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Final

Phase II Environmental Sampling Work Plan
Site UXO-04, Knox Trailer Park

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Contract Task Order 0191

September 2007

Prepared for

NAVFAC
Naval Facilities Engineering Command

Department of the Navy
Naval Facilities Engineering Command Atlantic Division

Under the

LANTDIV CLEAN III Program
Contract N62470-02-D-3052

Prepared by

CH2MHILL

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Acronyms and Abbreviations

°F	degrees Fahrenheit
AM	Activity Manager
ARAR/TBC	applicable or relevant and appropriate requirement/to be considered
bgs	below ground surface
CAR	Corrective Action Request
CD-ROM	compact disk-read only memory
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COC	chain-of-custody
COPC	contaminant of potential concern
CTO	contract task order
DGM	digital geophysical mapping
DGPS	differential global positioning system
DPT	direct-push technology
DQO	data quality objective
EMD	Environmental Management Division
EOD	explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
ESI	Expanded Site Inspection
ESRI	Environmental Systems Research Institute, Inc.
ESV	ecological screening values
FTL	Field Team Leader
GC/MS	gas chromatograph/mass spectrometer
GIS	geographic information system
HHRA	human health risk assessment
HSM	Health and Safety Manager
HSP	Health and Safety Plan
IDW	investigation-derived waste
IRP	Installation Restoration Program
LANTDIV	Atlantic Division
LDM	Lead Data Manager
MCB	Marine Corps Base
MDL	method detection limit
MEC	munitions and explosives of concern
MI	multi-incremental

MR	munitions response
MRP	Munitions Response Program
MS/MSD	matrix spike/matrix spike duplicate
NAVFAC	Naval Facilities Engineering Command
NCAC	North Carolina Administrative Code
NCDENR	Department of Environment and Natural Resources
PARCC	precision, accuracy, representativeness, comparability, and completeness
PC	project chemist
PCB	polychlorinated biphenyl
PDF	portable document format
PLS	Professional Land Surveyor
PM	Project Manager
PPV	public–private venture
PQL	practical quantification limit
PRG	preliminary remediation goal
QA	quality assurance
QACM	Quality Assurance Control Manager
QA/QC	quality assurance/quality control
QC	quality control
QCP	Quality Control Plan
RCW	red-cockaded woodpecker
RLL	rough-leaved loosestrife
RPD	relative percent difference
RTK	real-time kinematic
RTL	Review Team Leader
SLERA	screening-level ecological risk assessment
SOP	standard operating procedure
SSC	Site Safety Coordinator
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TNT	2,4,6-trinitrotoluene
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
VOC	volatile organic compound

SECTION 1

Introduction

CH2M HILL is conducting a second phase of environmental sampling to support an Expanded Site Inspection (ESI) at the Knox Trailer Park, Marine Corps Munitions Response Program (MRP) Site UXO-04, located at Marine Corps Base (MCB) Camp Lejeune, in Jacksonville, North Carolina. The Phase II Environmental Sampling is being conducted for the Department of the Navy, Naval Facilities Engineering Command (NAVFAC), Atlantic Division (LANTDIV), under the LANTDIV Comprehensive Long-Term Environmental Action Navy (CLEAN) III Program. This work is being performed under Contract Task Order 0191 (CTO-0191) of Contract No. N62470-02-D-3052.

1.1 Background and Project Objectives

Approximately 134 acres of land surrounding and including the former Knox Trailer Park have been targeted for a public–private venture (PPV) residential housing development. Based on historical activities at the site (refer to Section 1.4) and results from a previous phase of the ESI, this Phase II sampling event is being conducted to accomplish the following objectives:

1. Identify specific areas of surface soil contamination that exceed human health screening criteria and prohibit residential development by collecting surface soil samples from decision units across the site, and
2. Further evaluate potential subsurface, sediment, surface water, and groundwater contamination by collecting samples of these environmental media.

1.2 Work Plan Scope and Organization

This Phase II Environmental Sampling Work Plan provides background information needed to understand the project tasks and objectives, describes conditions at the site, and presents the technical approach to be used for implementation of the work. The following primary Phase II sampling activities will be performed to accomplish the objectives described in Section 1.1:

- Surface soil sampling using a multi-incremental (MI)/decision unit soil sampling technique (volatile organic compound samples will be collected from one discrete location in the center of each decision unit)
- Subsurface soil sampling using direct-push technology (DPT) sampling techniques
- Sediment sampling
- Surface water sampling
- Groundwater sampling

This work plan is divided into sections providing information on the detailed approach, including procedures to be employed during the execution of the project. Appendixes to the work plan provide supporting documentation that details specific procedures for the execution of the project.

This work plan is organized as follows:

- **Section 1, Introduction,** provides general information about this work plan, describes the Knox Trailer Park Site's physical characteristics and history, and presents the project scope and objectives
- **Section 2, Technical Management Plan,** identifies the technical approach, methods, and operational procedures that will be used to execute the project
- **Section 3, Field Investigation Plan,** details the technical approaches, methods, and operational procedures that will be used to execute the field investigation activities, including subcontractor procurement, mobilization and demobilization, land surveying, environmental sampling, and data tracking and management
- **Section 4, Quality Control Plan** (QCP), provides details of the approach, methods, and operational procedures to be employed for quality control (QC) of the sample collection and data analysis
- **Section 5, Environmental Protection Plan,** describes the approach, methods, and operational procedures to be employed to protect the natural environment during the performance of all tasks
- **Section 6, References,** lists the references cited in the preceding sections.
- **Appendix A, Health and Safety Plan** (HSP)**,** details specific health and safety procedures and provides an interface with CH2M HILL's overall health and safety program and with the Final MCB Camp Lejeune Master Health and Safety Plan (CH2M HILL, 2005).
- **Appendix B, Standard Operating Procedures** (SOPs), provides specific direction on how to accomplish field tasks.

1.3 Site Location and Description

MCB Camp Lejeune is bisected by the New River, which flows southeasterly and forms a large estuary before entering the Atlantic Ocean. The Atlantic Ocean forms the southeastern boundary of the facility. The western and northwestern boundaries are U.S. Route 17 and North Carolina State Route 24, respectively. The city of Jacksonville, North Carolina, is located immediately northwest of MCB Camp Lejeune. See **Figure 1-1**.

The Navy and MCB Camp Lejeune are planning a PPV development on the property formerly known as Knox Trailer Park which consists of approximately 134 acres in the northern portion of MCB Camp Lejeune (**Figure 1-2**). The Northeast Creek defines the southern boundary, Scales Creek flows near the northwestern boundary, and an unnamed tributary flows near the northeastern boundary. The former Knox Trailer Park covered

approximately 38 acres of the planned PPV. The trailer park property is level and vegetated with grass and minimal tree cover. A network of narrow roadways covers the trailer park (**Figure 1-3**). As of June 2006, all residents have vacated the trailer park and all mobile homes were removed from the site. All utilities, including telephone, cable, water, electricity, and sewers, are buried and are assumed to be intact.

The remaining area of Site UXO-04 consists of approximately 95 acres of woodland that surrounds the current Knox Trailer Park to the north, east, and west. Undergrowth less than three inches in diameter was removed from the majority of the wooded area during the field investigation in support of the geophysical survey. The density of undergrowth is light to moderate in the wooded areas where geophysical surveying was not conducted.

1.4 Site History and Previous Investigation

The Knox Trailer Park area began as a Civilian Conservation Corps Camp in 1941. One function of the Civilian Conservation Corps Camp at Camp Lejeune (in conjunction with the Malaria Control Detachment of the Marines) was to eliminate the source of endemic malaria by draining all surrounding wetlands. This was accomplished by ditching, using dynamite, and spraying diesel oil on water surfaces as a larvicide (Kymball, personal communication, 2005).

A dog-training school was located in the southernmost area of Knox Trailer Park and operated from 1942 to 1946. The dogs were subjected to overhead rifle and machine gun fire and explosions of charges of dynamite and 2,4,6-trinitrotoluene (TNT to simulate battlefield conditions (Marine Devil Dogs!, 2005). Explosives used during training included Dago bombs and quarter cans of TNT (Putney, 2001).

During WWII, there was increased research into the use of body armor to protect the troops from serious injury. While the specific testing at the Camp Knox research facilities has not been determined, it is known that the body armor was able to resist impact from .22 and .45 caliber automatic pistol bullets and Reising and Thompson sub–machine gun bullets at a distance of 15 feet. In addition, tests showed that the armor stopped all fragments from a detonated hand grenade (TNT-loaded) at a distance of 3 feet (Montrose, 1955). The research facilities at Camp Knox most likely fired ball-type ammunition at the vests. The firing was most likely performed inside buildings (based on historical photographs), and it is not thought that a significant amount of ammunition was expended for testing purposes (Kymball, personal communication, 2005). Testing and development continued at the Naval medical Field Research Laboratory throughout the Korean conflict until the cease fire was called in July 1953 (Montrose, 1955). From the early 1950s until the present time, the area has been used for residential housing.

In the 1974–1976 timeframe, an explosive ordnance disposal (EOD) technician responded to the discovery of unexploded ordnance (UXO) in the Knox Trailer Park area. A bulldozer operator uncovered a live WWII MK-II high-explosive hand grenade while conducting excavation activities (Cifelli, personal communication, 2005a). The safety pin had been removed, the grenade had been thrown, and the striker had impinged the primer without causing the primer to function, thereby rendering the grenade a dud. The exact location of the grenade is not documented, but Mr. Cifelli recalled it being located off the main road

leading to the trailer park (Cifelli, personal communication, 2005b). Mr. Cifelli also recalled responding to up to three additional discoveries of practice grenades during intrusive activities in the area.

A site visit with Mr. Cifelli was conducted on June 9, 2006. Although the exact locations of the grenades were not pinpointed, Mr. Cifelli was able to confirm that the grenades had been found in the vicinity of the Knox Trailer Park.

According to base personnel, this area was never a live fire range for grenades or any other munitions (Lowder, personal communication, 2005). In addition, the consulting historian for the base reported that he has not encountered any documentation that supports the Knox Trailer Park area having been an established range (Kymball, personal communication, 2005). No previous Navy Installation Restoration Program (IRP) investigations have been conducted at the Knox Trailer Park or the surrounding area (i.e., Site UXO-04).

The discovery of previous grenades, along with interviews from EOD personnel, may contribute to the Knox Trailer Park area's inclusion as a suspected historic hand grenade range [called the Knox Trailer Park Grenade Range (Area A)] in the draft range inventory report (URS, 2002).

The grenades used in this area were reportedly MK-II and MK-IIA1. According to the specifications, each type had a serrated cast-iron body; the MK-II grenades were equipped with an M204A1 fuse, whereas the MK-IIA1 grenades were equipped with a M10A3 fuse. Specifications state that each unit was filled with 2 oz. of flaked or granular TNT, though some older units contained E.C. Blank Smokeless Powder (U.S. Army Corp of Engineers, 2001).

A visual inspection of the Knox Trailer Park was conducted in November 2002 by the base's EOD team, and no UXO was discovered (McGurty, personal communication, 2005).

A former maneuver training area (AD Training Area) is located just north of the Knox Trailer Park. The area was in operation during the 1940s and was administratively closed by the Environmental Management Division of the Marine Corps in January 2004. No further action was determined for the AD Training Area (Richardson, personal communication, 2005; Department of the Navy, 2005). The area was a nonfiring area used for land navigation, patrolling, and field training, and is currently in use by the Marine Corps Combat Service Support School at Camp Johnson (D. Richardson, personal communication, August 3, 2005).

A field investigation was conducted at Knox Trailer Park from March 2006 to April 2006 with objectives that included evaluating the nature, number, and density of anomalies that could potentially represent subsurface munitions and explosives of concern (MEC) and to identify the presence and nature of any hazardous or toxic waste contamination that may exist in the project area.

A total of 90.9 acres were geophysically surveyed at the project site using a combination of a towed array EM61-MK2 system and two man-portable single-coil EM61-MK2 systems. A total of 38 acres were geophysically surveyed in the non-wooded area comprising the existing trailer park area. The remaining 53 acres were in wooded areas of the site. An MEC intrusive investigation was conducted on ten percent of the non-wooded area that was

geophysically surveyed. Out of a total of 1,811 geophysical anomalies, only one munitions-related item was discovered in 17 grids that were intrusively investigated. One of these anomalies was found to be a discarded military munition (identified as "Signal, Illumination, Ground: Red Star Parachute M131" in its original shipping container.

Based on the results of the intrusive investigation and historical information, it has been concluded that the Knox Trailer Park area was not the site of a former hand grenade range. Hand grenades that were reportedly found in the area were likely randomly discarded items or were likely found outside of the trailer park.

Ten DPT soil borings were sampled continuously for lithological characterization and collection of discrete soil samples from a depth just below the water table. Fifteen groundwater monitoring wells were installed, their water-level measurements recorded, and a round of groundwater samples collected. Ten sediment samples and ten surface water samples were also collected at the Knox Trailer Park during the ESI. Samples were collected from Northeast Creek, from the unnamed tributary along the eastern site boundary, and from unnamed drainage features that discharge into Northeast Creek and the unnamed tributary.

A screening-level human health risk assessment (HHRA) was conducted in order to compare analyte concentrations in environmental samples from the site to screening toxicity values, applicable or relevant and appropriate requirements (ARARs) and "to be considered" (TBC) information. If the maximum concentration of an analyte exceeded a corresponding screening toxicity value or ARAR/TBC value, then that analyte was retained as a contaminant of potential concern (COPC) for the medium in which it was evaluated. Groundwater was not evaluated in the screening-level HHRA because no current human exposure routes are known to exist and are not expected to occur under the future residential land use scenario.

A screening-level ecological risk assessment (SLERA) was also conducted to evaluate potential ecological threats posed by site conditions. Analyte concentrations in environmental samples at the site were compared to ecological screening values (ESV). Those analytes with maximum concentrations exceeding ESVs were then evaluated for potential risk to receptors through food chain transfer. If a Hazard Quotient resulting from this evaluation was greater than 1, then that analyte was retained as a COPC for the medium in which it was evaluated.

A detailed evaluation of potential risks for residential development will require the implementation of a more comprehensive surface soil sampling program than what was utilized during Phase I of the ESI.

1.5 Climate

The climate in the MCB Camp Lejeune area is characterized by short, mild winters with occasional short-duration cold periods and long, hot humid summers. Average annual net precipitation is approximately 50 inches. Ambient air temperatures generally range from 33 degrees to 53 degrees Fahrenheit (°F) in the winter months, and from 71°F to 88°F during the summer months. Winds are generally south-southwesterly in the summer and north-northwesterly in the winter (Water and Air Research, 1983). The hurricane season begins on

June 1 and continues through November 30. Storms of nontropical origins, such as frontal passages, local thunderstorms, and tornadoes, are more frequent and can occur year-round.

1.6 Site Geology and Hydrogeology

Based on drilling activities during the first field effort, the lithology at Site UXO-04 consists of layered, laterally-discontinuous, fine grained sediments. Particle sizes noted from soil boring logs indicate sediments ranging from clay and silt to medium sand.

Cross-sections generated during Phase I of the ESI suggest that the intermediate wells (screened from 28 – 50 feet below ground surface [bgs]) are screened in sediments consisting of poor and well graded fine sand with occasional silt, which are more uniformly distributed across the site.

Shallow wells (screened from 5 – 27 feet bgs) were screened across the uppermost water table with screen intervals selected based upon groundwater levels encountered during drilling and sampling. Water levels collected from the surficial wells in March and April 2006 suggest that groundwater is mounded near the center of the site around wells MR04-MW05 and MR04-MW07. Water levels in surficial wells ranged from 0.1 to 12 feet above mean sea level.

\\ariadne\groups\gis\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\Figure1-1_Base Overview.mxd

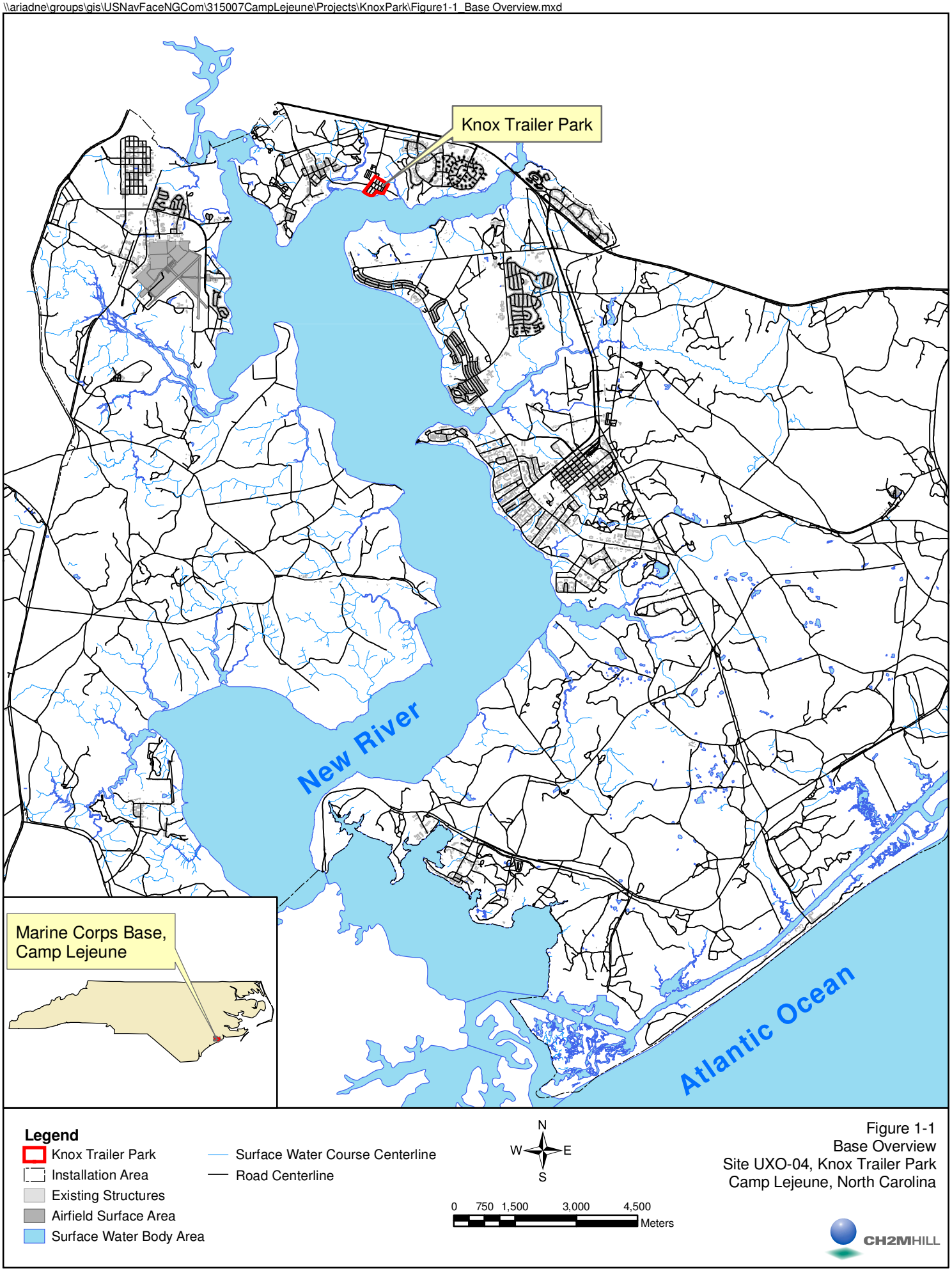

Figure 1-1
Base Overview
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

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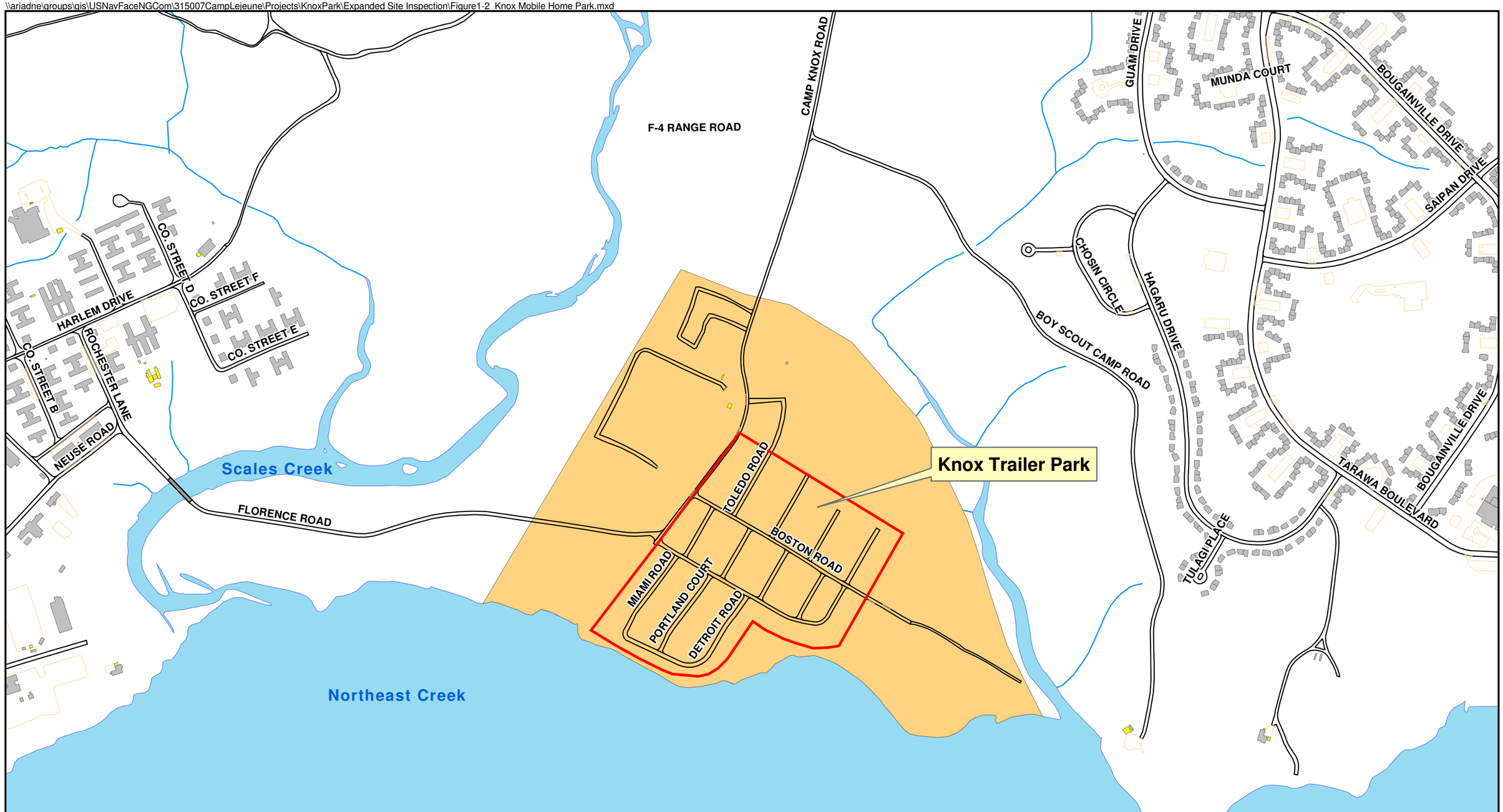
\\ariadne\groups\gis\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\Expanded Site Inspection\Figure1-2_Knox Mobile Home Park.mxd



Legend

- Installation Area
- Structure Area
- Vehicle Parking Area
- Road Area
- Surface Water Course Centerline
- Surface Water Body Area
- Knox Trailer Park
- Site Inspection Area

N
W E
S

0 600 1,200
Feet

Figure 1-2
Site Location Map
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

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\\ariadne\groups\gis\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\Expanded Site Inspection\Figure1-3_SitePlan.mxd

Legend

- Shallow Monitoring Well
- Deep Monitoring Well
- Surface Water/Sediment Sample Location
- Proposed DPT Sample Location
- Knox Mobile Home Park
- Installation Area
- Structure Area
- Vehicle Parking Area
- Road Area
- Surface Water Course Centerline
- Surface Water Body Area
- Site Inspection Area

N
W E
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400 0 400
Feet

Figure 1-3
Site Plan
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

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SECTION 2

Technical Management Plan

2.1 Project Personnel, Organization, Reporting and Schedule

2.1.1 Project Organization

The key organizations involved in this project are NAVFAC, MCB Camp Lejeune, the U.S. Environmental Protection Agency (EPA), the North Carolina Department of Environment and Natural Resources (NCDENR), and CH2M HILL, Inc. Project execution will be conducted by CH2M HILL and its subcontractors. CH2M HILL will issue subcontracts for utility locating, land surveying, DPT soil sampling, investigation-derived waste (IDW) handling and disposal, laboratory analytical services, data validation services, and support facilities.

