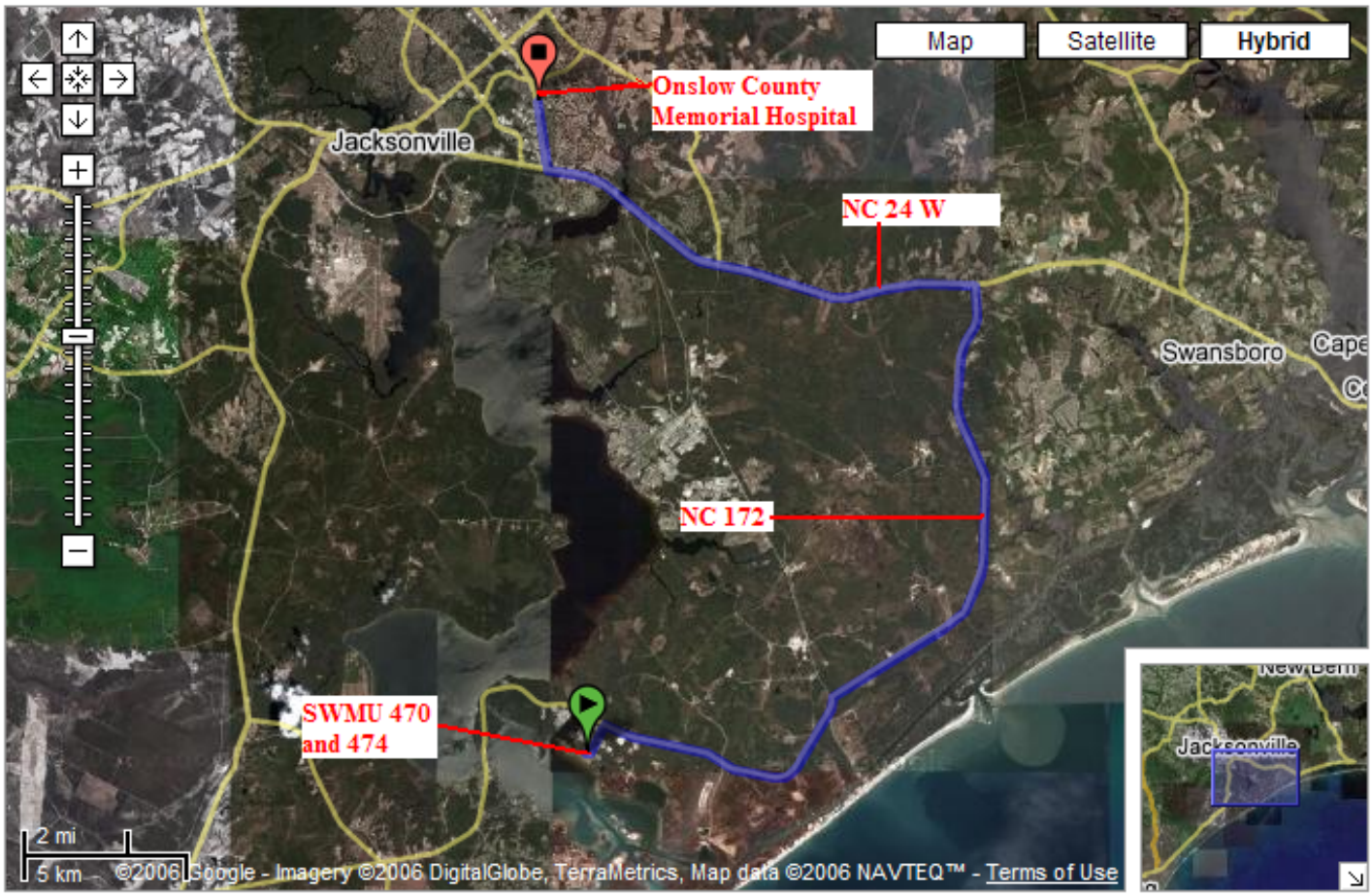
Evacuation Assembly Area(s): TBD by the SC-HW; will probably be the local hotel where the field team is staying

Facility/Site Evacuation Route(s): follow main roads towards access gates and off the Base

Route to Hospital: (Refer to Figure 12-1) Depends on location within base area

Directions to **Onslow County Memorial Hospital** from SWMU 470 and 474
Turn right on Clinton St.
Turn right on Horn Rd. and follow to the intersection of NC Highway 172
Turn right on NC 172 and follow for approx. 15 mi.
Turn left at NC 24 W and follow for approx 9 mi.
Turn right on Western Blvd and follow for approx. 1.3 miles until you reach the hospital at **317 Western Blvd.**

Figure 12-1



GOVERNMENTAL AGENCIES INVOLVED IN PROJECT

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

EMPLOYEE SIGNOFF

The employees listed below have been given a copy of this health and safety plan, have read and understood it, and agree to abide by its provisions.

EMPLOYEE NAME	EMPLOYEE SIGNATURE AND DATE

CH2MHILL

Attachment 3

Project H&S Forms and Permits

CH2MHILL

Attachment 4

Project Activity Self-Assessment Checklists

CH2MHILL

HS&E Self-Assessment Checklist - DRILLING

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's written safety plan.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to drilling hazards, 2) CH2M HILL staff are providing support function related to drilling activities, and/or 3) CH2M HILL oversight of a drilling subcontractor is required.

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

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to drilling hazards (complete Section 1).
☐ Evaluate CH2M HILL support functions related to drilling activities (complete Section 2)
☐ Evaluate a CH2M HILL subcontractor's compliance with drilling safety requirements (complete entire checklist).
Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in SOP HSE-35.

