Final

Work Plan for the Expanded Site Investigation Site UXO-04, Knox Trailer Park

Marine Corps Base Camp Lejeune Jacksonville, North Carolina

Contract Task Order 0109

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Prepared for

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Prepared by

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Acronyms and Abbreviations

°F	degrees Fahrenheit
AM	Activity Manager
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CADD	computer-aided drafting and design
CAP	corrective action plan
CAR	Corrective Action Request
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	characteristic leaching procedure
COC	chain-of-custody
CTO	contract task order
DENR	Department of Environment and Natural Resources
DFOW	definable feature of work
DGM	digital geophysical mapping
DGPS	differential global positioning system
DP	direct push
DQO	data quality objective
EOD	explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
ESI	Expanded Site Investigation
ESRI	Environmental Systems Research Institute, Inc.
ESS	explosives safety submission
FTL	Field Team Leader
GIP	Geophysical Investigation Plan
GIS	geographical information system
GPO	geophysical prove-out
HSM	Health and Safety Manager
HSP	Health and Safety Plan
HTW	hazardous or toxic waste
IDW	investigation-derived waste
IRP	Installation Restoration Program
LANTDIV	Atlantic Division
LDM	Lead Data Manager

MCB	Marine Corps Base
MEC	munitions and explosives of concern
MPPEH	material potentially presenting an explosive hazard
MR	munitions response
MRP	Munitions Response Program
MRSIMS	Munitions Response Site Information Management System
MS/MSD	matrix spike/matrix spike duplicate
MTBE	methyl tertiary butyl ether
NAIP	natural attenuation indicator parameter
NAVFAC	Naval Facilities Engineering Command
NCAC	North Carolina Administrative Code
PARCC	precision, accuracy, representativeness, comparability, and completeness
PC	project chemist
PCB	polychlorinated biphenyls
PDF	Portable Document Format
PM	Project Manager
PPV	public–private venture
PQL	practical quantification limit
QA	quality assurance
QACM	Quality Assurance Control Manager
QA/QC	quality assurance/quality control
QC	quality control
QCP	Quality Control Plan
RI	remedial investigation
RPD	relative percent difference
RTK	real-time kinematic
RTL	Review Team Leader
SOP	standard operating procedure
SSC	Site Safety Coordinator
SU	standard unit
SUXOS	Senior UXO Supervisor
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TOC	total organic carbon
TOX	total organic halogens
TRPH	total recoverable hydrocarbons
USA	USA Environmental, Inc.
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
UXOQCS	UXO QC Specialist
VOC	volatile organic compound

SECTION 1

Introduction

CH2M HILL is conducting an Expanded Site Investigation (ESI) at the Knox Trailer Park, Navy Munitions Response Program (MRP) Site UXO-04, located at Marine Corps Base (MCB) Camp Lejeune, in Jacksonville, North Carolina. The ESI 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 109 (CTO-109) of Contract No. N62470-02-D-3052.

1.1 Background and Project Objectives

Approximately 133 acres of land surrounding and including the current Knox Trailer Park has been targeted for a public–private venture (PPV) residential-housing development. Due to historical activities at the site (refer to Section 1.3), an ESI is being conducted to accomplish the following objectives:

1. Identify historical activities at the project area that may have resulted in environmental contamination with munitions of explosive concern (MEC) or hazardous or toxic waste (HTW)
2. Identify the presence and nature of any HTW contamination that may exist in the project area
3. Evaluate the nature, number, and density of anomalies that could potentially represent subsurface MEC, and provide geophysical data for future MEC intrusive investigations or removal actions

1.2 Work Plan Scope and Organization

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

- Conduct an archival records search to interview current and former installation personnel
- Conduct a field investigation for HTW contamination by installing groundwater monitoring wells and sampling and analyzing groundwater, soil, surface water, and sediment
- Perform digital geophysical mapping (DGM) of the entire 133-acre PPV area
- Prepare an ESI Report

This work plan is divided into sections providing information on the detailed approach, including procedures to be employed during the execution of the project. Appendices 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, summarizes the history of the site, 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 ESI project
- **Section 3, Field Investigation Plan,** identifies the technical approach, methods, and operational procedures that will be used to execute the field investigation activities, including mobilization and demobilization, land surveying, vegetation clearing, monitoring well installation, sampling of environmental media, and DGM
- **Section 4, Quality Control Plan (QCP),** provides details of the approach, methods, and operational procedures to be employed for quality control (QC) of the ESI at Knox Trailer Park
- **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 at the Knox Trailer Park, Site UXO-04
- **Section 6, References,** lists the references cited in the preceding sections.
- **Appendix A, Archival Records Search,** presents the results of the records search and personnel interviews that were conducted to identify historical activities that may have resulted in environmental contamination of the project area with MEC or HTW. Appendix A also includes historical photographs obtained for this ESI
- **Appendix B, Health and Safety Plan (HSP),** provides an interface with CH2M HILL's overall health and safety program and with the draft MCB Camp Lejeune Master Health and Safety Plan (CH2M HILL, June 2004). The HSP also includes the MEC avoidance procedures that will be used to ensure that onsite personnel are protected from MEC that may be present at the site
- **Appendix C, Geophysical Investigation Plan (GIP)**, details the approach, methods, and operational procedures that will be used in performing geophysical investigations at the site. The Geophysical Prove-Out (GPO) Plan is part of the GIP

Additionally, an explosives safety submission (ESS) waiver request has been submitted to NAVFAC LANTDIV for review and approval by the Naval Ordnance Safety and Security Activity.

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.

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 planned PPV development consists of approximately 133 acres in the northern portion of MCB Camp Lejeune (Figure 1-1). The Northeast River defines the southern boundary, Scales Creek flows near the northwestern boundary, and an unnamed tributary flows near the northeastern boundary. The planned PPV development is accessible by Florence Road from the west and Camp Knox Road from the north.

The existing Knox Trailer Park covers approximately 38 acres of the planned PPV. The trailer park property is level and vegetated with grass and minimal tree cover. Residential leases are not being renewed as they expire, and most of the mobile home tracts are now vacant. A network of narrow roadways covers the trailer park (Figure 1-2). All utilities, including telephone, cable, water, electricity, and sewers, are buried and are assumed to be intact.

The remaining area of the planned PPV development consists of approximately 95 acres of woodland that surrounds the Knox Trailer Park to the north, east, and west. The density of undergrowth in the wooded area is light to moderate.

1.4 Site 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 centered on Hadnot Point, where the major functions of the Base are located. 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, as well as the Gulf War. MCB Camp Lejeune hosts 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 MCB Camp Lejeune is to maintain combat-ready units for expeditionary deployment.

The Knox Trailer Park area began as a Civilian Conservation Corps Camp in 1941. Camp personnel assisted with road work, forestry, and other phases of developing the land into a modern military post (Carraway, 1946). Another 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 (Kimball, 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 TNT to simulate battlefield conditions (Marine Devil Dogs!, 2005). The dogs and handlers were exposed to explosives typically found in a combat environment on a weekly basis. 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. Most of the testing occurred at the Naval Medical Field Research Laboratory (NMFRL), though some research facilities were located at Camp Knox (now the Knox Trailer Park area). 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 ft. 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 (Lt. Col. L. Kimball (Ret.), personal communication, August 10, 2005). Testing and development continued at the NMFRL 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 EOD technician, Mr. Don Cifelli, 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 (D. Cifelli, personal communication, March 2005). 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 recalls it being located off the main road leading to the trailer park (personal communications, August 15 and 18, 2005). Mr. Cifelli also recalls responding to up to three additional discoveries of practice grenades during intrusive activities in the area.

The archival records search (refer to Appendix A) indicated that Area A essentially surrounded, but did not include, the Knox Trailer Park (U.S. Army Corps of Engineers, 2001). According to base personnel, this area was never a live fire range for grenades or any other munitions (Lowder, 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 (Lt. Col. L. Kimball, personal communication, August 10, 2005). No previous Navy Installation Restoration Program (IRP) investigations have been conducted at the Knox Trailer Park nor 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 2002 Range Inventory Report.

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 fuze, whereas the MK-IIA1 grenades were equipped with a M10A3 fuze. Specifications state that each unit was filled with 2 oz. of flaked or granular 2,4,6-trinitrotoluene (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 explosive ordnance disposal (EOD) team, and no UXO was discovered (Gunnery Sgt. G. McGurty, personal communication, July 22, 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 (D. Richardson, personal communication, August 3, 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).

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 Geology and Hydrogeology

Site-specific geologic information is not available for the immediate vicinity of the Knox Trailer Park, although the regional geology at MCB Camp Lejeune is discussed in the Draft MCB Camp Lejeune Master Project Plans (CH2M HILL, June 2004) (referred to herein as the master plans).

The land surface at MCB Camp Lejeune has been alternately exposed and submerged over time by water and marine deposits from an ancient inland sea. These deposits were laid down to form the weakly dissected alluvial plane. The deposits are mostly sands layered with clay and marine shells. Elevations range from 0 feet above sea level at the waterways to 72 feet above sea level between the New River and U.S. Route 17. MCB Camp Lejeune consists of both broad, level flatlands and gently rolling hills. Nearly 30 percent of the soils at MCB Camp Lejeune are considered hydric. Leon fine sand, Mukalee Loam, and Murville

fine sand are the most common hydric soils. Baymeade fine sand, a nonhydric soil, is the most prevalent soil type at the installation and encompasses 18 percent of the land (Department of the Navy, July 2005).

A soil survey for Onslow County indicates that the Baymead Foreston Stallings soil association is predominant in the Camp Johnson portion of Camp Lejeune. This association is typically found on level to gently sloping areas and ranges from somewhat poorly to well-drained with loamy subsoil throughout. Four soil map units are mapped in the study area. They are: Baymeade-Urban Complex, 0 to 6 percent slopes (BmB), Baymeade fine sand 0 to 6 percent slopes (BaB), Wando fine sand 1 to 6 percent slopes (WaB), and Craven fine sandy loam (CrC), 4 to 8 percent slopes. The affected soil map units have not been classified either as hydric soils or prime farmland by the Natural Resources Conservation Service (MCB Camp Lejeune, July 2002). Most soils within this area have been previously disturbed due to a history of intensive use.

From the regional geology, it can be inferred that the project site is underlain by the uppermost Undifferentiated Formation of Holocene and Pleistocene age sediments, which consists of mostly fine, loose- to medium-dense sands, with a lesser amount of silt and clay, and is present from land surface to depths of 20 feet to 30 feet below ground surface (bgs). Thin, discontinuous lenses of silt and clay may be regionally associated with the Belgrade Formation. The Belgrade Formation generally consists of mostly fine sands, silts, and clays with lesser amounts of shell fragments.

The upper portion of the River Bend Formation, which underlies the Quaternary-age sediments, is composed of sands, silts, shell and fossil fragments, and trace amounts of clay. The River Bend Formation overlies the Eocene Castle Hayne Formation. The Castle Hayne Formation consists of both poorly indurated and well-indurated biomicrite and biomicrudite limestone (Harris and Zullo, 1991). Thickness of the Castle Hayne Formation ranges between 150 feet and over 450 feet locally at MCB Camp Lejeune (Cardinell et al., 1993).

The surficial aquifer, Upper Castle Hayne Confining Unit, and Castle Hayne Aquifer at MCB Camp Lejeune have all been described (Cardinell et al., 1993). The surficial aquifer resides within the Undifferentiated Formation, and the Caste Hayne Aquifer resides locally within the River Bend Formation. The Belgrade Formation typically acts as a confining unit between the surficial and the Castle Hayne aquifers.

Surface water drainage in the project vicinity is carried by a dendritic system of small, permanent, and intermittent unnamed streams, with associated floodplains of various widths. These streams flow into Scales Creek, Northeast Creek, and New River. New River flows into the Atlantic Ocean via New River inlet (MCB Camp Lejeune, July 2002).

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\Figure 2- Base Overview.mxd

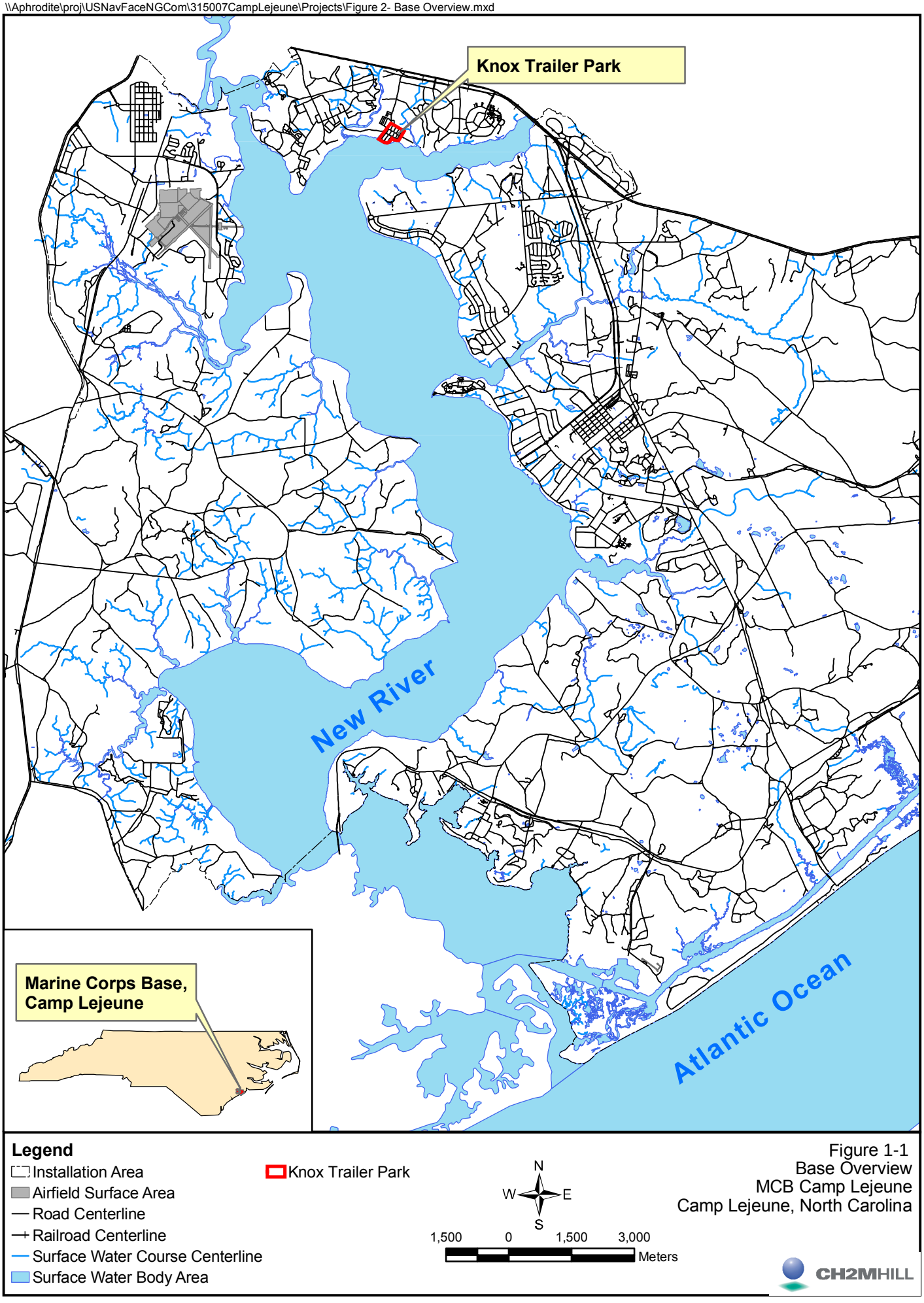

Figure 1-1
Base Overview
MCB Camp Lejeune
Camp Lejeune, North Carolina

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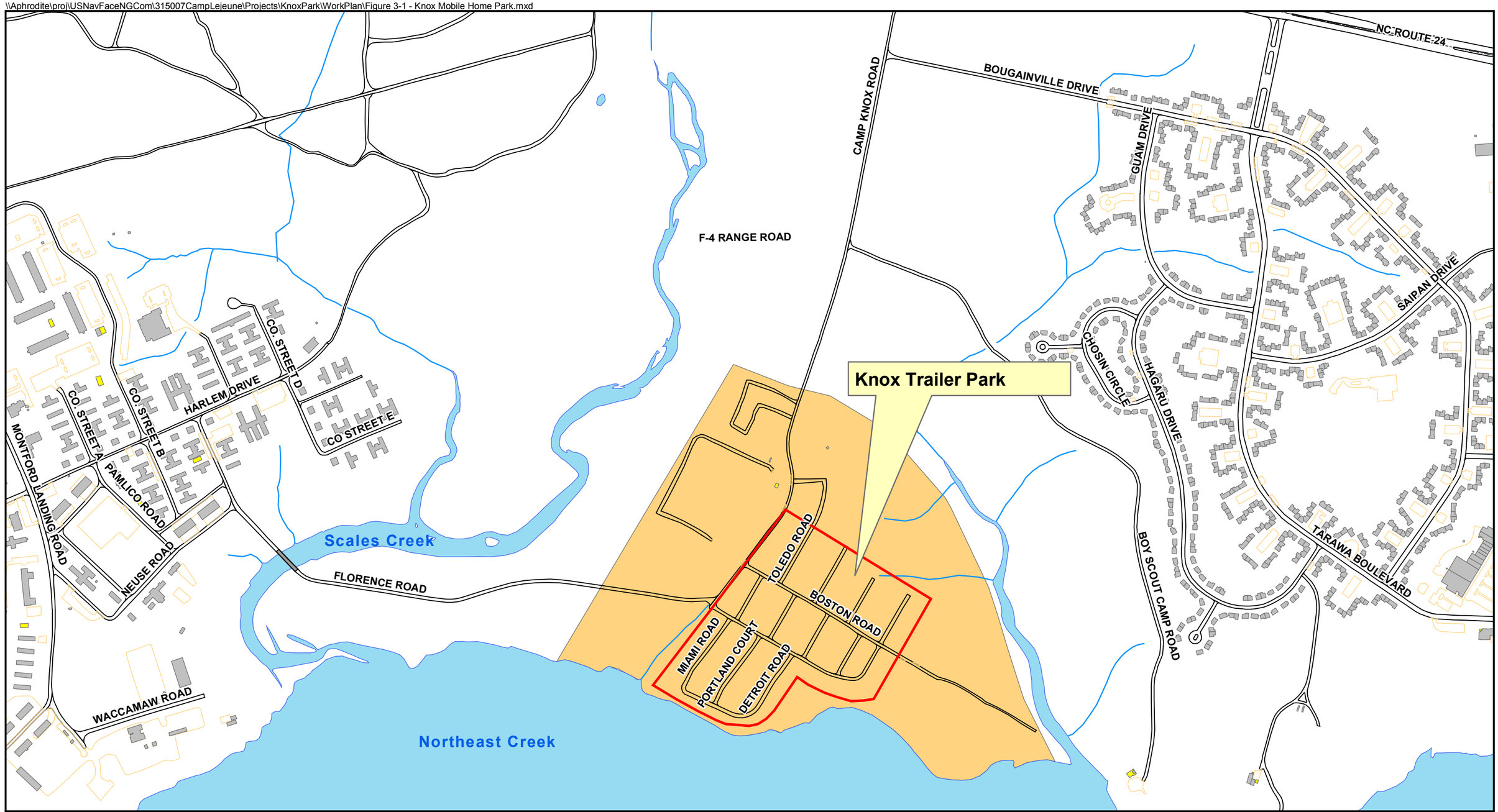
\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\WorkPlan\Figure 3-1 - Knox Mobile Home Park.mxd



Legend

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

N
W E
S

200 0 200
Meters

Figure 1-2
Knox Trailer Park
MCB Camp Lejeune
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 LANTDIV, the North Carolina Department of Environment and Natural Resources (DENR), and CH2M HILL, Inc. Project execution will be conducted by CH2M HILL and its subcontractors. CH2M HILL will issue subcontracts for MEC support, DGM, land surveying, vegetation clearing, monitoring well installation, direct push soil sampling, 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 and monitoring well installation, geophysical operations, geographical information system (GIS), and database management
- Performance of field sampling activities
- Analysis of data and preparation of ESI report
- Project closeout

USA Environmental—Subcontractor

USA Environmental (referred to herein as USA) will provide UXO-trained personnel for escort and MEC avoidance during field operations. Specific project duties will include the following:

- Train field personnel in appropriate MEC safety procedures prior to initiation of field activities and provide MEC safety briefings during daily health and safety tailgate meetings

- Escort site personnel into areas that have not been cleared of MEC
- Escort land-surveying subcontractor personnel
- Engage in surface MEC avoidance for vegetation removal and DGM operations
- Engage is subsurface MEC avoidance for drilling and soil and sediment sampling
- Coordinate with Marine Corps EOD personnel in the event MEC is discovered during the investigation

USA will provide the labor, equipment, and tools required for the work described above.

Geophysical Services Subcontractor

The geophysical services subcontractor will provide trained personnel for geophysical investigation services. Specific project duties assigned to the geophysical services subcontractor include the following:

- Implementing the GPO according to the GPO work plan (refer to GIP in Appendix C)
- Perform DGM services according to the GIP (refer to Appendix C), including the DGM survey using towed array and carried array, data processing and interpretation, and preparation of geophysical anomaly maps

The geophysical services subcontractor will provide the labor, equipment, and tools required for the work described above.

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.

- Program Manager—Doug Dronfield will provide program management support of this CTO and will ensure that all contract requirements are met during execution of this project
- Global Market Segment Director—Ben Redmond will serve as senior technical consultant for MEC-related matters and will provide quality assurance reviews on all MEC-related submittals
- CLEAN Contract MEC Manager—George Overby will provide MEC personnel and resources in support of field activities
- Activity Manager—Matt Louth will coordinate the implementation of all CTOs at MCB Camp Lejeune. Mr. Louth will ensure that information is shared between CTO project teams and will communicate with the LANTDIV Project Manager (PM) concerning the overall MCB Camp Lejeune activity
- PM—Tom Roth 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. Mr. Roth 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

- Corporate Munitions Response Safety Officer—Dan Young, CSP, will oversee the implementation of the HSP (refer to Appendix B) to ensure that it meets all specific needs of the project and that appropriate health and safety requirements relative to explosives safety are defined.
- Program Health and Safety Manager—Michael Goldman, C.I.H., will support the implementation of the HSP (refer to Appendix B) to ensure that it meets all specific needs of the project and that appropriate health and safety requirements are defined
- Program Geophysicist—Tamir Klaff will be responsible for ensuring that the QC procedures and objectives for the GPO and geophysical investigations are implemented and met. Mr. Klaff will work closely with the geophysical services subcontractor during the execution of this CTO and will provide oversight of the geophysical services subcontractor and will be responsible for the acceptance of their geophysical data

2.1.3 Project Schedule

Modification 1 to CTO-109, which authorizes CH2M HILL to perform the ESI at Knox Trailer Park, was issued by NAVFAC on June 17, 2005. The schedule for performing the ESI 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 eight tasks, which are described in the remainder of this subsection:

- Task 1—contract startup
- Task 2—project planning
- Task 3—data evaluation
- Task 4—explosives safety submission
- Task 5—site investigation
- Task 6—sample analysis and validation
- Task 7—GIS
- Task 8—reporting

2.2.1 Task 1—Contract Startup

This task, which is now complete, included the activities necessary for initiating this CTO. The primary activities included a site visit, preparation of the Implementation Plan and Fee Proposal, and project setup in the CH2M HILL accounting system.

2.2.2 Task 2—Project Planning

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

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 for during the course of this project. The meetings will be held as necessary to discuss proposed work, present investigation findings, and discuss project status. The meetings are planned to be held at MCB Camp Lejeune, CH2M HILL's Virginia Beach office, or at other locations as necessary.

Two versions of this work plan are scoped under this task. A draft work plan will be submitted for NAVFAC and DENR review, and a final work plan will be prepared that incorporates NAVFAC and DENR review comments.

Subcontractor procurement is also included under this task. Anticipated subcontractor services include MEC support, vegetation clearing, drilling and well installation, laboratory analysis, and data validation.

2.2.3 Task 3—Data Evaluation

This task includes the archival records search. The archival records search was performed during preparation of this work plan and the results are presented in Appendix A.

2.2.4 Task 4—Explosives Safety Submission

An ESS Waiver Request for the ESI field investigation was prepared under this task. An ESS for will also be prepared under this task for use in the event MEC investigations or removal actions are conducted in the future. It is to be noted that the current scope of work does not involve the handling, demolition, or disposal of MEC.

2.2.5 Task 5—Site Investigation

All field investigation activities will be performed under this task. The scope of the field investigation and the technical approach is presented in Section 3. The primary field investigation activities are the following:

- Surveying and vegetation clearance
- MEC support
- Digital geophysical mapping
- Well installation
- Environmental sampling

2.2.6 Task 6—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 samples that were required were collected and 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, laboratory data 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 from the analytical laboratory receives the "raw" laboratory data. A validation report will be expected within 3 weeks of the validator's receipt of Level IV laboratory data packages. Level IV data will be validated per the characteristic leaching procedure (CLP) criteria as outlined by the EPA (1999, 2004).

CH2M HILL will submit electronic updates to the MCB Camp Lejeune Environmental Information Management System in accordance with its electronic data deliverable format. This will include location coordinates for newly installed or abandoned wells and analytical data. All data will be submitted within 30 days following the completion of the site database.

2.2.7 Task 7—Geographical Information System

All data will be collected in preparation for the creation of a GIS tailored for the specific MEC investigative needs of the site. All digital data will be created using a software platform that will allow it to be loaded directly into the MEC GIS system. The main purpose of the GIS is to assemble all the data required to associate the nonintrusive subsurface geophysics investigative data with its correct geographical location, the relational database, mapping, and remote sensing data. The GIS tools are used to manage the project, assemble data for the administrative record, and help determine areas requiring further investigation. The level of effort estimated for this task is based on the assumptions that an electronic base map will be provided, survey grid information will be provided in electronic format (ASCII, CAD, or shape files), and MEC information will be delivered in electronic tabular format.

CH2M HILL will also input the collected mapping data into the existing ArcView GIS for MCB Camp Lejeune. This data include ArcView project and shape files that best delineate the area on the basis of uses, site conditions, and other information gathered during the study. CH2M HILL will develop a project base map that will include all geophysical grids that were digitally mapped during the investigation.

2.2.8 Task 8—Reporting

A draft ESI Report will be prepared to document the findings of the field investigation. The report will summarize all field activities, evaluate the collected geophysical and environmental data, and present a screening human health and ecological risk assessments for residential use. Following LANTDIV and DENR review, a final ESI Report will be prepared that incorporates review comments.

TABLE 2-1
Project Personnel Contact Information
Work Plan for the Expanded Site Investigation, Site UXO-04, Knox Trailer Park

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
Ben Redmond Global Market Segment Leader (MEC) CH2M HILL	151 Lafayette Drive Suite 110 Oak Ridge, TN 37830	865-483-9032 (office) 865-384-5511 (cell) 865-481-3541 (fax) Ben.Redmond@ch2m.com
George Overby CLEAN MEC Manager CH2M HILL	2415 Audubon Lane Hampton Cove, AL 23462	256-539-6405 (office) 678-579-8083 (fax) George.Overby@ch2m.com
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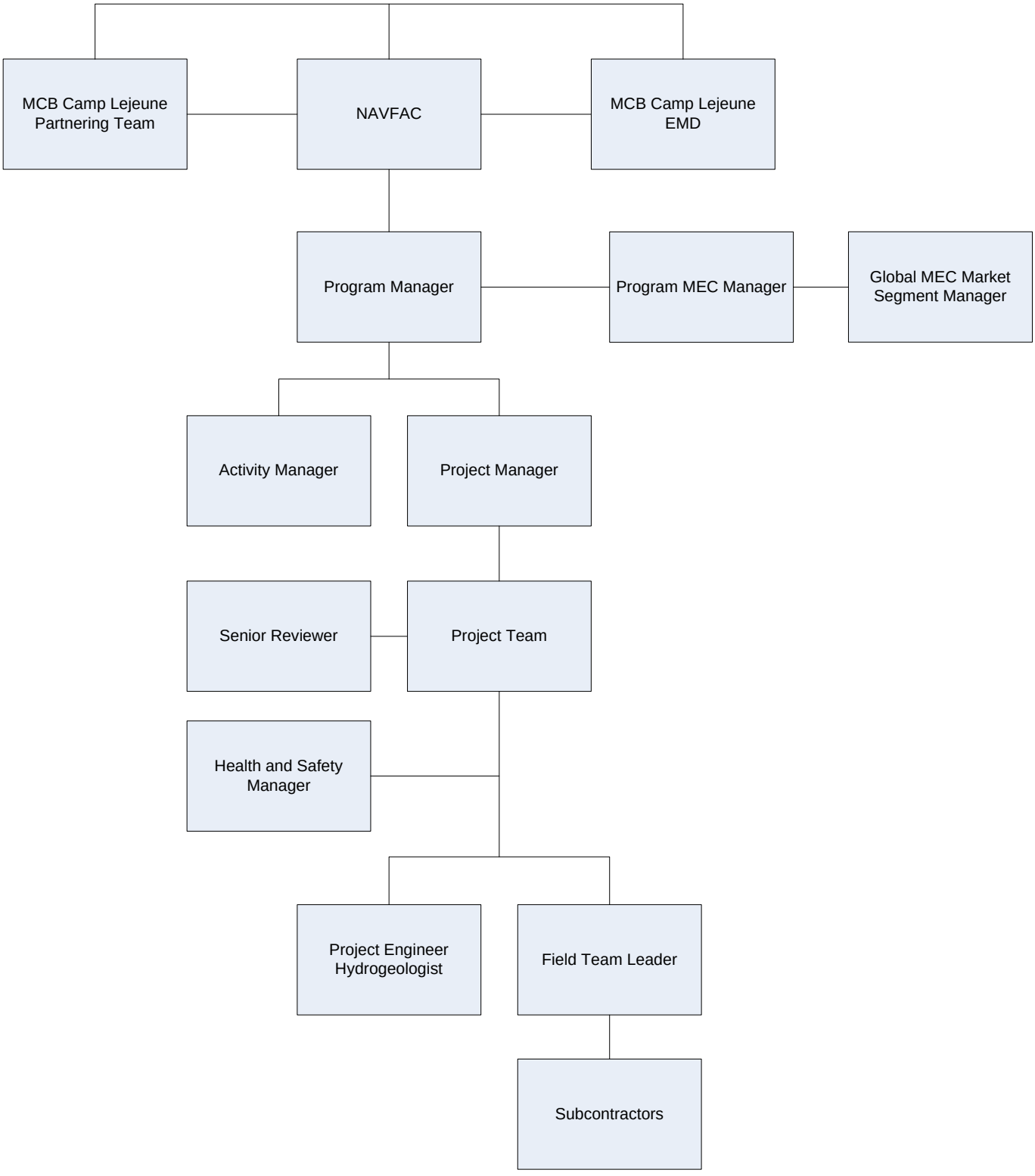
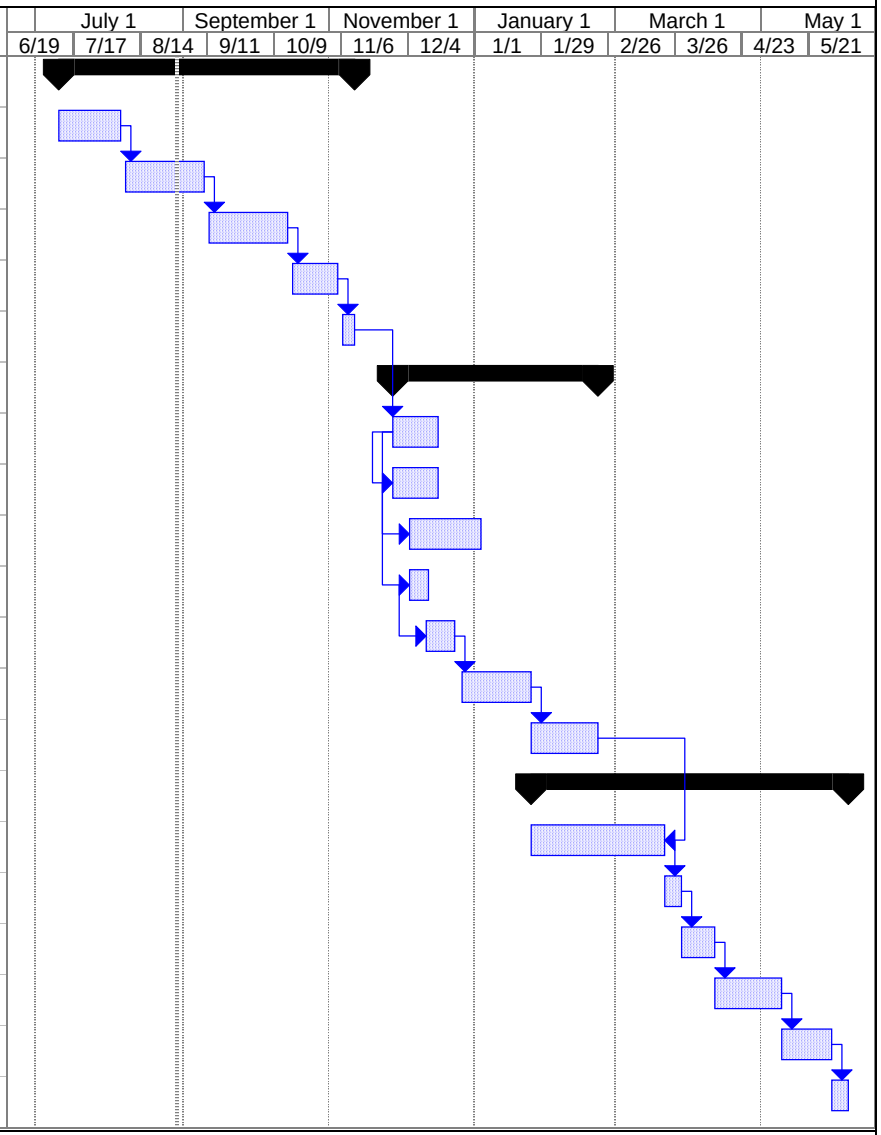


Figure 2-1
Project Team Organizational Structure
Knox Trailer Park, Site UXO-04
Expanded Site Investigation
MCB Camp Lejeune
Jacksonville, North Carolina

CH2MHILL

Figure 2-2. Project Schedule
Knox Trailer Park Expanded Site Investigation
MCB Camp Lejeune, North Carolina

ID	Task Name	Duration	Start	Finish
1	**Work Plan**	**90 days**	**Mon 7/11/05**	**Fri 11/11/05**
2	Archives Search	20 days	Mon 7/11/05	Fri 8/5/05
3	Draft WP	25 days	Mon 8/8/05	Fri 9/9/05
4	Regulatory Review of Draft WP	25 days	Mon 9/12/05	Fri 10/14/05
5	Final WP	15 days	Mon 10/17/05	Fri 11/4/05
6	Government Approval of Draft WP	5 days	Mon 11/7/05	Fri 11/11/05
7	**Site Investigation**	**60 days**	**Mon 11/28/05**	**Tue 2/21/06**
8	Brush Clearing	15 days	Mon 11/28/05	Fri 12/16/05
9	Land Surveying	15 days	Mon 11/28/05	Fri 12/16/05
10	Digital Geophysical Mapping	20 days	Mon 12/5/05	Tue 1/3/06
11	Well Installation	6 days	Mon 12/5/05	Mon 12/12/05
12	Environmental Sampling	10 days	Mon 12/12/05	Fri 12/23/05
13	Sample Analysis	20 days	Tue 12/27/05	Tue 1/24/06
14	Data Validation & Review	20 days	Wed 1/25/06	Tue 2/21/06
15	**Task 8 – Reporting**	**95 days**	**Wed 1/25/06**	**Tue 6/6/06**
16	Submit Draft Report	40 days	Wed 1/25/06	Tue 3/21/06
17	Government Review of Draft Report	5 days	Wed 3/22/06	Tue 3/28/06
18	Submit Draft-Final Report	10 days	Wed 3/29/06	Tue 4/11/06
19	Regulatory Review of Draft-Final Report	20 days	Wed 4/12/06	Tue 5/9/06
20	Submit Final Report	15 days	Wed 5/10/06	Tue 5/30/06
21	Government Approval of Final Report	5 days	Wed 5/31/06	Tue 6/6/06



Project: Knox Park ESI
Date: Mon 8/29/05

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

SECTION 3

Field Investigation Plan

3.1 Overall Approach

Navy/Marine Corps MRP Site UXO-04, Knox Trailer Park, was identified as a former hand grenade–training range by the Headquarters Marine 2002 Range report. The objectives for this field investigation are to:

- Identify the presence and nature of any HTW contamination that may exist in the project area
- Evaluate the nature, number, and density of anomalies that could potentially represent subsurface MEC
- Provide geophysical data for future MEC intrusive investigations or removal actions

The field investigation will accomplish the above objectives through the following activities, which will be conducted in accordance with Navy CLEAN Standard Operating Procedures (SOPs), CH2M HILL SOPs, and the draft MCB Camp Lejeune Master Project Plans (CH2M HILL, June 2004) (referred to herein as the Master Plans):

- Collect direct-push (DP) soil samples from 10 locations
- Collect surface water and sediment samples from 10 locations
- Install five pairs of shallow and intermediate depth groundwater monitoring wells and five additional shallow groundwater monitoring wells
- Collect groundwater samples from the newly installed monitoring wells at the site
- Perform DGM of the project area
- Interpret and present the data in the ESI Report for the site

The field investigation activities are detailed below and reference the Master Plans (CH2M HILL, June 2004).

3.2 Site Preparation and Restoration

The following subsections describe the procedures associated with site preparation, including mobilization of personnel and equipment, preparation for intrusive environmental investigation activities, and preparation for DGM.

3.2.1 Mobilization

A mobilization period will include identifying, briefing, and mobilizing staff, as well as securing and deploying equipment. Mobilization activities include general activities and a kickoff and safety meeting.

General Activities

- Identify/procure, package, ship, and inventory project equipment, including geophysical detection equipment, hand tools and supplies, and vegetation clearance equipment
- 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, accident prevention plan, HSP, and MEC procedures and hazards
- Verify that all forms and project documentation are in order and project team members understand their responsibilities regarding completing project-reporting requirements

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 Boundary Survey and Site Layout

A professional land surveyor will perform a boundary survey (refer to Figure 1-2) prior to the start of vegetation removal. The boundary survey will delineate the extent of the area that will be subjected to vegetation removal for the DGM effort.

After vegetation removal, the site will be divided for the DGM effort into 100-feet survey grids coinciding with the North Carolina State Plane coordinate system.

Each survey team will comprise a surveyor party chief, a surveyor technician, and a UXO escort. The escorts will be equipped with appropriate geophysical instruments to perform anomaly avoidance.

3.2.3 Vegetation Removal

Vegetation will be removed from approximately 76 acres of the 133-acre investigation area, assuming that of the balance, 38 acres are mowed grass within the remaining trailer park and the 19 acres adjacent to the roadways are maintained. Vegetation removal will be accomplished using a combination of mechanical and manual methods.

MEC technicians will clear the vegetation-removal areas according to the MEC avoidance procedures included in the HSP (refer to Section 3.6). The vegetation will be mulched and left in place. Trees greater than 4 inches in diameter will not be removed unless absolutely necessary. The Base will coordinate with Camp Lejeune's 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 will be identified and left in place in accordance with the Environmental Protection Plan (refer to Section 5).

3.2.4 Site Restoration and Demobilization

Site Restoration

Any damage caused by equipment or other site activities (e.g., deep ruts) will be repaired and revegetated as necessary to prevent erosion.