CH2M HILL – Prime Contractor

As the prime contractor, CH2M HILL is the primary point of contact with NAVFAC LANTDIV. CH2M HILL will manage the overall project, providing day-to-day oversight and related program management support to execute the project successfully. Project duties controlled by CH2M HILL include the following:

- Project planning, implementation, and reporting
- Subcontractor selection, management, and control
- Program- and project-level QC
- Program- and project-level health and safety
- Site management
- Technical direction for drilling , geographic information system (GIS), and database management
- Performance of field sampling activities
- Analysis of data and preparation of the ESI Report
- Project closeout

2.1.2 Project Personnel

The reporting relationships between key project personnel are illustrated in the organization chart provided as **Figure 2-1**. **Table 2-1** provides contact information for project team members. The roles and responsibilities of the key personnel are discussed below.

- MCB Camp Lejeune Partnering team (which has a representative from CH2M HILL, EPA, NAVFAC, NCDENR, and MCB Camp Lejeune) – will provide a consensus

decision on whether or not specific decision units within the proposed development at Knox Trailer Park are suitable for residential construction through decision point analysis.

- NAVFAC and MCB Camp Lejeune Environmental Management Division EMD – NAVFAC will provide contract obligations to CH2M HILL for work planned at MCB Camp Lejeune. Camp Lejeune EMD will work with CH2M HILL for all on-base coordination activities.
- Program Manager—will provide program management support of this CTO and will ensure that all contract requirements are met during execution of this project
- Senior Technical Consultants – will provide overall direction and oversight of project implementation, and will ensure that appropriate reviews are conducted on all submittals in their areas of technical expertise (e.g., munitions response [MR], hydrogeology). Senior technical consultants are a company-wide resource with significant experience in the various technical aspects involved in a complex project. The senior technical consultant is responsible for evaluating the technical merit of the work planning documents before field activities begin, and reviewing all deliverables before submittal to NAVFAC and MCB Camp Lejeune. The senior technical consultant assists the PM in coordinating review efforts, addressing review comments, and resolving technical issues.
- Activity Manager—will coordinate the implementation of all CTOs at MCB Camp Lejeune. The activity manager will ensure that information is shared between CTO project teams and will communicate with the NAVFAC Project Manager (PM) concerning the overall MCB Camp Lejeune activity.
- PM—will have overall CH2M HILL responsibility for technical support and oversight, budget and schedule review and tracking, invoice review, personnel resources planning and allocation, and project coordination. The PM will also coordinate field activities with project field personnel and act as CH2M HILL's primary point of contact with NAVFAC LANTDIV and MCB Camp Lejeune personnel during implementation of this CTO.
- Program Health and Safety Manager—will support the implementation of the HSP (**Appendix A**) to ensure that it meets all specific needs of the project and that appropriate health and safety requirements are defined. The HSP for Phase II of the ESI is an amended version of the HSP used from Phase I. The primary modification was to remove any references to MEC avoidance procedures.
- Field Team Leader —The Field Team Leader (FTL) will be CH2M HILL's onsite representative to coordinate and oversee the activities of field support personnel and subcontractor personnel. The FTL is also responsible for implementation of and compliance with HSP and QC requirements during the field effort.

2.1.3 Project Schedule

CTO-0191, which authorizes CH2M HILL to perform this Phase II environmental sampling at Knox Trailer Park, was issued by NAVFAC on May 24, 2007. The planning schedule for

performing this work is provided as **Figure 2-2**. This schedule will be revised as the project progresses.

2.2 Technical Approach

The work under this CTO has been divided into the following three main tasks, which are broken into various subtasks throughout this section:

- Task 1—Project Planning
- Task 2—Site Investigation
- Task 3—Sample Analysis and Validation

2.2.1 Task 1 – Project Planning

This task includes project management, meetings, and work plan preparation.

Project management includes all work necessary for controlling the project budget and schedule. This includes monthly status reports and invoicing, as well as all other administrative tasks needed for project performance.

Four meetings are planned during the course of this project. The meetings will be held as necessary to discuss proposed work, present investigation findings, and discuss project status.

Three versions of this work plan are scoped under this task. A preliminary draft work plan will be submitted for NAVFAC and MCB Camp Lejeune review. Once the Navy's comments have been incorporated into the work plan, it will be sent out for regulatory agency review. A final work plan will be prepared that incorporates regulatory agency review comments.

2.2.2 Task 2 – Site Investigation

All field investigation activities will be performed under this task. Subcontractor procurement is also included under this task. Anticipated subcontractor services include utility locating, land surveying, DPT soil sampling, IDW handling and disposal, laboratory analysis, and data validation.

The scope of the field investigation and the technical approach are presented in Section 3. The primary field investigation activities are the following:

- Utility locating
- Surveying of grid network
- DPT investigation
- Environmental sampling (surface soil, subsurface soil, sediment, surface water, and groundwater)

- A second round of surface soil sampling will be conducted within chosen decision units if they exceed human health screening criteria (estimate 25 percent of surface soil results will require additional sampling).
- Associated laboratory analytical

Part of the Site Investigation task is to generate an ESI report. An existing Draft ESI Report that documents the findings of the initial phase of investigation, which included digital geophysical mapping (DGM) operations, an MEC intrusive investigation, and environmental sampling, will be updated to include the data and conclusions from this second phase of environmental sampling. The report will summarize all field activities, evaluate the environmental data, and determine whether residential development can occur within specific decision units. Following stakeholder review, a Final ESI Report will be prepared that incorporates review comments.

2.2.3 Task 3 – Sample Analysis and Validation

This task includes management of environmental sample data from the time the samples are collected until the validated data is received and incorporated into the project reports. This includes sample tracking from field collection through the receipt of validated data, coordination and communications with the laboratory and data validator, and preparation and delivery of the site data sets to MCB Camp Lejeune.

Samples will be tracked from the field using chain-of-custody (COC) forms. Tracking will verify that all collected samples were sent to the laboratory. It will also determine that samples were analyzed for the appropriate parameters and this information was sent and received by the validator. Finally, upon receipt of the validated data, verification will assure that all required samples were collected, analyzed, validated, and received by CH2M HILL in the required electronic format.

Data validation will be conducted by a subcontracted data validation service, and will begin when the validator receives the "raw" laboratory data. A validation report will be expected within 14 calendar days of the validator's receipt of Level IV laboratory data packages. Level IV data will be validated using National Function Guidelines.

CH2M HILL will submit electronic updates to the MCB Camp Lejeune Environmental Information Management System in accordance with its electronic data deliverable format.

TABLE 2-1
Project Personnel Contact Information
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Name/Title/Organization	Mailing Address	Telephone/Fax/E-mail
Doug Dronfield Program Manager CH2M HILL	13921 Park Center Road Suite 600 Herndon, VA 20171-3241	703-471-1441 (office) 703-471-1508 Doug.Dronfield@ch2m.com
Matt Louth Activity Manager CH2M HILL	5700 Cleveland Street Suite 101 Virginia Beach, VA 23462	757-518-9666 (office) 757-460-4592 (fax) Matt.Louth@ch2m.com
William M. Waldron, P.E. Project Manager CH2M HILL	3125 Poplarwood Court Suite 304 Raleigh, NC 27604	919-875-4311 (office) 678-579-8109 (fax) wwaldron@ch2m.com
Thomas M. Roth, P.E. MEC Senior Engineer CH2M HILL	2607 Lavista Road Decatur, GA 30033-1725	404-474-7640 (office) 404-259-6674 (cell) 770-604-9183 (fax) Tom.Roth@ch2m.com
Sam Shannon Senior Hydrogeologist CH2M HILL	2567 Fairlane Drive Montgomery, AL 36116	334-271-1445 (office) 334-277-5763 (fax) Sam.Shannon@ch2m.com
Michael Goldman, C.I.H. Program H&S Manager CH2M HILL	115 Perimeter Center Place NE Suite 700 Atlanta, GA 30346-1278	770-604-9095 (office) 770-604-9183 (fax) Michael.Goldman@ch2m.com

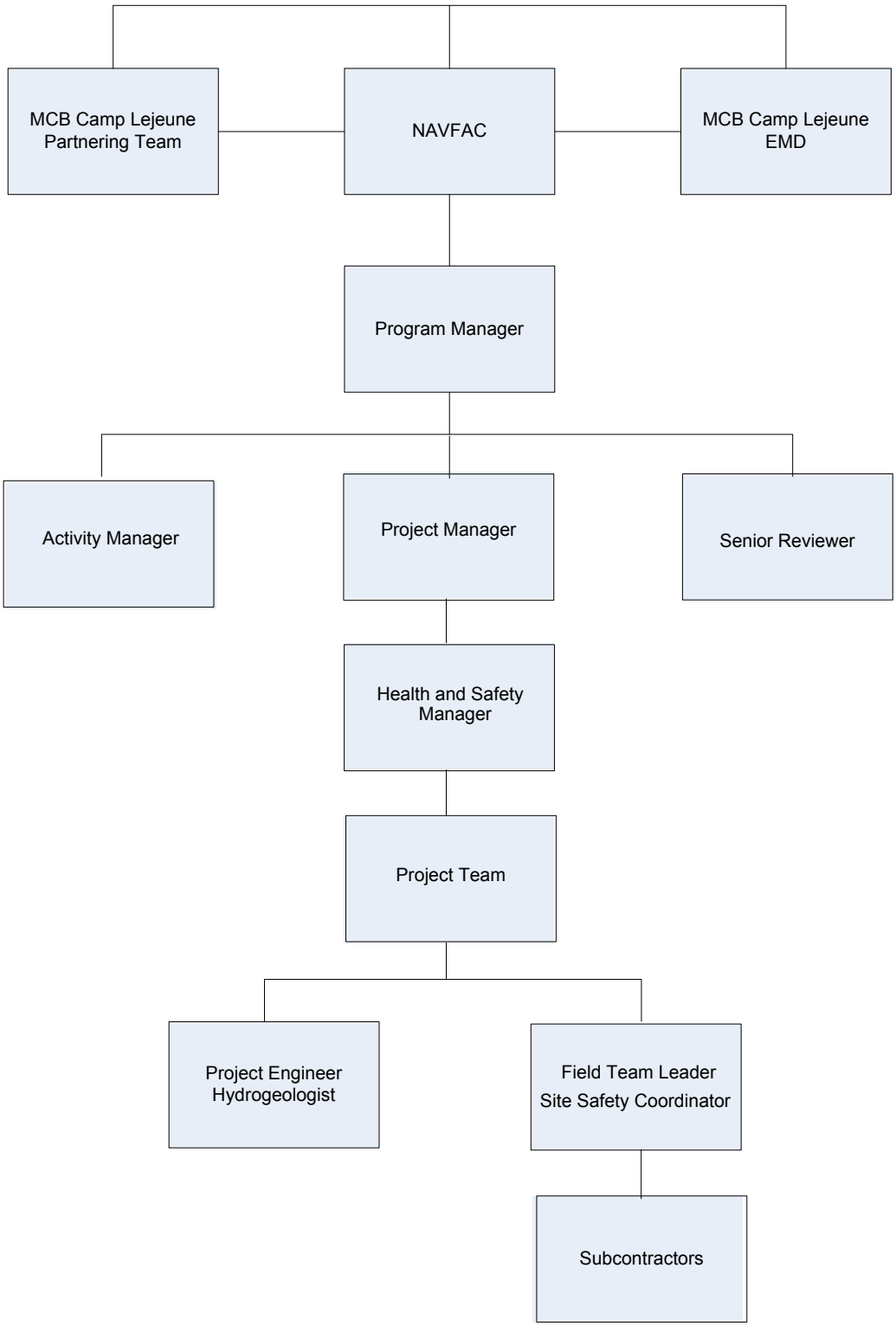
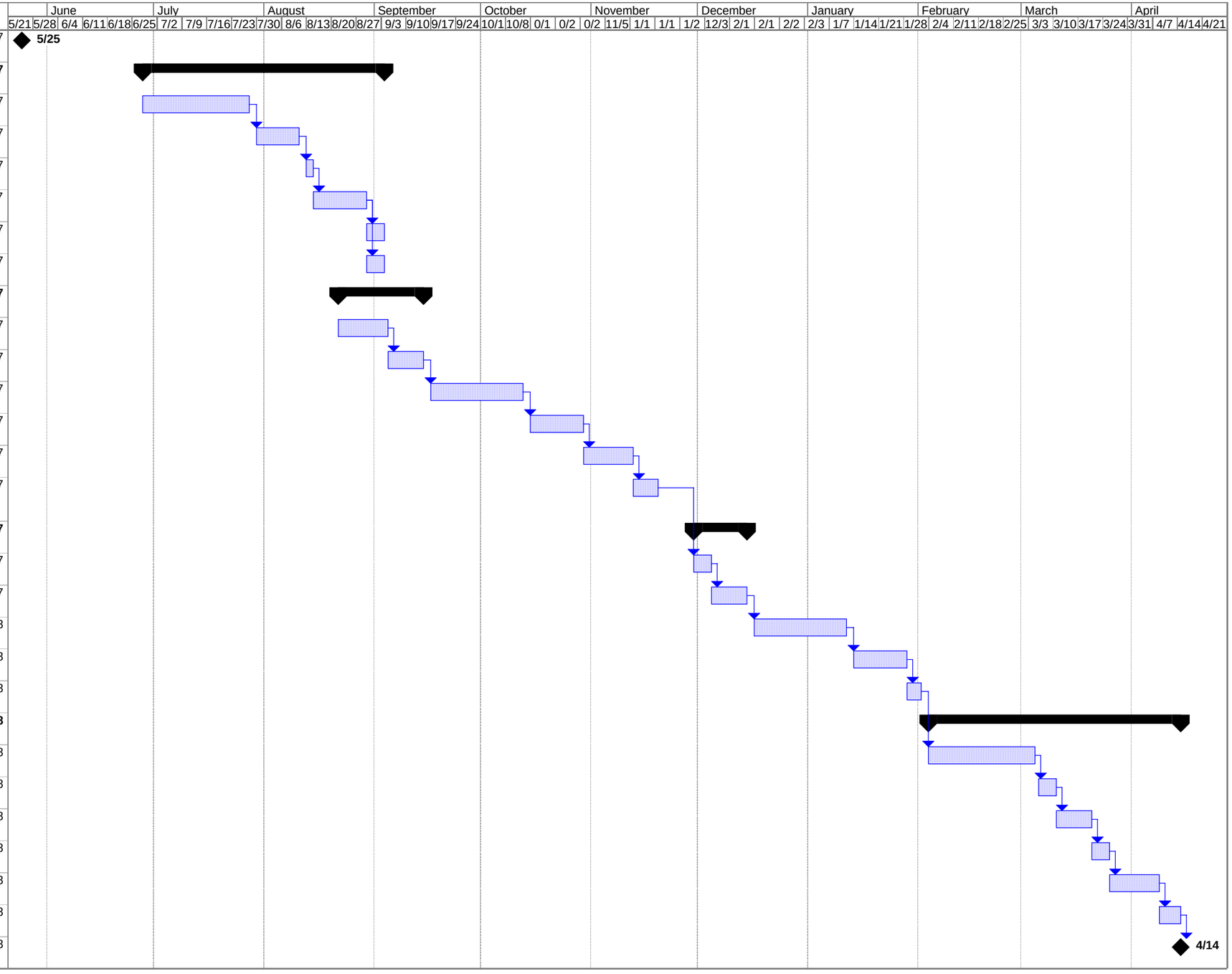


Figure 2-1
Project Organization Chart
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

ID	Task Name	Duration	Start	Finish
1	Award	0 days	Fri 5/25/07	Fri 5/25/07
2	**Work Planning**	**68 days**	**Thu 6/28/07**	**Mon 9/3/07**
3	Draft Work Plan	30 days	Thu 6/28/07	Fri 7/27/07
4	Navy/MCB Review	12 days	Mon 7/30/07	Fri 8/10/07
5	Draft Work Plan	2 days	Mon 8/13/07	Tue 8/14/07
6	Regulatory Review	15 days	Wed 8/15/07	Wed 8/29/07
7	Final Work Plan	5 days	Thu 8/30/07	Mon 9/3/07
8	Sub Coordination	5 days	Thu 8/30/07	Mon 9/3/07
9	**1st Field Event**	**24 days**	**Wed 8/22/07**	**Fri 9/14/07**
10	1st Field Prep	14 days	Wed 8/22/07	Tue 9/4/07
11	Field Activities	10 days	Wed 9/5/07	Fri 9/14/07
12	Laboratory Analysis	26 days	Mon 9/17/07	Fri 10/12/07
13	Data Validation	15 days	Mon 10/15/07	Mon 10/29/07
14	Data Entry and Review	14 days	Tue 10/30/07	Mon 11/12/07
15	Data Analysis and Summary for Partnering	7 days	Tue 11/13/07	Mon 11/19/07
16	**2nd Field Event**	**15 days**	**Fri 11/30/07**	**Fri 12/14/07**
17	2nd Field Prep	5 days	Fri 11/30/07	Tue 12/4/07
18	Field Activities	10 days	Wed 12/5/07	Fri 12/14/07
19	Laboratory Analysis	26 days	Mon 12/17/07	Fri 1/11/08
20	Data Validation	15 days	Mon 1/14/08	Mon 1/28/08
21	Data Entry and Review	4 days	Tue 1/29/08	Fri 2/1/08
22	**Reporting**	**71 days**	**Mon 2/4/08**	**Mon 4/14/08**
23	Internal Draft SI Report	30 days	Mon 2/4/08	Tue 3/4/08
24	Edit/Incorporate Comments	5 days	Thu 3/6/08	Mon 3/10/08
25	Client Review of Draft	10 days	Tue 3/11/08	Thu 3/20/08
26	Edit/Incorporate Comments	5 days	Fri 3/21/08	Tue 3/25/08
27	Regulatory Review	14 days	Wed 3/26/08	Tue 4/8/08
28	Submit Final SI Report	6 days	Wed 4/9/08	Mon 4/14/08
29	Project Complete	0 days	Mon 4/14/08	Mon 4/14/08



Project: CTO-191_Schedule_6-4-07
Date: Thu 7/26/07

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Figure 2-2
Project Schedule
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

CH2MHILL

SECTION 3

Field Investigation Plan

3.1 Overall Approach

Based on the results of the intrusive investigation and historical information, it has been concluded that the Knox Trailer Park area was not the site of a former hand grenade range, and therefore MR field procedures for MEC avoidance will not be implemented during this phase of work. But, based upon the environmental sampling conducted during the first phase of the ESI, it was determined that a more comprehensive surface soil evaluation was needed to determine which parts of the site are fit for residential development.

The objectives of this field investigation are to:

1. Identify specific areas of surface soil contamination that exceed human health screening criteria and prohibit residential development by collecting surface soil samples from decision units across the site, and
2. Further evaluate potential subsurface, sediment, surface water, and groundwater contamination by collecting samples of these environmental media.

The detailed sampling event will accomplish the above objectives through the following activities, which will be conducted in accordance with CH2M HILL SOPs and the Final MCB Camp Lejeune Master Project Plans (CH2M HILL, 2005) (referred to herein as the Master Plans):

- Establish a network of 100- by 200-foot decision units across the site, collecting surface soil samples from within each decision unit. It is estimated that approximately 270 decision units will be needed to cover the site area to be investigated
- Collect DPT soil samples from 24 locations
- Collect sediment samples from eight locations
- Collect surface water samples from eight locations
- Collect groundwater samples from 15 existing monitoring wells (10 intermediate, 5 deep)

The field investigation activities are detailed in the next section and reference the Master Plans (CH2M HILL, 2005).

3.2 Site Preparation and Restoration

The following subsections describe the procedures associated with site preparation including subcontractor procurement, mobilization, and preparation for environmental investigation activities.

3.2.1 Mobilization

A mobilization period before both planned field events will include scheduling, briefing, and equipping staff, as well as securing and deploying equipment. Mobilization activities include other general activities such as developing and reviewing project instructions and a kickoff and safety meeting.