SECTION 1 - SAFE WORK PRACTICES (4.1)

	Yes	No	N/A	N/O
1. Personnel cleared during rig startup	☐	☐	☐	☐
2. Personnel clear of rotating parts	☐	☐	☐	☐
3. Personnel not positioned under hoisted loads	☐	☐	☐	☐
4. Loose clothing and jewelry removed	☐	☐	☐	☐
5. Smoking is prohibited around drilling operation	☐	☐	☐	☐
6. Personnel wearing appropriate personal protective equipment (PPE), per written plan	☐	☐	☐	☐
7. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐

SECTION 2 - SUPPORT FUNCTIONS (4.2)

FORMS/PERMITS (4.2.1)

8. Driller license/certification obtained	☐	☐	☐	☐
9. Well development/abandonment notifications and logs submitted and in project files	☐	☐	☐	☐
10. Water withdrawal permit obtained, where required	☐	☐	☐	☐
11. Dig permit obtained, where required	☐	☐	☐	☐

UTILITY LOCATING (4.2.2)

12. Location of underground utilities and structures identified	☐	☐	☐	☐

SECTION 2 (Continued)

WASTE MANAGEMENT (4.2.3)	**Yes**	**No**	**N/A**	**N/O**
13. Drill cuttings and purge water managed and disposed properly	☐	☐	☐	☐
DRILLING AT HAZARDOUS WASTE SITES (4.2.4)				
14. Waste disposed of according to project's written safety plan	☐	☐	☐	☐
15. Appropriate decontamination procedures being followed, per project's written safety plan	☐	☐	☐	☐
DRILLING AT ORDNANCE EXPLOSIVES (OE)/UNEXPLODED ORDNANCE (UXO) SITES (4.2.5)				
16. OE plan prepared and approved	☐	☐	☐	☐
17. OE/UXO avoidance provided, routes and boundaries cleared and marked	☐	☐	☐	☐
18. Initial pilot hole established by UXO technician with hand auger	☐	☐	☐	☐
19. Personnel remain inside cleared areas	☐	☐	☐	☐
SECTION 3 - DRILLING SAFETY REQUIREMENTS (4.3)				
GENERAL (4.3.1)				
20. Only authorized personnel operating drill rigs	☐	☐	☐	☐
21. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
22. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
DRILL RIG PLACEMENT (4.3.2)				
23. Location of underground utilities and structures identified	☐	☐	☐	☐
24. Safe clearance distance maintained from overhead power lines	☐	☐	☐	☐
25. Drilling pad established, when necessary	☐	☐	☐	☐
26. Drill rig leveled and stabilized	☐	☐	☐	☐
27. Additional precautions taken when drilling in confined areas	☐	☐	☐	☐
DRILL RIG TRAVEL (4.3.3)				
28. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
29. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
30. Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
31. Safe clearance distance maintained while traveling under overhead power lines	☐	☐	☐	☐
32. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
DRILL RIG OPERATION (4.3.4)				
33. Kill switch clearly identified and operational	☐	☐	☐	☐
34. All machine guards are in place	☐	☐	☐	☐
35. Rig ropes not wrapped around body parts	☐	☐	☐	☐
36. Pressurized lines and hoses secured from whipping hazards	☐	☐	☐	☐
37. Drill operation stopped during inclement weather	☐	☐	☐	☐
38. Air monitoring conducted per written safety plan for hazardous atmospheres	☐	☐	☐	☐
39. Rig placed in neutral when operator not at controls	☐	☐	☐	☐
DRILL RIG SITE CLOSURE (4.3.5)				
40. Ground openings/holes filled or barricaded	☐	☐	☐	☐
41. Equipment and tools properly stored	☐	☐	☐	☐
42. All vehicles locked and keys removed	☐	☐	☐	☐
DRILL RIG MAINTENANCE (4.3.6)				
28. Defective components repaired immediately	☐	☐	☐	☐
29. Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
30. Cathead in clean, sound condition	☐	☐	☐	☐
31. Drill rig ropes in clean, sound condition	☐	☐	☐	☐
32. Fall protection used for fall exposures of 6 feet (U.S.) 1.5 meters (Australia) or greater	☐	☐	☐	☐
33. Rig in neutral and augers stopped rotating before cleaning	☐	☐	☐	☐
34. Good housekeeping maintained on and around rig	☐	☐	☐	☐

SECTION 4

Complete this section for all items checked "No" in previous sections. Deficient items must be corrected in a timely manner.

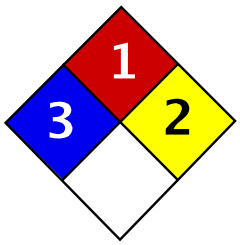
Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: _____ Project Manager: _____

CH2MHILL

Attachment 5

Applicable Material Safety Data Sheets



Health	3
Fire	1
Reactivity	2
Personal Protection	E

Material Safety Data Sheet
Arsenic MSDS

Section 1: Chemical Product and Company Identification

Product Name: Arsenic

Catalog Codes: SLA1006

CAS#: 7440-38-2

RTECS: CG0525000

TSCA: TSCA 8(b) inventory: Arsenic

CI#: Not applicable.

Synonym:

Chemical Name: Arsenic

Chemical Formula: As

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Arsenic	7440-38-2	100

Toxicological Data on Ingredients: Arsenic: ORAL (LD50): Acute: 763 mg/kg [Rat]. 145 mg/kg [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant), of eye contact (irritant).

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Classified A1 (Confirmed for human.) by ACGIH.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance is toxic to kidneys, lungs, the nervous system, mucous membranes.
Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.

Skin Contact: Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops.

Serious Skin Contact: Not available.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: Not available.

Flash Points: Not available.

Flammable Limits: Not available.

Products of Combustion: Some metallic oxides.