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:

- All areas to be geophysically mapped will be verified as completed
- COC records will be reviewed to ensure that all samples were collected as planned and were submitted for appropriate analyses
- Restoration of the site to an appropriate level will be verified
- All equipment will be inspected, packaged, and shipped to the appropriate location

3.3 Geophysical Investigation Plan

The GIP (refer to Appendix C) provides details of the equipment, approach, methods, operational procedures and quality control to be used in performing the geophysical investigations at the Knox Trailer Park site.

3.4 Geospatial Information and Electronic Submittals

3.4.1 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 (CADD)/GIS Technology Center Spatial Data Standards for Facilities Infrastructure and Environment and will be provided in metric units.

3.4.2 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.

A professional land surveyor licensed in the State of North Carolina will certify all survey data, including control points, grid corners, transect points, and boundaries. The professional land surveyor will use either real time kinematic (RTK) differential global positioning system (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.

Geophysical surveying at the project site will be conducted by the geophysical subcontractor using RTK DGPS.

3.4.3 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.

3.4.4 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.

3.4.5 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.

3.4.6 Digital Data

Location information will be collected as part of the DGM survey and will be sufficient to accurately relocate the position of geophysical anomalies in the field and accurately plot the position of each anomaly in the GIS.

3.4.7 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 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.

During execution of the field effort, the GIS database will be updated at intervals of 1 week or less to add survey and DGM data. The updated GIS database will be made available to LANTDIV for download from the project website or from a file transfer protocol site.

3.5 Field Sampling Plan

3.5.1 Field Operations

In order to identify the presence and nature of any HTW contamination that may exist in the project area, the project team will investigate groundwater, surface water, soil, and sediment in the project area. This will include installing monitoring wells and collecting groundwater samples from the monitoring wells, DP soil samples, surface water samples, and sediment samples.

Direct Push Soil Sampling

A DP rig will be used to collect soil samples above the water table in accordance with Navy CLEAN SOPs, CH2M HILL SOPs, and the Master Plans (CH2M HILL, June 2004). MEC anomaly avoidance procedures will be used as described in the HSP (refer to Section 3.6). Ten subsurface soil samples (MR04-SS01 through -SS10) will be collected from just above the water table at the locations shown in Figure 3-1. Locations will be numbered in the field. 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):

- Target Compound List (TCL) volatile organic compounds (VOCs)
- TCL semivolatile organic compounds (SVOCs)
- TCL pesticides
- TCL polychlorinated biphenyls (PCBs)
- Target Analyte List (TAL) metals and cyanide
- Energetics
- Total petroleum hydrocarbons (TPH)
- Total organic carbon (TOC)
- Total organic halogens (TOX) (9020B)

The water table elevations will be evident by the soil cores removed at each location. The water table is expected to be approximately 5 feet or less bgs throughout the site.

All samples will be Level IV validated by a third-party validator, as described in Section 4 and the Master Plans (CH2M HILL, June 2004).

Surface Water and Sediment Sampling

Ten sediment samples (MR04-SD01 through -SD10) and 10 surface water samples (MR04-SW01 through -SW10) will be collected in accordance with Navy CLEAN SOPs, CH2M HILL SOPs, and the Master Plans (CH2M HILL, June 2004). Samples will be collected from downstream to upstream to avoid cross-contamination by sediment suspension. The surface water and sediment samples will be colocated at the locations shown in Figure 3-1. Locations will be numbered in the field. 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 (and filtered TAL metals for surface water)
- Energetics
- TPH
- TOC (filtered TOC for surface water)
- TOX
- Grain size (for sediment)
- Total dissolved solids (for surface water)

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, June 2004).

Monitoring Well Installation and Sampling

Basis for Proposed Locations and Depths. Paired monitoring wells will be installed at the five locations shown in Figure 3-1 to monitor shallow (15 to 30 feet bgs) and intermediate (45 to 50 feet bgs) groundwater zones. Five additional shallow monitoring wells will be installed to assist in characterizing the site.

This phase of the investigation will provide site-specific lithologic and hydrogeologic information. The depths of the groundwater zones discussed above are based on the geology of other sites at MCB Camp Lejeune. The actual screened intervals of the monitoring wells will be selected based on the site-specific lithology that is identified while installing the monitoring well boreholes. The 15 monitoring wells (MR04-MW01 through MW15) will be numbered as they are installed in the field.

Monitoring Well Installation Procedures. All wells will be installed using rotary hollow-stem augers in accordance with Navy CLEAN SOPs, CH2M HILL SOPs, and the Master Plans

(CH2M HILL, June 2004). MEC anomaly avoidance procedures will be utilized during monitoring well installation as described in the HSP (refer to Section 3.6).

Continuous soil cores will be collected as the borehole is advanced. Discrete soil samples will be collected from the continuous soil cores at 5-feet-depth intervals. This information will be used to characterize site lithology and screen for the presence of VOCs using field screening equipment.

Boreholes for shallow monitoring wells will be advanced to anticipated depths of 15 to 30 feet bgs, whereas intermediate monitoring wells will be advanced to anticipated depths of approximately 45 to 50 feet bgs. The screened interval of each well will be placed on the basis of the lithology data collected during the borehole installations. In general, layers having assumed higher permeability than adjacent layers will be selected for screening. This is consistent with well installations at other MCB Camp Lejeune IRP sites and with the Master Plans (CH2M HILL, June 2004). Precise well construction depths will be determined in the field following a review of the boring logs. Boring logs and well completion diagrams will be provided in the ESI Report.

The monitoring wells will be constructed within each borehole using 2-inches-diameter, flush threaded, Schedule 40 polyvinyl chloride riser and 5 feet of 10-slot (0.010-inch) polyvinyl chloride screen. Ten-slot screen was selected due to the fine silt and clay content of the soil generally present at MCB Camp Lejeune. A Type II silica sand filter pack will be placed in the annular space between the well screen and borehole wall, from the bottom of the borehole to approximately 2 feet above the top of the well screen. Bentonite pellets will be placed on top of the filter pack and hydrated to form a seal approximately 4 feet thick.

After hydration of the bentonite pellets, the remaining annular space of the borehole will be grouted to within a few inches of the ground surface. Grout will consist of cement and no more than 3 percent sodium bentonite and will be placed using a tremmie pipe and pumped from the bottom of the annular space to land surface. Pumping will continue until the grout returns at the surface are within 5 percent of the weight of the grout being pumped into the well annulus to insure the grout is not diluted by groundwater standing in the borehole.

A watertight, locking expansion cap will be installed on top of the 2-inches-diameter casing. Each monitoring well will be completed at the surface with either an 8-inches-diameter steel manhole-type protective cover with concrete pad or a steel stick-up protective cover with concrete pad (depending on the location of the well). The drilling and well installation activities will be conducted by a North Carolina–licensed well driller under the supervision of a CH2M HILL engineer or hydrogeologist in accordance with the well construction standards provided the North Carolina Administrative Code (1999).

Each new monitoring well will be developed within 48 hours after installation depending on scheduled field activities. Wells will be developed in accordance with Navy CLEAN SOPs, CH2M HILL SOPs, and the Master Plans (CH2M HILL, June 2004). Well development will include surging and overpumping with a submersible pump across the length of the well screen. With respect to the volume of groundwater removed, adequate well development is normally achieved when the column of water in the well is free of visible sediment. With respect to groundwater geochemical parameters, adequate development is achieved when the pH, specific conductance, and temperature of the

groundwater have stabilized, and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units. Stabilization occurs when pH measurements remain constant within 0.1 standard unit (SU), specific conductance varies no more than 10 percent, and the temperature is constant for three consecutive readings.

All new monitoring wells will be surveyed by a professional land surveyor for vertical coordinates. Actual monitoring well location coordinates will be determined using an RTK DGPS unit in the field.

Monitoring Well Groundwater Sampling. Once all of the new monitoring wells have been installed and developed, a complete round of water-level elevations will be collected prior to purging and sampling and well. 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 (MR04-GW01 through -GW15) will be collected in accordance with Navy CLEAN SOPs, CH2M HILL SOPs, and the Master Plans (CH2M HILL, June 2004). 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 over 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
- Energetics
- TPH
- Filtered TOC
- TOX

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, June 2004).

3.5.2 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, June 2004). 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%	Same parameters as parent sample
MS/MSD	Designed to evaluate potential matrix interferences, accuracy, and precision. Three aliquots of a single sample—one native and two spiked with the same concentration of matrix spike compounds—are analyzed.	5%	Same parameters as parent sample

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

Sample Identification System

The following is a general guide for sample identification; an electronic sample–tracking program will be used to manage the flow of information from the field sampling team to the laboratory and to internal and external data users. The tracking program is used to produce sample labels and COC forms and to manage the entry of sampling-related data, such as station locations and field measurements. The method of sample identification used depends on the type of sample collected and the sample container.

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

Labels for samples sent to a laboratory for analysis will be produced electronically. If they cannot be produced electronically, they must be written in indelible ink. The following information typically is included on the sample label:

- Site name or identifier
- Sample identification number
- Date and time of sample collection
- Sample matrix or matrix identifier
- Type of analyses to be conducted

Each analytical sample will be assigned a unique number of the following format 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 Munitions Response Program. Therefore, the prefix "MR04" will be used.

Media: GW = Groundwater
SW = Surface water
SS = Surface or subsurface soil
SD = Sediment

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.

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:

"05" will be used for the year 2005
"A" will be used for the first round of samples collected at the site

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

2–3 = 2 to 3 feet bgs

Under this sample designation format, "MR04-GW01-05A" would mean the following:

MR04-GW01-05A	MRP Site UXO-04
MR04-GW01-05A	Groundwater sample from monitoring well #1
MR04-GW01-05A	First round sampled

"MR04-TB1-05A" would mean the following:

MR04-TB1-05A	MRP Site UXO-04
MR04-TB1-05A	Trip Blank #1
MR04-TB1-05A	Sampled during the first round

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 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. Chain of custody will begin with the collection of the samples in the field and will continue through the analysis of the sample at the analytical laboratory.

3.5.3 IDW Management

All IDW generated will be managed during the investigation in accordance with the Master Plans (CH2M HILL, June 2004). IDW includes soil cuttings from the monitoring well drilling and liquid waste (e.g., purged groundwater or decontamination fluids) generated during well development and sampling.

3.6 Health and Safety Plan (HSP)

The draft MCB Camp Lejeune Master Health and Safety Plan (CH2M HILL, June 2004) will be utilized along with the project specific HSP in Appendix B.

Due to the potential presence of MEC at this site, MEC avoidance techniques will be employed throughout the field investigation to ensure the safety of all onsite personnel. Procedures for conducting MEC avoidance are provided in the HSP in Appendix B.

3.7 Data Documentation and Processing Procedures

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

3.7.1 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, June 2004). 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 3.5.2 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.

3.7.2 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 bound 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. A tracking form will be used to show that at least 10 percent of all calculations have been checked by the analyst and the laboratory QA supervisor from the raw data to the final value stages prior to reporting the results of a group of samples. This tracking form, as well as all logs and calculations, will be made available for any QA audit conducted during the investigation.

Instrument calibration logs and internal quality control 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 3.5. Documentation of these activities will be made available during QA audits.

The reporting requirements will be in accordance with the CLP Statement of Work OLM01.0 for organics analysis and ILM01.0 for inorganics analysis, or other specified analytical method.

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

3.7.3 Investigation Results

The results of the ESI 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 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
- Boundaries of sampling locations
- Stratigraphy and water level elevations
- Horizontal extent of contamination
- Vertical distribution of contaminants

3.8 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.

3.8.1 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.

3.8.2 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 Quality Assurance 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.

3.8.3 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 CD-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
Knox Trailer Park, Site UXO-04, Expanded Site Investigation Work Plan
MCB Camp Lejeune
Jacksonville, North Carolina

Sample Media	Sample ID Number	Sample Depth/Location and Rationale	Analysis												
			VOCs	SVOCs	Pesticides/ PCBs	Energetics	TPH	Total TAL Metals	Cyandie	Filtered TAL Metals	TOC	Filtered TOC	TOX	Grain Size	TDS
Direct Push Soil	MR04-SS01-T-B through MR04-SS10-T-B	Collected from a 2 feet interval just above the water table at eah location shown on Figure 3-2. Will allow for characterization of soil across site, as well as characterization at locations of potential historical dumping and depositional locations at the beginning of drainage points (i.e., streams). Co-located with some monitoring wells.	x	x	x	x	x	x	x		x		x		
Monitoring Well Groundwater	MR04-GW01-05A through MR04-GW15-05A	From monitoring wells MR04-MW01 through MW15 to be installed as shown on Figure 3-2. Will allow for characterization of groundwater across site, including upgradient and downgradient locations.	x	x	x	x	x	x	x	x		x	x		
Surface Water	MR04-SW01 through MR04-SW10	Collected at each location shown on Figure 3-2. Will allow for evaluation of transport of contaminants into adjacent water body. Includes locations at beginning and end of streams and just offshore of site.	x	x	x	x	x	x	x	x		x	x		x
Sediment	MR04-SD01 through MR04-SD10	Collected at each location shown on Figure 3-2. 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		x		x	x	

Notes and Abbreviations

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

For Monitoring Well Groundwater Samples: 05A Refers to the samples being collected in 2005, and that they are the first round of samples collected from the wells.

TCL = Target Compound List
VOC = Volatile organic compounds
SVOC = Semivolatile organic compounds
PCBs = Polychlorinated biphenyls
TDS = Total dissolved solids (TDS)
TAL = Target Analyte List
TPH = Total petroleum hydrocarbons
TOC = Total organic carbon
TOX = Total organic halogens

TABLE 3-2
Analyses, Bottleware, Preservation, and Holding Time Requirements
Knox Trailer Park, Site UXO-04, Expanded Site Investigation Work Plan
MCB Camp Lejeune
Jacksonville, North Carolina

Media	Analysis	Method	Container	Preservation / Storage	Holding Times
Soil and Sediment	TCL VOCs	OLM04	2x5-gram + 1x25-gram Encore™ Sampling receptacle	4ºC	48 hours
	Total Organic Halogens	SW-846 9020B	1x4-oz bottle, Teflon cap	4ºC	48 hours
	TCL SVOCs	OLM04	1x8-oz bottle, Teflon cap	4ºC	7 days to extraction, 40 days from extraction to analysis
	Energetics	SW-846 8330	1x8-oz bottle, Teflon cap	4ºC	7 days to extraction, 40 days from extraction to analysis
	TCL Pesticides/PCBs	OLM04	1x8-oz bottle, Teflon cap	4ºC	7 days to extraction, 40 days from extraction to analysis
	TAL Metals/Cyanide	ILM04	1x4-oz bottle, Teflon cap	4ºC	6 months, Cyanide: 14 days, Mercury: 28 days
	Total Petroleum Hydrocarbons (full range)	EPA 8015/5030 EPA 8015/3550 EPA 9071 (Oil & Grease)	1x4-oz bottle, Teflon cap 1x8-oz bottle, Teflon cap	4ºC	48 hours
	Total Organic Carbon	EPA 415.2 / SW-846 9060	1x4-oz bottle, Teflon cap	4ºC	28 days
	Grain Size	sieve and hydrometer (ASTM D422)	1x16-oz bottle, Teflon cap	4ºC	28 days
Groundwater and Surface Water	TCL VOCs	OLC02	3x40-mL vials	HCl to pH <2; cool to 4ºC	14 days
	Total Organic Halogens	SW-846 9020B	2x50-mL amber jar	H_2SO_4 to pH <2, no head space, and cool to 4ºC	28 days
	TCL SVOCs	OLC02	2x1-L amber jar	4ºC	28 days to analysis, nitrate 48 hours
	Energetics	OLC02	2x1-L amber jar	4ºC	7 days to extraction, 40 days from extraction to analysis
	TCL Pesticides/PCBs	OLC02	3x1-L amber jar	4ºC	7 days to extraction, 40 days from extraction to analysis
	Total and Filtered TAL Metals	ILM04	1x1-L Poly bottle	HNO_3 to pH <2 and cool to 4ºC	6 months, Mercury: 28 days
	Cyanide	ILM04	1x1-L Poly bottle	NaOH to pH >12 and cool to 4ºC	14 days
	Total Petroleum Hydrocarbons (full range)	EPA 8015/5030 EPA 8015/3550 EPA 9071 (Oil & Grease)	2x40-mL vials 2x1-L amber jar	HCl to pH <2; cool to 4ºC 4ºC	14 days 48 hours
	Total Dissolved Solids	MCAWW 160.1	1x250-mL Poly bottle	4ºC	7 days
	Filtered Total Organic Carbon	EPA 415.2 / SW-846 9060	2x40-mL vials	H_2SO_4 to pH <2, and cool to 4ºC	28 days

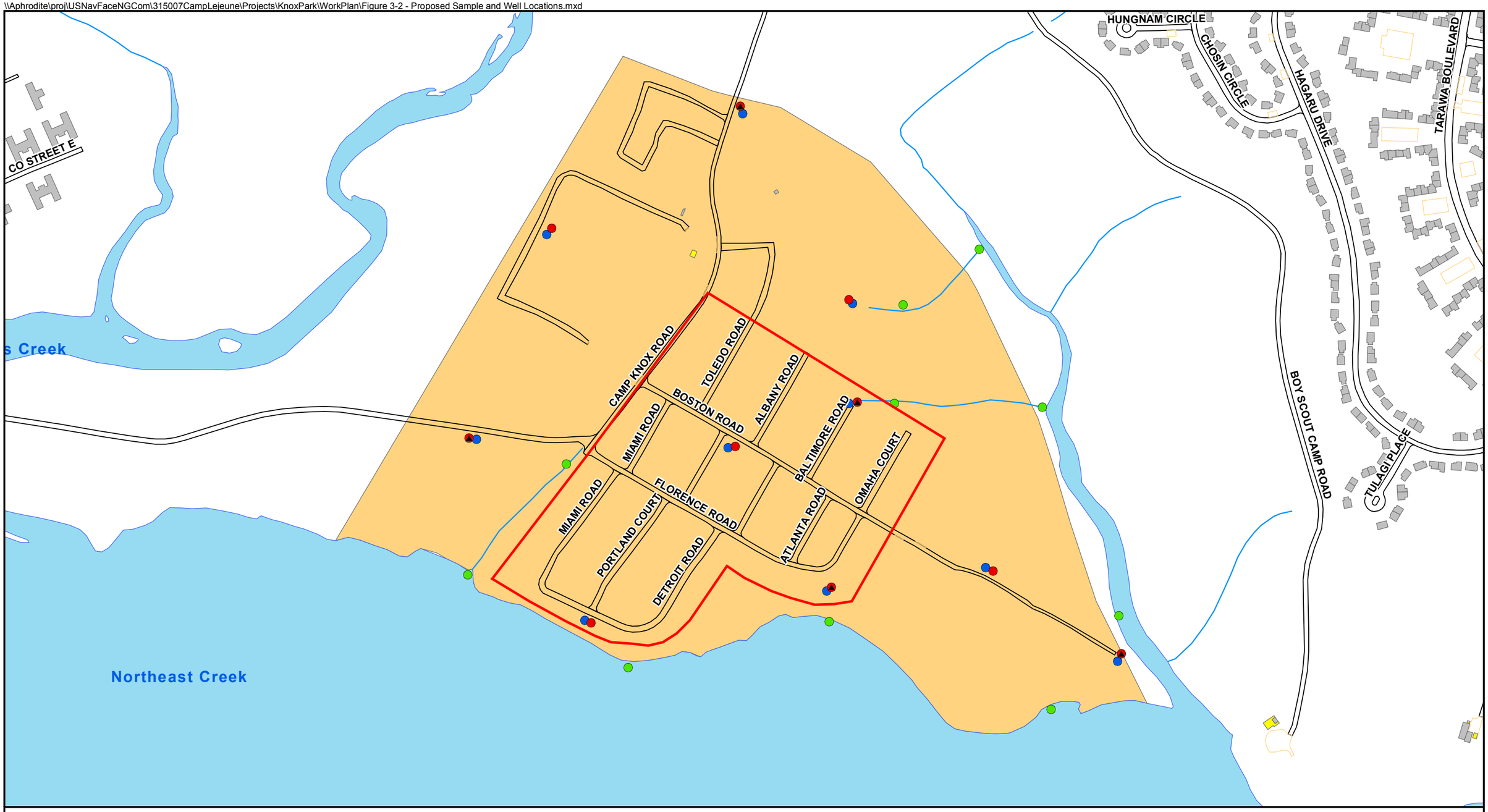
Notes
mL = milliliter
oz = ounce
g = gram
HCL = hydrochloric acid
HNO_3 = nitric acid
H_2SO_4 = sulfuric acid
NaOH = Sodium Hydroxide
TAL = Target Analyte List (TAL) metals
TCL = Target Compound List
VOCs = Volatile Organic Compounds
SVOCs = semivolatile organic compoundss
BTEX = Benzene, toluene, ethylbenzene, and total xylenes
MTBE = Methyl tertiary butyl ether
PCBs = polychlorinated biphenyls

TABLE 3-3
Sample Collection Frequencies
Knox Trailer Park, Site UXO-04, Expanded Site Investigation Work Plan
MCB Camp Lejeune
Jacksonville, 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) (with Encore samplers provided by lab)	Solid	10	1	2	1	1	2
TCL SVOCs by CLP (OLM04)		10	1	2	1	1	
TCL Pesticides and PCBs by CLP (OLM04)		10	1	2	1	1	
TAL Metals and Cyanide by CLP (ILM04)		10	1	2		1	
TPH (8015 and 9071)		10	1	2	1	1	
Total Organic Carbon (415.2/ 9060)		10	1			1	
Total Organic Halogens (9020B)		10	1	2	1	1	
Monitoring Well Groundwater Samples							
TCL VOCs by CLP (OLM04) without Encore	Aqueous	15	2	3	1	2	3
TCL SVOCs by CLP (OLM04)		15	2	3	1	2	
TCL Pesticides and PCBs by CLP (OLM04)		15	2	3	1	2	
Total TAL Metals and Cyanide by CLP (ILM04)		15	2	3		2	
Filtered TAL Metals by CLP (ILM04)		15	2	3		2	
TPH (8015 and 9071)		15	2	3	1	2	
Total Dissolved Solids (160.1)		15	2			1	
Filtered Total Organic Carbon (415.2/ 9060)		15	2			1	
Total Organic Halogens (9020B)		15	2	3	1	2	
Surface Water							
TCL VOCs by CLP (OLM04) without Encore	Aqueous	10	1	2	1	1	2
TCL SVOCs by CLP (OLM04)		10	1	2	1	1	
TCL Pesticides and PCBs by CLP (OLM04)		10	1	2	1	1	
Total TAL Metals and Cyanide by CLP (ILM04)		10	1	2		1	
Filtered TAL Metals by CLP (ILM04)		10	1	2		1	
TPH (8015 and 9071)		10	1	2	1	1	
Total Dissolved Solids (160.1)		10	1			1	
Filtered Total Organic Carbon (415.2/ 9060)		10	1			1	
Total Organic Halogens (9020B)		10	1	2	1	1	
Sediment							
TCL VOCs by CLP (OLM04) without Encore	Solid	10	1	2	1	1	2
TCL SVOCs by CLP (OLM04)		10	1	2	1	1	
TCL Pesticides and PCBs by CLP (OLM04)		10	1	2	1	1	
TAL Metals and Cyanide by CLP (ILM04)		10	1	2		1	
TPH (8015 and 9071)		10	1	2	1	1	
Grain size - sieve and hydrometer (ASTM D422)		5					
Total Dissolved Solids (160.1)		10	1			1	
Total Organic Carbon (415.2/ 9060)		10	1			1	
Total Organic Halogens (9020B)		10	1	2	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
VOCs = Volatile organic compounds
PCBs = Polychlorinated biphenyls
TPH = Total Petroleum Hydrocarbons
SVOCs = Semivolatile organic compounds
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

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\WorkPlan\Figure 3-2 - Proposed Sample and Well Locations.mxd



Legend

- Installation Area
- Structure Area
- Vehicle Parking Area
- Road Area
- Surface Water Course Centerline
- Surface Water Body Area
- Knox Trailer Park
- Estimated Site Investigation Area
- Surface Water and Sediment Sample Location
- Direct Push Soil Sample Location
- Shallow Monitoring Well Location
- Shallow/Intermediate Monitoring Well Pair Location

N
W E
S

250 0 250
Meters

Figure 3-1
Proposed Sample and Well Locations
Knox Trailer Park, Site UXO-04
MCB Camp Lejeune
Camp Lejeune, North Carolina

CH2MHILL

SECTION 4

Quality Control Plan

4.1 Introduction

This QCP describes the QC approach and procedures for the ESI at the Camp Lejeune Knox Trailer Park site and references the MCB Camp Lejeune Master Quality Assurance Project Plan (CH2M HILL, June 2004). The QCP is divided into two parts: Section 4.3 and its subsections address the environmental investigation activities, whereas Section 4.4 and its subsections address the MEC avoidance, surveying, and DGM activities.

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 2.6 for the project schedule summary.

4.2.1 Project Team Members

The organizational structure and responsibilities of the project team (refer to Figure 4-1) 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 1-1. Selected positions are described in the following paragraphs.

Project Manager

The PM for this project is Tom Roth. 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 (RTL)

The senior consultants for this project are Sam Shannon, Chris Bozzini, Teg Williams, George Overby, and Ben Redmond. 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 (LDM)

The lead data manager (LDM) for this project is Adrienne Jones. 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.

UXO Quality Control Specialist and Senior UXO Safety Officer

The UXO quality control specialist (UXOQCS) and senior UXO safety officer for this project has not been determined. The UXOQCS is responsible for implementing and administering this project QCP and communicating the onsite QC program policies, objectives, and procedures to the project personnel and subcontractors during project meetings and informal discussions. Onsite technical personnel, who will include MEC avoidance technicians (also called UXO technicians), will assist the UXOQCS in monitoring, controlling, and documenting the quality of the onsite field activities. Documentation related to the control of project quality, including audits and equipment check results, will be reviewed or prepared by the UXOQCS. The UXOQCS's responsibilities include, but are not limited to, the following:

- Developing, assessing the effectiveness of, and maintaining this QCP and related procedures
- Reviewing and approving the qualifications of proposed technical staff and subcontractors
- Planning and ensuring the performance of preparatory, initial, follow-up, and completion audits for each definable feature of work (DFOW) (e.g., DGM completion, MEC identification, scrap removal)
- Identifying quality problems and verifying that appropriate corrective actions are implemented

- Ensuring that the requisite QC records, including submittals, are generated and retained as prescribed in this QCP
- Performing QC audits and surveillance
- Ensuring document control is implemented
- Administering project records
- Following the responsibilities specific to munitions response operations

This multifunctional UXOQCS will also be the SUXOS with the following responsibilities:

- Plan, coordinate, and supervise all explosives operations
- Assist in the development of munitions response plans
- Supervise multiple teams

The UXOQCS/SUXOS will coordinate with the PM and will report to the Program QC Officer. The UXOQCS has authority to enforce the procedures defined in this QCP. The UXOQCS has the authority to stop work to ensure project activities comply with specifications of this QCP, the Contract, and the project. This authority applies equally to all project activities, whether performed by CH2M HILL or its subcontractors.

Health and Safety Manager (HSM)

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 (FTL) and Site Safety Coordinator (SSC)

The field team leader (FTL) for this project is Dan Tomczak. 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 Dan Tomczak. The SSC develops and implements the project-specific HSP (refer to Appendix B) 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
- Drilling and groundwater monitoring well installation
- Analytical laboratory services
- Data validation
- Survey the location and elevation of the groundwater monitoring wells
- Vegetation removal and clearing services
- MEC avoidance services

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 prepare a weekly report detailing project progress.

During the field effort, the FTL will be in regular telephone or face-to-face contact with the project team. When significant problems or decisions requiring additional authority occur, the FTL can immediately contact the PM for assistance. The 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 and weekly reports, boring logs, QA reports, and other project information will be shared by the members of the project team as needed. All communications with MCB Camp Lejeune will be channeled through the PM for MCB Camp Lejeune, who will be informed 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.

The environmental QC forms (Form 4-1a and Form 4-2a) referenced in this section are provided at the end of the section.

4.3.1 Background

The purpose of this ESI is to evaluate the presence of MEC, scrap, and HTW at the Knox Trailer Park. The specific objectives include the following:

- Identify the nature of any HTW contamination that may exist in the project area
- Evaluate the nature, number, and density of anomalies that could potentially represent subsurface MEC
- Provide geophysical data for future MEC intrusive investigations or removal actions

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 3 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 3—Laboratory Analyses

The purposes of Level 3 data include to determine the nature, extent, and potential fate and transport of HTW contamination at Site UXO-04 and the presence of MEC, scrap, and MEC anomalies at Site UXO-04.

Samples will be analyzed for the analyses presented in Tables 3-1 through 3-3. EPA-approved methods from the current edition of publication SW-846, *Test Methods for Evaluating Solid Waste,*[1] will be used to analyze samples. Data package deliverables are summarized below.

Level 3 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
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
General Chemistry
Includes potentiometric, gravimetric, colorimetric, and titrimetric analytical techniques. TRPH (418.1), project, etc. The following forms must be included (where applicable)
Form 1—Sample Results
Form 2A—Initial and Continuing Calibration Summary
Form 3—Initial and Continuing Calibration Blanks and Method Blanks Summary
Form 5A –MS/MSD Recoveries Summary
Form 6—Native Duplicate and MS/MSD Precision Summary
Form 7—Laboratory Control Sample Recovery Summary
Form 10—Instrument or Method Detection Limit Summary
Form 13—Preparation Log Summary

[1] Available at http://www.epa.gov/epaoswer/hazwaste/test/main.htm#table.

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 matrix spikes. It is calculated from analytical data and is not measured directly. Spiking of reference materials into a sample matrix is the preferred technique because it provides a measure of the matrix effects on analytical accuracy. Accuracy is defined as percent recovery.

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 Sampling 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 3.5.2. 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 4.3.12). 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 3.7. 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 3.5.2. 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 (refer to Form 4-1, at the end of this section).

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.

Laboratory Analyses

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

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

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

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

- U—Undetected. Samples were analyzed for this analyte, but it was not detected above the method detection limit (MDL) or instrument detection limit
- 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 review and validation process, the laboratory qualifying flags are evaluated and replaced with the project-specific validation flags.

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

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 3.5.2. These QC samples will be submitted blind to the laboratory. Field measurement QC procedures will include the calibration requirements discussed in Section 4.3.5.

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 4.3.7
- 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. Laboratory performance will be audited by the QACM or designee

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

Field audits are not currently anticipated during this investigation, but will be performed if necessary.

Laboratory Audits

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

Laboratory systems are audited annually and as required by specific projects. The laboratories are required to submit a laboratory quality assurance plan and 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.

The laboratory will be required to perform the following:

- Monthly project review of 10 percent of all projects done by the QA department
- Audits by the laboratory QA manager at a frequency greater than specified in the laboratory quality assurance plan

- Special audits by the QACM or corporate management when a problem is suspected
- Yearly audits by the corporate QACM

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 nonroutine maintenance. Laboratories will be audited by the PC prior to the start of analyses.

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 4.3.7. 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 form for problems associated with sample collection is completed by the person discovering the QA problem (refer to Form 4-2 at the end of this section). 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 corrective action request 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 corrective action request 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:

- Resampling and reanalyzing
- 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 QAP for any target compound.
- Undesirable trends are detected in matrix spike recoveries or RPD between matrix spike duplicates.
- There are unusual changes in detection limits.
- Deficiencies are detected by the laboratory QA Director during internal or external audits, or from the results of performance evaluation samples.

If nonconformances including, but not limited to, analytical methodologies or QC sample results are identified by the bench analyst, 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. Corrective action requests will be documented with Form 4-2 (refer to the end of this section).

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 ESI report and may include the following:

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

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

4.4 MEC-Related Quality Assurance Objectives

The MEC-related QC forms (Forms 4-1b through 4-9b) referenced throughout this section are included at the end of the section. As discussed in Section 4.3.1, the purpose of this ESI is to evaluate the presence of MEC, scrap, and HTW at the Knox Trailer Park. The specific objectives include the following:

- Identify the presence and nature of any HTW contamination that may exist in the project area
- Evaluate the nature, number, and density of anomalies that could potentially represent subsurface MEC
- Provide geophysical data for future MEC intrusive investigations or removal actions

4.4.1 Definable Features of Work and the Three-Phase Control Process

MEC-related QC will be monitored through the DFOWs using a three-phase control process.

Definable Features of Work

The DFOWs for this project are divided into activities related to planning, field operations, and final project reports and closeout:

Planning Pre-Mobilization Activities: System set up for GIS, document management and control, data management and subcontracting.

- Preparing work plan
- Preparing an ESS Waiver: Preparing and obtaining approval from appropriate EOD personnel.

Field Operations Site Preparation: mobilization, survey, vegetation removal, surface clearance.

- DGM survey
- Scrap identification and stockpiling onsite
- Site restoration and demobilization

Final Project Reports and Closeout Preparing GIS maps.

- Preparing ESI Draft and Final Reports: preparing and obtaining approval
- Data archiving and project closeout

Three Phases of Control

The UXOQCS is responsible for ensuring that the three-phase control process, including the Preparatory Phase, Initial Phase, and Follow-up Phase, is implemented for each DFOW listed in this QCP, regardless of whether it is performed by CH2M HILL or its subcontractors. Each control phase is important for obtaining a quality product and meeting the project objectives; however, the preparatory and initial audits are particularly valuable in preventing problems. Production work is not to be performed on a DFOW until successful Preparatory and Initial Phases have been completed.

Preparatory Phase. The Preparatory Phase culminates with the planning and design process leading up to actual field activities. Successful completion of the Preparatory Phase verifies that the project delivery, QC, and safety plans have been completed. The following actions will be performed as applicable for each DFOW:

1. Confirm that the appropriate technical procedures are incorporated into the project work plan and review procedures.
2. Confirm that adequate testing is called for to ensure quality delivery.
3. Confirm definition of preliminary work required at the work site and examine the work area to confirm required preliminary work has been properly completed.
4. Confirm availability of required materials and equipment. Examine materials and equipment to confirm compliance with approved submittals and procedures. Ensure equipment testing procedures are in place, with control limits and frequency, for each piece of equipment.
5. Confirm qualifications/training of personnel and verify roles/responsibilities are well-defined and communicated.
6. Confirm with the HSM that the site HSP adequately address the work operations and that applicable safety requirements have been incorporated into the plan.

7. Discuss methods to be employed during the field activities.
8. Confirm any required permits and other regulatory requirements are met.
9. Verify that lessons learned during previous similar work have been incorporated as appropriate into the project procedures to prevent recurrence of past problems.

Project staff must correct or resolve discrepancies between existing conditions and the approved plans/procedures identified by the UXOQCS and the team during the Preparatory Phase. The UXOQCS or designee must verify that unsatisfactory and nonconforming conditions have been corrected prior to granting approval to begin work.

Results of the activity are to be documented in the Preparatory Inspection Checklist (Form 4-1b) specific for the DFOW and summarized in the Weekly QC Report.

Initial Phase. The Initial Phase occurs at the startup of field activities associated with a specific DFOW. The Initial Phase confirms that this QCP, other applicable work plan sections, and procedures are being effectively implemented and the desired results are being achieved.

During the Initial Phase, the initial segment of the DFOW is observed and inspected to ensure that the work complies with contract and work plan requirements. The Initial Phase should be repeated if acceptable levels of specified quality are not met. The following shall be performed for each DFOW:

1. Establish the quality of work required to properly deliver the project in accordance with contractual requirements. The UXOQCS will ensure that the field teams are aware of expectations associated with the field methods established under the Preparatory Phase by observing the initial work activities and interacting with the PM, AM, and responsible subcontractors' supervisors.
2. Resolve conflicts. The UXOQCS will guide the PM and responsible supervisor(s) in resolving conflicts. Should conflicts arise in establishing the baseline quality for the DFOW, the responsibility to resolve the conflict falls to the PM. Should the conflict not be resolved in a manner that satisfies the project requirements, the UXOQCS must elevate the conflict to the program level (i.e., the Program QC Manager) and issue a non-conformance report. The UXOQCS may direct a cessation of work activity with the concurrence of the Program QC Manager should the issue jeopardize the results of the DFOW or put the project at risk of non-conformance.
3. Verify with the HSM that the site HSP was developed to ensure that the identified hazards adequately address field conditions. Confirm that applicable safety requirements are being implemented during field activities.

Upon completion of Initial Phase activities, the results are to be documented in the Initial Phase Inspection Checklist (Form 4-2b) and the QC logbook and summarized in the Weekly QC Report. Should results be unsatisfactory, the Initial Phase will be rescheduled and performed again.

Follow-up Phase. Completion of the Initial Phase of QC activity leads directly into the Follow-up Phase, which addresses the routine day-to-day activities at the site. Inspection

and audit activities associated with each DFOW are addressed in Section 4.4. Specific concerns associated with the Follow-up Phase include:

1. Inspection of the work activity to ensure work complies with the Contract and work plans.
2. Evaluation and confirmation that the quality of work is being maintained at least at the level established during the Initial Phase.
3. Evaluation and confirmation that required testing is being performed in accordance with procedures established during the Preparatory Phase and confirmed during the Initial Phase.
4. Confirmation that nonconforming work is being corrected promptly and in accordance with the direction provided by the UXOQCS.

To conduct and document these inspections, the UXOQCS is to generate the Follow-up Phase Inspection Checklist (Form 4-3b). The Follow-up Phase inspections will be performed daily or as otherwise identified in this QCP until the completion of each DFOW.

The UXOQCS is responsible for onsite monitoring of the practices and operations taking place and verifying continued compliance with the specifications and requirements of the Contract, project, and approved project plans and procedures. The UXOQCS is also responsible for verifying that a daily health and safety inspection is performed and documented as prescribed in the HSP (refer to Appendix B, Attachment B). Discrepancies between site practices and approved plans and procedures are to be resolved and corrective actions for unsatisfactory and nonconforming conditions or practices are to be verified by the UXOQCS or a designee prior to granting approval to continue work. Follow-up Phase inspection results are to be documented in the QC logbook and summarized in the Weekly QC Report.

Additional Audits. Additional audits performed on the same DFOW may be required at the discretion of the Program QC Officer or the UXOQCS. Additional preparatory and initial audits are generally warranted under any of the following conditions: unsatisfactory work, changes in key personnel, resumption of work after a substantial period of inactivity (e.g., 2 weeks or more), or changes to the project scope of work/specifications.

Final Acceptance Audit. Upon conclusion of the DFOW and prior to closeout, the Final Acceptance Inspection must be performed to verify that project requirements relevant to the work are satisfied. Outstanding and nonconforming items are to be documented on the Final Inspection Checklist (Form 4-4b). Resolution of each item must be noted on the checklist. Contractor acceptance and closeout of each definable work feature is a prerequisite to project closeout.

4.4.2 Audit Procedures

The UXOQCS is responsible for verifying compliance with this QCP through audits and surveillance. The UXOQCS or a designee is to inspect/audit the quality of work being performed for the definable feature of work. The UXOQCS or a designee is to verify that procedures conform to applicable specifications stated in this work plan or other applicable guidance. Identified deficiencies are to be communicated to the responsible individual and

documented in the QC logbook and Weekly QC Report. Corrective actions are to be verified by the UXOQCS and recorded in the Weekly QC Report.

The specific QC audit procedures for the DFOWs, including the phase during which it is performed, the frequency of performance, the pass/fail criteria, and actions to take if failure occurs, are presented in Table 4-1.