General Activities

- Identify/procure, package, ship, and inventory project equipment, including hand tools and supplies, survey equipment, and drill rigs.
- Coordinate with local agencies, including the Marines, police, hospital, and fire department, as appropriate
- Coordinate communications and other logistical support
- Finalize operating schedules
- Test and inspect equipment
- Conduct site-specific training on the work plan and HSP.
- Verify that all forms and project documentation are in order and project team members understand their responsibilities regarding completing project-reporting requirements
- Procure temporary restroom facility

Kickoff/Safety Meeting

During mobilization, a kickoff and site safety meeting will be conducted. This meeting will include a review of this work plan and a review and acknowledgment of the accident prevention plan by all site personnel. Additional meetings will occur as needed, as new personnel, visitors, and/or subcontractors arrive at the site.

3.2.2 Utility Locating

All utilities, including telephone, cable, water, electricity, and sewers are buried and are assumed to be intact. CH2M HILL will procure a licensed subsurface utility engineer to locate area utilities prior to beginning the site setup and soil excavation activities. The MCB Camp Lejeune Utility Location tracking sheet will be employed to make certain the utility locators have completed a thorough assessment of the subsurface.

3.2.3 Surveying

A professional land surveyor (PLS) licensed in the State of North Carolina will conduct land surveying under subcontract. Land surveying will be performed using data from the original DGM network (100- by 100-foot grids) to establish a network of 100- by 200-foot decision units across the entire area of investigation (see **Figure 3-1**).

The final product of this operation is the generation of a spatially referenced site drawing that accurately depicts the locations of site boundaries, decision units, and environmental

sampling locations. Upon completion of the project, the data contained on this map will be used to generate the Draft ESI Report.

3.2.4 Site Restoration and Demobilization

Demobilization

Full demobilization will occur when the project is completed and appropriate quality assurance and quality control (QA/QC) checks have been performed. Personnel who are no longer needed during the course of field operations may be demobilized prior to the final project completion date. The following will occur prior to demobilization:

- COC records will be reviewed to ensure that all samples were collected as planned and were submitted for appropriate analyses
- Site restoration, including but not limited to abandonment of DPT borings with bentonite and grout mix, will be verified
- All equipment will be inspected, packaged, and shipped to the appropriate location

3.3 Geospatial Information and Electronic Submittals

3.3.1 General Information

This subsection describes the methods, equipment, and accuracy requirements for conducting location surveys and mapping for the investigation at Knox Trailer Park. This plan also identifies the requirements for the electronic submittal of documents and survey, mapping, and GIS data.

All geospatial data will conform to the computer-aided drafting and design /GIS Technology Center Spatial Data Standards for Facilities Infrastructure and Environment and will be provided in English units.

3.3.2 Surveying

Horizontal and vertical control of "Class I, Third Order" or better will be established for the network of monuments at the site. Horizontal control will be based on the metric system and referenced to the North American Datum of 1983 (NAD83) and the Universal Transverse Mercator Grid System. Vertical control will also be based on the metric system and referenced to the North American Datum of 1988 (NAVD88).

If new control points are established, they will be of a permanent nature to allow for future recoverability. All control points will be established using iron or steel pins, concrete monuments, or other permanent construction method. Control points and monuments will be established in accordance with EM 1110-1-1002: Survey Markers and Monumentation.

A PLS licensed in the State of North Carolina will certify all survey data, including control points, grid corners, and boundaries. The PLS will use either a real-time kinematic differential global positioning system (RTK DGPS) or conventional geodetic survey instruments to collect or emplace points. Upon completion of the field work, the Eastings

and Northings (X,Y) for all control points and grid corners will be presented in a certified letter or drawing, along with an electronic submittal of the same.

3.3.3 Geographic Information System Incorporation

The final submittal in electronic format will contain all required project (ArcGIS.mxd) files and layout files for all drawings that are presented in the final report.

Environmental Systems Research Institute, Inc. (ESRI)–compliant formats (shapefiles, coverages, or geodatabases) will be used to present GIS data during the project, with supporting tabular data provided in Microsoft Excel format, Microsoft Access format, or both, as needed.

3.3.4 Plotting

All of the control points recovered and/or established at the site will be plotted at the appropriate coordinate points on reproducible electronic media for production of planimetric or topographic maps at scales appropriate for the parcel size being described.

3.3.5 Mapping

The location, identification, coordinates, and elevations of all control points that are recovered and/or established at the site will be plotted on one or more site maps. Each control point will be identified on the map by its name and number and the final adjusted coordinates.

Each map will include a legend showing the standard symbols used for the mapping, a north arrow, and a title block.

3.3.6 Computer Files and Digital Data Sets

All final document files, including reports, figures, and tables, will be submitted in electronic format. These files will be compatible with Microsoft Office 97 or later formats and in portable document format (PDF) on compact disk-read only memory (CD-ROM). The PDF files will also be posted to the project website if so directed.

CDs containing PDF files will also include the Adobe Acrobat Reader so that the user can use the CD either to install the programs and documents on a machine or to view the document files in stand-alone mode.

All final GIS data generated for the Knox Trailer Park site will be submitted in ESRI's shape file, coverage, or geodatabase format. All data will conform to Spatial Data Standards for Facilities Infrastructure and Environment.

3.4 Field Sampling Plan

3.4.1 Field Operations

In order to determine if decision units are fit for residential development, the project team will investigate surface soil by collecting multi-increment surface soil samples from across the site. Subsurface soil, groundwater, surface water, and sediment samples will also be

collected to complement the data from the Phase I of the ESI. This will include collecting groundwater samples from existing monitoring wells, DPT soil samples, surface soil samples, surface water, and sediment samples.

Surface Soil Sampling

Surface soil samples will be collected across the Knox Park Site using a decision unit/MI sampling technique. Of the 144 total Site acres, CH2M HILL is assuming that approximately 10 acres will not be investigated because they are not fit for development (coastal areas, wetlands, etc.). CH2M HILL will grid the remaining acreage into 100- by 200-foot decision units using the grid node data developed during the initial round of investigation in 2006 **(Figure 3-1)**. The grid corners from the initial investigation will be reacquired by a North Carolina licensed surveyor.

For analysis of volatile organic compounds (VOCs), CH2M HILL will collect a single sample from the center of the decision unit. For all other analyses, including semivolatile organic compounds (SVOCs), target analyte list (TAL) metals/cyanide, pesticides/polychlorinated biphenyls (PCBs), explosive residues, and perchlorate, CH2M HILL will collect five incremental samples from within the decision unit. An MI sampling technique will be used in each decision unit by homogenizing five systematically-located soil increments taken from within the decision unit **(Figure 3-2)**. Incremental soil samples will be collected in accordance with CH2M HILL SOPs (**Appendix B),** except that the soil samples will be taken from 0-1 foot bgs instead of the 0-0.5 foot bgs as outlined in the SOP. The increments will be homogenized into a single sample that will be sub-sampled for shipment to the analytical laboratory. A systematic sampling approach has been selected for this surface soil sampling event in order to establish a consistent protocol and eliminate error.

If constituents are detected in surface soils at concentrations above preliminary remediation goals (PRGs) and background concentrations, further evaluation will be conducted. For noncarcinogenic constituents, target organ evaluations will be made to identify how many constituents affect the same target organ. If the sum of the concentration divided by the PRG for each target organ is below 1, then further evaluation is not needed and no further action will be required for this decision unit.

Carcinogenic constituents will be evaluated to determine if they fall within EPA's acceptable risk range of 10^{-4} to 10^{-6}. If carcinogenic constituents fall within EPA's acceptable range, then further evaluation is not needed and no further action will be required for this decision unit.

If constituents cannot be eliminated based on this review of the data, additional investigation will be performed. CH2M HILL has assumed that 25percent of the decision units may need further investigation once the analytical data are tabulated. The decision units with exceedances will be divided in half and re-sampled as before (see **Figure 3-2**). If exceedances still occur following above evaluation procedure, then a strategy for addressing the decision units displaying impacted soil will need to be developed.

The EPA, NCDENR, NAVFAC, and MCB Camp Lejeune will concur on the decision whether a decision unit is fit for residential development before any action is taken.

Samples will be analyzed by a fixed-base laboratory for the following analyses (also refer to **Tables 3-1** through **3-3**):

- Target compound list (TCL) VOCs
- TCL SVOCs
- TCL pesticides
- TCL PCBs
- TAL metals and cyanide
- Explosives Residues
- Perchlorate

Direct Push Soil Sampling

A DPT rig will be used to collect soil samples above the water table in accordance with CH2M HILL SOPs and the Master Plans (CH2M HILL, 2005). Twenty-four subsurface soil samples will be collected from just above the water table at the locations shown in **Figure 1-3**. Actual sample location coordinates will be determined using an RTK DGPS unit in the field.

Samples will be analyzed by a fixed-base laboratory for the following analyses (also refer to **Tables 3-1** through **3-3**):

- TCL VOCs
- TCL SVOCs
- TCL pesticides
- TCL PCBs
- TAL metals and cyanide
- Explosives Residues

All samples will be Level IV validated by a third-party validator, as described in Section 4 and the Master Plans (CH2M HILL, 2005).

Sediment Sampling

Eight sediment samples will be collected in accordance with CH2M HILL SOPs and the Master Plans (CH2M HILL, 2005). Samples will be collected from downstream to upstream to avoid cross-contamination by sediment suspension. The sediment sample locations for this phase of the ESI are shown on **Figure 1-3**. Samples will be analyzed by a fixed-base laboratory for the following analyses (also refer to **Tables 3-1** through **3-3**):

- TCL VOCs
- TCL SVOCs
- TCL pesticides
- TCL PCBs
- TAL metals and cyanide
- Explosives Residues
- Perchlorate

All samples will be Level IV validated by a third-party validator, as described in the Quality Control Plan in Section 4 and the Master Plans (CH2M HILL, 2005).

Surface Water Sampling

Eight surface water samples will be collected in accordance with CH2M HILL SOPs and the Master Plans (CH2M HILL, 2005). Samples will be collected from downstream to upstream to avoid cross-contamination. The surface water sample locations for this phase of the ESI are shown on **Figure 1-3**. Samples will be analyzed by a fixed-base laboratory for the following analyses (also refer to **Tables 3-1** through **3-3**):

- TCL VOCs
- TCL SVOCs
- TCL pesticides
- TCL PCBs
- Total and dissolved TAL metals
- Total cyanide
- Perchlorate
- Explosives Residues

All samples will be Level IV validated by a third-party validator, as described in the Quality Control Plan in Section 4 and the Master Plans (CH2M HILL, 2005).

Monitoring Well Groundwater Sampling

A complete round of water-level elevations will be collected prior to purging and sampling. Water-level measurements will be converted to water-level elevations using the top-of-casing elevation survey data. This data will also be used to estimate general groundwater flow direction.

One round of groundwater samples will be collected in accordance with CH2M HILL SOPs and the Master Plans (CH2M HILL, 2005). Prior to sampling, each monitoring well will be low-flow purged. During the monitor well low-flow purging, field parameters of groundwater pH, specific conductance, temperature, dissolved oxygen, oxidation-reduction potential, and turbidity will be measured using portable meters calibrated in the field. Groundwater samples will be collected after: (1) field parameters have become stable after three consecutive readings and at least one well volume has been purged, or (2) at least three well volumes have been purged from the well.

Groundwater samples will be analyzed by a fixed-base laboratory for the following analyses:

- TCL VOCs
- TCL SVOCs
- TCL pesticides
- TCL PCBs
- Total and filtered TAL metals
- Total cyanide
- Perchlorate
- Explosives Residues

All samples will be Level IV validated by a third-party validator, as described in the Quality Control Plan in Section 4 and the Master Plans (CH2M HILL, 2005).

3.4.2 Analytical requirements and Sample handling

Sample Preservation and Handling

Sample preservation occurs in the field immediately after collection. The containers supplied by the laboratory will contain applicable preservative. This will protect field personnel from transporting, handling, and measuring concentrated acids and bases. QA/QC samples, with the exception of trip blanks, will be collected in the same containers with preservatives as the field samples. The preservative and holding time for analysis is shown in **Table 3-2**.

Quality Assurance and Quality Control

QA/QC requirements for environmental sampling, handling, and management are detailed in Section 4 and in the Master Plans (CH2M HILL, 2005). Field QC samples (including trip blanks, field blanks, equipment blanks, duplicate samples, and matrix spike/matrix spike duplicate (MS/MSD) samples) will be collected during the investigation and submitted for laboratory analysis. Required QA/QC samples and the required frequency of collection are as follows:

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

Sample Type	Description	Frequency	Analytes
MS/MSD	Designed to evaluate potential matrix interferences, accuracy, and precision. Three aliquots of a single sample—one native and two spiked with the same concentration of matrix spike compounds—are analyzed.	5 percent	Same parameters as parent sample

Table 3-3 presents the anticipated number of field samples and their associated QA/QC samples.

Sample Identification System

The field analysis data are recorded in field logbooks, along with sample identity information, while in the custody of the sampling team.

Labels for samples sent to a laboratory for analysis 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 similar to other sample numbers for MCB Camp Lejeune under the IRP:

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

An explanation of each of these identifiers is given below.

Site#: This investigation includes MRP Site UXO-04 under the MRP. Therefore, the prefix "MR04" will be used.

Media: GW = Groundwater
SS = Surface soil
IS = Subsurface soil
SD = Sediment
SW=Surface water

Station#: Each monitoring well will be identified with a unique identification number. Existing monitoring well numbers will be used. Soil borings will be numbered consecutively. Surface soil samples will be identified by the decision unit name and number in which it was collected in. Each column of the grid network will have a letter designation and the first decision unit within that column will always be 01, see **Figure 3-1**.

QA/QC: D = Duplicate sample (following sample type/number)
FB = Field blank
ER = Equipment rinsate

TB = Trip blank

All MS/MSD samples will be entered in the same line as the field sample on the COC. The total number of sample containers submitted will be entered on the COC and "MS/MSD" will be indicated in the comments section.

Year/Round#: Year/round indicators will be used for samples collected from monitoring wells. Each round of sampling will have a distinct identification number:

"07" will be used for the year 2007
"C" will be used to indicate that these samples were collected in the third quarter

Depth Interval: Depth indicators will be used for soil and groundwater samples collected using DPT. The number will reference the depth interval of the sample:

2–3 = 2 to 3 feet bgs

Under this sample designation format, "MR04-GW01-07C" would mean the following:

MR04-GW01-07C	MRP Site UXO-04
MR04-GW01-07C	Groundwater sample from monitoring well #1
MR04-GW01-07C	Sampled during the third quarter of 2007

"MR04-TB1-07C" would mean the following:

MR04-TB1-07C	MRP Site UXO-04
MR04-TB1-07C	Trip Blank #1
MR04-TB1-07C	Sampled during the third quarter of 2007

"MR04-A01-07C" would mean the following:

MR04-A01-07C	MRP Site UXO-04
MR04-A01-07C	VOC surface soil sample collected within decision unit A01
MR04-A01-07C	Sampled during the third quarter of 2007

"MR04-A01-0-0.5-07C" would mean the following:

MR04-A01-0-1-07C	MRP Site UXO-04
MR04-A01-0-1-07C	Homogenized incremental surface soil sample collected within decision unit A01
MR04-A01-0-1-07C	Surface soil depth interval, 0 to 1 foot bgs
MR04-A01-0-1-07C	Sampled during the third quarter of 2007

This sample designation format will be followed throughout the project. Required deviations to this format in response to field conditions will be documented.

Sample Packaging and Shipping

Samples will be tightly packed in a cooler with bubble wrap packaging material and ice as a preservative. The samples will be either picked up at the site by the analytical laboratory or shipped to the laboratory via overnight courier. The field team leader or their designee is responsible for completion of the following forms:

- Sample labels and COC seals
- COC forms
- Appropriate labels and forms required for shipment

Custody of the samples will be maintained and documented at all times. COC will begin with the collection of the samples in the field and will continue through the analysis of the sample at the analytical laboratory.

3.4.3 IDW Management

CH2M HILL will procure a subcontractor for handling and disposal of all IDW generated during investigation activities. IDW includes soil cuttings from the DPT sampling, liquid waste (e.g., purged groundwater or decontamination fluids), and personal protective equipment generated during groundwater sampling. The DPT subcontractor is responsible for transporting IDW from the site to the designated Base accumulation area. Before the waste is transported to the staging area, CH2M HILL will collect representative samples for Toxicity Characteristic Leaching Procedure analysis on the waste to determine disposal requirements and transporting of the IDW to proper disposal facilities.

3.5 Health and Safety Plan

The HSP for Phase II of the ESI is an amended version of the HSP used from Phase I. The primary modification was to remove any references to MEC avoidance procedures. The project-specific HSP is located in **Appendix A.**

3.6 Data Documentation and Processing Procedures

During the Phase II sampling, three types of data will be generated: field, laboratory, and investigation interpretive. This subsection presents documentation and processing procedures for the data.

3.6.1 Field Data

The field team will document all field activities, including any visits to the site by regulatory personnel or their contractors, in a bound field logbook. The logbook will also be used to document, explain, and justify all deviations from the approved work plan and master plans (CH2M HILL, 2005). Its pages will have water-resistant sizing and will be consecutively numbered. Waterproof ink, preferably black, will be used to record entries in the field logbook. Each page will be dated and signed by the individual making the entry. The field logbook should provide a summary of the field activities.

The sampling team will record in the field logbook sampling information, physical and geological information, and any field measurements (e.g., pH, temperature) taken during sampling. The sample identification system in Section 3.4.2.3 will be used to identify each sample, in accordance with Camp Lejeune protocol. An identification label will be affixed on each sample container sent to the laboratory.

A copy of all field logbook entries and COC records will be made available upon request.

3.6.2 Laboratory Data

Upon their arrival at the laboratory, the samples will be cross-referenced against the COC records. All sample labels will be checked against the COC, and any mislabeling will be identified, investigated, and corrected prior to the samples into the laboratory. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.

Raw data will be entered by the analysts in laboratory notebooks. A separate book will be maintained for each analytical procedure. All calculations will be entered into designated laboratory notebooks with a sufficient amount of data to compute without reference to other documents.

Instrument calibration logs and internal QC procedures will be documented in accordance with the analytical method in use. All proposed analytical methods have been documented in detail in the Master Plans and in Section 3.4. Documentation of these activities will be made available during quality assurance (QA) audits.

The reporting requirements will be in accordance with the Contract Laboratory Program (CLP) Statement of Work OLM04.3 and OLC03.2 for organics analysis and ILM05.3 for inorganics analysis, as well as SW-846 methodologies.

Copies of all the analytical data reports, including the QC data, will be maintained by CH2M HILL in the project files.

3.6.3 Investigation Results

The results of the Draft ESI Report will be presented in tabular and graphical formats, as well as descriptive and interpretive text. The raw data will be included in a tabular format in appendices of the subsequent investigation report. The Draft ESI Report will include results from Phase I environmental sampling, the MEC Intrusive Investigation, and this Phase II environmental sampling. The report shall include results of the DGM surveys, MEC intrusive investigation, site inspections, HHRA, and SLERA. The following data will be presented in tables:

- Water level elevations
- Sampling location coordinates
- Comparative data between study areas and background areas

Graphs or figures will be used to depict the following:

- Layout and topography
- Sampling locations and grid network
- Boundaries of sampling locations
- Stratigraphy and water level elevations
- Horizontal extent of contamination
- Vertical distribution of contaminants

3.7 Project File Requirements

This project will require the administration of a central project file. The data and records management protocols will provide adequate controls and retention of all materials related to the project. Record control will include receipt from external sources, transmittals, transfer to storage and indication of record status. Record retention will include receipt at storage areas, indexing, filing, storage, maintenance, and retrieval.

3.7.1 Record Control

All incoming materials related to the project, including sketches, correspondence, authorizations, and logs, shall be forwarded to the PM or designated assistant. These documents will be placed in the project file. Project personnel will work from a copy of the necessary documents. All records shall be legible and easily identifiable.

Examples of the types of records that will be maintained in the project file are:

- Field documents
- Correspondences
- Photographs
- Laboratory data
- Reports
- Procurement agreements

Outgoing project correspondence and reports will be reviewed and signed by the PM.

3.7.2 Record Status

To prevent the inadvertent use of obsolete or superseded project-related procedures, the project team members will be responsible for reporting changes in protocol to the CH2M HILL PM. The PM will then inform other members of the Project Team and the Project QA Officer of these changes.

Revisions to procedures shall be subject to the same level of review and approval as the original document. The revised document will be distributed to all holders of the original document and discussed with project personnel. Outdated procedures will be marked "void." One copy of a document marked "void," along with the reason(s) for marking the document "void" will be maintained in the project file. In addition, the date a document is marked "void" will be recorded.

3.7.3 Record Storage

All project-related information will be maintained by CH2M HILL for the duration specified by Contract N62470-02-D-3052. Designated personnel will assure that incoming records are legible and in suitable condition for storage. Record storage will be performed in two stages: storage during and immediately following the project, and permanent storage of records directly related to the project.

CH2M HILL will use storage facilities providing a suitable environment, one that will minimize deterioration or damage and prevent loss. Records will be secured in steel file cabinets labeled with the appropriate project identification. CH2M HILL will use Microsoft

Excel for data storage. Data will be maintained on DVD-ROM and backed up each time a file is edited. Upon presentation of data to MCB Camp Lejeune, a backup of that version will be permanently stored in the central filing location.

At the completion of the project, the PM or his appointed document custodian will be responsible for the project file inventory. All material from the project file, including drawings, project related QA documents, and electronic project documentation and verification records will be maintained by CH2M HILL for the duration specified by Contract N62470-02-D-3052.