Fire Hazards in Presence of Various Substances: Flammable in presence of open flames and sparks, of heat, of oxidizing materials.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards:
Material in powder form, capable of creating a dust explosion. When heated to decomposition it emits highly toxic fumes.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Be careful that the product is not

present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids, moisture.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection: Safety glasses. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 0.01 from ACGIH (TLV) [United States] [1995]
Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Lustrous solid.)

Odor: Not available.

Taste: Not available.

Molecular Weight: 74.92 g/mole

Color: Silvery.

pH (1% soln/water): Not applicable.

Boiling Point: Not available.

Melting Point: Sublimation temperature: 615°C (1139°F)

Critical Temperature: Not available.

Specific Gravity: 5.72 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: Not available.

Solubility: Insoluble in cold water, hot water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Not available.

Incompatibility with various substances: Reactive with oxidizing agents, acids, moisture.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 145 mg/kg [Mouse].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified A1 (Confirmed for human.) by ACGIH.
Causes damage to the following organs: kidneys, lungs, the nervous system, mucous membranes.

Other Toxic Effects on Humans:
Very hazardous in case of ingestion, of inhalation.
Slightly hazardous in case of skin contact (irritant).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are as toxic as the original product.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: CLASS 6.1: Poisonous material.

Identification: : Arsenic UNNA: UN1558 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Arsenic
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer which would require a warning under the statute: Arsenic
Pennsylvania RTK: Arsenic
Massachusetts RTK: Arsenic
TSCA 8(b) inventory: Arsenic

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada):
CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC).
CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):
R22- Harmful if swallowed.
R45- May cause cancer.

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 1

Reactivity: 2

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 1

Reactivity: 2

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Safety glasses.

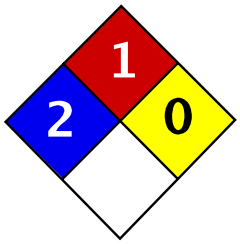
Section 16: Other Information

References:
-Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987.
-Liste des produits purs tératogènes, mutagènes, cancérogènes. Répertoire toxicologique de la Commission de la Santé et de la Sécurité du Travail du Québec.
-Material safety data sheet emitted by: la Commission de la Santé et de la Sécurité du Travail du Québec.
-SAX, N.I. Dangerous Properties of Indutrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984.
-The Sigma-Aldrich Library of Chemical Safety Data, Edition II.
-Guide de la loi et du règlement sur le transport des marchandises dangeureuses au canada. Centre de conformité internatinal Ltée. 1986.

Other Special Considerations: Not available.

Created: 10/09/2005 04:16 PM

Last Updated: 11/06/2008 12:00 PM



Health	2
Fire	1
Reactivity	0
Personal Protection	E

Material Safety Data Sheet
Chromium MSDS

Section 1: Chemical Product and Company Identification

Product Name: Chromium

Catalog Codes: SLC4711, SLC3709

CAS#: 7440-47-3

RTECS: GB4200000

TSCA: TSCA 8(b) inventory: Chromium

CI#: Not applicable.

Synonym: Chromium metal; Chrome; Chromium Metal Chips 2" and finer

Chemical Name: Chromium

Chemical Formula: Cr

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Chromium	7440-47-3	100

Toxicological Data on Ingredients: Chromium LD50: Not available. LC50: Not available.

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of inhalation. Slightly hazardous in case of ingestion.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH, 3 (Not classifiable for human.) by IARC.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to kidneys, lungs, liver, upper respiratory tract.
Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 580°C (1076°F)

Flash Points: Not available.

Flammable Limits: Not available.

Products of Combustion: Some metallic oxides.

Fire Hazards in Presence of Various Substances:
Slightly flammable to flammable in presence of open flames and sparks, of heat.
Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards:
Moderate fire hazard when it is in the form of a dust (powder) and burns rapidly when heated in flame.
Chromium is attacked vigorously by fused potassium chlorate producing vivid incandescence.
Pyrophoric chromium unites with nitric oxide with incandescence.
Incandescent reaction with nitrogen oxide or sulfur dioxide.

Special Remarks on Explosion Hazards:
Powdered Chromium metal +fused ammonium nitrate may react violently or explosively.
Powdered Chromium will explode spontaneously in air.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe dust. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids, alkalis.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 0.5 (mg/m3) from ACGIH (TLV) [United States]
TWA: 1 (mg/m3) from OSHA (PEL) [United States]
TWA: 0.5 (mg/m3) from NIOSH [United States]
TWA: 0.5 (mg/m3) [United Kingdom (UK)]
TWA: 0.5 (mg/m3) [Canada]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Metal solid.)

Odor: Odorless.

Taste: Not available.

Molecular Weight: 52 g/mole

Color: Silver-white to Grey.

pH (1% soln/water): Not applicable.

Boiling Point: 2642°C (4787.6°F)

Melting Point: 1900°C (3452°F) +/- !0 deg. C

Critical Temperature: Not available.

Specific Gravity: 7.14 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: Not available.

Solubility:
Insoluble in cold water, hot water.
Soluble in acids (except Nitric), and strong alkalies.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Excess heat, incompatible materials

Incompatibility with various substances: Reactive with oxidizing agents, acids, alkalis.

Corrosivity: Not available.

Special Remarks on Reactivity:
Incompatible with molten Lithium at 180 deg. C, hydrogen peroxide, hydrochloric acid, sulfuric acid, most caustic alkalies and alkali carbonates, potassium chlorate, sulfur dioxide, nitrogen oxide, bromine pentafluoride.
It may react violently or ignite with bromine pentafluoride.
Chromium is rapidly attacked by fused sodium hydroxide + potassium nitrate.
Potentially hazardous incompatibility with strong oxidizers.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals:
LD50: Not available.
LC50: Not available.