Detailed QC procedures for DGM activities are outlined in the GIP in Chapter 4. The QC performed for the DGM activities will be tracked in the Munitions Response Site Information Management System (MRSIMS) (refer to Section 4.4.4) and will be audited by the Project Geophysicist or his designee on a daily basis.

The Inspection Schedule and Tracking Form (Form 4-5b) is to be used by the UXOQCS for planning, scheduling and tracking the progress of audits for this project. The information on the form is to be kept up to date and reviewed by the UXOQCS for planning purposes. Audit activities and corrective actions are to be documented by the UXOQCS in accordance with this chapter. Audit records are to be maintained as part of the project QC file.

4.4.3 Corrective/Preventive Action Procedures

The corrective and preventive action procedures are designed to prevent quality problems and to facilitate process improvements, as well as identify, document, and track deficiencies until corrective action has been verified.

Preventive Measures

While the entire QC program is directed toward problem prevention, certain elements of the program have greater potential to be proactive. The primary tools for problem prevention on this project are discussed in Three Phases of Control (Section 4.4.1), Submittal Management (Section 4.4.5), and Personnel Qualification and Training (Section 4.4.6). Should these preventive measures fail, tracking and communicating deficiencies provide a mechanism for preventing their recurrence.

Continual Improvement

Project staff at all levels are encouraged to provide recommendations for improvements in established work processes and techniques. The intent is to identify activities that are compliant but can be performed in a more efficient or cost-effective manner. Typical quality improvement recommendations include identifying an existing practice that should be improved and/or recommending an alternate practice that provides a benefit without compromising prescribed standards of quality. Project staff are to bring their recommendations to the attention of project management or the QC staff through verbal or written means. However, deviations from established protocols are not to be implemented without prior written approval by the PM and concurrence of the UXOQCS. Where a staff-initiated recommendation results in a tangible benefit to the project, public acknowledgment is to be given by the PM.

Deficiency Identification and Resolution

While deficiency identification and resolution occurs primarily at the operational level, QC audits provide a backup mechanism to address problems that either are not identified or

cannot be resolved at the operational level. Through implementation of the audit program prescribed in this QCP, the QC staff is responsible for verifying that deficiencies are identified, documented as prescribed herein, and corrected in a timely manner. Deficiencies identified by the QC staff are to be corrected by the operational staff and documented by the QC staff.

Corrective Action Request

A Corrective Action Request (CAR) (Form 4-6b) can be issued by any member of the project staff, including CH2M HILL and subcontractor employees. If the individual issuing the CAR is also responsible for correcting the problem, then that individual should do so and document the results on Part B of the CAR (Form 4-6b). Otherwise, the CAR should be forwarded to the PM, who is then responsible for evaluating the validity of the request, formulating a resolution and prevention strategy, assigning personnel and resources, and specifying and enforcing a schedule for corrective actions. Once a corrective action has been completed, the CAR and supporting information are to be forwarded to the UXOQCS for closure. Sufficient information is to be provided to allow the QC reviewer to verify the effectiveness of the corrective actions.

In addition to observing actual work operations, CARs are to be reviewed during follow-up QC audits. The purposes of this review are as follows: to ensure that established protocols are implemented properly; to verify that corrective action commitments are met; to ensure that corrective actions are effective in resolving problems; to identify trends within and among similar work units; and to facilitate system root cause analysis of larger problems. Particular attention is to be given by the QC staff to work units that generate either an unusually large or unusually small number of CARs.

The UXOQCS will determine whether a written Corrective Action Plan (CAP) (Form 4-7b) is necessary, based on whether or not any of the following are met: the CAR priority is high; deficiency requires a rigorous corrective action planning process to identify similar work product or activities affected by the deficiency; or deficiency requires extensive resources and planning to correct the deficiency and to prevent recurrence. The CAP is developed by a PM designee and approved and signed by the PM. The CAP is to indicate whether it is submitted for informational purposes or for review and approval. In either event, the operational staff are encouraged to discuss the corrective action strategy with the QC staff throughout the process. The CAP form is included at the end of this chapter.

Deficiency and Corrective Action Tracking

Each CAR must be given a unique identification number and tracked until corrective actions have been taken and documented in Part B of the form and the CAR is submitted to the UXOQCS or a designee for verification and closure.

Lessons Learned and Other Documentation

The lessons learned through the deficiency management process are documented on CARs and CAPs. To share the lessons learned, these documents can be submitted to the Client through a Weekly QC Report summarizing the week's QC activities and including a grouping of the Daily QC Reports (Form 4-8b) and all other pertinent reports created during the week.

CARs should be cited in the Weekly QC Report. Minor deficiencies identified during a QC audit that are readily correctable and can be verified in the field are to be documented in the QC logbook and Weekly QC Report without initiating a CAR. Deficiencies that cannot be readily corrected are to be documented by the QC staff on a CAR and in the Weekly QC Report. Copies of CARs are to be referenced in and attached to the Weekly QC Report. CAPs will also be attached to Weekly QC Reports to document the final outcome of the deficiency. Similar or related deficiencies may be addressed on a single CAP.

4.4.4 Records Generated

Onsite Project File

The UXOQCS will establish and maintain an onsite project file in accordance with the CH2M HILL corporate quality manual for document control. The onsite files will be maintained in the project field office or designated field vehicle. The purpose of these files is to maintain a complete set of all documents, reports, certifications, and other records that provide information on project plans, contractual agreements, and project activities.

The CH2M HILL MRSIMS, which consists of a mobile field data collection device used to collect form-based information of MEC and DGM operations and a centralized desktop interface and database, will be the repository for most of the information collected by the field team (e.g., daily reports). This database will contain information that can be easily presented and delivered through automated report production, which reduces the amount of actual paper in the files. The database will be backed-up daily and stored in an offsite location as well as in the project trailer. The files (in either paper or digital format) will include copies of the following:

- Qualifications and training records of all site personnel
- Submittals
- Schedule and progress reports
- Survey records
- Conversation logs
- Meeting minutes and agenda
- Audit logs and schedules
- Photo documentation
- Site maps
- Equipment check records
- Nonconformance and corrective action reports
- Daily work activity summary reports, which may include:
  - Weekly QC Report
  - Daily Health and Safety Report
  - Daily Report (including activity log)
  - Daily MEC Team Logs
  - Daily DGM Team Logs
  - Reports on any emergency response actions (EOD will handle emergencies on this project)
  - Equipment check records
  - COC records

- Incident reports
- Truck load tickets and shipping papers (if applicable)

As the project activities progress, the UXOQCS will monitor the usefulness of the project filing system for information retrieval. If additional file sections are needed, the UXOQCS will expand the initial filing structure to include additional sections.

Weekly QC Report

The UXOQCS is responsible for preparing and submitting the Weekly QC Report to the Program QC Officer for the project file and providing concurrent courtesy copies to the PM. The Weekly QC Report with attachments is to be submitted to the Program QC Officer on the first workday following the dates covered by the report.

The Weekly QC Report is to provide an overview of QC activities performed each day, including those performed by subcontractors. The QC reports must present an accurate and complete picture of QC activities by reporting both conforming and deficient conditions, and the reports should be precise, factual, legible, and objective. Copies of supporting documentation, such as checklists and surveillance reports, are to be attached.

A field QC log is to be maintained by the UXOQCS to document details of field activities during QC monitoring activities. At the end of each day, copies of the log entries are to be attached to the Weekly QC Report. The information in the field QC log provides backup information and is intended to serve as a phone log and memory aid in the preparation of the Weekly QC Report and for addressing follow-up questions.

QC and health and safety staff input for the Weekly QC Report is to be provided in writing to the UXOQCS at a previously agreed upon time and place, generally no later than 1 hour before normal close of business. For the sake of simplicity and completeness, the format for QC staff input should follow the same format as the Weekly QC Report with only the relevant sections completed.

Copies of Weekly QC Reports with attachments and field QC logs no longer in use are to be maintained in the project QC file. Upon project closeout, all QC logs are to be included in the project QC file.

4.4.5 Submittal Management

The PM is responsible for overall management and control of project submittals. The PM is also responsible for submittal scheduling and tracking.

The UXOQCS is responsible for ensuring, through detailed review, that submittals as well as the materials and the work they represent, are in full compliance with applicable contractual specifications and the project plans. The UXOQCS is also responsible for ensuring that a project file is established and maintained and that accountable project documents are retained and controlled appropriately.

Review of Plans and Specifications

During the Preparatory Phase of a DFOW, the UXOQCS is responsible for reviewing the plans and, when necessary, requesting clarification from the project team. The primary

purpose of this review is to identify and resolve potential conflicts prior to initiating work operations.

Review and Approval of Submittals

The UXOQCS and the PM must review submittals prepared by CH2M HILL and subcontractors for completeness and compliance with the specifications of the project and Contract. Non-compliant submittals are to be returned to the originator for corrective action and re-submittal to the UXOQCS or his designee.

Prior to submittal to the UXOQCS for certification, technical documents (e.g., reports and plans) are to be reviewed by qualified staff. Although part of the QC process, technical reviewers may include, but are not limited to, the QC staff.

For each project document that is submitted for technical review, a Document Review and Release Form (Form 4-9b) is to be initiated by the author, submitted with the document to be reviewed, and used to document and track the review process. A copy of the completed Document Review and Release Form is to be submitted to the UXOQCS together with the corrected document for his review and certification. Each document is to provide a signature block for UXOQCS certification. Original Document Review and Release Forms, reviewer comments, and annotated versions are to be retained with the deliverable in the project file and reviewed by the QC staff during project audits.

4.4.6 Personnel Qualifications and Training

All project staff members will be qualified to perform their assigned jobs in accordance with the terms outlined in the Contract and by the project plans. Specific qualifications and training required for UXO-qualified personnel are stated in the following subsections. Qualifications for DGM operations-related personnel are covered in the GIP in Section 3.4.

Documentation of Qualification and Training for UXO-qualified Personnel

The UXOQCS will maintain records documenting the required qualifications, training, and certifications for each site worker. The UXOQCS will monitor expiration dates to provide advance warning to the PM of when employees will require refresher training or other renewals. The UXOQCS will maintain records of site-specific and routine training for personnel and visitors, as required by these project plans. These records will be maintained onsite for audit purposes.

All UXO Personnel

All MEC personnel will comply with the training requirements specified by the Program QC Manager. UXO personnel assigned to the position of UXO Technician I, UXO Technician II, or UXOQCS will be graduates of one of the following schools or courses:

- U.S. Army Bomb Disposal School, Aberdeen Proving Ground, Maryland
- U.S. Naval EOD School, Indian Head, Maryland
- U.S. Naval EOD School, Eglin Air Force Base, Florida
- U.S. Department of Defense-certified equivalent course (UXO Technician I only)

EOD experience in National Guard or Reserve Units will be based on the actual documented time spent on active duty, not on the total time of service.

UXO Sweep Personnel

UXO sweep personnel assist UXO technicians and UXO-qualified personnel in the performance of UXO-related operations. UXO sweep personnel do not have to be UXO technicians; however, they must be provided job and site-specific training. At a minimum, training will include: explosives safety; recognition of MEC, particularly UXO; and the proper use of personal protective equipment. UXO sweep personnel are not involved in the execution of explosives operations and will not have intentional physical contact with MEC. With direction and supervision of UXO-qualified personnel, UXO sweep personnel may:

- Conduct visual and/or detector-aided MEC field search activities
- Locate subsurface MEC by operating geophysical detection instruments and related equipment
- Perform field maintenance and tests on geophysical detection instruments and related equipment
- Remove nonhazardous munitions debris and range-related debris, only after such items have been inspected by a UXO technician or UXO-qualified personnel and determined to be safe for handling
- Perform site and area security functions

UXO Technician I

In addition to being able to perform all functions of the UXO sweep personnel listed in this section, for this project, UXO Technician I personnel may, with the direction and supervision from UXO-qualified personnel:

- Reconnoiter and classify MEC
- Identify all types of military munitions, including possible fuzes and their condition, armed or unarmed; examples are the following:
  - Bombs
  - Guided missiles
  - Projectiles
  - Rockets
  - Land mines and associated components
  - Pyrotechnic items
  - Military explosives and demolition materials
  - Grenades
  - Submunitions
- Operate personnel decontamination stations

UXO Technician II

In addition to being able to perform all functions of the UXO sweep personnel and UXO Technician I listed in this chapter, for this project, UXO Technician II personnel may:

- Determine precise location in field environment using a variety of techniques such as global positioning equipment or basic land navigation using topographical map and compass
- Perform field-expedient identification procedures to identify contaminated soil
- Perform limited technical supervision of UXO sweep personnel
- Escort personnel who are not directly involved in UXO-related operations (e.g., personnel performing environmental monitoring), but who have activities to perform within exclusion zones
- Inspect material potentially presenting an explosive hazard (MPPEH) for the presence of explosive safety hazards

UXO Quality Control Specialist

In addition to being able to perform all functions of the UXO sweep personnel, UXO Technicians I and II, listed in this section, for this project the UXOQCS may:

- Develop and implement the MEC-specific sections of the QCP for all explosives-related operations
- Conduct daily audits of the procedures used by UXO teams and individuals for processing MPPEH
- Perform and document random sampling (by pieces, volume, or area) of all MPPEH collected from the various teams to ensure no items with explosive hazards, engine fluids, illuminating dials and other visible liquid HTW materials are identified as munitions debris or range-related debris
- Conduct QC audits of all explosives operations for compliance with established procedures
- Identify and verify completion of all corrective actions to ensure all explosives operations comply with requirements

UXO Team Composition and Roles

For all MEC-related operations, each UXO team will consist of one UXO Technician II and two to six team members. Teams will have a minimum of two UXO-qualified personnel, one of which will be the UXO Technician II. A UXO Technician II will supervise all MEC operations and all teams operating within an exclusion zone.

Health and Safety Training

Health and safety training requirements for onsite project personnel have been established in accordance with Occupational Safety and Health Act/Occupational Safety and Health Administration requirements for hazardous site workers (29 CFR 1910.120) and are specified in the HSP (Appendix B). These training requirements must be met before project personnel can begin site work.

4.4.7 Testing and Maintenance

Testing and maintenance of equipment such as geophysical instruments, radios, cell phones, vehicles and machinery will be performed per the manufacturer's specifications, this work plan, and all applicable SOPs. Geophysical detection equipment will be tested daily, as specified in the GIP.

Test results must be documented by the individual performing the test. Testing and maintenance records associated with the measuring and testing of equipment must be generated by the individual performing the activity. Documentation for testing and maintenance of equipment is to be made available to the client upon request.

The UXOQCS is responsible for ensuring that the tests are performed and that the results are summarized and provided with the weekly QC report. To track each failing test for future retesting, the failing test must be noted on the deficiency log. Resolution of the failing test is complete when retesting is performed and the corrective action is verified on the deficiency log.

4.4.8 DGM Systems Quality Control

An extensive QC program will be applied to the DGM operations at the site. Figure 4-2 shows an overall chart of the QC steps, and details for those steps are provided in the following subsections.

DGM Instruments Quality Control

Each of the geophysical systems will be field tested to confirm proper operating conditions. Several basic QC tests will be performed in addition to instrument-specific tests. The instrument-specific tests are described in the instrument operation SOPs in the GIP and a description of each basic QC test, its acceptance criteria, and its frequency is provided below and summarized in Table 4-2.

1. **Equipment Warm-up**. This is an instrument-specific activity, although standard warm-up time is 5 minutes. Some geophysical systems require more warm-up time than others. Each system-specific SOP defines the equipment-specific warm-up time. Equipment warm-up will be performed the first time an instrument is turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down

2. **Record Sensor Positions**. Positioning accuracy of the final processed data will be demonstrated by operating the equipment over one or more known points. It is important that the positioning system be tested in exactly the same manner in which it is to be used during the actual surveys. The accuracy of the data positioning will be assessed by calculating the difference between the location where the track-plots cross each other on the map and the actual location of the known point(s). Presumably, the actual track-plots will cross exactly over the known point when the data was collected, and the difference, if any, observed on the final track-plot map is a direct measure of the positioning system's accuracy. The sensor position test will be conducted at the beginning of the survey operation for each work day

3. **Personnel Test.** This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that can possibly create false anomalies. The personnel test will be conducted at the beginning of the survey operation for each work day

4. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that can possibly create false anomalies. The vibration test will be conducted at the beginning of the survey operation for each work day

5. **Static Background and Static Spike**. Static tests will be performed by positioning the survey equipment within or near the survey boundaries in an area free of metallic contacts and collecting data for (minimally) a 3-minute period. During this time, the instrument will be held in a fixed position without a spike (known standard) and then with a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. The static background and static spike test will be conducted at the beginning and end of each survey operation

6. **Azimuthal Test.** This test will be performed to verify that a system's sensors are oriented in such a manner that minimizes data drop-outs and maximizes instrument response. This test will be performed only for magnetometer systems and will be conducted the first time the system is used at the site

7. **Height Optimization.** This test is performed to verify that a system's sensors are positioned at the most appropriate height to achieve the project DQOs. This test will be conducted the first time the system is used at the site

8. **Six Line Test.** The Six Line Test is a standard response test consisting of a predetermined route (survey line) established on or near the site in an area free of metallic contacts. The beginning, midpoint, and end of the line will be marked; data will be collected along the line. The line will be traversed six times: (1) *normal* data collection speed *without* a spike at the center point; (2) *normal* data collection speed *without* a spike at the center point; (3) *normal* data collection speed *with* a spike at the center point; (4) *normal* data collection speed *with* a spike at the center point; 5) *fast* data collection speed *with* a spike at the center point; and (6) *slow* data collection speed *with* a spike at the center point. (Speed of data collection will also be evaluated as part of the GPO analysis process.) The Six Line Test will be conducted the first time a system is used at the site

9. **Repeat Data.** This test is performed to verify repeatability of the data and will be performed after the initial survey over an area

QC Seed Items

The seed items will test the DGM subcontractor's ability to meet the project DQOs and the MEC subcontractor's intrusive activities. At least one inert MEC item (or surrogate if necessary) will be seeded per 2 acres to be surveyed. The seed items will be painted blue and tagged with a nonbiodegradable label identifying the items as inert and providing a contract reference, a point of contact address, phone number, and a target identifier. CH2M HILL personnel will perform seeding using hand or mechanical tools, depending on soil conditions. The seed locations will be checked using a hand-held analog geophysical instrument to confirm that no existing anomalies are present at the seed location. Once placed, the locations of all seeded items will be surveyed using an RTK DGPS. The items will be placed at detectable depths (as determined by the GPO in the GIP). Over 75 percent of the items will be placed at a depth of at least 75 percent of the maximum detection depth determined from the DQO for that specific item. Once the items are placed, any evidence of excavation will be removed by hand by raking the surface.

A summary of the seed items' descriptions, locations, depths, and orientations will be provided to the QA geophysicist.

Quality Control of DGM Data and Deliverables

Both the DGM subcontractor and CH2M HILL will perform QC of geophysical data and data deliverables at each step of the processing path. Figure 4-3 shows the processing path and the QC steps performed. Data will not move to the next stage until they have passed the QC check.

The following items are among the QC checks performed on the field forms (the terms "appropriate" and "acceptable" will be in accordance with what is defined through the GPO process):

- Appropriate fields have been completed
- Field entries are appropriate for work performed
- Data required for geophysical data processors have been entered
- General editorial review (spelling, dates, etc.)

The following items are among the QC checks performed (as applicable to the particular data set) on the *preprocessed* data:

- Data have been translated from local coordinates into the State Plane system
- Coordinates are correct (grids fall in correct locations when loaded into GIS)
- Line gaps have been accounted for
- Background geophysical noise is acceptable
- Cross-track distances between lines are acceptable
- Magnetometer dropouts are acceptable
- Downline data density is acceptable
- Appropriate file headers have been attached
- Files contain appropriate grids

The following items are among the QC checks performed (as applicable to the particular data set) on the *processed* data:

- Heading correction is appropriate
- Lag correction is appropriate
- Despiking is appropriate
- Leveling is appropriate
- Filtering performed is appropriate
- Line breaking is appropriate
- Anomaly selections are appropriate

Corrective Measures

Specific corrective measures are dependent on the type of geophysical equipment used; however, the following are the basic corrective measures to be followed in association with DGM surveying:

- Replacement of sensors if they fail to meet instrument check requirements
- Resurvey of grids if seeded items are not identified (do not show in the DGM data). In a situation in which there is a failure to select a seed item from the data but the item is clearly present in the DGM data, a resurvey will not be performed, but instead a reanalysis of the DGM data

A detailed discussion of corrective measures or nonconformance is presented in the GIP. QC will be implemented by the UXOQCS under the program oversight of the Program QC Manager.

4.4.9 Analog Geophysical Systems Quality Control

QC over the analog geophysical instruments will be accomplished through daily checks that the instruments are functioning prior to using them for field activities. The GPO plot will be used for checking instrument functionality for each analog instrument at the start of each work day. Each instrument will be operated over a 20-mm projectile buried close to the maximum detection depth determined for that item during the GPO. If the instrument is not able to detect the item, it will be taken out of use until it is repaired.

TABLE 4-1
Definable Features of Work Auditing Procedures
Knox Trailer Park, Site UXO-04, Expanded Site Investigation Work Plan
MCB Camp Lejeune
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Planning						
Geographical Information System (GIS) Setup (Pre-mobilization Activities)	Project GIS Manager	Verify GIS system has been set up and is ready for site data.	PP	O	GIS system has been set up and is ready for site data.	Do not proceed with field activities until criterion is passed.
Document management and control (Pre-mobilization Activities)	Project Manager	Verify appropriate measures are in place to manage and control project documents.	PP	O	Appropriate measures are in place to manage and control project documents.	Do not proceed with field activities until criterion is passed.
Data Management (Pre-mobilization Activities)	Project Manager, Project Geophysicist	Verify appropriate measures are in place to manage and control project data.	PP	O	Appropriate measures are in place to manage and control project data.	Do not proceed with field activities until criterion is passed.
Subcontracting (Pre-mobilization Activities)	Project Manager, Site Manager	Verify subcontractor qualifications, training, and licenses.	PP/IP	O	Subcontractors' qualifications, training, and licenses are up to date and acceptable.	Ensure subcontractor provides the qualifications, training, and licenses or change subcontractor.
Technical and Operational approach (Technical Project Planning)	Project Manager	Verify technical and operational approaches have been agreed on by the project team.	PP/IP	O	Technical and operational approaches have been agreed on by project team and incorporated into the Work Plans.	Do not proceed with field activities until criterion is passed
Geophysical Prove-out (GPO) Work Plan preparation and approval	Project Manager	Verify GPO Plan has been prepared and approved.	PP/IP	O	GPO Work Plan has been approved	Do not proceed with field activities until criterion is passed.
GPO Execution	Project Manager, Project Geophysicist	Verify data quality objectives (DQOs) established in GPO Work Plan have been accomplished.	PP/IP	O	DQOs identified in GPO Work Plan have been achieved	Continue with GPO until DQOs are achieved.
GPO Report	Project Manager, Project Geophysicist	Verify recommendations in GPO Report for Digital Geophysical Mapping (DGM) system and associated DQOs have been approved.	PP/IP	O	Recommendations for DGM equipment and associated DQOs are approved by USACE.	Do not proceed with DGM field activities until recommendations of GPO Report are approved.
Work Plan and Explosives Safety Submission (ESS) Waiver preparation and approval	Project Manager	Verify Work Plan and ESS Waiver have been prepared and approved.	PP/IP	O	ESS Waiver has been approved	Do not proceed with field activities (excluding site mobilization) until criterion is passed.
Field Operations						
Site preparation (Mobilization)	Project Manager	Verify local agencies are coordinated.	PP/IP	O	Local agencies are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Project Manager	Verify equipment has been inspected and tested.	PP/IP	E	Equipment passes inspection and testing.	Proceed only with activities for which equipment has passed inspection and testing.
Site preparation (Mobilization)	Project Manager	Verify communications and other logistical support are coordinated.	PP/IP	O	Communications and other logistical support are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Project Manager	Verify emergency services have been coordinated.	PP/IP	O	Emergency services are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	MEC QCS	Verify explosive storage and Munitions and Explosives of Concern (MEC) debris/scrap storage areas have been established.	PP/IP	O	Explosive storage and MEC debris/scrap storage areas are established.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	MEC QCS, Project Manager	Verify site-specific training is performed and acknowledged.	PP/IP	O	Site-specific training is performed and acknowledged	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	MEC QCS, Project Manager	Hold pre-mobilization meeting and Operations Readiness Review (ORR) with the project team.	PP/IP	O	Project plans are reviewed and acknowledged by team members.	Do not proceed with field activities until criterion is passed.
Site preparation (Site Survey)	Project Manager	Verify surveyor qualifications.	PP/IP	O	Surveyor's qualifications are up to date and acceptable.	Ensure surveyor provides the qualifications prior to starting work or change surveyor.
Site preparation (Site Survey)	Project Manager	Verify surveyor licenses.	PP/IP	O	Surveyor's licenses are up to date and acceptable.	Ensure surveyor provides the licenses prior to starting work or change surveyor.

TABLE 4-1
Definable Features of Work Auditing Procedures
Knox Trailer Park, Site UXO-04, Expanded Site Investigation Work Plan
MCB Camp Lejeune
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Site Preparation (Site Survey)	Project Manager	Verify benchmarks for survey have been established and documented.	PP/IP	O	Benchmarks for survey have been established and documented.	Ensure benchmarks for survey are established and documented prior to performing survey.
Site Preparation (Site Survey)	Project Manager	Verify site boundaries and grids have been established.	PP/IP	O	Site boundaries and grids have been established.	Do not proceed with dependent field activities until criterion is passed.
Site Preparation (Site Survey)	Project Manager	Verify surveyor notes are legible, accurate, and complete.	IP	O	Surveyor notes are legible, accurate and complete.	Ensure surveyor replaces deficient notes with legible, accurate and complete notes.
Site Preparation (Vegetation Removal)	Project Manager	Verify personnel qualifications and training.	PP/IP	O	Personnel qualifications and training are appropriate.	Ensure subcontractor provides appropriately trained and qualified personnel or replace with properly trained personnel.
Site Preparation (Vegetation Removal)	Project Manager	Verify environmental controls are correct and functional.	IP/FP	O	Environmental controls are correct and functional.	Ensure that appropriate environmental controls are in place prior to proceeding with vegetation removal.
Site Preparation (Vegetation Removal)	Project Manager, MEC QCS	Verify vegetation removal is conducted IAW the Geophysical Investigation Plan (Section 3.3 of Work Plan).	FP	D	Vegetation removal is conducted IAW the Geophysical Investigation Plan (Section 3.3).	Stop vegetation removal activities until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
Site Preparation (Surface MEC identification)	MEC QCS	Verify equipment testing is performed per Section 4.11 of the Quality Control Plan (Chapter 4 of Work Plan)	IP/FP	O/D	Equipment passes daily function test in equipment check area.	Repair or replace instrument.
Site Preparation (Surface MEC identification)	MEC QCS	Verify area/boundary.	PP/IP	O	Area/boundary is marked.	Stop activities until area/boundary can be verified.
Site preparation (Surface MEC identification)	MEC QCS, Project Geophysicist	Verify work methods are conducted IAW the Geophysical Investigation Plan (Section 3.3) and Health and Safety Plan (Section 3.6). Survey/Sweeps MEC Surface Sweeps Scrap Inspection Operations	IP/FP	D	Work methods are being performed IAW the Work Plan and SOPs.	Stop activities until Work Plan and SOPs are being followed and any activities not performed within compliance are re-evaluated and re-performed if necessary.
Site Preparation (Surface MEC identification)	MEC QCS	Verify team separation distance IAW the Geophysical Investigation Plan (Section 3.3 of Work Plan).	IP/FP	D	Team separation distance is appropriate for work being performed and the site munitions with the greatest fragmentation distance	Stop activities until appropriate separation distance is being followed.
Site Preparation (Surface MEC identification)	MEC QCS	Check at least 10% of each grid for any remaining MEC or metal.	FP	E	No MEC or visible metallic item equal to or greater in mass to a 20mm projectile is found.	Perform additional 20% quality control (QC) check in grid, and if additional item is found, grid must be redone.

TABLE 4-1
Definable Features of Work Auditing Procedures
Knox Trailer Park, Site UXO-04, Expanded Site Investigation Work Plan
MCB Camp Lejeune
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Demobilization	Project Manager	Verify facilities-support infrastructures are dismantled and shipped to appropriate location and area is returned to original condition.	FP	O	Facilities-support infrastructures are dismantled and shipped to appropriate location and site is returned to original condition.	Ensure that all support facilities are removed and that the site is returned to original condition
Final Project Reports and Closeout						
Site Specific Final Report preparation and approval	Project Manager, Project Geophysicist	Verify tabulations of all MEC, MD, and other material recovered during the removal actions are accurate and complete.	IP	O	Tabulations of all MEC, MD, and other material recovered during the removal actions are accurate and complete.	Ensure tabulation of all MEC, MD, and other material recovered during the removal actions are accurate and complete
Site Specific Final Report preparation and approval	Project Manager, Project Geophysicist	Verify all dig sheets where geophysical mapping and investigation performed are accurate and complete.	FP	O	All dig sheets where geophysical mapping and investigation performed are accurate and complete.	Ensure all dig sheets where geophysical mapping and investigation performed are accurate and complete
MEC Response Completion Acceptance	Project Manager	Verify Final Report has been approved.	IP	O	Final Report has been approved.	Take appropriate actions to ensure Report gets approved
Archiving	GIS Manager	Verify data back-up systems are in place.	IP	O	Data back-up systems are in place	Ensure data back-up systems are in place
Project Closeout	Project Manager	Verify purchase orders have been closed out.	IP	O	Purchase orders have been closed out	Ensure purchase orders are closed out
Project Closeout	Project Manager	Verify invoices completed and approved.	IP	O	Invoices completed and approved	Ensure invoices are completed and approved

Notes:
IAW = in accordance with

QC Phase	Frequency
PP = Preparatory Phase	O = Once
IP = Initial Phase	D = Daily
FP = Follow-up Phase	W = Weekly
	E = Each occurrence

[1] The responsible person (if other than the MEC QCS) is the individual with whom the MEC QCS will coordinate with to ensure compliance with requirements and to verify that any necessary follow-up actions are taken.
[2] Where appropriate, a reference has been included referring the reader to a more detailed description of the procedures being audited.
[3] Documentation to be in accordance with the three-phase control process as outlined in the Quality Control Plan.

TABLE 4-1
Definable Features of Work Auditing Procedures
Knox Trailer Park, Site UXO-04, Expanded Site Investigation Work Plan
MCB Camp Lejeune
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
DGM Survey	Project Geophysicist	Verify DGM Survey conducted IAW Geophysical Investigation Plan (Chapter 3.3) and DGM SOPs: EM-61 Metal Detection Munition Response Surveys Geophysical Surveying with EM-61 Configuration and Operation of the NovAtel GPS Base-Station System Configuration and Operation of the NovAtel GPS Rover System Field Methodology and Survey Setup Quad Bike Safe Operating Instructions Configuration and Operation of the Ashtech GPS Rover System Configuration and Operation of the Ashtech GPS Base-Station System TM-4 System Configuration – Towed TM-4 Data Acquisition using DGPS Positioning TM-6 System Configuration using DGPS Positioning TM-6 Data Acquisition using DGPS Positioning G-856AX Base Station Operation TM-4 Data Downloading TM-6 Data Downloading G856AX Data Downloading	IP/FP	O/D	DGM Survey conducted IAW Geophysical Investigation Plan (Chapter 3) and DGM SOPs.	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
DGM Survey	Project Geophysicist	Check results of QC tests performed as specified in QCP and DGM SOPs: Field Data Collection: QC Two-Line Test Magnetic Data Acquisition QC Tests	FP	E	QC tests must pass IAW standards determined during the GPO and referenced SOPs.	If a QC test does not pass, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Survey	Project Geophysicist	Confirm that DGM survey DQOs established during GPO are being met.	FP	E	DGM survey DQOs are being met.	If the DQOs are not being met, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Survey	Project Geophysicist	Check results of QC field audits performed by MEC QCS to ensure that no MEC missed from DGM surveys.	FP	E	No MEC or metallic item equal or greater in mass to a 20mm projectile.	If the item was found within the depth criteria established during the GPO, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Data Processing	Project Geophysicist	Verify data checks specified in QCP and SOPs: EM-61 Data Processing and Database Management Uploading and Downloading Data to the FTP Site TM-4 Data Downloading TM-6 Data Downloading G856AX Data Downloading G-856AX Data Validation Magnetometer Data Validation TMI Data Processing Magnetic Data Interpretation in MAGSYS – Inverse Modeling and Discrimination TMI Final Deliverables	FP	E	Data checks must pass in accordance with standards determined during the GPO and referenced SOPs.	If a QC test does not pass, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
Site Restoration	Project Manager	Verify the damage caused by deep ruts is backfilled and laid to original grade and completed	FP	O	Damage caused by heavy vehicle traffic is backfilled and laid to original grade.	Ensure that damage caused by heavy vehicle traffic is backfilled and laid to original grade
Site Restoration	Project Manager	Verify re-vegetation at limited areas to control runoff.	FP	O	Re-vegetation performed as necessary to control runoff.	Re-vegetate as necessary to control runoff

TABLE 4-2
Digital Geophysical Mapping Instruments Standardization Tests and Acceptance Criteria
Knox Trailer Park, Site UXO-04, Expanded Site Investigation Work Plan
MCB Camp Lejeune
Jacksonville, North Carolina

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day	First Time Instr. Used	2% of Total Area Surveyed
1	Equipment Warm-up	Equipment specific (typically 5 min)	X				
2	Record Sensor Positions	+/- 4 inch (2.54 cm)		X			
3	Personnel Test	Based on instrument used. Personnel, clothing, etc. should have no effect on instrument response		X			
4	Vibration Test (Cable Shake)	Data profile does not exhibit data spikes		X			
5	Static Background & Static Spike	+/- 20% of standard item response, after background correction			X		
6	Azimuthal Test *	Sensor orientation that minimizes drop-outs				X	
7	Height Optimization	Maximum S/N ratio that reliably detects smallest target objective				X	
8	Six Line Test	Repeatability of response amplitude +/-20%, Positional Accuracy +/- 20 cm				X	
9	Repeat Data	Repeatability of response amplitude +/-20%, Positional Accuracy +/- 20 cm					X

* Magnetometer Only

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: _____

FORM 4-1b

Preparatory Inspection Checklist
(Part I)

Contract No.:

Date: _____

TITLE AND NO. OF TECHNICAL SECTION: _____

A. Planned Attendees:

	Name	Position	Company
1)			
2)			
3)			
4)			
5)			
6)			
7)			
8)			
9)			
10)			
11)			

B. Submittals required to begin work:

	Item	Submittal No.	Action Code
1)			
2)			
3)			
4)			
5)			
6)			
7)			
8)			

I hereby certify, that to the best of my knowledge and belief, that the above required materials delivered to the job site are the same as those submitted and approved.

_____

Contractor Quality Control Systems Manager

FORM 4-1b (Continued)

Preparatory Inspection Checklist
(Part I)

Contract No.:

Date: _____

C. Equipment to be used in executing work:

1) _____
2) _____
3) _____
4) _____
5) _____

D. Work areas examined to ascertain that all preliminary work has been completed:

_____
_____

E. Methods and procedures for performing Quality Control, including specific testing requirements:

_____
_____

The above methods and procedures have been identified from the project plans and will be performed as specified for the Definable Feature of Work.

_____
Contractor Quality Control Systems Manager

FORM 4-1b (Continued)

Preparatory Inspection Checklist
(Part II)

A. Persons in attendance: See Meeting Attendance Sheet (attached)

B. Because of mutual understanding developed during review of preparatory outline and Contract Requirements: (Contract items not specifically covered during the preparatory inspection conference are assumed to be in strict conformance with the contract requirements.)

The items noted above constitute a memorandum of mutual understanding and will be performed as planned and specified.

MEC QCS

Technical Representative

FORM 4-2b

Initial Phase Check List

Contract No.:

Date: _____

Title and No. of Technical Section: _____

Description and Location of Work Inspected: _____

A. Key Personnel Present:

Name	Position	Company

B. Materials being used are in strict compliance with the contract plans and specifications: Yes ___ No ____

If not, explain: _____

C. Procedures and/or work methods witnessed are in strict compliance with the contract specifications: Yes No ___

If not, explain: _____

D. Workmanship is acceptable: Yes ____ No ____

State where improvement is needed: _____

E. Workmanship is free of safety violations: Yes ____ No ____

If no, corrective action taken: _____

_____

MEC QCS

FORM 4-3b

FOLLOW-UP CHECKLIST

Date:
Contractor:
Contract No:

Y=YES; N=NO; SEE REMARKS BLANK=NOT APPLICABLE	
WORK COMPLIES WITH CONTRACT AS APPROVED IN INITIAL PHASE	

IDENTIFY DEFINABLE FEATURE OF WORK, LOCATION, AND LIST PERSONNEL PRESENT

TESTING PERFORMED & WHO PERFORMED TEST (Include number of samples and/or tests taken)

QA Representative_____ **Date** _____

MEC QCS_____ **Date** _____

FORM 4-4b

Final Inspection Checklist
(Part I)

DATE: _____

CONTRACT NO.:_____

Project / Area of Inspection: _____

A. DEFINABLE FEATURES OF WORK: Status of Inspection:

I hereby certify, that to the best of my knowledge and belief, that the work inspected is complete and all materials and equipment used and work performed were completed in accordance with plans submitted and approved.

_____

CONTRACTOR QUALITY CONTROL SYSTEMS MANAGER

B. Final Acceptance is Approved, Subject to the Correction of the Punchlist Items Below:

FORM 4-4b (Continued)

Final Inspection Checklist
(Part I)

DATE:_____

CONTRACT NO.:

A. Persons in Attendance: See Meeting Attendance Sheet (attached)

B. Resolution of Punchlist Items:

The items noted above constitute a memorandum of mutual understanding and work has been performed as planned and specified.

MEC QCS

TECHNICAL REPRESENTATIVE

FORM 4-4b (Continued)

Final Inspection Checklist
(Part II)

MEETING ATTENDANCE LIST

Meeting:		Date:
Name	**Organization**	**Phone Number**

FORM 4-5b

INSPECTION SCHEDULE AND TRACKING FORM

Project:	**Project Manager:**	**MEC QCS:**

Reference Number	Definable Feature of Work	**Preparatory**		**Initial**		**Follow-Up**		**Completion**		
		Date Planned	Actual Date	Date Planned	Actual Date	Planned Begin/End	Actual Dates	Planned Begin/End	Actual Dates	Status

FORM 4-6b

CORRECTIVE ACTION REQUEST

(2)CAR #:	(3)PRIORITY: □HIGH □NORMAL	(4)DATE PREPARED:

PART A: NOTICE OF DEFICIENCY

(5)PROJECT:		
(6)PROJECT MANAGER:	(7)MEC QCS:	
(8)WORK UNIT:	(9)WORK UNIT MANAGER:	
(10)ISSUED TO (INDIVIDUAL & ORGANIZATION):		
(11)REQUIREMENT & REFERENCE:		
(12)PROBLEM DESCRIPTION & LOCATION: (4)CAP REQUIRED? □YES □NO		(14)RESPONSE DUE:
(15)ISSUED BY (PRINTED NAME & TITLE): SIGNATURE: DATE:		(16)MANAGEMENT CONCURRENCE:

Forrm4-6B (continued)
CORRECTIVE ACTION REQUEST

PART B: CORRECTIVE ACTION

(17)PROPOSED CORRECTIVE ACTION/ACTION TAKEN: NOTE: SUPPORTING DOCUMENTATION MUST BE LISTED ON THE BACK OF THIS FORM AND ATTACHED.