TABLE 3-1
Summary of Sampling Program
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Sample Media	Sample Depth/Location and Rationale	Analysis							
		VOCs	SVOCs	Pesticides/ PCBs	Explosive Residues	Total TAL Metals	Cyandie	Filtered TAL Metals	Perchlorate
Direct Push Soil	Collected from a 2 feet interval just above the water table at each location shown on **Figure 1-3**. Will allow for characterization of soil across site.	x	x	x	x	x	x		x
Monitoring Well Groundwater	From existing monitoring wells MR04-MW01 through MW15, shown on **Figure 1-3**.	x	x	x	x	x	x	x	x
Surface Water	Collected from each location shown on **Figure 1-3**.	x	x	x	x	x	x	x	x
Surface Soil	Collected at each location shown on **Figure 3-2**.	x	x	x	x	x	x		x
Sediment	Collected at each location shown on **Figure 1-3**. Will allow for evaluation of transport of contaminants into adjacent sediment and water body. Includes locations at beginning and end of streams and just offshore of site.	x	x	x	x	x	x		x

Notes and Abbreviations
TAL = Target Analyte List
VOC = Volatile organic compounds
SVOC = Semivolatile organic compounds
PCBs = Polychlorinated biphenyls

TABLE 3-2
Analyses, Bottleware, Preservation, and Holding Time Requirements
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Media	Analysis	Method	Container	Preservation / Storage	Holding Times
Soil and Sediment	TCL VOCs	OLM04.3	2x5-gram + 1x25-gram Encore™ Sampling receptacle	4ºC	48 hours
	TCL SVOCs	OLM04.3	1x8-oz bottle, Teflon cap	4ºC	7 days to extraction, 40 days from extraction to analysis
	Explosive Residues	SW-846 8330	1x8-oz bottle, Teflon cap	4ºC	7 days to extraction, 40 days from extraction to analysis
	Perchlorate	DoD Perchlorate Handbook or SW-846 6850	1x4-oz amber glass jar, Teflon cap	4ºC	28 days to extraction, 28 days from extraction to analysis
	TCL Pesticides/PCBs	OLM04.3	1x8-oz bottle, Teflon cap	4ºC	7 days to extraction, 40 days from extraction to analysis
	TAL Metals/Cyanide	ILM05.3	1x4-oz bottle, Teflon cap	4ºC	6 months, Cyanide: 14 days, Mercury: 28 days
Groundwater and Surface Water	TCL VOCs	SOM01.1	3x40-mL vials	HCl to pH <2; cool to 4ºC	14 days
	TCL SVOCs	SOM01.1	2x1-L amber jar	4ºC	28 days to analysis, nitrate 48 hours
	Explosive Residues	SW846 8330	2x1-L amber jar	4ºC	7 days to extraction, 40 days from extraction to analysis
	Perchlorate	EPA 6850	1x1-L Poly bottle	4ºC	7 days to extraction, 40 days from extraction to analysis
	TCL Pesticides/PCBs	OLC03.2	3x1-L amber jar	4ºC	7 days to extraction, 40 days from extraction to analysis
	Total and Filtered TAL Metals	ILM05.3	1x1-L Poly bottle	HNO_3 to pH <2 and cool to 4ºC	6 months, Mercury: 28 days
	Cyanide	ILM05.3	1x1-L Poly bottle	NaOH to pH >12 and cool to 4ºC	14 days

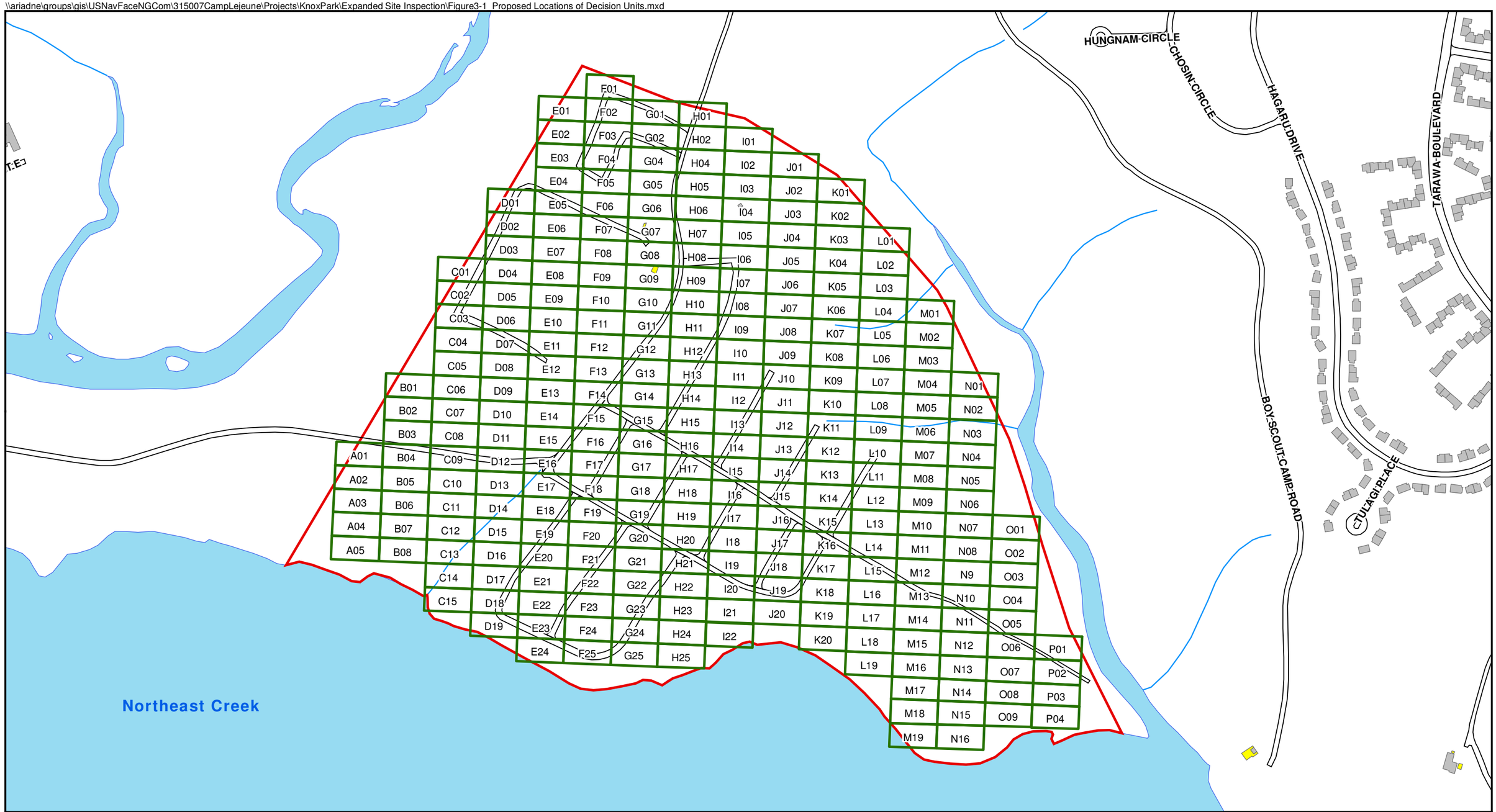
Notes
mL = milliliter
oz = ounce
g = gram
HCL = hydrochloric acid
HNO_3 = nitric acid
H_2SO_4 = sulfuric acid
NaOH = Sodium Hydroxide
TAL = Target Analyte List (TAL) metals
TCL = Target Compound List
VOCs = Volatile Organic Compounds
SVOCs = semivolatile organic compoundss

TABLE 3-3
Sample Collection Frequencies
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Analysis/Test	Sample Matrix	Field Samples	Field Duplicates	Equipment Blanks	Field Blanks	MS/MSDs	Trip Blanks
Direct Push Soil Samples							
TCL VOCs by CLP (OLM04.3) (with Encore samplers provided by lab)	Solid	24	3	3	1	2	2
TCL SVOCs by CLP (OLM04.3)		24	3	3	1	2	
Explosive Residues by SW846 8330		24	3	3	1	2	
TCL Pesticides and PCBs by CLP (OLM04.3)		24	3	3	1	2	
TAL Metals and Cyanide by CLP (ILM05.3)		24	3	3	1	2	
Surface Soil Samples							
TCL VOCs by CLP (OLM04.3)	Solid	335	34	15	3	16	10
TCL SVOCs by CLP (OLM04.3)		335	34	15	3	16	
Explosive Residues by SW846 8330		335	34	15	3	16	
Perchlorate by DoD Perchlorate Handbook or SW846 6850		335	34	15	3	16	
TCL Pesticides and PCBs by CLP (OLM04.3)		335	34	15	3	16	
TAL Metals and Cyanide by CLP (ILM05.3)		335	34	15	3	16	
Monitoring Well Groundwater Samples							
TCL VOCs by CLP (OLC03.2) without Encore	Aqueous	15	2	3	1	2	3
TCL SVOCs by CLP (OLC03.2)		15	2	3	1	2	
Explosive Residues by SW846 8330		15	2	3	1	2	
Perchlorate by EPA 6850		15	2	3	1	2	
TCL Pesticides and PCBs by CLP (OLC03.2)		15	2	3	1	2	
Total TAL Metals and Cyanide by CLP (ILM05.3)		15	2	3	1	2	
Filtered TAL Metals by CLP (ILM05.3)		15	2	3	1	2	
Surface Water Samples							
TCL VOCs by CLP (OLC03.2) without Encore	Aqueous	8	1	--	1	1	2
TCL SVOCs by CLP (OLC03.2)		8	1	--	1	1	
Explosive Residues by SW846 8330		8	1	--	1	1	
Perchlorate by EPA 6850		8	1	--	1	1	
TCL Pesticides and PCBs by CLP (OLC03.2)		8	1	--	1	1	
Total TAL Metals and Cyanide by CLP (ILM05.3)		8	1	--	1	1	
Filtered TAL Metals by CLP (ILM05.3)		8	1	--	1	1	
Sediment							
TCL VOCs by CLP (OLM04.3) without Encore	Solid	8	1	1	1	1	2
TCL SVOCs by CLP (OLM04.3)		8	1	1	1	1	
Explosive Residues by SW846 8330		8	1	1	1	1	
Perchlorate by DoD Perchlorate Handbook or SW846 6850		8	1	1	1	1	
TCL Pesticides and PCBs by CLP (OLM04.3)		8	1	1	1	1	
TAL Metals and Cyanide by CLP (ILM05.3)		8	1	1	1	1	
IDW Sampling							
Full TCLP	1 Solid and 1 Aqueous	2					
RCI		2					

Notes
MS/MSD = Matrix Spike and Matrix Spike Duplicate pair
TCL = Target Compound List
TAL = Target Analyte List
SVOCs = Semivolatile organic compounds
VOCs = Volatile organic compounds
PCBs = Polychlorinated biphenyls
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
One trip blank is supplied in each cooler submitted to an offsite lab containing VOCs and is analyzed only for VOCs
MS/MSDs are collected at the rate of 1 for every 20 samples
TCLP = Toxicity Characteristic Leaching Procedure
RCI = Reactivity, Corrosivity, and Ignitability Characteristics

\\ariadne\groups\gis\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\Expanded Site Inspection\Figure3-1_Proposed Locations of Decision Units.mxd

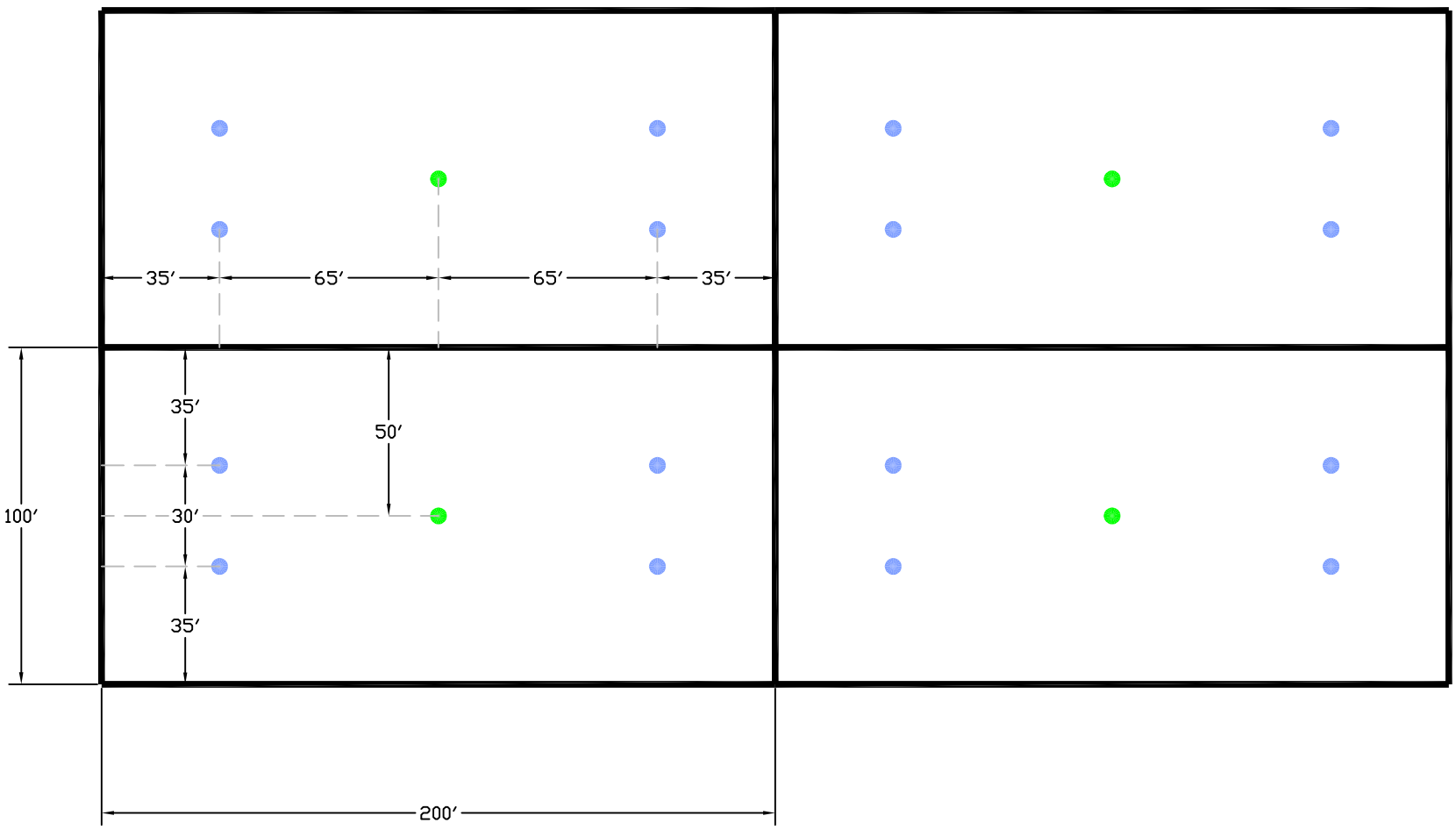


Legend

- Decision Units -100 ft X 200 ft
- Structure Area
- Road Area
- Site UXO-04
- Surface Water Course Centerline
- Surface Water Body Area

Figure 3-1
Proposed Locations of Decision Units
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

CH2MHILL



LEGEND

100 ft x 200 ft DECISION UNIT

SURFACE SOIL SAMPLE INCREMENTS

SURFACE SOIL SAMPLE FOR VOC's AND SURFACE SOIL SAMPLE INCREMENT

NOTES:

1. 5 SAMPLE LOCATIONS PER DECISION UNIT

2. VOC AND ONE SAMPLE INCREMENT WILL BE COLLECTED FROM CENTER LOCATION.

3. REMAINING FOUR SAMPLES INCREMENT WILL BE COLLECTED FROM SURROUNDING LOCATIONS WITHIN DECISION UNIT ACCORDING TO DIMENSIONS SHOWN ABOVE.

N
W E
S

0 50 100
1"=50'

Figure 3-2
Surface Soil Samples in Decision Units
Knox Trailer Park, Site UXO-04
Camp Lejeune, North Carolina

CH2MHILL

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SECTION 4

Quality Control Plan

4.1 Introduction

This QCP describes the QC approach and procedures for the Phase II sampling at the Camp Lejeune Knox Trailer Park site and references the MCB Camp Lejeune Master Quality Assurance Project Plan (CH2M HILL, 2005). The requirements and systems established in this QCP are relevant and applicable to project work performed by CH2M HILL and its subcontractors.

4.2 Project Organization and Responsibilities

This section identifies key project team members and lists the QA/QC responsibilities associated with each position and describes communication procedures that will be followed throughout the project. Refer to Section 2.2 for the project schedule summary.

4.2.1 Project Team Members

The organizational structure and responsibilities of the project team are designed to provide project QA/QC for the ESI at Knox Trailer Park, Site UXO-04. **Figure 4-1** expands on the organizational structure of the project team provided in **Figure 2-1**. Selected positions are described in the following paragraphs.

NAVFAC and MCB Camp Lejeune EMD

NAVFAC will provide contract obligations to CH2M HILL for work planned at MCB Camp Lejeune. Camp Lejeune EMD will work with CH2M HILL for all on base coordination activities.

Project Manager

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

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

Activity Manager

The activity manager (AM) for this project is Matt Louth. The primary objectives of the AM are to build and maintain the relationship with the client and to provide continuity across all projects at MCB Camp Lejeune. The AM will provide overall guidance with regards to NAVFAC LANTDIV and MCB Camp Lejeune and will serve as the alternate CH2M HILL contact. The AM has overall responsibility for client satisfaction.

Senior Consultant and Review Team Leader

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

Lead Data Manager

The lead data manager (LDM) for this project is Felicia Arroyo. The LDM is responsible for the structure, organization, format, implementation, and operation of the project database as described in the work plan. She provides a point of communication between the laboratory and the project team, supervises the analytical data quality evaluation, and participates in preparing deliverables to the client. The LDM is also responsible for monitoring project-specific laboratory activities, including checking laboratory invoices and reports. She also supervises the data management team and provides direction to the database manager.

Health and Safety Manager

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

Field Team Leader and Site Safety Coordinator

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

The SSC for this project is Jonathan Burton. The SSC develops and implements the project-specific HSP (**Appendix A**) 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.

Subcontractors

Subcontractors will be used for the investigation at Site UXO-04, Knox Trailer Park. The following services will be provided by subcontractors:

- Utility location
- DPT sampling
- Analytical laboratory services
- Data validation
- Surveying
- IDW disposal

Procurement of subcontractors will be performed in accordance with the Navy CLEAN Contract Procurement Manual.

4.2.2 Project Communication

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

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

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

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

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

4.3 Environmental Investigation Quality Assurance Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of data required from field and laboratory data collection activities to support decisions concerning risk and remediation. DQOs are established prior to data collection and describe what data are needed, why the data are needed, and how the data will be used to address the problems being investigated. DQOs help to ensure that all data collected are legally and scientifically defensible. See **Table 4-1** for DQOs developed for Phase II of the ESI.

4.3.1 Background

The purpose of this Phase II ESI is to evaluate the environmental media at Knox Trailer Park and determine if residential development can occur without further action. We are defining discrete areas of surface soil contamination to determine whether or not these areas are fit for residential construction. Based on historical activities at the site (refer to Section 1.4) and results from a previous phase of the ESI, this Phase II sampling event is being conducted to accomplish the following objectives:

1. Identify areas of surface soil contamination that exceed human health screening criteria by collecting surface soil samples from discrete decision units across the site, and
2. Further evaluate potential subsurface soil, sediment, surface water, and groundwater contamination by collecting samples of these environmental media.

4.3.2 Levels of Data Quality

Three categories of data will be collected as part of the field effort, and each category has a different level of supporting QA/QC documentation. Level 1 includes field monitoring activities, such as pH, conductivity, temperature, and turbidity. Level 2 includes the analyses associated with the characterization of the IDW samples. All other samples will be submitted to the laboratory for Level 4 analyses. For each QC level, the measures and methods to be used, as well as the applicable data package deliverables, are outlined below.

Level 1 – Field Surveys

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

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

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

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

Level 2 – IDW Analyses

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

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

Level 4 – Laboratory Analyses

The purpose of Level 4 data is to determine whether residential development can occur at Site UXO-04 without further action.

Samples will be analyzed for the analyses presented in **Tables 3-1** through **3-3**. Current CLP and EPA-approved methodologies will be used to analyze samples. Data package deliverables are summarized below.

Level 4 Data Package Deliverables (Standard Deliverable Package)
All Analytical Fractions
Case Narrative
Sample ID Cross Reference Sheet (Lab IDs and Client IDs)
Completed COC form and any sample receipt information
Any analytical/procedural changes (copies of "Confirmation of Communication")
Copies of non-conformance memos and corrective actions
All raw data sheets associated with sample analysis
Gas Chromatograph/Mass Spectrometer (GC/MS) Organic Analyses
Form 1—Sample Results
Form 2—Surrogate Recovery Summary
Form 3—MS/MSD Accuracy and Precision Summary
Form 4—Method Blank Summary
Form 5—Instrument Tuning Summary
Form 6—Initial Calibration Summary
Form 7—Continuing Calibration Summary
Form 8—Internal Standard Summary
Inductively Coupled Plasma/Mass Spectrometer Inorganics
Form 1—Sample Results
Form 2A—Initial and Continuing Calibration Summary
Form 3—Initial and Continuing Calibration Blanks and Method Blanks Summary
Form 5A –MS/MSD Recoveries Summary
Form 6—Native Duplicate and MS/MSD Precision Summary
Form 7—Laboratory Control Sample Recovery Summary
Form 10—Instrument or Method Detection Limit (MDL) Summary
Form 13—Preparation Log Summary

4.3.3 Quality Assurance Objectives for Chemical Data Management

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

Precision

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

Accuracy

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

Representativeness

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

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.

Completeness

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

4.3.4 Sample Procedures

Sampling locations and procedures are discussed in Section 3.

4.3.5 Sample Custody

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

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

- Packing lists
- COC records

- Air bills (such as Federal Express, UPS)
- Field logbooks
- Color photographs of the field activities

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

Definition of Custody

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

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

Field Custody

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

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

- Labels will be completed for each sample with waterproof ink, making sure that the labels are legible and affixed firmly on the sample container
- All sample-related information will be recorded in the site logbook
- The field sampler will retain custody of the samples until they are transferred or properly dispatched
- To simplify the COC record and minimize potential problems, as few people as possible will handle the samples or physical evidence. One individual from the field sampling team will be designated as the responsible individual for all sample transfer activities. This field investigator will be responsible for the care and custody of the samples until they are properly transferred to another person or facility
- All samples will be accompanied by a COC record, which documents the transfer of custody of samples from the field investigator to another person, the laboratory, or other organizational elements. Each change of possession must be accompanied by a signature for relinquishment and receipt of the samples
- Completed COC forms will be placed in a plastic cover, which is then placed inside the shipping container used for sample transport from the field to the laboratory

- When samples are relinquished to a shipping company for transport, the tracking number from the shipping bill or receipt will be recorded on the COC form or in the site logbook
- Custody seals will be used on the shipping containers when samples are shipped to the laboratory to inhibit sample tampering during transportation

Sample Labels

The sampling location identification and sample labeling, handling, and shipping must be performed using standardized and well-documented procedures so that a sample can be tracked to its point of origination. Tracking will be performed from the time of sampling until the analytical data are released from the laboratory. The effectiveness of the tracking process will determine the integrity of the samples. Therefore, a sample-numbering system with a tracking mechanism that allows the retrieval of sample information including sampling locations, date, time, and analytical parameters must be used. Procedures for this system are provided in Section 3.4.2.3. The method of sample identification to be used depends on the type of sample collected and container used, as follows:

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

Chain-of-Custody Record

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

Transfer-of-Custody and Shipment

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

Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate COC record accompanying each shipping container.