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH, 3 (Not classifiable for

human.) by IARC.
May cause damage to the following organs: kidneys, lungs, liver, upper respiratory tract.

Other Toxic Effects on Humans:
Hazardous in case of skin contact (irritant), of inhalation.
Slightly hazardous in case of ingestion.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
May cause cancer based on animal data. There is no evidence that exposure to trivalent chromium causes cancer in man.

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
May cause skin irritation.
Eyes: May cause mechanical eye irritation.
Inhalation: May cause irritation of the respiratory tract and mucous membranes of the respiratory tract.
Ingestion: May cause gastrointestinal tract irritation with nausea, vomiting, diarrhea.
Chronic Potential Health Effects:
Inhalation: The effects of chronic exposure include irritation , sneezing, reddness of the throat, bronchospasm, asthma, cough, polyps, chronic inflammation, emphysema, chronic bronchitis, pharyngitis, bronchopneumonia, pneumoconoisis. Effects on the nose from chronic chromium exposure include irritation, ulceration, and perforation of the nasal septum. Inflammation and ulceration of the larynx may also occur.
Ingestion or Inhalation: Chronic exposure may cause liver and kidney damage.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations:

Connecticut hazardous material survey.: Chromium
Illinois toxic substances disclosure to employee act: Chromium
Illinois chemical safety act: Chromium
New York release reporting list: Chromium
Rhode Island RTK hazardous substances: Chromium
Pennsylvania RTK: Chromium
Minnesota: Chromium
Michigan critical material: Chromium
Massachusetts RTK: Chromium
Massachusetts spill list: Chromium
New Jersey: Chromium
New Jersey spill list: Chromium
Louisiana spill reporting: Chromium
California Director's List of Hazardous Substances: Chromium
TSCA 8(b) inventory: Chromium
SARA 313 toxic chemical notification and release reporting: Chromium
CERCLA: Hazardous substances.: Chromium: 5000 lbs. (2268 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada): Not controlled under WHMIS (Canada).

DSCL (EEC):
R40- Limited evidence of carcinogenic effect
S36/37/39- Wear suitable protective clothing, gloves and eye/face protection.
S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 1

Reactivity: 0

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 1

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Dust respirator. Be sure to use an approved/certified respirator or equivalent.
Splash goggles.

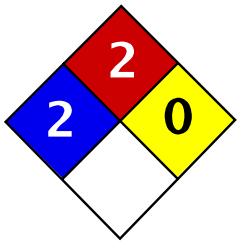
Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/10/2005 08:16 PM

Last Updated: 11/06/2008 12:00 PM



Health	2
Fire	2
Reactivity	0
Personal Protection	E

Material Safety Data Sheet
1,4-Dichlorobenzene MSDS

Section 1: Chemical Product and Company Identification

Product Name: 1,4-Dichlorobenzene

Catalog Codes: SLD4093

CAS#: 106-46-7

RTECS: CZ4550000

TSCA: TSCA 8(b) inventory: 1,4-Dichlorobenzene

CI#: Not available.

Synonym:

Chemical Formula: C6H4Cl2

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
{1,4-}Dichlorobenzene	106-46-7	100

Toxicological Data on Ingredients: 1,4-Dichlorobenzene: ORAL (LD50): Acute: 500 mg/kg [Rat]. DERMAL (LD50): Acute: 6000 mg/kg [Rabbit].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), of ingestion, of inhalation.
Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
Very hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), of ingestion, of inhalation.
CARCINOGENIC EFFECTS: Classified A3 (Proven for animal.) by ACGIH. Classified 2 (Reasonably anticipated.) by NTP.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance is toxic to kidneys, lungs, liver, mucous membranes.
Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.

Skin Contact:
After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.

Serious Inhalation: Not available.

Ingestion:
Do not induce vomiting. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 413°C (775.4°F)

Flash Points: CLOSED CUP: 65.56°C (150°F). (TAG)

Flammable Limits: LOWER: 2.5% UPPER: 16%

Products of Combustion: These products are carbon oxides (CO, CO2), halogenated compounds.

Fire Hazards in Presence of Various Substances: Slightly flammable to flammable in presence of oxidizing materials.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.
Slightly explosive to explosive in presence of oxidizing materials.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill:
Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority

requirements.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. In case of insufficient ventilation, wear suitable respiratory equipment If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes

Storage:
Keep container dry. Keep in a cool place. Ground all equipment containing material. Carcinogenic, teratogenic or mutagenic materials should be stored in a separate locked safety storage cabinet or room.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection:
Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 75 CEIL: 110 (ppm)
TWA: 450 CEIL: 675 (mg/m3)
Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid.

Odor: Not available.

Taste: Not available.

Molecular Weight: 147 g/mole

Color: Not available.

pH (1% soln/water): Not available.

Boiling Point: 174.12°C (345.4°F)

Melting Point: 53.75°C (128.8°F)

Critical Temperature: Not available.

Specific Gravity: 1.46 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: 5.08 (Air = 1)

Volatility: Not available.

Odor Threshold: 15 ppm

Water/Oil Dist. Coeff.: The product is equally soluble in oil and water; log(oil/water) = 0

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, methanol, diethyl ether, acetone.

Solubility:
Soluble in methanol, diethyl ether, acetone.
Very slightly soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Not available.

Incompatibility with various substances: Not available.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
Acute oral toxicity (LD50): 500 mg/kg [Rat].
Acute dermal toxicity (LD50): 6000 mg/kg [Rabbit].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified A3 (Proven for animal.) by ACGIH. Classified 2 (Reasonably anticipated.) by NTP.
The substance is toxic to kidneys, lungs, liver, mucous membranes.