(18)PART B COMPLETED BY (NAME & TITLE): SIGNATURE: DATE:	(19)QC CONCURRENCE:

PART C: CORRECTIVE ACTION VERIFICATION

(20)CAR VERIFICATION AND CLOSE-OUT: (CHECK ONLY ONE & EXPLAIN STIPULATIONS, IF ANY)
- □APPROVED FOR CLOSURE WITHOUT STIPULATIONS
- □APPROVED FOR CLOSURE WITH FOLLOWING STIPULATIONS

COMMENTS/STIPULATIONS:

(21)CLOSED BY (PRINTED NAME & TITLE):

SIGNATURE: DATE:

Forrm4-6B (continued)
CORRECTIVE ACTION REQUEST

CORRECTIVE ACTION REQUEST (CAR) INSTRUCTION SHEET

(1) **MEC QCS**: Verify that the total number of pages includes all attachments.

(2) **MEC QCS**: Fill in CAR number from CAR log.

(3) **MEC QCS**: Fill in appropriate priority category. **High** priority indicates resolution of deficiency requires expediting corrective action plan and correction of deficient conditions noted in the CAR and extraordinary resources may be required due to the deficiency's impact on continuing operations. **Normal** priority indicates that the deficiency resolution process may be accomplished without further impacting continuing operations.

(4) **CAR Requestor**: Fill in date CAR is initiated.

(5) **CAR Requestor**: Identify project name, number, CTO, and WAD.

(6) **CAR Requestor**: Identify Project Manager

(7) **CAR Requestor**: Identify CQC System Manager.

(8) **CAR Requestor**: Identify project organization, group, or discrete work environment where deficiency was first discovered.

(9) **CAR Requestor**: Identify line manager responsible for work unit where deficiency was discovered.

(10) **MEC QCS**: Identify responsible manager designated to resolve deficiency (this may not be work unit manager).

(11) **CAR Requestor**: Identify source of requirement violated in contract, work planning document, procedure, instruction, etc; use exact reference to page and, when applicable, paragraph.

(12) **CAR Requestor**: Identify problem as it relates to requirement previously stated. Identify location of work activities impacted by deficiency.

(4) **MEC QCS**: Identify if Corrective Action Plan (CAP) is required. CAP is typically required where one or more of the following conditions apply: CAR priority is **High**; deficiency requires a rigorous corrective action planning process to identify similar work product or activities affected by the deficiency; or deficiency requires extensive resources and planning to correct the deficiency and to prevent future recurrence.

(14) **MEC QCS**: Identify date by which proposed corrective action is due to QC for concurrence.

(15) **MEC QCS**: Sign and date CAR and forward to responsible manager identified in (10) above.

(16) **Responsible Manager**: Initial to acknowledge receipt of CAR.

(17) **Responsible Manager**: Complete corrective action plan and identify date of correction. Typical corrective action response will include statement regarding how the condition occurred, what the extent of the problem is (if not readily apparent by the problem description statement in [12]), methods to be used to correct the condition, and actions to be taken to prevent the condition from recurring. If a CAP is required, refer to CAP only in this section.

(18) **Responsible Manager**: Sign and date corrective action response.

(19) **MEC QCS**: Initial to identify concurrence with corrective action response from responsible manager.

(20) **MEC QCS**: Check appropriate block to identify if corrective action process is complete so that CAR may be closed. Add close-out comments relevant to block checked.

(21) **MEC QCS**: Indicate document closeout by signing and dating.

FORM 4-7b

CORRECTIVE ACTION PLAN

Attach clarifications and additional information as needed. Identify attached material in appropriate section of this form.

PART A: TO BE COMPLETED BY PROJECT MANAGER OR DESIGNEE

(1)PROJECT:		
(2)PROJECT MANAGER:	(3)MEC QCS:	
(4)CAR NO(S) AND DATE(S) ISSUED:		
(5)DEFICIENCY DESCRIPTION AND LOCATION:		
(6)PLANNED ACTIONS	(7)ASSIGNED RESPONSIBILITY	(8) COMPLETION DUE DATE
(9)PROJECT MANAGER SIGNATURE:		DATE:

PART B: TO BE COMPLETED BY MEC QCS OR DESIGNEE

(10)CAP REVIEWED BY:	DATE:
(11)REVIEWER COMMENTS:	
(12)CAP DISPOSITION: (CHECK ONLY ONE AND EXPLAIN STIPULATIONS, IF ANY) ☐ APPROVED WITHOUT STIPULATIONS ☐ APPROVED WITH STIPULATIONS ☐ APPROVAL DELAYED, FURTHER PLANNING REQUIRED COMMENTS:	
(4)MEC QCS SIGNATURE:	DATE:

FORM 4-8b

DAILY QUALITY CONTROL REPORT

Contract No.: _____

Date: _____Task Order No.:_____Report No:_____

LOCATION OF WORK: _____
DESCRIPTION: _____ _____
WEATHER: (CLEAR) (FOG) (P.CLOUDY) (RAIN) (WINDY)
TEMPERATURE: MIN °F MAX °F

1. Work performed today:

_____
_____

2. Work performed today by CH2MHILL subcontractor(s):

_____
_____

3. Preparatory Phase Inspections performed today (include personnel present, specification section, drawings, plans, and submittals required for definable feature of work):

_____
_____

4. Initial phase Inspections performed today (include personnel present, workmanship standard established, material certifications/test are completed, plans and drawings are reviewed):

_____
_____

5. Follow-up Phase Inspections performed today (include locations, feature of work and level of compliance with plans and procedures):

_____
_____
_____

6. List tests performed, samples collected, and results received:

_____
_____
_____

7. Verbal instructions received (instructions given by Government representative and actions taken):

_____
_____
_____

8. Non-conformances/deficiencies reported:

_____
_____
_____

9. Site safety monitoring activities performed today:

_____
_____

10. Remarks:

_____
_____
_____
_____

CERTIFICATION: *I certify that the above report is complete and correct and that I, or my representative, have inspected all work identified on this report performed by CH2M HILL and our subcontractor(s) and have determined to the best of my knowledge and belief that noted work activities are in compliance with the plans and specifications, except as may be noted above.*

MEC QCS (or designee) Signature: _____

Form 4-9b

Document Release and Review

Client:	Author:						Submittal Register Item No.:		Date:
Document Title:							Revision:	D.O.#	WAD#
Reviewer (*print)*	Reviewer initial & date	Technical	Project Manager	CQC System Mgr.	Health & Safety	Editorial	Chemistry	Construction	Reviewer Comments Resolved (*Signature & Date)*
Same as Technical Reviewer Above		X	Topic outline with objectives for each section submitted prior to Rev. A						

Program Reviewer's Acceptance for Document Submittal	Signature	Yes	No
1) A 4025 (as applicable) prepared and submitted with document?			
2) Technical Conclusions adequately supported by text and data?			
3) Tables and Figures are in the proper format and checked and approved?			
4) The Table of Contents consistent with text information?			
5) Technical Reviewers are qualified and accepted by Technical Manager?			
6) A document Distribution List been prepared and submitted with document?			

Approval: _____
Project Manager

Approval: _____
MEC QCS

Recommended
4025 Code _____

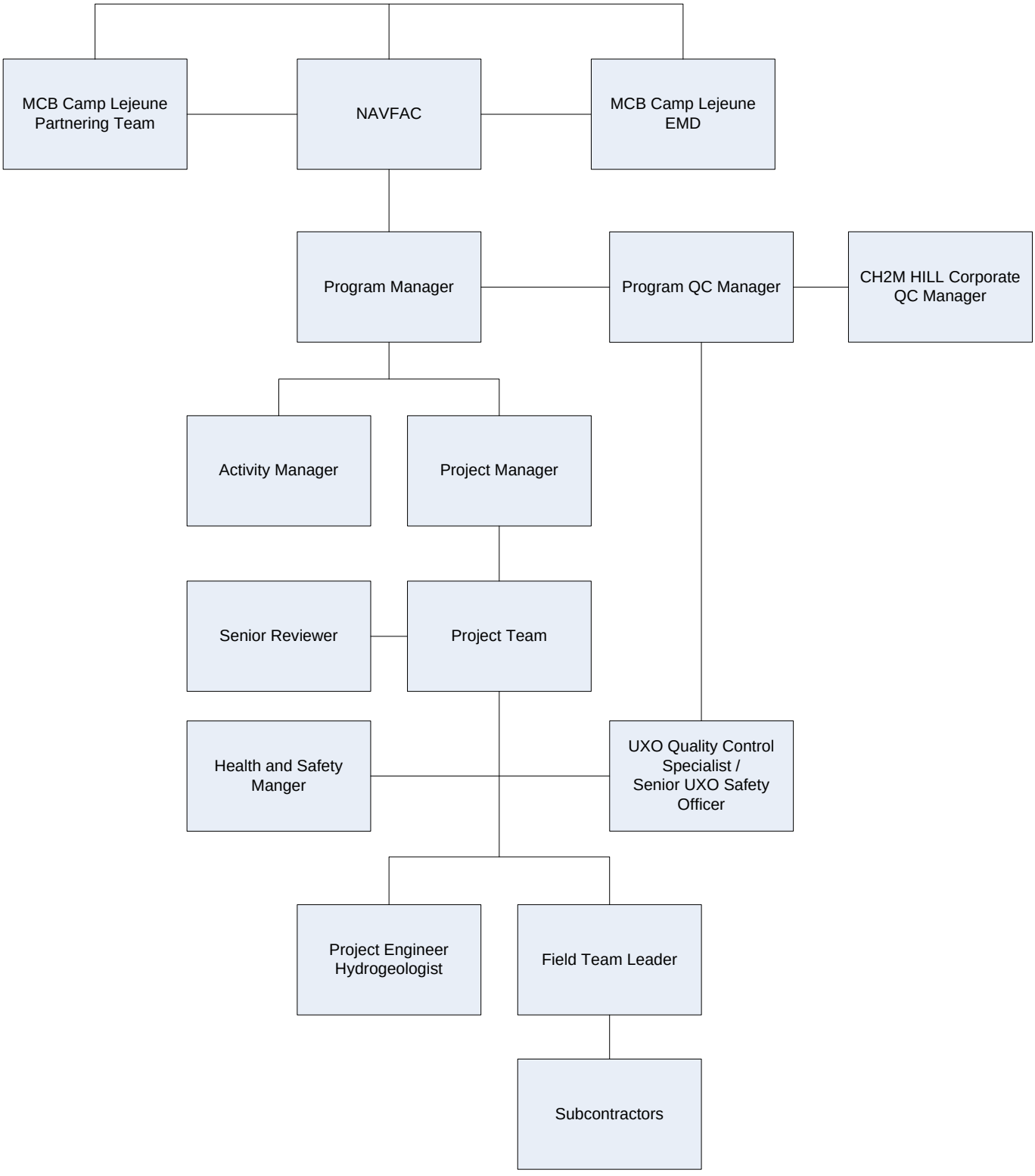


Figure 4-1
Quality Control Project Team Organizational Structure
Knox Trailer Park, Site UXO-04
Expanded Site Investigation
MCB Camp Lejeune
Jacksonville, North Carolina

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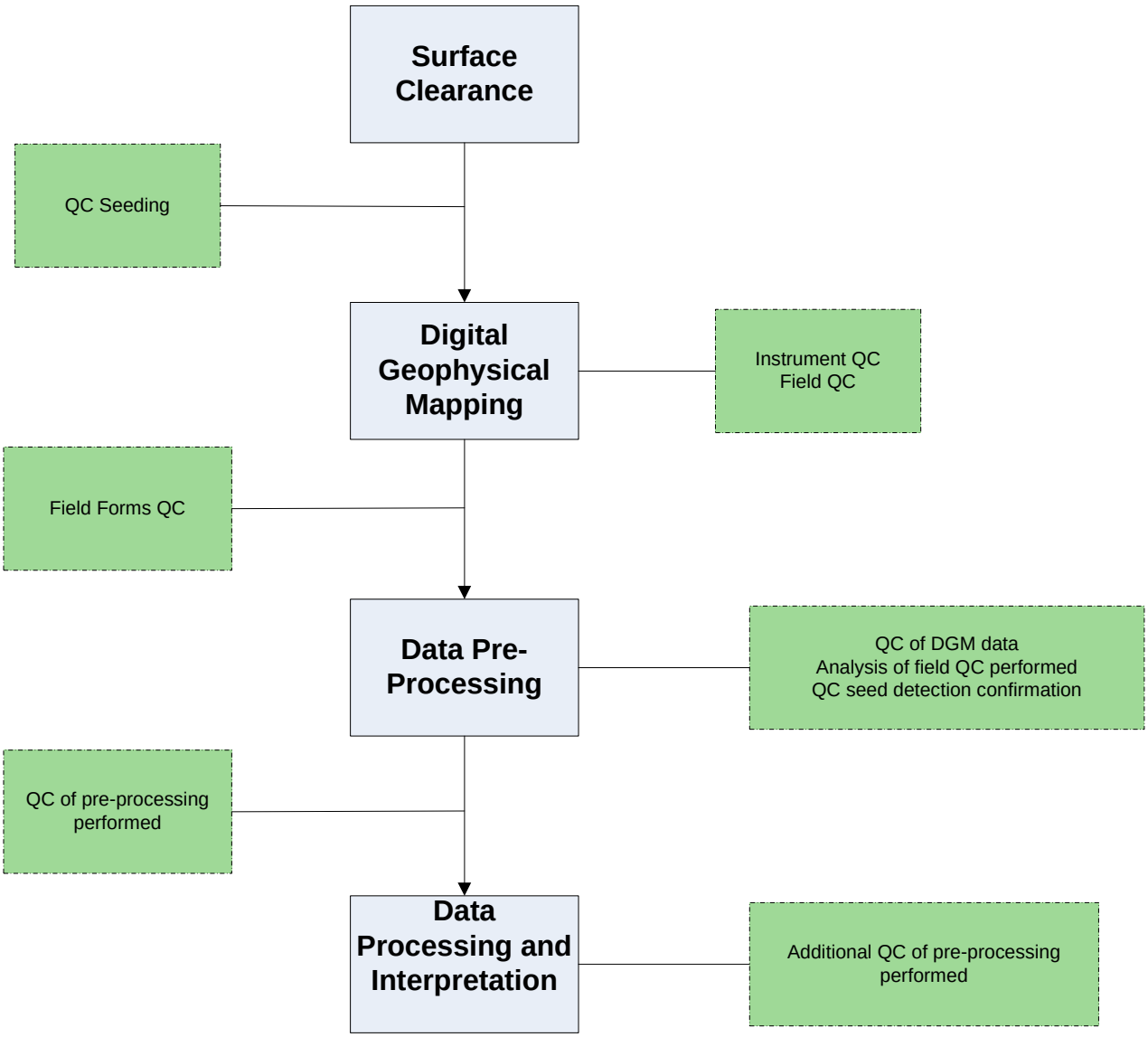

Figure 4-2
Overview of DGM Process QC
Knox Trailer Park, Site UXO-04
Expanded Site Investigation
MCB Camp Lejeune
Jacksonville, North Carolina

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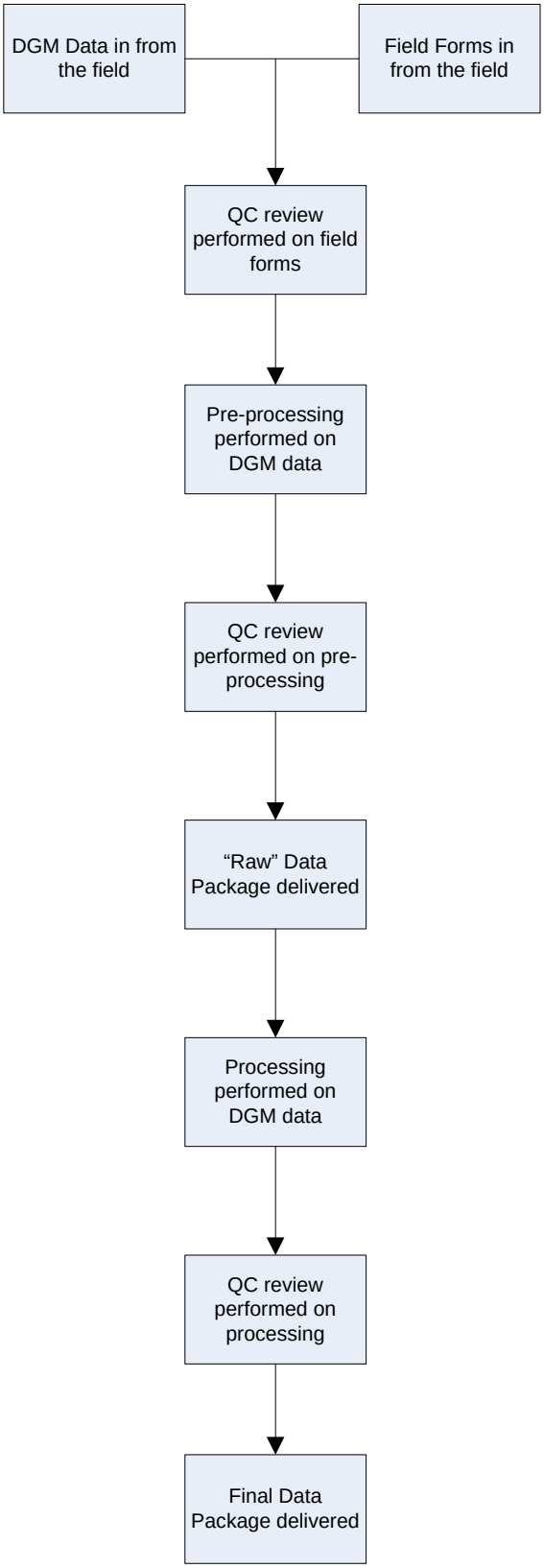

Figure 4-3
QC of DGM Data – Process Flowpath
Knox Trailer Park, Site UXO-04
Expanded Site Investigation
MCB Camp Lejeune
Jacksonville, North Carolina

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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 due to 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 United States 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. Since 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 (feeding, breeding, 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.

Seabeach amaranth. This annual 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 Oslow 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 environmental and DGM 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 MEC 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 will be removed from approximately 76 acres of the 133 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 will be mulched and left in place. Trees greater than 4 inches in diameter will not be removed unless absolutely necessary. The base will 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 will be identified and 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 (ARARS)

CH2M HILL will follow all applicable regulations 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 the USFWS
Work Plan for the Expanded Site Investigation, Site UXO-04, Knox Trailer Park

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', 1000', and 1500' from the nest site.
Laterallus jamaicensis	Black rail	FSC	
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	

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by the USFWS
Work Plan for the Expanded Site Investigation, Site UXO-04, Knox Trailer Park

Scientific Name	Common Name	Federal Status	Habitat
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	
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 powerline 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.

TABLE 5-1
Species Potentially Occurring on or Adjacent to Camp Lejeune Listed as Threatened, Endangered, or of Special Concern by the USFWS
Work Plan for the Expanded Site Investigation, Site UXO-04, Knox Trailer Park

Scientific Name	Common Name	Federal Status	Habitat
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 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 RCW habitat- single bands of white paint on the trees surrounding the plant site. The marked area indicates a 100' 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	
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 due to similarity of appearance (e.g., American alligator)--a species that is threatened due to 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
Work Plan for the Expanded Site Investigation, Site UXO-04, Knox Trailer Park

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
State Requirements	
15A NCAC 7H	Guidelines for areas of environmental concern.
GS 113-331 to 133-337	North Carolina Endangered Species Act

SECTION 6

References

Cardinell, A.P., S.A. Berg, and O.B. Lloyd, Jr. 1993. Hydrogeologic Framework of U.S. Marine Corps Base at Camp Lejeune, North Carolina. *Water Resources Investigations Report 93-4049.* U.S. Geological Survey.

Carraway, G. S. 1946. *Camp Lejeune Leathernecks: Camp Lejeune, N.C., Marine Corps' Largest All-Purpose Base*. New Bern Owen G. Dunn.

CH2M HILL. 2004. Draft Master Project Plans, Marine Corps Base, Camp Lejeune, Jacksonville, North Carolina.

Department of the Navy. 2005. Revised Pre-Final Environmental Assessment for Privatization of Military Housing at MCB Camp Lejeune, MCAS New River, and MCAS Cherry Point. July.

EPA. 1999. Contract Laboratory Program National Functional Guidelines for Organic Data Review. *EPA-540/R-99-008.* (Available at http://www.epa.gov/superfund/programs/clp/download/fgorg.pdf.)

EPA. 2004. Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. *EPA 540-R-04-004.* (Available at http://www.epa.gov/superfund/programs/ clp/download/inorgfg10-08-04.pdf.)

Harris, W.B., and V.A. Zullo. 1991. "Eocene and Oligocene Stratigraphy of the Outer Coastal Plain." In J.W. Horton, Jr., and V.A. Zullo (eds.), *The Geology of the Carolinas: Carolina Geological Society, 50th Anniversary Volume*.

Marine Devil Dogs!: Introduction to the U.S. Marine Corps War Dogs, http://community-2.webtv.net/Hahn-50thAP-K9/K9History4/. Accessed April 25, 2005.

MCB Camp Lejeune. 2002. Environmental Assessment Construction of a Consolidated Academic Instruction Facility and Barracks, Camp Johnson, Marine Corps Base, Camp Lejeune, Onlow County, North Carolina. July.

Montrose, Lynn. 1955. "Development of Our Body Armor." *Marine Corp Gazette*. June.

North Carolina Department of Environment and Natural Resources. 2003. Guidelines for Performing Screening Level Ecological Risk Assessments within the North Carolina Division of Waste Management. October. (Available at http://www.wastenotnc.org/SFHOME/SLERA.doc.)

North Carolina Administrative Code. 1999. Title 15A, Department of Environment and Natural Resources, Division of Water Quality. Subchapter 2L, Classifications and Water Quality Standards Applicable to the Groundwaters of North Carolina. May.

North Carolina Ecological Services. U.S. Fish and Wildlife: North Carolina's Threatened and Endangered Species, http://nc-es.fws.gov/es/index.html. Accessed August 25, 2005.

Putney, William W. 2001. *Always Faithful: A Memoir of the Marine Dogs of WWII*. The Free Press.

URS. 2002. Draft Marine Corps Base Camp Lejeune Range Inventory Report. February.

U.S. Army Corps of Engineers. 2001. Final Range Identification and Preliminary Range Assessment, Marine Corps Base Camp Lejeune. Onslow, North Carolina. December.

Water and Air Research. 1983. Initial Assessment Study of Marine Corps Base, Camp Lejeune. North Carolina.

Appendix A
Archival Research Report for the Expanded Site Investigation

Final

Archival Records Search Report for the Expanded Site Investigation

Knox Trailer Park
MCB Camp Lejeune, NC

Contract Task Order 109
October 2005

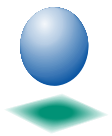
Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

Under the

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

Prepared by



CH2MHILL

Herndon, Virginia

Contents

Acronyms and Abbreviations

°F	degrees Fahrenheit
asl	above sea level
CCC	Civilian Conservation Corps
CTO	Contract Task Order
DMM	Discarded Military Munitions
EOD	Explosive Ordnance Disposal
ESI	Expanded Site Investigation
HTW	hazardous and toxic wastes
LANTDIV	Atlantic Division
MCB	Marine Corps Base
MEC	munitions of explosive concern
NARA	National Archives and Records Administration
NAVFAC	Naval Facilities Engineering Command
NMFRL	Naval Medical Field Research Laboratory
PA	preliminary assessment
TNT	2,4,6-trinitrotoluene
UXO	unexploded ordnance
WWII	World War II

SECTION 1

Introduction, Purpose, and Scope

An Expanded Site Investigation (ESI) is currently underway at the Knox Trailer Park, Marine Corps Base (MCB) Camp Lejeune, North Carolina, under the Navy CLEAN III Contract N62470-02-D-3052, Contract Task Order (CTO) 109, for the Naval Facilities Engineering Command (NAVFAC), Atlantic Division (LANTDIV). The results of the ESI will determine if the property can be used for residential development. To support the ESI effort, this archival records search report has been prepared to provide a narrative of the historical activities at the project area that may have resulted in environmental contamination with munitions of explosive concern (MEC) and/or hazardous and toxic wastes (HTW). The site has been identified as a former hand grenade training range and may contain ordnance materials.

The archival records search report is an investigative review of existing information about the site and its surrounding area, with an emphasis on obtaining information from personnel and historical resources that might indicate a potentially hazardous release to the environment, specifically MEC or HTW. The scope of the report includes:

- A review of existing information about the site (including MCB Camp Lejuene maps, drawings, and reports, and interviews with MCB Camp Lejuene personnel).
- A site and environs reconnaissance.
- Collection of additional information about the site.

A complete listing of resources identified and investigated for this report is provided in Attachment 1. Attachment 1 also includes details concerning the reviews of the historical information from the Marine Corp Library, National Archives and Records Administration (NARA) map and text files, and Camp Lejeune base files. Attachment 2 contains photographs obtained during the research activities.

SECTION 2

Background Information

2.1 Facility Information

MCB Camp Lejeune is located on the Atlantic coast in Jacksonville, North Carolina (refer to Figure A-1). The city of Jacksonville in Onslow County is the principal support community for the base. MCB Camp Lejeune occupies 153,439 acres including more than 450 miles of roads, 6,946 buildings, and facilities 14 miles of beach on the Atlantic Ocean for amphibious training (Department of the Navy, July 2005, OCS Website, 2005). Originally established in 1941, the base is home to Marine Expeditionary Force units and includes six major Marine Corps commands, two Navy commands, one Coast Guard command, and is home to several Marine Corps Formal schools. MCB Camp Lejeune supports a total population of approximately 138,000 people, to include 37,221 active duty military and 53,614 military dependents. In addition, the base employs 4,883 civilian employees and supports 42,562 military retirees and their dependents located in the region (Department of the Navy, July 2005). The base is bisected by the New River, which branches off to the northeast into the Northeast Creek. Knox Trailer Park is situated in the north central portion of the base along the Northeast Creek, just west of Camp Johnson (refer to Figure A-1)

2.1.1 Site Conditions

The mobile home park (i.e., trailer park) is located along the eastern side of Camp Knox Road (refer to Figure A-2) and serves as a residential area for enlisted personnel (John Jordan, 2005). Woodlands surround the property to the north, east, and west. The northern 1/3 of the property has been cleared of trees while the remaining 2/3 of the property is woodland. Most of the forested areas have light to moderate undergrowth and are easily traversed, although part of the land has dense undergrowth that is difficult to penetrate (CH2M HILL, July 2005).

As part of the ongoing Housing Privatization project, a 69-acre parcel has been allocated as the Knox Trailer Park Expansion Area. The expansion area is located immediately north of the trailer park on the west side of Camp Knox Road (Baker, November 2004). North Carolina Route 24 is located approximately 400 feet to the north of the expansion area (Department of the Navy, July 2005). The Tarawa Terrace housing area is located to the east of the Knox Trailer Park.

2.1.2 Climate and Meteorology

The climate in the MCB Camp Lejeune area 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 degrees 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 MCB 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.

2.1.3 Topography, Geology and Hydrology

The aesthetic environment in and around Knox Trailer Park is characterized by flat topography with minimal slopes. The housing area is situated in an open field (Department of the Navy, July 2005) and is relatively secluded from other areas.

The land surface at MCB Camp Lejeune has been alternately exposed and submerged over time by water and marine deposits from an ancient inland sea. These deposits were laid down to form the weakly dissected alluvial plane. The deposits are mostly sands layered with clay and marine shells. Elevations range from 0 feet above sea level (asl) at the waterways to 72 feet asl between the New River and US Rte 17. MCB Camp Lejeune consists of both broad, level flatlands and gently rolling hills.

Nearly 30 percent of the soils at MCB Camp Lejeune are considered hydric. Leon fine sand, Mukalee Loam, and Murville fine sand are the most common hydric soils. Baymeade fine sand, a non-hydric soil, is the most prevalent soil type at the installation and encompasses 18 percent of the land (Department of the Navy, July 2005).

A soil survey for Onslow County indicates that the Baymead Foreston Stallings soil association is predominant in the Camp Johnson portion of Camp Lejeune. This association is typically found on level to gently sloping areas and ranges from somewhat poorly to well-drained with loamy subsoil throughout. Four soil map units are mapped in the study area. They are: Baymeade-Urban Complex, 0 to 6 percent slopes (BmB), Baymeade fine sand 0 to 6 percent slopes (BaB), Wando fine sand 1 to 6 percent slopes (WaB), and Craven fine sandy loam (CrC), 4 to 8 percent slopes. The affected soil map units have not been classified either as hydric soils or prime farmland by the Natural Resources Conservation Service (MCB Camp Lejeune, July 2002). Most soils within this area have been previously disturbed due to a history of intensive use.

Surface water drainage in the project vicinity is carried by a dendritic system of small, permanent and intermittent, unnamed streams, with associated floodplains of various widths. These streams flow into Scales Creek, Northeast Creek, and/or New River. New River flows into the Atlantic Ocean via New River inlet (MCB Camp Lejeune, July 2002).

2.2 Ownership and Operational History

2.2.1 Ownership History

The history of the land now occupied by Camp Lejeune is documented primarily through land records and maps. Following the start of World War II (WWII), the War Department began purchasing tracts of land in 1941 from local residents to meet the need for an East Coast amphibious training facility. Prior to the Marines occupation, the land had been occupied by white and African-American communities and farms since the Colonial era. The land contained plantation houses, cabins, farm buildings, tobacco barns, stores, and various cemeteries (Global Security website, July 2005).

The initial land transferred to the government was acquired in 14 different transactions between April and October 1941 and totaled 173.8 square miles or 111,155 acres, of which there were 85,155 land acres and about 26,000 acres under water (Loftfield, 1981, Louis Berger Group, 2002).

The individual tracts of land were grouped into various 'Areas' for consolidation. The Knox Trailer Park area is located in Area A, which extended from Wilson Bay in the west, covering Montford Point (now Camp Johnson), to Tarawa Terrace in the east. Area A included 65 tracts of land and was one of the first parcels to be acquired. The current Knox Trailer Park appears to have been located in tract A-12, and possibly into tract A-11, as shown in the 1941 Property Map for Area A (John Jordan, 2005, MCB New River, April 1941). At the time of purchase in March 1941, tract A-12 was owned by W.H. Humphrey and the land contained a cabin, smokehouse, barn, and pier. Photographs of tract A-12 and surrounding properties at time of purchase are contained in Attachment 2. Mr. Humphrey also claimed ownership for Tract 11, which contained similar buildings as well as a garage, outhouse, and shack (Dept of the Navy, March 25, 1941 and March 27, 1947). The facility at that time was known as Marine Barracks New River, N.C. and was changed to MCB Camp Lejeune in 1942 (Global Security website, July 19, 2005).

2.2.2 Operational History

Following the acquisition of Area A, the Civilian Conservation Corps (CCC) established a camp in the area now occupied by the Knox Trailer Park. The camp is estimated to have been in operation from July 1941 to June 1942, with approximately 155 enrollees (Kimball, 2005). The camp encompassed one block and included administrative and housing facilities, a blacksmith shop and an incinerator as shown on the site development plan for the CCC camp (Kimball, 2005, MBNR, July 1941). Materials burned in the incinerator were unable to be determined during the archival research activities. Camp personnel assisted with road work, forestry, and other phases of developing the land into a modern military post (Carraway, 1946).

Another function of the CCC 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, use of dynamite, and by spraying diesel oil on water surfaces as a larvacide. Approximately 140,000 gallons of waste oil was spread on base water surfaces over a 2-year period (1941-43). As Scales Creek is the nearest water source to the camp, it is considered a likely target of oil spraying. Records from June 1941 indicate that the oil spraying occurred every 2 weeks for a period and then every 3 weeks (Kimball, 2005).

In August 1942, Black Marines began to arrive at Montford Point and soon outgrew the facilities there. As a result, the CCC Camp, which was then renamed Camp Knox, was enlarged in March 1943 to accommodate 1,000 Black Marines from Montford Point. The expansion now included Blocks D-E (Kimball, 2005). A 1947 General Area Map references the two CCC camps, which could be the additional blocks that were added during the expansion (NACP, March 1947).

In November 1942, the area was the headquarters of the War Dog Training Company. The facility was redesignated as the War Dog Training School in January 1943 (Louis Berger

Group, 2002). It appears that the Black Marines and dog school occupied the area concurrently (Kimball, 2005). The Camp Knox area and dog training area are shown on 1942 and 1943 maps (MBNR, January 1943, NACP, 1942). The training School had been re-located from Quantico Bay, Cuba to Camp Knox (K-9 History, 2005). According to one source, the training school sat on a bluff overlooking the north fork of the New River (Putney, 2001). Additionally, the current site of Tarawa Terrace II was also used as a training area for the War Dog Training School (Louis Berger Group, 2002).

During WWII, seven Marine War Dog Platoons were trained at Camp Knox. The majority of the dogs were Doberman Pinschers, though German shepherds, Labrador retrievers, and other breeds also served (Louis Berger Group, 2002). Just over 1,000 dogs were processed at the base, with over 450 actually being trained (Carraway, 1946). The dogs first underwent a six-week basic training where dogs were taught to heel, down, crawl, come, or stay on both voice commands and arm and hand signals (K-9 History, 2005).

Following basic training, the dogs were divided up for specialized training as scouts, messengers, sentry duty, or search and rescue duty (Louis Berger Group, 2002). Scout dogs were trained to alert the troops of the enemy, but not to bark and alert the enemy; guard prisoners; provide night security in foxholes and outpost; enter caves and pillboxes to determine presence of enemy. Detection of strangers was signaled by the dogs in ways other than barking (K-9 History, 2005, Putney, 2001). Messenger dogs were taught to carry messages, ammunition, and or special medical supplies from one handler to the other handler, avoiding all other persons. They were subjected to overhead rifle and machine gun fire and explosions of charges of dynamite and 2,4,6-trinitrotoluene (TNT) to simulate as nearly as possible actual battle field conditions (K-9 History, 2005).

Sentry dogs were trained to warn (fixed) troops of the approach or the nearness of any other people by barking. Not many sentry dogs were trained by the Marines (K-9 History, 2005). Search and rescue dogs were trained to help locate wounded soldiers (Carraway, 1946). There were also mine dogs trained detection of mines, trip wires, booby traps, and other explosive devices buried or hidden from view (Putney, 2001).

The dogs and handlers were exposed to explosives typically found in a combat environment on a weekly basis. Explosives used during training included Dago bombs and quarter cans of TNT (Putney, 2001).

The War Dog Training School was terminated in August 1945. The dog detachment continued to perform limited activities until October 1946 for the demobilization of war dogs returning from overseas (Louis Berger Group, 2002).

Historical inspection records indicate that approximately 2,000 troops could be housed in buildings in Camp Knox (NACP, June 20, 1945). The buildings reported to be in Camp Knox in 1945 included 5 wooden huts and one wooden mess hall in poor condition (NARA, December 1945). The mess hall had a 200 person capacity. Temporary warehouses and storerooms constructed of sheet metal were also reported to have been at Camp Knox. Combat Dog Training was noted as a specialist school, though no classes were in session during the December 1945 inspection (NARA, December 1945).

During WWII, there was increased research into the use of body armor to protect the troops from serious injury. Body armor was recommended to the Marine Corps for use in the

summer of 1944 and adopted in the spring of 1945. In March 1945 an informal Navy-Marine board met at Camp Lejeune to test the mobility and maneuverability of troops wearing the armor. Testing was suspended with the end of WWII, but was resumed at Camp Lejeune in 1947 (Montrose, 1955). Photographs of the area in 1948 are provided as Photographs 1-4 in Attachment 2. While most of the testing occurred at the Naval Medical Field Research Laboratory (NMFRL), other body armor research facilities were located in Camp Knox, as shown on a 1949 Index Sheet drawing (MCB Camp Lejeune, January 1949). Specific buildings indicated as Body Armor Research facilities were D-22, which was the former hospital at the dog training area and D-23, former dog kennel (MCB Camp Lejeune, January 1949a, MBNR, January 1943). Building E-1 was also identified as a former mess converted to a testing laboratory (MCB Camp Lejeune, January 1949b, MBNR, May 1943).

While the specific testing at the Camp Knox research facilities has not been determined, it is known that the body armor, similar to a vest, was made of a light-weight glass-fabric-plastic laminate, bonded at high pressure and designed to stop most of the artillery, mortar and grenade fragments that caused two-thirds of all serious infantry casualties. The body armor was able to resist impact from .22 and .45 caliber automatic pistol bullets or Reising and Thompson sub-machine bullets at a distance of 15 feet. Additionally, 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 done inside based on historical photographs and it is not thought that a significant amount of ammunition was expended for testing purposes (Kimball, 2005).

Testing and development continued at the NMFRL throughout the Korean War until the cease fire was called in July 1953 (Montrose, 1955).

The onset of the Korean War brought additional personnel to Camp Lejuene and prompted the base to build new housing including converting Camp Knox to a trailer park in 1952 (Louis Berger Group, 2002, John Jordan, 2005). In 1953, the base acquired 1,150 new trailers to be placed in Camp Knox and Camp Geiger (Louis Berger Group, 2002). The original trailers were owned by the government, though in 1974 and 1985, the area was expanded and allowed for privately owned trailers (John Jordan, 2005). Photographs showing the area conditions in 1951 and 1954 are provided as Photographs 5 and 6 in Attachment 2. The area has continued to operate as a trailer park to the present time.

In the 1974-1976 timeframe, an EOD technician, Mr. Don Cifelli, responded to the discovery of UXO in the Knox Trailer Park area. During excavation activities, a bulldozer operator uncovered a live WWII MK-II high explosive hand grenade. The bulldozer operator informed Mr. Cifelli, that during his tenure as a Marine preparing for WWII, Marines used the mobile home area (i.e., Knox Trailer Park) as a hand grenade range (Cifelli, March 2005). This would coincide with the time frame that dog training area was in operation. While Mr. Cifelli no longer recalls the exact location of the grenade he generally estimates that it could have been located 500-600 meters away from the water on the west side of the main road that leads to the trailer park. He recalls that water was visible from where he was standing, but does not recall the depth at which the grenade was found. According to his recollection, the grenade was live and had been thrown, but did not detonate. The safety pin had been removed, but the firing pin had become impacted in the primer. An incident report was probably filled out, but he does not believe any other specifics would have been included in

the report. The grenade was then taken to the range at Verona Loop and destroyed. Mr. Cifelli also recalls also possibly responding 2-3 additional times to discoveries of practices grenades when intrusive activities were being performed.

A 1942 Range Overlay Map contained in the Final Range Identification and Preliminary Range Assessment Report delineated Area A. Area A essentially surrounded, but did not include, the Knox Trailer Park. According to base personnel, this area was never a live fire range for grenades or any other munitions (Lowder, 2005).

Mr. Kimball, consulting historian for the base, reports that he has not encountered any documentation that supports the area as an established range and that ordnance is likely to be found in any given area of the base. During war time, it is possible that the base used several areas as unofficial ranges to support war efforts. Additionally, he reported that it was not uncommon during war time for Marines to hide ammunition in order to ensure receiving a new allotment (Kimball, 2005).

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 Knox Trailer Park Grenade Range (Area A), in the Draft 2002 Range Inventory Report. In the report, the range was classified as a live land-to-land grenade training range of an estimated 115 acres. Ordnance use included explosive grenades. Practice grenades were not indicated as having been used. No portion of the land has been confirmed as having UXO, though there is the potential for the presence of Discarded Military Munitions (DMM) in the area (URS, 2002, Ben Redmond, 2005). The MK-II high explosive hand grenade is thought to be the most likely grenade used at the site (Richardson, 2005). According to the specifications, the grenades had a serrated cast-iron body and the MK-II grenades were equipped with a M204A1 Fuze, while the MK-IIA1 grenades were equipped with a M10A3 Fuze. The specifications state that the units were filled with 2 ounces of flaked or granular TNT, though some older units contained E.C. Blank Smokeless Powder (USCOE, 2001).