Shipping containers will be sealed with custody seals for shipment to the laboratory. Courier name(s), and other pertinent information, will be entered in the '"Received By" section of the COC record.

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

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

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

Laboratory Chain-of-Custody Procedures

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

When sample analyses and necessary QA checks have been completed in the laboratory, the unused portion of the sample will be disposed of properly. All identifying stickers, data sheets, and laboratory records will be retained as part of the documentation. Sample containers and remaining samples will be disposed in compliance with all federal, state, and local regulatory requirements.

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

Care will be exercised to annotate any labeling or descriptive errors. If discrepancies occur in the documentation, the laboratory will immediately contact the FTL as part of the corrective action process (refer to Section 4.3.3). A qualitative assessment of each sample container will be performed to note anomalies, such as broken or leaking bottles. This assessment will be recorded as part of the incoming COC procedure.

Sample Storage. The laboratory custodian will use the sample identification number and assign a unique laboratory number to each sample, and is responsible for seeing that all

samples are transferred to the proper analyst or stored in the appropriate secure area. The laboratory will send a sample acknowledgement letter to the PM or FTL as a record of the shipment's arrival and the condition of the containers. Any discrepancy will be identified by the laboratory custodian, and corrective actions taken. The PC may need to provide guidance concerning additional actions. A copy of the sample acknowledgement letter will be retained with the COC by the PM.

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

Documentation Procedures

Field documentation for activities at MCB Camp Lejeune will consist of one or more site-specific field logbooks and any necessary field forms as described in Section 3.6.1. Each logbook will be identified uniquely by project task and consecutively numbered. For extended field activities, logbooks will be maintained onsite until complete, then stored in the project files.

Photographs will be taken during key field activities.

Sample Identification. Sample identification procedures are identified in Section 3.4.2.3. The sample designation format will be followed throughout the project. Required deviations from this format in response to field conditions will be documented.

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

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

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

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

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

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

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

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

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

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

- Field analysis data and methods
- Sample distribution and transporter

Corrections to Documentation. All original handwritten data recorded in field logbooks, sample identification tags, COC records, and receipts-for-sample forms will be written in black, waterproof ink. Corrections must be marked with a single line, dated, and initialed. No accountable control documents (such as site, field, and calibration logbooks) are to be destroyed or discarded, even if they are illegible or contain inaccuracies that require a replacement document.

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

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

4.3.6 Calibration Procedures

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

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

Field Instruments

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

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

All field instruments will be set up and operated in strict accordance with the manufacturer's instructions. When the operation of these instruments needs modification

because of specific site or sample conditions, such modification will be documented in the instrument logs and field logbooks.

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's quality assurance plan, which will be reviewed and approved by the PC or designee before samples are submitted for analysis.

4.3.7 Analytical Procedures

Field Testing and Screening

All field parameters will be analyzed in accordance with SOPs for the individual equipment. Field parameters include temperature, pH, dissolved oxygen, conductance, and oxygen-reduction potential, as discussed in Section 3.

Laboratory Methods

The parameters to be analyzed and the specific analytical methods to be used are discussed in Section 3.

4.3.8 Data Reduction, Validation and Reporting

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

Level 1 – Field Survey Data

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

- Instrument identification
- Calibration information (standards used and results)
- Date and time of calibration and sample measurement
- Sample results
- Supporting information if appropriate
- Data will be reviewed by the FTL, who is responsible for the collection and verification of all field data while in the field. Data initially will be accepted or rejected by the FTL before leaving the sampling site. Extreme readings (readings that appear significantly different from other readings at the same site) will be accepted only after the instrument has been checked for malfunction and the readings verified by re-testing.

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

Level 2 – Screening Analyses

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

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

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

Level 4 - Laboratory Analyses

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

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

The data package will be reviewed by the data validator using the process outlined by the EPA (1999, 2004).

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

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

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

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

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

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

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

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

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

When surrogate spike recoveries for field samples fall outside the method target acceptance windows, the samples are re-extracted if appropriate, then re-analyzed. If the surrogate

spike recovery is still outside the acceptance window for the re-analyzed sample, then the sample results are qualified as affected by matrix interferences.

Matrix Spike Recoveries. For this QC measure, three aliquots of a single sample are analyzed—one normal and two spiked with the same concentration of matrix spike compounds. Unlike the surrogate spike compounds, matrix spike compounds are found on the method target compound list. Spike recovery is used to evaluate potential matrix interferences, as well as accuracy. The duplicate spike results are compared to evaluate precision.

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

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

Laboratory Data Reporting. Laboratory data will be reported in Level 3 QC and validated for risk assessment. Level 3 reporting includes all QC and calibration summaries for a project-specific batch of samples. Matrix-specific QC is performed relative to project sample delivery groups.

4.3.9 Internal Quality Control

Field Measures

Field sampling QC procedures will include collecting trip blanks, field blanks, equipment blanks, field duplicates, and MS/MSD samples, as discussed in Section 3.4.2. These QC samples will be submitted blind to the laboratory. Field measurement QC procedures will include the calibration requirements discussed in Section 4.3.6.

Samples will be collected by personnel wearing Level D personal protection equipment.

Routine Analytical Services

Laboratory QC procedures will include the following:

- Analytical methodology according to the specific methods identified
- Instrument calibrations and standards as defined in the specific methods
- Laboratory blank measurements at a minimum frequency of 5 percent or one-per-batch
- Accuracy and precision measurements at a minimum frequency of 5 percent or one-per-set
- Data reduction and reporting according to the specific methods and the specifications outlined in Section 4.3.8

- Laboratory documentation according to the specifications outlined in Section 4.3.7.

4.3.10 Performance and System Audits

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

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

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

Project Systems Audit

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

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

Technical Performance Audits

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

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

The first three items above will be checked for completeness. Sampling operations will be reviewed to determine if they are being performed as stated in Section 3 or as directed by the FTL. A performance surveillance may be conducted by the PM and the FTL during the first week of sampling if it is deemed necessary by the PM, FTL, or client. The surveillance may focus on verifying that proper procedures are followed so that subsequent sample data will be valid. Before the surveillance, a checklist will be prepared by the PM and the FTL to serve as a guide for the performance surveillance. The surveillance may verify the following:

- Collection of samples follows the available written procedures
- COC procedures are followed for traceability of sample origin
- Appropriate QC checks are being made in the field and documented in the field logbook

- Specified equipment is available, calibrated, and in proper working order
- Sampling crews are adequately trained
- Record-keeping procedures are being followed and appropriate documentation is maintained
- Corrective action procedures are followed

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

Field Audits

A field audit will be conducted during this investigation.

Laboratory Audits

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

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

4.3.11 Preventive Maintenance

Field Equipment

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

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

Laboratory Equipment

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

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

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

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

Instrument Maintenance Logbooks

All maintenance will be documented in permanent logs that will be available for review by auditing personnel. Both scheduled and unscheduled maintenance required by operational failures will be recorded. The designated laboratory operations coordinator will review maintenance records regularly to ensure that required maintenance is occurring.

Instrument maintenance logbooks are maintained in laboratories at all times. The logbooks, in general, contain a schedule of maintenance, as well as a complete history of past routine and non-routine maintenance.

4.3.12 Specific Procedures Used to Assess Data

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

Data assessment will follow the data review and validation described in Section 4.3.8. An assessment report will be prepared at the end of the project. The report will summarize the findings of the data review/validation as relevant to project usage. Data accuracy, precision, and completeness values will be summarized in the assessment report. The following subsections describe the quantitative definition of accuracy, precision, and completeness.

Precision

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

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

where

X_1 = native sample
X_2 = 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 or matrix spikes. It is calculated from analytical data and is not measured directly. Spiking of reference materials into a sample matrix is the preferred technique because it provides a measure of the matrix effects on analytical accuracy. Accuracy, defined as percent recovery (P), is calculated as follows:

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

where

SSR=spiked sample result
SR=sample result (native)
SA=the spike concentration added to the spiked sample

Completeness

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

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

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

4.3.13 Corrective Actions

Field Activities

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

Documentation of the problem is important to the overall management of the study. A corrective action request (CAR) form for problems associated with sample collection is

completed by the person discovering the QA problem (refer to Form 4-2a). This form identifies the problem, establishes possible causes, and designates the person responsible for action. The responsible person will be either the PM or the FTL.

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

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

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

Laboratory Activities

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

- QC data are outside the warning or acceptable windows for precision and accuracy established for laboratory samples.
- Blanks contain contaminants at concentrations above the levels specified in the laboratory QA plan for any target compound.
- Undesirable trends are detected in matrix spike recoveries or RPD between matrix spike duplicates.
- There are unusual changes in detection limits.
- Deficiencies are detected by the laboratory QA Director during internal or external audits, or from the results of performance evaluation samples.

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

inclusion in the project file if data are affected. Corrective actions may include, but are not limited to, the following:

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

Following the implementation of the required 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's quality assurance plan. CARs will be documented with Form 4-2a.

4.3.14 Quality Assurance Reports

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

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

The final QA report can be attached as an appendix to the Draft ESI Report and may include the following:

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

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

Table 4-1
Data Quality Objectives
Site UXO-04, Knox Trailer Park,
Camp Lejeune, North Carolina

DQO	Problem Statement	Decision Points	Input to Decisions	Study Boundaries	Decision Rules	Acceptable Limits on Decision Errors	Optimized Sampling Design
1.	Have surface soil conditions in the vicinity of Knox Trailer Park/Site UXO-04 been evaluated sufficiently to determine the risk to human health?	Collection of surface soil samples. Compare results from the Phase II surface soil sampling to EPA Region 9 residential PRGs for further assessment. PRGs based on noncarcinogenic effects will be adjusted by dividing by 10.	For the surface soil investigation at Knox Trailer Park, the investigation area will be divided into decision units. Each decision unit will contain five (5) surface soil sampling locations as part of a multi-incremental sampling scheme. These five sampling locations will be composited into one sample that will be sent to the laboratory for all analysis excluding VOC. A discrete sample from the center of each decision unit will be collected for VOC analysis.	Spatial: The Knox Trailer Park investigation area is 133 acres, and will be divided into 268 decision units, each measuring 100 ft x 200 ft. Each decision unit will be investigated individually, see Figure 3-2, for the sample distribution within each decision unit. Temporal: Samples will be collect over a ten day period. Samples will be compared against PRGs and MCB Camp Lejeune background concentrations.	If constituents are detected in surface soils at concentrations above PRGs and background concentrations, further evaluation will be conducted. For noncarcinogenic constituents, target organ evaluations will be made to identify how many constituents affect the same target organ. If the sum of the concentration divided by the PRG for each target organ is below the 1, then further evaluation is not needed and no further action will be required for this decision unit. Carcinogenic constituents will be evaluated to determine if they fall within EPA's acceptable risk range of 10^{-4} to 10^{-6}. If carcinogenic constituents fall within EPA's acceptable range, then further evaluation is not needed and no further action will be required for this decision unit. If constituents cannot be eliminated based on this review of the data, additional investigation will be performed. The decision units with exceedances will be divided in half and re-sampled as before. If exceedences still occur following above evaluation procedure, then a strategy for addressing contaminated surface soil will need to be developed.	Decision errors include inaccurate characterization of surface soil contamination due to lack of PRG or background concentration.	Surface soil samples will be collected over a 133 acre area. To optimize sample collection this area will be divided into 268 decision units and multi-incremental sampling will be used for sample collection of all parameters excluding VOCs. Based on decision rule outcomes, each decision unit may be split in half and multi-incremental sampling employed again to further optimize sample collection and narrow the area of any excavation that may be necessary.
2.	Have subsurface soil conditions in the vicinity of Knox Trailer Park/Site UXO-04 been evaluated sufficiently to determine the risk to human health?	Collection of subsurface soil samples. Compare results from the Phase II subsurface soil sampling to EPA Region 9 residential soil PRGs for further assessment.	For the subsurface soil investigation at Knox Trailer Park, soil samples will be collected via DPT. There will be twenty-four (24) DPT locations for subsurface investigation. A grab sample will be collected from each location and analyzed according to the analyses listed in Table 3-2.	Spatial: Subsurface soil samples will be collected above the water table via DPT in 24 locations throughout Knox Trailer Park, see Figure 1-3. Temporal: Samples will be collect over a ten day period. Samples will be compared against PRGs, and MCB Camp Lejeune background concentrations if available.	If constituents are detected in subsurface soils at concentrations that would warrant concern to human health it will be noted and land use controls will be recommended for residential land use.	Decision errors include inaccurate characterization of surface soil contamination due to lack of PRG or background concentration. Another decision error is insufficient DPT sample locations within the investigation area.	In order to reduce decision errors due to insufficient DPT sample locations, sample results from the Phase II investigation will be considered along with the results from the Phase I investigation for accuracy.

DQO	Problem Statement	Decision Points	Input to Decisions	Study Boundaries	Decision Rules	Acceptable Limits on Decision Errors	Optimized Sampling Design
3	Have sediment conditions in the vicinity of Knox Trailer Park/Site UXO-04 been evaluated sufficiently to determine the risk to human health?	Collection of sediment samples. Compare results from the Phase II sediment sampling to EPA Region 9 residential soil PRGs for further assessment.	For the sediment investigation at Knox Trailer Park, sediment samples will be collected at eight (8) locations. A grab sample will be collected from each location and analyzed according to the analyses listed in Table 3-2.	Spatial: Sediment samples will be from eight (8) locations (3 along the creek to the east and 5 along the New River to the south) adjacent to Knox Trailer Park, see Figure 1-3. Temporal: Samples will be collect over a ten day period and will be compared against PRGs, and MCB Camp Lejeune background concentrations if available.	If constituents are detected in sediment samples at concentrations that would warrant concern to human health, it will be noted.	Decision errors include inaccurate characterization of sediment contamination due to lack of PRG or background concentration. Another decision error is insufficient sediment sample locations within the investigation area.	In order to reduce decision error due to insufficient sediment sample locations, sediment sample locations for the Phase II ESI investigation will be based upon locations that had detections of various constituents at higher concentrations during Phase I of the ESI.
4	Have surface water conditions in the vicinity of Knox Trailer Park/Site UXO-04 been evaluated sufficiently to determine the risk to human health?	Collection of surface water samples. Compare results with results from the Phase II surface water sampling to North Carolina surface water standards and EPA national recommended water quality criteria.	For the surface water investigation at Knox Trailer Park, surface water samples will be collected at eight (8) locations. A grab sample will be collected from each location and analyzed according to the analyses listed in Table 3-2.	Spatial: Surface water samples will be from eight (8) locations (3 along the creek to the east and 5 along the New River to the south) adjacent to Knox Trailer Park, see Figure 1-3. Temporal: Samples will be collect over a ten day period and will be compared against PRGs, and MCB Camp Lejeune background concentrations if available.	If constituents are detected in surface water samples at concentrations that would warrant concern to human health, it will be noted.	Decision errors include inaccurate characterization of surface water contamination due to lack of water quality standards or background concentration. Another decision error is insufficient surface water sample locations within the investigation area.	In order to reduce decision error due to insufficient surface water sample locations, surface water sample locations for the Phase II ESI investigation will be based upon locations that had detections of various constituents at higher concentrations during Phase I of the ESI.
5	Have groundwater conditions in the vicinity of Knox Trailer Park/Site UXO-04 been evaluated sufficiently to determine the risk to human health?	Collection of monitoring well groundwater samples. Collect groundwater elevation data to further understand site hydrology and direction of groundwater flow. Compare results with results from the Phase II groundwater sampling to EPA Region 9 Tap Water PRGs.	For the groundwater investigation at Knox Trailer Park, groundwater samples will be collected at fifteen (15) existing monitoring wells. A grab sample will be collected from each location and analyzed according to the analyses listed in Table 3-2.	Spatial: Groundwater samples will be from fifteen (15) existing monitoring wells (10 shallow and 5 deep) located throughout Knox Trailer Park, see Figure 1-3. Temporal: Samples will be collect over a ten day period and will be compared against PRGs, and MCB Camp Lejeune background concentrations.	If constituents are detected in groundwater samples at concentrations that would warrant concern to human health, it will be noted.	Decision errors include inaccurate characterization of groundwater contamination due to lack of PRG or background concentration.	Samples are collected for purposes of gathering additional information only. No action will be taken based upon the results of the Phase II sampling.

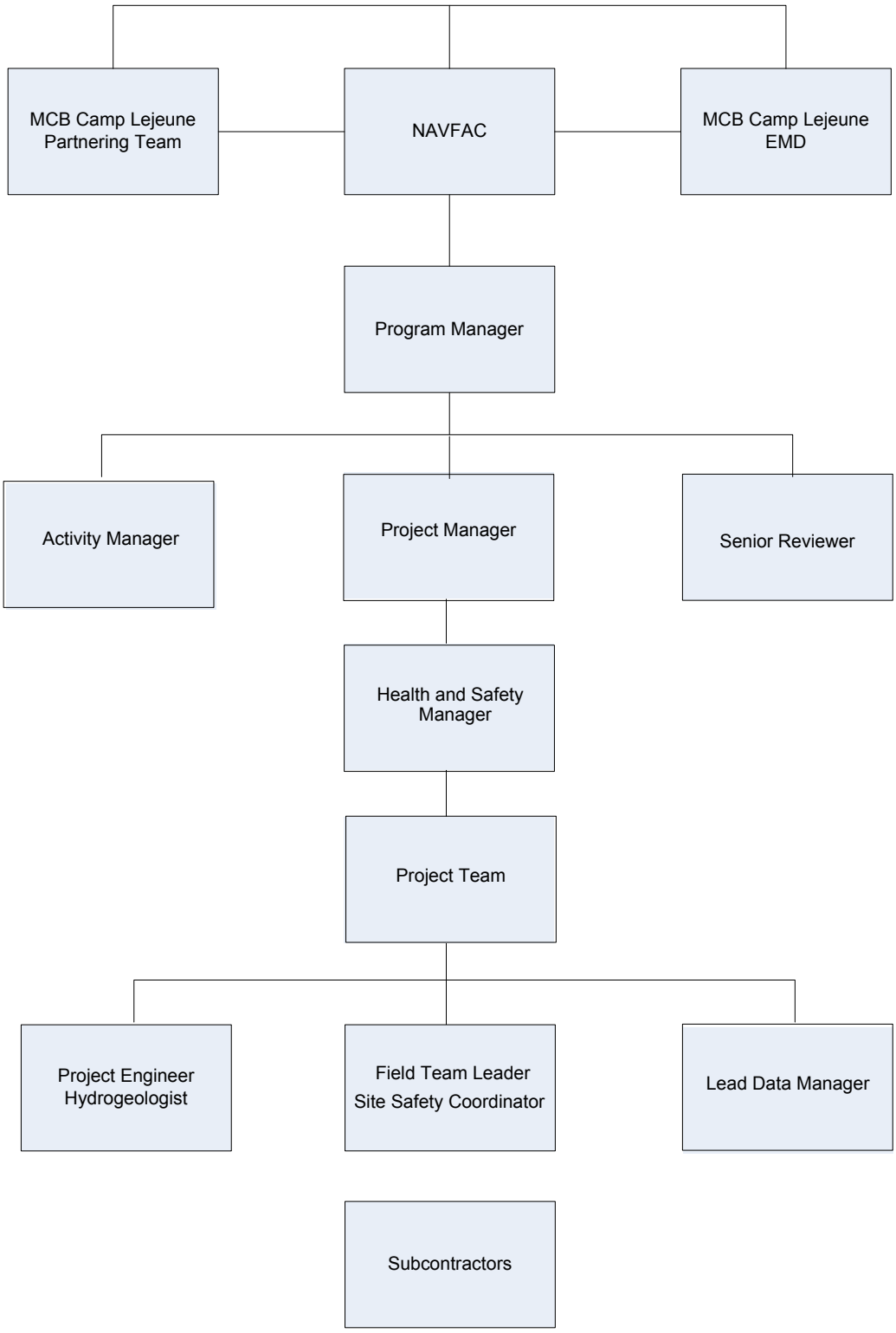

Figure 4-1
Quality Control Project Team Organization Structure
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Form 4-1a: Field Change Documentation

Date: _____

Page _____ **of** _____

Project:

Project No.:

Applicable Document:

Change Description:

Reason for change:

Recommended disposition:

Impact on present and completed work:

Final disposition (MCB Camp Lejeune only)

Request by:

CH2M HILL Project Manager: _____ Date:_____

Approvals:

MCB Camp Lejeune Project Manager: _____ Date:_____

Form 4-2a: Corrective Action Request Form

Originator: _____ Date: _____

Person responsible for replying: _____

Description of problem and when identified: _____

_____

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

State date, person, and action planned:

_____

_____

_____

_____

_____

CA initially approved by: _____ Date: _____

Follow-up date: _____

Final CA approval by: _____ Date: _____

Information copies to:

Responsible person:_____

Field Team Leader:_____

Project Manager: _____

SECTION 5

Environmental Protection Plan

5.1 Regional Ecological Summary

MCB Camp Lejeune is located within the headwaters of the New River watershed. The New River is a slow moving and placid river that was dedicated as a National Scenic River in 1976. The topography along this coastal region is generally flat to gently rolling, which slopes from an altitude of 63 feet above sea level to sea level. Approximately 59 percent of the New River watershed is forested, with croplands and pastures making up 35 percent and the remaining area being considered urban.