Other Toxic Effects on Humans: Very hazardous in case of skin contact (irritant, permeator), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: CLASS 9: Miscellaneous hazardous material.

Identification: : Environmentally hazardous substance, solid, n.o.s. (p-Dichlorobenzene) : UN3077 PG: III

Special Provisions for Transport: Marine Pollutant

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: 1,4-Dichlorobenzene
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer which would require a warning under the statute: 1,4-Dichlorobenzene
Pennsylvania RTK: 1,4-Dichlorobenzene
Massachusetts RTK: 1,4-Dichlorobenzene
TSCA 8(b) inventory: 1,4-Dichlorobenzene
SARA 313 toxic chemical notification and release reporting: 1,4-Dichlorobenzene
CERCLA: Hazardous substances.: 1,4-Dichlorobenzene

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada):
CLASS D-1B: Material causing immediate and serious toxic effects (TOXIC).
CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):
R38- Irritating to skin.
R41- Risk of serious damage to eyes.
R45- May cause cancer.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 2

Reactivity: 0

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 2

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/09/2005 05:07 PM

Last Updated: 11/06/2008 12:00 PM

MSDS Number: **L2347** * * * * * *Effective Date:* ***07/05/07*** * * * * * *Supercedes:* ***05/07/07***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

LEAD METAL

1. Product Identification

Synonyms: Granular lead, pigment metal; C.I. 77575
CAS No.: 7439-92-1
Molecular Weight: 207.19
Chemical Formula: Pb
Product Codes:
J.T. Baker: 2256, 2266
Mallinckrodt: 5668

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Lead	7439-92-1	95 - 100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! MAY BE FATAL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. NEUROTOXIN. AFFECTS THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM. POSSIBLE CANCER HAZARD. MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on duration and level of exposure.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Cancer Causing)
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate (Life)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:

Lead can be absorbed through the respiratory system. Local irritation of bronchia and lungs can occur and, in cases of acute exposure, symptoms such as metallic taste, chest and abdominal pain, and increased lead blood levels may follow. See also Ingestion.

Ingestion:

POISON! The symptoms of lead poisoning include abdominal pain and spasms, nausea, vomiting, headache. Acute poisoning can lead to muscle weakness, "lead line" on the gums, metallic taste, definite loss of appetite, insomnia, dizziness, high lead levels in blood and urine with shock, coma and death in extreme cases.

Skin Contact:

Lead and lead compounds may be absorbed through the skin on prolonged exposure; the symptoms of lead poisoning described for ingestion exposure may occur. Contact over short periods may cause local irritation, redness and pain.

Eye Contact:

Absorption can occur through eye tissues but the more common hazards are local irritation or abrasion.

Chronic Exposure:

Lead is a cumulative poison and exposure even to small amounts can raise the body's content to toxic levels. The symptoms of chronic exposure are like those of ingestion poisoning; restlessness, irritability, visual disturbances, hypertension and gray facial color may also be noted.

Aggravation of Pre-existing Conditions:

Persons with pre-existing kidney, nerve or circulatory disorders or with skin or eye problems may be more susceptible to the effects of this substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Immediately flush skin with plenty of soap and water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

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5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard. Powder/dust is flammable when heated or exposed to flame.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire. Do not allow water runoff to enter sewers or waterways.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Can produce toxic lead fumes at elevated temperatures and also react with oxidizing materials.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

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7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Areas in which exposure to lead metal or lead compounds may occur should be identified by signs or appropriate means, and access to the area should be limited to authorized persons. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For lead, metal and inorganic dusts and fumes, as Pb:
-OSHA Permissible Exposure Limit (PEL): 0.05 mg/m3 (TWA)
For lead, elemental and inorganic compounds, as Pb:
-ACGIH Threshold Limit Value (TLV): 0.05 mg/m3 (TWA), A3 animal carcinogen
ACGIH Biological Exposure Indices (BEI): 30 ug/100ml, notation B (see actual Indices for more information).
For lead, inorganic:
-NIOSH Recommended Exposure Limit (REL): 0.1 mg/m3 (TWA)
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half-face high efficiency particulate respirator (NIOSH type N100 filter) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece high efficiency particulate respirator (NIOSH type N100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.
Other Control Measures:
Eating, drinking, and smoking should not be permitted in areas where solids or liquids containing lead compounds are handled, processed, or stored. See OSHA substance-specific standard for more information on personal protective equipment, engineering and work practice controls, medical surveillance, record keeping, and reporting requirements. (29 CFR 1910.1025).

9. Physical and Chemical Properties

Appearance:
Small, white to blue-gray metallic shot or granules.
Odor:
Odorless.
Solubility:
Insoluble in water.
Density:
11.34
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
1740C (3164F)
Melting Point:
327.5C (622F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
1.77 @ 1000C (1832F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Does not decompose but toxic lead or lead oxide fumes may form at elevated temperatures.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Ammonium nitrate, chlorine trifluoride, hydrogen peroxide, sodium azide, zirconium, disodium acetylide, sodium acetylide and oxidants.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Toxicological Data:
Investigated as a tumorigen, mutagen, reproductive effector.

Reproductive Toxicity:
Lead and other smelter emissions are human reproductive hazards. (Chemical Council on Environmental Quality; Chemical Hazards to Human Reproduction, 1981).
Carcinogenicity:
EPA / IRIS classification: Group B2 - Probable human carcinogen, sufficient animal evidence.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Lead (7439-92-1)	No	No	2B

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12. Ecological Information

Environmental Fate:
When released into the soil, this material is not expected to leach into groundwater. This material may bioaccumulate to some extent.
Environmental Toxicity:
No information found.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

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14. Transport Information

Not regulated.