A visual inspection of the Knox Trailer Park was conducted in November 2002 by the base's Explosive Ordnance Disposal (EOD). No unexploded ordnance was discovered during the inspection (McGurty, 2005). No previous investigations of this site have been conducted.

The expansion area located just north of the current trailer park is the site of a former maneuver training area, called AD Training Area. The area was in operation during the 1940s and was administratively closed by the Environmental Management Division of the Marine Corps in January 2004 and no further action is required on the site (Richardson, 2005, Department of the Navy, 2005). The area was a non-firing area used for land navigation, patrolling, field training and is still in use by the Marine Corps Combat Service Support School at Camp Johnson (Richardson, 2005).

2.3 Current Operational Information

Currently, the housing area, approximately 38 acres, is situated in an open field with pads providing space for 187 mobile homes (Department of the Navy, 2005). As of June 2004, 32 occupied trailers remained at the site, but base personnel have reported that leases are not

being renewed and residents are moving out as leases expire (CH2M HILL, July 2005, Department of the Navy, 2005). Mobile homes still occupying the site vary in condition.

Electricity is supplied directly from Progress Energy, Inc. Potable water is obtained from groundwater wells on the installation in the Castle Hayne Aquifer. Water is treated by the Holcomb Boulevard and Hadnot WTP. Wastewater is conveyed to the wastewater treatment plant located in the French Creek area of the base (Department of the Navy, 2005).

Figure A-3 shows the area's proximity to the nearest storage tank (former), hazardous waste storage area, solid waste management units, and CERCLA site. All are located in or around the Tarawa Terrace housing area. The nearest unit is SWMU 461 (UST-TT3548), located approximately 1/3 of a mile from the trailer park in Tarawa Terrace II. This UST site has a no further action status and environmental sampling results indicate that surface soils do not pose a threat to human health. The Knox Park expansion area, a previous maneuver training area, is located approximately 1/8 of a mile north of the trailer park area (Department of the Navy, 2005).

SECTION 3

Findings

3.1 Summary of Findings

Based on the research activities, the following historical activities have been identified as having some level of concern for the ESI. Site Screening Review Meetings were conducted to determine which sites could be closed out based on the information gathered during the preliminary assessment (PA). The following table summarizes the conclusions that were reached in the meetings.

Activity	Level of Concern
CCC Camp	Minimal
War Dog Training School	Moderate
Body Armour Research Facilities	Minimal
Suspected range Use	High

3.2 Specific Findings

3.2.1 CCC Camp

The CCC Camp previously located at the Knox Trailer Park from 1941-1942 routinely used dynamite and diesel oil in its efforts to control the mosquito population. Possible environmental concerns could include groundwater and sediment contamination in nearby water sources from the spraying of diesel oil and soil contamination from the use of explosive materials.

3.2.2 War Dog Training School

The War Dog Training School, in operation from 1942-1946, used explosives such as overhead rifle and machine gun fire, charges of dynamite and TNT, and Dago bombs on a weekly basis. Possible environmental concerns could include soil contamination as well as the presence of UXO or DMM.

3.2.3 Body Armor Research Facilities

The body armor research facilities, in operation from approximately 1948-1953, tested the armor vests using pistol and submarine bullets as well as hand grenades. Ammunition most likely used at the Knox Trailer Park was ball-type ammunition. Environmental concerns from this activity are assumed to be minimal as testing was most likely done inside and the amount of ammunition expended on the testing is thought to be small.

3.2.4 Suspected Range Use

The discovery of live ordnance in the Knox Trailer Park gives indication of the area as a suspected range. No portion of the land has been confirmed as having UXO, though there is the potential for the presence of DMM in the area. Given the history of the entire base, ordnance is likely to be found in any given area of the base.

SECTION 4

References

Baker Environmental, *Draft Report Phase I- Environmental Baseline Survey (EBS) Public/Private Venture of Family Housing, Marine Corps Base Camp Lejeune, United States Navy, Mid-Atlantic Region, NAVFAC Atlantic,* November 2004.

Carraway, Gertrude S. Camp Lejeune Leathernecks, USMC Training Center, October 1946, New Bern Owen G. Dunn Company Publishers.

CH2M HILL, July 2005. Project Instructions for CTO-109: Expanded Site Investigation at Knox Trailer Park, Camp Lejeune, NC.

Cifelli, Don. Ret. EOD Tech, Camp Lejeune. Personal communication, August 15 and 18, 2005

Department of the Navy, Appraisal Report, LA-Navy-Jacksonville, NC, Tract No. A-11, March 27, 1941.

Department of the Navy, Appraisal Report, LA-Navy-Jacksonville, NC, Tract No. A-12, March 25, 1941.

Global Security Website, July 19, 2005.
http://www.globalsecurity.org/military/facility/camp-lejeune.htm

Jordan, John, Camp Lejeune Real Estate Expert. Personal communication, August 3, 2005.

K-9 History WWII PTO-USMC Devil Dogs! April 25, 2005.

WebTV Community Webpages, Http://community-2.webtv.net/Hahn-50thAP-K9/K9History4/

Kimball, Lt. Col. Lynn (USMC, Ret.), Camp Lejeune Consulting Historian. Personal communication, August 10, 2005.

Loftfield, Thomas C., Principal Investigator, University of North Carolina, Wilmington, *Archeological and Historical Survey of USMC Base, Camp Lejuene*, Naval Facilities Engineering Command Norfolk, Coastal Zone Resource Corp, Vol II, Contract # N62470-79-C-4273, August 1981.

Lowder, Robert, Environmental Management Division. Personal communication, September, 23, 2005.

Louis Berger Group Inc. under USCOE, Wilmington District Contract DACWS4-99-C-0004, *Semper Fidelis: A Brief History of Onslow County, North Carolina and MCB, Camp Lejuene, 2002, U.S.M.C.*, Lt. Col Lynn J. Kimball (USMC, Ret.), consulting historian.

Marine Barracks-New River (MBNR), North Carolina, *Camp Knox, Site Plan Block "E,"* Y&D Drawing No. 162070, May 31, 1943.

MBNR, North Carolina, *Camp Knox, Site Plan Dog Training Area*, Y&D Drawing No. 162059, January 1, 1943.

MBNR, North Carolina, *Site Development Plan for Civilian Conservation Corps Camp*, Y&D Drawing No. 162044, July 23, 1941.

MCB Camp Lejeune. *Environmental Assessment Construction of a Consolidated Academic Instruction Facility and Barracks, Camp Johnson, Marine Corps Base, Camp Lejeune, Onlow County, North Carolina*, July 2002.

MCB Camp Lejeune. *Body Armour Research Facilities, Camp Knox, Bldgs. D-23, E-1, and D-22, Index Sheet*, Y&D Drawing No. 452288, January 20, 1949a.

MCB Camp Lejeune. *Body Armour Research Facilities, Camp Knox, Bldg. E-1, Conversion to Testing Laboratory, Floor Plan, Elevation, and Details*, Y&D Drawing No. 452295, January 20, 1949b.

MCB New River, North Carolina, *Property Map Area A*, Y&D Drawing No. 159372, Contract No. 4717, April 5, 1941.

McGurty, Gerard, Gunnery Sgt. MCB Ops Chief, Camp Lejeune, personal communication, July 22, 2005.

Montrose, Lynn. Marine Corp Gazette, June 1955, "*Development of Our Body Armor*."

National Archives at College Park, College Park, MD (NACP), *Camp Lejeune General Area Map, Y & D Drawing No. 387415, March 11, 1947*, Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Camp Lejuene to 2285-10 Camp Lejuene, Box 1572, folder *Inspector General's Report, Annual Inspection, Marine Barracks, Camp Lejuene, North Carolina, 2-4 December 1947.*

National Archives at College Park, College Park, MD (NACP), *Camp Lejeune General Area Map, Y & D Drawing No. 162050 February 10, 1942,* Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Brooklyn to 2285-10 Camp Lejuene, Box 1570, folder *Camp Lejuene, North Carolina.*

National Archives at College Park, College Park, MD (NACP), *Confirmation of Verbal Instructions*, June 20, 1945*,* Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 1275/70-800 (10/44-1/45) to 1275/70-800 (7/45-9/45), Box 219, folder 1275/70-800 Camp Lejuene, North Carolina, Vol. 5, from 1 June 45 to 30 June 45.

National Archives at College Park, College Park, MD (NACP), *Enclosure A, Questionnaire for Commanding General, December 8, 1945*, Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Brooklyn to 2285-10 Camp Lejuene, Box 1570 folder Camp Lejuene, North Carolina, Annual Inspector General's Inspection of Camp Lejeune, Questionnaire for Commanding General, pgs. 4-8, 13, Annex.

Onslow County Schools (OCS) Website August 15, 2005, http://www.onslowcountyschools.org/OCinfosheet.htm

Pappas, Glenn, Camp Lejeune Military Historian, personal communication, August 3, 2005.

Redmond, Ben (Ret. U.S.M.C), CH2M HILL, personal communication, August 17, 2005.

Richardson, Duane, Camp Lejeune Range Safety Officer. Personal communication, August 3, 2005.

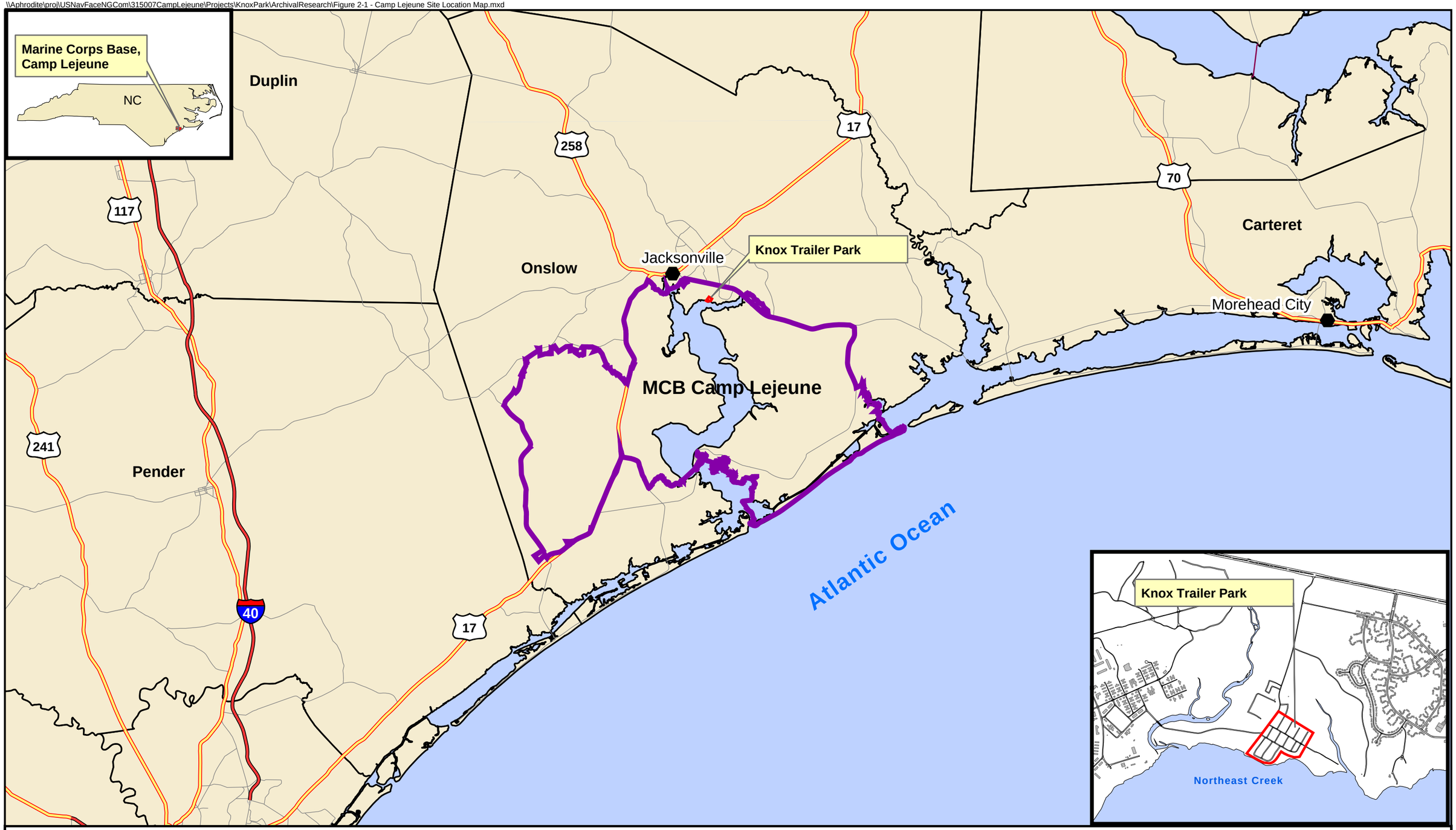
Putney, Captain William W., D.V.M., U.S.M.C. (Ret.), *Always Faithful: A Memoir of the Marine Dogs of WWII*, The Free Press, 2001.

URS Corp, *Draft Marine Corps Base Camp Lejeune Range Inventory Report*, February 2002.

US Army Corps of Engineers, St. Louis District. *Final Range Identification and Preliminary Range Assessment,* Marine Corps Base Camp Lejeune, Onslow, North Carolina, December 2001.

Water and Air Research. 1983. Water and Air Research, Inc. *Initial Assessment Study of Marine Corps Base, Camp Lejeune. North Carolina*. Prepared for Naval Energy and Environmental Support Activity.

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\ArchivalResearch\Figure 2-1 - Camp Lejeune Site Location Map.mxd



Legend
- Military Installation Area
- Knox Trailer Park
- Highway
- Limited Access Highwhay
- Local Roads
- Cities

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Figure A-1
Camp Lejeune Site Location Map
MCB Camp Lejeune, North Carolina

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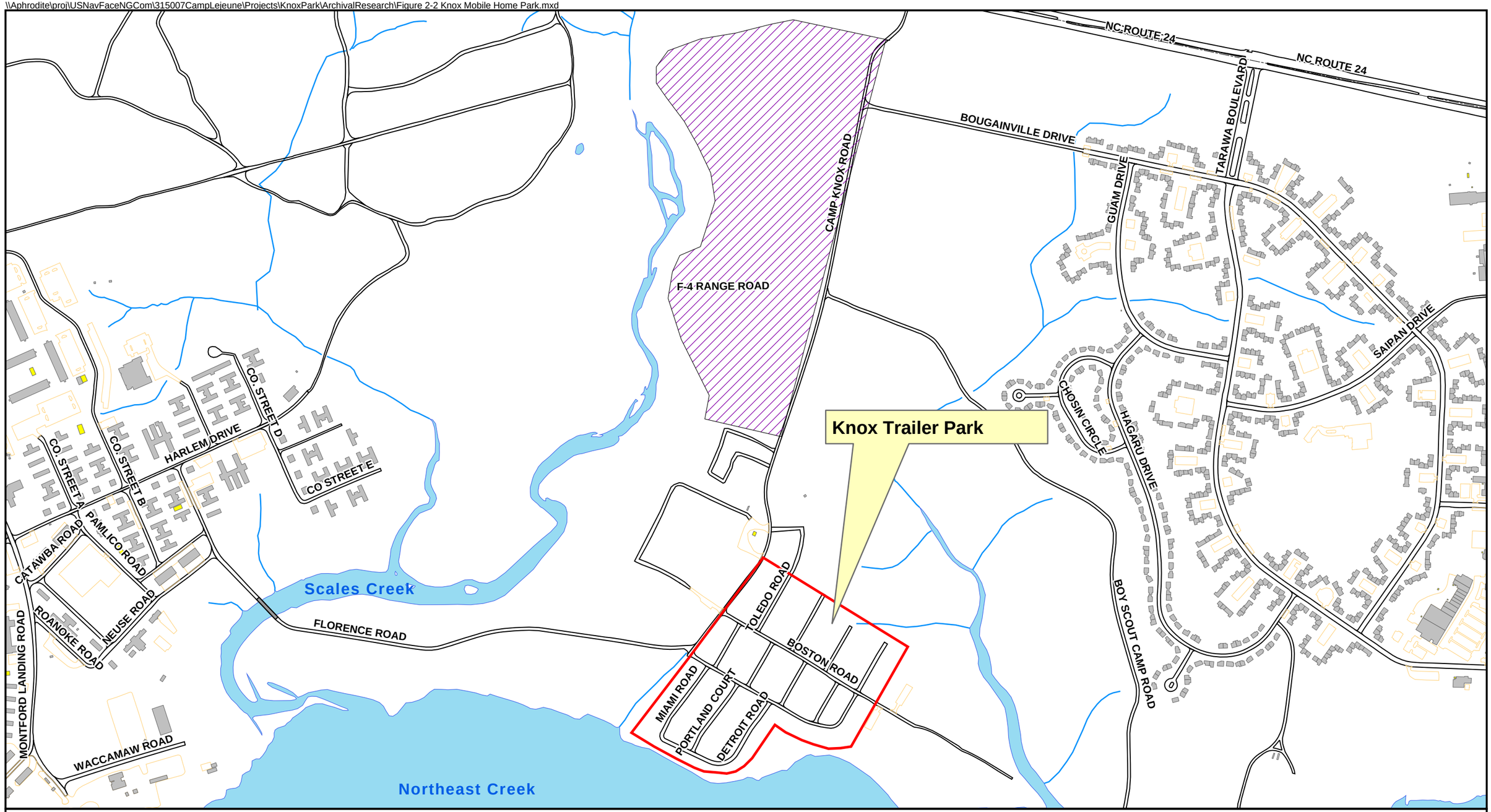
\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\ArchivalResearch\Figure 2-2 Knox Mobile Home Park.mxd



Legend

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

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Figure A-2
Knox Trailer Park
MCB Camp Lejeune
Camp Lejeune, North Carolina

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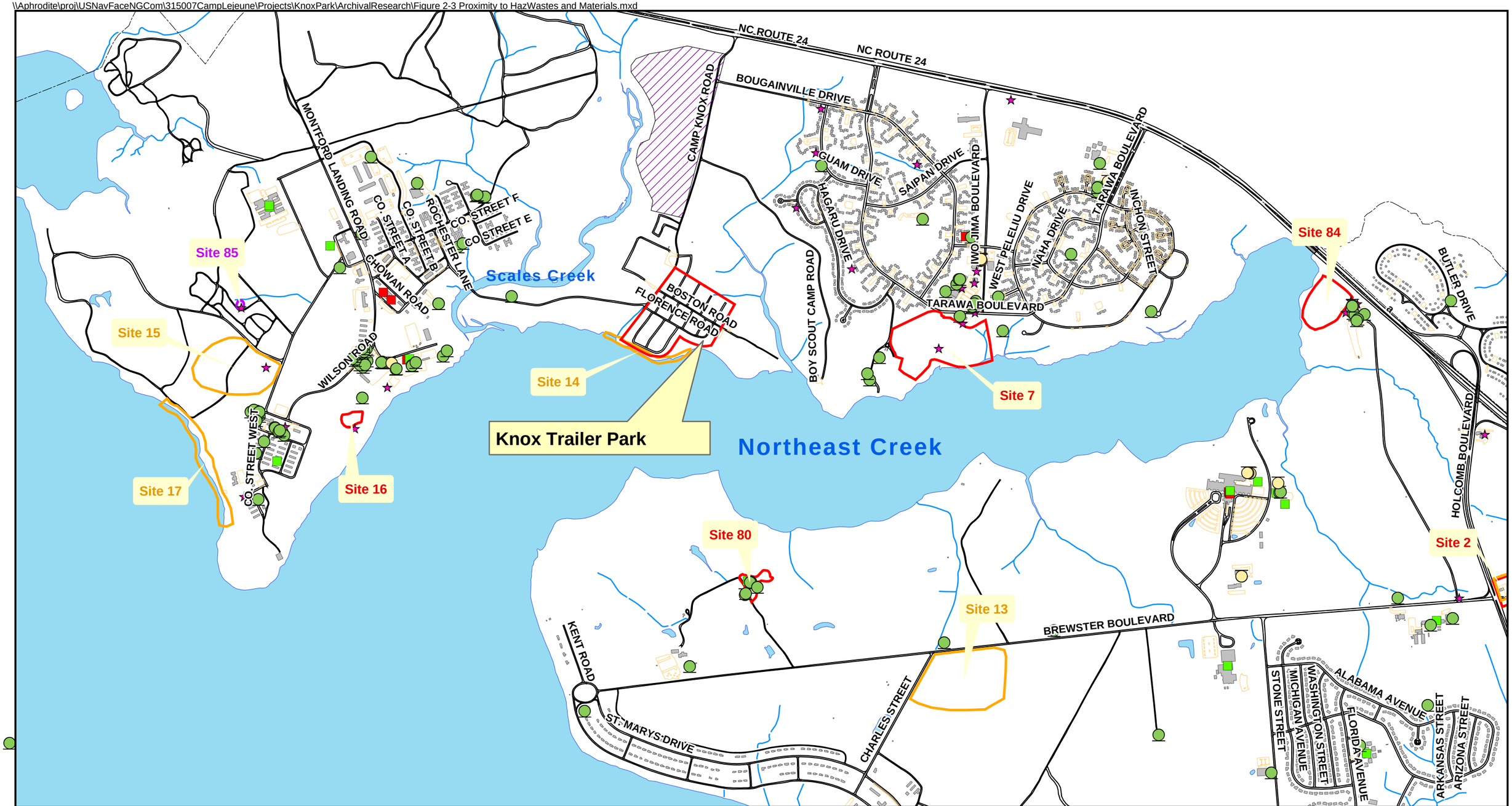
\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\ArchivalResearch\Figure 2-3 Proximity to HazWastes and Materials.mxd



Legend

- Installation Area
- Structure Area
- Vehicle Parking Area
- Road Area
- Surface Water Course Centerline
- Surface Water Body Area
- Knox Trailer Park
- Knox Park Expansion Area
- Above Ground Storage Tank
- Underground Storage Tank
- CERCLA Pre-remediation Sites
- CERCLA Sites
- Initial Assessment Sites
- Hazardous Materials Storage
- Hazardous Waste Storage
- SWMUs

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Figure A-3
Proximity to Active Hazardous Wastes and Materials,
ASTs, USTs, LUSTs, SWMUs, CERCLA Sites, and IR Sites
Knox Trailer Park
MCB Camp Lejeune, North Carolina

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Attachment 1
Resource Review Summary

ATTACHMENT 1

A. Resource Review Summary

The following table provides a summary of the specific references identified for review, interview, or contact for the archival report.

Resource	Actions Completed
Washington Navy Yard, Marine Corp Library Historical Aerial Photos	Reviewed all available file folders related to Camp Lejeune and copied relevant aerial photographs.
Lena Kaljot/MC Library	See *Marine Corp Library Review*
US National Archives (NARA II) Historical Files	Reviewed text and drawing files from Text Division and Cartographic Division.
Barry Zirby/National Archives Text File	See *US National Archives Files Review*
US National Archives (WDC) Historical Files	Contacted and interviewed Trevor Plant. No records on Camp Lejeune are maintained at the WDC facility.
US National Archives, Philadelphia Region	Contacted and interviewed Patrick Connelly. Philadelphia facility does not maintain records on North Carolina.
US National Archives, Atlanta Region	No response from facility personnel.
Camp Lejeune Library files	Reviewed and copied all relevant documents related to historical land use at Knox Trailer Park.
Camp Lejeune Real Estate files	Reviewed and copied all relevant documents related to historical land use and land acquisition at Knox Trailer Park.
Camp Lejeune Website	Reviewed and copied all relevant documents related to historical land use at Knox Trailer Park.
Camp Lejeune Personnel	
Bob Lowder/Environmental	Contacted and interviewed
John Jordan/ Real Estate Exert	Contacted and interviewed
Glenn Pappas/MCB Camp Lejeune Military Historian	Contacted and interviewed
Disel Hinkle/Range Ops Div	Contacted and interviewed
Gunnery Sgt. Luke Moore (Camp Geiger EOD)	Contacted and interviewed
New River EOD	No response.
Duane Richardson/ Base Range Safety Officer	Contacted and interviewed
Other Contacts	
Lt. Col. Lynn Kimball (U.S.M.C. Ret) /historical consultant	Contacted and interviewed.
Mr. Cifelli/ Retired Camp Lejeune EOD Tech	Contacted and interviewed.

A.1 Marine Corp Library Review

Text Division

Contact: Bob Aquilina
Telephone Interview: July 13, 2005

Mr. Aquilina stated that it is unlikely that the Marine Corp Library reference materials would have information related to the identification of historical ordnance use. The library's materials consist mainly of public affairs articles, newspaper clippings, Commanding Officer's list, and Gazette articles. He recommended contacting the National Archive facilities in College Park, MD and Washington, D.C.

Photographic Division

Contact: Ms. Lena Kaljot, (202) 433-2631
Site visit on July 15, 2005

Reviewed 10 file folders of photographs for Camp Lejuene:

1- Camp Lejuene, North Carolina Aerial Views, 1940-1960s

2- Camp Lejuene, North Carolina, Aerial Views Undated-photos primarily of the headquarters area

3- North Carolina General- photos primarily of the airstrip

4- Camp Lejuene, North Carolina 1948- primarily Pontoon Bridge Beach Area and main post buildings

5- Camp Lejuene, North Carolina Ice Cream Plant

6- Camp Lejuene, North Carolina Lumber

7- Camp Lejuene, North Carolina Midway Park, 1948

8- Camp Lejuene, North Carolina, Miscellaneous

9- Camp Lejuene, North Carolina, Training

10- Camp Lejuene, North Carolina, Storage

List of Documents Obtained from Marine Corp Library

Photo ID #1, folder 1, *Montford Point, Camp Knox Area, Camp Lejuene, North Carolina, September 20, 1948, F.L. 6", Ele. 3500, Looking West*.

Photo ID #2, folder 1, *Montford Point, Camp Knox Area, Camp Lejuene, North Carolina, September 22, 1948, F.L. 6", Ele. 5000, Looking North.*

Photo ID #3, folder 1, *Montford Point, Camp Knox Area, Camp Lejuene, North Carolina, September 22, 1948, F.L. 6", Ele. 5000, Looking South.*

Photo ID #4, folder 1, *Officer's Quarters, Camp Lejuene, North Carolina, October 13, 1948, F.L. 12", Ele. 9000', Looking North*.

Photo ID #5, folder 1, *Montford Point, Camp Lejuene, North Carolina, September 10, 1951, 6500 ft ele*.

Photo ID #6, folder 8, *Trailer Park at Camp Lejuene, North Carolina, May 1954, #22, Defense Department Photo A340216*.

Photo ID #7, folder 1, *Camp Lejuene, North Carolina, May 6, 1948, Looking North, Alt 20,000', F.L. 6"*.

Photo ID #8, folder 1, *Montford Point and Camp Knox Area, Camp Lejuene, North Carolina, September 20, 1948, F.L. 6", Ele. 4300, Looking East*.

Photo ID #9, folder 1, *Officer's Housing Area, Camp Lejuene, North Carolina, September 14, 1951, Negative # 2 MAW 421-9-51*.

A.2 National Archives and Records Administration Review

Text Division

Contact: Mr. Barry Zirby, 301-713-7250 x285
Site visit on July 15 and 18, 2005

Reviewed 18 boxes of files associated with the Marine Corps, 1939-1950

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 1275/70-800 (10/45-1/47) to 1275/70-727 (1/44-12/47), Box 218.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 1275/70-800 (10/44-1/45) to 1275/70-800 (7/45-9/45), Box 219.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-10 (1/48-12/48) to 2000-10 (5/24-12/36), Box 1201.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-10 (6/45-4/46) to 2000-10 (5/44), Box 1202.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20 (1/49-10/49) to 2000-10 (1/45-6/45), Box 1203.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20 (1/44-6/47) to 2000-20 (5/48-12/48), Box 1204.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-5 (6/46-12/47) to 2000-20 (6/43), Box 1205.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-10 (7/48-10/47) to 2000-20-5 (4/45-6/46), Box 1206.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-10 (7/41-11/42) to 2000-20-10 (1/45-6/45), Box 1207.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-10 (7/39-2/40) to 2000-20-10 (2/40-6/41), Box 1208.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-20 (1/48-12/48) to 2000-20-15 (1/49-6/50), Box 1209.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-20 (1/44-11/46) to 2000-20-20 (11/46-12/47), Box 1210.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2000-20-20 (2/33-8/36) to 2000-20-20 (6/42), Box 1211.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2015 (3/43) to 2000-80 (1/44-12/47), Box 1241.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Brooklyn to 2285-10 Camp Lejuene, Box 1570.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Camp Lejuene to 2285-10 Camp Lejuene, Box 1571.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Camp Lejuene to 2285-10 Camp Lejuene, Box 1572.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Camp Lejuene to 2285-10 Camp Lejuene, Box 1573.

Record Group 127 (USMC), Office of the Commandant, General Correspondence, January 1939-June 1950, 2295-10 Camp Lejuene to 2285-10 Camp Lejuene, Box 1574.

The boxes contained information primarily related to weapons test results, weapons cost distribution, weapons training classes, weapon specifications, and cleaning and maintenance. The material was not specific to Camp Lejeune and included information for several MC bases.

Cartographic Division

The cartographic division did not contain any relevant information pertaining to historical ordnance use in the Knox Trailer Park area of Camp Lejeune. Information for Camp Lejeune is located under Record Group (RG) 71-Bureau of Yards and Docks. The index for locating cartographic materials is then grouped by subject codes. The only available drawing for Camp Lejeune was for Subject Area 19- Water Systems. Subject Areas 44 is Rifle ranges, machine gun ranges, sighting ranges, bombing targets; however, no materials were located under this Subject Area.

List of Documents Obtained from National Archives

Document: *Enclosure B, Commanding General's Questionnaire, pgs 4- 8.*
Location: Text Division, Box 1572, folder *Inspector General's Report, Annual Inspection, Second Marine Division, Fleet Marine Force, Camp Lejuene, North Carolina, 5-15 December 1947.*
Relevance: Description of weapons and training ranges.

Document: *Camp Lejeune General Area Map, March 11, 1947, Y & D Drawing No. 387415.*

Location: Text Division, Box 1572, folder *Inspector General's Report, Annual Inspection, Marine Barracks, Camp Lejuene, North Carolina, 2-4 December 1947.*
Relevance: Dog training area renamed CCC.

Document: *Training Facilities and Regulations Governing the Use of, 17 August, 1949*
Location: Text Division, Box 1573, folder *Inspector General's Report, Annual Inspection, Marine Barracks, Camp Lejuene, North Carolina, 7-9 November 1949, pgs. 1-7.*
Relevance: Description of Training Facilities

Document: *Confirmation of Verbal Instructions, June 20, 1945*
Location: Text Division, Box 219, folder *1275/70-800 Camp Lejuene, North Carolina, Vol. 5, from 1 June 45 to 30 June 45.*
Relevance: Housing capacity of Camp Knox

Document: *Enclosure A, Questionnaire for Commanding General, December 8, 1945.*
Location: Text Division, Box 1570, folder *Camp Lejuene, North Carolina, Annual Inspector General's Inspection of Camp Lejeune, Questionnaire for Commanding General, pgs. 4-8, 13, Annex A.*
Relevance: Description of buildings and specialist schools at Camp Knox

Document: *Camp Lejeune General Area Map, February 10, 1942, Y & D Drawing No. 162050.*
Location: Text Division, Box 1570, folder *Camp Lejeune, North Carolina.*
Relevance: Reference Dog Training Area.

A.3 MCB Camp Lejeune Base Site Visit and Records Review

Base Contact: Mr. Bob Lowder, Environmental Management Division, 910-451-9607
Site visit August 3 and 4, 2005

File reviews of records in the base Real Estate office, base library, and EOD office were conducted during the site visit. Additionally, interviews were conducted with the Glenn Pappas/Military Historian, John Jordan/Real Estate expert, and Duane Richardson/EOD Base Range Safety Officer.

Specific figure files reviewed in the Real Estate Office included the follwoing:

Year 1941, 162044, Civilian Conservation Corp Site
Year 1943, 267616-618, Mess Hall
Year 1943, 162059, 162070, CCC Camp and Dog Training Area
Year 1943, 248193L-198L, 248188-248A, Dog Training School, Plumbing and Electrical Layout
Year 1949, 452288-95, Body Armour Research
Year 1952, 505605-608-617, Camp Knox Trailer Park, Private Trailer
Year 1952, 505397, Site and Boundary Survey
Year 1952, 567134-136, PHA Trailers
Year 1952, 567128-133, PHA Trailer Park
Year 1952, 567148-152, Trailer Park Ext.
Year 1974, 401305-317, Mobile Home Park
Year 1985, 4163858-879, Mobile Home Park

A walkthrough of the Knox Trailer Park was conducted on August 4, 2005. No visual evidence of MEC or HTW contamination was observed. There were several areas in the woods off of Boston Road and Camp Knox Road, where residential items had been disposed.

Specific interviews with base representatives for Natural Resources, Archeological Resources, Tank Program, Hazardous Waste, and SWMUs were not conducted as this information was adequately covered in the recent reports: *Draft Report Phase I- Environmental Baseline Survey (EBS) Public/Private Venture of Family Housing, Marine Corps Base Camp Lejeune (November 2004)* and *Revised Pre-Final Environmental Assessment for Privatization of Military Housing at MCB Camp Lejeune, MCAS New River, and MCAS Cherry* Point (July 2005).

Mr. Jerry Swain was contacted and emailed on 5 different occasions to obtain information regarding past residents of Knox Park. To date, there has been no response from the base housing department regarding this request.

The Range Inventory Report listed Margaret Briley as the point of contact for the suspected range at Knox Trailer Park. She has since retired from the base and been replaced by Disel Hinkle. When contacted on August 25, 2005, he reported that the report had been completed before his arrival and he had no additional information to provide regarding the Knox area as a previous range.

Follow-up calls were made to the EOD offices at Camp Geiger and New River to determine if there were additional ordnance responses made to Camp Knox other than the ones reported by Mr. Cifelli. Gunnery Sgt. Luke Moore from Camp Geiger, stated that the office had no records going back to the 1970s. Their records only go back about 10 years. He had no knowledge of any other incidents at Knox Trailer Park other than the EOD sweep a few years back and the information provided by Mr. Cifelli. No response was obtained from the New River EOD office.

Former base employees contacted were Lt. Col Lynn J. Kimball (USMC, Ret.) and Mr. Don Cifelli. Lt. Col. Kimball served as consulting historian on a book entitled *Semper Fidelis: A Brief History of Onslow County, North Carolina and MCB, Camp Lejuene*, which was also reviewed during the site visit. He was interviewed on August 10, 2005. Mr. Cifelli was contacted on August 15, 2005 and August 18 as a follow-up to a March 31, 2005 conversation with Mr. Bob Lowder regarding his past experience with ordnance at Knox Park.

List of Documents Obtained from Camp Lejeune

Base Real Estate Office

Appraisal Report, LA-Navy-Jacksonville, NC, Tract No. A-30, March 26, 1941 photos included.

Appraisal Report, LA-Navy-Jacksonville, NC, Tract No. A-31, March 26, 1941 photos included.

Appraisal Report, LA-Navy-Jacksonville, NC, Tract No. A-33, March 25, 1941 photos included.

Appraisal Report, LA-Navy-Jacksonville, NC, Tract No. A-11, March 27, 1941 photos included.

Appraisal Report, LA-Navy-Jacksonville, NC, Tract No. A-12, March 25, 1941 photos included.

Index-500' Scale Maps, Existing Condition, Marine Corps Base, Camp Lejeune, North Carolina, July 31, 1984.

Marine Corps Base New River, North Carolina, Property Map Area A, Y&D Drawing No. 159372, Contract No. 4717, April 5, 1941.

Body Armour Research Facilities, Camp Knox, Bldgs. D-23, E-1, and D-22, Index Sheet, Y&D Drawing No. 452288, January 20, 1949.

Body Armour Research Facilities, Camp Knox, Bldg. D-23, Alteration to Animal Facility, Floor Plan and Details, Y&D Drawing No. 452290, January 20, 1949.

Body Armour Research Facilities, Camp Knox, Bldg. E-1, Conversion to Testing Laboratory, Floor Plan, Elevation, and Details, Y&D Drawing No. 452295, January 20, 1949.

Body Armour Research Facilities, Camp Knox, Bldg. D-23, Alteration to Animal Facility, Electrical, Y&D Drawing No. 452294, January 20, 1949.

Marine Barracks-New River, N.C., Camp Knox, Site Plan Block "E", Y&D Drawing No. 162070, May 31, 1943.

Marine Barracks-New River, N.C., Camp Knox, Site Plan Dog Training Area, Y&D Drawing No. 162059, January 1, 1943.

Marine Barracks-New River, N.C., Site Development Plan for Civilian Conservation Corps Camp, Y&D Drawing No. 162044, July 23, 1941.

Base Library

Louis Berger Group Inc. under USCOE, Wilmington district Contract DACWS4-99-C-0004, Semper Fidelis: A Brief History of Onslow County, North Carolina and MCB, Camp Lejuene, 2002, U.S.M.C., Lt. Col Lynn J. Kimball (USMC, Ret.), consulting historian.

Putney, Captain William W., Always Faithful: A Memoir of the Marine Dogs of WWII, D.V.M., U.S.M.C. (Ret.), The Free Press, 2001.

Loftfield, Thomas C., Principal Investigator, University of North Carolina, Wilmington, August 1981. Archeological and Historical Survey of USMC Base, Camp Lejuene, Naval Facilities Engineering Command Norfolk, Coastal Zone Resource Corp, Vol. II, Contract # N62470-79-C-4273.

Montrose, Lynn. Marine Corp Gazette, June 1955, "Development of Our Body Armor"

Carraway, Gertrude S. Camp Lejeune Leathernecks, USMC Training Center, October 1946, New Bern Owen G. Dunn Company Publishers.

D'oench, PFC Derry, The Camp Lejeune Globe, "War Dogs, Trained here, Have outstanding Combat Record", Wed., February 13, 1946.

Tarpinian, Dick. The Camp Lejeune Globe, "War Dogs Undergoing Separation", Wed., September 26, 1945.

Marino, Carl L. On Land On Sea. In the Air, 1775 Semper Fidelis 1943.

Map of Montford Point Area and Vicinity, Camp Lejeune, North Carolina, Showing Conditions on June 30, 1964, Sheet 6 of 18.

EOD Office

Range and Training Regulations, BO P3570.1A, SOP for Range Control, Undated. Appendix C, Current Ops for Training Area AD

Final Range Identification and Preliminary Range Assessment, Marine Corps Base Camp Lejeune, Onslow, North Carolina, December 2001, Prepared by US Army Corps of Engineers, St. Louis District.