This portion of the North Carolina coast is a diverse region containing over 30 miles of sandy beaches which make up a continuously altering coastline. Many areas of the North Carolina coastline are highly erodable because of the sandy substrate and violent currents. These sandy coastlines transition into a region of pines (*Pinus sp*.), scrub oaks (*Quercus sp*.), sweetgum (*Liquidambar styraciflua*), and dogwood (*Cornus sp*.). Bermuda grass (*Cynodon dactylon*) is the primary undergrowth species of the area. These areas are interspersed with bottomland hardwood forests that were once more prevalent in this region. These forest types are dominated by bald cypress (*Taxodium distichum*), and swamp tupelo (*Nyssa sylvatica var. biflora*), with white cedar (*Chamaecyparis thyoides*) being common on organic substrates underlain by sand. Croplands are also common in this area and are predominantly corn, cotton, peanuts, and tobacco.

The climate in Jacksonville, North Carolina, is characterized by short, mild winters and long, hot, humid summers. Average annual net precipitation is approximately 50 inches Ambient air temperatures generally range from 33°F to 53°F in the winter months, and 71°F to 88°F during the summer months.

5.2 Endangered/Threatened Species Within the Project Site

Many protected species have been sited near and on MCB Camp Lejeune such as the American alligator, the Bachmans sparrow, the black skimmer, the green turtle, the loggerhead turtle, the piping plover, the red-cockaded woodpecker, and the rough-leaf loosestrife (North Carolina Ecological Services, 2005). The flora and fauna species that could occur in or adjacent to Camp Lejeune are listed as threatened, endangered, or of special concern by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act of 1973, as amended (refer to **Table 5-1**).

Camp Lejeune has active programs in place to protect the three federally protected avian species (American bald eagle, piping plover, and red cockaded woodpecker) that have been spotted somewhere on the base. Camp Lejeune entered into Section 7 consultation with the USFWS, regarding protection and management of the red-cockaded woodpecker. Camp Lejeune worked with the USFWS to establish guidelines for military training in red-

cockaded woodpecker cluster sites. Additionally, through Section 7 consultation, the Base implemented measures to properly manage the red-cockaded woodpecker habitats located on base (loblolly pine and longleaf and pond pine areas). Camp Lejeune's red-cockaded woodpecker population has been continually monitored since 1985. Reproductive success, population demographics, and habitat use are recorded annually to help successfully manage the population while facilitating the military use of the land.

A bald eagle's nest is documented on Camp Lejeune's property. The nest is located at the junction of Sneads Creek and the New River. Three protective buffers that restrict ground and air-use activities have been established at approximately 750 feet; 1,000 feet; and 1,500 feet from the nest site. The Knox Trailer Park site is not within any of these buffer zones.

Suitable habitat for the piping plover does not exist at the Knox Trailer Park site. The Atlantic Coast populations of piping plovers tend to prefer sandy beaches close to the primary dune of barrier islands and coastlines. They prefer sparsely vegetated open sand, gravel, or cobble for a nest site. They forage along the rack line where the tide washes up onto the beach. As such, it is unlikely that piping plovers are located on or adjacent to the Knox Trailer Park site. Because the Knox Trailer Park site is not located along the Atlantic Ocean coastline, piping plovers are not expected to be present at the site for any reason (e.g., feeding, breeding, and nesting).

The Knox Trailer Park site is approximately 12.5 miles from the Atlantic coast, and as such all of the federally protected marine species (e.g., green sea turtle, leatherback sea turtle, loggerhead sea turtle, and West Indian manatee) listed in **Table 5-1** are unlikely to have access to the site.

The eastern cougar is the only federally listed mammal species that could be in Onslow County. Suitable habitat for the eastern cougar does not exist at the Knox Trailer Park site. Although the eastern cougar does not generally have a preference for specific habitat types, it needs a large wilderness area with an adequate food supply. Cougars feed primarily on deer, but their diet may also include small mammals, wild turkeys, and occasionally domestic livestock, when available. It is unlikely that Camp Lejeune, particularly the area around Knox Trailer Park site, would not be expected to provide adequate food supply. As an active military installation, Camp Lejeune, including the Knox Trailer Park site, does not provide the large wilderness area the eastern cougar requires.

Two of the four federally listed plant species have been identified on the base: rough-leaved loosestrife and seabeach amaranth. Approximately 22 rough-leaved loosestrife sites are found on Camp Lejeune with 76 acres buffered and marked to protect this species. Rough-leaved loosestrife sites are visited annually to visually inspect for changes in extent and apparent health. Approximately half of the rough-leaved loosestrife sites occur within protected red-cockaded woodpecker sites, obviating the need for marking each of these sites individually. This significantly lessens the amount of encumbered area by restrictions involving the plants. The other sites, mostly falling within the Greater Sandy Run Area are marked with white paint around a perimeter that extends 100 feet from the outermost individuals. None of these sites are located on or adjacent to the Knox Trailer Park site.

The second federally listed plant species identified on the base, seabeach amaranth, is an annual and has been described as a dune-builder because it frequently occupies areas seaward of primary dunes often growing closer to the high tide line than any other coastal plant. As such, this plant is generally found along Onslow Beach and thus is not located on or adjacent to the Knox Trailer Park site. Management of seabeach amaranth by staff at MCB Camp Lejeune consists of annual surveys from late June through the growing season. Once identified, seabeach amaranth sites are marked with signs to prevent traffic from harming the plants. The plants are also monitored for webworm herbivory or other causes of mortality.

No adverse impacts to listed species are expected to result from the proposed work at the Knox Trailer Park site. Project design features have been developed to prevent impacts to listed species.

5.3 Wetlands Within the Project Site

No wetlands are known to be located in the project site. Therefore, no direct impacts to wetlands will result from the project. Soil disturbance and subsequent erosion from stormwater runoff could impact wetlands downstream of the site. If the screening of soils upslope of the two tributaries draining the site is necessary, silt fencing will be erected to protect the streams and downstream areas from potential sedimentation impacts from stormwater runoff. Following screening, slopes above the channels that would be subject to rill or gully erosion will be stabilized with coir fabric to minimize the potential for erosion until revegetation. No wetlands on or downstream of the Knox Trailer Park site are expected to be impacted by the project.

5.4 Cultural and Archaeological Resources Within the Project Site

Based on available data, the probability that significant cultural or archaeological resources are located within the project area is low. If any new cultural or archaeological materials or resources are discovered within the project area, a qualified archaeologist will be notified to provide guidance on performing further work in the area.

5.5 Water Resources Within the Project Site

As shown in **Figures 1-1** and **1-2**, the Knox Trailer Park site is bordered by the Northeast Creek to the south, a small branch of the Northeast Creek to the east, and Scales Creek to the west. Based on a review of available maps, no water resources are located within the project area. Any activities required along the tributaries will be limited to manual labor with hand implements to minimize soil disturbance. If the screening of soils adjacent or upslope from the water bodies is necessary, silt fencing will be erected to protect the surface waters from potential sedimentation impacts from stormwater runoff. Following screening, slopes above the channels that would be subject to rill or gully erosion will be stabilized with coir fabric to minimize the potential for erosion until re-vegetation. No water resources are expected to be impacted by the project.

5.6 Coastal Zones Within the Project Site

The site is located approximately 12.5 miles from Onslow Beach along the Atlantic coast. No coastal zones are designated in the site area.

5.7 Trees and Shrubs to be Removed Within the Project Site

Site vegetation has been removed from approximately 76 acres of the 134-acre site in order to facilitate the geophysical mapping. Note that the site would be cleared for the anticipated construction and land development.

The vegetation was mulched and left in place. Trees greater than 4 inches in diameter were not removed unless absolutely necessary. The base was required to coordinate with the Environmental Management Division office to identify any federally protected species or archeological sites that may be encountered during the contractor's work. Any federally listed plant species identified were left in place.

5.8 Existing Waste Disposal Sites Within the Project Site

No waste disposal sites are present in the Knox Trailer Park site.

5.9 Compliance with Applicable or Relevant and Appropriate Requirements

CH2M HILL will follow all ARARs concerning environmental protection, pollution control, and abatement for the proposed project work. No permits have been determined to be required for the proposed work. **Table 5-2** lists the ARARs for environmental protection.

5.10 Detailed Procedures and Methods to Protect and/or Mitigate the Resources/Sites Identified

Prior to initiation of the proposed work, a general survey of the project area will be conducted by a qualified ecologist to identify any obvious environmental concerns. The ecologist, in conjunction with the PM, will provide instructions to field personnel regarding the protection of onsite environmental resources. Such protective measures will include, but are not limited to, the following:

- Avoid contact with any federally protected plant that is found within the project area. Flag specimens within the project area for easy relocation and verification. Color photos of rough-leaved loosestrife and seabeach amaranth will be available at the site.
- Any MEC found within or near a wetland will be identified, avoided, and reported to the Navy's EOD team (or equivalent) with only minor and temporary disturbance of wetland soils, vegetation, or hydrology.

- If any cultural or archaeological material or resource is discovered within the project area, a qualified archaeologist will be notified to provide guidance on performing further work in the area.
- Any MEC found in the immediate vicinity of a water body will be identified, avoided, and reported to EOD or equivalent with only minor and temporary disturbance of the resource.

The PM will seek the guidance of the qualified ecologist to determine appropriate mitigation measures in the event that the performed work activities impact any environmental resource.

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by USFWS
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Scientific Name	Common Name	Federal Status	Habitat
Chelonia mydas	Green sea turtle	T	Green turtles are generally found in fairly shallow waters (except when migrating) inside reefs, bays, and inlets. The turtles are attracted to lagoons and shoals with an abundance of marine grass and algae. Open beaches with a sloping platform and minimal disturbance are required for nesting.
Caretta caretta	Loggerhead sea turtle	T	The loggerhead is widely distributed within its range. It may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers.
Dermochelys coriacea	Leatherback sea turtle	E	An open ocean species, it sometimes moves into shallow bays, estuaries and even river mouths.
Trichechus manatus	West Indian Manatee	E	Manatees inhabit both salt and fresh water of sufficient depth (1.5 meters to usually less than 6 meters) throughout their range.
Alligator mississippiensis	American alligator	T(S/A)	rivers, swamps, estuaries, lakes, and marshes
Charadrius melodus	piping plover	T	Open, sandy beaches close to the primary dune of the barrier islands and coastlines of the Atlantic for breeding. They prefer sparsely vegetated open sand, gravel, or cobble for a nest site. They forage along the rack line where the tide washes up onto the beach.
Aimophila aestivalis	Bachman's sparrow	FSC	
Haliaetus leucocephalus	American bald eagle	T	A single bald eagle's nest is found on Camp Lejeune- at the junction of Sneads Creek and the New River near the back gate. Three protective buffers have been established at approximately 750, 1,000, and 1,500 feet from the nest site.
Laterallus jamaicensis	Black rail	FSC	

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by USFWS
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Scientific Name	Common Name	Federal Status	Habitat
Rana capito capito	Carolina gopher frog	FSC	
Puma concolor couguar	Eastern cougar	E	No preference for specific habitat types has been noted. The primary need is apparently for a large wilderness area with an adequate food supply. Male cougars of other subspecies have been observed to occupy a range of 25 or more square miles, and females from 5 to 20 square miles.
Passerina ciris ciris	Eastern painted bunting	FSC*	
Ammodramus henslowii	Eastern Henslow's sparrow	FSC	
Ophisaurus mimicus	Mimic glass lizard	FSC	
Picoides borealis	Red-cockaded Woodpecker	E	For nesting/roosting habitat, open stands of pine containing trees 60 years old and older. Red-cockaded woodpeckers need live, large older pines in which to excavate their cavities. Longleaf pines (*Pinus palustris*) are most commonly used, but other species of southern pine are also acceptable. Dense stands (stands that are primarily hardwoods, or that have a dense hardwood understory) are avoided. Foraging habitat is provided in pine and pine hardwood stands 30 years old or older with foraging preference for pine trees 10 inches or larger in diameter. In good, moderately-stocked, pine habitat, sufficient foraging substrate can be provided on 80 to 125 acres.
Heterodon simus	Southern hognose snake	FSC	
Procambarus plumimanus	Croatan crayfish	FSC	
Isoetes microvela	A quillwort	FSC	
Rhexia aristosa	Awned meadowbeauty	FSC	
Lobelia boykinii	Boykin's lobelia	FSC	
Tofieldia glabra	Carolina asphodel	FSC	
Solidago pulchra	Carolina goldenrod	FSC	
Parnassia caroliniana	Carolina grass-of-parnassus	FSC	
Asplenium heteroresiliens	Carolina spleenwort	FSC	

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by USFWS
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Scientific Name	Common Name	Federal Status	Habitat
Carex chapmanii	Chapman's sedge	FSC	
Rhynchospora pleiantha	Coastal beaksedge	FSC	
Solidago villosicarpa	Coastal Goldenrod	FSC	
Thalictrum cooleyi	Cooley's meadowrue	E	Cooley's meadowrue occurs in moist to wet bogs and savannahs. It grows along fireplow lines, roadside ditches, woodland clearings, and power line rights-of-way, and needs some type of disturbance to maintain its open habitat.
Carex lutea	Golden sedge	E	Biologists have located golden sedge in only eight locations, all in coastal savannas in Onslow and Pender counties that are underlain by calcareous, or chalk, deposits.
Dichanthelium sp.	Hirst's panic grass	FSC	
Myriophyllum laxum	Loose watermilfoil	FSC	
Calopogon multiflorus	Many-flower grass-pink	FSC	
Litsea aestivalis	Pondspice	FSC	
Lysimachia asperulaefolia	Rough-leaved loosestrife	E	Species generally occurs in the ecotones or edges between longleaf pine uplands and pond pine pocosins (areas of dense shrub and vine growth usually on a wet, peaty, poorly drained soil) (Barry 1980), on moist to seasonally saturated sands and on shallow organic soils overlaying sand. Rough-leaved loosestrife (RLL) has also been found on deep peat in the low shrub community of large Carolina bays (shallow, elliptical, poorly drained depressions of unknown origin) (Matthews et al., 1980). RLL habitat is marked in the same way of red-cockaded woodpecker (RCW) habitat- single bands of white paint on the trees surrounding the plant site. The marked area indicates a 100-foot buffer zone around the outermost plants. Within the marked area, vehicular traffic, excavation, and the cutting or damaging of pine trees is prohibited. Pedestrian traffic is allowed. While the vast majority of RLL sites are found within protected RCW areas, several stand-alone sites occur in the Greater Sandy Run Area.
Amaranthus pumilus	Seabeach amaranth	T	Seabeach amaranth occurs on barrier island beaches.
Solidago verna	Spring-flowering goldenrod	FSC	

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by USFWS
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Scientific Name	Common Name	Federal Status	Habitat
Rhynchospora thornei	Thorne's beaksedge	FSC	
Dionea muscipula	Venus flytrap	FSC	

E = Endangered—A taxon in danger of extinction throughout all or a significant portion of its range.
T = Threatened—A taxon likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
FSC = Federal species of special concern—species may or may not be listed in the future.
T(S/A)—Threatened because of similarity of appearance (e.g., American alligator)--a species that is threatened because of its similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation.
*Historic record—the species was last observed in the county more than 50 years ago.

TABLE 5-2
Applicable or Relevant and Appropriate Requirements for Environmental Protection
Site UXO-04, Knox Trailer Park
Camp Lejeune, North Carolina

Reference	Title
Federal Requirements	
33 USC 1251, et seq.	Clean Water Act
33 USC 403	Rivers and Harbors Act of 1899
16 USC 1531 et seq., per 50 CFR 402	Endangered Species Act
16 USC 703, et seq.	Migratory Bird Treaty Act
16 USC 470	National Historic Preservation Act of 1966
16 USC 469, et seq., and 36 CFR 65	National Archaeological and Historic Preservation Act
40 CFR 130 A Part II	Solid Waste Rules
State Requirements	
15A NCAC 7H	Guidelines for areas of environmental concern
GS 113-331 to 133-337	North Carolina Endangered Species Act
15A NCAC 13A .0100 - .0119	NC Hazardous Waste Rules

USC = U.S. Code

CFR = Code of Federal Regulations

NCAC = North Carolina Administrative Code

SECTION 6

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Appendix A
Health and Safety Plan

CH2M HILL HEALTH AND SAFETY PLAN

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

Project Information and Description

PROJECT NO: 360362

CLIENT: Navy

PROJECT/SITE NAME: CLEAN III CTO-191 / MCB Camp Lejeune, Knox Park Trailer Site

SITE ADDRESS: Jacksonville, North Carolina

CH2M HILL PROJECT MANAGER: Bill Waldron//RDU (INC)

CH2M HILL OFFICE: Raleigh

DATE HEALTH AND SAFETY PLAN PREPARED: 7/30/2007

DATE(S) OF SITE WORK: August 2007 through January 2008

SITE ACCESS: Refer to attached Figure 1-3. Access to all sites is restricted. 'Main-Side" sites, e.g. Hadnot Point Industrial Area Sites 78, 88, and 94, etc. may be accessed through the Main Gate or the Piney Green Road Gate (contractors entrance) on the east side of the New River, while sites located within the Marine Corps Air Station (MCAS) New River, e.g. Sites 35, 86, 89, and 93 should be accessed via the MCAS New River Gate located west of the New River

SITE SIZE: MCB, Camp Lejeune is approximately 236 square miles. Knox Park Trailer site is approximately 144 acres.

SITE TOPOGRAPHY: The site is mostly forested with some mowed areas within the remaining trailer park.

PREVAILING WEATHER: The climate at MCB, Camp Lejeune is characterized by mild winters and hot humid summers. Winters are usually short and mild with occasional and short duration cold periods. Summers are long, hot and humid. Average annual net precipitation is approximately 50 inches. Ambient air temperatures generally range from 33 to 53 degrees Fahrenheit (°F) in the winter months, and 71°F to 88°F during the summer months. Winds are generally south-southwesterly in the summer, and north-northwesterly in the winter (Water and Air Research, 1983). The hurricane season in the immediate area surrounding Camp Lejeune begins on June 1 and continues through November 30. Storms of non-tropical origins such as frontal passages, local thunderstorms, and tornadoes are more frequent and can occur year-round.

SITE DESCRIPTION AND HISTORY: Construction of MCB, Camp Lejeune began in 1941 with the objective of developing the "World's Most Complete Amphibious Training Base". Construction of the Base started at Hadnot Point where the major functions of the Base are centered. During World War II, MCB, Camp Lejeune was used as a training area to prepare Marines for combat. MCB, Camp Lejeune was again used for training during the Korean and Vietnam conflicts, and the Gulf War. MCB, Camp Lejeune is host to five Marine Corps commands and one Navy command. In addition, MCB Camp Lejeune provides support and training for the following tenet commands: Headquarters Nucleus; Second Marine Expeditionary Force; Second Marine Division; Second Marine Force Service Support Group; Second Marine Surveillance, Reconnaissance, and Intelligence Group; Sixth Marine Expeditionary Brigade; the Naval Hospital; and the Naval Dental Clinic. All of the real estate and infrastructure are owned, operated, and maintained by the host command. The mission of Camp Lejeune is to maintain combat ready units for expeditionary deployment.

MCB, Camp Lejeune is bisected by the New River, which flows in a southeasterly direction and forms a large estuary before entering the Atlantic Ocean. The Atlantic Ocean forms the southeastern boundary of the facility. The western and northwester boundaries are U.S. Route 17 and State Route 24, respectively. The City of Jacksonville, North Carolina is located immediately northwest of MCB, Camp Lejeune.

A majority of the land surrounding the facility is used for agriculture. Estuaries along the coast support commercial fishing and residential resort areas are located adjacent to MCB, Camp Lejeune along the Atlantic Ocean.

The Knox Park Trailer site (refer to attached Figure 1-3) was identified as a former hand grenade training range by the HQ Marine 2002 Range report. Records indicate the potential presence of hand grenades.

DESCRIPTION OF SPECIFIC TASKS TO BE PERFORMED:

- Oversight of surveying and utility location;
- Collection of Direct-Push Technology (DPT) soil samples from up to 24 locations;
- Collection of sediment samples from up to 8 locations;
- Collection of surface soil samples from up to 270 locations;
- Collection of groundwater samples from 15 existing groundwater monitoring wells; and
- Collection of surface water samples from 8 locations.

Site Map

This page is reserved for a Site Map.

(refer to Figure 1-3)

Table of Contents

1 Tasks to be Performed Under this Plan

1.1 Description of Tasks

(Reference Field Project Start-up Form)

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

1.1.1 Hazwoper-Regulated Tasks

- Test pit excavation
- Drilling
- Geoprobe boring
- Groundwater monitoring
- Sediment sampling
- Surface Water Sampling
- Surface soil sampling
- Hand auguring
- Surveying
- Investigation-derived waste (drum) sampling and disposal
- Observation of material loading for offsite disposal
- Oversight of remediation and construction
-

1.1.2 Non-Hazwoper-Regulated Tasks

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

1.2 Task Hazard Analysis

(Refer to Section 2 for hazard controls)

POTENTIAL HAZARDS	TASKS									
	Test pit/ excavation	Drilling, geoprobe, and well installation & abandonment	Groundwater monitoring, aquifer testing		Surface water and sediment sampling from the shore or water	Hand augering	Surveying	IDW drum sampling and disposal	Observation of loading material for offsite disposal	Remediation & construction oversight
Flying debris/objects	X	X			X	X		X	X	X
Noise > 85dBA	X	X							X	X
Electrical	X	X	X							X
Suspended loads	X	X							X	X
Buried utilities, drums, tanks	X	X				X				X
Slip, trip, fall	X	X	X		X	X	X	X	X	X
Back injury	X	X	X		X	X		X		X
Confined space entry	X						X			X
Trenches / excavations	X									X
Visible lightning	X	X	X		X	X	X	X	X	X
Vehicle traffic									X	X
Elevated work areas/falls	X				X					X
Fires	X	X			X			X		X
Entanglement		X				X				
Drilling		X								
Heavy equipment	X	X							X	X
Working near water					X					
IDW Drum Sampling								X		

2 Hazard Controls

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

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

2.1 Project-Specific Hazards

2.1.1 Arsenic

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Avoid skin and eye contact with liquid and particulate arsenic or arsenic trichloride.
- Arsenic is considered a “Confirmed Human Carcinogen.”
- Arsenic particulates (inorganic metal dust) are odorless. Vapor and gaseous odor varies depending upon specific organic arsenic compound.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

2.1.2 Benzene

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Skin absorption is a potential route of benzene exposure.
- Benzene is considered a “Confirmed Human Carcinogen.”
- A Short Term Exposure Limit (STEL: 15 minutes) exists for this material.
- Benzene has an aromatic odor.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

2.1.3 Cold Stress

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

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

- NSC Guidelines for Work and Warm-Up Schedules can be used with the wind-chill index to estimate work and warm-up schedules for fieldwork. The guidelines are not absolute; workers should be monitored for symptoms of cold-related illnesses. If symptoms are not observed, the work duration can be increased.
- Persons who experience initial signs of immersion foot, frostbite, hypothermia should consult the SSC/DSC to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast – be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

2.1.4 Heat Stress

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

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°F to 60°F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SSC/DSC to avoid progression of heat-related illness.

2.1.5 Drilling

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

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

2.1.6 Earthmoving Equipment

(Reference CH2M HILL SOP HS-27, *Earthmoving Equipment*)

- Only authorized personnel are permitted to operate earthmoving equipment.
- Maintain safe distance from operating equipment and stay alert of equipment movement. Avoid positioning between fixed objects and operating equipment and equipment pinch points, remain outside of the equipment swing and turning radius. Pay attention to backup alarms, but not rely on them for protection. Never turn your back on operating equipment.
- Approach operating equipment only after receiving the operator's attention. The operator shall acknowledge your presence and stop movement of the equipment. Caution shall be used when standing next to idle

equipment; when equipment is placed in gear it can lurch forward or backward. Never approach operating equipment from the side or rear where the operator's vision is compromised.
- When required to work in proximity to operating equipment, wear high-visibility vests to increase visibility to equipment operators. For work performed after daylight hours, vests shall be made of reflective material or include a reflective stripe or panel.
- Do not ride on earthmoving equipment unless it is specifically designed to accommodate passengers. Only ride in seats that are provided for transportation and that are equipped with seat belts.
- Stay as clear as possible of all hoisting operations. Loads shall not be hoisted overhead of personnel.
- Earthmoving equipment shall not be used to lift or lower personnel.
- 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.

2.1.7 IDW Drum Sampling

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

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

2.2 General Hazards

2.2.1 General Practices and Housekeeping

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

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

2.2.2 Hazard Communication

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

The SSC is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M HILL using Attachment 2.
- Confirm that an inventory of chemicals brought on site by CH2M HILL subcontractors is available.

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

2.2.3 Shipping and Transportation of Chemical Products

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

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

2.2.4 Lifting

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

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

2.2.5 Fire Prevention

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

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet. Extinguishers must:
  - be maintained in a fully charged and operable condition,
  - be visually inspected each month, and
  - undergo a maintenance check each year.
- The area in front of extinguishers must be kept clear.
- Post "Exit" signs over exiting doors, and post "Fire Extinguisher" signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.
- Flammable/combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.

2.2.6 Electrical

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

- Only qualified personnel are permitted to work on unprotected energized electrical systems.
- Only authorized personnel are permitted to enter high-voltage areas.
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service.
- All temporary wiring, including extension cords and electrical power tools, must have ground fault circuit interrupters (GFCIs) installed.
- Extension cords must be:

  - equipped with third-wire grounding.
  - covered, elevated, or protected from damage when passing through work areas.
  - protected from pinching if routed through doorways.
  - not fastened with staples, hung from nails, or suspended with wire.
- Electrical power tools and equipment must be effectively grounded or double-insulated UL approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet from overhead power lines for voltages of 50 kV or less, and 10 feet plus ½ inch for every 1 kV over 50 kV.
- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage.
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

2.2.7 Stairways and Ladders

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

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

2.2.8 Heat Stress

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

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50^{o}F to 60^{o}F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.

- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SSC/DSC to avoid progression of heat-related illness.

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

Monitoring Heat Stress

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

2.2.9 Cold Stress

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

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

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

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

2.2.10 Compressed Gas Cylinders

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

2.2.11 Procedures for Locating Buried Utilities

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted. 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 to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include:

- **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.

Procedure

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

- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions.
- The survey contractor shall employ the same geophysical techniques used on the project to identify the buried utilities, to survey the proposed path of subsurface construction work to confirm no buried utilities are present.
- Identify customer specific permit and/or procedural requirements for excavation and drilling activities. For military installations contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.
- Contact utility companies or the state/regional utility protection service at least two (2) working days prior to excavation 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.
- Schedule the independent survey.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances are to be in writing, signed by the party conducting the clearance.
- Underground utility locations must be physically verified by hand digging using wood or fiberglass-handled tools when any adjacent subsurface construction activity (e.g. mechanical drilling, excavating) work is expected to come within 5 feet of the marked underground system. If subsurface construction activity is within 5 feet and parallel to a marked existing utility, the utility location must be exposed and verified by hand digging every 100 feet.
- 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.
- Conduct a site briefing for employees 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).

2.2.12 Confined Space Entry

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

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

2.3 Biological Hazards and Controls

2.3.1 Snakes

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

2.3.2 Poison Ivy and Poison Sumac

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

2.3.3 Ticks

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

If bitten by a tick, grasp it at the point of attachment and carefully remove it. After removing the tick, wash your hands and disinfect and press the bite areas. Save the removed tick. Report the bite to human resources. Look for symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme: a rash might appear that looks like a bullseye with a small welt in the center. RMSF: a rash of red spots under the skin 3 to 10 days after the tick bite. In both cases, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, seek medical attention.

2.3.4 Bees and Other Stinging Insects

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

2.3.5 Bloodborne Pathogens

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

Exposure to bloodborne pathogens may occur when rendering first aid or CPR, or when coming into contact with landfill waste or waste streams containing potentially infectious material. Exposure controls and personal protective

equipment (PPE) are required as specified in CH2M HILL SOP HS-36, *Bloodborne Pathogens*. Hepatitis B vaccination must be offered before the person participates in a task where exposure is a possibility.

2.3.6 Other Anticipated Biological Hazards

None Anticipated

2.4 Radiological Hazards and Controls

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

Hazards	Controls
None Known	None Required

2.5 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Arsenic	GW: SB: SS:	0.01 mg/m^3	5 Ca	Ulceration of nasal septum, respiratory irritation, dermatitis, gastrointestinal disturbances, peripheral neuropathy, hyperpigmentation	NA
Benzene	GW: SB: SS:	1 ppm	500 Ca	Eye, nose, skin, and respiratory irritation; headache; nausea; dermatitis; fatigue; giddiness; staggered gait; bone marrow depression	9.24
2-Butanone (Methyl Ethyl Ketone, MEK)	GW: SB: SS:	200 ppm	3,000	Eye, skin, and nose irritation; headache; dizziness; vomiting; dermatitis	9.54
Cadmium	GW: SB: SS:	0.005 mg/m^3	9 Ca	Pulmonary edema, coughing, chest tightness/pain, headache, chills, muscle aches, nausea, vomiting, diarrhea, difficulty breathing, loss of sense of smell, emphysema, mild anemia	NA
Carbon Tetrachloride	GW: SB: SS:	2 ppm	200 Ca	Central nervous system (CNS) depression, nausea, vomiting, eye and skin irritation, liver and kidney injury, drowsiness, dizziness	11.47
Chlordane	GW: SB: SS:	0.5 mg/m^3	100 Ca	Blurred vision, confusion, ataxia, delirium, coughing, abdominal pain, nausea, vomiting, diarrhea, irritability, tremors anuria	UK
Chlorobenzene	GW: SB: SS:	10 ppm	1,000	Skin, eye, and nose irritation; drowsiness; uncoordination; CNS depression	9.07
Chloroform	GW: SB: SS:	2 ppm	500 Ca	Dizziness, mental dullness, nausea, confusion, disorientation, headache, fatigue, eye and skin irritation, anesthesia, enlarged liver	11.42
Chromium (as Cr(II) & Cr(III))	GW: SB: SS:	0.5 mg/m^3	25	Irritated eyes, sensitization dermatitis, histologic fibrosis of lungs	NA
Chromium (hexavalent)	GW: SB: SS:	0.01 mg/m^3	15 Ca	Irritated respiratory system, nasal septum perforation, liver and kidney damage, leucytosis, leupen, monocytosis, eosinophilla, eye injury, conjunctivitis, skin ulcer, sensitization dermatitis	NA
Cobalt (Metal, Dusts, and Fumes)	GW: SB: SS:	0.05 mg/m^3	20	Coughing, difficulty breathing, wheezing, decreased pulmonary function, diffuse nodule fibrosous, dermatitis, respiratory hypersensitivity, asthma	NA
Cresol (all isomers of 2-, 3-, & 4-methylphenol)	GW: SB: SS:	5 ppm	250	Eye, skin, and mucous membrane irritant; CNS effects including confusion, depression, and respiratory failure; difficulty breathing; irregular rapid respiration; weak pulse; eye and skin burns; dermatitis; lung, liver, kidney, and pancreas damage	8.98

2.5 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
DDT	GW: SB: SS:	0.5 mg/m^3	500 Ca	Paresthesia of tongue, lips, hand, and face; tremors; dizziness; confusion; headache; fatigue; convulsion; eye and skin irritation; vomiting	UK
Dibutylphthalate (DBP)	GW: SB: SS:	5 mg/m^3	4,000	Eye, upper respiratory system, and stomach irritant	UK
o-Dichlorobenzene (1,2-Dichlorobenzene)	GW: SB: SS:	25 ppm	200	Nose and eye irritation, liver and kidney damage, skin blisters	9.06
p-Dichlorobenzene (1,4-Dichlorobenzene)	GW: SB: SS:	10 ppm	150 Ca	Headache, eye irritation, nausea, vomiting, swelling periorbital, profus rhinitis, jaundice, cirrhosis	8.98
1,1-Dichloroethane	GW: SB: SS:	100 ppm	3,000	CNS depression, skin irritation; liver, kidney, and lung damage	11.06
1,2-Dichloroethane (Ethylene Dichloride)	GW: SB: SS:	1 ppm	50 Ca	CNS depression, nausea, vomiting, dermatitis, eye irritation, liver, kidney, and CNS damage; corneal opacity	11.05
Bis-(2-ethylhexyl)phthalate (DEHP, DOP)	GW: SB: SS:	5 mg/m^3	5,000 Ca	Eye and mucous membrane irritant	UK
Endosulfan	GW: SB: SS:	0.1 mg/m^3	NL	Irritated skin, nausea, confusion, agitation, flushing, dry mouth, tremor, convulsion, headache	UK
Ethyl Benzene	GW: SB: SS:	100 ppm	800	Eye, skin, and mucous membrane irritation; headache; dermatitis; narcotic; coma	8.76
Lead	GW: SB: SS:	0.05 mg/m^3	100	Weakness lassitude, facial pallor, pal eye, weight loss, malnutrition, abdominal pain, constipation, anemia, gingival lead line, tremors, paralysis of wrist and ankles, encephalopathy, kidney disease, irritated eyes, hypertension	NA
Mercury	GW: SB: SS:	0.05 mg/m^3	10	Skin and eye irritation, cough, chest pain, difficult breathing, bronchitis, pneumontitis, tremors, insomnia, irritability, indecision, headache, fatigue, weakness, GI disturbance	

2.5 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)
Naphthalene	GW: SB: SS:	10 ppm	250	Eye irritation, headache, confusion, excitement, nausea, vomiting, abdominal pain, bladder irritation, profuse sweating, dermatitis, corneal damage, optical neuritis	8.12
PCBs (Limits as Aroclor 1254)	GW: SB: SS:	0.5 mg/m^3	5 Ca	Eye and skin irritation, acne-form dermatitis, liver damage, reproductive effects	UK
PNAs (Limits as Coal Tar Pitch)	GW: SB: SS:	02 mg/m^3	80 Ca	Dermatitis and bronchitis	UK
1,1,2,2-Tetrachloroethane (Tetrachlorethane)	GW: SB: SS:	1 ppm	100 Ca	Nausea, vomiting, abdominal pain, finger tremors, jaundice, hepatitis, liver tenderness, monocytosis, kidney damage, dermatitis	11.10
Tetrachloroethylene (PCE)	GW: SB: SS:	25 ppm	150 Ca	Eye, nose, and throat irritation; nausea; flushed face and neck; vertigo; dizziness; sleepiness; skin redness; headache; liver damage	9.32
1,1,2-Trichloroethane	GW: SB: SS:	10 ppm	100 Ca	Eye and nose irritation, CNS depression, liver damage, dermatitis	11.00
Trichloroethylene (TCE)	GW: SB: SS:	50 ppm	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	9.45
Toluene	GW: SB: SS:	50 ppm	500	Eye and nose irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, excessive tearing, nervousness, muscle fatigue, paresthesia, dermatitis, liver and kidney damage	8.82
Xylenes	GW: SB: SS:	100 ppm	900	Irritated eyes, skin, nose, and throat; dizziness; excitement; drowsiness; incoherence; staggering gait; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; dermatitis	8.56
Vinyl Chloride	GW: SB: SS:	1 ppm	NL Ca	Weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities	9.99
Vinylidene Chloride (1,1-dichloroethylene)	GW: SB: SS:	1 ppm	NL Ca	Eye, skin, and throat irritation; dizziness; headache; nausea; difficult breathing; liver and kidney dysfunction; pneumonitis	10.0

2.5 Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum[a] Concentration (ppm)	Exposure Limit[b]	IDLH[c]	Symptoms and Effects of Exposure	PIP[d] (eV)

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.

2.6 Potential Routes of Exposure

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

3 Project Organization and Personnel

3.1 CH2M HILL Employee Medical Surveillance and Training

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

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

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

Employee Name	Office	Responsibility	SSC/FA-CPR
Erin Must	RDU	Field Team Leader	Level D SC-HW: FA-CPR
Jonathan Burton	CLT	Site Safety Coordinator	Level D SC-HW: FA-CPR

3.2 Field Team Chain of Command and Communication Procedures

3.2.1 Client

Client Contact
Daniel Hood, PE
NAVFAC Atlantic
Code: OPCEV
6506 Hampton Blvd
Norfolk, Virginia 23508-1278
757-322-4630
757-322-4805 fax
daniel.r.hood@navy.mil

Base Contact
Robert Lowder
Camp Lejeune - EMD
Building 12
Marine Corps Base
Camp Lejeune, NC 28542-0004
(910) 451-9607
(910) 451-5997
robert.a.lowder@usmc.mil

3.2.2 CH2M HILL

Project Manager: Waldron, Bill/RDU
Health and Safety Manager: Michael Goldman/ATL
Field Team Leader: TBD
Site Safety Coordinator: TBD

The SSC is responsible for contacting the Field Team Leader and Project Manager. In general, the Project Manager will contact the client. The Health and Safety Manager should be contacted as appropriate.

3.2.3 CH2M HILL Subcontractors

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

Subcontractor: To be determined
Subcontractor Contact Name:
Telephone:

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

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

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

- Brief subcontractors on the provisions of this plan, and require them to sign the Employee Signoff Form included in Attachment 1.
- Request subcontractor(s) to brief the project team on the hazards and precautions related to their work.
- When apparent non-compliance/unsafe conditions or practices are observed, notify the subcontractor safety representative and require corrective action – the subcontractor is responsible for determining and implementing necessary controls and corrective actions.
- When repeat non-compliance/unsafe conditions are observed, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented.
- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented. Notify the Project Manager and HSM as appropriate.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

3.2.4 Contractors

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

Contractor: To be determined
Contractor Contact Name:
Telephone:

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

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

- Request the contractor to brief CH2M HILL employees and subcontractors on the precautions related to the contractor's work.

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

4 Personal Protective Equipment (PPE)

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

PPE Specifications [a]

Level		Head	Respirator [b]
General site entry Surveying Observation of material loading for offsite disposal Oversight of remediation and construction	D	Work clothes; steel-toe, leather work boots; work glove.	Hardhat [c] Safety glasses Ear protection [d]	None required
Sediment sampling Surface soil sampling Hand augering Geoprobe boring	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 hazardous materials.

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

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

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

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

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

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

5 Air Monitoring/Sampling

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

5.1 Air Monitoring Specifications

Instrument	Tasks	Action Levels[a]		Frequency [b]	Calibration
FID: OVA model 128 or equivalent	Geoprobe sampling. Monitoring well drilling and sampling. Sediment sampling Water level monitoring of wells Groundwater sampling activities. IDW drum sampling	<1 ppm 1 to 10 ppm >10 ppm	Level D Level C Evacuate work area and contact HSM	Initially and periodically during task	Daily
PID: OVM with 10.6eV lamp or equivalent		<1 ppm 1 to 10 ppm >10 ppm	Level D Level C Evacuate work area and contact HSM	Initially and periodically during task	Daily
CGI: MSA model 260 or 261 or equivalent		0-10% : 10-25% LEL: >25% LEL:	No explosion hazard Potential explosion hazard Explosion hazard; evacuate or vent	Continuous during advancement of boring or trench	Daily
O_2Meter: MSA model 260 or 261 or equivalent		>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 SSC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., "Breathing Zone/MW-3", "at surface/SB-2", etc.).

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

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

[e] Noise monitoring and audiometric testing also required.

5.2 Calibration Specifications

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

Instrument	Gas	Span	Reading	Method
PID: OVM, 10.6 or 11.8 eV bulb	100 ppm isobutylene	RF = 1.0	100 ppm	1.5 lpm reg T-tubing
PID: MiniRAE, 10.6 eV bulb	100 ppm isobutylene	CF = 100	100 ppm	1.5 lpm reg T-tubing
PID: TVA 1000	100 ppm isobutylene	CF = 1.0	100 ppm	1.5 lpm reg T-tubing
FID: OVA	100 ppm methane	3.0 $\pm$ 1.5	100 ppm	1.5 lpm reg T-tubing
FID: TVA 1000	100 ppm methane	NA	100 ppm	2.5 lpm reg T-tubing
Dust Monitor: Miniram-PDM3	Dust-free air	Not applicable	0.00 mg/m^3 in "Measure" mode	Dust-free area OR Z-bag with HEPA filter
CGI: MSA 260, 261, 360, or 361	0.75% pentane	N/A	50% LEL $\pm$ 5% LEL	1.5 lpm reg direct tubing

5.3 Air Sampling

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

Method Description

Additional air monitoring is not required at this time.

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
Other: Dan Young/NVR

6 Decontamination

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

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

6.1 Decontamination Specifications

Personnel

- Boot wash/rinse
- Glove wash/rinse
- Outer-glove removal
- Body-suit removal
- Inner-glove removal
- Respirator removal
- Hand wash/rinse
- Face wash/rinse
- Shower ASAP
- Dispose of PPE in municipal trash, or contain for disposal
- Dispose of personnel rinse water to facility or sanitary sewer, or contain for offsite disposal

Sample Equipment

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

Heavy Equipment

- Power wash
- Steam clean
- Dispose of equipment rinse water to facility or sanitary sewer, or contain for offsite disposal

6.2 Diagram of Personnel-Decontamination Line

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

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

7 Spill-Containment Procedures

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

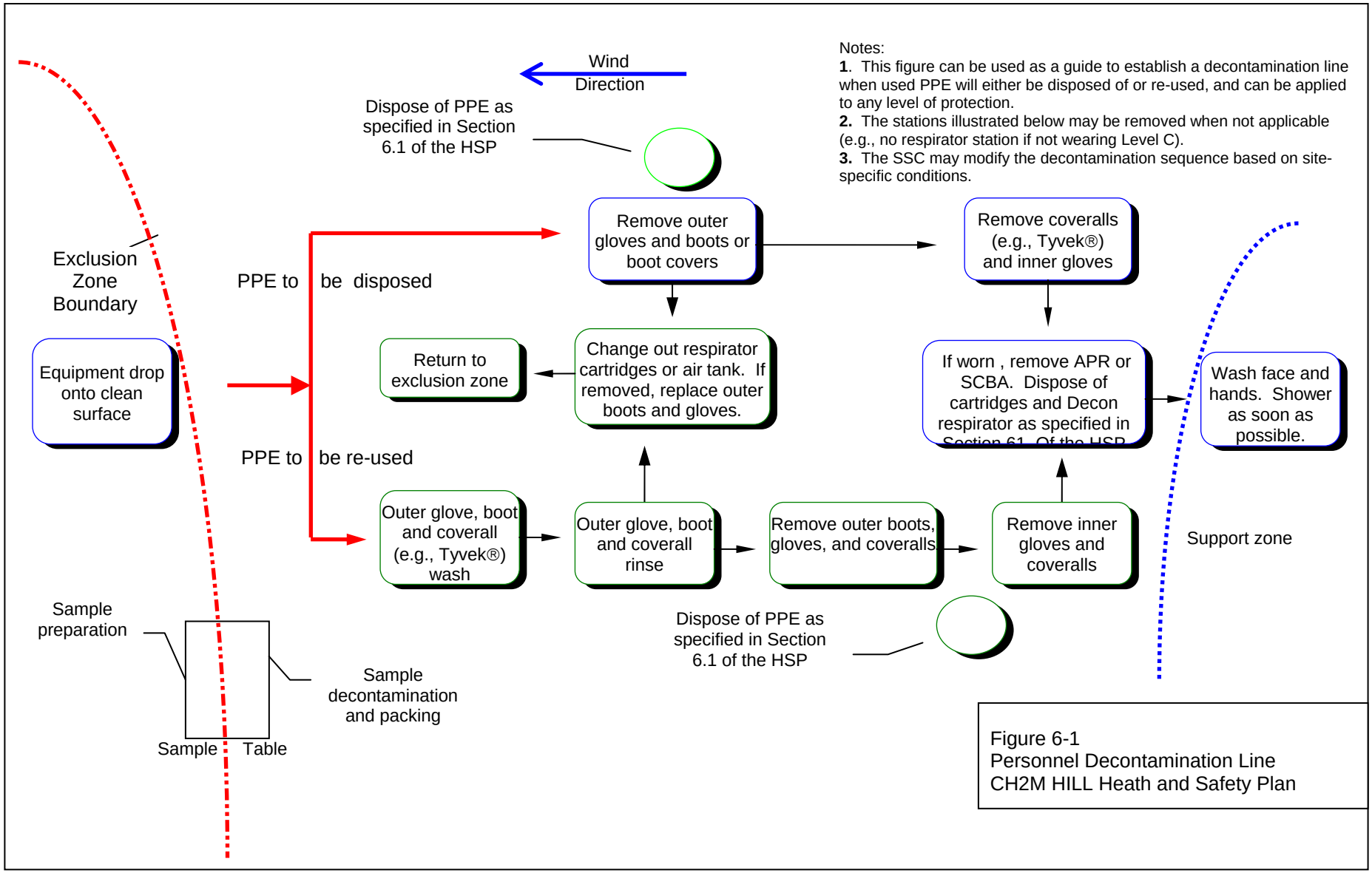


Figure 6-1
Personnel Decontamination Line
CH2M HILL Heath and Safety Plan

8 Site-Control Plan

8.1 Site-Control Procedures

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

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

8.2 Hazwoper Compliance Plan

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

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

- In many cases, air sampling, in addition to real-time monitoring, must confirm that there is no exposure to gases or vapors before non-Hazwoper-trained personnel are allowed on the site, or while non-Hazwoper-trained staff are working in proximity to Hazwoper activities. Other data (e.g., soil) also must document that there is no potential for exposure. The HSM must approve the interpretation of these data. Refer to subsections 2.5 and 5.3 for contaminant data and air sampling requirements, respectively.
- When non-Hazwoper-trained personnel are at risk of exposure, the SSC must post the exclusion zone and inform non-Hazwoper-trained personnel of the:
  - nature of the existing contamination and its locations
  - limitations of their access
  - emergency action plan for the site
- Periodic air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-Hazwoper-trained personnel (e.g., in an adjacent area) are not exposed to airborne contaminants.
- When exposure is possible, non-Hazwoper-trained personnel must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.
- Remediation treatment system start-ups: Once a treatment system begins to pump and treat contaminated media, the site is, for the purposes of applying the Hazwoper standard, considered a treatment, storage, and disposal facility (TSDF). Therefore, once the system begins operation, only Hazwoper-trained personnel (minimum of 24 hour of training) will be permitted to enter the site. All non-Hazwoper-trained personnel must not enter the TSDF area of the site.

9 Emergency Response Plan

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

9.1 Pre-Emergency Planning

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

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

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

9.2 Emergency Equipment and Supplies

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

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

9.3 Incident Response

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

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

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

9.4 Emergency Medical Treatment

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

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

9.5 Evacuation

- Evacuation routes and assembly areas (and alternative routes and assembly areas) are specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the SSC before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The SSC and a "buddy" will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The SSC will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).
- The SSC will write up the incident as soon as possible after it occurs and submit a report to the Corporate Director of Health and Safety.

9.6 Evacuation Signals

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

9.7 Incident Notification and Reporting

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

10 Approval

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

10.1 Original Plan

Written By: **Jonathan Burton/CLT** **Date: 07/30/07**

Approved By: Michael Goldman CIH, CSP, CHMM **Date: August 13, 2007**

10.2 Revisions

Revisions Made By: **Date:**

Revisions to Plan:

Revisions Approved By: **Date:**

From: Goldman, Michael/ATL
Sent: Monday, August 13, 2007 9:07 PM
To: Burton, Jonathan/CLT
Cc: Wheelus, Vanessa/ATL
Subject: RE: MCB C. Lejeune - Knox Park - HSP

Jonathan

Please find the approved plan attached. Call me with any questions.

Thanks

MG

From: Burton, Jonathan/CLT
Sent: Monday, July 30, 2007 3:23 PM
To: Goldman, Michael/ATL
Subject: MCB C. Lejeune - Knox Park - HSP

Mike,

Please review and approve the attached Health and Safety Plan for environmental assessment activities at Knox Trailer Park, MCB Camp Lejeune. Site activities for this investigation include: DPT soil sampling, groundwater sampling, sediment sampling, and surface soil sampling.

pn = 360362.pp.wp

Thanks,

Jonathan Burton
Staff Engineer
CH2M HILL
4824 Parkway Plaza Blvd. Ste. 200
Charlotte, NC 28217
Direct – 704.329.0073 x 216
Fax – 704.329.0141
www.ch2mhill.com

Solutions Without Boundaries

11 Attachments

Attachment 1: **Employee Signoff Form – Field Safety Instructions**
Attachment 2: **Project-Specific Chemical Product Hazard Communication Form**
Attachment 3: **Chemical-Specific Training Form**
Attachment 4: **Emergency Contacts**
Attachment 5: **Project H&S Forms/Permits**
Attachment 6: **Project Activity Self-Assessment Checklists**
Attachment 7: **Applicable Material Safety Data Sheets**

CH2MHILL

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

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

Project Name: CLEAN III CTO-191 / MCB Camp Lejeune, Knox Park Trailer Site **Project Number:** 360362

EMPLOYEE NAME (Please print)	EMPLOYEE SIGNATURE	COMPANY	DATE

Project-Specific Chemical Product Hazard Communication Form

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

Project Name: CLEAN III CTO-191 / MCB Camp Lejeune, Knox Park Trailer Site **Project Number:** 360362

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

Hazardous Chemical Products Inventory

Chemical	Quantity	Location	MSDS Available	Container labels	
				Identity	Hazard
Methane	1 liter, compressed	Support Zone			
Isobutylene	1 liter, compressed	Support Zone			
Pentane	1 liter, compressed	Support Zone			
Hydrochloric acid	< 500 ml	Support Zone / sample bottles			
Nitric acid	< 500 ml	Support Zone / sample bottles			
Sulfuric Acid	< 500 ml	Support Zone / sample bottles			
Sodium hydroxide	< 500 ml	Support Zone / sample bottles			
Methanol	< 1 Gallon	Support/Decon Zones			
Hexane	< 1 Gallon	Support/Decon Zones			
pH buffers	< 500 ml	Support Zone			
MSA Sanitizer	< 1 liter	Support/Decon Zones			
Alconox/Liquinox	< 1liter	Support/Decon Zones			

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

CH2MHILL

CHEMICAL-SPECIFIC TRAINING FORM

Location:	Project # : 360362
HCC:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

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

☐ Physical and health hazards

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

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

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

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

EMERGENCY CONTACTS

If an injury occurs, notify the injured person's personnel office as soon as possible after obtaining medical attention for the injured person. Notification MUST be made within 24 hours of the injury.

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
(800) 756-1130
(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) 452-1111

Security & Police – 911 or
Base Security #: (910) 451-2555

Corporate Director Health and Safety
Name: Mollie Netherland/SEA
Phone: (206) 453-5005

On-Scene Coordinator
Name: Fire Chief
Phone: (910) 451-5815

Environmental Management Division (EMD)
Names: Bob Lowder
Phone: (910) 451-9607

Utilities Emergency
Water:
Gas: Contact Base EMD
Electric:

Health and Safety Manager (HSM)
Name: Michael Goldman/ATL
Phone: (770) 604-9182 x 396
Cell: 770/331-3127

Designated Safety Coordinator (DSC) see Site-Specific HASP
Name: Bill Waldron
Phone: (919) 875-4311 x 34

Regional Human Resources Department
Name: Carol Miscoe/SAN
Phone: (210) 377-3085 x 291

Project Manager see Site-Specific HASP
Name:
Phone:

Corporate Human Resources Department
Name: Pete Hannon/DEN
Phone: (303) 886-1229

Federal Express Dangerous Goods Shipping
Phone: (800) 238-5355

CH2M HILL Emergency Number for Shipping Dangerous Goods
Phone: (800) 255-3924

Worker's Compensation and Auto Claims
Zurich Insurance Company
Phone: (800) 382-2150

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

Nearest On-Base hospital:
Base Naval Hospital (only to be used in extreme emergency)
Building NH100
100 Brewster Blvd.
Camp Lejeune, NC 28547
Phone: (910) 451-4840, (910) 451-4841, (910) 451-4842

Local hospital:
Onslow County Memorial Hospital
317 Western Boulevard
Jacksonville, NC 28546
Phone: (910) 577-2240

Local ambulance service:
Base Ambulance: (910) 451-3004, (910) 451-3005
Public Ambulance: (910) 451-9111

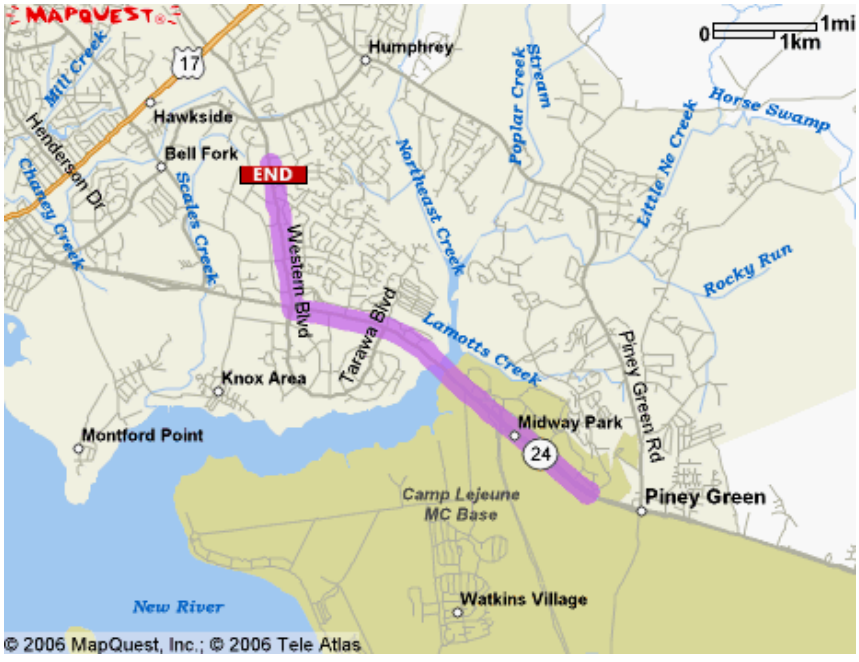
From MCB Camp Lejeune

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

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

Directions to Onslow County Memorial Hospital :

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



CH2M HILL HEALTH AND SAFETY PLAN

Attachment 5

Project H&S Forms and Permits

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 6

Project Activity Self-Assessment Checklists

CH2MHILL

H&S Self-Assessment Checklist - DRILLING

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

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

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

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

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to drilling hazards
☐ Evaluate a CH2M HILL subcontractor's compliance with drilling H&S requirements
Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HS-35.

SECTION 1	Yes	No	N/A	N/O
PERSONNEL SAFE WORK PRACTICES (3.1)				
1. Only authorized personnel operating drill rig	☐	☐	☐	☐
2. Personnel cleared during rig startup	☐	☐	☐	☐
3. Personnel clear of rotating parts	☐	☐	☐	☐
4. Personnel not positioned under hoisted loads	☐	☐	☐	☐
5. Loose clothing and jewelry removed	☐	☐	☐	☐
6. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐
7. Smoking is prohibited around drilling operation	☐	☐	☐	☐
8. Personnel wearing appropriate PPE, per HSP/FSI	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (3.2.1)				
9. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
10. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
DRILL RIG PLACEMENT (3.2.2)				
11. Location of underground utilities identified	☐	☐	☐	☐
12. Safe clearance distance maintained from overhead powerlines	☐	☐	☐	☐
13. Drilling pad established, when necessary	☐	☐	☐	☐
14. Drill rig leveled and stabilized	☐	☐	☐	☐
DRILL RIG TRAVEL (3.2.3)				
15. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
16. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
17. Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
18. Safe clearance distance maintained while traveling under overhead powerlines	☐	☐	☐	☐
19. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
DRILL RIG OPERATION (3.2.4)				
20. Kill switch clearly identified and operational	☐	☐	☐	☐
21. All machine guards are in place	☐	☐	☐	☐
22. Rig ropes not wrapped around body parts	☐	☐	☐	☐
23. Pressurized lines and hoses secured from whipping hazards	☐	☐	☐	☐
24. Drill operation stopped during inclement weather	☐	☐	☐	☐
25. Air monitoring conducted per HSP/FSI for hazardous atmospheres	☐	☐	☐	☐
26. Rig placed in neutral when operator not at controls	☐	☐	☐	☐
DRILL RIG MAINTENANCE (3.2.5)				
27. Defective components repaired immediately	☐	☐	☐	☐
28. Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
29. Cathead in clean, sound condition	☐	☐	☐	☐
30. Drill rig ropes in clean, sound condition	☐	☐	☐	☐
31. Fall protection used for fall exposures of 6 feet or greater	☐	☐	☐	☐
32. Rig in neutral and augers stopped rotating before cleaning	☐	☐	☐	☐
33. Good housekeeping maintained on and around rig	☐	☐	☐	☐
DRILLING AT HAZARDOUS WASTE SITES (3.2.6)				
34. Waste disposed of according to HSP	☐	☐	☐	☐
35. Appropriate decontamination procedures being followed, per HSP	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked “No” in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

CH2MHILL

H&S Self-Assessment Checklist - EARTHMOVING EQUIPMENT

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

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

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

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

Project Name: _____ Project No.: _____

Location: _____ PM: _____

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to earthmoving equipment hazards
☐ Evaluate a CH2M HILL subcontractor's compliance with earthmoving equipment H&S requirements
Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the earthmoving equipment subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HS-27.

SECTION 1	Yes	No	N/A	N/O
PERSONNEL SAFE WORK PRACTICES (3.1)				
1. Only authorized personnel operating earthmoving equipment	☐	☐	☐	☐
2. Personnel maintaining safe distance from operating equipment	☐	☐	☐	☐
3. Personnel and equipment operator in close communication when personnel must be in proximity of operating equipment	☐	☐	☐	☐
4. Personnel approach operating equipment safely	☐	☐	☐	☐
5. Personnel wearing high-visibility and/or reflective vests when close to operating equipment	☐	☐	☐	☐
6. Personnel riding only in seats of equipment cab and using seat belts	☐	☐	☐	☐
7. Personnel not positioned under hoisted loads	☐	☐	☐	☐
8. Personnel not hoisted by equipment	☐	☐	☐	☐
9. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐
10. Personnel wearing appropriate PPE, per HSP/FSI	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (3.2.1)				
11. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
12. Daily inspection of equipment and equipment accessories conducted before use	☐	☐	☐	☐
13. At least one fire extinguisher available at the equipment operating area	☐	☐	☐	☐
EARTHMOVING EQUIPMENT COMPONENTS (3.2.2)				
14. Backup alarm or spotter used when backing equipment	☐	☐	☐	☐
15. Operational horn provided on bi-directional equipment	☐	☐	☐	☐
16. Seat belts are provided and used	☐	☐	☐	☐
17. Rollover protective structures (ROPS) provided	☐	☐	☐	☐
18. Braking system capable of stopping full payload	☐	☐	☐	☐
19. Headlights and taillights operable when additional light required	☐	☐	☐	☐
20. Brake lights in operable condition	☐	☐	☐	☐
21. Cab glass provides no visible distortion to the operator	☐	☐	☐	☐
22. Hauling equipment (dump trucks) provided with cab shield or canopy	☐	☐	☐	☐
23. Dump truck beds provided with positive means of support during maintenance or inspection	☐	☐	☐	☐
24. Dump truck operating levers provided with latch to prevent accidental dumping	☐	☐	☐	☐
EARTHMOVING EQUIPMENT PLACEMENT (3.2.3)				
25. Location of underground utilities identified	☐	☐	☐	☐
26. Safe clearance distance maintained while working under overhead powerlines	☐	☐	☐	☐
27. Safe distance is maintained while traveling under powerlines	☐	☐	☐	☐
28. Unattended equipment visibly marked at night	☐	☐	☐	☐
29. Parking brake set when equipment parked and equipment chocked when parked on incline	☐	☐	☐	☐
EARTHMOVING EQUIPMENT OPERATION (3.2.4)				
30. Equipment operated on safe roadways and grades	☐	☐	☐	☐
31. Equipment operated at safe speed	☐	☐	☐	☐
32. Equipment not operated during inclement weather, lightning storms	☐	☐	☐	☐
33. Using equipment to lift loads, other than earth, done according to equipment manufacturer specifications	☐	☐	☐	☐
34. Lifting and hauling capacities are not exceeded	☐	☐	☐	☐
35. Equipment components lowered when not in use	☐	☐	☐	☐
36. All machine guards are in place	☐	☐	☐	☐
37. Air monitoring conducted per HSP/FSI for hazardous atmospheres	☐	☐	☐	☐
EARTHMOVING EQUIPMENT MAINTENANCE (3.2.5)				
38. Defective components repaired immediately	☐	☐	☐	☐
39. Suspended equipment or equipment parts are supported prior to work under or between	☐	☐	☐	☐
40. Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
41. Tires on split rims removed using safety tire rack or cage	☐	☐	☐	☐
42. Good housekeeping maintained on and around equipment	☐	☐	☐	☐
EXCAVATING AT HAZARDOUS WASTE SITES (3.2.6)				
43. Waste disposed of according to HSP	☐	☐	☐	☐
44. Appropriate decontamination procedures being followed, per HSP	☐	☐	☐	☐

<u>SECTION 3</u>

Complete this section for all items checked "No" in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 7

Applicable Material Safety Data Sheets

Appendix B
Standard Operating Procedures

STANDARD OPERATING PROCEDURE

Sediment Sampling

I. Purpose

These general outlines describe the collection and handling of sediment samples during field operations.

II. Scope

The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Operators manual , if available, should be consulted for specific details

III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device)
- Stainless steel spoon or spatula for media transfer
- Measuring tape
- Log book
- Personal protection equipment (rubber or latex gloves, boots, hip waders, etc.)
- Materials for classifying soils, particularly the percentage of fines
- Sample jars, including jars for Total Organic Carbon and pH, as appropriate

IV. Procedures and Guidelines

1. Field personnel will start downstream and work upstream to prevent contamination of unsampled areas. In surface water bodies that are tidally influenced, sampling will be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants. Sediment sampling activities will not occur immediately after periods of heavy rainfall.
2. Make a sketch of the sample area that shows important nearby river features and permanent structures that can be used to locate the sample points on a map. Whenever possible, include measured distances from such identifying features. Also include depth and width of waterway, rate of flow, type and consistency of sediment, and point and depth of sample removal (along shore, mid-channel, etc).

3. Transfer sample into appropriate sample jars with a stainless steel utensil. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. The fine particles have a higher adsorption capacity than larger particles. Minimize the amount of water that is collected within the sample matrix. Decant the water off of the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment since gloves may introduce organic interference into the sample. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.

4. Samples for volatile organics should immediately be placed in jars. Rocks and other debris should be removed before placement in jars.

5. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loss silt and muck) which can make wading difficult.

6. Sample sediment for TOC and pH also, to give context to organic and inorganic data during the risk assessment.

7. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.

8. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

V. Attachments

None.

VI. Key Checks and Items

- Start downstream, work upstream.
- Log exact locations using permanent features.
- Beware of hidden hazards.

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 – C.8

Homogenization of Soil and Sediment Samples

I. Purpose

The homogenization of soil and sediment samples is performed to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample.

II. Scope

Standard techniques for soil and sediment homogenization and equipment are provided in this SOP. These procedures do not apply to aliquots collected for VOCs or field GC screening; samples for these analyses should NOT be homogenized.

III. Equipment and Materials

Sample containers, stainless steel spoons or spatulas, and stainless steel pans.

IV. Procedures and Guidelines

Soil and sediment samples to be analyzed for explosives residues, semivolatiles, pesticides, PCBs, metals, cyanide, or perchlorate should be homogenized in the field. After a sample is taken, a stainless steel spatula should be used to remove the sample from the split spoon or other sampling device. The sampler should not use fingers to do this, as gloves may introduce organic interferences into the sample.

If samples for VOCs are collected, they should be taken immediately upon opening the spoon and should not be homogenized.

The sample should be placed in a decontaminated stainless steel pan and thoroughly mixed using a stainless steel spoon. The soil or sediment material in the pan should be scraped from the sides, corners, and bottom, rolled into the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled to the center of the pan and mixed with the entire sample again.

All stainless steel spoons, spatulas, and pans must be decontaminated following procedures specified in the appropriate SOP prior to homogenizing the sample. A composite equipment rinse blank of homogenization equipment should be taken each day it is used.

V. Attachments

None.

VI. Key Checks and Items

- Take VOC samples immediately and do not homogenize the soil.
- Homogenize soil for analyses other than VOCs in a clean, stainless steel bowl.

STANDARD OPERATING PROCEDURE

Direct-Push Soil Sample Collection

I. Purpose

To provide a general guideline for the collection of soil samples using direct-push (e.g., Geoprobe®) sampling methods.

II. Scope

Standard direct-push (e.g., Geoprobe®) soil sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Sampling rods
- Sampling tubes and acetate liners (if desired)
- Pre-cleaned sample containers and stainless-steel sampling implements
- Clean latex or surgical gloves.

IV. Procedures and Guidelines

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*.

2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.

3. Remove the rods and sampling tube from the borehole and remove the sample from the tube.

4. Fill all sample containers, beginning with the containers for VOC analysis, using a decontaminated or dedicated sampling implement.

5. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP *Decontamination of Personnel and Equipment*.

6. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.

2. Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.

3. Verify that the borehole made during sampling activities has been properly backfilled.

STANDARD OPERATING PROCEDURE

Surface Water Sampling

I. Purpose and Scope

This procedure presents the techniques used in collecting surface water samples. Materials, equipment, and procedures may vary; refer to the Field Sampling Plan and operators manuals for specific details.

II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the Field Sampling Plan should be consulted for project-specific details. Typical equipment required includes:

- Open tube sampler
- Dip sampler
- Weighted bottle sampler
- Hand pump
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Sample containers
- Meters for specific conductance, temperature, pH, and dissolved oxygen

III. Procedures and Guidelines

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in SOP *Decontamination of Personnel and Equipment*. Surface water samples collected from water bodies tidally influenced should be collected at low tide and under low flow conditions to minimize the dilution of potential contaminants. Methods for surface water sample collection are described below.

A. Manual Sampling

Surface water samples are collected manually by submerging a clean glass, stainless steel, or Teflon container into the water body. Samples may be collected at depth with a covered bottle that can be removed with a tripline. The most common sampler types are beakers, sealable bottles and jars, pond samplers, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the sampler assembly.

Specific types of weighted bottle samplers include dissolved oxygen, Kemmerer, or Van Dorn, and are acceptable in most instances.

A sample is taken with the following specific steps:

1. The location and desired depth for water sampling are selected.
2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle.
3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.
4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time.
5. Measure dissolved oxygen, specific conductance, temperature, and pH at the sampling location.

IV. Attachments

None.

V. Key Checks and Items

- Start downstream, work upstream
- Log exact locations using permanent features
- Beware of hidden hazards