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15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Lead (7439-92-1)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\--------------------------------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Lead (7439-92-1)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Lead (7439-92-1)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Lead (7439-92-1)	10	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Solid)

WARNING:
THIS PRODUCT CONTAINS CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: None allocated.
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **3** Flammability: **1** Reactivity: **0**
Label Hazard Warning:
POISON! DANGER! MAY BE FATAL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. NEUROTOXIN. AFFECTS THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM. POSSIBLE CANCER HAZARD. MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on duration and level of exposure.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give

anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases, get medical attention.

Product Use:
Laboratory Reagent.

Revision Information:
MSDS Section(s) changed since last revision of document include: 3.

Disclaimer:
****

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **T0767** * * * * * *Effective Date:* ***05/19/08*** * * * * * *Supercedes:* ***08/16/05***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

TETRACHLOROETHYLENE

1. Product Identification

Synonyms: ethylene tetrachloride; tetrachloroethene; perchloroethylene; carbon bichloride; carbon dichloride
CAS No.: 127-18-4
Molecular Weight: 165.83
Chemical Formula: Cl2C:CCl2
Product Codes:
J.T. Baker: 9218, 9360, 9453, 9465, 9469
Mallinckrodt: 1933, 8058

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Tetrachloroethylene	127-18-4	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER AND KIDNEYS. SUSPECT CANCER HAZARD. MAY CAUSE CANCER. Risk of cancer depends on level and duration of exposure.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate (Life)
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Blue (Health)

Potential Health Effects

Inhalation:
Irritating to the upper respiratory tract. Giddiness, headache, intoxication, nausea and vomiting may follow the inhalation of large amounts while massive amounts can cause breathing arrest, liver and kidney damage, and death. Concentrations of 600 ppm and more can affect the central nervous system after a few minutes.
Ingestion:
Not highly toxic by this route because of low water solubility. Used as an oral dosage for hookworm (1 to 4 ml). Causes abdominal pain, nausea, diarrhea, headache, and dizziness.
Skin Contact:
Causes irritation to skin. Symptoms include redness, itching, and pain. May be absorbed through the skin with possible systemic effects.
Eye Contact:
Causes irritation, redness, and pain.
Chronic Exposure:
May cause liver, kidney or central nervous system damage after repeated or prolonged exposures. Suspected cancer risk from animal studies.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired liver or kidney function may be more susceptible to the effects of the substance. The use of alcoholic beverages enhances the toxic effects.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
Aspiration hazard. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of

water. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Wash skin with soap or mild detergent and water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
Do not administer adrenaline or epinephrine to a victim of chlorinated solvent poisoning.

---

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard but becomes hazardous in a fire situation because of vapor generation and possible degradation to phosgene (highly toxic) and hydrogen chloride (corrosive). Vapors are heavier than air and collect in low-lying areas.
Explosion:
Not considered to be an explosion hazard. Containers may explode when involved in a fire.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire. Water spray may be used to keep fire exposed containers cool.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

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6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

---

7. Handling and Storage

Store in a cool, dry, ventilated area away from sources of heat or ignition. Isolate from

flammable materials. Protect from direct sunlight. Wear special protective equipment (Sec. 8) for maintenance break-in or where exposures may exceed established exposure levels. Wash hands, face, forearms and neck when exiting restricted areas. Shower, dispose of outer clothing, change to clean garments at the end of the day. Avoid cross-contamination of street clothes. Wash hands before eating and do not eat, drink, or smoke in workplace. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
100 ppm (TWA), 200 ppm (ceiling),
300 ppm/5min/3-hour (max)

-ACGIH Threshold Limit Value (TLV):
25 ppm (TWA), 100 ppm (STEL); listed as A3, animal carcinogen
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.
Odor:
Ethereal odor.
Solubility:
0.015 g in 100 g of water.
Specific Gravity:
1.62 @ 20C/4C
pH:
No information found.
% Volatiles by volume @ 21C (70F):

100
Boiling Point:
121C (250F)
Melting Point:
-19C (-2F)
Vapor Density (Air=1):
5.7
Vapor Pressure (mm Hg):
18 @ 25C (77F)
Evaporation Rate (BuAc=1):
0.33 (trichloroethylene = 1)

---

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Slowly decomposed by light. Deteriorates rapidly in warm, moist climates.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition. Hydrogen chloride gas and phosgene gas may be formed upon heating. Decomposes with moisture to yield trichloroacetic acid and hydrochloric acid.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Strong acids, strong oxidizers, strong alkalis, especially NaOH, KOH; finely divided metals, especially zinc, barium, lithium. Slowly corrodes aluminum, iron and zinc.
Conditions to Avoid:
Moisture, light, heat and incompatibles.

---

11. Toxicological Information

Oral rat LD50: 2629 mg/kg; inhalation rat LC50: 4100 ppm/6H; investigated as a tumorigen, mutagen, reproductive effector.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Tetrachloroethylene (127-18-4)	No	Yes	2A

---

12. Ecological Information

Environmental Fate:

When released into the soil, this material is expected to quickly evaporate. When released into the soil, this material may leach into groundwater. When released into the soil, this material may biodegrade to a moderate extent. When released to water, this material is expected to quickly evaporate. When released into water, this material is not expected to biodegrade. This material is not expected to significantly bioaccumulate. When released into the air, this material may be moderately degraded by reaction with photochemically produced hydroxyl radicals.

Environmental Toxicity:

The LC50/96-hour values for fish are between 1 and 10 mg/l. The LC50/96-hour values for fish are between 10 and 100 mg/l. This material is expected to be toxic to aquatic life.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

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14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: TETRACHLOROETHYLENE
Hazard Class: 6.1
UN/NA: UN1897
Packing Group: III
Information reported for product/size: 4L

International (Water, I.M.O.)