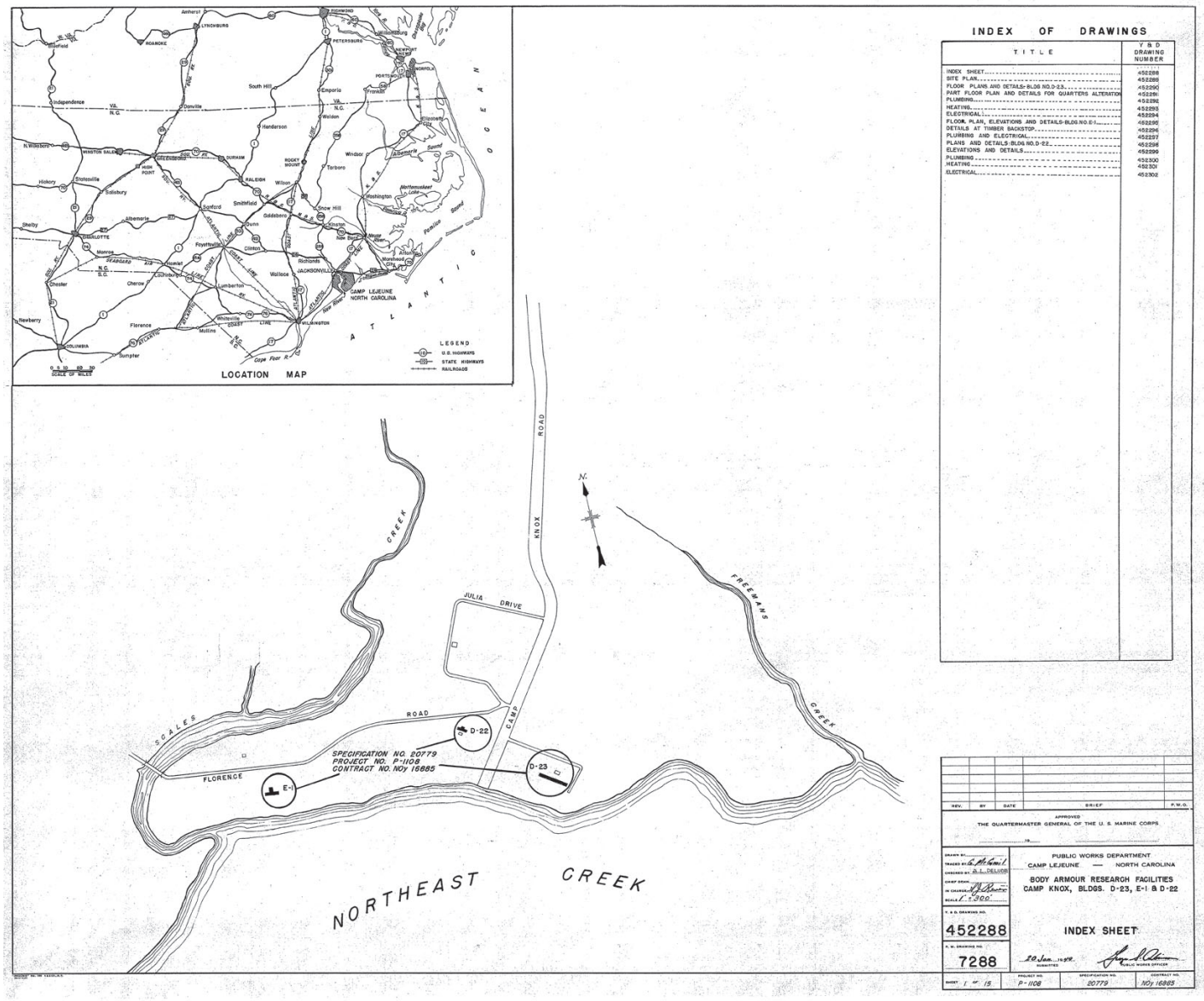
Environmental Office

Draft Marine Corps Base Camp Lejeune Range Inventory Report, February 2002, Prepared for USACE Mobile District, Mobile, Alabama.

Lowder, Robert, Environmental Management Division, Camp Lejeune. Electronic mail communication from Bob Lowder documenting phone interview with Mr. Cifelli, retired EOD personnel on Mary 30, 2005.

Attachment 2
Photo Log

Aerial Photographs



INDEX OF DRAWINGS

TITLE	Y & D DRAWING NUMBER
INDEX SHEET	452288
SITE PLAN	452289
FLOOR PLANS AND DETAILS-BLDG NO.D-23	452290
PART FLOOR PLAN AND DETAILS FOR QUARTERS ALTERATION	452291
PLUMBING	452292
HEATING	452293
ELECTRICAL	452294
FLOOR PLAN, ELEVATIONS AND DETAILS-BLDG.NO.E-1	452295
DETAILS AT TIMBER BACKSTOP	452296
PLUMBING AND ELECTRICAL	452297
PLANS AND DETAILS-BLDG.NO.D-22	452298
ELEVATIONS AND DETAILS	452299
PLUMBING	452300
HEATING	452301
ELECTRICAL	452302

REV.	BY	DATE	BRIEF	P.W.O.

APPROVED
THE QUARTERMASTER GENERAL OF THE U. S. MARINE CORPS

19

PUBLIC WORKS DEPARTMENT
CAMP LEJEUNE — NORTH CAROLINA

BODY ARMOUR RESEARCH FACILITIES
CAMP KNOX, BLDGS. D-23, E-1 & D-22

INDEX SHEET

DRAWN BY
TRACED BY G. Mitchell
CHECKED BY S.T. DELUCIA
CHIEF DRAFTSMAN
IN CHARGE OF DRAWING
SCALE 1" = 300'

Y. & D. DRAWING NO. 452288

P. W. DRAWING NO. 7288

20 Jan. 1949
SUBMITTED

PUBLIC WORKS OFFICER

SHEET	PROJECT NO.	SPECIFICATION NO.	CONTRACT NO.
1 OF 15	P-1108	20779	NOy 16885

Body Armour Research Facilities #32
Camp Knox Bldg. D-23, E-1 and D-22
Index Sheet
Y&D Drawing No. 452288
January 20, 1949

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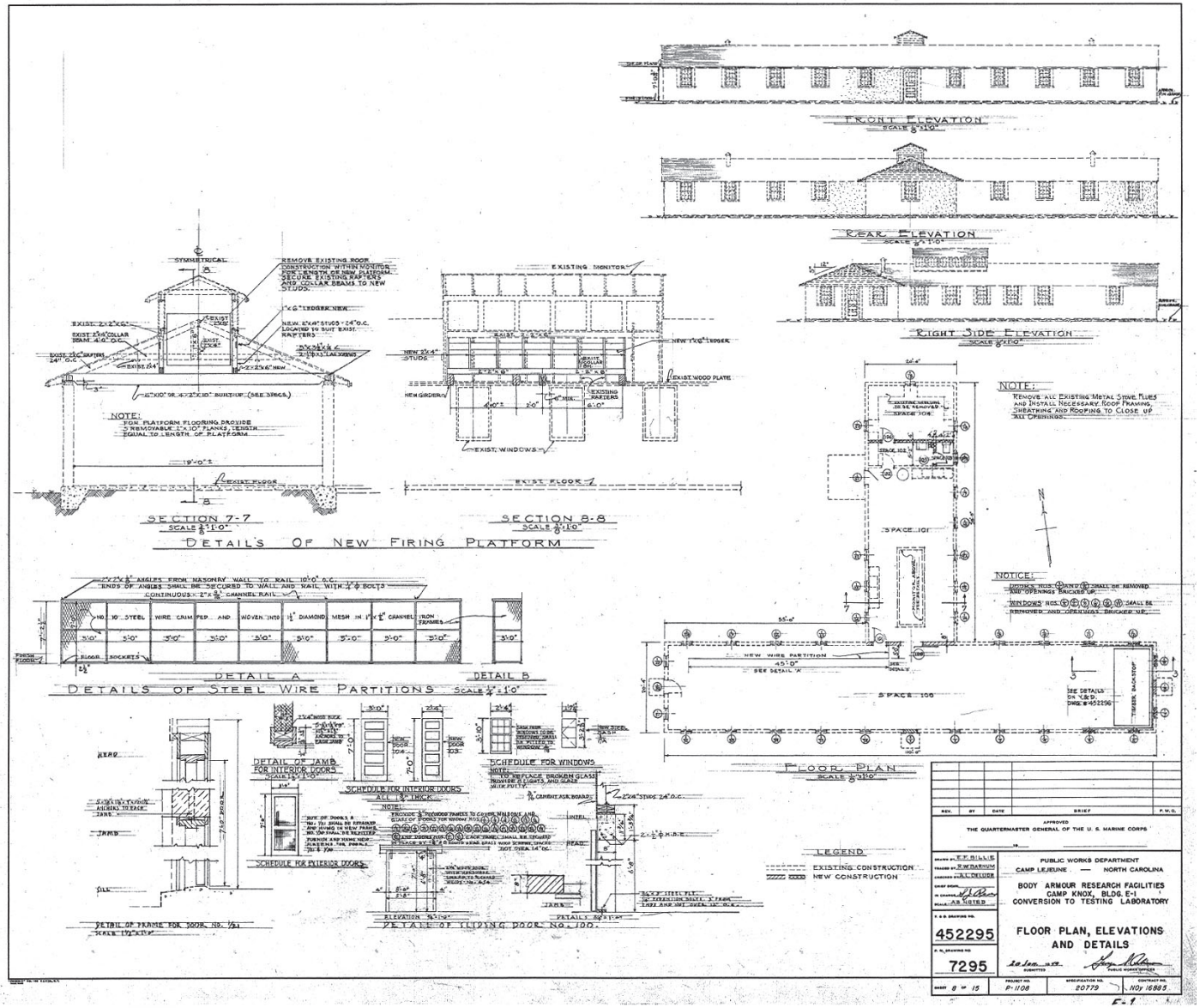
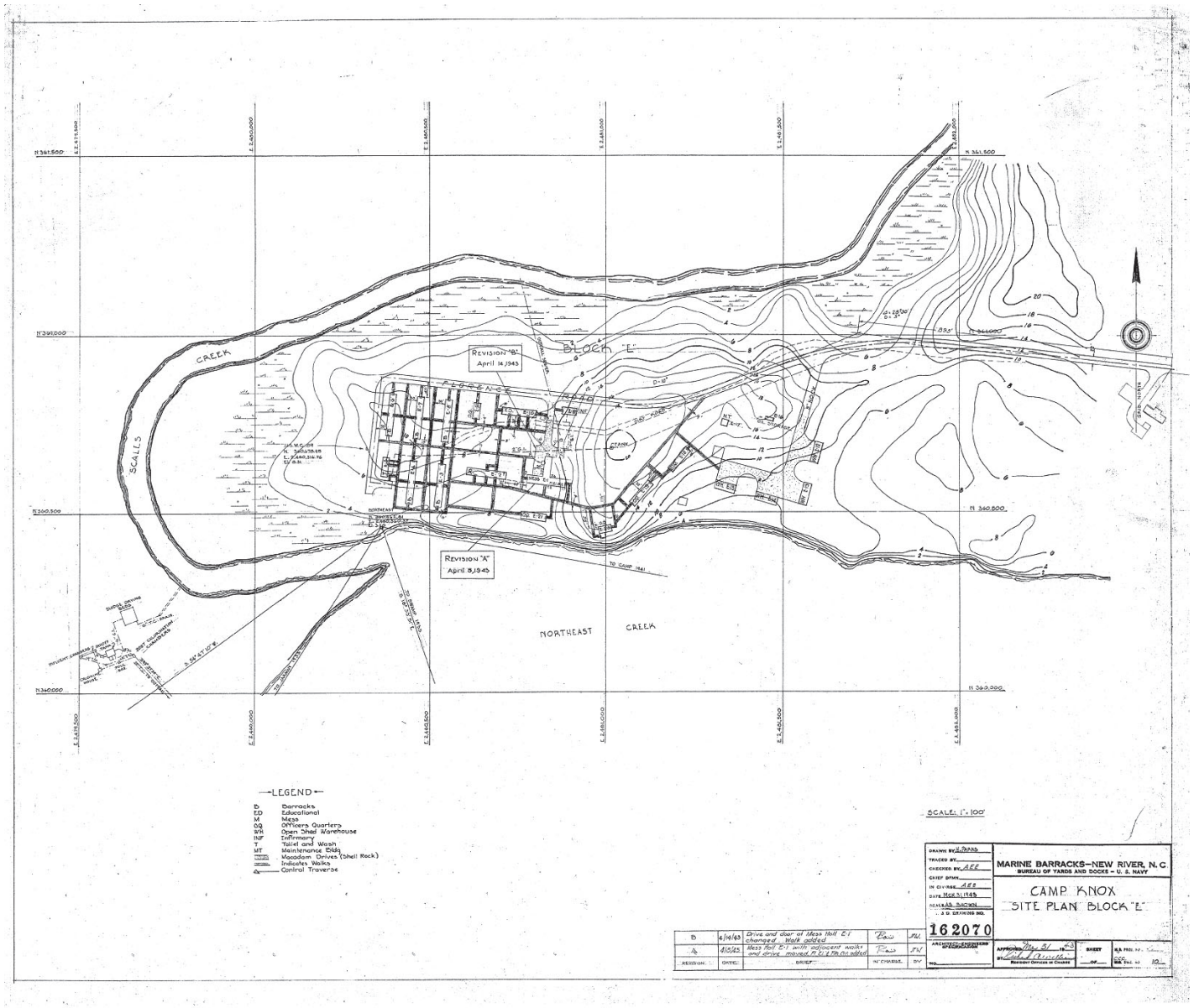


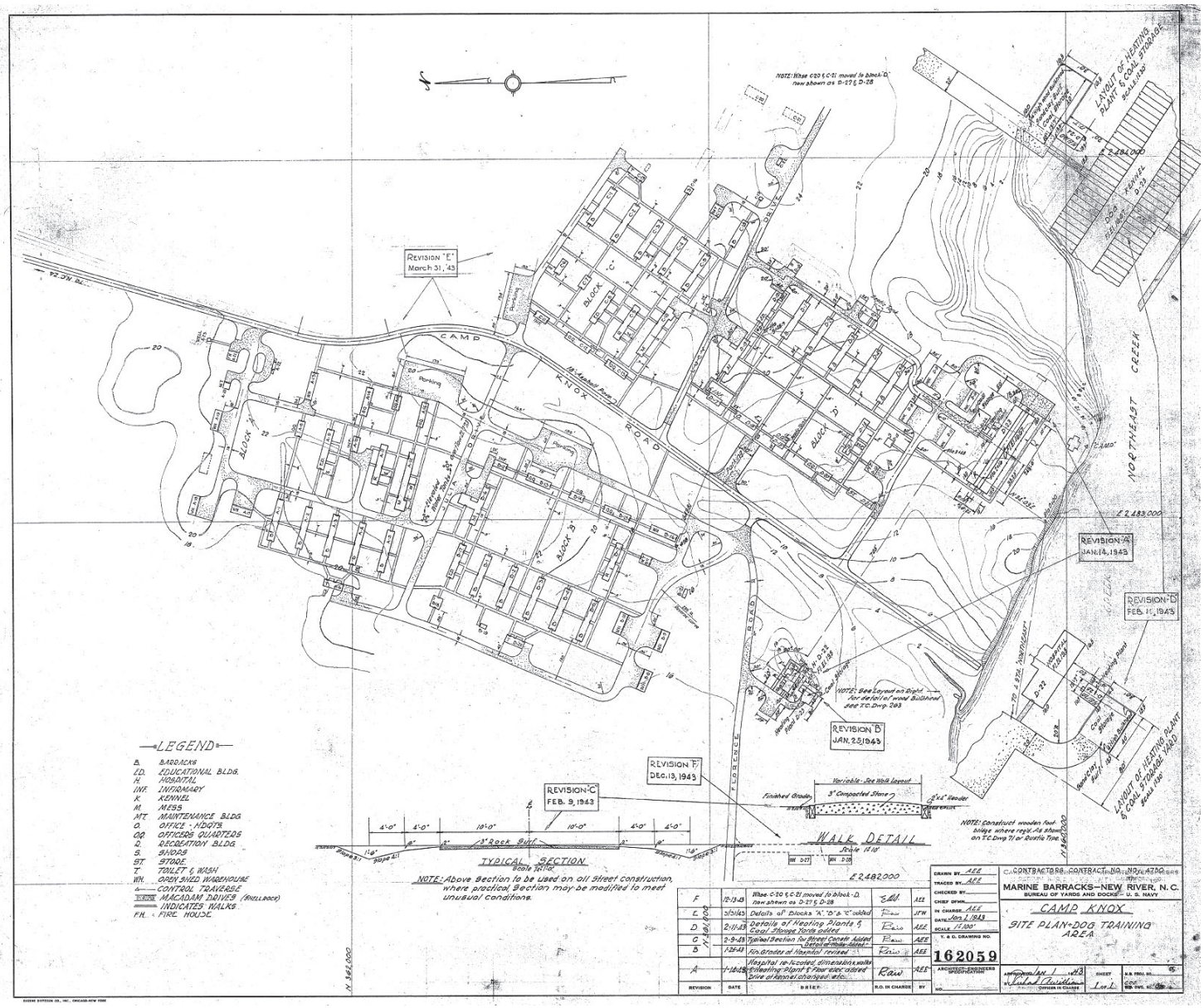
Body Armour Research Facilities #34
Camp Knox Bldg. E-1
Conversion to Testing Laboratory
Floor Plan Elevations and Details
Y&D Drawing No. 452295
January 20, 1949

CH2MHILL



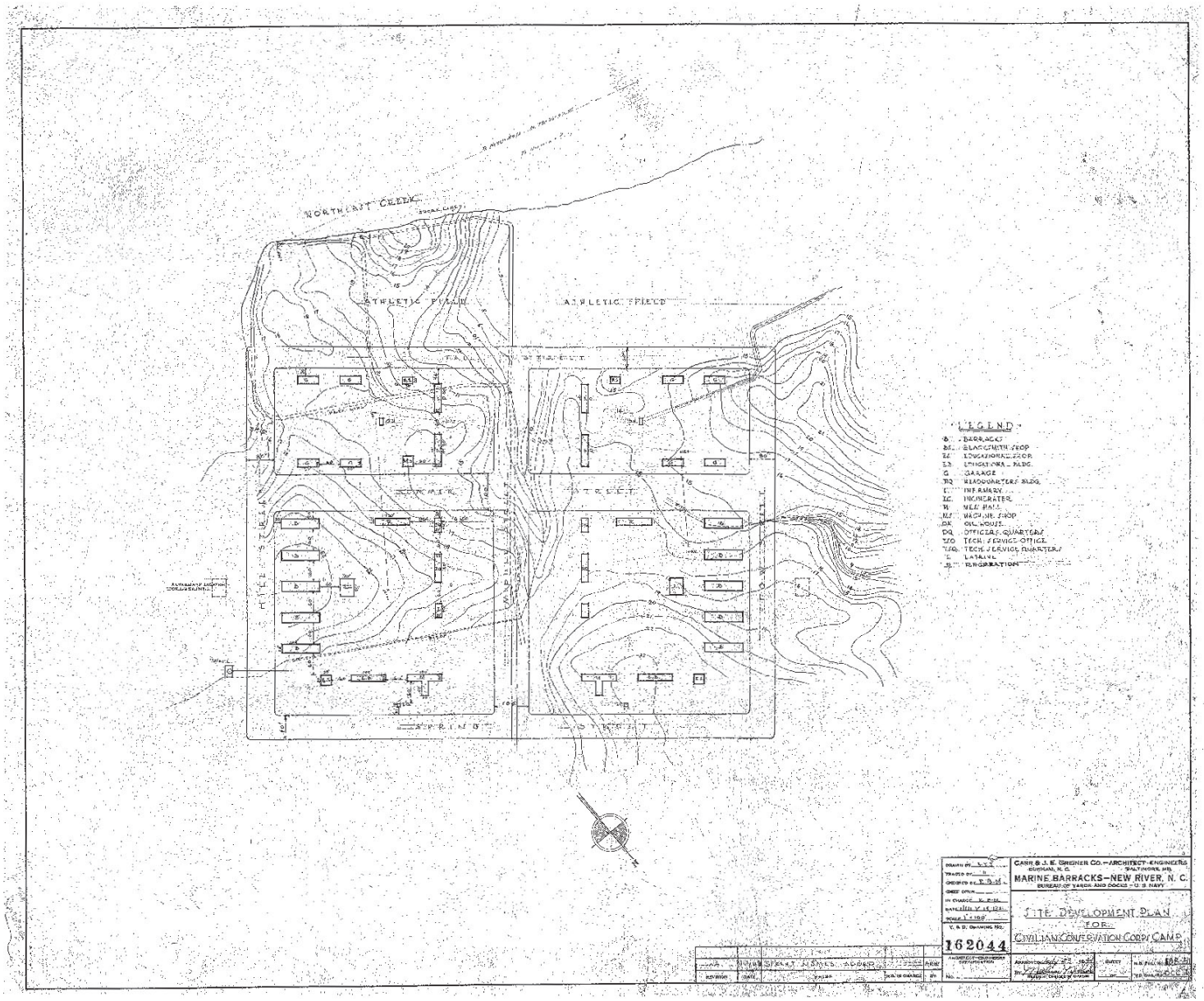
Body Armour Research Facilities #36
Site Plan Block "E"
Y&D Drawing No. 162070
May 31, 1943

CH2MHILL



Camp Knox
Site Plan Dog Training Area #37
Y&D Drawing No. 162059
January 1, 1943

CH2MHILL



Site Development Plan for Civilian Conservation Corps
Camp #38
Y&D Drawing No. 162044
July 23, 1941

CH2MHILL

Camp Lejeune General Map Y&D #39
Drawing No. 162050
February 10, 1942

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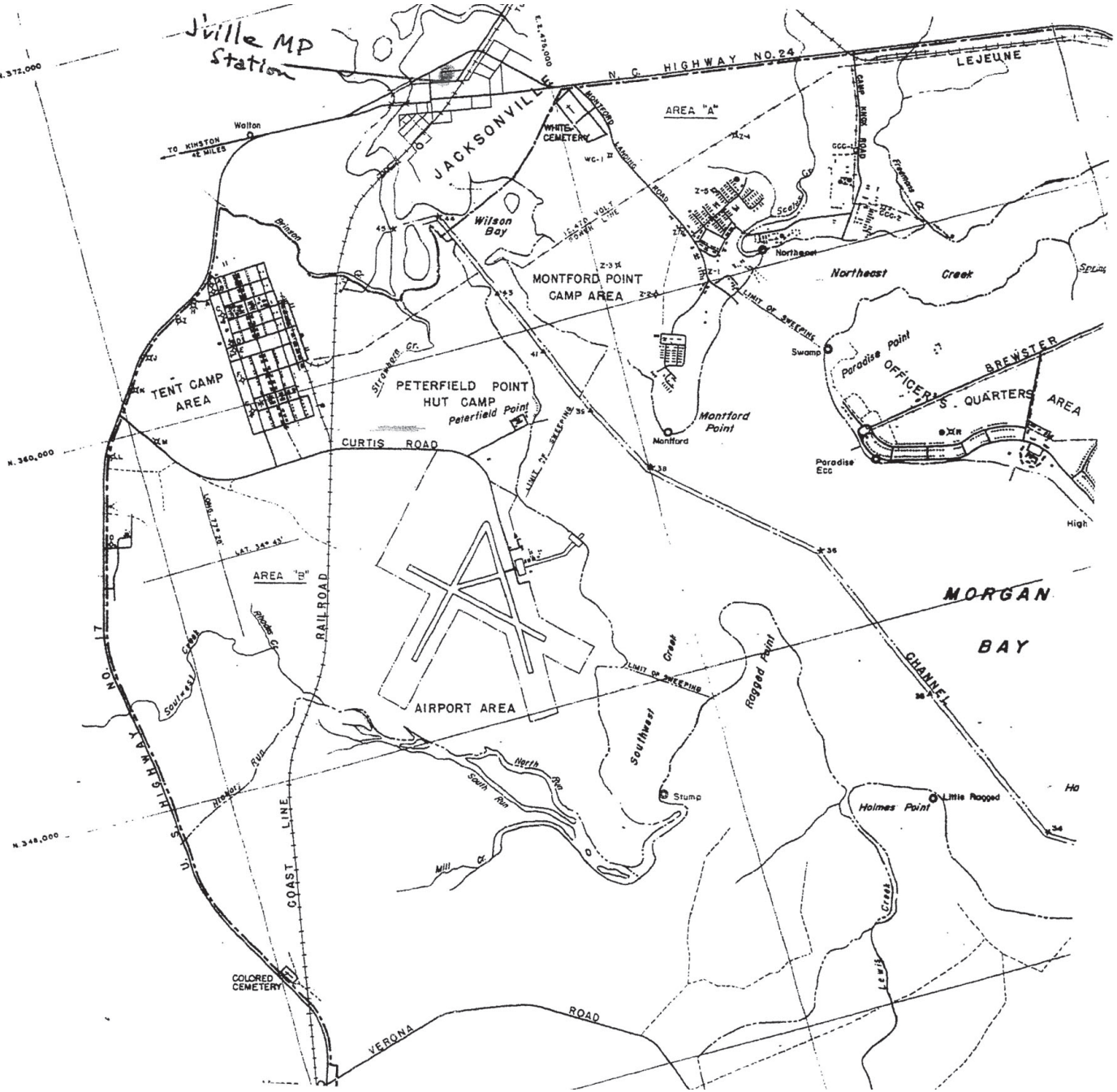

Camp Lejeune General Map Y&D #40
Drawing No. 387415
March 11, 1947

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Property Tract Photographs

Property Tract A-11 Photo #1 - Dwelling

Property Tract A-11 Photo #3 - Cabin

Property Tract A-12 Photo #1 - Dwelling

Property Tract A-12 Photo #4 - Pier

Property Tract A-12 Photo #5 - Cabin

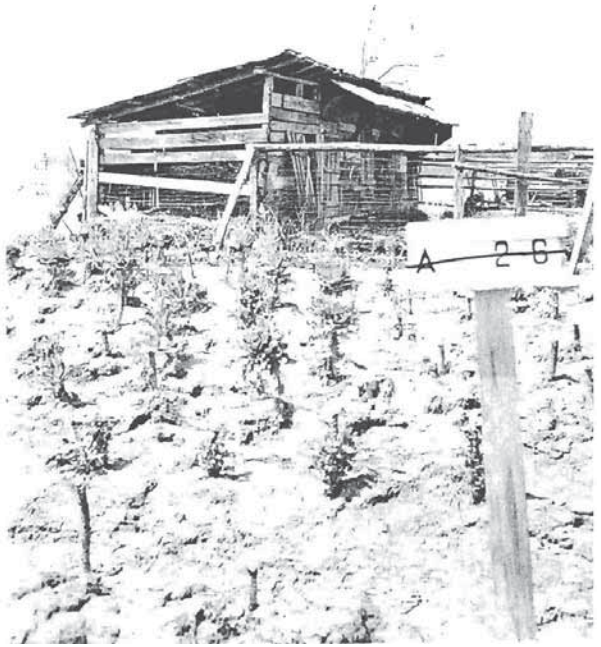
Property Tract A-12 Photo #3 - Barn

Property Tract A-30 Photo #1 - Unkown Structure

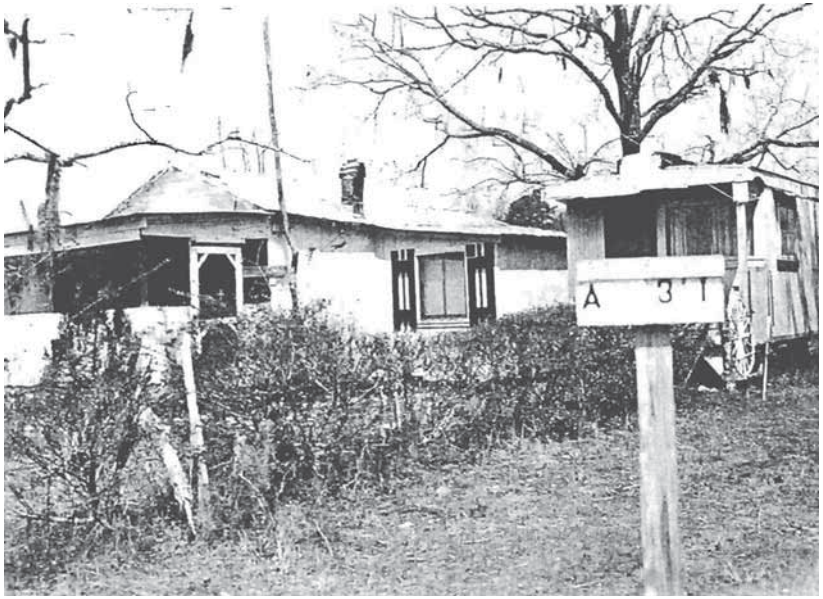
Property Tract A-30 Photo #3 - Crib

Property Tract A-30 Photo #2 - Smokehouse

Property Tract A-31 Photo #5 - Tobacco Barn



Property Tract A-31 Photo #4 - Stalls



Property Tract A-31 Photo #6 - Cottage

Property Tract A-31 Photo #8 - Garage

Property Tract A-31 Photo #21 - Unidentied Structure

Property Tract A-31 Photo #7 - Cottage

Property Tract A-33 Photo #2 - Tobacco Barn

Property Tract A-33 Photo #1 - Shack

Appendix B
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: 330966

CLIENT: Navy

PROJECT/SITE NAME: CLEAN III CTO-109 / MCB Camp Lejeune, Knox Trailer Park Site

SITE ADDRESS: Jacksonville, North Carolina

CH2M HILL PROJECT MANAGER: Tom Roth/ATL (CCI)

CH2M HILL OFFICE: Atlanta

DATE HEALTH AND SAFETY PLAN PREPARED: 8/18/2005

DATE(S) OF SITE WORK: November 2005 through May 2006

SITE ACCESS: Refer to attached Figure 1-2. 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 Trailer Park site is approximately 133 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.

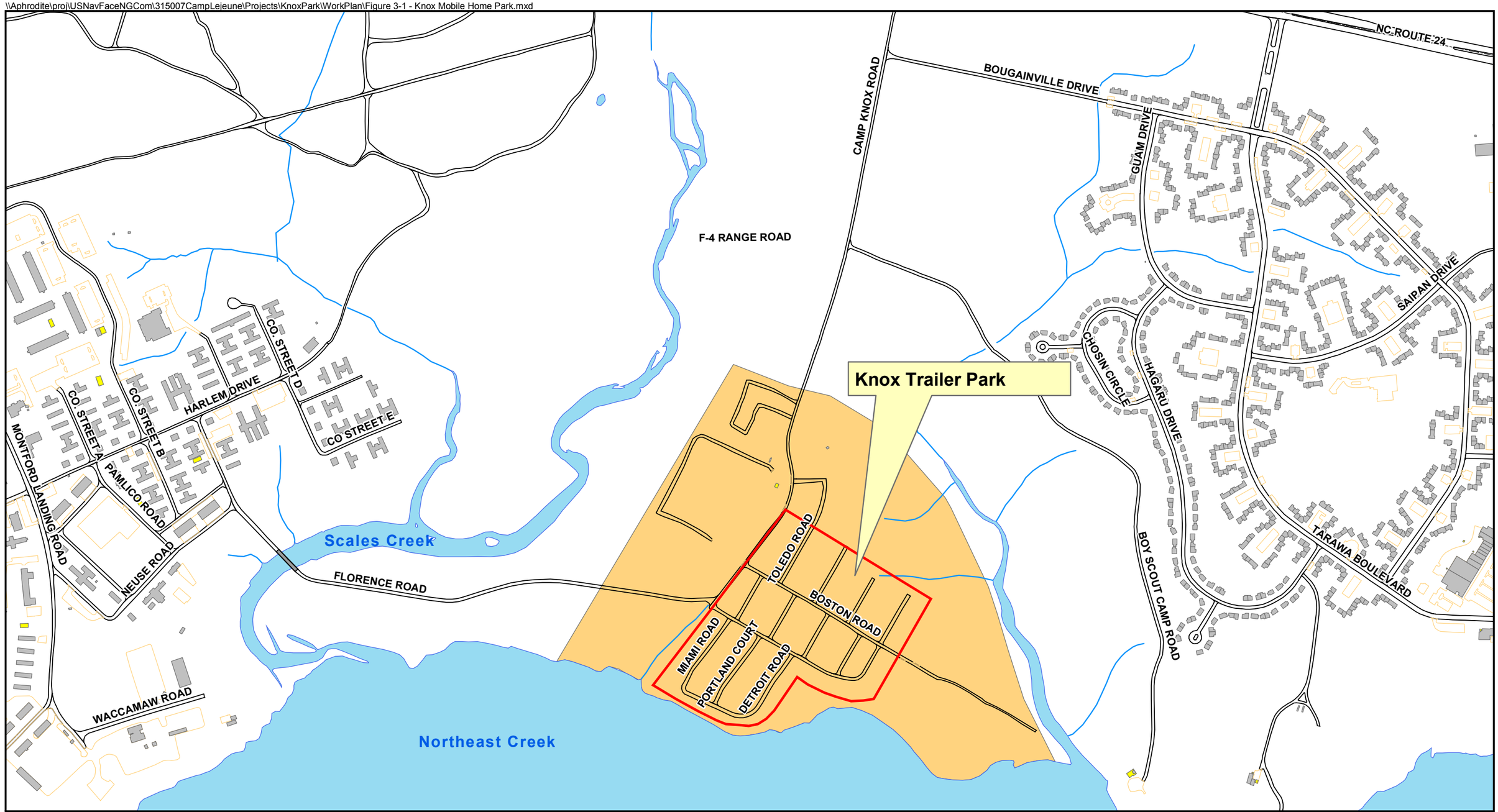
A majority of the land surrounding the facility is used for agriculture. Estuaries along the coast support commercial fishing and residential resort areas are located adjacent to MCB, Camp Lejeune along the Atlantic Ocean.

The Knox Trailer Park site (refer to attached Figure 1-2) 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:

- Collection of Direct-Push (DP) soil samples from up to 10 locations;
- Collection of surface water and sediment samples from up to 10 locations;
- Installation of five pairs of shallow and intermediate depth and 10 additional shallow groundwater monitoring wells;
- Collection of groundwater samples from the newly installed monitoring wells at the site; and
- Removal of vegetation followed by performance of a surface MEC clearance; and
- Performance of a geophysical prove out and mapping of the project area.

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\KnoxPark\WorkPlan\Figure 3-1 - 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
- Estimated Site Investigation Area

N
W E
S

200 0 200
Meters

Figure 1-2
Knox Trailer Park
MCB Camp Lejeune
Camp Lejeune, North Carolina

CH2MHILL

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

- Drilling
- Geoprobe boring
- Groundwater monitoring
- Removal of vegetation

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							
	Removal of vegetation	**Drilling, geoprobe, and well installation & abandonment**	**Groundwater monitoring, aquifer testing**	**Direct Push and Geoprobe**				
Flying debris/objects	X	X		X				
Noise > 85dBA	X	X		X				
Electrical	X	X	X	X				
Suspended loads		X		X				
Buried utilities, drums, tanks		X		X				
Slip, trip, fall	X	X	X	X				
Back injury	X	X	X	X				
Confined space entry								
Trenches / excavations								
Visible lightning	X	X	X	X				
Vehicle traffic	X			X				
Elevated work areas/falls				X				
Fires		X						
Entanglement	X	X		X				
Drilling		X		X				
Heavy equipment		X		X				
Working near water								
Working from boat								
IDW Drum Sampling								

2 Hazard Controls

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

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

Project-specific frequency for completing self-assessments: Bi-weekly or at the beginning of each project phase.

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-211, *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-211 *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.

2.1.5 Drilling

(Reference CH2M HILL SOP HS-204, *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-306, *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-209, *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-112, *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-208 *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-206 *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-214, *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-211, *Heat and Cold Stress*)

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

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

Monitoring Heat Stress

These procedures should be considered when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress.

The heart rate (HR) should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

2.2.9 Cold Stress

(Reference CH2M HILL SOP HS-211, *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

Local Utility Mark-Out Service

Name: To be determined
Phone:

- Where available, obtain utility diagrams for the facility.
- Review locations of sanitary and storm sewers, electrical conduits, water supply lines, natural gas lines, and fuel tanks and lines.
- Review proposed locations of intrusive work with facility personnel knowledgeable of locations of utilities. Check locations against information from utility mark-out service.
- Where necessary (e.g., uncertainty about utility locations), excavation or drilling of the upper depth interval should be performed manually
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change n advancement of auger or split spoon).
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the SSC should confirm that arrangement.

2.2.12 Confined Space Entry

(Reference CH2M HILL SOP HS-203, *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-202, *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 Mosquito Bites

Due to the recent detection of the West Nile Virus in the Southeastern United States it is recommended that **preventative measures** be taken to reduce the probability of being bitten by mosquitoes whenever possible. Mosquitoes are believed to be the primary source for exposure to the West Nile Virus as well as several other types of encephalitis . The following guidelines should be followed to reduce the risk of these concerns for working in areas where mosquitoes are prevalent.

- Stay indoors at dawn, dusk, and in the early evening.
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Spray clothing with repellents containing permethrin or DEET since mosquitoes may bite through thin clothing.
- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35% DEET (N,N-diethyl-meta-toluamide). DEET in high concentrations (greater than 35%) provides no additional protection.
- Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands.
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

Note: Vitamin B and "ultrasonic" devices are NOT effective in preventing mosquito bites.

Symptoms of Exposure to the West Nile Virus

Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile Virus incubation period is from 3-15 days.

If you have any questions or to report any suspicious symptoms, contact the project Health and Safety Manager.

2.3.7 Fire Ant Bites

Fire ants are common in the southern U.S. These insects typically build mounds on the land surface that are usually easy to identify. Avoid disturbing these mounds. A bite from a fire ant can be painful but rarely is life threatening. However, it is possible that the bite could cause an allergic reaction. If bitten, check for symptoms of an allergic reaction such as weakness, nausea, vomiting, dizziness, or shortness of breath. If symptoms appear, seek medical attention

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 UXO/MEC

MEC Avoidance Procedures. MEC avoidance operations will be required during vegetation removal, sampling and drilling operations. Avoidance operations will consist of a team composed of two UXO Technicians. This team will consist of a UXO Technician III and a UXO Technician II. The UXO Team will not destroy any MEC encountered. All MEC contacts and suspected MEC anomalies will be reported to the site manager who will in turn notify in accordance with contractual requirements.

Access routes to sampling locations. Prior to sampling or well drilling crews on site, the UXO Technicians will conduct a reconnaissance of the sampling area. The reconnaissance will include locating the designated sampling or drilling location(s) and insuring that they are free of anomalies. If anomalies are detected the point will be relocated as directed. Once the designed point has been cleared, an access route for the sampling crew's vehicles and equipment will be cleared. The access route, at a minimum will be twice the width of the widest vehicle and the boundaries will be clearly marked to prevent personnel from straying into non cleared areas. If surface MEC is encountered, the UXO Team will mark and report the item and divert the approach path around the MEC. A magnetometer will be used to ensure there are no subsurface MEC with the approach path. If a subsurface magnetic anomaly is encountered, it will be assumed to be a possible MEC and the path diverted to avoid it.

Vegetation removal will be performed under the direction of UXO Technicians; all activities will be conducted after a visual and/or electronic (magnetic) sweep of the area by the UXO Technicians. Mechanical and manual vegetation removal teams will include one or more UXO Technicians using appropriate geophysical instruments and observations to avoid MEC.

Soil Sampling and Well Drilling Sites. The UXO Technicians will clear a work site for soil samples and well drilling and clearly mark the boundaries. The area will be large enough to accommodate the drilling equipment and provide a work area for the crews. As a minimum, the cleared area will be a square, with a side dimension equal to twice the length of the largest vehicle or piece of equipment for use on site. If a pre-selected area indicates magnetic anomalies, a new sampling / drill site will be chosen.

Borehole Sampling. If surface samples are required they will be obtained prior to the start of boring. The borehole procedures will be completed using a hand auger, power auger or direct push technology (DPT) equipment. The UXO Technicians will check the borehole with a down hole magnetometer a minimum of every one foot, to the deepest sampling depth or a maximum of 4 feet (based on MK II Hand Grenade) to ensure that smaller items of MEC, undetectable from the surface will be detected.

Monitoring Well installation. Prior to drilling equipment being moved to the proposed site, the UXO Technicians will have checked the designed site, using a magnetometer or equivalent, to assure that the well location is anomaly free to a depth of one foot. If surface samples are required they will be obtained prior to the start of drilling. To complete the subsurface magnetometer checks, one of two methods may be used.

- Monitoring at 1 foot increments, during the actual well drilling operation. This will require the withdrawal of the drill rod or augers from the well and moving the drill rig a minimum of 20 feet away from the well location to prevent the rig from influencing the magnetometer , or
- Installing an offset monitoring hole within two feet of the well location. This monitoring hole can be installed by the UXO Technician with a hand or power auger, and monitored at one foot increments to the desired well depth or a maximum of 4 feet.

Removal of MEC-related scrap & non-MEC related scrap. For the purpose of disposal, scrap material shall be segregated and defined as Groups 1a, Group 1b, or Group 2.

Group 1 includes property that previously contained explosives or that does not contain items of a dangerous nature and can be certified inert and or free of explosives or other dangerous materials.

Group 1a includes firing range expended small arms cartridges and inert metals gleaned from range cleanup.

Group 1b includes any certifiable material or items not meeting the criteria in 1a above. A determination shall be made as to whether the material or item requires demilitarization. Damage sustained does not necessarily constitute demilitarization.

Group 2 includes inherently dangerous items that may potentially contain MEC and cannot be certified as inert.

MPPEH Certification and Verification

SUXOS will confirm that non-MEC scrap and MEC scrap is properly inspected in accordance with DOD standards. Only UXO Technicians will perform these inspections. The SUXOS will certify that the scrap metal is free of explosive hazards and the UXOSO will verify that information via DD Form 1348-1A.

As part of the transfer of MD or range related debris for final disposition, the following certification / verification will be entered on each DD 1348-1A will be signed by the SUXOS and the UXOSO.

"This certifies that the material listed has been 100 percent properly inspected and to the best of our knowledge and belief, are free of explosive hazards, engine fluids, illuminating dials, and other visible liquid HTWR materials."

Maintaining the Chain of Custody and Final Disposition

All MPPEH that is to be inspected and certified / verified will be kept under control to ensure no foreign material is inadvertently added. This may require locking rings for drums, fenced in area or containers that can be secured. Labeling as to content and hazard (if appropriate) must be accomplished. Final disposition will be in accordance with contractual requirements.

CONTACT WITH MEC IS PROHIBITED

Grenades

- Do not attempt to re-install safety pins on a dud fired grenade;
- Do not attempt to withdraw impinged firing pins from the fuze of a dud fired grenade;
- Do not dispose of grenades by functioning them as designed;

Chemical hazards associated with MEC include toxicity. Toxicity may occur following inhalation of chemical vapors that could potentially be released from soil and ingestion or direct contact with soil and/or ground water that could potentially contain hazardous substances. Therefore, ensure basic sanitation (washing of hands), eating, smoking, etc., are prohibited in the Area.

Explosive Residues such as 2,4,6-trinitrotoluene (TNT) 1,3-dinitrobenzene (DNB) and 1,3,5-trinitrobenzene (TNB) are synthetic substances used in explosives. They dissolve in certain liquids. They have no odor or taste. Could affect the nervous system and liver if swallowed or gets on the skin. Exposure to residues can occur through eating, drinking, touching, or inhaling contaminated soil, water, food or air. Therefore ensure proper PPE use, and basic sanitation (washing of hands), eating and smoking are prohibited n the Area.

Dioxins/Furans - polychlorinated dibenzo-para-dioxins (PCDDs) and polychlorinated dibensofurans (PCDFs) are solid at room temperature and have a rather low volatility. Route of exposure is through ingestion. Therefore, ensure proper PPE use, basic sanitation (washing of hands); eating and

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
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
2,4,6-trinitrotoluene (TNT) and	GW: SB: SS:	1.5 mg/m^3	500 mg/m^3	Irritation skin, mucous membrane; liver damage, jaundice; cyanosis; sneezing; cough, sore throat; peripheral neuropathy, muscle pain; kidney damage; cataract; sensitization dermatitis; leukocytosis (increased blood leukocytes); anemia; cardiac irregularities	UK
1,3-dinitrobenzene (DNB)	GW: SB: SS:	1 mg/m^3	50 mg/m^3	Anoxia, cyanosis; visual disturbance, central scotomas; bad taste, burning mouth, dry throat, thirst; yellowing hair, eyes, skin; anemia; liver damage	UK

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-113, *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
Dan Tomczak	***RDU***	***Field Team Leader***	SC-HW, FA-CPR Level ___ SSC; 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: Roth, Tom
Health and Safety Manager: Michael Goldman/ATL for General and Dan Young./NVR for MEC
Field Team Leader: Dan Tomczak/RDU
Site Safety Coordinator: Dan Tomczak/RDU
Uxo Site Safety And Health Officer: 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.

UXO TECHNICIAN III

The UXO Technician III for this project will report directly to the Project Manager on issues pertaining to the operations at the Knox Trailer Park project site. The UXO Technician III will have the following safety and health related responsibilities:

- Reports directly to the CH2M HILL Project Manager;
- Managing the funding, manpower and equipment necessary to safely conduct site operations;
- Reviewing and becoming familiar with the site Work Plan (WP) and SSHP;
- Provide copies of the WP and SSHP to site and subcontract personnel;
- Review the scope of work (SOW) and ensure that the required safety and health elements are addressed in the SSHP and/or WP;
- Coordinating the assignment of personnel and ensuring that the personnel and equipment provided meet the requirements of the WP and SSHP;
- Ensuring implementation of project quality, safety and health procedures;
- Early detection and identification of potential problem areas, including safety & health matters, and instituting corrective measures;
- Directly interfacing with the Project manager and advising him of safety and health matters related to conduct of the site operations.
- Acts as the On-Scene-Incident-Commander (OSIC) in the event of an MEC emergency, notifying and coordinating with off site emergency and medical response agencies.

UXO SITE SAFETY AND HEALTH OFFICER

The UXO Site Safety Officer (UXOSO) for this project reports directly to the Project Manager and oversees all UXO safety and heath aspects for this site. For this project the UXO Technician III will assume the duties of the UXOSO. He/she will coordinate all daily activities with the Project Manager. The UXOSO will have the following responsibilities;

- Has STOP WORK authority for UXO safety and heath reasons;
- Implement and enforce the SSHP, and report safety violations to the Project Manager and other appropriate personnel;
- Establishing work zones and controlling access to these zones;
- Conduct daily UXO Safety Briefings;
- Implement and document the Site Specific Hazard Information Training Program;
- Consulting with the SUXOS as necessary;
- Assisting in the continued development of this Avoidance Plan, and the SSHP and other safety and health procedures, as applicable;
- Investigate and report accidents/incidents and ‘near misses;”
- Conduct visitor orientation;
- Enforce the “buddy” system;
- Restrict site personnel from site activities if they exhibit systems of alcohol or drug use or illness, and continually monitor site personnel for signs of environmental exposure or physical stress;
- Maintain the site safety and monitoring logs;

- Maintains an alternate line of communication with the Project Manager.

UXO TECHNICIANS

All UXO Technicians are required to comply with the provisions of this Avoidance Plan, the SSHP, the WP and all applicable Federal, State and local regulations. They will report to the UXO Technician III.

3.2.3 CH2M HILL Subcontractors

(Reference CH2M HILL SOP HS-215, *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-215, *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-117, *Personal Protective Equipment*, HS-121, *Respiratory Protection*)

PPE Specifications [a]

Task	Level	Body	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
Surface water sampling Aquifer testing 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.
Test pit excavation 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-207 - *Exposure Assessment for Airborne Chemical Hazards)*

5.1 Air Monitoring Specifications

Instrument	Tasks	Action Levels[a]		Frequency [b]	Calibration
FID: OVA model 128 or equivalent	Geoprobe and drilling.	<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	Geoprobe and drilling.	<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	Geoprobe and drilling.	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	Geoprobe and drilling.	>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

None anticipated.

Personnel and Areas

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

HSM: Michael Goldman/ATL
Other: Dan Young/NVR

6 Decontamination

(Reference CH2M HILL SOP HS-506, *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.

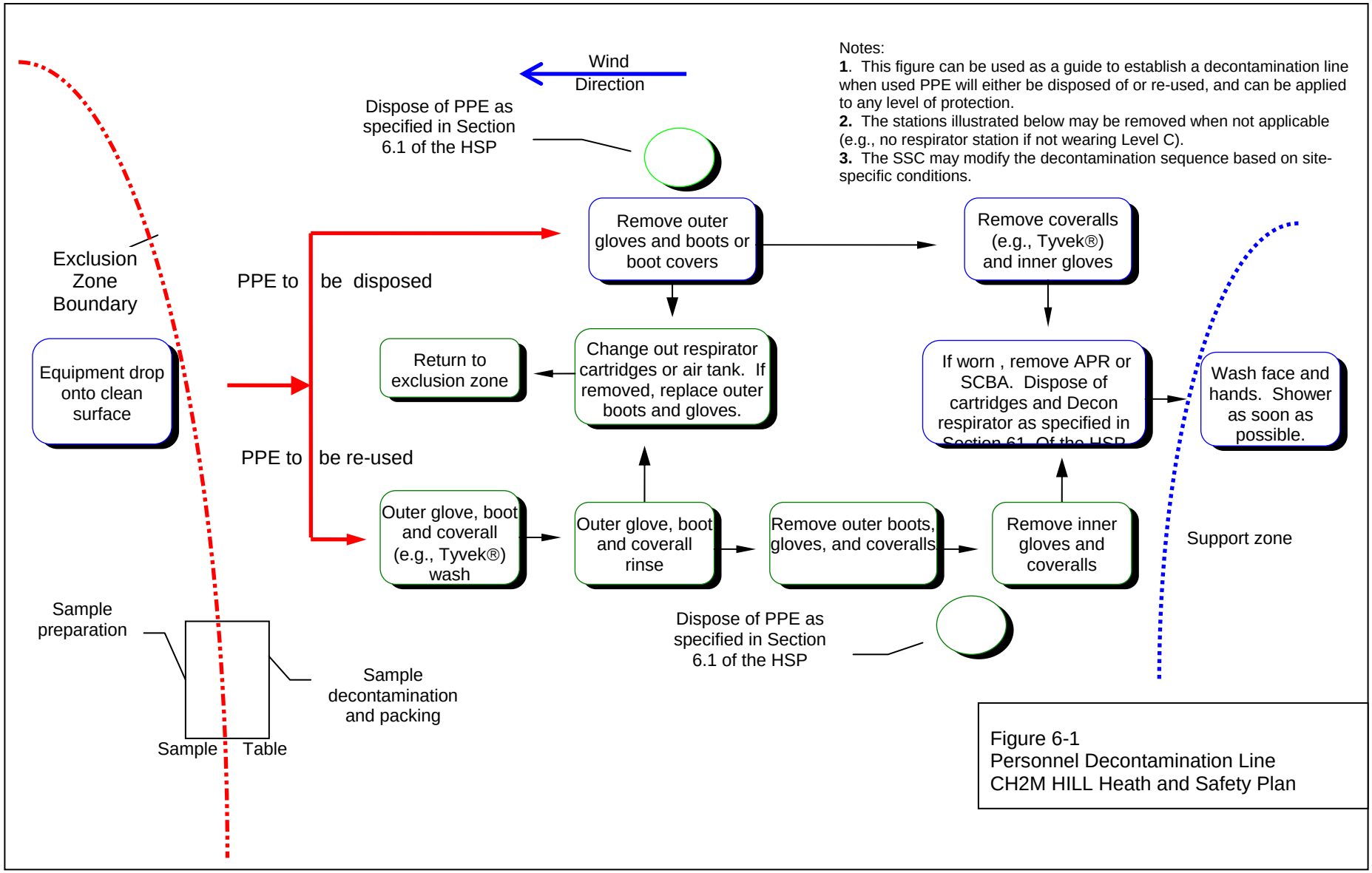


Figure 6-1
Personnel Decontamination Line
CH2M HILL Heath and Safety Plan

8 Site-Control Plan

8.1 Site-Control Procedures

(Reference CH2M HILL SOP HS-510, *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 UXO Site Control

The UXO Technician III coordinates access control and security on site. Due to the hazardous nature of MEC work, only authorized personnel will be allowed in the exclusion zone (EZ). The EZ is the work site encompassing an area large enough to prevent personnel injuries from fragmentation and overpressure resulting from either an unintentional or intentional detonation of MEC.

During all intrusive operations the EZ will be a radius of 400 feet minimum (MK II Grenade) (distance from DDESP TP-16, Chapter 4). During UXO operations, only UXO trained or authorized essential personnel are allowed in the EZ. Authorized personnel are those that have completed the required training, meet medical requirements and are essential to the ongoing operation.

During all operations on site, the site UXO Technician III will cease operations if non-essential personnel are observed within the operating area (EZ). During duty hours, personnel will provide security at the site. Equipment will be returned to a designated area and secured at the end of each work day. Future site control measures to ensure safety are as follows;

- Eating, drinking and smoking are prohibited except in designated areas;
- MEC operations will cease if non-UXO trained or non-essential personnel are present;
- The UXO Technician III will escort all authorized visitors to the site;
- The UXO Technician III will maintain the site entry control log to ensure accurate accountability of personnel;
- The UXO Technician III will brief this UXO Avoidance Plan to all personnel entering the site to inform them of the potential site hazards. All personnel will acknowledge this briefing by signing the briefing log;
- In case of an emergency, personnel will exit the site and move to the designated safe area. The safe area will be located upwind of the site and outside of the fragmentation (400 feet) area. The UXO Technician III will assist in determining the severity of the emergency. If the emergency warrants evacuation, the UXO Technician III will notify the Project Manager.

8.2 Hazwoper Compliance Plan

(Reference CH2M HILL SOP HS-220, *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-106, *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: **Ed Corack/WDC** **Date:08/24/05**
Dan Young/NVR

Approved By: Michael Goldman **Date: September 2, 2005**

10.2 Revisions

Revisions Made By: **Date:**

Revisions to Plan:

Revisions Approved By: **Date:**

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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

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-109 / MCB Camp Lejeune, Knox Trailer Park **Project Number:** 330966

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-109 / MCB Camp Lejeune, Knox Trailer Park **Project Number:** 330966

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.

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CHEMICAL-SPECIFIC TRAINING FORM

Location:	Project #: 330966
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 Beeper – 888/444-1226

Medical Emergency – 911 or
Hospital ER (On-Base) #: (910) 451-4840
(910) 451-4841
(910) 451-4842
Onslow County ER (Off-Base) #: (910) 577-2240
Ambulance (On-Base) #: (910) 451-3004
(910) 451-3005
Ambulance (Public) #: (910) 451-9111
LEPC (Poison Control)#: (800) 222-1222

CH2M HILL Medical Consultant
Dr. Peter Greaney
GMG WorkCare, Orange, CA
800/455-6155
(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
24-hour emergency beeper: 888-444-1226

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

Designated Safety Coordinator (DSC) see Site-Specific HASP
Name:
Phone:

Regional Human Resources Department
Name: Mary Jo Jordan/GNV
Phone: 352/355-2867

Project Manager see Site-Specific HASP
Name:
Phone:

Corporate Human Resources Department
Name: John Monark/COR
Phone: 303/771-0900

Federal Express Dangerous Goods Shipping
Phone: 800/238-5355

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

Worker's Compensation and Auto Claims
Sterling Administration Services
Phone: 800/420-8926 After hours: 800/497-4566

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

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

Facility Alarms: TBD

Evacuation Assembly Area(s): TBD by the SC-HW; will probably be the local hotel where the field team is staying

Facility/Site Evacuation Route(s): follow main roads towards access gates and off the Base

Route to Hospital: (Depends on location within base area (refer to attached Figures 12-1 and 12-2)

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 :

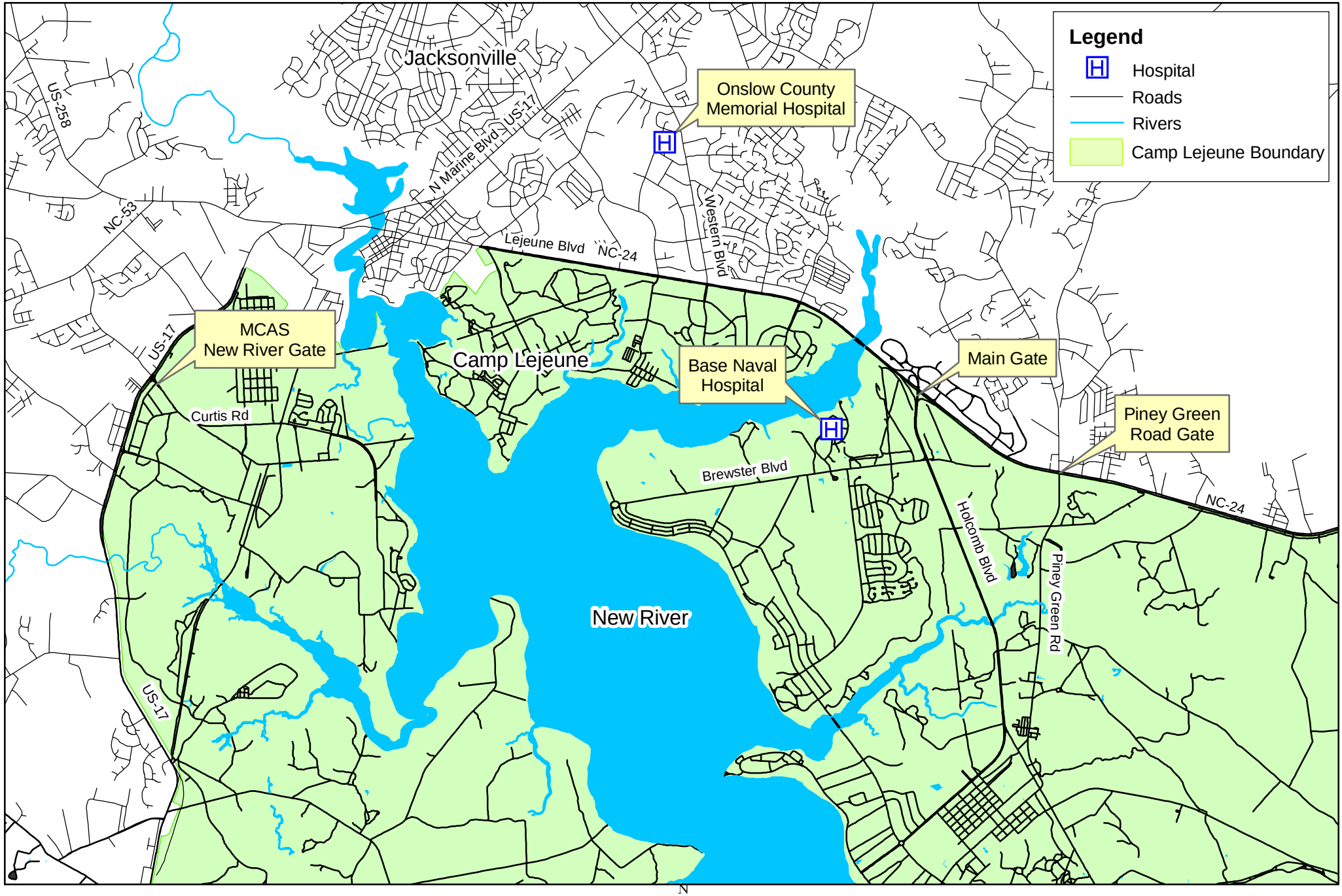
1. From Holcomb Boulevard, exit Base through main gate.
2. Follow Highway 24 west until intersecting with Western Boulevard.
3. Turn right onto Western Boulevard.
4. The Onslow County Memorial Hospital is on the left, approximately 2 miles (fifth stop light) from Highway 24.
5. Follow the signs to the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

From Air Station and Camp Geiger

Directions to Onslow County Memorial Hospital:

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

Follow the signs to the emergency room.



CH2MHILL

Figure 12-1
Route to Hospitals
Marine Corps Base, Camp Lejeune
North Carolina

\\Aphrodite\proj\USNavFaceNGCom\315007CampLejeune\Projects\Figure 2- Base Overview.mxd

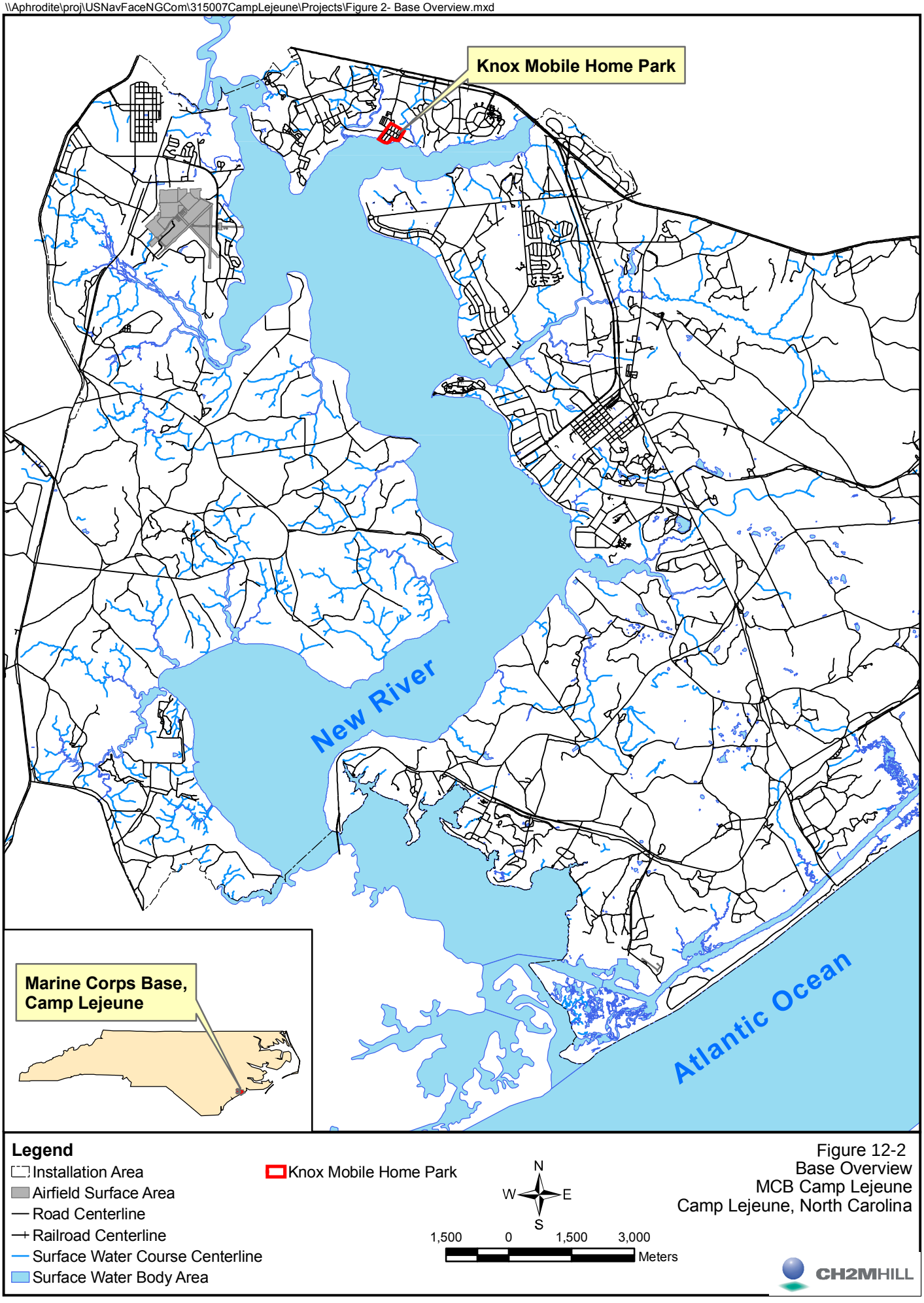


Figure 12-2
Base Overview
MCB Camp Lejeune
Camp Lejeune, North Carolina

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CH2M HILL HEALTH AND SAFETY PLAN

Attachment 5

Project H&S Forms and Permits

To be completed as needed for task specific operations.

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	☐	☐	☐	☐

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CH2MHILL

H&S Self-Assessment Checklist - DRILLING

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

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CH2M HILL HEALTH AND SAFETY PLAN

Attachment 7

Applicable Material Safety Data Sheets

Appendix C
Geophysical Investigation Place

APPENDIX C

Geophysical Investigation Plan

This GIP provides details of the equipment, approach, methods, operational procedures and quality control to be used in performing the geophysical investigations at the Knox Trailer Park site. The following topics are covered in the GIP subsections: safety issues; geophysical data quality objectives (DQOs); description of the site; anticipated MEC types, quantities, compositions, and depths; site physical conditions (e.g., geology and topography); adverse geophysical conditions; site utilities and manmade features that may affect the geophysical operation; data acquisition and reporting; and geophysical program QC requirements.

C.1 Geophysical Operations Overview

Geophysical instruments will be used during DGM survey operations. DGM operations use instruments that record instrument response digitally, allowing for the subsequent download and interpretation of the data. DGM instruments will be operated by the DGM subcontractor. Geophysical instruments used during operations such as clearance of locations for emplacement of survey stakes will be analog, meaning these instruments will be used to detect metallic items in the subsurface on a real-time basis and the instrument response will not be recorded. Generally analog instruments indicate the presence of metallic anomalies through sound or visual display. The analog instruments will be operated by unexploded ordnance (UXO) technicians.

C.2 Safety Issues

Because MEC and MPPEH items may be present in the survey area, DGM survey personnel are prohibited from touching, handling, moving, or investigating any item that resembles MEC or MPPEH. Upon encountering such an item, survey personnel will immediately inform the Senior UXO Supervisor (SUXOS) or a UXO technician. In the event that such an item is discovered, either inside or outside the controlled project boundaries, and no UXO-qualified personnel are present, survey personnel will conspicuously mark and secure a perimeter around the item and immediately contact the SUXOS. DGM survey personnel should not remain within 200 feet of any suspected MEC or MPPEH item.

DGM survey personnel will not access areas that have not been previously surface cleared by a UXO technician. Personnel will also be required to adhere to the project Health and Safety Plan (refer to Appendix B of this WP).

C.3 DGM Personnel Qualifications

DGM operations will be conducted by personnel experienced in MEC geophysical operations and led by a qualified MEC geophysicist. All DGM support personnel onsite will have documentation of 40-hour Occupational Safety and Health Administration (OSHA) certification, any necessary re-certification (8-hour refresher), and OSHA-compliant medical

monitoring physical exams. Throughout DGM operations, DGM support personnel will strictly adhere to the general practices given in this WP and specifically in the project Health and Safety Plan (refer to Appendix B of this WP).

C.4 Area to be Investigated

The area to be investigated consists of a 133-acre Public Private Venture (PPV) development in the area of the Knox Trailer Park at MCB Camp Lejeune. The planned PPV development consists of an area of approximately 133 acres in the northern portion of MCB Camp Lejeune (refer to Work Plan Figure 1-1). The Northeast River defines the southern boundary, while Scales Creek flows near the northwestern boundary and an unnamed tributary flows near the northeastern boundary. The planned PPV development is accessible by Florence Road from the west and Camp Knox Road from the north.

The existing Knox Trailer Park covers approximately 38 acres of the planned PPV. The trailer park property is level and vegetated with grass and minimal tree cover. Residential leases are not being renewed as they expire, and most of the mobile home tracts are now vacant. A network of narrow roadways covers the mobile home park (refer to Work Plan Figure 1-2). All utilities, including telephone, cable, water, electricity, and sewers, are buried and are assumed intact.

The remaining area of the planned PPV development consists of approximately 95 acres of woodland and roadways, which surround the Knox Trailer Park to the north, east, and west. The density of undergrowth in the wooded area is light to moderate.

C.5 Past, Current, and Future Site Uses

The Knox Trailer Park area began as a Civilian Conservation Corps Camp in 1941. Camp personnel assisted with road work, forestry, and other phases of developing the land into a modern military post (Carraway, 1946). Another function of the CCC 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, use of dynamite, and by spraying diesel oil on water surfaces as a larvacide (Kimball, 2005).

A dog training school was located in the southernmost area of Knox Trailer Park. The dog training school was in operation from 1942-1946. The dogs were subjected to overhead rifle and machine gun fire and explosions of charges of dynamite and TNT to simulate battle field conditions (K-9 History, 2005). The dogs and handlers were exposed to explosives typically found in a combat environment on a weekly basis. 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. Most of the testing occurred at the Naval Medical Field Research Laboratory (NMFRL), though some research facilities were located at Camp Knox (now the Knox Trailer Park area). 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 0.22 inch and 0.45 inch caliber automatic pistol bullets or Reising and Thompson sub-machine

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 (Kimball, 2005). Testing and development continued at the NMFRL throughout the Korean conflict until the cease fire was called in July 1953 (Montrose, 1955). From the early 1950's until the present time, the area has been used for residential housing.

In the 1974-1976 timeframe, an Explosives Ordnance Disposal (EOD) technician, Mr. Don Cifelli, responded to the discovery of 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, March 2005). The grenade had been thrown and the safety pin had been removed, but the firing pin had become impacted in the primer so it did not detonate. The exact location of the grenade is not documented, but Mr. Cifelli recalls the grenade being located off the main road leading to the trailer park (Cifelli, August 2005). Mr. Cifelli also recalls responding to up to three additional discoveries of practice grenades during intrusive activities in the area.

The archival records search (refer to Work Plan Appendix A) indicated that Area A essentially surrounded, but did not include, the Knox Trailer Park (U.S. Army Corps of Engineers, 2001). According to base personnel, this area was never a live fire range for grenades or any other munitions (Lowder, 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 (Lt. Col. L. Kimball, personal communication, August 10, 2005). No previous Navy Installation Restoration Program (IRP) investigations have been conducted at the Knox Trailer Park nor 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 2002 Range Inventory Report.

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 fuze, whereas the MK-IIA1 grenades were equipped with a M10A3 fuze. Specifications state that each unit was filled with 2 oz. of flaked or granular 2,4,6-trinitrotoluene (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 (Gunnery Sgt. G. McGurty, personal communication, July 22, 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 Range Management Division of the Marine Corps in January 2004. No further action was determined for the AD Training Area (Richardson, 2005; Department of the Navy,

2005). The area was a non-firing 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 (Richardson, 2005).

C.6 Anticipated MEC Types, Composition, and Quantities

Anticipated MEC at the site includes MK-II, High Explosive hand grenades, as documented in the archives search report (refer to Work Plan Appendix A).

C.7 Anticipated Depth of MEC Items

The anticipated depth of potential MEC items is anywhere from near-surface to approximately 4 feet deep.

C.8 Vegetation and Topography

The 38-acre trailer park property is level and vegetated with grass and minimal tree cover. Residential leases are not being renewed as they expire, and most of the mobile home tracts are now vacant. A network of narrow roadways covers the trailer park (refer to Work Plan Figure 1-2). The remaining 95 acres of the planned PPV development surrounding the trailer park to the north, east, and west consists of woodland and roadways. The density of undergrowth in the wooded area is light to moderate. Most of this vegetation will be removed prior to the DGM surveys. There are no apparent topography issues that might significantly impede geophysical operations at the site.

C.9 Geologic Conditions

The local geology (interlayered, unconsolidated sediment) is amenable to either magnetics or electromagnetic detection techniques; however, because the items of interest are small (hand grenades), the magnetics technique will not be considered for use as it has been shown at multiple MEC sites to be less effective for finding smaller items at shallow depths than electromagnetic detection techniques. No geologic conditions that will impede geophysical operations at the site are known.

C.10 Shallow Groundwater Conditions

Groundwater is anticipated to be relatively shallow, within approximately 10 feet below ground surface; however, the hand grenades are likely to be within the top 6 feet below the ground surface. Additionally, the only hand grenades anticipated to be below 1-2 feet below ground surface would be those placed in disposal pits.

C.11 Adverse Geophysical Conditions

No geophysical conditions at the Knox Trailer Park site that might interfere with electromagnetic near-surface geophysical instrument operation are anticipated.

C.12 Site Utilities

All utilities within the trailer park, including telephone, cable, water, electricity, and sewers, are buried and are assumed intact. Other utilities, both underground and aboveground, may cross the remainder of the PPV area.

C.13 Manmade Features Potentially Affecting Geophysical Operations

The project area includes a 38-acre trailer park. Several mobile homes are still present and fences, cars, decks, carports, swing sets, and other residential-related features are present at these locations. Each mobile home parking area is also served by underground utilities, which are still in place.

C.14 Site-Specific Dynamic Events

No site-specific dynamic events (e.g., unusually strong winds, harsh weather conditions) that might affect the DGM survey operations at Knox Trailer Park site are anticipated. Although it is possible that weather conditions may impede operations at some time during the project, no significant delays or effects on geophysical instruments resulting from weather are expected.

C.15 Overall Site Accessibility and Impediments

The only know issues with respect to site access are related to the vegetation, which will be removed prior to the DGM surveys, and the occupied homes in the existing trailer park. DGM surveys will not be performed inside the yards of the inhabitants of the park.

C.16 Potential Worker Hazards

No potential worker hazards are apparent at the Knox Trailer Park site other than those associated with conducting project fieldwork, which are addressed in the project Health and Safety Plan (refer to Work Plan Appendix B).

C.17 Geophysical Prove-out

A site-specific GPO will be used to finalize project DQOs and validate the geophysical system selected for the DGM surveys. The GPO Work Plan is provided as Attachment 1 to this GIP.

C.18 DGM Data Quality Objectives

The primary objective of the DGM activities at the site is to identify metallic anomalies that may be MEC or MPPEH. DQOs specific to the DGM surveys at the site will be determined through the GPO process.

C.19 Geophysical Instrumentation

C.19.1 Analog Geophysical Instruments

The analog geophysical instrument to be used during non-DGM operation where a geophysical instrument is needed to detect metallic items will be a Schonstedt GA-52/Cx magnetometer.

C.19.2 DGM Instruments

The actual instrumentation and system configuration to be used for DGM operations at the site will be determined through the GPO process.

C.20 Data Acquisition, Processing and Reporting

C.20.1 Field Data Sheets

Field data sheets (paper or digitally recorded) will include, at a minimum, the following:

- Site ID
- Grid ID (or other identifier of surveyed area)
- Field team leader name
- Field team members' names
- Date of data collection
- Instrument used
- Positioning method used
- Instrument serial numbers
- File names in data recorders
- Data collection sampling rate
- Line numbers, survey direction, fiducial locations, start and end points
- Weather conditions
- Grid conditions
- Terrain conditions
- Cultural conditions
- Survey area sketch
- Associated QC data file names
- Field notes (other)

C.20.2 Data Processing

Instrument-specific software will be used for initial data processing and the output will be imported into Geosoft Oasis Montaj™ (or comparable software if available) for additional processing, graphical display, anomaly selections and QA/QC. Types of processing will be system specific, but the general processing steps that may be performed on the data include the following:

- Positional offset correction
- Sensor bias, background leveling and/or standardization adjustment

- Sensor drift removal
- Latency correction
- Geophysical noise identification and removal (spatial, temporal, motional, terrain induced)
- Contour level selection with background shading
- Digital filtering and enhancement (low pass, high pass, band pass, convolution, correlation, non-linear, etc.)

C.20.3 Interpretation/Anomaly Selection

MEC-experienced data processing geophysicists will use the following criteria, supplemented by site- and system-specific criteria established during the GPO, for selecting and locating anomalies:

- Maximum amplitude of the response with respect to local background conditions
- Lateral extent (plan size) of the area of response
- Three-dimensional shape of the response
- Location of the response with respect to the edge of the grid, unsurveyable areas, land features, cultural features, or utilities within or adjacent to the grid
- Shape and amplitude of the response with respect to the response of known targets buried in the GPO test plot
- Shape and amplitude of the response with respect to relevant anomalies encountered in previous MEC removal grids
- Apparent depth of the anomaly
- Potential distortions in the response due to interference from nearby cultural features

C.20.4 Dig Sheets

The target analysis process culminates in the creation of dig sheets, which contain target information location, amplitude, and other distinguishing characteristics (e.g., depth and weight estimates) when possible. At a minimum, the following information will be provided on the dig sheets:

- Project site
- DGM contractor
- Responsible geophysicist
- Grid identification
- Unique anomaly identification numbers
- Predicted location in State Plane Coordinates in Easting (meters) and Northing (meters)
- Instrument peak value (where applicable) at each anomaly location

C.20.5 Grid Maps

With each dig sheet, the DGM subcontractor will also provide a grid map, which contains the following:

- Client
- Project
- Contractor
- Map creator
- Map approver
- Date map was created
- Map file name (full path and file extension)
- Scale
- Grid identification
- Grid corner locations
- Contoured data
- Anomaly locations with unique identification numbers
- North arrow, legend, title block, etc.

C.20.6 Records Management

All files will be made available for QC verification during the project to verify that the field and data processing procedures are properly implemented. All raw data files, final processed data files, hard copies, and field notes will be maintained for the duration of the project.

C.20.7 Final Reports, Maps, and Geophysical Mapping Data

No later than 3 work days after collection, the DGM subcontractor will provide each day's data for QC inspection via the Internet using a File Transfer Protocol (FTP) site, electronic mail (email) attachments for small files under 5 megabytes, or digital compact disk (CD). Such data are considered to be in raw form. These data will be corrected for sensor offsets, diurnal variations, latency, heading error, and drift. Also provided will be a digital planimetric map, in Environmental Systems Research Institute (ESRI) ArcView and Geosoft format and coincident with the location of the geophysical survey, so that each day's geophysical data set can be registered within the original mission plan survey map.

All geophysical field data will be provided to CH2M HILL in delineated fields as x, y, z, v1, v2, and so on, where x and y are North American Datum 83 (NAD83) Universal Transverse Mercator (UTM) 18N Coordinates in Easting (meters) and Northing (meters) directions, z (elevation is an optional field in feet), and v1, v2, v3, and so on are the instrument readings. The last data field will be a time stamp. Each data field will be separated by a comma or tab. No individual file may be more than 100 megabytes in size and no more than 600,000 lines long. Each grid of data will be logically and sequentially named so that the file name can be easily correlated with the grid name used by other project personnel.

Within 5 working days of data collection, the processed geophysical field data, all final maps, and supporting geophysical interpretations will be provided to CH2M HILL. All geophysical data will be accompanied by a Microsoft®Word 6.0 or higher file documenting

the field activities associated with the data and the processing performed. Required information is summarized in Table C-1.

TABLE C-1
Processing Documentation Requirements

Information Type	"Raw" Data Delivery	Final Data Delivery	Must be in File Headers
Site ID	X	X	X
Geophysical instrument type used	X	X	X
Positioning method used	X	X	X
Instrument serial numbers (geophysical and positioning)	X	X	
Coordinate system and unit of measure	X	X	X
Grid ID (or other identifier of surveyed area)	X	X	X
Date of data collection	X	X	X
Raw data file names associated with delivery	X	X	X
Processed data file names associated with delivery	X	X	X
Name of Project Geophysicist	X	X	
Name of Site Geophysicist	X	X	
Name of data processor	X	X	X
Data processing software used	X	X	
Despiking method and details	X	X	
Sensor drift removal and details	X	X	
Latency correction and details	X	X	
Sensor bias, background leveling and/or standardization adjustment method and details	X	X	
Geophysical noise identification and removal (spatial, temporal, motional, terrain induced) and details		X	
Other filtering/processing performed and details		X	
Gridding method		X	
Anomaly selection and decision criteria details		X	
Other processing comments		X	
Date data processing is completed	X	X	
Data delivery date	X	X	
Scanned copy of field notes and field mobile data collection device notes (if applicable)	X		

At the completion of the project, all project geophysical data described in this chapter will be collected, organized, and submitted to the CENWO in a separate package that will be referenced in the After Action Report.

All sensor data will be correlated with navigational data based upon a local "third order" (1:5,000) monument or survey marker. If a suitable point is not available, a North Carolina-certified PLS will establish a minimum of two new monuments or survey markers per sector with a minimum of third-order accuracy.

C.21 DGM Systems Quality Control

An extensive QC program will be applied to the DGM operations at the Knox Trailer Park site. Figure C-1 shows an overall chart of the QC steps, and details for those steps are provided in the following subsections.

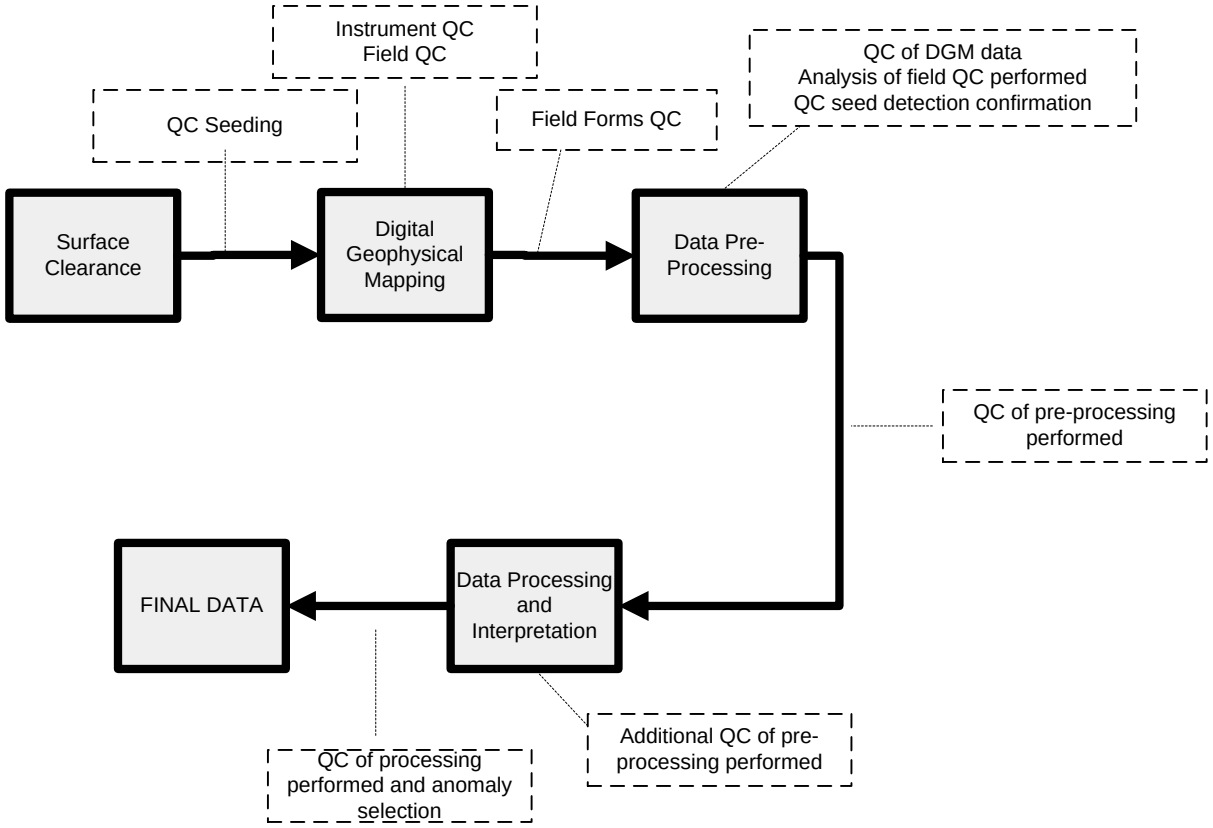

FIGURE C-1
Overview of DGM Process QC

C.22 DGM Instruments Quality Control

Each of the geophysical systems will be field tested to confirm proper operating conditions. Several basic QC tests will be performed in addition to instrument-specific tests. A description of each basic QC test, its acceptance criteria, and its frequency is provided below and summarized in Table C-2.

1. **Equipment Warm-up**. This is an instrument-specific activity, although standard warm-up time is 5 minutes. Some geophysical systems require more warm-up time than others. Each system-specific SOP defines the equipment-specific warm-up time. Equipment warm-up will be performed the first time an instrument is turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.

2. **Record Sensor Positions**. Positioning accuracy of the final processed data will be demonstrated by operating the equipment over one or more known points. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which a positioning instrument is held and the displayed position. The sensor position test will be conducted at the beginning of the survey operation for each work day.

3. **Personnel Test.** This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that can possibly create false anomalies. The personnel test will be conducted at the beginning of the survey operation for each work day.

4. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that can possibly create false anomalies. The vibration test will be conducted at the beginning of the survey operation for each work day.

5. **Static Background and Static Spike**. Static tests will be performed by positioning the survey equipment within or near the survey boundaries in an area free of metallic contacts and collecting data for (minimally) a 1-minute period. During this time, the instrument will be held in a fixed position without a spike (known standard) and then with a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. The static background and static spike test will be conducted at the beginning and end of each survey operation.

6. **Six Line Test.** The Six Line Test is a standard response test consisting of a predetermined route (survey line) established on or near the site in an area free of metallic contacts. The beginning, midpoint, and end of the line will be marked; data will be collected along the line. The line will be traversed a total of six times as follows: 1)

normal data collection speed *without* a spike at the centerpoint; 2) *normal* data collection speed *without* a spike at the centerpoint; 3) *normal* data collection speed *with* a spike at the centerpoint; 4) *normal* data collection speed *with* a spike at the centerpoint; 5) *fast* data collection speed *with* a spike at the centerpoint; 6) *slow* data collection speed *with* a spike at the centerpoint. (Speed of data collection will also be evaluated as part of the GPO analysis process.) The Six Line Test will be conducted the first time a system is used at the site.

7. **Repeat Data.** This test is performed to verify repeatability of the data and will be performed after the initial survey over an area. At least 2% of the survey lines will be repeated.

TABLE C-2
DGM Instruments Standardization Tests and Acceptance Criteria

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day	First Time Instr. Used	2% of Total Area Surveyed
1	Equipment Warm-up	Equipment specific (typically 5 min)	X				
2	Record Sensor Positions	± 4 inch (2.54 cm)		X			
3	Personnel Test	Based on instrument used. Personnel, clothing, etc. should have no effect on instrument response		X			
4	Vibration Test (Cable Shake)	Data profile does not exhibit data spikes		X			
5	Static Background & Static Spike	± 20% of standard item response, after background correction			X		
6	Six Line Test	Repeatability of response amplitude ± 20%, Positional Accuracy ± 20 cm				X	
7	Repeat Data	Repeatability of response amplitude ± 20%, Positional Accuracy ± 20 cm					X

C.23 QC Seed Items

At least one inert MEC item (or surrogate if necessary) will be seeded per 2 acres to be surveyed. The seed items will be painted blue and tagged with a non-biodegradable label identifying the items as inert and providing a contract reference, a point of contact address, phone number, and a target identifier. CH2M HILL personnel will perform seeding using hand or mechanical tools, depending on soil conditions. The seed locations will be checked using a hand-held analog geophysical instrument to confirm that no existing anomalies are present at the seed location. Once placed, the locations of all seeded items will be surveyed using an RTK DGPS. The items will be placed at detectable depths (as determined by the GPO).

C.24 Quality Control of DGM Data and Deliverables

Both the DGM subcontractor and CH2M HILL will perform QC of geophysical data and data deliverables at each step of the processing path. Figure C-2 shows the processing path and the QC steps performed. Data will not move to the next stage until they have passed the QC check.

The following items are among the QC checks performed on the field forms (the terms "appropriate" and "acceptable" will be in accordance with what is defined through the GPO process):

- Appropriate fields have been completed
- Field entries are appropriate for work performed
- Data required for geophysical data processors have been entered
- General editorial review (spelling, dates, etc.)

The following items are among the QC checks performed (as applicable to the particular data set) on the "Pre-processed Data":

- Data have been translated from local coordinates into the State Plane system
- Coordinates are correct (grids fall in correct locations when loaded into GIS)
- Line gaps have been accounted for
- Background geophysical noise is acceptable
- Crosstrack distances between lines are acceptable
- Downline data density is acceptable
- Appropriate file headers have been attached
- Files contain appropriate grids

The following items are among the QC checks performed (as applicable to the particular data set) on the "Processed Data":

- Lag correction is appropriate
- Despiking is appropriate
- Leveling is appropriate
- Filtering performed is appropriate
- Line breaking is appropriate
- Anomaly selections are appropriate

C.25 Corrective Measures

Specific corrective measures are dependent on the type of geophysical equipment used; however, the following are the basic corrective measures to be followed in association with DGM surveying:

- Replacement of sensors if they fail to meet instrument check requirements.
- Resurvey of grids if seeded items are not identified (do not show in the DGM data). In a situation in which there is a failure to select a seed item from the data but the item is

clearly present in the DGM data, a resurvey will not be performed, but instead a re-analysis of the DGM data.

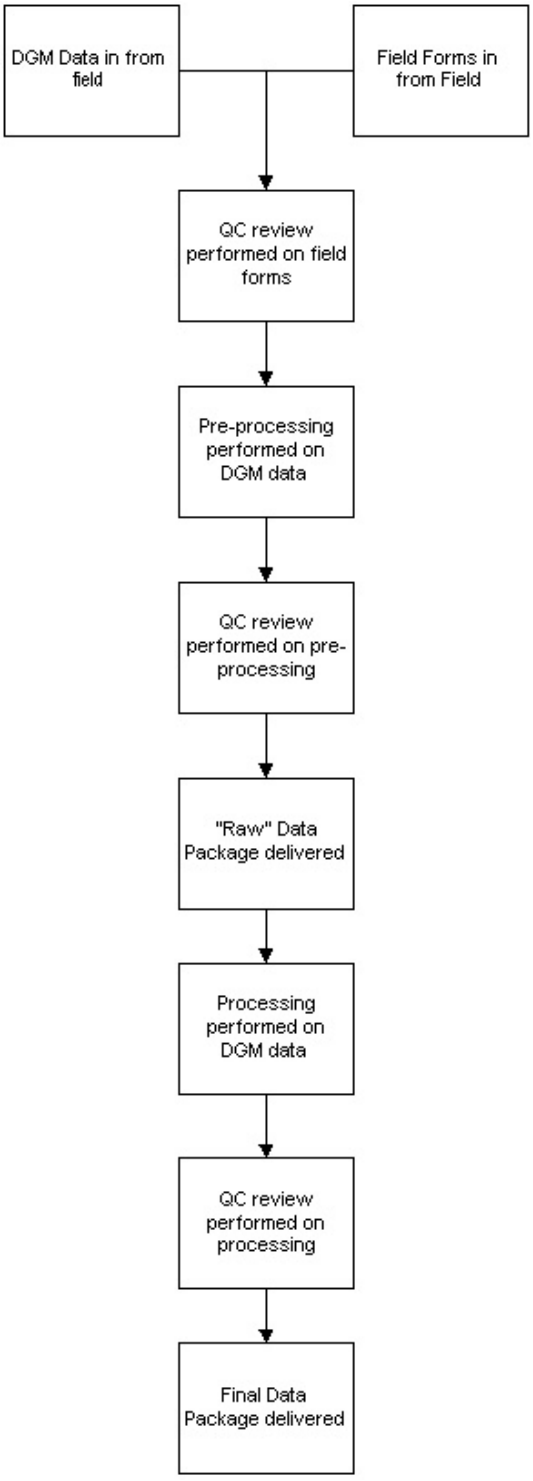

FIGURE C-2
QC of DGM Data – Process Flowpath

C.26 Analog Geophysical Systems Quality Control

QC over the analog geophysical instruments will be accomplished through daily checks that the instruments are functioning prior to using them for field activities. The GPO plot will be used for checking instrument functionality for each analog instrument at the start of each work day. Each instrument will be operated over a small metallic item buried close to the maximum detection depth determined for that item during the GPO. If the instrument is not able to detect the item, it will be taken out of use until it is repaired.

Attachment 1
Geophysical Prove-Out Work Plan

Draft

Geophysical Prove-Out Work Plan

Knox Trailer Park Investigation
MCB Camp Lejeune, North Carolina

Contract Task Order 0109

August 2005

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic Division

Under the

LANTDIV CLEAN III Program
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Prepared by

Virginia Beach, Virginia

Contents

Acronyms and Abbreviations

CD	Compact Disk
cm	centimeters
DGM	Digital Geophysical Mapping
DGPS	Differential Global Positioning System
DID	Data Item Description
DQO	Data Quality Objective
FAR	False Alarm Rate
GPO	Geophysical Prove-Out
GPS	Global Positioning System
Mb	megabytes
MEC	Munitions and Explosives of Concern
QC	Quality Control
RLS	Registered Land Surveyor
RTK	Real-Time Kinematic
RTS	Robotic Total Station
SOP	Standard Operating Procedure
TDEM	Time Domain Electromagnetic
USACE	U.S. Army Corps of Engineers

1.0 Purpose

1.01 CH2M HILL Inc. was awarded Contract Task Order No. 0019 under LANTDIV CLEAN III Program Contract No. N62470-02-D-3052 to conduct an Expanded Site Investigation at the Knox Trailer Park at MCB Camp LeJeune, North Carolina. This Geophysical Prove-Out (GPO) Plan documents GPO activities to be performed as part of the process for selecting the digital geophysical mapping (DGM) system to be utilized during the RI. The plan has been developed in accordance with the Draft Final ITRC document "Geophysical Prove-Outs for Munitions Response Projects."

1.0.2 The primary objective of the GPO is to demonstrate and document the site-specific capabilities of a DGM system to operate as an integrated system capable of meeting project data quality objectives (DQOs). For the purposes of this work, a system is considered to include the survey platform, sensors, navigation equipment, data analysis and management, and associated equipment and personnel. Additional objectives of the GPO include:

- Document the consideration given to various geophysical detection instruments, the criteria used to identify geophysical instruments for consideration, and the causes for their respective selection or rejection.
- Document the capabilities and limitations of the geophysical detection instrument selected for consideration.
- Confirm the achievable percent detection with respect to the specific items, orientations and depths seeded in the GPO to support decision-making at the site.
- Observe the geophysical detection instrument operating in the DGM subcontractor's configuration, using their personnel and methodologies.
- Evaluate the DGM subcontractor's data collection, data transfer quality and data QC method(s).
- Evaluate the DGM subcontractor's method(s) of data analysis and evaluation.
- Establish anomaly selection criteria.

1.0.3 The GPO objectives will be attained through evaluation of the achievement of the DQOs (discussed below) and observation of the GPO activities by the CH2M HILL Project Geophysicist. An evaluation chart (presented in Section 4.0) will be used to assist in the evaluation. A full discussion of the evaluation will be provided in the Expanded Site Evaluation Report (see Section 9.0 for topics to be discussed).

2.0 Project Data Quality Objectives

DGM operations performed in the GPO area will demonstrate the ability of the tested system to achieve specific project DQOs. The project DQOs, measurement performance criteria, and test method to be used during the GPO are discussed in the following sub-sections and summarized in Table 1.

2.1 General Geophysical Systems Functioning

2.1.1 DGM Systems Positioning

The DQO for DGM systems positioning is that the coordinates being obtained from the positioning systems are at a sufficient enough accuracy to allow for appropriate relocation of munitions and explosives of concern (MEC) items for intrusive investigation. The measurement performance criterion for this is that the positional error at known monuments will not exceed ±20 cm. This will be evaluated during the GPO by ensuring that, on a daily basis, the positioning system in use passes QC Test #2 (Record Sensor Positions), as outlined in Section 6.0.

2.1.2 DGM Systems Data Repeatability

The DQO for DGM systems data repeatability is that the systems respond consistently from the beginning to the end of an operation. The measurement performance criterion for this is that the response to a standardized item will not vary more than ±20%. This will be evaluated during the GPO by ensuring that, on a daily basis, the geophysical system being used passes QC Test # 5 (Static Background and Static Spike) and QC Test #7 (Repeat Data), as outlined in Section 6.0.

TABLE 1
Project Data Quality Objectives

Data Quality Objective	Measurement Performance Criteria	Test Method During GPO
General System Functioning		
Accurate coordinates are being obtained from DGM positioning systems.	Positional error at known monuments will not exceed ±20 cm.	Results of QC Test #2 (Record Sensor Positions) (see Section 6.0) will be evaluated to ensure compliance.
Repeatable data are being obtained from DGM system.	Response to standardized item will not vary more than ±20%.	Results of QC Test #5 (Static Background and Static Spike) (see Section 6.0) will be evaluated to ensure compliance.
DGM Surveys		
DGM survey system can detect all MEC to the depths specified by the following equation: Estimated Detection Depth (meters) = 11*diameter (mm) / 1000 (Depth is to top of the item.) Note: This DQO will be modified for the production surveys based on the results of the GPO.	Sensor to identify 100% of all MEC items (or their surrogates in the GPO) at depths fitting within the detection depth equation.	Verify that: All of the seed items fitting within the detection depth equation have anomalies selected from the DGM surveys within 1 meter of a point on the surface above the item.
Downline data density is sufficient to detect MEC items.	Over 98% of possible sensor readings are captured along a transect. In addition, any transect containing a data gap of 2 ft or greater does not meet the DQO.	Results of DGM surveys with various systems and configurations will be evaluated to ensure compliance.
Coverage over survey area is sufficient to detect MEC items.	Search transect spacing to vary no more than ±20% of spacing specified in sampling design.	Results of DGM surveys with various systems will be evaluated to ensure compliance.
Positioning of detected anomalies is accurate.	95% of all anomaly locations (as shown on the dig sheets) lie within a 1-meter radius of a point on the ground surface directly above the source of the anomaly.	Anomalies selected will be compared with known seed item locations to ensure compliance.
Data Handling		
All data must be delivered in a timely manner and in a useable format.	Data packages (see Section 8) are completed and delivered to the CH2M HILL Project Geophysicist within 1 working day of data collection.	Evaluate based on actual delivery of data

2.2 DGM Surveys

2.2.1 MEC Detection

2.2.1.1 The DQO for MEC detection is to detect all MEC to their maximum detectable depths. However, actual maximum detectable depths may vary based on site-specific and munitions-specific parameters, such as: 1) item orientation, 2) site background/noise levels, 3) masking effects from adjacent metallic items, 4) item shape, 5) magnetic conductivity of item materials, and 6) weathering effects on the magnetic conductivity of item materials.

2.2.1.2 An equation has been developed based on empirical data that describes typical detection depths for most MEC items (USACE DID FPRI-005-05.01):

Estimated Detection Depth (meters) = 11*diameter (mm) / 1000
(Depth is to top of the item.)

This relationship reflects the fact that MEC detection capability is reduced with greater item depth and/or decreased item size. The equation assumes worst-case orientations for ordnance items, a ratio of length to width of at least 2:1, and that the item is not thin-walled. Because of these assumptions, the formula is to be used only as a guiding point as opposed to a final metric. The GPO process will be used to determine an appropriate final MEC detection DQO for the site surveys.

2.2.1.3 Because only MK-II hand grenades are suspected to present at the site, only MK-II surrogates will be buried at various depths and orientations to test the tested system's detection capabilities. The measurement performance criterion for this is that the system tested must identify 100 percent of all MEC items in the GPO at depths fitting within the detection depth equation. This will be evaluated by verifying that all of the seed items in this category have anomalies selected from the DGM surveys within 1 meter of a point on the surface above the item.

2.2.1.4 The actual project DQO for detection depth will be based on the depth and orientation that the item was detectable (using the signal-to-noise ratio, shape of the anomaly, and width of the anomaly for anomaly selection) without causing an unreasonable false alarm rate (FAR) using the same anomaly selection criteria. It should be noted that there is no absolute rule to determine an acceptable FAR. A high FAR may increase the possibility that the target items will be detected; however, the inefficiencies associated with a high FAR increase field efforts, data processing and handling, and the likelihood of errors; and may decrease the overall quality of the GPO and project fieldwork results.

2.2.2 Downline Data Density

The DQO for downline (along the survey transect) data density is to have sufficient data collected along each transect to detect MEC items. The measurement performance criterion for this is that at least 98 percent of possible sensor readings are captured along each transect. In addition, any transect containing a data gap of 2 feet or greater does not meet the DQO. This will be evaluated during the GPO by verifying that all of the DGM data collected and used for anomaly selection meets this standard.

2.2.3 Survey Coverage (Lane Spacing)

The DQO for lane spacing is to maintain appropriate lane spacing to provide 100 percent coverage of the survey area at sufficient density to detect all detectable MEC items. The measurement performance criterion for this is that the lane spacing varies no more than ±20 percent of spacing specified in the sampling design. This will be evaluated during the GPO by verifying that all of the DGM data collected and used for anomaly selection meets this standard.

2.2.4 Positioning Accuracy

The DQO for horizontal positioning accuracy is that positioning of detected anomalies is accurate enough to allow for effective reacquisition of the anomaly. The measurement performance criterion for this is that 95 percent of all anomaly locations (as shown on the dig sheets) lie within a 1-meter radius of a point on the ground surface directly above the source of the anomaly. Any anomaly that is selected (coordinates shown on the dig sheets) outside of 1 meter from a point directly above the item will not be considered to be a detection of that item. This will be evaluated during the GPO by verifying that all anomalies selected are within this standard or can be otherwise explained.

2.3 Data Handling

The DQO for data handling is that all data must be delivered in a timely manner and in a useable format. Because of the need for rapid feedback during GPO operations to effectively test potential DGM systems, the measurement performance criterion for data handling during GPO activities will require that data packages (see Section 8) be completed and delivered to the CH2M HILL Project Geophysicist **within 1 working day of data collection**. During production surveys, the measurement performance criterion for data handling will require that "draft" (raw) data packages be completed and delivered to the CH2M HILL Project Geophysicist within 3 working days of data collection and the final data packages within 5 working days of data collection. This will be evaluated based on the actual delivery of data during the GPO.

3.0 Personnel and Qualifications

3.0.1 In addition to all personnel involved in performance of the GPO and the production geophysical surveys meeting the qualifications as listed in Section C of the Basic Contract, the following are additional qualifications that will be met:

- **Project Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 7 years of directly related geophysical experience. This individual will be capable of managing a geophysical data collection and processing project/program including several task orders/sites.
- **Site Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 5 years of directly related geophysical experience. This individual will be capable of competently managing personnel, equipment and data on projects requiring multiple (three or more) geophysical field teams and geophysical data processors.

- **Geophysical Data Processor:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have at least 6 months experience in processing geophysical data related to MEC projects.
- **Field Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have a minimum of 2 years of directly related geophysical experience related to MEC projects.
- **Geophysical Technician:** will have at least 6 months of experience in geophysical data collection on MEC related projects.

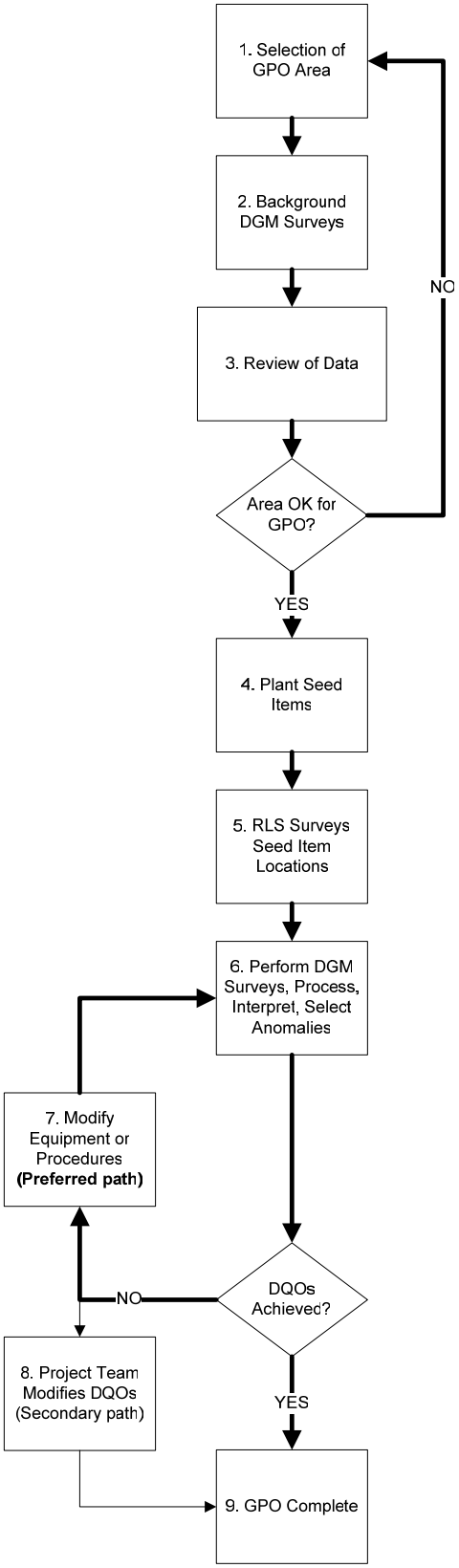
3.0.2 The following CH2M HILL team individuals will be involved.

- CH2M HILL Project Geophysicist
- UXO Technician II (or higher)
- DGM subcontractor's Site Geophysicist
- DGM subcontractor's Field Geophysicist/Data Processor
- DGM subcontractor's Geophysical Technician

4.0 Procedures

A qualified and experienced MEC DGM operations geophysical team (see Section 3.0) will separately employ each system to be tested on the GPO plot. Figure 1 illustrates the GPO process and the procedures to be employed (numbered in accordance with the steps shown on Figure 1) during site work.

FIGURE 1
GPO Process



1. A GPO area will be selected based on:

    (a) Terrain, geology and vegetation similar to that of the project site.

    (b) Geophysical noise conditions similar to those expected across the survey area.

    (c) Large enough site to accommodate all necessary GPO tests and equipment and for adequate spacing of the seed items to avoid ambiguities in data evaluation.

    (d) Readily accessible to project personnel.

    (e) Close proximity to the actual survey site.

2. A "background" DGM survey will be performed by the DGM subcontractor with the instrument to be tested in the GPO. This step will allow background geophysical conditions to be recorded, will help determine the appropriateness of the location (i.e., few existing anomalies), and will verify that items are not seeded near existing anomalies. The data will be post-processed (i.e., filtered and positions attached to the geophysical data) but the DGM subcontractor will not view the results apart from this.

3. The data will be provided to the CH2M HILL Project Geophysicist for evaluation.

4. A sufficient number of seed items will be buried at a range of depths and orientations to document detection limits within the GPO grid. The targets will include simulated items intended to represent MK-II hand grenades.

    CH2M HILL personnel will construct the GPO using shovels and, if necessary, a mechanical auger or backhoe to dig the holes to the appropriate depths for burial of the seed items. The seed items will be painted blue and tagged with a non-biodegradable label identifying the items as inert and providing a contract reference, a point of contact address, phone number, and a target identifier. The background survey data and anomaly avoidance techniques will be used to ensure that corner stakes and seed items are not placed on top of or near existing anomalies. Personnel will emplace each seed item and record the emplacement data (depth, orientation, and azimuth). All seed items will be photographed prior to burial.

5. A Registered Land Surveyor (RLS) will use a Real-Time Kinematic (RTK) Differential Global Positioning System (DGPS) or conventional Total Station survey equipment to record seed item locations to a horizontal accuracy of 3 centimeters (cm) and a vertical accuracy of 5 cm, providing an Easting and Northing (in NAD83 UTM 16N, meters) for the center and each end (where applicable) of the targets. The location of the four corners of the grid will also be recorded (in UTM meters). All target markings in the GPO grid will be removed and the grid will be returned as near as possible to its natural condition. Information on the seeded target's location will not be released to the DGM subcontractor.

6. DGM surveys will be performed by the DGM subcontractor using an EM61-MK2 time domain metal detector system. The system configurations to be tested are shown in Table 3. The data will be processed and interpreted by the DGM subcontractor and anomaly selections made. "Draft-Final" data packages will be provided to the CH2M HILL Project Geophysicist for evaluation.

7. If the initial DQOs have not been met, the CH2M HILL Project Geophysicist will meet with the DGM subcontractor to discuss whether modifications (e.g., sensor spacing) or procedures (e.g., lane spacing) can be made to the DGM system in order to meet the DQOs.
8. If the DQOs cannot be met by the DGM subcontractor, the CH2M HILL Project Geophysicist will meet with the NAVFAC LANTDIV Project Manager to discuss a resolution (i.e., modification of a DQO) prior to completing the GPO.
9. Once the surveys have been performed and at least one of the configurations has been determined capable of meeting the initial (or modified) DQOs, the GPO will be complete.

TABLE 2
Evaluation Chart

Criteria	System					
	1	2	3	4	5	6
P%[1]						
P% (items within typical detection depths equation[2])						
P% – MK-II Simulant Seed Items						
P% – MK-II Simulant Seed Items (items within typical detection depths equation[2])						
Number of false positives						
False Anomaly Rate[4]						
Downline Data Density DQO Met? (Y/N)						
Survey Coverage (Lane Spacing) DQO Met? (Y/N)						
DGM Positioning Accuracy DQO Met? (Y/N)						
Average positioning error on initial anomaly selection (meters)						
Data Handling DQO Met? (Y/N)						
Maximum depth MK-II Simulant Seed Items detected[3] at all orientations						

[1]P% = Percent Detected (anomaly selected within 1.0m of point at surface above seed item)
[2]USACE (USACE DID MR-005-05.01): Estimated Depth (meters) = 11*diameter (mm)/1000
[3]Anomaly selected within 1.0 m of point at surface above seed item.
[4]Number of false positives per detected item.

TABLE 3
Geophysical Equipment Tests to be Performed during GPO

Test	Instrument	Positioning System	Approximate Sensor Height Above Ground Surface (ft)	Lane Width (ft)	Data Collection Rate (per second)	Approximate Survey Speed (ft/s)
1	EM61-MK2 Single Coil	RTK GPS	1.35	2.5	10	3
2	EM61-MK2 Single Coil	TBD*	1.35	2.5	10	3
3	EM61-MK2 Array	RTK GPS	TBD*	TBD*	TBD*	TBD*
4	EM61-MK2 Array	TBD*	TBD*	TBD*	TBD*	TBD*

Note that some of the data elements are subject to modification and evaluation in the field.

*Based on proposals from DGM subcontractor. (To be updated prior to final Work Plan submittal.)

5.0 Additional GPO Considerations

Additional topics taken into consideration for the design of the GPO include plot location, size, and shape; quantities of seeded items; and geophysical and positioning instruments and technologies.

5.1 GPO Plot Location

The location of the GPO will be determined on the basis of field conditions at the time the GPO is conducted. The plot will be located in an area where the geology, vegetation, and terrain area as similar as possible to the actual site conditions. Consideration will also be given to locating the GPO plot in an area with the least amount of metallic debris on the surface and in the subsurface.

5.2 GPO Size and Shape

The intended dimensions of the GPO plot are 100 ft x 100 ft.

5.3 Number and Types of Geophysical Instruments and Technologies Selected for Testing

5.3.1 Because of the type of targets to be detected at the site, a pre-field analysis of the two primary techniques used in the industry, magnetics and time domain electromagnetics (TDEM), CH2M HILL recommends testing of the TDEM technique only. This recommendation is based on experience at multiple other sites at which the small and shallow items have consistently been detected at a higher rate with TDEM than with magnetics. The geology at the site is not anticipated to be advantageous to either system.

5.3.2 A complete description of the EM61 is provided in the instrument-specific Standard Operating Procedures (SOPs) to be provided by the geophysical services subcontractor.

5.4 Number and Types of Positioning Instruments and Technologies Selected for Testing

Both sub-centimeter GPS and Robotic Total Station (RTS) systems will be tested for positioning of the geophysical data. Although it is understood that some degree of tree and other vegetation removal will take place prior to performing the geophysical surveys at the site, if there are still trees remaining then CH2M HILL may need to use the RTS for some of the surveys because of inadequate satellite availability through the trees.

6.0 Quality Control

All systems will be field tested by the DGM subcontractor to ensure that they are operating properly. Several basic quality control (QC) tests will be performed in addition to instrument specific tests. The instrument specific tests are described in the instrument operation SOPs that will be provided by the geophysical services subcontractor. A description of each basic QC test, its acceptance criteria and test frequency is provided below and summarized in Table 4.

1. **Equipment Warm-up**. This is an instrument specific activity (although standard warm-up time is 5 minutes). Some geophysical systems require more warm-up time than others. Each system specific SOP (attached in Attachment A) defines the equipment-specific warm-up time. Equipment warm-up will be performed each time the instrument is first turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.
2. **Record Sensor Positions**. Positioning accuracy of the final processed data will be demonstrated by operating the equipment over one or more known points. It is important that the positioning system be tested in exactly the same manner in which it is to be used during the actual surveys. The accuracy of the data positioning will be assessed by calculating the difference between the location where the track-plots cross each other on the map and the actual location of the known point(s). Presumably, the actual track-plots will cross exactly over the known point when the data was collected, and the difference, if any, observed on the final track-plot map is a direct measure of the positioning system's accuracy. The sensor position test will be conducted at the beginning of the survey operations for each work day.
3. **Personnel Test.** This test checks the response of instruments to the personnel and their clothing and proximity to the system. On a daily basis, instrument coils/sensors (for those instruments being used that day) will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that can possibly create false anomalies. The personnel test will be conducted at the beginning of the survey operations for each work day.

TABLE 4
Geophysical Instrument Standardization Tests and Acceptance Criteria

Test	Test Description	Acceptance Criteria	Power on	Beginning of day	Beginning and end of day	1st time instrument used	2% of Total Area Surveyed
1	Equipment Warm-up	Equipment specific (typically 5 min)	X				
2	Record Sensor Positions	+/- 4 inch (2.54 cm)		X			
3	Personnel Test	Based on instrument used. Personnel, clothing, etc. should have no effect on instrument response.		X			
4	Vibration Test (Cable Shake)	Data profile does not exhibit data spikes		X			
5	Static Background & Static Spike	+/- 20% of standard item response, after background correction			X		
6	Six Line Test	Repeatability of response amplitude +/-20%, Positional Accuracy +/- 20 cm				X	
7	Repeat Data	Repeatability of response amplitude +/-20%, Positional Accuracy +/- 20 cm					X

* Magnetometer Only

4. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, instrument coils/sensors (for those instruments being used that day) will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that can possibly create false anomalies. The vibration test will be conducted at the beginning of the survey operations for each work day.

5. **Static Background and Static Spike**. Static tests will be performed by positioning the survey equipment within or near the survey boundaries in an area free of metallic contacts, and collecting data for a minimum period of three minutes. During this time, the instrument will be held in a fixed position without a spike (known standard) and then with a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. The static background and static spike test will be conducted at the beginning and end of each survey operation.

6. **Six Line Test.** The Six Line test is a standard response test consisting of a predetermined route (survey line) established on or near the site in an area free of metallic contacts. The beginning, midpoint, and end of the line will be marked, and data will be collected along the line. The line will be traversed a total of six times as follows: 1) *normal* data collection speed *without* a spike at the centerpoint; 2) *normal* data collection speed *without* a spike at the centerpoint; 3) *normal* data collection speed *with* a spike at the centerpoint; 4) *normal* data collection speed *with* a spike at the centerpoint; 5) *fast* data collection speed *with* a spike at the centerpoint; 6) *slow* data collection speed *with* a "pike at the centerpoint. (Speed of data collection will also be evaluated as part of the GPO evaluation process.) The Six Line test will be conducted the first time a system is used at the site.
7. **Repeat Data.** This test is performed to ensure repeatability of the data and will be performed after the initial survey over an area.

7.0 Records Management

All raw data files, final processed data files, hard copies, and field notes will be maintained by the DGM subcontractor for the duration of the GPO and then turned over to the CH2M HILL Project Geophysicist.

8.0 Data Delivery

The DGM data delivery requirements include the following:

- All sensor data will be correlated with navigational data based upon a local "third order" (1:5,000) monument or survey marker. If a suitable point is not available, CH2M HILL will have a professional land surveyor establish a point.
- All sensor data will be preprocessed for sensor offsets, diurnal magnetic variations, latency corrections, drift corrections, etc., and correlated with navigation data.
- Diurnal magnetic variations measured at a base-station must be collected at a minimum of once per minute.
- The DGM system will digitally capture the instrument readings into a file coincident with the grid coordinates.
- All raw and final processed data will be delivered corrected and processed in ASCII files.
- Corrections such as for navigation, instrument bias, and diurnal magnetic shift will be applied.
- All corrections will be documented (see Table 5).
- Data will be presented in delineated fields as x, y, z, v1, v2, etc., where x and y are NAD83 UTM Grid Plane Coordinates in Easting (meters) and Northing (meters) directions, z (elevation is an optional field in meters), and v1, v2, v3, etc., are the instrument readings.

- The last data field should be a time stamp.
- Each data field will be separated by a comma or tab.
- No individual file may be more than 100 megabytes (Mb) in size and no more than 600,000 lines long.
- Each grid (or set) of data will be logically and sequentially named so that the file name can easily be correlated with the grid name used by other project personnel.
- Within one working day after collection, the DGM subcontractor will furnish draft-final data packages for each system's survey via internet using FTP, E-mail attachment for small files under 5 Mb, digital compact disk (CD) or other approved method. Final data packages must include the following:
  - Dig sheets (anomaly selections) in Microsoft Excel formats
  - PDF file(s) of color contoured geophysical results with anomaly selections shown and labeled at a readable scale
  - Geosoft format GDB files and packed maps
  - Raw data files
  - Final processed data files
  - All quality control data files associated with the survey files
  - Microsoft Word 6.0 or higher file documenting the field activities associated with the data, and the processing performed (see Table 5)
  - Digital planimetric map, in Geosoft and ArcView format, and coincident with the location of the geophysical survey

TABLE 5
Processing Documentation Requirements

Information Type	Final Data Delivery	Must be in File Headers
Site ID	X	X
Geophysical instrument type used	X	X
Positioning method used	X	X
Instrument serial numbers (geophysical and positioning)	X	
Coordinate system and unit of measure	X	X
Grid ID (or other identifier of surveyed area)	X	X
Date of data collection	X	X
Raw data file names associated with delivery	X	X
Processed data file names associated with delivery	X	X
Name of Project Geophysicist	X	
Name of Site Geophysicist	X	
Name of data processor	X	X
Data processing software used	X	
Despiking method and details	X	
Sensor drift removal and details	X	
Latency correction and details	X	
Heading correction and details	X	
Sensor bias, background leveling and/or standardization adjustment method and details	X	
Diurnal correction (magnetic data)	X	
Geophysical noise identification and removal (spatial, temporal, motional, terrain induced) and details	X	
Other filtering/processing performed and details	X	
Gridding method	X	
Anomaly selection and decision criteria details	X	
Other processing comments	X	
Date data processing is completed	X	
Data delivery date	X	
Scanned copy of field notes and field PDA notes (if applicable)	X	

9.0 Reporting

9.0.1 CH2M HILL will prepare a GPO Report that will include the following elements:

- As-built drawing of the GPO plot
- Pictures of the seed items
- Color maps of the geophysical data
- Summary of the GPO results
- Geophysical equipment, techniques, and methodologies selected for the production survey
- Sufficient supporting information to justify selection

APPENDIX A

DGM Subcontractor Standard Operating Procedures

DGM Subcontractor SOP No	Version	Title