Proper Shipping Name: TETRACHLOROETHYLENE
Hazard Class: 6.1
UN/NA: UN1897
Packing Group: III
Information reported for product/size: 4L

International (Air, I.C.A.O.)

Proper Shipping Name: TETRACHLOROETHYLENE
Hazard Class: 6.1
UN/NA: UN1897
Packing Group: III
Information reported for product/size: 4L

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Tetrachloroethylene (127-18-4)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

Ingredient		--Canada--		
	Korea	DSL	NDSL	Phil.
Tetrachloroethylene (127-18-4)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302-		------SARA 313------	
	RQ	TPQ	List	Chemical Catg.
Tetrachloroethylene (127-18-4)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient		-RCRA-	-TSCA-
	CERCLA	261.33	8(d)
Tetrachloroethylene (127-18-4)	100	U210	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Liquid)

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: 2[Z]
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **2** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
WARNING! HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER AND KIDNEYS. SUSPECT CANCER HAZARD. MAY CAUSE CANCER. Risk of cancer depends on level and duration of exposure.
Label Precautions:

Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.

Label First Aid:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. In all cases call a physician.

Product Use:

Laboratory Reagent.

Revision Information:

No Changes.

Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

CH2MHILL

Attachment 6

Behavior Based Loss Prevention System

Behavior Based Loss Prevention System

A Behavior Based Loss Prevention System (BBLPS) is a system to prevent or reduce losses using behavior-based tools and proven management techniques to focus on behaviors or acts that could lead to losses.

The four basic Loss Prevention tools that will be used CH2M HILL projects to implement the BBLPS include:

- Activity Hazard Analysis (AHA)
- Pre-Task Safety Plans (PTSP)
- Loss Prevention Observations (LPO)
- Loss and Near Loss Investigations (NLI)

The SC or designated CH2M HILL representative onsite is responsible for implementing the BBLPS on the project site. The Project Manager remains accountable for its implementation. The SC or designee shall only oversee the subcontractor's implementation of their AHAs and PTSPs processes on the project.

Activity Hazard Analysis

An Activity Hazard Analysis (AHA) defines the activity being performed, the hazards posed and control measures required to perform the work safely. Workers are briefed on the AHA before doing the work and their input is solicited prior, during and after the performance of work to further identify the hazards posed and control measures required.

Activity Hazard Analysis will be prepared before beginning each project activity posing H&S hazards to project personnel using the AHA form provided in Attachment 6. The AHA shall identify the work tasks required to perform each activity, along with potential H&S hazards and recommended control measures for each work task. In addition, a listing of the equipment to be used to perform the activity, inspection requirements and training requirements for the safe operation of the equipment listed must be identified.

An AHA shall be prepared for all field activities performed by CH2M HILL and subcontractor activities during the course of the project. Hazard Controls (found in Sections 2.0 and its subsections of the HSP), the Hazard Analysis Table (Table 1), and applicable CH2M HILL CSs and SOPs should be used as a basis for preparing AHAs.

CH2M HILL subcontractors are required to provide AHAs specific to their scope of work on the project for acceptance by CH2M HILL. Each subcontractor shall submit AHAs for their field activities, as defined in their work plan/scope of work, along with their project-specific safety plan/accident prevention plan. Additions or changes in CH2M HILL or subcontractor field activities, equipment, tools or material to perform work or additional/different hazard encountered that require additional/different hazard control measures requires either a new AHA to be prepared or an existing AHA to be revised.

Pre-Task Safety Plans

Daily safety meetings are held with all project personnel in attendance to review the hazards posed and required H&S procedures/AHAs, that apply for each day's project activities. The PTSPs serve the same purpose as these general assembly safety meetings, but the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews. At the start of each day's activities, the crew supervisor completes the PTSP, provided in Attachment 6, with input from the work crew, during their daily safety meeting. The day's tasks, personnel, tools and equipment that will be used to perform these tasks are listed, along with the hazards posed and required H&S procedures, as identified in the AHA. The use of PTSPs, better promotes worker participation in the hazard recognition and control process, while reinforcing the task-specific hazard and required H&S procedures with the crew each day. The use of PTSPs is a common safety practice in the construction industry.

Loss Prevention Observations

Loss Prevention Observations (LPO's) shall be conducted by SC or designee for specific work tasks or operations comparing the actual work process against established safe work procedures identified in the project-specific HSP and AHAs. LPO's are a tool to be used by supervisors to provide positive reinforcement for work practices performed correctly, while also identifying and eliminating deviations from safe work procedures that could result in a loss. The SC or designee shall perform at least one LPO each week for tasks/operations addressed in the project-specific HSP or AHA. The SC or designee shall complete the LPO form in **Attachment 6** for the task/operation being observed.

Loss/Near Loss Investigations

Loss/Near Loss Investigations shall be performed for CH2M HILL and subcontractor incidents involving:

- Person injuries/illnesses and near miss injuries
- Equipment/property damage
- Spills, leaks, regulatory violations
- Motor vehicle accidents

The cause of loss and near loss incidents are similar, so by identifying and correcting the causes of near loss causes, future loss incidents may be prevented. The following is the Loss/Near Loss Investigation Process:

- Gather all relevant facts, focusing on fact-finding, not fault-finding, while answering the who, what, when, where and how questions.
- Draw conclusions, pitting facts together into a probable scenario.
- Determine incident root cause(s), which are basic causes on why an unsafe act/condition existed.
- Develop and implement solutions, matching all identified root causes with solutions.
- Communicate incident as a Lesson Learned to all project personnel.
- Filed follow-up on implemented corrective active action to confirm solution is appropriate.

The SC or designee shall perform an incident investigation, as soon as practical after incident occurrence during the day of the incident, for all Loss and Near Loss Incidents that occur on the project. Loss and Near Loss incident investigations shall be performed using the following incident investigation forms provided in **Attachment 6**:

- Incident Report Form (IRF)
- Root Cause Analysis Form

All Loss and Near Loss incident involving personal injury, property damage in excess of $1,000 or near loss incidents that could have resulted in serious consequences shall be investigated by completing the incident investigation forms and submitting them to the PM and RHSM within 24 hours of incident occurrence. A preliminary Incident Investigation and Root Cause Analysis shall be submitted to the Project Manager and RHSM within 24 hours of incident occurs. The final Incident Investigation and Root Cause Analysis shall be submitted after completing a comprehensive investigation of the incident.

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Pre-Task Safety Plan (PTSP)

Project: _____ Location: _____Date:_____

Supervisor: _____ Job Activity:_____

_____

Task Personnel:

_____

_____

_____

List Tasks:

_____

_____

_____

Tools/Equipment Required for Tasks (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools):

_____

_____

_____

Potential H&S Hazards, including chemical, physical, safety, biological and environmental (check all that apply):

__ Chemical burns/contact	__ Trench, excavations, cave-ins	__ Ergonomics
__ Pressurized lines/equipment	__ Overexertion	__ Chemical splash
__ Thermal burns	__ Pinch points	__ Poisonous plants/insects
__ Electrical	__ Cuts/abrasions	__ Eye hazards/flying projectile
__ Weather conditions	__ Spills	__ Inhalation hazard
__ Heights/fall > 6 feet	__ Overhead Electrical hazards	__ Heat/cold stress
__ Noise	__ Elevated loads	__ Water/drowning hazard
__ Explosion/fire	__ Slips, trip and falls	__ Heavy equipment
__ Radiation	__ Manual lifting	__ Aerial lifts/platforms
__ Confined space entry	__ Welding/cutting	__ Demolition

Other Potential Hazards (Describe):

_____

_____

_____

_____

Hazard Control Measures (Check All That Apply):			
PPE __ Thermal/lined __ Eye __ Dermal/hand __ Hearing __ Respiratory __ Reflective vests __ Flotation device	Protective Systems __ Sloping __ Shoring __ Trench box __ Barricades __ Competent person __ Locate buried utilities __ Daily inspections	Fire Protection __ Fire extinguishers __ Fire watch __ Non-spark tools __ Grounding/bonding __ Intrinsically safe equipment	Electrical __ Lockout/tagout __ Grounded __ Panels covered __ GFCI/extension cords __ Power tools/cord inspected
Fall Protection __ Harness/lanyards __ Adequate anchorage __ Guardrail system __ Covered opening __ Fixed barricades __ Warning system	Air Monitoring __ PID/FID __ Detector tubes __ Radiation __ Personnel sampling __ LEL/O2 __ Other	Proper Equipment __ Aerial lift/ladders/scaffolds __ Forklift/heavy equipment __ Backup alarms __ Hand/power tools __ Crane with current inspection __ Proper rigging __ Operator qualified	Welding & Cutting __ Cylinders secured/capped __ Cylinders separated/upright __ Flash-back arrestors __ No cylinders in CSE __ Flame retardant clothing __ Appropriate goggles
Confined Space Entry __ Isolation __ Air monitoring __ Trained personnel __ Permit completed __ Rescue	Medical/ER __ First-aid kit __ Eye wash __ FA-CPR trained personnel __ Route to hospital	Heat/Cold Stress __ Work/rest regime __ Rest area __ Liquids available __ Monitoring __ Training	Vehicle/Traffic __ Traffic control __ Barricades __ Flags __ Signs
Permits __ Hot work __ Confined space __ Lockout/tagout __ Excavation __ Demolition __ Energized work	Demolition __ Pre-demolition survey __ Structure condition __ Isolate area/utilities __ Competent person __ Hazmat present	Inspections: __ Ladders/aerial lifts __ Lanyards/harness __ Scaffolds __ Heavy equipment __ Cranes and rigging	Training: __ Hazwaste __ Construction __ Competent person __ Task-specific (THA) __ Hazcom
Field Notes:_____ _____ _____			

Name (Print): _____
Signature:_____ Date:_____

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Safe Work Observation Form		
Project:	Observer:	Date:
Position/Title of worker observed:	Background Information/ comments:	
Task/Observation Observed:		

- ❖ Identify and reinforce safe work practices/behaviors
- ❖ Identify and improve on at-risk practices/acts
- ❖ Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- ❖ Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- ❖ Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current & accurate Pre-Task Planning/Briefing (Project safety plan, STAC, AHA, PTSP, tailgate briefing, etc., as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Observer's Corrective Actions/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's Corrective Actions/Comments:**
Other…			

CH2MHILL **Job Hazard Analysis**

Activity:	**Date:**
	Project:
Description of the work:	**Site Supervisor:**
	Site Safety Officer:
	Review for latest use: Before the job is performed.

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	Potential Health and Safety Hazards (Analyze each principal step for potential hazards)	Hazard Controls (Develop specific controls for each potential hazard)

CH2MHILL **Job Hazard Analysis**

Equipment to be used (List equipment to be used in the work activity)	Inspection Requirements (List inspection requirements for the work activity)	Training Requirements (List training requirements including hazard communication)

	PRINT NAME	SIGNATURE	
Supervisor Name:			**Date/Time:**
Safety Officer Name:			**Date/Time:**
Employee Name(s):			**Date/Time:**
			Date/Time:
			Date/Time:
			Date/Time:
			Date/Time:
			Date/Time:
			Date/Time:
			Date/Time:
			Date/Time: