

Final

# Focused Preliminary Assessment/Site Inspection Report Site UXO-16, Former Gun Positions 41A and 41B

Marine Corps Base Camp Lejeune  
Jacksonville, North Carolina



Prepared for

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

Under the  
Multi-Media

Contract No. N62470-07-D-0501  
Task Order 009

**August 2009**

Prepared by

**CH2MHILL**

Charlotte, North Carolina

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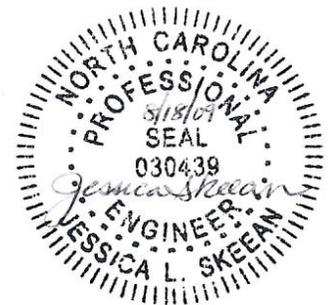
**Navy Multi-Media Program  
Contract N62470-07-D-0501**

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# Executive Summary

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This document presents data, results, and conclusions for the Focused Preliminary Assessment/Site Inspection (PA/SI) conducted at Site Unexploded Ordnance 16 (UXO-16), Former Gun Positions 41A & 41B (referred to hereafter as Gun Position 41) located at Marine Corps Base (MCB) Camp Lejeune in Jacksonville, North Carolina. The PA/SI was conducted to evaluate the presence of munitions and explosives of concern (MEC) and to characterize potential impacts to soil and groundwater related to historical activities at Gun Position 41. The PA/SI was performed in accordance with the *Site Specific Work Plan Addendum for Focused Preliminary Assessment/Site Inspection Former Gun Positions 41A & 41B* (CH2M HILL, 2008a).

MCB Camp Lejeune is implementing a military construction (MILCON) project in an area encompassing Gun Position 41 that consists of a Marine Special Operations Command (MARSOC) facility covering approximately 1,244 acres, of which approximately four acres is the Gun Position 41 investigation area.

## Field Activities

Field activities included land surveying, vegetation clearing, buried utility locating, soil and groundwater sampling, digital geophysical mapping (DGM), and a MEC intrusive investigation. A summary of the results from these investigation activities is provided below.

## Surface Soil Results

Twelve surface soil samples were collected from four decision units. The samples were analyzed for explosives residue, perchlorate, and Resource Conservation and Recovery Act (RCRA) metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Analytical results were compared to the U.S. Environmental Protection Agency (USEPA) Adjusted Soil Regional Screening Levels (RSLs), North Carolina Soil Screening Limits (NC SSLs), and twice the mean Base background concentrations. Explosives residues and perchlorate were not detected in any of the surface soil samples. Two metals (arsenic and mercury) exceeded regulatory standards.

## Subsurface Soil Results

Four subsurface soil samples were collected from Gun Position 41. The samples were analyzed for explosives residue, perchlorate, and RCRA metals. Analytical results were compared to the Adjusted Soil RSLs, NC SSLs, and twice the mean Base background concentrations. Explosives residues and perchlorate were not detected in any of the subsurface soil samples. Arsenic was the only constituent detected above regulatory standards.

## Groundwater Results

Four groundwater samples were collected from temporary monitoring wells installed at Gun Position 41. The samples were analyzed for explosives residue, perchlorate, and total and dissolved RCRA metals. Analytical results were compared to the Adjusted Tap Water RSLs, North Carolina Groundwater Quality Standards (NCGWQS), and two times the mean Base background concentrations. Three metals (arsenic, chromium, and lead) were all detected above regulatory standards.

## MEC Intrusive Investigation

A total of 895 geophysical anomalies were selected from the geophysical mapping results as representing potential subsurface MEC. All of these anomalies were intrusively investigated and no MEC was discovered; all items found were identified as either munitions debris (MD) or cultural debris (CD).

## Human Health Risk Assessment

The human health risk evaluation for Gun Position 41 was performed in two phases. No constituents of potential concern (COPCs) for soil were identified from the Phase I evaluation; therefore, exposure to soil would not be expected to result in any unacceptable human health. The Phase I evaluation indicated the potential for risks associated with exposure to groundwater; therefore, groundwater was evaluated in Phase II. The Phase II evaluation concluded that groundwater does not pose a current risk to human health and is unlikely to pose risks in the future based on expected land use.

## Ecological Risk Screening

An ecological risk screening was performed for soil and groundwater, at Gun Position 41. Results of the ecological risk screening concluded that there are no significant risks anticipated for ecological receptors exposed to Gun Position 41 soil or groundwater.

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# Acronyms and Abbreviations

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ASR	Archives Search Report
bgs	below ground surface
BIP	blow-in-place
Cal EPA	California Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action – Navy
COC	chain-of-custody
COPC	constituents of potential concern
CSF	cancer slope factor
CSM	conceptual site model
CTE	central tendency exposure
DGM	digital geophysical mapping
DOT	Department of Transportation
DPT	direct push technology
DQO	data quality objective
ELCR	excess lifetime cancer risk
EOD	Explosive Ordnance Disposal
EPC	exposure point concentration
ESS	explosion safety submission
GI	gastrointestinal
GIS	geographic information system
GPO	geophysical prove-out
GPS	global positioning system
HEAST	Health Effects Assessment Summary Table
HHRA	Human Health Risk Assessment
HHRS	Human Health Risk Screening
HI	hazard index
HQ	hazard quotient
IEUBK	Integrated Exposure/Uptake Biokinetic (model)
IDW	investigation-derived waste
IRIS	Integrated Risk Information System
L/day	liters per day
µg/dL	micrograms per deciliter
µg/L	micrograms per liter
MARCORSYSCOM	Marine Corps Systems Command
MARSOC	Marine Special Operations Command

MC	munitions constituents
MCB	Marine Corps Base
MCL	maximum contaminant level
MD	munitions debris
MEC	munitions and explosives of concern
MF	modifying factor
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
MI	multi-increment
MILCON	military construction
m	meter
mm	millimeter
MPPEH	material potentially presenting an explosive hazard
MRP	Munitions Response Program
MS/MSD	matrix spike/matrix spike duplicate
mV	millivolt
NAD83	North American Datum of 1983
NAVD 88	North American Datum of 1988
NAVFAC	Naval Facilities Engineering Command
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCEA	National Center for Environmental Assessment
NCGWQS	North Carolina groundwater quality standards
NC SSL	North Carolina soil screening level
NOSSA	Naval Ordnance Safety and Security Activity
PA/SI	Preliminary Assessment/Site Inspection
PPE	personal protective equipment
PPRTV	Provisional Peer Reviewed Toxicity Value
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RME	reasonable maximum exposure
RSL	regional screening level
RTK	real time kinematic
RTS	robotic total station
SOP	standard operating procedure
SSWP	Site-specific Work Plan
STSC	Superfund Health Risk Technical Support Center
UCL	upper confidence limit
UF	uncertainty factor

USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
WHO	World Health Organization
WW II	World War II

# Introduction

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This document presents data, results, and conclusions for the Focused Preliminary Assessment/Site Inspection (PA/SI) conducted at Former Gun Positions 41A & 41B (referred to hereafter as Gun Position 41) located at Marine Corps Base (MCB) Camp Lejeune in Jacksonville, North Carolina. The PA/SI was conducted to evaluate the potential presence of munitions and explosives of concern (MEC) and to characterize potential impacts to soil and groundwater related to historical activities at Gun Position 41. The PA/SI was performed in accordance with the *Site Specific Work Plan Addendum for Focused Preliminary Assessment/Site Inspection Former Gun Positions 41A & 41B* (CH2M HILL, 2008a), referred to herein as the Site Specific Work Plan (SSWP).

This PA/SI was conducted by CH2M HILL under the Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, Multi Media Contract N62470-07-D-0501, Task Order 09. This report is for submittal to NAVFAC Mid-Atlantic, MCB Camp Lejeune, the U.S. Environmental Protection Agency (USEPA), and the North Carolina Department of Environment and Natural Resources (NCDENR).

## 1.1 Objectives

The objectives of the PA/SI were to:

- Identify historical activities at Gun Position 41 that may have resulted in environmental contamination with MEC and/or munitions constituents (MC)
- Evaluate the presence and nature of any MC contamination that may exist at Gun Position 41
- Investigate the potential for the presence of MEC
- Assess the potential risk to ecological and human health receptors at Gun Position 41

## 1.2 Site Description and History

Gun Position 41, also referred to as Archives Search Report (ASR) Number 2.212 in the *Range Identification and Preliminary Range Assessment* (USACE, 2001), is estimated at approximately four acres in size and is located in the Stone Bay area east of Rifle Range Road (**Figure 1-1**). Based on a review of publicly available aerial photographs and site reconnaissance, approximately 70 percent of the investigation area is heavily vegetated with trees and dense undergrowth. During the site reconnaissance, several 'fox holes' were identified along with ammunition packaging. A portion of the area is cleared and an unpaved access road, locally referred to as the 'Red Trail', crosses through the northeast portion of the site.

Access to Gun Position 41 is restricted to military personnel and authorized government contractors.

The topography of Gun Position 41 is generally flat except for a low-lying area in the northwest portion of the site and areas where 'foxholes' were indentified in the eastern half of the site. Surface water features were not observed within the boundary of Gun Position 41; however the low-lying area was noted to retain water for a short period of time following precipitation events.

An interview with the Base Safety Specialist (Richardson, 2007) indicated that Gun Position 41 was first established during World War II (WW II) and was also used during the Korean War era as a training ground. Howitzers were reportedly positioned at Gun Position 41 and fired 105 millimeter (mm) and 155mm munitions into the K-2 and G-10 Impact Areas; other munitions suspected to be used at Gun Position 41 include 4.2-inch, 81mm, 120mm, 175mm, 4.2-inch, or 8-inch munitions (Redmond, 2007). Until recently, Gun Position 41 was used as a training ground. No live fire training was conducted; however, blanks and pyrotechnics were used.

## 1.3 Report Organization

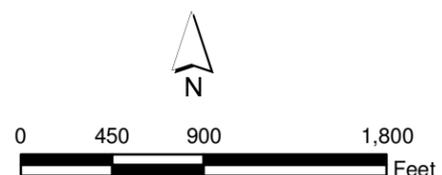
The PA/SI report comprises the following sections:

- Section 1 - Introduction
- Section 2 - Field Investigation Activities
- Section 3 - Investigation Results
- Section 4 - Human Health Risk Assessment
- Section 5 - Ecological Risk Screening
- Section 6 - Conclusions and Recommendations
- Section 7 - References

Figures and tables are provided at the end of each respective section and appendices are provided after Section 7.



- Legend**
- Former Gun Positions 41A & 41B
  - MARSOC MILCON Construction Plans
  - Road Centerline
  - Surface Water Course Centerline



1 inch equals 900 feet

Figure 1-1  
Site Location Map  
Former Gun Positions 41A & 41B  
PA/SI Report  
MCB Camp Lejeune  
North Carolina



## SECTION 2

# Field Investigation Activities

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Field investigation activities were conducted in March, April, September, and October 2008, in accordance with the SSWP (CH2M HILL, 2008a).

Generally, the field activities consisted of the following:

- Vegetation clearing
- Surface and subsurface soil sampling
- Installation of temporary groundwater monitoring wells
- Groundwater sampling
- DGM
- MEC Intrusive Investigation

Details of the field activities conducted at Gun Position 41 are provided below.

## 2.1 Site Preparation and Support

### 2.1.1 MEC Avoidance

During mobilization, potential MEC hazards were cleared as necessary in accordance with the Explosives Safety Submission (ESS) Determination Request (CH2M HILL, 2008b). CH2M HILL supplied a trained and qualified Unexploded Ordnance (UXO) Technician and provided MEC escort and avoidance services to the surveying, vegetation clearing, and DGM subcontractors. The UXO Technician inspected the ground surface prior to vegetation clearing to reduce the risk of MEC being encountered by the clearing equipment. The UXO technician also conducted subsurface MEC avoidance at all utility locating, soil boring, and well installation locations. No MEC was encountered.

### 2.1.2 Site Surveying

Lanier Surveying, a North Carolina-licensed surveyor, was subcontracted to delineate the site boundary, establish the DGM grid, and layout the corners of each decision unit. Using mapping provided by NAVFAC, the surveyor marked the approximate boundaries of Gun Position 41. The DGM grid consisted of a network of 50 meter (m) × 50 m grids across the site coinciding with the existing Base-wide grid system, marked with non-metallic stakes. Each corner stake was marked with the grid number and the compass direction (e.g., NE, SW) indicating which grid corner was represented. After the DGM grid layout was complete, the decision unit layout survey was conducted to identify the boundary of each decision unit shown in **Figure 2-1**.

After completion of the environmental sampling activities, the coordinates and elevations of the temporary monitoring wells and soil samples locations were surveyed. Top-of-casing and ground surface elevations were measured to the nearest 0.01 feet, and tied to the nearest North American Datum of 1988 (NAVD 88) datum bench mark. Horizontal control was

based on the metric system and referenced to the North American Datum of 1983 (NAD83) and the Universal Transverse Mercator Grid System. Lanier Surveying provided all survey results for incorporation into the CH2M HILL geographic information system (GIS).

### 2.1.3 Vegetation Clearing

In order to facilitate the DGM and environmental sampling, CH2M HILL subcontracted East Coast Land Improvement, a landscaping and brush clearing company, to clear vegetation at Gun Position 41. Vegetation less than three inches in diameter was cut to within 6 inches of the ground surface, mulched and left in place.

## 2.2 Environmental Investigation Activities

The PA/SI field activities were completed at Gun Position 41 between March and September 2008. Environmental sampling activities were conducted in April 2008.

### 2.2.1 Surface Soil Sampling

Surface soil sampling was conducted in accordance with the Systematic Random Multi-Increment Sampling standard operating procedure (SOP) in Appendix C of the *Munitions Response Program Master Project Plans, Marine Corps Base Camp Lejeune, North Carolina* (CH2M HILL, 2008c). The dimensions of each decision unit were approximately 64 m × 64 m. Three composite surface soil samples were collected from each of four decision units for a total of 12 samples (designated as ASR2.212-GP41-DU01-SS[01,02,03] through ASR2.212-GP41-DU04-SS[01,02,03]). Within each decision unit, a minimum of 30 sample aliquots were collected from a depth of zero to two inches, combined in a stainless steel bowl, and homogenized with a stainless steel spoon to produce three composite soil samples per decision unit. Manmade and natural debris collected during the sampling process was removed from the soil sample during homogenization. The surface soil samples were analyzed by CompuChem Labs, Inc. of Cary, North Carolina for explosives residues (SW-846 USEPA Method 8330), perchlorate (USEPA Method 6850), and Resource Conservation and Recovery Act (RCRA) metals (SW-846 USEPA Method 6010B/7000). Surface soil samples were collected in April 2008.

### 2.2.2 Subsurface Soil Sampling

Prior to direct push technology (DPT) drilling, underground utilities were identified by Professional Locating Services, Inc. Subsurface soil borings were advanced by North Carolina-licensed well driller, Parratt-Wolff, Inc to depths up to 12 ft bgs using a direct push technology (DPT) drill rig; a total of four subsurface soil samples were collected in accordance with the *Direct-Push Soil Sample Collection SOP* in Appendix C of the *Munitions Response Program (MRP) Master Project Plans* (CH2M HILL, 2008c). The four subsurface soil samples (designated ASR2.212-GP41-IS01 through ASR2.212-GP41-IS04), one from each decision unit, were collected from the locations shown on **Figure 2-1**.

During the sampling activities, continuous soil cores were collected in disposable acetate sleeves. The CH2M HILL geologist examined each soil core and recorded soil descriptions using the Unified Soil Classification System.

The subsurface soil samples were collected from the two foot interval immediately above the water table; the water table at Gun Position 41 is approximately 3 ft bgs. All samples were analyzed by CompuChem Labs, Inc. for explosives residues (SW-846 USEPA Method 8330), perchlorate (USEPA Method 6850), and RCRA metals (SW-846 USEPA Method 6010B/7000).

### 2.2.3 Temporary Monitoring Well Installation

Groundwater sampling activities required the installation, development and subsequent abandonment of four temporary monitoring wells. The four shallow monitoring wells (designated as ASR2.212-TW01 through ASR2.212-TW04), were installed to a depth of 12 ft bgs by Parratt-Wolff, Inc. using DPT. The screened interval of each well was installed to bracket the water table, except for ASR2.212-TW01 where the water table was just below the surface. These activities were conducted in accordance with the *Temporary Well Installation SOP* in Appendix C of the MRP Master Project Plans (CH2M HILL, 2008c). **Figure 2-1** shows the temporary monitoring well locations.

Each temporary well consisted of a 10-foot length of 0.010-inch machine slotted one-inch inner diameter Schedule 40 polyvinyl chloride (PVC) screen and solid riser pipe. The well screen was equipped with an attached pre-packed sand-filled filter pack. Following installation, silica filter sand was also placed around the annular space of the well screen from the bottom of the boring extending to a depth of 1 ft above the top of the screen. A layer of bentonite granules was placed above the top of the sand pack to the ground surface. A locking watertight cap was placed on the PVC riser pipe. Well completion diagrams can be found in **Appendix B**.

Within five days of construction, the temporary wells were sampled, surveyed and abandoned in accordance with North Carolina Well Construction Standards.

### 2.2.4 Groundwater Sampling

Following well completion, CH2M HILL collected groundwater samples (designated as ASR2.212-TW01 through ASR2.212-TW04) from each of the four temporary monitoring wells. Groundwater samples were collected using low-flow purge rates in accordance with the *Low-Flow Groundwater Sampling from Monitoring Wells SOP* in Appendix C of the MRP Master Project Plans (CH2M HILL, 2008c). Groundwater quality parameters were collected during purging of each temporary groundwater monitoring well and are shown on **Table 2-2**.

All groundwater samples were analyzed by CompuChem Labs, Inc. for explosives residues (SW-846 USEPA Method 8330), perchlorate (USEPA Method 6850), and total and dissolved RCRA metals (SW-846 USEPA Method 6010B/7000).

### 2.2.5 Quality Assurance/Quality Control Sampling

Appropriate quality assurance/quality control (QA/QC) sampling was performed in accordance with the Quality Control Plan in Section 8 of the MRP Master Project Plans (CH2M HILL, 2008c), including the collection of trip blanks, field blanks, equipment blanks, duplicates, and matrix spike/matrix spike duplicates (MS/MSDs).

## 2.3 Data Tracking and Validation

Sample identification numbers and the required analytical tests were recorded on chain-of-custody (COC) forms, which accompanied the samples to the laboratory. COC entries were checked against the SSWP to verify that all designated samples were collected and submitted for the appropriate analyses. Upon receipt of the samples by the laboratories, a comparison to the field information was made to verify that each sample was analyzed for the correct parameters. In addition, a check was made to ensure that the appropriate number and types of QA/QC samples were collected.

Analytical data reports, in hard copy and electronic format, were submitted to DataQual Environmental Services LLC, for third-party validation. The procedures used for the validation process included *National Functional Guidelines for Organic Data Review* (USEPA, 1999), and *National Functional Guidelines for Inorganic Data Review* (USEPA, 2004b).

## 2.4 Investigation-derived Waste Management

Investigation-derived waste (IDW) generated during this phase of investigation were managed in accordance with the Base Waste Management Plan (CH2M HILL, 2008d). IDW included soil cuttings from the DPT borings and liquid waste (e.g., purged groundwater and decontamination fluids) generated during temporary well sampling. Soil cuttings generated during surface and subsurface soil sampling were re-deposited on the site near the soil sampling locations. Liquid waste generated during groundwater sampling activities was containerized in a labeled Department of Transportation (DOT)-approved 55-gallon drum. The liquid IDW was properly disposed of within 90 days of generation, based on the results of the waste characterization. Personal protective equipment (PPE) and other trash generated during field activities were disposed of in an on-Base dumpster.

## 2.5 Geophysical Survey

Digital geophysical mapping (DGM) was performed by NAEVA Geophysics, Inc. to identify anomalies that could potentially represent subsurface MEC. All DGM activities were conducted in accordance with Geophysical Proveout (GPO) Plan and the Geophysical Investigation Plan (GIP) in Appendix B and C of the SSWP, respectively. Quality control was performed by both NAEVA and CH2M HILL. The DGM was performed within all accessible areas of the site, using a two coil EM61-MK2. In areas where the tree canopy allowed the use of GPS, the EM61-MK2 was linked to a Trimble S6 robotic total station (RTS) system. In the heavily wooded areas where GPS could not be used, positioning data was collected using an odometer wheel, as opposed to use of the RTS. In areas of Gun Position 41 where DGM could not be conducted due to site conditions (see **Figure 2-2**), unexploded ordnance (UXO) technician used a Schonstedt GA-52Cx fluxgate gradiometers to identify metallic anomalies that may represent subsurface MEC or MPPEH during first phase of the intrusive investigation. A summary of the DGM activities is provided below; the Geophysical Investigation Report is provided in **Appendix C**.

## 2.5.1 Geophysical Proveout

Geophysical proveout (GPO) activities were performed as part of the process for validating the DGM systems utilized during the geophysical mapping effort. The DGM system evaluated as part of the GPO was a two coil EM61-MK2. The GPO was mapped twice, once using RTS and once by odometer with fiducial markers placed every 25 feet. Following review of the GPO activities results by NAEVA and CH2M HILL, it was determined that the system met project data quality objectives (DQOs), and was considered suitable for use at Gun Position 41. NAEVA Geophysics, Inc generated color contour maps of the EM61-MK2 Channel 2 data from both the RTS and fiducial surveys of the GPO with a targeting threshold of 3 mV are included in Appendix A of the Geophysical Investigation Report. A summary of the GPO activities is included in the Geophysical Investigation Report provided in **Appendix C**.

## 2.5.2 Data Quality Objectives

All DQOs outlined in the SSWP were met during the DGM survey.

## 2.5.3 Quality Control

An extensive QC program was applied to the DGM operations at Gun Position 41. **Figure 2-2** shows an overall chart of the QC steps.

The geophysical system was field tested in accordance with the SSWP, as summarized in **Table 2-1**. Review of the raw geophysical data and data deliverables was conducted jointly by NAEVA and CH2M HILL.

The field test results were checked by NAEVA's QC Geophysicist prior to delivery to CH2M HILL and subsequently checked by the CH2M HILL QC Geophysicist. If necessary, corrective actions were taken as appropriate to ensure that the geophysical system functioned as required.

In order to evaluate the DGM subcontractor's ability to meet the project DQOs, CH2M HILL placed ('seeded') four QC items (one per acre) at Gun Position 41. Prior to burial of the QC items, MK2 hand grenade simulates, the selected locations were cleared by a UXO Technician using a hand-held analog geophysical instrument to confirm that no geophysical anomalies were present. The QC items were 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. Once placed, the locations of all seeded items were surveyed using a real-time kinematic (RTK) global positioning system (GPS). All of the QC items were detected by the EM61-MK2.

## 2.6 MEC Intrusive Investigation Activities

Based on the results of the DGM, an intrusive investigation was conducted to evaluate if the source of the geophysical anomalies identified during the DGM represented subsurface MEC. The intrusive investigation at Gun Position 41 was conducted in two phases. Phase I was subcontracted to UXB International, Inc. and Phase II was subcontracted to USA Environmental, Inc.

All 895 geophysical anomalies (**Figure 2-3**) identified during the DGM were manually excavated. Five anomalies which were identified during Phase I using a handheld magnetometer in the area of the Gun Position 41 where DGM could not be conducted were also intrusively investigated. All investigation locations are shown on **Figure 2-4**.

All geophysical anomalies identified for excavation were reacquired by a member of the intrusive investigation team using RTK GPS and an appropriate geophysical instrument. Excavation of individual anomalies was performed by qualified UXO Technicians using hand-excavation tools such as shovels, spades, trowels, and pry bars. The UXO team performing this work was supervised by a UXO Technician III.

The following basic technique described in the SSWP was used for anomaly excavation:

- The UXO technician investigated within a 1-meter radius of a flagged anomaly with an appropriate geophysical instrument.
- Until identified otherwise, the anomaly was assumed to be MEC. Excavation was initiated adjacent to the subsurface anomaly. The excavation continued until the excavated area reached a depth below the top of the anomaly as determined by frequent inspection with an appropriate geophysical instrument.
- Using progressively smaller and more delicate tools to remove the soil carefully, the excavation team expanded the sidewall to expose the metallic item for inspection and identification without moving or disturbing the item. If the UXO technician had excavated to a depth of 2 ft without exposing the item, the excavation stopped.
- If an item was exposed for inspection, the excavation team determined whether the item was MEC or material potentially presenting an explosive hazard (MPPEH). If the item was MEC, it would have been blown-in-place (BIP). For items that were identified as MPPEH, the logic diagram presented in Section 8.4 of the ESS (CH2M HILL, 2008e) was followed.
- If the item was not suspected to be MEC or MPPEH, the source of the anomaly was removed to the scrap metal collection point for verification and certification and the area was rechecked with the appropriate geophysical instrument to ensure that an item was not hidden beneath the item that was removed. The excavation team then annotated the results of the excavation on the dig sheet and moved on to the next geophysical anomaly.

Intrusive investigation QC inspections were performed by the UXO QC Specialist (UXOQCS) during the course of the fieldwork. Additional QA/QC removal verification requirements were followed as required. The following is the procedure followed for quality control inspections of the intrusive investigation:

- After the dig team intrusively investigated an anomaly location, the hole was to be left open to the depth investigated and a PVC flag placed in the hole or bent after the investigation was completed.
- The UXOQCS inspected at least 10 percent of the intrusively investigated anomaly locations using an appropriate geophysical instrument to determine whether all detectable metallic items within a 2-ft radius of the hole to a depth of 2 ft had been

removed. The locations checked were distributed in a spatially representative sample across each grid.

- All holes related to intrusive investigations were filled back to original grade or covered before departing the site each day.
- Anomaly locations inspected, along with results of the inspection and corrective actions planned in the event that the UXOQCS determines that inspection results require a change in intrusive team procedures or a re-performance of any work, were documented by the subcontractor and provided to the CH2M HILL site manager.
- Additional QC analyses of intrusive results versus original amplitude of geophysical anomalies were performed by the CH2M HILL Project Geophysicist within the project database. Anomaly locations that were determined to need re-investigation through this process were re-inspected.

**TABLE 2-1**  
DGM Instruments Standardization Tests and Acceptance Criteria  
*Former Gun Position 41A & 41B*  
*MCB Camp Lejeune, North Carolina*

<b>Test</b>	<b>Test Description</b>	<b>Acceptance Criteria</b>	<b>Power On</b>	<b>Beginning of Day</b>	<b>Beginning and End of Day</b>	<b>First Time Instr. Used</b>	<b>2% of Total Area Surveyed</b>
1	Equipment Warm-up	Equipment specific (typically 5 min)	X				
2	Positioning System Accuracy	10 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

**TABLE 2-2**  
 Groundwater Field Sampling Parameters  
*Former Gun Position 41A & 41B*  
*MCB Camp Lejeune, North Carolina*

<b>Station ID</b>	ASR2.212-GP41-TW01	ASR2.212-GP41-TW02	ASR2.212-GP41-TW03	ASR2.212-GP41-TW04
<b>Sample Date</b>	04/22/08	04/21/08	04/22/08	04/22/08
<b>Field Parameters</b>				
Dissolved Oxygen (mg/L)	3.68	0.28	2.31	3.47
Oxidation Reduction Potential (mV)	-3	-22	171	64
pH	5.49	5.20	4.31	6.53
Specific Conductance (mS/cm)	0.26	0.463	0.163	0.970
Temperature (C)	17.7	19.4	17.1	16.9
Turbidity (NTU)	534	280	NA	NA

**Notes:**

mg/L = milligrams per liter

mS/cm = millisiemens per centimeter

mV = millivolts

NTUs = Nephelometric Turbidity Units

NA = Not available due to equipment malfunction



- Legend**
- Groundwater Sample Locations
  - Subsurface Soil Sample Locations
  - Subsurface Soil/ Groundwater Sample Locations
  - Surface Water Course Centerline
  - Road Centerline
  - Decision Units
  - Former Gun Positions 41A & 41B

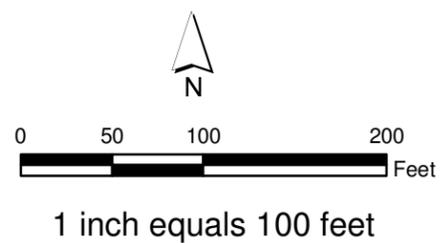
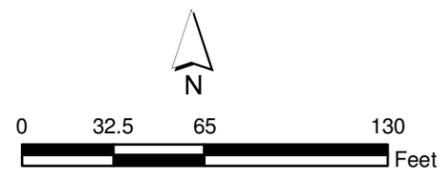


Figure 2-1  
Environmental Sampling Locations  
Former Gun Positions 41A & 41B  
PA/SI Report  
MCB Camp Lejeune  
North Carolina





- Legend**
- Geophysical Anomaly (greater than 3 mV)
  - Former Gun Positions 41A & 41B
  - Areas Unaccessible for DGM



1 inch = 65 feet

Figure 2-2  
Digital Geophysical Mapping Results  
Former Gun Positions 41A and 41B  
PA/SI Report  
MCB Camp Lejeune  
North Carolina



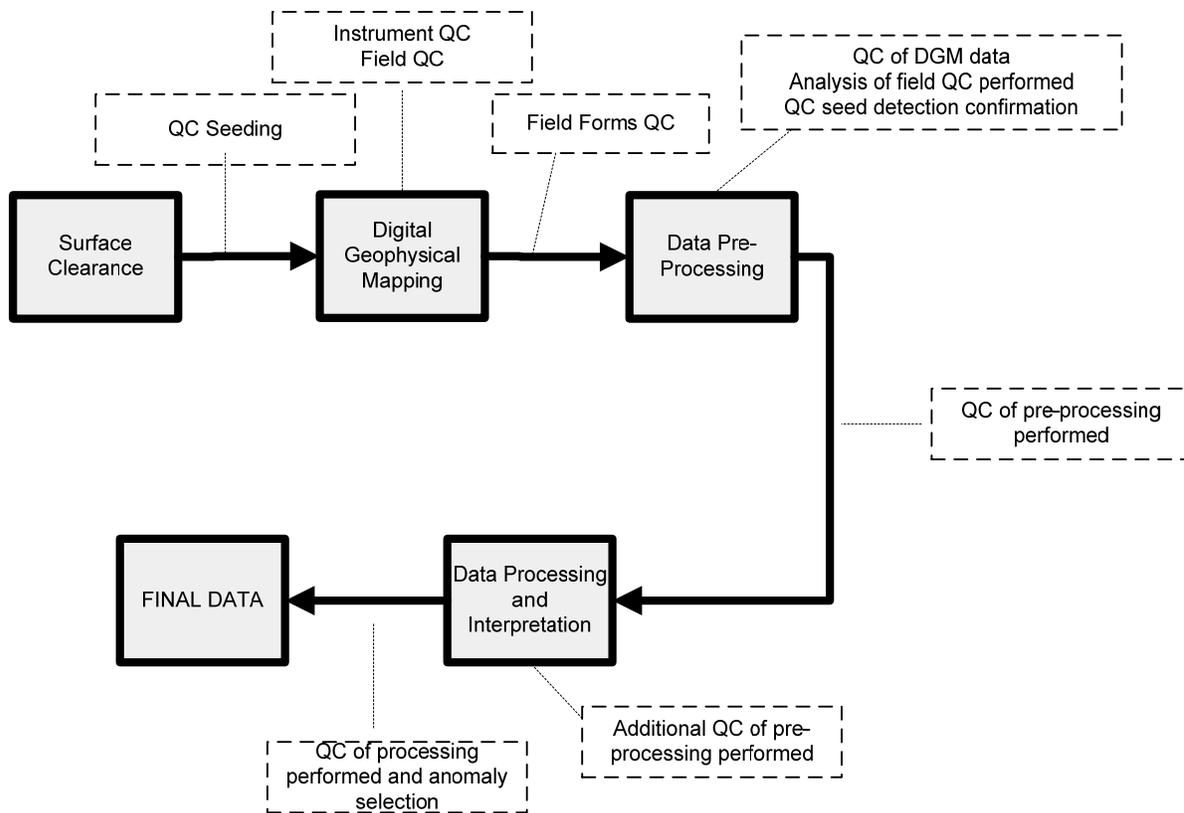
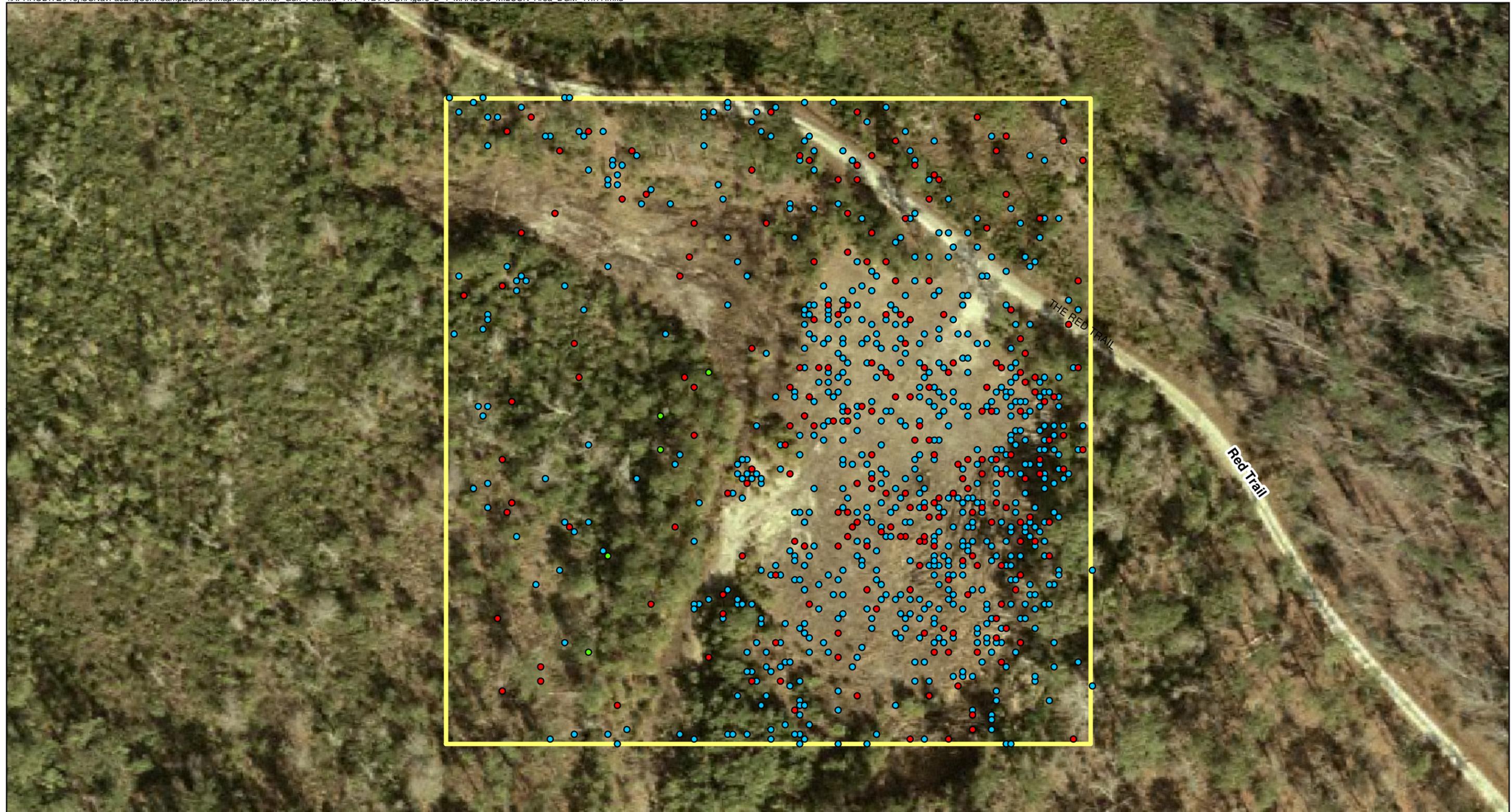
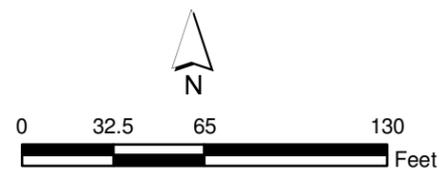


Figure 2-3  
 Overview of DGM Process QC  
 Former Gun Position 41A & 41B  
 PA/SI Report  
 MCB Camp Lejeune  
 North Carolina



- Legend**
- Phase I DGM Intrusive Locations
  - Phase I Magnetometer Locations
  - Phase II DGM Intrusive Locations
  - Former Gun Positions 41A & 41B



1 inch = 65 feet

Figure 2-4  
Intrusive Investigation Locations  
Former Gun Positions 41A and 41B  
PA/SI Report  
MCB Camp Lejeune  
North Carolina



# Investigation Results

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The following subsections present and summarize the findings of the field investigation discussed in Section 2.

## 3.1 Environmental Investigation

A discussion of the detected results for the soil and groundwater samples is presented below. All raw analytical data can be found in **Appendix D**.

### 3.1.1 Geology & Hydrogeology

From the regional geology, it can be inferred that Gun Position 41 is underlain by the uppermost Undifferentiated Formation of Holocene and Pleistocene age sediments, which consist 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 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 sediments underlying Gun Position 41 consist of layered laterally-discontinuous fine grained sediments. Particle sizes noted from soil boring logs (advanced to approximately 12 ft bgs) indicate sediments ranging from clay to fine sand. Soil boring logs can be found in **Appendix B**.

Groundwater elevations and water levels and collected from the temporary wells during the PA/SI field work on April 22, 2008 are shown on **Table 3-4**. A limited number of temporary wells were installed and gauged during the PA/SI field work providing an insufficient amount of data points to develop an accurate water table contour map. The horizontal gradient calculated from the surficial potentiometric surface ranges from 0.0059 to 0.0069 ft/ft.

### 3.1.2 Surface Soil

The surface soil analytical data were screened against the North Carolina Soil Screening Levels (NC SSLs) (NCDENR, 2005), the USEPA Adjusted Soil Regional Screening Level (RSLs) (USEPA, 2008a) and two times the mean MCB Camp Lejeune background surface soil concentrations (Baker, 2001). Detected analytes exceeding regulatory standards are presented in **Table 3-1** and **Figure 3-1**. A summary of the surface soil analytical results is provided below.

- Explosives residues and perchlorate were not detected in any of the surface soil samples.
- Arsenic concentrations detected in decision unit ASR2.212-GP41-DU02 sample ASR2.212-GP41-DU02-SS02 (0.66 milligrams per kilogram [mg/kg]) and decision unit

ASR2.212-GP41-DU03 samples ASR2.212-GP41-DU03-SS01 (1.2 mg/kg), ASR2.212-GP41-DU03-SS02 (0.95 mg/kg), and ASR2.212-GP41-DU03-SS03 (1.4 mg/kg) exceeded the Adjusted Residential Soil RSL (0.39 mg/kg) and two times the mean background concentration (0.626 mg/kg) but did not exceed the NC SSL or the Adjusted Industrial Soil RSL.

- Mercury concentrations detected in decision units ASR2.212-GP41-DU02, -DU03, and -DU04 exceeded the NC SSL (0.015 mg/kg) in at least one surface soil sample but did not exceed Adjusted Soil RSLs or two times the mean background concentration.
- Lead and selenium were detected at concentrations greater than two times the mean background concentration in at least one surface soil sample but did not exceed the Adjusted Soil RSLs or the NC SSLs.

### 3.1.3 Subsurface Soil

The subsurface soil analytical data were screened against the NC SSLs (NCDENR, 2005), the USEPA Adjusted Soil RSLs (USEPA, 2008a) and two times the mean MCB Camp Lejeune background subsurface soil concentrations (Baker, 2001). Detected analytes exceeding regulatory standards are presented in **Table 3-2** and **Figure 3-2**. A summary of the subsurface soil analytical results is provided below.

- Explosives residues and perchlorate were not detected in any of the subsurface soil samples.
- Arsenic concentrations detected in samples ASR2.212-GP41-IS01 (0.68 mg/kg) and ASR2.212-GP41-IS03 (0.85 mg/kg) exceeded the Adjusted Residential Soil RSL (0.39 mg/kg) but did not exceed the NC SSL, the Adjusted Industrial Soil RSL, or two times the mean background concentration.
- The mercury concentration detected in sample ASR2.212-GP41-IS03 (0.023 mg/kg) exceeded the NC SSL (0.015 mg/kg) but did not exceed the Adjusted Soil RSLs or two times the mean background concentration.
- Chromium and lead were detected at concentrations greater than two times the mean background concentrations at sample location ASR2.212-GP41-IS01 but did not exceed the Adjusted Soil RSLs or the NC SSLs.

### 3.1.4 Groundwater

The groundwater analytical data were compared to the North Carolina Groundwater Quality Standards (NCGWQS) (NCDENR, 2006), USEPA Adjusted Tap Water RSLs (USEPA, 2008a), and two times the mean MCB Camp Lejeune background groundwater concentrations (Baker, 2002). In accordance with Subchapter 2L of the North Carolina Administrative Code (NCAC) Title 15A, if the Maximum Contaminant Level (MCL) for a constituent is more stringent than the NCGWQS, then the MCL was used instead of the NCGWQS.

Detected analytes exceeding regulatory standards are presented in **Table 3-3** and **Figure 3-3**. A summary of the groundwater analytical results is provided below.

- Explosives residues and perchlorate were not detected in any of the groundwater samples.
- Arsenic concentrations ranged from 3.0 micrograms per liter ( $\mu\text{g/L}$ ) (ASR2.212-GP41-TW04) to 18.8  $\mu\text{g/L}$  (ASR2.212-GP41-TW01). Arsenic concentrations exceeded the Adjusted Tap Water RSLs (0.045  $\mu\text{g/L}$ ) in each groundwater sample, but only exceeded two times the mean background concentration (5.77  $\mu\text{g/L}$ ) at two locations (ASR2.212-GP41-TW01 and ASR2.212-GP41-TW03) and the USEPA MCL (10  $\mu\text{g/L}$ ) in one location (ASR2.212-GP41-TW01).
- Chromium was detected at concentrations ranging from 2  $\mu\text{g/L}$  (ASR2.212-GP41-TW01) to 62.3  $\mu\text{g/L}$  (ASR2.212-GP41-TW03), which exceeded the NCGWQS (50  $\mu\text{g/L}$ ) and two times the mean background concentration (3.13  $\mu\text{g/L}$ ) at sample location ASR2.212-GP41-TW03, but did not exceed the Adjusted Tap Water RSL (110  $\mu\text{g/L}$ ). Chromium concentrations also exceeded two times the mean background concentration at sample location ASR2.212-GP41-TW01 and ASR2.212-GP41-TW04 but did not exceed the Adjusted Tap Water RSL or the NCGWQS.
- Lead was detected at concentrations ranging from 5.3  $\mu\text{g/L}$  (ASR2.212-GP41-TW01) to 56.9  $\mu\text{g/L}$  (ASR2.212-GP41-TW03). Lead concentrations exceeded the NCGWQS (15  $\mu\text{g/L}$ ) and two times the mean background concentration (2.8  $\mu\text{g/L}$ ) at sample locations ASR2.212-GP41-TW02 and ASR2.212-GP41-TW03. Lead concentrations also exceeded two times the mean background concentration at sample location ASR2.212-GP41-TW01 and ASR2.212-GP41-TW04 but the concentrations did not exceed the Adjusted Tap Water RSL or the NCGWQS.
- Barium and mercury were detected at concentrations above two times the mean background concentration at one or more of the sample locations but they did not exceed the Adjusted Tap Water RSLs or NCGWQS.

## 3.2 Geophysical Survey

With the exception of the areas that could not be accessed using the EM61-MK2 due to site conditions (**Figure 2-2**), DGM was performed across all of Gun Position 41. The areas inaccessible for DGM were surveyed using a Schonstedt GA-52Cx fluxgate gradiometer. The DGM activities yielded a total of 895 anomalies with a signal greater than 3 millivolts (mV). The distribution of geophysical anomalies was found to be particularly concentrated in the eastern half of Gun Position 41, as shown on **Figure 2-2**. The Geophysical Investigation Report is provided in **Appendix C**.

## 3.3 MEC Intrusive Investigation

The intrusive investigation did not encounter MEC at Gun Position 41. All items were found to be either munitions debris (MD) or cultural debris (CD). The MD and CD recovered during the intrusive investigation are presented in **Appendix E**.

Following the required demilitarization, certification, and verification, all MD recovered during Phase I was disposed of with the CD at the Jacksonville Scrap Iron and Metal Co., in

Jacksonville, North Carolina in accordance with Ordnance Publication (OP)-5 (NAVSEA, 2004).

For Phase II, after certifications and verifications, the recovered MD was shipped to the Bedford Recycling, Inc. in Bedford, Indiana. The Phase II MD was smelted at the Bedford Recycling, Inc. under a joint venture with Demil Metals, Inc. The CD recovered during Phase II was disposed of at the Jacksonville Scrap Iron and Metal Co.

TABLE 3-1  
 Surface Soil Analytical Results  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Station ID Sample ID Sample Date	NC SSL (May 2005)	RSLs Industrial Soil Adjusted	RSLs Residential Soil Adjusted	Camp Lejeune Background SS 2X Mean	ASR2.212-GP41-DU01		
					ASR2.212-GP41-DU01-SS01 04/15/08	ASR2.212-GP41-DU01-SS02 04/16/08	ASR2.212-GP41-DU01-SS03 04/16/08
<b>Chemical Name</b>							
<b>Explosives (µg/kg)</b>							
No Detections							
<b>Total Metals (mg/kg)</b>							
Arsenic	5.24	1.6	0.39	0.626	0.44 U	0.42 U	0.41 U
Barium	848	19000	1500	14.5	6 J	6.4 J	5.1 J
Chromium	27.2	1400	280	6.05	2.9	2.8	3.3
Lead	270	800	400	12.3	4.2	4.4	3.7
Mercury	0.015	31	2.3	0.081	0.023 U	0.022 U	0.022 U
Selenium	12.2	510	39	0.563	<b>0.62 J</b>	<b>0.91 J</b>	0.57 UJ

**Notes:**

RSL - Regional Screening Level  
 NC SSL - North Carolina Soil Screening Level  
 µg/kg - Micrograms per kilogram  
 mg/kg - Milligrams per kilogram  
 J - Analyte present, value may or may not be accurate or precise  
 U - The material was analyzed for, but not detected  
 UJ - Analyte not detected, quantitation limit may be inaccurate

Shading indicates exceedance of the NC SSL

**Bold numbering indicates an exceedance of 2X the mean Camp Lejeune Background**

Underlined numbering indicates an exceedance of the Adjusted Residential Soil RSL

TABLE 3-1  
 Surface Soil Analytical Results  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Station ID Sample ID Sample Date	NC SSL (May 2005)	RSLs Industrial Soil Adjusted	RSLs Residential Soil Adjusted	Camp Lejeune Background SS 2X Mean	ASR2.212-GP41-DU02			
					ASR2.212-GP41-DU02-SS01 04/16/08	ASR2.212-GP41-DU02-SS01D 04/16/08	ASR2.212-GP41-DU02-SS02 04/16/08	ASR2.212-GP41-DU02-SS03 04/16/08
<b>Chemical Name</b>								
<b>Explosives (µg/kg)</b>								
No Detections								
<b>Total Metals (mg/kg)</b>								
Arsenic	5.24	1.6	0.39	0.626	<u>0.61</u> J	<u>0.47</u> J	<b>0.66</b> J	<u>0.42</u> J
Barium	848	19000	1500	14.5	5.7 J	6.3 J	6.7 J	6.6 J
Chromium	27.2	1400	280	6.05	2.6	2.6	2.6	2.7
Lead	270	800	400	12.3	6.6	6.7	9	8.4
Mercury	0.015	31	2.3	0.081	0.02 U	0.018 U	0.019 U	0.022 J
Selenium	12.2	510	39	0.563	0.52 UJ	0.51 UJ	0.49 UJ	0.48 UJ

**Notes:**  
 RSL - Regional Screening Level  
 NC SSL - North Carolina Soil Screening Level  
 µg/kg - Micrograms per kilogram  
 mg/kg - Milligrams per kilogram  
 J - Analyte present, value may or may not be accurate or precise  
 U - The material was analyzed for, but not detected  
 UJ - Analyte not detected, quantitation limit may be inaccurate

Shading indicates exceedance of the NC SSL  
**Bold numbering indicates an exceedance of 2X the mean Camp Lejeune Background**  
Underlined numbering indicates an exceedance of the Adjusted Residential Soil RSL

TABLE 3-1  
 Surface Soil Analytical Results  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Station ID Sample ID Sample Date	NC SSL (May 2005)	RSLs Industrial Soil Adjusted	RSLs Residential Soil Adjusted	Camp Lejeune Background SS 2X Mean	ASR2.212-GP41-DU03			
					ASR2.212-GP41-DU03-SS01 04/16/08	ASR2.212-GP41-DU03-SS01D 04/16/08	ASR2.212-GP41-DU03-SS02 04/17/08	ASR2.212-GP41-DU03-SS03 04/17/08
Chemical Name								
Explosives (µg/kg)								
No Detections								
Total Metals (mg/kg)								
Arsenic	5.24	1.6	0.39	0.626	<b>0.75 J</b>	<b>1.2</b>	<b>0.95 J</b>	<b>1.4</b>
Barium	848	19000	1500	14.5	8.4 J	8.7 J	12.9 J	7.8 J
Chromium	27.2	1400	280	6.05	3.4	5.1	4.6	6
Lead	270	800	400	12.3	9.3	8.4	9.5	5.9
Mercury	0.015	31	2.3	0.081	0.019 J	0.02 U	0.026 J	0.021 J
Selenium	12.2	510	39	0.563	<b>0.57 J</b>	0.51 UJ	<b>0.58 J</b>	0.53 UJ

**Notes:**  
 RSL - Regional Screening Level  
 NC SSL - North Carolina Soil Screening Level  
 µg/kg - Micrograms per kilogram  
 mg/kg - Milligrams per kilogram  
 J - Analyte present, value may or may not be accurate or precise  
 U - The material was analyzed for, but not detected  
 UJ - Analyte not detected, quantitation limit may be inaccurate

Shading indicates exceedance of the NC SSL  
**Bold numbering indicates an exceedance of 2X the mean Camp Lejeune Background**  
Underlined numbering indicates an exceedance of the Adjusted Residential Soil RSL

TABLE 3-1  
 Surface Soil Analytical Results  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Station ID Sample ID Sample Date	NC SSL (May 2005)	RSLs Industrial Soil Adjusted	RSLs Residential Soil Adjusted	Camp Lejeune Background SS 2X Mean	ASR2.212-GP41-DU04		
					ASR2.212-GP41-DU04-SS01 04/17/08	ASR2.212-GP41-DU04-SS02 04/17/08	ASR2.212-GP41-DU04-SS03 04/17/08
<b>Chemical Name</b>							
<b>Explosives (µg/kg)</b>							
No Detections							
<b>Total Metals (mg/kg)</b>							
Arsenic	5.24	1.6	0.39	0.626	0.38 U	<u>0.42</u> J	<u>0.49</u> J
Barium	848	19000	1500	14.5	10.5 J	11.9 J	9 J
Chromium	27.2	1400	280	6.05	4	4.8	4.3
Lead	270	800	400	12.3	<b>12.9</b>	<b>13.7</b>	11.3
Mercury	0.015	31	2.3	0.081	0.024 J	0.025 J	0.019 U
Selenium	12.2	510	39	0.563	<b>0.83</b> J	0.55 UJ	<b>0.6</b> J

**Notes:**  
 RSL - Regional Screening Level  
 NC SSL - North Carolina Soil Screening Level  
 µg/kg - Micrograms per kilogram  
 mg/kg - Milligrams per kilogram  
 J - Analyte present, value may or may not be accurate or precise  
 U - The material was analyzed for, but not detected  
 UJ - Analyte not detected, quantitation limit may be inaccurate

Shading indicates exceedance of the NC SSL  
**Bold numbering indicates an exceedance of 2X the mean Camp Lejeune Background**  
Underlined numbering indicates an exceedance of the Adjusted Residential Soil RSL

TABLE 3-2  
 Subsurface Soil Analytical Results  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Station ID Sample ID Sample Date	NC SSL (May2005)	RSLs Residential Soil Adjusted	RSLs Industrial Soil Adjusted	Camp Lejeune Background SB 2X Mean	ASR2.212-GP41-IS01 ASR2.212-GP41-IS01-1-3 04/22/08	ASR2.212-GP41-IS02 ASR2.212-GP41-IS02-1-3 04/21/08	ASR2.212-GP41-IS03 ASR2.212-GP41-IS03-1-3 04/22/08		ASR2.212-GP41-IS04 ASR2.212-GP41-IS04-1-3 04/21/08
<b>Chemical Name</b>									
<b>Explosives (µg/kg)</b>									
No Detections									
<b>Total Metals (mg/kg)</b>									
Arsenic	5.24	0.39	1.6	2.12	<u>0.68</u> J	0.35 U	0.85 J	0.37 J	0.35 U
Barium	848	1500	19000	16.6	16.5 J	5 J	5.3 J	3.3 J	4.5 J
Chromium	27.2	280	1400	14.5	<b>24</b>	6.2	2.4	3.8	4.5
Lead	270	400	800	8.49	<b>11.8</b>	4.1	3.1	3.6	3.3
Mercury	0.015	2.3	31	0.071	0.021 U	0.018 U	0.023 J	0.019 U	0.017 U

**Notes:**  
 RSL - Regional Screening Level  
 NC SSL - North Carolina Soil Screening Level  
 µg/kg - Micrograms per kilogram  
 mg/kg - Milligrams per kilogram  
 J - Analyte present, value may or may not be accurate or precise  
 U - The material was analyzed for, but not detected

Shading indicates exceedance of the NC SSL  
**Bold numbering indicates an exceedance of 2X the mean Camp Lejeune Background**  
Underlined numbering indicates an exceedance of the Adjusted Residential Soil RSL

TABLE 3-3  
 Groundwater Analytical Results  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Station ID Sample ID	NCGWQS	Adjusted Tapwater RSLs	Camp Lejeune Background GW 2X Mean	ASR2.212-GP41-TW01		ASR2.212-GP41-TW02	ASR2.212-GP41-TW03	ASR2.212-GP41-TW04
				ASR2.212-GP41-TW01-2-12	ASR2.212-GP41-TW01D-2-12	ASR2.212-GP41-TW02-2-12	ASR2.212-GP41-TW03-2-12	ASR2.212-GP41-TW04-2-12
Sample Date				04/22/08	04/22/08	04/21/08	04/22/08	04/22/08
Chemical Name								
Explosives (µg/L)								
No Detections								
Total Metals (µg/L)								
Arsenic	10*	0.045	5.77	<b>18.8</b>	<b>9.6</b>	3	<b>7.8</b>	4.6 J
Barium	2,000	730.0	86.2	79.4	81.1	<b>94.4</b>	<b>118</b>	<b>87.4</b>
Cadmium	1.75	1.8	0.358	0.17 J	0.1 J	0.089 J	0.22 J	0.11 U
Chromium	50	11	3.13	<b>6.8 J</b>	2 J	<b>21.3 J</b>	<b>62.3 J</b>	<b>12.1 J</b>
Lead	15	---	2.8	<b>8.7 J</b>	<b>5.3 J</b>	<b>16.3 J</b>	<b>56.9 J</b>	<b>14.3 J</b>
Mercury	1.05	1.1	0.1	0.1 U	0.1 U	0.1 U	<b>0.28</b>	0.1 U
Selenium	50	18	3.14	0.94 J	0.63 U	0.91 J	<b>5.4 J</b>	3.2 U
Dissolved Metals (µg/L)								
Arsenic	50	0.045	5.77	<b>14.7</b>	<b>10.4</b>	1.7	<u>0.8 J</u>	3
Barium	2,000	730	86.2	67.8	66.2	84.7	76.9	82.3
Chromium	50	11	3.13	2	2 U	<b>6.1</b>	<b>3.4</b>	2 U
Lead	15	---	2.8	<b>3.2 J</b>	2.5 J	<b>4.4 J</b>	2.3 J	<b>26.6 J</b>
Selenium	50	18	3.14	0.64 J	0.63 U	0.63 U	0.65 J	0.85 J
Silver	17.5	18	0.77	0.054 U	0.054 U	0.064 J	0.054 U	0.054 U

Notes:

RSL - Regional Screening Level  
 NCGWQS - North Carolina Groundwater Quality Standard  
 MCL - Maximum Contaminant Level  
 µg/L - Micrograms per liter  
 U - The material was analyzed for, but not detected  
 J - Analyte present, value may or may not be accurate or precise

Shading indicates exceedance of NCGWQS  
**Bold numbering indicates an exceedance of 2X the mean Camp Lejeune Background**  
Underlined numbering indicates exceedance of the Adjusted Tapwater RSL

\* The MCL for arsenic is more stringent than the NCGWQS; therefore, as defined by NCAC 2L .0202(d), the MCL is used for comparison purposes

**TABLE 3-4**

Groundwater Elevation and Well Construction Information

*Former Gun Position 41A & 41B**MCB Camp Lejeune, North Carolina*

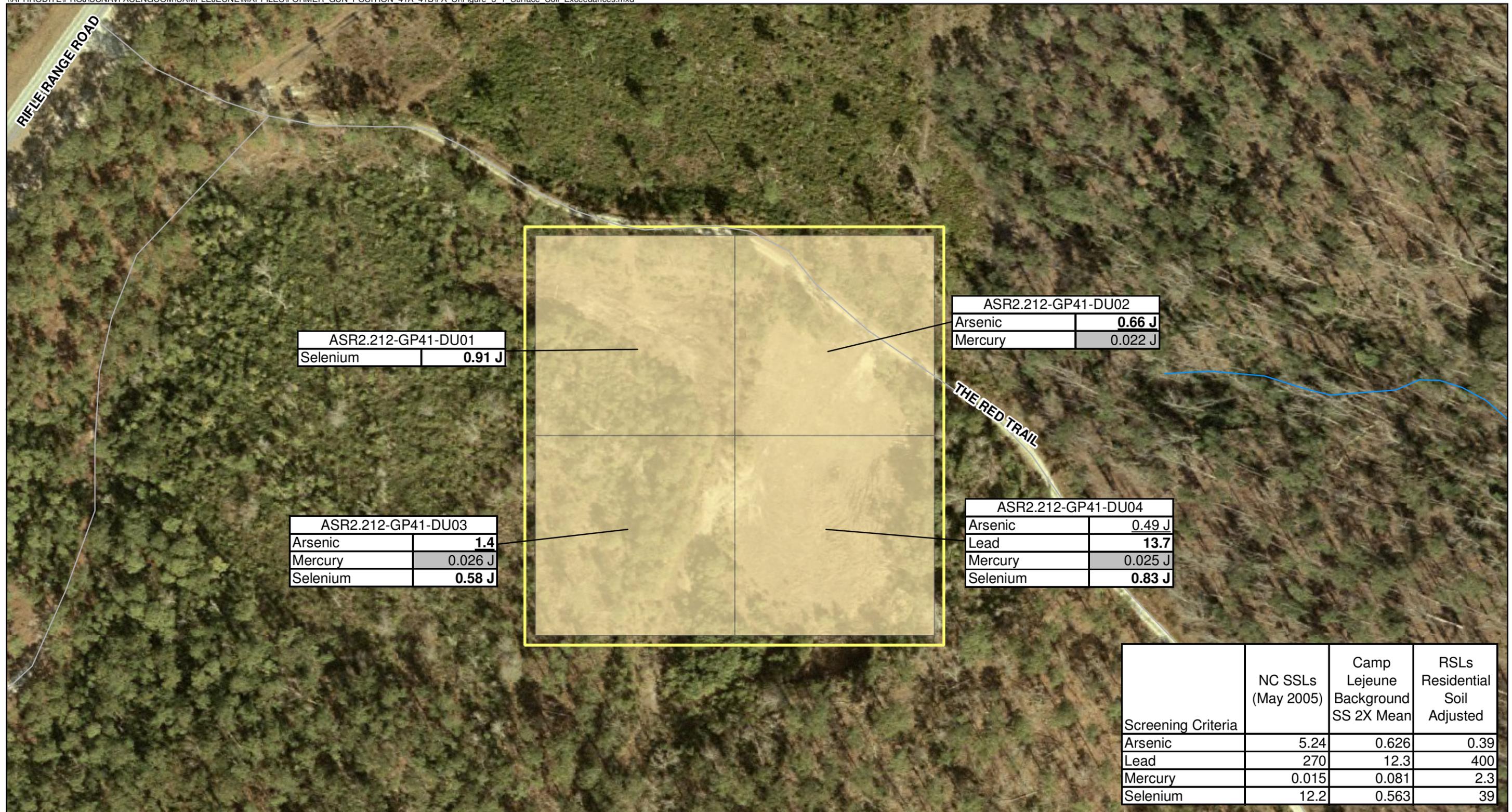
<b>Well ID</b>	<b>Date Installed (mm/dd/yy)</b>	<b>Screened Interval (ft bgs)</b>	<b>Bottom of Well (ft bTOC)</b>	<b>Surveyed Top of Casing Elevation (ft msl)</b>	<b>Surveyed Ground Surface of Well (ft msl)</b>	<b>Depth to Water April 22, 2008 (ft bTOC)</b>	<b>Groundwater Elevation April 22, 2008 (ft msl)</b>
ASR2.212-GP41-TW01	04/22/08	2-12	12.00	33.07	33.00	0.30	32.77
ASR2.212-GP41-TW02	04/21/08	2-12	12.00	34.41	33.55	3.00	31.41
ASR2.212-GP41-TW03	04/24/08	2-12	12.00	32.87	32.79	2.00	30.87
ASR2.212-GP41-TW04	04/25/08	2-12	12.00	32.69	32.42	2.00	30.69

**Note:**

ft bgs = feet below ground surface

ft bTOC = feet below top-of-casing

ft msl = feet above mean sea level



- Legend**
- Surface Water Course Centerline
  - Road Centerline
  - Decision Units
  - Former Gun Positions 41A & 41B

Note:  
 All screening criteria and concentrations are expressed as milligrams per kilogram (mg/kg)  
 J - analyte detected, value may or may not be accurate or precise  
**Bold** - exceeds two times base-wide background levels  
Underlined - Exceeds Residential Soil Adjusted Regional Screening Levels (RSLs)  
 Shaded - exceeds North Carolina Soil Screening Levels (NC SSLs)

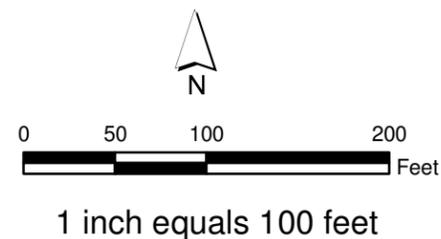
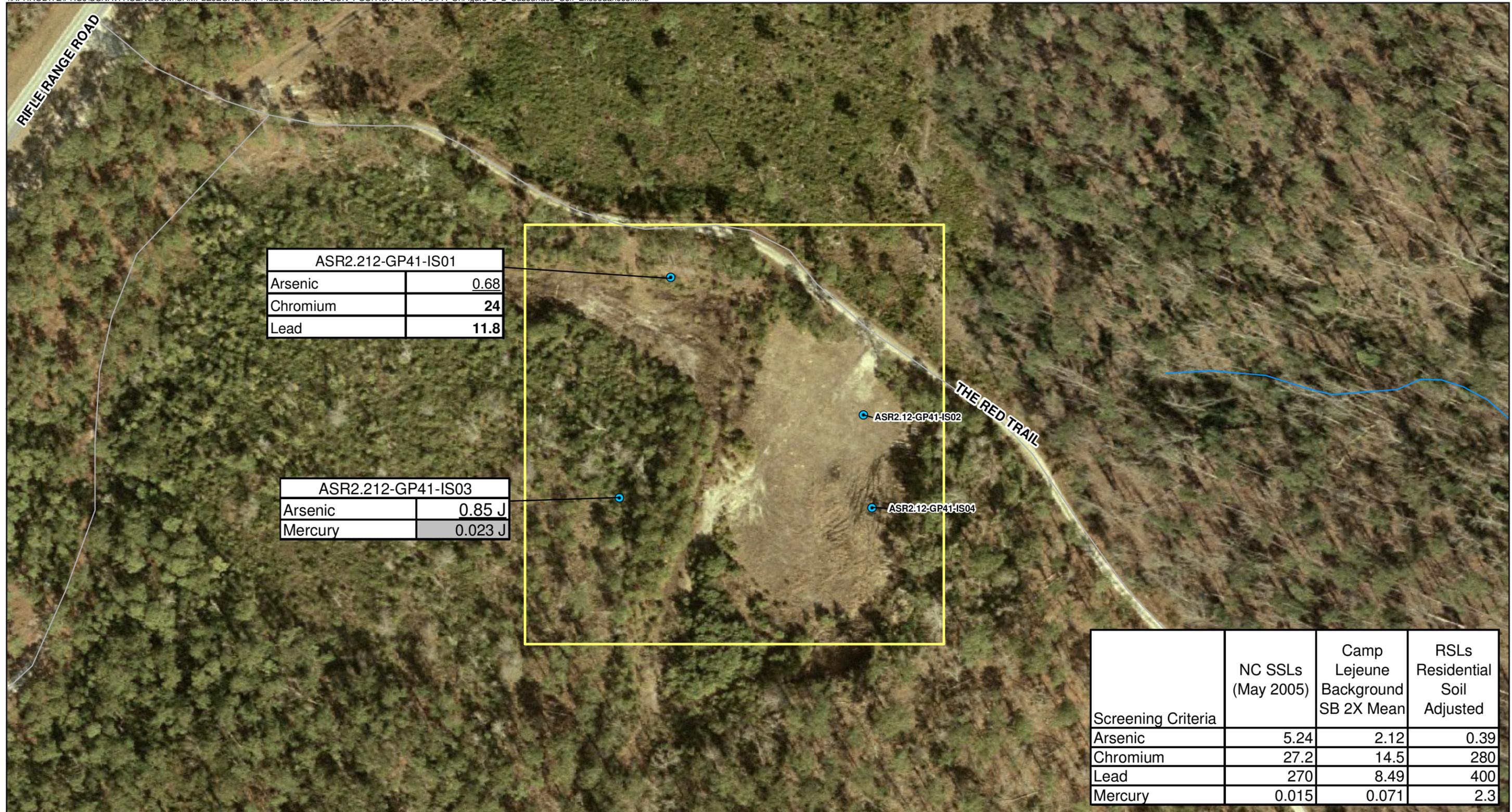


Figure 3-1  
 Surface Soil Exceedances  
 Former Gun Positions 41A & 41B  
 PA/SI Report  
 MCB Camp Lejeune  
 North Carolina



**Legend**

- Subsurface Soil Sample Locations
- Surface Water Course Centerline
- Road Centerline
- Former Gun Positions 41A & 41B

**Note:**  
 All concentrations and screening criteria are expressed in milligrams per kilogram (mg/kg)  
 J - analyte detected, value may or may not be accurate or precise  
**Bold - exceeds two times base-wide background levels**  
Underlined - exceeds Residential Soil Adjusted Regional Screening Levels (RSLs)  
 Shaded - exceeds North Carolina Soil Screening Levels (NC SSLs)

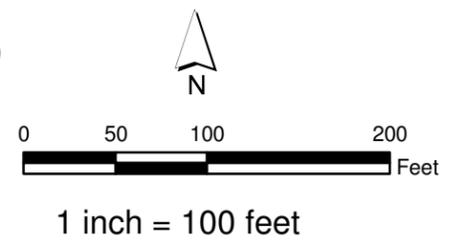
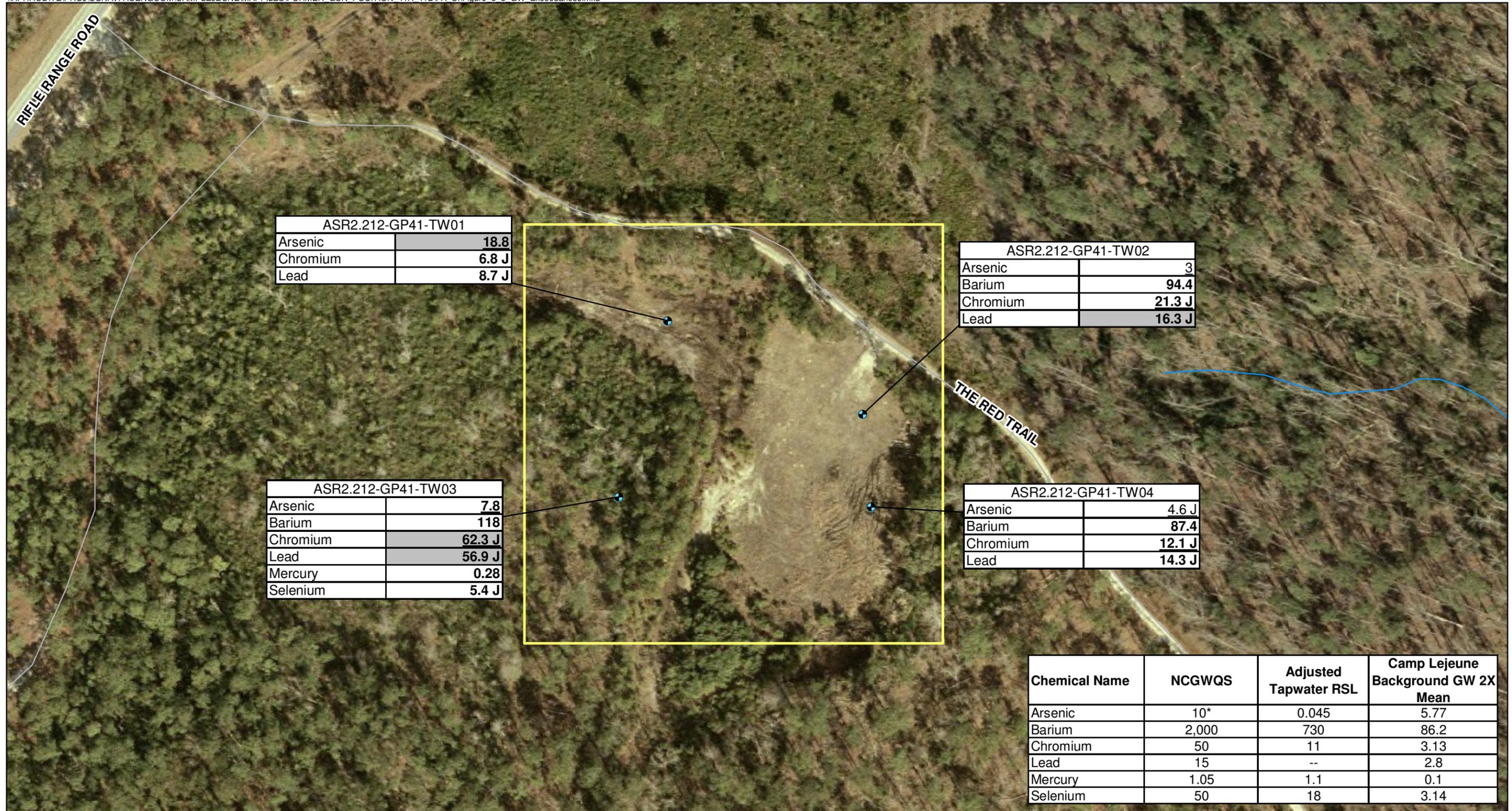


Figure 3-2  
 Subsurface Soil Exceedances  
 Former Gun Positions 41A & 41B  
 PA/SI Report  
 MCB Camp Lejeune  
 North Carolina



- Legend**
- Groundwater Sample Locations
  - Surface Water Course Centerline
  - Road Centerline
  - Former Gun Positions 41A & 41B

Note:  
 All concentrations and screening criteria are expressed in micrograms per liter (µg/L)  
 J - analyte present, value may or may not be accurate or precise  
**Bold** - exceeds two times the mean background concentration  
Underlined - exceeds Adjusted Tapwater RSL  
 Shaded - exceeds NCGWQS  
 Dissolved metals exceedances are not shown.  
 \* The MCL for arsenic is more stringent than the NCGWQS; therefore, as defined by NCAC 2L .0202(d), the MCL is used for comparison purposes.

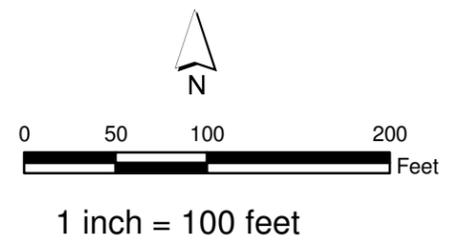


Figure 3-3  
 Groundwater Exceedances  
 Former Gun Positions 41A & 41B  
 PA/SI Report  
 MCB Camp Lejeune  
 North Carolina



# Human Health Risk Assessment

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The analytical results for the soil and groundwater samples collected as part of this PA/SI were evaluated to assess the potential for human health risks associated with exposure to these media. The risk evaluation was performed in two phases. The first phase included a conservative preliminary Human Health Risk Screening (HHRS) using appropriate human health risk-based screening values and MCB Camp Lejeune background concentrations (for inorganics only). The first phase also included a risk ratio evaluation. If either of the media indicated the potential for unacceptable human health risks based on the preliminary HHRS, that medium was carried forward to the second phase of the risk evaluation. The second phase of the risk evaluation was a complete Human Health Risk Assessment (HHRA). Only those media that showed the potential for human health risks based on the first phase were carried forward to the second phase of evaluation.

The data evaluated during both phases of the risk assessment are presented in **Appendix D**, and the samples are identified on **Table 4-1**. Soil (both surface and subsurface combined) and groundwater analytical data for samples were evaluated in the risk assessment. The data included in the risk evaluation were all validated. The validated data were evaluated to determine the reliability of the data for use in the HHRA. A review of the data identified the following criteria for data usability:

- Estimated values flagged with a J, J+, or J- qualifier were treated as detected concentrations.
- Data qualified with an R (rejected) were not used in the risk assessment.
- Data qualified with a B (blank contamination) were used in the risk assessment as if the constituents were not detected, with the blank-related concentrations of each constituent used as the sample detection limit.
- For duplicate samples, the maximum concentration between the two samples was used as the sample concentration.
- Unfiltered groundwater samples were analyzed in the Phase I and Phase II risk evaluations following USEPA Region IV guidance (USEPA, 2000).

## 4.1 Human Health Conceptual Site Model

The human health conceptual site model (CSM) presents an overview of site conditions, potential contaminant migration pathways, and exposure pathways to potential receptors. The human health CSM for combined soil (includes both surface soil and subsurface soil) and groundwater at Gun Position 41 is presented in **Figure 4-1**. **Table 1** in **Appendix F** summarizes the potential exposure pathways and scenarios considered. **Section 1.2** presents the site history and setting.

As public access to Gun Position 41 is restricted, current receptors include military personnel and construction workers. Based on the nature of the current site use, current receptors could come in contact with surface soil. Potential future receptors include future residents, construction workers, and military personnel (the most likely receptor based on planned future site use). Future receptors could be exposed to soil if future residential houses or industrial buildings or piping are constructed at the site and the soil is re-worked, bringing the subsurface soil to the surface. Exposure routes include incidental ingestion of and dermal contact with the soil, and inhalation of particulate emissions from soil.

Potable water supplies for MCB Camp Lejeune and the surrounding residential area are provided by water supply wells that pump groundwater from the Castle Hayne aquifer. Although freshwater is present within the surficial, Castle Hayne, Beaufort, and Peedee aquifers, all of which are located below MCB Camp Lejeune, only the Castle Hayne aquifer is used by MCB Camp Lejeune as a water supply source (Cardinell et al., 1993). There are no active water supply wells within a 4.8 mile radius of the Gun Position 41. The groundwater use patterns are already established for the Base and area around Gun Position 41, thus use of site groundwater for industrial or residential purposes is unlikely. However, state and federal governing policies assume that underground fresh water resources are potable, and should be aimed to be maintained as such. Therefore, a potable use scenario was evaluated in this risk assessment. The potable use scenario was evaluated for a future adult resident of the barracks on base (the most likely future residential receptor for potable groundwater). Additionally, construction workers could be exposed to the shallow groundwater during construction activities, and future residents (children and adults) could use the groundwater as a potable water supply if Gun Position 41 is developed for future residential use not associated with barracks. The residents would be exposed through ingestion and dermal contact while bathing. Additionally, due to the groundwater depth (less than 10 ft bgs), construction workers could be exposed to the groundwater by dermal contact in an excavation during construction activities. There were no VOCs detected in the groundwater, therefore, inhalation of volatiles from groundwater while showering or from an open excavation is not a complete pathway.

Because VOCs are not anticipated to be present in soil or groundwater at Gun Position 41 based on past use of the site, the following exposure pathways were not considered to be of concern and were not evaluated in the risk assessment.

- Vapor intrusion into current or future buildings
- Inhalation of volatiles from groundwater while showering
- Inhalation of volatiles from an open excavation

## 4.2 Phase I - Human Health Risk-Based Screening and Risk Ratio Evaluation

The methodology and results of the human health risk based screening and risk ratio evaluation are described below.

## 4.2.1 Methodology

The HHRS was conducted in three steps using a risk ratio technique (Navy, 2000). If constituents of potential concern (COPCs) were identified after Step 1, the COPCs were evaluated in Step 2. If COPCs were identified after Step 2, the COPCs were evaluated in Step 3. The three-step screening process is described below:

### Step 1

The maximum detected constituent concentrations for each medium were compared to human health Regional Screening Levels (RSLs) (USEPA, 2008a) and two times the mean background concentration (for inorganics only). RSLs based on noncarcinogenic effects were divided by 10 to account for exposure to multiple constituents (i.e., were adjusted to a hazard quotient (HQ) of 0.1, from the HQ of 1.0 used on the RSL table). RSLs based on carcinogenic endpoints were used as presented in the RSL table, and are based on a carcinogenic risk of  $1 \times 10^{-6}$ .

The soil data were compared to residential soil RSLs. Although construction workers and industrial workers are potential receptors for soil (see Section 4.1) in addition to residential receptors, the soil data were only screened against residential soil RSLs. Residential soil RSLs are more conservative (i.e., lower) than the industrial soil RSLs, and are therefore protective of the industrial worker and construction worker. The groundwater data were compared to tap water RSLs. Groundwater data were also compared to USEPA maximum contaminant levels (MCLs) (USEPA, 2003a) and the NCGWQS (NCDENR, 2006); however, these comparisons were not used to identify the groundwater COPCs to carry forward to Step 2.

If the maximum detected concentration exceeded the appropriate RSL and background concentration (for inorganics only), the analyte was identified as a COPC and the screening levels risk evaluation proceeded to Step 2.

### Step 2

For constituents identified as COPCs in Step 1, a corresponding risk level value was calculated using the following equation:

$$\text{corresponding risk level} = \frac{\text{concentration} \times \text{acceptable risk level}}{\text{RSL}}$$

The concentration is the maximum detected concentration (the same concentration that was used in Step 1). The acceptable risk level is 1 for noncarcinogenic COPCs and  $10^{-6}$  for carcinogenic COPCs. RSLs based on noncarcinogenic effects were not adjusted by 10 as was done in Step 1, they are used as presented in the USEPA RSL table. The corresponding risk level for each COPC is calculated using the equation above. All of the corresponding risk levels for each COPC within a medium are summed to calculate the cumulative corresponding hazard index (HI) (for noncarcinogens) and cumulative corresponding carcinogenic risk (for carcinogens). A cumulative corresponding HI is also calculated for each target organ/critical effect. If the cumulative corresponding HI for a target organ/critical effect is greater than 0.5, or the cumulative corresponding carcinogenic risk is

greater than  $5 \times 10^{-5}$ , the constituents contributing to these values are retained as COPCs and carried forward to Step 3.

### Step 3

A corresponding risk level was calculated as discussed above for Step 2, however, the 95 percent upper confidence limit (95 percent upper confidence level [UCL]) was used in place of the maximum detected concentration, if more than five samples were available for that media, to obtain a more site-specific risk ratio. If the cumulative corresponding HI by target organ/effect is greater than 0.5, or the cumulative corresponding carcinogenic risk is greater than  $5 \times 10^{-5}$ , then constituents contributing to these values are considered COPCs.

The most current version of the ProUCL software program (USEPA, 2007), was used to test the data distribution and calculate 95-percent UCL exposure point concentrations used for the Step 3 risk ratio calculations. In cases where there was less than five samples in the data set, or the recommended UCL exceeded the maximum detected concentration, the maximum concentration was used as the exposure point concentration (EPC).

## 4.2.2 Results

### Soil

*Step 1:* **Table 2.1, Appendix F**, shows the results of the Step 1 screening. Arsenic was retained as a COPC for soil, therefore, arsenic was carried forward to Step 2.

*Step 2:* Step 2 risk ratio screening for soil, shown on **Table 2.1a, Appendix F**, eliminated arsenic from consideration as a COPC. The cumulative corresponding cancer risk of  $4 \times 10^{-6}$  is below the target level of  $5 \times 10^{-5}$ . Therefore, exposure to soil would not be expected to result in any unacceptable human health risks and no further evaluation for soil is necessary based on potential human exposure and risk.

### Groundwater

*Step 1:* **Table 2.2, Appendix F**, shows the results of the Step 1 screening. Arsenic, chromium, and lead were retained as COPCs and carried forward to Step 2.

*Step 2:* Step 2 risk ratio screening for groundwater, **Table 2.2a, Appendix F**, did not eliminate any of the COPCs. The cumulative corresponding cancer risk of  $4.2 \times 10^{-4}$  (based on arsenic) is above the target level of  $5 \times 10^{-5}$ , and the cumulative corresponding HI of 0.6 (based on chromium) is above the target level of 0.6. Lead is not evaluated using risk ratio screening as lead risks are not evaluated using toxicity criteria, as described below, therefore, lead was retained as a COPC.

*Step 3:* Step 3 was not performed as only four groundwater samples were available, and a 95 percent UCL could not be calculated.

Residential exposure to lead was evaluated based on the USEPA's Integrated Exposure/Uptake Biokinetic (IEUBK) model (USEPA, 2005). The principal assumption associated with the use of the IEUBK model is that a child from age 0 to 6 years is the receptor for potential exposure to lead (in this case, lead in drinking water). The concentration of lead in drinking water was hypothetically assumed to be the same as that detected in the groundwater. With the exception of the lead drinking water concentration

(which was set to equal the mean concentration of lead detected in the unfiltered groundwater), the default parameters associated with the IEUBK model were used. The results of the model (distribution probability plots) are presented in **Appendix F**.

The predicted geometric mean blood lead level for a young child exposed to lead in the unfiltered groundwater is 5 micrograms lead per deciliter of blood, with 6.9 percent of the population potentially experiencing concentrations exceeding 10 micrograms per deciliter ( $\mu\text{g}/\text{dL}$ ). These results indicate that if the unfiltered groundwater were to be used as a potable water supply in the future, the percent of the exposed population with a blood lead level exceeding 10  $\mu\text{g}/\text{dL}$  (e.g., 6.9 percent) exceeds the percentage level considered by USEPA to be protective of human health (e.g., 5 percent).

The IEUBK model indicates potable use of unfiltered groundwater could result in exposure to lead above levels considered by USEPA to be protective of human health (USEPA, 2005). However, it is unlikely that residential children would be exposed to unfiltered groundwater because potable water is typically filtered.

### 4.3 Phase II - Human Health Risk Assessment

A HHRA was performed for groundwater, the only media with COPCs based on the Phase I human health-risk based screening and risk ratio evaluations. Supplemental information used in this HHRA, and the risk calculations, are presented in **Appendix F** and include the *Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments (RAGS Part D)* (USEPA, 2001a) tables, and additional supporting tables. Guidance documents used for preparing the risk assessment include *RAGS Part A* (USEPA, 1989), *RAGS Part D* (USEPA, 2001a), *RAGS Part E* (USEPA, 2004a), and *USEPA Region IV Supplemental Guidance to RAGS: Region IV Bulletins* (USEPA, 2000).

The primary objective of the HHRA was to assess the health risks associated with exposure to groundwater under current site conditions. The risk assessment is comprised of the following components:

- **Identification of Chemicals of Potential Concern** – Identification of the chemicals found onsite and selection of the COPCs. COPCs are the focus of the subsequent evaluation in the risk assessment.
- **Exposure Assessment** – Identification of the potential pathways of human exposure, and estimation of the magnitude, frequency, and duration of these exposures.
- **Toxicity Assessment** – Compilation of the toxicity values used for developing numerical risk estimates for the COPCs.
- **Risk Characterization** – Integration of the results of the exposure and toxicity assessments to develop numerical estimates of health risks.
- **Uncertainty Assessment** – Identification and discussion of sources of uncertainty in the risk assessment.

### 4.3.1 Identification of COPCs

Groundwater data were quantitatively evaluated in the risk assessment. The samples evaluated in the risk assessment are identified in **Table 4-1**. Unfiltered groundwater samples were analyzed in the risk assessment following USEPA Region IV guidance (USEPA, 2000).

The COPC screening is presented in **Table 2.2** in **Appendix F**. The methodology used to select the COPCs for quantitative evaluation in the HHRA was the same as Step 1 of the Phase I risk screening evaluation.

**Table 4-2** identifies the chemicals that were selected as COPCs for groundwater. Arsenic, chromium, and lead were each identified as a COPC.

### 4.3.2 Exposure Assessment

Exposure assessment is the estimation of the likelihood, magnitude, frequency, duration, and routes of exposure to a chemical. Exposure refers to the potential contact of a receptor with a chemical. Exposure can occur when contaminants migrate from a source to an exposure point, or when a receptor comes into direct contact with contaminated media.

The three components of exposure assessment include:

- Characterization of exposure setting
- Identification of exposure pathways
- Quantification of exposure

#### Characterization of Exposure Setting

A descriptions and the history of Gun Position 41 is included in Sections 1.2. **Table 4-3** summarizes the receptors that may be exposed to groundwater in the future. The surficial aquifer groundwater is not currently used as a water supply for MCB Camp Lejeune, and therefore, there is no current exposure to groundwater.

#### Identification of Exposure Pathways

An exposure pathway can be described as the physical course that a COPC takes from the point of release to a receptor. To be complete, an exposure pathway must have all of the following components:

- A source (e.g., constituent residues in soil)
- A mechanism for chemical release and migration (e.g., leaching)
- An environmental transport medium (e.g., groundwater)
- An exposure point (e.g., potable use of the groundwater)
- A route of intake (e.g., ingestion of groundwater used as a drinking water source)

In the absence of any one of these components, an exposure pathway is considered incomplete and, by definition, there is no risk or hazard. In some cases, a receptor may contact a source directly, eliminating the release and transport pathways.

The potential exposure pathways for groundwater are shown in **Table 4-3** and **Table 1, Appendix F**. There is no current exposure to groundwater at Gun Position 41. The potential exposure pathways for future land use include:

- Resident (adult resident of barracks, and adult and child longer term resident): ingestion of groundwater, and dermal contact with groundwater while showering/bathing.
- Construction Worker: dermal contact with groundwater during excavation and construction activities.

### Quantification of Exposure

Exposure is quantified by estimating the EPCs of COPCs in environmental media and COPC intake by the receptor.

### Exposure Concentrations

EPCs are estimated constituent concentrations that a receptor may contact and are specific to each exposure medium. EPCs may be directly measured or estimated using environmental fate and transport models. Constituent concentrations in groundwater were measured and no fate and transport modeling was performed for the risk evaluation.

USEPA Region IV guidance (USEPA, 2000) directs that the EPCs for groundwater should be the arithmetic average of the COPC concentrations detected in the wells that are within the most contaminated part of the plume. There is no plume identified at Gun Position 41 based on the four groundwater samples collected at the site. Therefore, as a conservative evaluation of risk, the maximum detected concentrations were used as the reasonable maximum exposure (RME) EPCs. The arithmetic average concentrations from the four temporary monitoring wells were used as the central tendency exposure (CTE) EPC.

**Tables 3.1.RME** and **3.1.CTE** in **Appendix F** present the EPCs for the COPCs.

### Estimation of Chemical Intakes

Chemical intake is the amount of the chemical constituent entering the receptor's body. The quantification of exposure is based on an estimate of the average daily intake, the average amount of the chemical contaminant entering the receptor's body per day. Chemical intakes are generally expressed as follows:

$$ADI = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

Where:

- ADI = average daily intake (milligrams per kilogram per day [mg/kg-day])
- C = chemical concentration (milligrams per liter [mg/L], mg/kg)
- CR = contact rate (liters per day [L/day], milligrams per day [mg/day])
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- BW = body weight (kg)
- AT = averaging time (days)

The intake equation requires exposure parameters that are specific to each exposure pathway. Many of the exposure parameters have default values, which were used for this assessment. These assumptions, based on estimates of body weights, media intake levels, and exposure frequencies and duration, are provided in USEPA guidance. Both RME and CTE exposure parameters were compiled. CTE risks were only calculated for scenarios where the RME risk was greater than USEPA's non-carcinogenic HI of 1 or above USEPA's carcinogenic risk target range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$ . **Tables 4.1.RME and 4.1.CTE in Appendix F** identify the exposure parameters and intake equations for each of the scenarios evaluated in the risk assessment.

### 4.3.3 Toxicity Assessment

Toxicity assessment defines the relationship between the magnitude of exposure and possible severity of adverse effects, and weighs the quality of available toxicological evidence. Toxicity assessment generally consists of two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining the potential adverse effects from exposure to the constituent along with the type of health effect involved. Dose-response assessment is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the constituent administered or received and the incidence of adverse health effects in the exposed population. Toxicity criteria (e.g., reference doses and slope factors) are derived from the dose-response relationship.

The USEPA recommends that a tiered approach be used to obtain the toxicity values, the reference doses (RfDs) and cancer slope factors (CSFs), used to calculate non-cancer and cancer risks, respectively (USEPA, 2003b). The sources of toxicity values are as follows:

- The USEPA's Integrated Risk Information System (IRIS) database (USEPA, 2008b)
- The Provisional Peer Reviewed Toxicity Value (PPRTV) database maintained by the USEPA's National Center for Environmental Assessment (NCEA) and the Superfund Health Risk Technical Support Center (STSC)
- Other USEPA and non-USEPA sources including: NCEA, Agency for Toxic Substances and Disease Registry, Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997), California Environmental Protection Agency (Cal EPA), USEPA's Office of Water, and World Health Organization (WHO).

The use of provisional toxicity values, such as those from the PPRTV database, increases the uncertainty of the quantitative risk estimate.

USEPA-derived oral and inhalation chronic and subchronic RfDs, and associated uncertainty factors (UFs) and modifying factors (MFs), for the COPCs are listed in **Tables 5.1 and 5.2 in Appendix F**. USEPA-derived oral and inhalation CSFs are listed in **Tables 6.1 and 6.2 in Appendix F**.

Dermal RfDs and CSFs were estimated from oral RfDs and CSFs using an oral to dermal adjustment factor. This factor is designed to convert the orally administered dose toxicity factors to dermally absorbed dose toxicity factors (USEPA, 2004a). The oral RfDs were converted to dermal RfDs by multiplying by the oral to dermal adjustment factor

(gastrointestinal absorption [GI] factor) and the oral CSFs were converted to dermal CSFs by dividing by the GI absorption factor. If a chemical-specific GI absorption factor was not available or was greater than 50 percent, a GI absorption factor of 100 percent was assumed. The dermal RfDs are included in **Table 5.1, Appendix F**. The dermal CSFs are presented in **Table 6.1, Appendix F**.

#### 4.3.4 Risk Characterization

Risk characterization combines the results of the previous elements of the risk assessment to evaluate the potential health risks associated with exposure to the COPCs. The risk characterization is then used as an integral component in remedial decision-making and selection of potential remedies or actions, as necessary.

##### Noncarcinogenic and Carcinogenic Risk Estimation Methods

Potential human health risks are discussed independently for carcinogenic and noncarcinogenic constituents because of the different toxicological endpoints, relevant exposure duration, and methods used to characterize risk. Some constituents may produce both noncarcinogenic and carcinogenic effects, and were evaluated in both groups. The methodology used to estimate noncarcinogenic hazards and carcinogenic risks are described below.

Noncarcinogenic health risks are estimated by comparing the calculated intake to an RfD. The calculated intake divided by the RfD is equal to the HQ:

$$HQ = Intake / RfD$$

The intake and RfD represent the same exposure period (i.e., chronic or subchronic) and the same exposure route (i.e., oral intakes are divided by oral RfDs). A HQ that exceeds 1.0 (i.e., the intake exceeds the RfD) indicates that there is a potential for adverse health effects associated with exposure to that constituent.

To assess the potential for noncarcinogenic health effects posed by exposure to multiple constituents, a HI approach is used (USEPA, 1986). This approach assumes that noncarcinogenic hazards associated with exposure to more than one constituent are additive, and the HQs for individual constituents are added together. Synergistic or antagonistic interactions between constituents are not considered. The HI may exceed 1.0 even if all of the individual HQs are less than one. HIs are also added across exposure routes and media to estimate the total noncarcinogenic health effects to a receptor posed by exposure through multiple routes and media. A HI greater than one indicates that there is some potential for adverse noncarcinogenic health effects associated with exposure to the contaminants of concern, possibly warranting remedial action. However, if the HI is greater than one, the HI is calculated for each target organ/effect, to determine if the HI for a specific target organ/effect is greater than one. If the HI for each target organ/effect is not above one, it can be assumed that there is no unacceptable noncarcinogenic hazard to the receptor.

The potential for carcinogenic effects due to exposure to site-related constituents is evaluated by estimating the excess lifetime carcinogenic risk (ELCR). ELCR is the incremental increase in the probability of developing cancer during one's lifetime in

addition to the background probability of developing cancer. For example, an individual exposed to a carcinogen with a calculated cancer risk of  $2 \times 10^{-6}$  indicates that the probability of the individual getting cancer increases by 2 in a million above background levels.

Carcinogenic risk is calculated by multiplying the intake by the CSF.

$$ELCR = Intake \times CSF$$

The combined risk from exposure to multiple constituents was evaluated by adding the risks from individual constituents. Risks were also added across the exposure routes and media if an individual would be exposed through multiple routes and to multiple media.

When a cumulative carcinogenic risk to an individual receptor under the assumed RME exposure conditions at the site exceeds 100 in a million (i.e.,  $10^{-4}$  excess carcinogenic risk), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) generally requires remedial action to reduce risks at the site (USEPA, 1991). If the cumulative risk is less than  $10^{-4}$ , action generally is not required, but may be warranted if a risk-based chemical-specific standard (for example, MCL) is exceeded.

#### 4.3.5 Risk Assessment Results

The results of the risk characterization for groundwater are presented below by receptor. The risks are calculated in **Tables 7.1.RME through 7.5.RME** and **7.1.CTE through 7.4.CTE** in **Appendix F**. The risks are summarized in **Tables 9.1.RME through 9.5.RME** and **9.1.CTE through 9.4.CTE** in **Appendix F**. A summary of the RME results is shown in **Table 4-4** and a summary of the CTE results is shown in **Table 4-5**. CTE risks were calculated only when the RME hazard exceeded 1 or the RME carcinogenic risk exceeded  $10^{-4}$ .

##### Future Adult Barracks Resident, Noncarcinogenic Hazard (Table 9.1.RME and 9.1.CTE, Appendix F)

The risk assessment assumed that a future adult resident living at barracks on Gun Position 41 (shorter duration than a traditional resident) could be exposed to groundwater used as a potable water supply through ingestion and dermal contact while showering. The RME noncarcinogenic hazard (HI = 2.5) exceeds USEPA's target HI of 1. The RME hazard is primarily associated with ingestion of arsenic (HQ = 1.7). The RME carcinogenic risk (CR =  $4.4 \times 10^{-5}$ ) is within USEPA's target risk range of  $10^{-6}$  to  $10^{-4}$ . The CTE noncarcinogenic hazard (HI = 0.5) is below USEPA's target HI of 1.0.

##### Future Adult Resident (Tables 9.2.RME and 9.2.CTE, Appendix F)

The risk assessment assumed that a future adult resident could be exposed to groundwater used as a potable water supply through ingestion and dermal contact while showering. The RME noncarcinogenic hazard (HI = 2.5) is greater than USEPA's target HI of 1. Carcinogenic risks were not calculated for an adult resident but were calculated for a lifetime resident, following USEPA guidance. The CTE noncarcinogenic hazard (HI = 0.5) is below USEPA's target HI of 1.0.

### Future Child Resident, Noncarcinogenic Hazard (Tables 9.3.RME and 9.3.CTE, Appendix F)

The risk assessment assumed that a future child resident could be exposed to groundwater used as a potable water supply through ingestion and dermal contact while bathing. The RME noncarcinogenic hazard (HI = 6.1) is greater than USEPA's target HI of 1. The RME hazard is primarily associated with ingestion of arsenic (HQ = 4.0) and chromium (HQ = 1.3). Carcinogenic risks were not calculated for a child resident but were calculated for a lifetime resident, following USEPA guidance. The CTE noncarcinogenic hazard (HI = 1.6) exceeds USEPA's target HI of 1. The CTE noncarcinogenic hazard is primarily associated with ingestion of arsenic, which contributes an HQ of 1.2.

### Future Lifetime Resident, Carcinogenic Risk (Table 9.4.RME and 9.4.CTE, Appendix F)

Carcinogenic risks were not calculated individually for an adult or child resident but were calculated for a lifetime resident, following USEPA guidance. The risk assessment assumed that a lifetime resident could be exposed to groundwater used as a potable water supply through ingestion and dermal contact while showering. The carcinogenic risk from exposure to the groundwater (CR =  $4.2 \times 10^{-4}$ ) exceeds USEPA's acceptable cancer risk range of  $10^{-6}$  to  $10^{-4}$ . The risk is associated with the ingestion of arsenic ( $4.2 \times 10^{-4}$ ), the only carcinogenic COPC. The CTE carcinogenic risk ( $6.8 \times 10^{-5}$ ) is within USEPA's target risk range.

### Future Construction Worker (Table 9.5.RME, Appendix F)

The risk assessment assumed that a future construction worker could be exposed to groundwater in an excavation through dermal contact during excavation and construction activities. The RME noncarcinogenic hazard (HI = 0.0083) is below USEPA's target HI of 1.0. The RME carcinogenic risk ( $1.1 \times 10^{-8}$ ) is below USEPA's target risk range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$ .

### Lead Evaluation (Appendix F)

The maximum detected concentration of lead exceeded the screening level, and therefore lead was retained as a COPC. Risks associated with exposure to lead are not evaluated in the same manner as risks associated with exposure to the other groundwater COPCs because there are no toxicity values for lead. Residential exposure to lead was evaluated using the USEPA's IEUBK model (discussed in Section 4.2.2) (USEPA, 2005). The IEUBK model indicates potable use of unfiltered groundwater could result in exposure to lead above levels considered by USEPA to be protective of human health.

## 4.3.6 Uncertainty Associated with Human Health Assessment

The risk measures used in human health risk assessments are not fully probabilistic estimates of risk, but are estimates based on a set of assumptions about exposure and toxicity. Thus it is important to specify the assumptions and uncertainties inherent in the risk assessment to place the risk estimates in proper perspective (USEPA, 1989).

### General Uncertainty in COPC Selection

The general assumptions used in the COPC selection process were conservative to ensure that true COPCs were not eliminated from the quantitative risk assessment and that the

highest possible risk was estimated. Residential screening levels were used to select the COPCs for all of the scenarios evaluated in the HHRA, including non-residential scenarios.

### Uncertainty Associated with Exposure Assessment

Uncertainty in the exposure assessment was generally treated with conservative decision rules and assumptions, and therefore, the uncertainty likely overestimates actual exposure to COPCs. Several exposure pathways evaluated by this HHRA, such as potable use of groundwater, are hypothetical and are not anticipated to exist in the future. It is not likely that the surficial aquifer groundwater will ever be used as a potable water supply.

The exposure factors used for the quantitation of exposure were conservative and reflect worst-case or upper-bound assumptions on the exposure. The reliability of the values chosen for the exposure factors also contributes substantially to the uncertainty of the resulting risk estimates. Because most of the exposure factors are worst-case or upper-bound assumptions, the resulting risks are worst-case and likely overestimate the actual risk.

The maximum detected concentrations for the groundwater data were used as the EPCs for the groundwater COPCs. This overestimates the actual risk, as the maximum detected concentration of the COPCs did not occur in the same samples. The unfiltered inorganic data was used in the risk assessment, following USEPA Region IV guidance. It is likely that the inorganic concentrations in a developed potable water supply well would be more like the filtered inorganic data than the unfiltered data, and therefore, use of the unfiltered data may overestimate any risks associated with use of the groundwater as a potable water supply.

Concentrations are expected to decrease with time due to naturally occurring attenuation processes (e.g., advection, dispersion, leaching due to infiltrating precipitation). The risk assessment assumed concentrations would remain constant throughout the exposure period and that these concentrations occur everywhere throughout Gun Position 41; this most likely overestimates the risk.

### Uncertainty Associated with Toxicity Assessment

Uncertainty associated with the noncarcinogenic toxicity factors is included in **Tables 5.1** and **5.2** in **Appendix F**. Several UFs were applied by USEPA to extrapolate dose points from animal studies to humans. The UFs for the COPCs range between 3 and 300. Additional modification factors are also used based on the professional judgment of the USEPA. Therefore, there is a high degree of uncertainty in the noncarcinogenic toxicity criteria based on the available scientific data for each constituent. The noncarcinogenic toxicity factors are most likely an overestimate of actual toxicity.

The uncertainty associated with CSFs is mostly associated with the low dose extrapolation where carcinogenicity at low doses is assumed to be a linear response. This is a conservative assumption, which introduces a high uncertainty into slope factors that are extrapolated from this area of the dose-response curve. The CSFs are based on the assumption that there is no threshold level for carcinogenicity; however, most of the experimental studies indicate existence of a threshold level. Therefore, CSFs developed by USEPA represent upper bound estimates. Carcinogenic risks generated in this assessment should be regarded as an upper bound estimate on the potential carcinogenic risks, rather than an accurate representation of

carcinogenic risk. The true carcinogenic risk is likely to be less than the predicted value (USEPA, 1989).

Additional uncertainty is in the prediction of relative sensitivities of different species of animals and the applicability of animal data to humans.

There is a large degree of uncertainty associated with the oral to dermal adjustment factors (based on constituent-specific gastrointestinal absorption factors) used to transform the oral RfDs and CSFs based on administered doses to dermal RfDs and CSFs based on absorbed doses. It is not known if the adjustment factor results in an underestimation or overestimation of the actual toxicity associated with dermal exposure.

### Uncertainty in Risk Characterization

The uncertainties identified in each component of risk assessment ultimately contribute to uncertainty in risk characterization.

## 4.4 Human Health Risk Summary

The human health risk evaluation for soil and groundwater at Gun Position 41 was performed in two phases. The Phase I evaluation indicated that exposure to soil would not result in any COPCs; therefore, exposure to soil would not be expected to result in any unacceptable human health risks and no further evaluation of soil is necessary based on human health risks. The Phase I evaluation indicated the potential for risks associated with exposure to groundwater; therefore, groundwater was evaluated in Phase II.

Phase II (the HHRA) evaluated risk related to exposure to the surficial aquifer groundwater for future adult barrack residents, adult and child longer term traditional residents, and construction workers. **Tables 9.1.RME through 9.5.RME and 9.1.CTE through 9.4.CTE in Appendix F** summarize the RME and CTE cancer risks and noncarcinogenic hazard indices. Potential future contact with groundwater by these receptors may result in RME noncarcinogenic hazards above USEPA's target HI for:

- Adult long term traditional residents because of exposure to arsenic
- Child long term traditional residents because of exposure to arsenic and chromium

The CTE noncarcinogenic hazards for the adult barrack resident and adult longer term resident are below USEPA's target HI. However, the CTE noncarcinogenic hazard for the future child resident is above USEPA's target HI, associated with exposure to arsenic. The RME carcinogenic risk to a future longer term resident (not adult resident of barrack) from exposure to groundwater also exceeds USEPA's acceptable risk range, associated with arsenic; the CTE carcinogenic risk is within the acceptable risk range. Arsenic was detected in all of the groundwater samples (in both the unfiltered and filtered samples) at fairly similar concentrations. Three out of the four samples had detected concentrations above the background concentration, and all four samples had detected concentrations above the RSL.

Lead was also retained as a COPC for groundwater. The IEUBK model indicated risks associated with exposure to lead in groundwater used as a drinking water supply would exceed levels considered by USEPA to be protective of human health (USEPA, 2005).

Potential future contact with groundwater by construction workers would not result in any noncarcinogenic hazards or carcinogenic risks above USEPA target levels.

**TABLE 4-1**  
 Summary of Samples Evaluated in Phases I and II of the Human Health Risk Evaluation  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Medium	Date of Sampling	Sample	Parameters
<b>Combined Surface and Subsurface Soil</b>	04/15/08	ASR2.212-GP41-DU01-SS01	Explosives, Metals
	04/16/08	ASR2.212-GP41-DU01-SS02	Explosives, Metals
	04/16/08	ASR2.212-GP41-DU01-SS03	Explosives, Metals
	04/16/08	ASR2.212-GP41-DU02-SS01	Explosives, Metals
	04/16/08	ASR2.212-GP41-DU02-SS01D <sup>a</sup>	Explosives, Metals
	04/16/08	ASR2.212-GP41-DU02-SS02	Explosives, Metals
	04/16/08	ASR2.212-GP41-DU02-SS03	Explosives, Metals
	04/16/08	ASR2.212-GP41-DU03-SS01	Explosives, Metals
	04/16/08	ASR2.212-GP41-DU03-SS01D <sup>b</sup>	Explosives, Metals
	04/17/08	ASR2.212-GP41-DU03-SS02	Explosives, Metals
	04/17/08	ASR2.212-GP41-DU03-SS03	Explosives, Metals
	04/17/08	ASR2.212-GP41-DU04-SS01	Explosives, Metals
	04/17/08	ASR2.212-GP41-DU04-SS02	Explosives, Metals
	04/17/08	ASR2.212-GP41-DU04-SS03	Explosives, Metals
	04/22/08	ASR2.212-GP41-IS01-1-3	Explosives, Metals
	04/21/08	ASR2.212-GP41-IS02-1-3	Explosives, Metals
	04/22/08	ASR2.212-GP41-IS03-1-3	Explosives, Metals
	04/22/08	ASR2.212-GP41-IS03D-1-3	Explosives, Metals
	04/21/08	ASR2.212-GP41-IS04-1-3	Explosives, Metals
	<b>Groundwater</b>	04/22/08	ASR2.212-GP41-TW01-2-12
04/22/08		ASR2.212-GP41-TW01D-2-12 <sup>c</sup>	Explosives, Metals (total and dissolved)
04/21/08		ASR2.212-GP41-TW02-2-12	Explosives, Metals (total and dissolved)
04/22/08		ASR2.212-GP41-TW03-2-12	Explosives, Metals (total and dissolved)
04/22/08		ASR2.212-GP41-TW04-2-12	Explosives, Metals (total and dissolved)

<sup>a</sup> Duplicate of sample ASR2.212-GP41-DU02-SS01D

<sup>b</sup> Duplicate of sample ASR2.212-GP41-DU03-SS01

<sup>c</sup> Duplicate of sample ASR2.212-GP41-TW01-2-12

**TABLE 4-2**  
Summary of COPCs for the Phase II Risk Evaluation  
*Former Gun Position 41A & 41B*  
*MCB Camp Lejeune, North Carolina*

<p style="text-align: center;"><b>Groundwater</b></p> <p style="text-align: center;">Arsenic</p> <p style="text-align: center;">Chromium</p> <p style="text-align: center;">Lead</p>
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**TABLE 4-3**

Phase II Human Health Risk Evaluation - Potentially Complete Human Health Exposure Pathways for Soil and Groundwater

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Land Use	Exposure Media	Potentially Exposed Populations	Exposure Route (Human Health)	Pathway Selected for Evaluation	Rationale
<b>Current</b>					
Residential	Groundwater	Residential	Ingestion and Dermal Contact	No	Groundwater not currently used as potable water supply.
<b>Future</b>					
Residential	Groundwater	Resident - Adult and Child	Ingestion, Dermal Contact and Inhalation	Yes	Although unlikely, if site used for future residential development, groundwater could be used as a water supply and residents could ingest, inhale, or have dermal contact with groundwater
Residential	Groundwater	Construction Worker	Dermal Contact	Yes	Construction worker may contact shallow groundwater during excavation activities.

**TABLE 4-4**

Summary of RME Cancer Risks and Hazard Indices for Groundwater

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-5</sup> and <10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-6</sup> and <10 <sup>-5</sup>	Hazard Index	Chemicals with HI>1
Future Adult Resident in Barracks	Groundwater	Ingestion	4.4E-05		Arsenic		2.3	Arsenic
		Dermal Contact	2.3E-07				0.25	
		Inhalation	NA				NA	
		Total	4.4E-05		Arsenic		2.5	Arsenic
Future Adult Resident	Groundwater	Ingestion	NA				2.3	Arsenic
		Dermal Contact	NA				0.25	
		Inhalation	NA				NA	
		Total	NA				2.5	Arsenic
Future Child Resident	Surface Soil	Ingestion	NA				5.3	Arsenic, Chromium
		Dermal Contact	NA				0.73	
		Inhalation	NA				NA	
		Total	NA				6.1	Arsenic, Chromium
Future Resident Child/Adult	Groundwater	Ingestion	4.2E-04	Arsenic			NA	
		Dermal Contact	2.4E-06			Arsenic	NA	
		Inhalation	NA				NA	
		Total	4.2E-04	Arsenic			NA	
Future Construction Worker Adult	Groundwater	Ingestion	NA				NA	
		Dermal Contact	1.1E-08				0.0083	
		Inhalation	NA				NA	
		Total	1.1E-08				0.0083	

**TABLE 4-5**

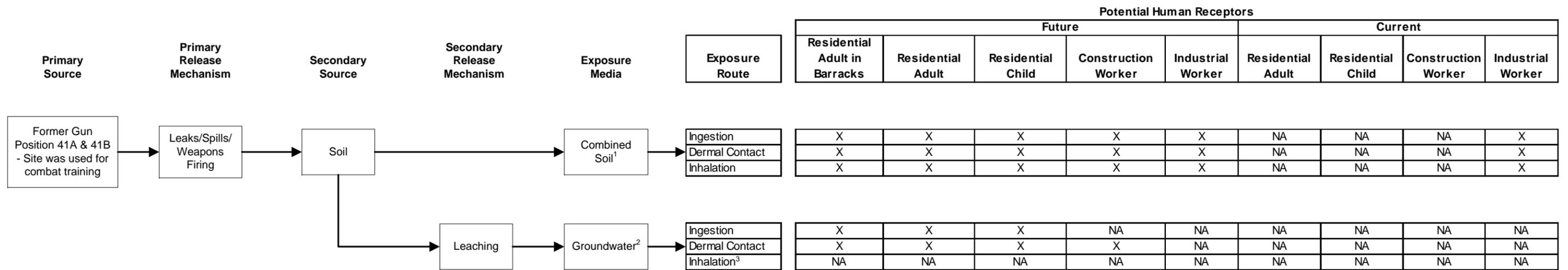
Summary of CTE Cancer Risks and Hazard Indices for Groundwater

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-5</sup> and <10 <sup>-4</sup>	Chemicals with Cancer Risks >10 <sup>-6</sup> and <10 <sup>-5</sup>	Hazard Index	Chemicals with HI>1
Future Adult Resident in Barracks	Groundwater	Ingestion	9.4E-06			Arsenic	0.47	
		Dermal Contact	3.0E-08				0.029	
		Inhalation	NA				NA	
		Total	9.4E-06			Arsenic	0.50	
Future Resident Adult	Groundwater	Ingestion	NA				0.47	
		Dermal Contact	NA				0.029	
		Inhalation	NA				N	
		Total	NA				0.50	
Future Resident Child	Groundwater	Ingestion	NA				1.6	Arsenic
		Dermal Contact	NA				0.07	
		Inhalation	NA				N	
		Total	NA				1.6	Arsenic
Future Resident Child/Adult	Groundwater	Ingestion	6.8E-05		Arsenic		NA	
		Dermal Contact	1.7E-07				NA	
		Inhalation	NA				NA	
		Total	6.8E-05		Arsenic		NA	

...



<sup>1</sup> includes both surface and subsurface soil  
<sup>2</sup> Complete risk evaluation for groundwater  
<sup>3</sup> Groundwater not analyzed for VOCs as they are not associated with historical site use  
 NA - Not Applicable or pathway is incomplete  
 X - Potentially complete exposure pathways

**FIGURE 4-1**  
 Conceptual Site Model for HHRA  
 Former Gun Position 41A & 41B  
 PA/SI Report  
 MCB Camp Lejeune  
 North Carolina

# Ecological Risk Screening

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Soil and groundwater data were screened for potential effects to the environment by comparing the maximum detected concentrations to effects concentrations published in scientific literature and ecological screening values (ESVs) from guidance documents. Because ecological receptors (earthworms, tree roots) may potentially be exposed to subsurface soils, the maximum detected concentration in all soil samples shallower than 5 ft bgs were used for this preliminary screening evaluation. Constituents that were not detected in any sample were not considered to present an unacceptable risk to the environment.

The majority of the values that soil data were screened against are conservative values meant to be protective of environmental resources that include soil microbes, earthworms, plants, and wildlife. Similarly, the screening values for groundwater are conservative values meant to be protective of aquatic organisms such as aquatic plants, aquatic invertebrates, and fish. Preference in selection of screening benchmarks was given to values published in guidance documents from regulatory agencies such as the USEPA or the NCDENR. For each medium, the maximum detected concentrations were compared to the screening value to derive a HQ. The benchmarks were identified as the lowest available from the following sources:

- *Region 4 Recommended Ecological Screening Values* (USEPA, 2001b)
- *National Recommended Water Quality Criteria* (USEPA, 2006)
- *Ecological Soil Screening Levels* (USEPA, 2008)
- *Guidelines for Performing Screening Level Ecological Risk Assessment within North Carolina* (NCDENR, 2003)
- *Division of Water Quality "Redbook", Surface Water and Wetlands Standards* (NCDENR, 2007)

There were 14 surface soil samples collected, including two duplicate samples, and five groundwater samples collected, including one duplicate sample. The screening results for each medium are discussed below. HQs are shown in parentheses.

## 5.1 Ecological Soil Screening

As shown on **Table G-1** in **Appendix G**, two analytes had maximum concentrations in excess of available screening values: lead (HQ = 1.25) and selenium (HQ = 1.44). The maximum concentrations of these inorganics were also greater than two times the mean MCB Camp Lejeune background surface soil concentrations (Baker, 2001).

Lead was detected in all 14 surface soil samples, while selenium was only detected in six of the 14 samples. Two of the 14 samples were duplicates and were not included in the

calculation of the average site concentration. The average site concentrations of these metals (using one-half the detection limit for non-detect data) were 8.24 mg/kg for lead and 0.6 mg/kg for selenium. These concentrations were less than or equal to the screening values (11 mg/kg for lead and 0.63 mg/kg for selenium). Based on this, no significant risks are anticipated for ecological receptor populations exposed to soils at Gun Position 41.

## 5.2 Ecological Groundwater Screening

As shown on **Table G-2** in **Appendix G**, two analytes had maximum concentration in excess of available screening values: lead (HQ = 10.64) and silver (HQ = 5.33). The closest surface water body to Gun Position 41 is a tributary to the New River that is approximately 0.3 miles away; because of the distance between Gun Position 41 and the nearest surface water body the lead and silver exceedances are not expected to pose a risk to populations of aquatic receptors.

The maximum concentration of silver was less than two times the mean MCB Camp Lejeune background groundwater concentration (Baker Environmental, 2002), while the maximum lead concentration was greater than the two times the mean background groundwater concentration. Lead was detected in all five samples. One of the five samples was a duplicate and was not included in the average site concentration. The average site concentration of lead exceeded the National Recommended Water Quality Criteria (NRWQC) of 2.5 µg/L (based on a hardness of 100 mg calcium carbonate per liter).

Lead concentrations exceeded the ESV in three of the four samples. However, risks to the aquatic environment are unlikely. First, the data used is for total metals. NRWQC are expressed as dissolved for most metals because the dissolved fraction is considered the most bioavailable. Second, aquatic organisms are not directly exposed to groundwater, thus concentrations in groundwater do not necessarily reflect concentrations to which aquatic organism would be exposed in the environment. In the absence of site-specific dilution factors for groundwater, Buchman (1999) recommends using of a dilution factor of 10 to account for the dilution expected during migration and upon discharge of groundwater to surface water. With a factor of 10, the maximum lead concentration would still exceed the ESV but would be less than two times the mean background groundwater concentration.

# Conclusions and Recommendations

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This section presents the conclusions from the investigation results, data evaluation, the human health risk assessment, and the ecological risk screening. Recommendations based on these conclusions are also presented.

## 6.1 Conclusions

### 6.1.1 MEC Intrusive Investigation

Out of a total of 895 geophysical anomalies that were intrusively investigated at Gun Position 41 no MEC was discovered; all items found were identified as either MD or CD. The MD recovered was typical for military training operations and only presents a minimal safety risk that does not require any additional munitions response action. While it is not possible to provide 100 percent assurance that all MEC items have been removed, the intrusive investigation performed does significantly reduce the risk of encountering MEC during future construction activities.

### 6.1.2 Environmental Investigation

An environmental investigation of surface soil, subsurface soil and groundwater did not detect the presence of explosives residues or perchlorate. However, several metals were detected at concentrations that exceeded regulatory standards in soil and groundwater; these exceedances are summarized below.

- In surface soil, arsenic was the only analyte that exceeded the Adjusted Residential Soil RSL and two times the mean background concentration. Mercury exceeded the NC SSLs in surface soil but did not exceed the Adjusted Soil RSLs or two times the mean background concentration. None of the detected analyte concentrations exceeded the Adjusted Industrial Soil RSLs.
- In subsurface soil, arsenic exceeded the Adjusted Residential Soil RSLs but did not exceed the NC SSL or two times the mean background concentration. Mercury also exceeded the NC SSLs in subsurface soil but did not exceed the Adjusted Soil RSLs or two times the mean background concentration. None of the detected analyte concentrations exceeded the Adjusted Industrial Soil RSLs.
- In groundwater, arsenic exceeded the Adjusted Tap Water RSL, the USEPA MCL, and two times the mean background concentration but did not exceed the NCGWQS. Chromium exceeded the NCGWQS and two times the mean background concentration but not the Adjusted Tap Water RSL or the USEPA MCL. Lead exceeded the NCGWQS, the USEPA MCL, and two times the mean background concentration but not the Adjusted Tap Water RSL.

### 6.1.3 Human Health Risk Assessment

The human health risk evaluation for Gun Position 41 was performed in two phases. No COPCs for soil were identified from the Phase I evaluation; therefore, exposure to soil would not be expected to result in any unacceptable human health risks and no further evaluation of soil for human health risk is necessary. The Phase I evaluation indicated the potential for risks associated with exposure to groundwater; therefore, groundwater was evaluated in Phase II. Phase II (the HHRA) evaluated risk related to exposure to the surficial aquifer groundwater for future adult barrack residents, adult and child longer term traditional residents, and construction workers.

The CTE noncarcinogenic hazards for the adult barrack resident and adult longer term resident are below USEPA's target HI. However, the CTE noncarcinogenic hazard for the future child resident is above USEPA's target HI, associated with exposure to arsenic. The RME carcinogenic risk to a future longer term resident (not adult resident of barrack) from exposure to groundwater also exceeds USEPA's acceptable risk range, associated with arsenic; the CTE carcinogenic risk is within the acceptable risk range.

Lead was also retained as a COPC for groundwater. The IEUBK model indicated risks associated with exposure to lead in groundwater used as a drinking water supply would exceed levels considered by USEPA to be protective of human health (USEPA, 2005).

Potential future contact with groundwater by construction workers would not result in any noncarcinogenic hazards or carcinogenic risks above USEPA target levels.

The future land use scenario evaluated in this assessment is conservative, since it is likely that land use will not change. Gun Position 41 is not currently residential, and future land use is expected to be industrial. Additionally, shallow groundwater at Gun Position 41 is not a current potable source, and it is not expected that it will be used as a potable water supply in the future because the Base already has established water supply wells that pump groundwater from the Castle Hayne aquifer (a deeper aquifer).

Exposure to arsenic in shallow groundwater used as a potable water supply was the main hazard identified from the HHRA for potential future receptors. The concentration of arsenic in the majority of the surface and subsurface soil samples was below two times the mean background concentration and the NC SSL which indicates that the concentrations of arsenic are most likely naturally occurring and there is no source of contamination to shallow groundwater. In addition, explosives residues and perchlorate were not detected in soil or groundwater which further indicates that historical activities at Gun Position 41 did not impact these media. For arsenic, the concentrations were below the NCGWQS in shallow groundwater and only one of four shallow groundwater samples exceeded the MCL (10 µg/L). The average arsenic concentration (8.55 µg/L) was below the MCL. The analytical results for metals that were above regulatory standards may be attributable to the high turbidity that was observed in the groundwater samples, which is typical for temporary wells.

Based on this information, no further evaluation of groundwater for human health risks is necessary.

### 6.1.4 Ecological Risk Screening

An ecological risk screening was performed for soil and groundwater, at Gun Position 41. Results of the ecological risk screening concluded that there are no significant risks anticipated for ecological receptors exposed to Gun Position 41 soil or groundwater.

## 6.2 Recommendations

An intrusive investigation was conducted to remove the source of all geophysical anomalies representing potential subsurface MEC at Gun Position 41; therefore, no further MEC investigations are recommended. The purpose of the intrusive investigation was to significantly reduce the risk of encountering subsurface MEC. However, because it is not possible to provide 100 percent assurance that all MEC items have been removed, it would be prudent to provide "3R" (Recognize, Retreat, Report) training to all workers who will be onsite during grading and excavation activities and to provide on-call support from MCB Camp Lejeune Explosive Ordnance Disposal (EOD) or a qualified UXO contractor for inspection and disposal of suspected MEC that may be unearthed during construction activities.

The environmental investigation was conducted to evaluate the presence of MC contamination and to evaluate risk to human health and ecological receptors. Explosives residues and perchlorate were not detected in soil or groundwater which indicates that historical activities at Gun Position 41 did not impact these media. The HHRA and the ecological risk screening conducted for Gun Position 41 concluded that soil and groundwater are not anticipated to pose any unacceptable risk to human health or ecological receptors; therefore, no further evaluation of soil or groundwater is recommended.

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**Appendix A**  
**Archival Records Search Report**

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# Appendix A

## Archival Records Search Report Former Gun Positions 41A & 41B

Marine Corps Base Camp Lejeune  
Jacksonville, North Carolina

Task Order 009

March 2008

Prepared for

Department of the Navy  
Naval Facilities Engineering Command  
Atlantic

Under the

Multi-Media  
Contract N62470-07-D-0501

Prepared by



**CH2MHILL**

Charlotte, North Carolina

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## Attachment

1	Resource Review Summary
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# Acronyms and Abbreviations

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°F	degrees Fahrenheit
asl	above sea level
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CTO	Contract Task Order
DGM	Digital Geophysical Mapping
HE	High-Explosive
MARSOC	Marine Special Operations Command
MC	Munitions Constituents
MCB	Marine Corps Base
MEC	Munitions and Explosives of Concern
MRP	Munitions Response Program
NARA	National Archives and Records Administration
PA/SI	Preliminary Assessment/ Site Inspection
UXO	Unexploded Ordnance
WWII	World War II

# Introduction, Purpose, and Scope

---

Marine Corps Base (MCB) Camp Lejeune is planning a military construction (MILCON) project in an area encompassing the Former Gun Positions 41A & 41B (Gun Position 41). The military construction plan consists of a Marine Special Operations Command (MARSOC) facility covering approximately 1,244 acres, four acres of which include the former location of Gun Position 41 (Figure 1-1). Due to the historical activities at Gun Position 41, potential impacts to soil and groundwater was assessed within this portion of the proposed MILCON area under the munitions response program (MRP).

To support the site investigation effort, this archival records search report has been prepared to provide a narrative of the historical activities at Gun Position 41 that may have resulted in environmental contamination with Munitions and Explosives of Concern (MEC) or munitions constituents (MC).

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. The scope of the report includes:

- A review of existing information about the site (including MCB Camp Lejeune maps, drawings, and reports, and interviews with MCB Camp Lejeune personnel).
- 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 Corps Library at Quantico, National Archives and Records Administration (NARA) map and text files, and MCB Camp Lejeune base files.

# Site Information

---

## A.2 Ownership and Operational History

### A.2.1 MCB Camp Lejeune Ownership History

The history of the land now occupied by MCB 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, 2007).

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.

### A.2.2 Gun Position 41

Gun Position 41, was identified in the Range Identification and Preliminary Range Assessment (USACE, 2001) as Archives Search Report (ASR) Site 2.212. The site is located on MCB Camp Lejeune, in the Stone Bay area east of Rifle Range Road (USACE, 2001).

An interview with the Base Safety specialist indicated that Gun Position 41 was established during the WWII and Korean War era as a training ground. A Howitzer, a type of artillery piece that is characterized by a relatively short barrel and the use of comparatively small explosive charges to propel projectiles at trajectories with a steep angle of descent, was positioned at Gun Position 41 and fired 105 mm and 155 mm ammunition into the K-2 and G-10 Impact Areas (see **Figure A-1 through A-3**). In addition, according to a former BSRO, other munitions including 4.2-inch mortars, 175 mm guns, 8-inch howitzers, and 120 mm mortars may have been fired at the Gun Position (Redmond, 2007). Live fire training ceased in the 1960s and then continued in the 1980s due to a change in training philosophy (Redmond, 2007). Until recently, the site continues to be used as a training ground, but no live fire training was conducted in this area. Training included the use of blanks and pyrotechnics. As a result of the usage and type of training conducted at the site, there should be no ground UXO; although, ammunition packaging, range residue, barbwire, and buried garbage may be present (Richardson, 2007).

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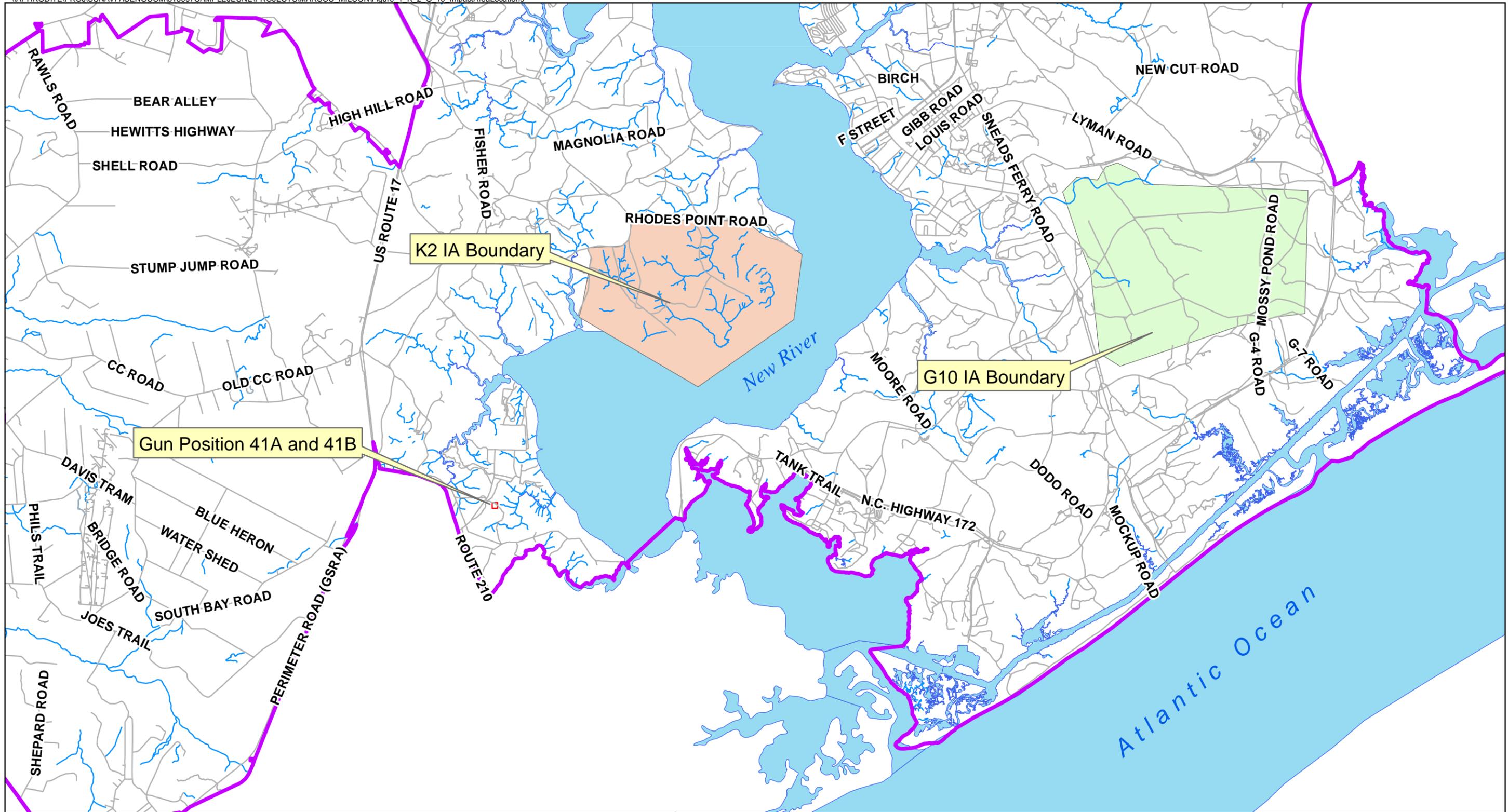
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## Figures

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- Legend**
- Road Centerline
  - Surface Water Course Centerline
  - ▭ Base Boundary
  - ▭ G10 IA Boundary
  - ▭ K2 IA Boundary
  - ▭ Surface Water Course Area
  - ▭ Former Gun Position 41A & 41B

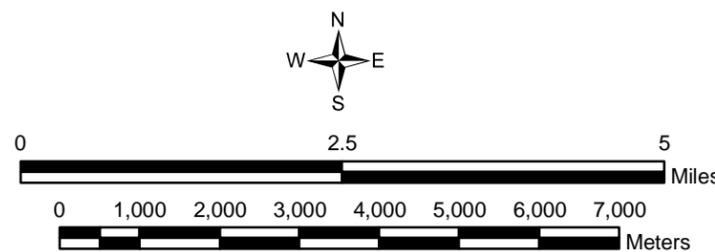


Figure A-1  
 K-2 and G-10 Impact Area Locations  
 Former Gun Position 41A & 41B  
 Proposed MARSOC MILCON Area  
 Camp Lejeune, North Carolina



**Figure A-2**  
105 mm Howitzer  
Former Gun Position 41A & 41B  
Proposed MARSOC MILCON Area  
Camp Lejeune, NC



155 mm



105 mm

**Figure A-3**  
105 mm and 155mm Howitzer Projectiles  
Former Gun Position 41A & 41B  
Proposed MARSOC MILCON Area  
Camp Lejeune, NC

**Attachment A**  
**Resource Review Summary**

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# Resource Review Summary

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

Resource	Actions Completed
Quantico, Virginia, Marine Corps Library, Gray Research Center	Reviewed all available file folders related to Camp Lejeune – No relevant files to copy.  Reviewed all available file photos related to Camp Lejeune – No relevant photos to copy.
US National Archives (NARA II) Historical Files	Reviewed text and drawing files from Text Division. Made copies of relevant files.  See US National Archives Files Review
Camp Lejeune Technical Records files	Reviewed and copied all relevant documents related to historical land use.

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### Camp Lejeune Personnel

Bob Lowder/Environmental	Contacted and interviewed
Linda Futrell/ Real Estate Expert	Contacted and interviewed
Anna Watts/ Technical Records	Contacted and interviewed
Carl Baker/ Technical Records	Contacted and interviewed
Duane Richardson/ Base Range Safety Officer	Contacted and interviewed

## Marine Corp Library Review

### Text Division

Contact: Annette Amerman

Site visit: November 1, 2007

File review at Marine Corps Base, Quantico, Virginia, Gray Research Center, Marine Corps Archives and Special Collections.

No pertinent documents were obtained from the file review.

## National Archives and Records Administration Review

### Text Division

Contact: Mr. Barry Zirby

Site visits: November 5 and 6, 2007

Reviewed 17 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.
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- 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, 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), Quartermaster, General Correspondence, January 1940, 215-4 to 215-6, Box 145.
- Record Group 127 (USMC), Correspondence Files of the Office of the Commandant, Headquarters Support Division Central Files Section, 1950-1958, Box 172.

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 MCB Camp Lejeune.

### List of Documents Obtained from National Archives

No pertinent documents were obtained from the file review.

## MCB Camp Lejeune Base Site Visit and Records Review

Base Contact: Mr. Bob Lowder, Environmental Management Division

File reviews of records in the base Technical Records office were conducted during the site visit. Additionally, interviews were conducted with Bob Lowder/Environmental Manager, Anna Watts/Technical Records, Carl Baker/Technical Records, and Duane Richardson/EOD Base Range Safety Officer.

### List of Documents Obtained from Camp Lejeune

#### Base Real Estate Office

- "Proposed Borrow Sites, Vicinity Map", 1992. NAVFAC Drawing 14854, Sheet 1 of 4.
- "Proposed Borrow Area, Camp Geiger", 1992. NAVFAC Drawing 14855, Sheet 2 of 4.

#### 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 Lejeune*, 2002, United States Marine Corps, Lt. Col Lynn J. Kimball (USMC, Retired) Consulting Historian.
- Lotfield, Thomas, C. Principal Investigator. UNCW, August 1981. *Archeological and Historical Survey of USMC Base, Camp Lejeune; Naval Facilities Engineering Command Norfolk, Coastal Zone Resource Corp., Vol. II, Contract No. N62470-79-C-4273.*

#### Environmental Office

No pertinent documents were obtained from the file review.

**Appendix B**  
**Soil Boring Logs, Well Construction Diagrams**  
**and Survey Data**

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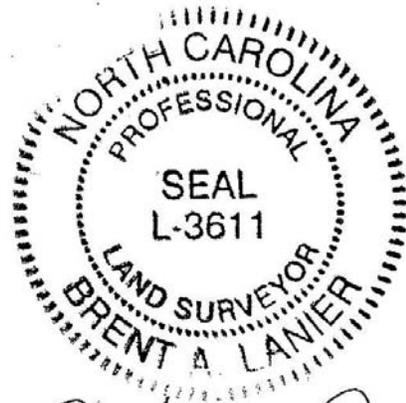






WELL ID	NORTHING	EASTING	PVC	GROUND
TW-01	3829432.021	275371.250	10.079	10.058
SB-01	3829446.071	275372.052		11.219
TW-02	3829402.231	275433.832	10.487	10.425
TW-04	3829372.587	275436.530	10.019	9.993
TW-03	3829375.781	275355.588	9.963	9.881

**BENCHMARK REF: NORTH CAROLINA GEODETIC NETWORK  
JACKSONVILLE CORS  
MOREHEAD CITY CORS  
CASTLE HAYNE CORS  
UTM ZONE 18 NORTH NAD 83 (NSRS 2007) METERS  
5/2/2008**



*Brent A. Lanier*  
5/2/08

Appendix C  
Geophysical Investigation Report

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GPR  
MAGNETICS  
ELECTROMAGNETICS  
SEISMICS  
RESISTIVITY  
UTILITY LOCATION  
UXO DETECTION  
BOREHOLE CAMERA  
STAFF SUPPORT

## GEOPHYSICAL INVESTIGATION REPORT

### **Focused Preliminary Assessment/Site Inspection Former Gun Positions 41A & 41B Marine Corps Base Camp Lejeune, North Carolina**

Dates of Investigation:

April 8<sup>th</sup> – April 12<sup>th</sup>, 2008

FINAL SUBMITTAL

November 20<sup>th</sup>, 2008

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## Plate

Plate 1: MARSOC Former Gun Position 41A\_41B Mosaic

## Appendices

Appendix A:	GPO Color Contour Maps
Appendix B:	Example EM61 QC Tests
Appendix C:	CD-ROM containing EM61 Data, Grid Maps, Target Lists

## **1 INTRODUCTION**

NAEVA Geophysics, Inc. was contracted by CH2M HILL to conduct digital geophysical mapping (DGM) of the former Gun Positions 41A & 41B Military Construction (MILCON) area at Marine Corps Base (MCB) Camp Lejeune, North Carolina. The site is located near the Stone Bay gate, east of Rifle Range Road and north of Route 210. Field operations were conducted from April 8<sup>th</sup> to April 12<sup>th</sup>, 2008.

The objective of the investigation was to locate Munitions and Explosives of Concern (MEC) within the MILCON area, resulting from historical use of the site as a firing point for 105mm and 155mm Howitzer projectiles. The site is part of a proposed MARSOC (Marine Special Operations Command) construction project. Prior to the commencement of mapping, a Geophysical Prove-Out (GPO) was completed for the purpose of establishing an appropriate anomaly targeting threshold and to test the effectiveness of the geophysical instrument.

## **2 METHODS**

A Geonics EM61-MK2 combined with a Trimble S6 Robotic Total Station (RTS) was used to map the area. The RTS was placed in locations best suited for line-of-sight tracking of the instrument after performing a spatial resection in order to calculate its position.

Most data were referenced by RTS during collection, with file names containing the grid name of the southwest corner of the designated grid block. To ensure efficient collection and full coverage, tapes were measured along the length of a grid setup and ropes with marks painted every 2.5 ft were stretched across the grid at intervals of 10 meters. A 50 meter Universal Transverse Mercator (UTM) grid system was pre-established and used for back-sighting points to the RTS. In areas of the site where numerous trees and thick vegetation obstructed line-of-site between the instrument and the RTS, measuring tapes and ropes were pulled from grid corners and measurements were triggered by an odometer wheel, with fiducial markers placed at known intervals along each line. The geophysical data were

collected along grid N-S and grid E-W oriented lines depending on the most efficient direction.

All daily logs, field notes, and sketches were input digitally into a Trimble GeoXT unit using CartoPac CE software. All point, line, and polygon sketches are geo-referenced to within approximately 1 to 3 meters. At the end of each day, the forms were uploaded for use in preprocessing the geophysical data.

## **2.1 Geonics EM61-MK2 Background**

The EM61-MK2 is a time-domain electromagnetic instrument designed to detect, with high spatial resolution, shallow ferrous and non-ferrous metallic objects. The applicability of the instrument for MEC detection has been widely demonstrated. The instrument consists of two air-cored coils (1 m x 0.5 m), batteries, processing electronics, and a digital data recorder. The larger of the two coils functions as the EM transmitter and receiver and is positioned below a second receiver coil. Secondary currents induced in both coils are measured in millivolts (mV). For this survey, the EM61 was set up to collect data from 4 time gates (channels) from the bottom coil.

The EM61 was operated in wheel mode with the bottom coil 40 cm above the ground surface. The EM61 data were recorded with an Allegro CX data logger and Geonics NAV61MK2 acquisition software, set to record data at a rate of 10 Hz. When not using RTS, a reading was triggered by the odometer wheel every 10 cm.

## **2.2 Trimble S6 RTS Background**

Trimble's S6 Robotic Total Station (RTS) was used to acquire positional data with the EM61-MK2. The S6 is a total station with the ability to track in real time the movement of a prism via a laser. The S6 consists of a "gun" (the base) and a 360° prism. The base is either set up over a known point and back-sighted to another known point or set up on an unknown point and back-sighted to two or more known points, called a resection. The latter method was used for all RTS setups at former Gun Position 41. The gun tracks the prism and the

positions are sent via radio to a handheld computer (Trimble TSC2) that sends a data string via a serial cable to the Allegro CX. The data is logged real time with the EM61-MK2 data into the NAV61MK2 program.

### **3 GEOPHYSICAL PROVE-OUT (GPO)**

The purpose of surveying a GPO is to demonstrate the effectiveness of all instrumentation, methods, and personnel prior to the initiation of fieldwork. Serial number identification was recorded for all instrumentation (i.e. data logger, coils, EM61 electronics), and the GPO was mapped using the same personnel, equipment, and methodologies employed for the DGM survey.

The GPO was located at the north end of the base near Knox Park. The dimensions were 40 feet by 200 feet. Though the UTM coordinate system in meters was used at the MARSOC site, since the GPO was originally established in survey feet it was mapped using the US State Plane system. A survey line spacing of 2.5 ft was used, the same as used for the mapping of the MARSOC site. This spacing results in coil overlap on successive lines, reducing the likelihood of data gaps and improving the chance of detecting small MEC items. The GPO had been seeded for previous work at MCB Camp Lejeune, so a background survey was not performed. The GPO was mapped twice, once using RTS and once by odometer with fiducial markers placed every 25 feet.

Processed data from Channel 2 were presented and selected for use in processing the data from the MARSOC area. Color contour maps of EM61-MK2 Channel 2 data from both the RTS and fiducial survey of the GPO with a targeting threshold of 3 mV are included in Appendix A. All GPO data can be found in the GPO folder on the included CD-ROM.

### **4 FIELD DATA ACQUISITION**

The mapped area of the former Gun Position 41 (the “site”) is approximately 4 acres. Over half of the site was open, but the rest was sparsely to thickly covered with trees. A steep

berm ran along the eastern boundary. In the center of the site was a raised mound of very thick vegetation bounded on both sides by steep gullies. The site was grubbed of vegetation and small trees prior to mapping, and the topography ranged from flat in the open to steep on the berms, with isolated mounds and ruts created by heavy machinery.

Data gaps are defined in the project Data Quality Objectives (DQOs) as any down-line gap larger than 2 feet, or when less than 98% of possible readings are collected along a line. Additionally, line spacing variance greater than 20% of the specified spacing constitutes a gap. Gaps in the data appear around either obstructions, such as trees, or around topographic features like mounds and trenches, where the RTS prism, mounted above the coil, moved to one side and created the appearance of a gap, even if no such physical coil gap existed. Several low areas where water had collected were deep enough to risk submerging the EM61 coil and were avoided. Major cultural and topographic features were documented using the Trimble GeoXT GPS-linked drawing capabilities and are noted on the grid maps. Though much of the vegetation on site was cut, it was not removed or chipped, which resulted in a higher number of gaps due to fallen trees. Efforts were made to clear grids of brush before mapping, but due to time constraints data collection took precedence.

## **5 QUALITY CONTROL DATA**

To establish confidence in the data reliability, Quality Control (QC) tests were conducted throughout the project. Tests were conducted prior to, during, and after all data collection sessions. All QC tests for the EM61-MK2 were conducted after a minimum 15 minute warm-up period for the electronics. Sample graphical displays of such QC data are included in Appendix B. All quality control data are included on the enclosed CD-ROM in Appendix C.

### **5.1 QC Test Descriptions and Acceptance Criteria**

1. **RTS Check:** Prior to data collection, the RTS prism was mounted on top of a pole and placed over a grid stake of known coordinates. The reported position was

compared to the actual location to check proper resection results. Positions within 10 cm were accepted.

2. **Personnel Test:** A personnel test was conducted each day with the coil in a stationary position. The test included briefly logging background response and the response while one team member operated the equipment and the other walked in the vicinity of the coil. The purpose was to demonstrate that clothing or objects carried by personnel had no effect on instrument response.
3. **Cable Shake Test:** Prior to beginning data collection, data were recorded with the coil held in a stationary position, and the cables and connections were tested for possible shorts by shaking them. The operator monitored the response for any spikes during the process.
4. **Static Background / Spike Test:** A location identified as having minimal response was designated as a calibration point. Readings were collected in a stationary position to ensure a stable response. Data were collected for a period of one minute with no object placed on the coil. After this, a board with a bolt drilled through the center was fitted onto the coil, and the instrument's response was observed. Data were recorded for one minute with the board in place. The board was then removed, and static readings continued for an additional minute. This test was performed at the beginning and end of the day, as well as between data sets to establish that the instrument was functioning properly, as indicated by a stable and repeatable response with no spikes or other anomalous activity. A response of  $\pm 20\%$  after background correction was acceptable.
5. **Latency Test:** Following the morning static test, an iron railroad spike was placed on the ground and data were collected as the instrument was moved back and forth along a line over the object. The proper latency and lag between the peak response of the instrument and the reported item location was then determined. When responses generated by an object merge as a single anomaly, the correct latency has been applied.
6. **Six Line Test:** On the first day of data collection, a six line test was conducted along a 50 foot line near the GPO. Line 1 was collected to the north with no test object, Line 2 to the south (along the same line) with no test object. Lines 3 and 4

followed the same pattern, though with a railroad spike placed at the midpoint. With the test object still in place, line 5 was collected to the north at a faster than normal pace, and Line 6 was collected to the south at a slower than normal pace. Acceptable criteria were peak response amplitude  $\pm 20\%$  and positional accuracy to  $\pm 20$  cm.

7. **Repeat Data:** Upon completion of the original collection of a data set, approximately 2% of the grid set was re-collected as a check of instrument repeatability and positioning. Since small deviations in line path can greatly affect instrument response, repeat lines were evaluated qualitatively rather than quantitatively.

## 5.2 QC Test Results

QC data were evaluated using Geosoft's QA/QC software. Static, spike, cable shake, and personnel test profiles were plotted with an acceptance criterion of  $\pm 2$  mV from the mean. Any readings outside this range were flagged on the profiles and an associated failure percentage was reported.

1. **RTS Check:** All daily checks of RTS positioning accuracy were within 10 cm.
2. **Personnel Test:** No deviation from background response was observed.
3. **Cable Shake Test:** No spikes were observed in any of the tests.
4. **Static Background / Spike Test:** Static and spike tests were within acceptance criteria; stable, repeatable, and without spikes.
5. **Latency Test:** Latency tests were plotted showing the line path and gridded response and were within tolerance.
6. **Six Line Test:** Latency corrected profiles were plotted to evaluate the effect of movement speed on response repeatability and positioning accuracy. Both amplitude and positioning were within tolerance.
7. **Repeat Data:** Repeat lines generally showed good repeatability upon visual inspection, though due to the difficulty of walking an identical line twice over, some lines deviated slightly in response and positioning.

## 6 DATA PROCESSING

The geophysical data were stored in an Allegro CX data logger and then downloaded into a laptop computer for review and editing. Using Geomar's TrackMaker software, .xyz files were created incorporating the RTS location information. When data were collected using the fiducial method, Geonics' DAT61MK2 software was used to position the data using line numbers and station increments. Once in-field review was completed, the data were transferred to NAEVA's Charlottesville, Virginia office for preprocessing, analysis/target selection, and final map production. Geosoft's Oasis Montaj software package was employed to process and contour the raw data, and to identify and characterize potential MEC targets by isolating peak amplitude responses.

## **6.1 Preprocessing**

Converted raw data files were imported into Geosoft's Oasis Montaj to perform the following:

- Conversion of local coordinates (if collected without RTS) to projected UTM coordinates
- Evaluation of data density
- Application of auto leveling and instrument drift corrections
- Application of default lag correction
- Generation of preliminary contour map(s) from gridded data
- Generation of formatted ASCII files containing preprocessed data by grid block
- Generation of Planimetric Map for tracking survey progress

## **6.2 Final Processing**

After completion of preprocessing, the data were further evaluated and processed to generate final processed data files. Final processing steps included:

- Evaluation and refinement of auto leveling and instrument drift corrections
- Evaluation and refinement of lag correction
- Additional digital filtering and enhancement, as necessary
- Targeting of data, as described below
- Splitting datasets into grid blocks and individual 50 m x 50 m grid files
- Generation of formatted ASCII files containing processed data by grid block
- Generation of final maps for each grid showing contoured, gridded data and target locations.

## **6.3 Analysis and Target Selection**

The UX-Detect module within Oasis Montaj identifies peak amplitude responses associated with, but not limited to, MEC items. Single-source anomalies may generate multiple target designations depending on shape and orientation. Initial target selections were made based on the gridded data. Data profiles corresponding to the anomalies selected by Geosoft were then analyzed by trained geophysicists, with the targets evaluated as to their validity and position. Targets found to be invalid or incorrectly located were removed or adjusted. Additionally, anomalies that were not selected by the UX-Detect module, yet deemed to represent a potential MEC target, were manually selected. All target selection was performed on final processed data from Channel 2 of the bottom coil of the EM61-MK2.

Final processed XYZ (ASCII) files were created by grid block, and individual geophysical maps and target lists were created for 50 m x 50 m grids, denoted by the SW corner of each grid. All anomalies that occurred at or above the targeting threshold of 3 mV were identified using an ID number. Each target list provides a Target ID, Grid Cell ID, Easting (x) and Northing (y) UTM (NAD83, Zone 18N, meters) Grid Plane coordinate location for each target, and the recorded peak response in millivolts. The target IDs were prioritized by designating the highest amplitude response as the number one target in each grid. In addition, targets were assigned a Type, a numerical value with “1” representing a legitimate target, “2” known culture, and “3” data gap targets (see Section 7).

Data delivery reports are included on the CD, with information on all steps of the survey from raw to processed data, including field survey forms, processing methods, and processor comments. Additional reports and documentation of the QC of preprocessing and processing stages were entered into the MRSIMS Project Database provided by CH2M HILL.

## **7 RESULTS**

Within the total surveyed area, 886 targets were selected at a threshold of 3 mV in Channel 2. See Plate 1 for the color contour mosaic of the entire site, showing the grid system, anomaly distribution, and major topographic and cultural features.

The open area outside the tree line contains the highest concentration of anomalies, especially in grids C3J1E8 (340 targets) and C3J1E9 (192 targets). Some are large in both response amplitude and size, indicating large pieces of metal close to the surface. A couple fence posts were observed on the surface, which may indicate the presence of similar construction-related debris in the subsurface. As former Gun Position 41 was a firing point rather than an impact area these anomalies could also represent larger munitions debris, such as projectile casings, that might be expected at such a site. The area within the tree line (see maps for approximate line) has comparatively few anomalies. Numerous foxholes were present along the tree line, indicating prior use as fighting positions. There is not a noticeable concentration of metal near these locations, though due to their steep nature no data were collected inside the holes.

Since there were no power lines or other utilities near the site cultural noise levels were quite low, allowing confident selection of low amplitude anomalies. Any suspected noise anomalies likely originated from stumps of trees striking the EM61 coil, which can create spikes in the data. However, these readings are often out of phase, and during the processing stage can be identified as not originating from metal in the ground.

Grid C3J1C8 and a portion of grid C3J1C9 in grid block C3J1C8 collected on the last day of field activities contained negative data spikes later discovered to have resulted from a loose cable. The data gaps created by these spikes did not meet the project DQOs and were analyzed in a Root Cause Analysis dated April 25, 2008. It was determined that gaps up to 0.75 meters would still detect small munitions items based on an examination of the GPO data. 9 gap locations larger than 0.75 meters were targeted with an anomaly type of "3" to be checked during reacquisition to make sure no munitions are missed. These locations are marked with a black triangle on the target maps instead of the standard red target triangle.

The ability to detect MEC items depends greatly on the possibility of larger objects hiding or masking smaller objects. In areas with large metallic objects the probability of detection decreases. However, as the level of surface metal for the majority of the site was low, it can

be assumed that most of the selected targets are legitimate. MEC at depths comparable to those in the GPO should be accurately detectable.

All raw, preprocessed, and processed EM61-MK2 data, EM61-MK2 QC data, project database, contoured maps and target lists for all grids, as well as a copy of this report are included on the CD (with accompanying readme.txt) in Appendix C.



**Figure 1: Grid setup with berm in background**



**Figure 2: Southern wooded area**



**Figure 3: Western wooded area**

## **Plate**

**Plate 1: MARSOC Former Gun Position 41A\_41B Mosaic**

## **Appendices**

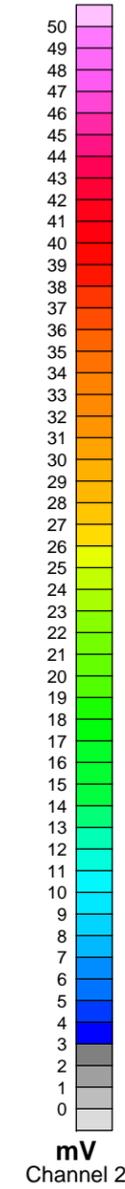
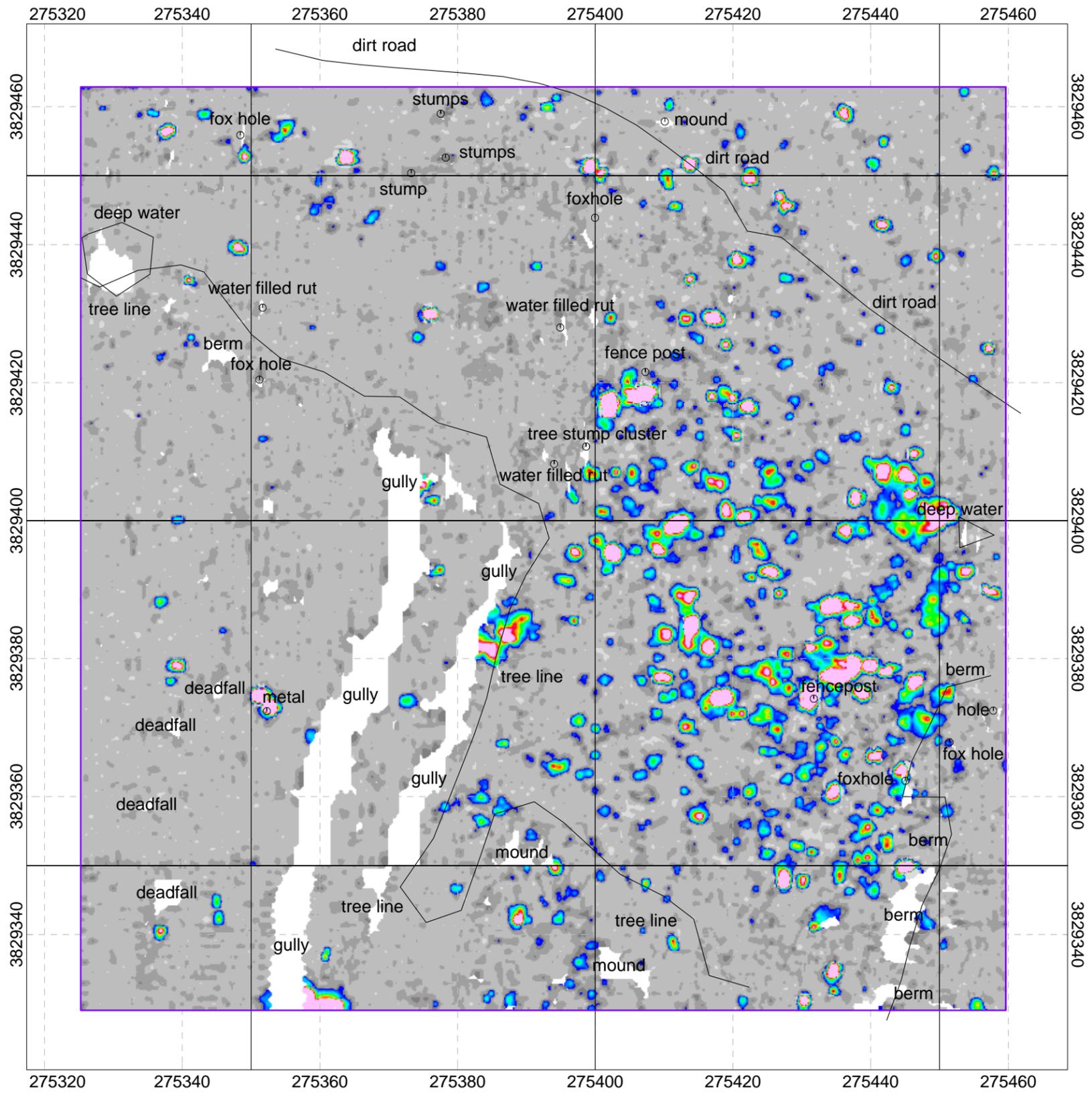
**Appendix A: GPO Color Contour Maps**

**Appendix B: Example EM61 QC Tests**

**Appendix C: CD-ROM containing EM61 Data, Grid Maps, Target Lists**

Plate 1  
MARSOC Former Gun Position 41A and 41B  
Mosaic

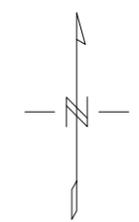
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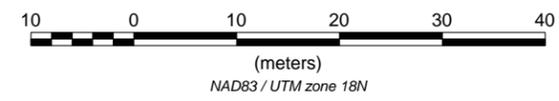
C3J2B1	C3J2C1	C3J2D1	C3J2E1	C3J2F1	C3J2G1
C3J1B0	C3J1C0	C3J1D0	C3J1E0	C3J1F0	C3J1G0
C3J1B9	C3J1C9	C3J1D9	C3J1E9	C3J1F9	C3J1G9
C3J1B8	C3J1C8	C3J1D8	C3J1E8	C3J1F8	C3J1G8
C3J1B7	C3J1C7	C3J1D7	C3J1E7	C3J1F7	C3J1G7
C3J1B6	C3J1C6	C3J1D6	C3J1E6	C3J1F6	C3J1G6

**Legend**

- Grid Boundary
- Thin black lines, symbols and text indicate field sketch from GeoXT device (Accuracy in the range of 1-3m)  
NOTE: For detailed culture, see individual maps.
- Former Gun Positions 41A - 41B



Scale 1:700

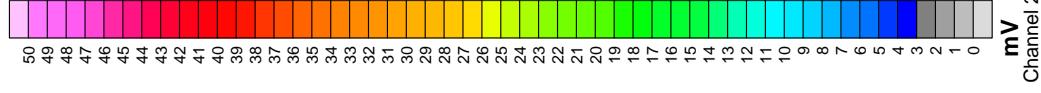
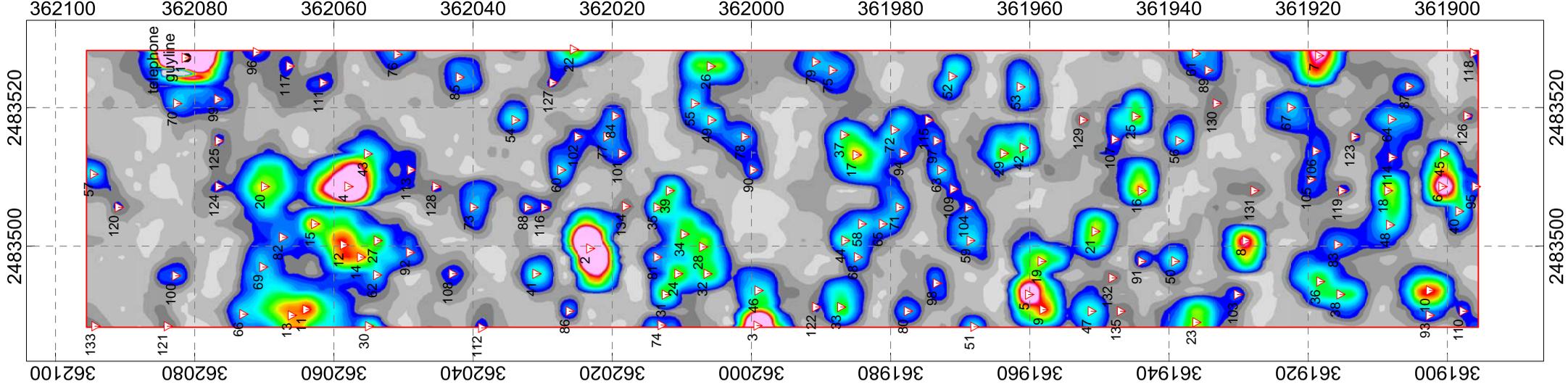


**PLATE 1**

<b>Client: CH2M HILL</b>
EM61 MK2 Bottom Coil Site Mosaic Former Gun Positions 41A_41B Proposed MARSOC MILCON Area Marine Corps Base, Camp Lejeune, North Carolina
Date of Survey: April 08 -12, 2008 Date of Map Creation: April 16, 2008
Map Approver: K.Lemley

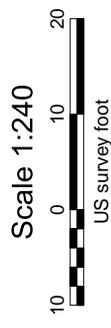
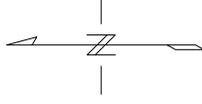
**Appendix A**  
**GPO Color Contour Maps**

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**Legend**

- Grid Boundary
- Thin black lines, symbols and text indicate field sketch from GeoxT device (Accuracy in the range of 1-3m)
- Brush
- Selected Target (See Target Pick List For Response and Location)



NAD83 / North Carolina CS83

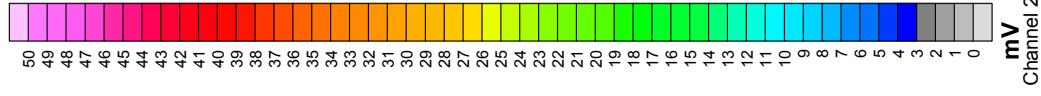
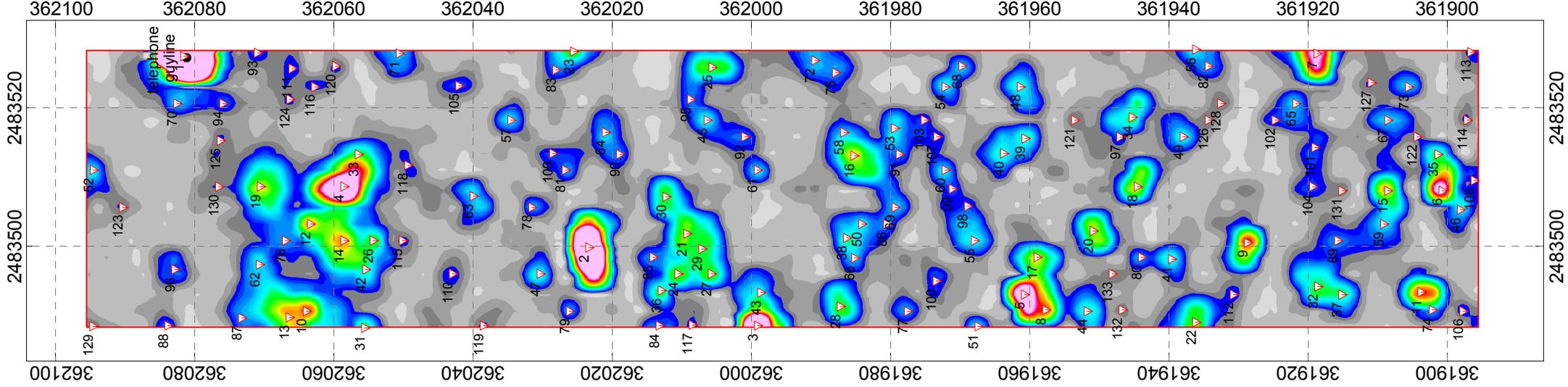
**Client: CH2M HILL**

EM61 MK2 Bottom Coil  
 Block 0408GPORIS Grid GPO\_RTS  
 Former Gun Positions 41A & 41B  
 Proposed MARSOC MILCON Area  
 Marine Corps Base, Camp Lejeune, North Carolina

Date of Survey: 04/08/2008

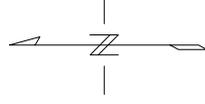
Date of Map Creation: 04/09/2008

Map Approver: K. Lemley



**Legend**

- Grid Boundary
- Thin black lines, symbols and text indicate field sketch from GeoXT device (Accuracy in the range of 1-3m)
- Selected Target  
(See Target Pick List For Response and Location)



NAD83 / North Carolina CS83

**Client: CH2M HILL**

EM61 MK2 Bottom Coil  
 Block 0408GPOFID Grid GPO\_FID  
 Former Gun Positions 41A & 41B  
 Proposed MARSOC MIL-CON Area  
 Marine Corps Base, Camp Lejeune, North Carolina

Date of Survey: 04/08/2008  
 Date of Map Creation: 04/10/2008

Map Approver: K.Lentley

**Appendix B**  
**Example EM61 QC Tests**

---

# Corrected Channel 2

# MAP 6 line test

## LEGEND

- Normal Pace
- ← Normal Pace
- Normal Pace with object
- ← Normal Pace with object
- Fast Pace with object
- ← Slow Pace with object
- ▲ Target position
- △ Lateral tol. exc.

Proposed distance lag = -0.346  
Proposed time lag = -0.080 sec

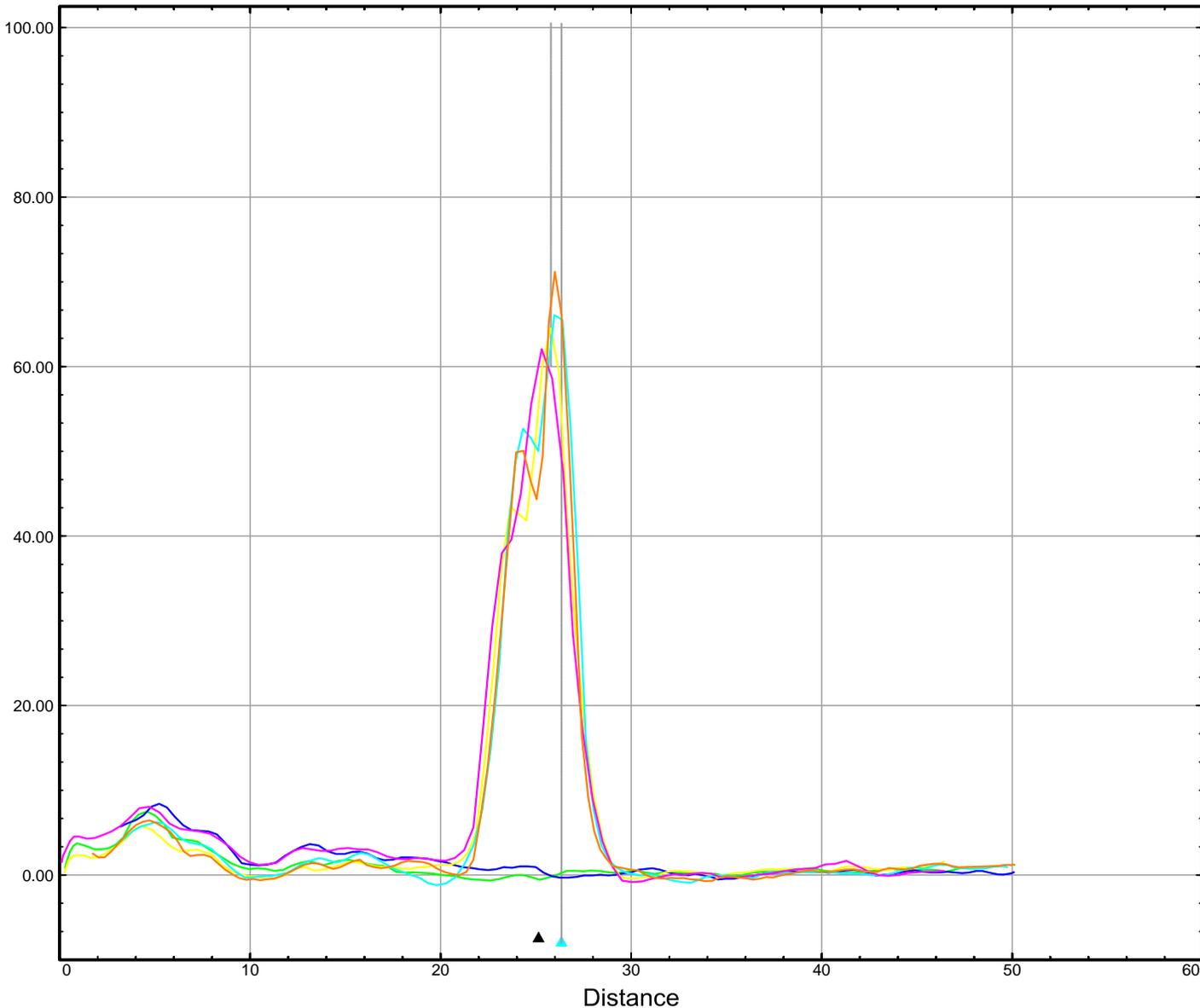
Scale 1:333.3333



Map Scale:



Grid North: 0°0'0"  
Mag North: 0°0'0"



Client: CH2M HILL

Project: TO-09 Camp Lejeune

Contractor: NAEVA Geophysics Inc.

Created by:

Verified by:

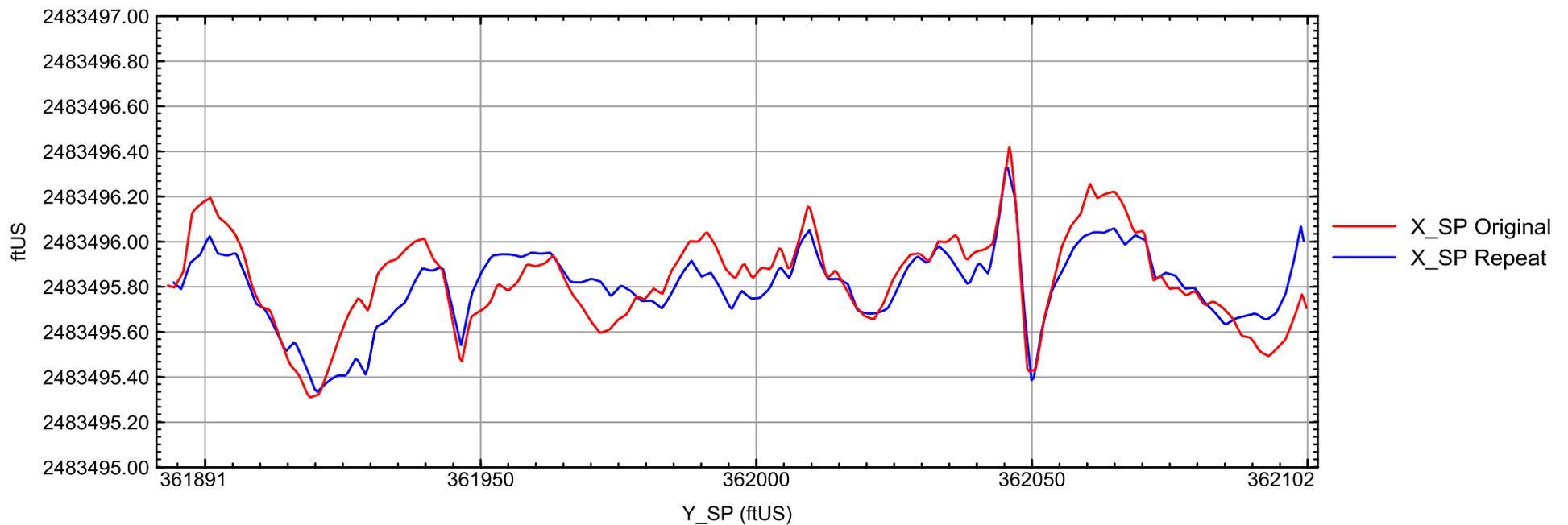
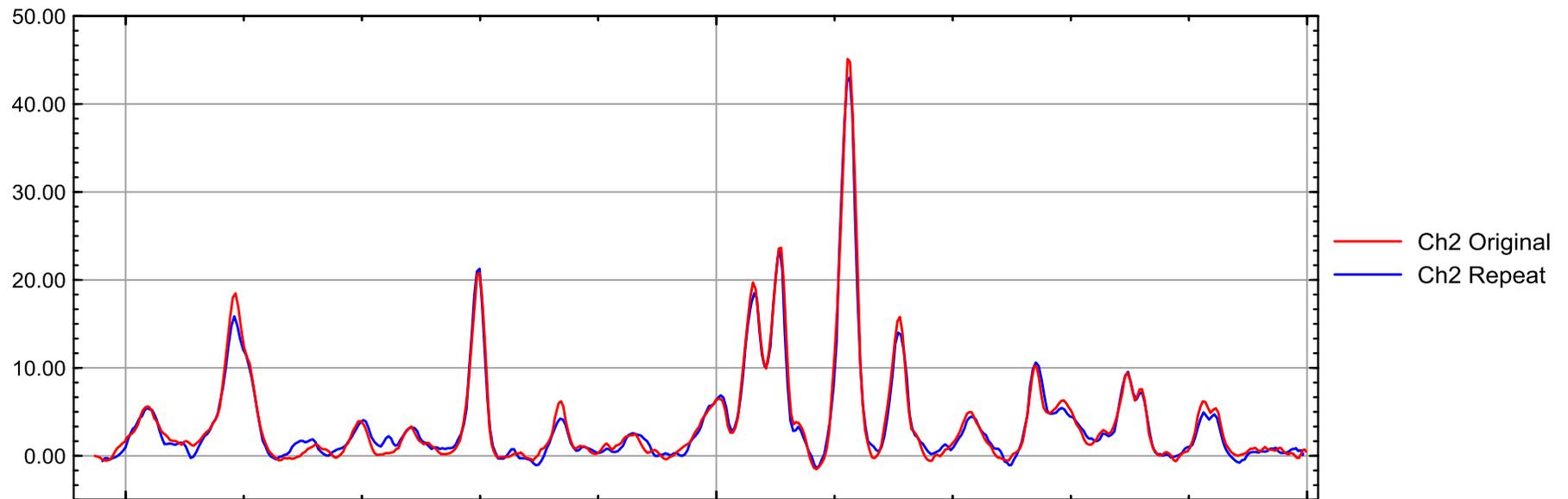
Date: 04/08/2008

File: 04086line\_6LineTest

Page number:

Approved:

# TO-09 - Camp Lejeune, North Carolina - 0408GPOTRS EM61 MK2 Repeat Line 7.5

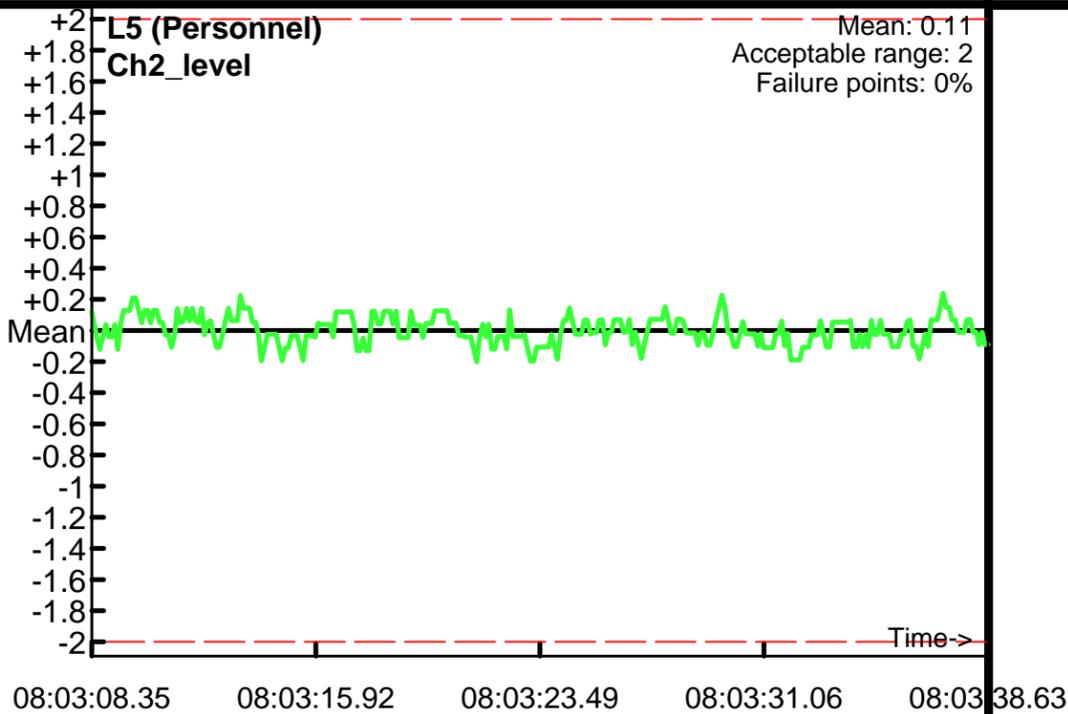
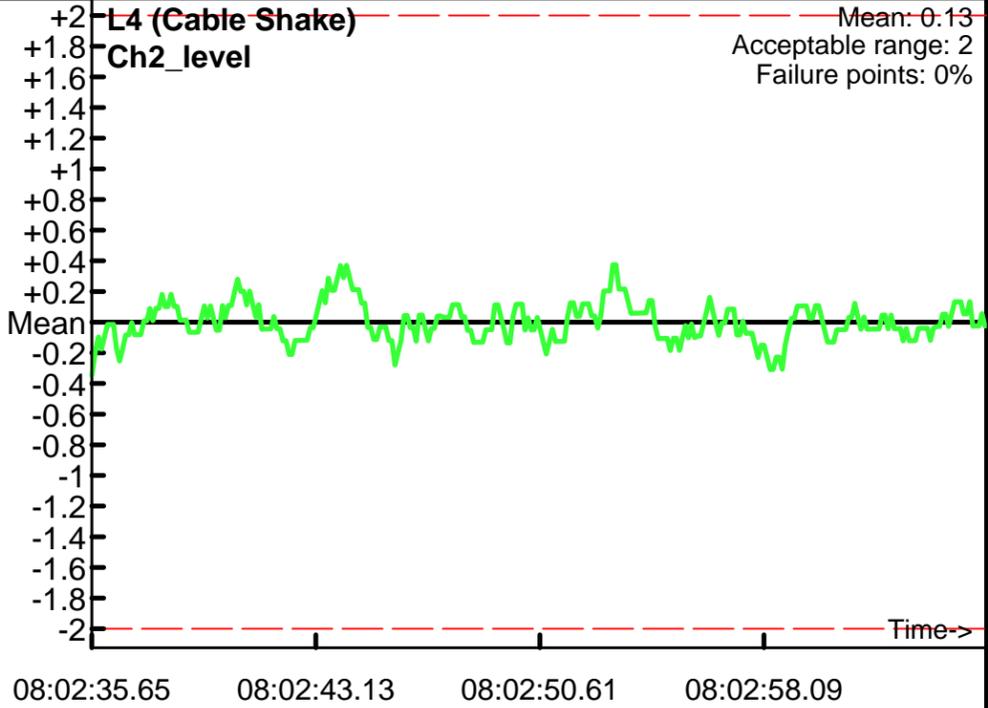


# Cable Shake and Personnel Tests

Project: TO-09 Camp Lejeune  
Equipment: EM-61 Mark II  
Grid/Location: Localized QC Area

Instrument Threshold: 20%  
● Outside range  
--- Acceptable limits

QC1 test  
Operator: GeoA  
Date: 2008/04/11

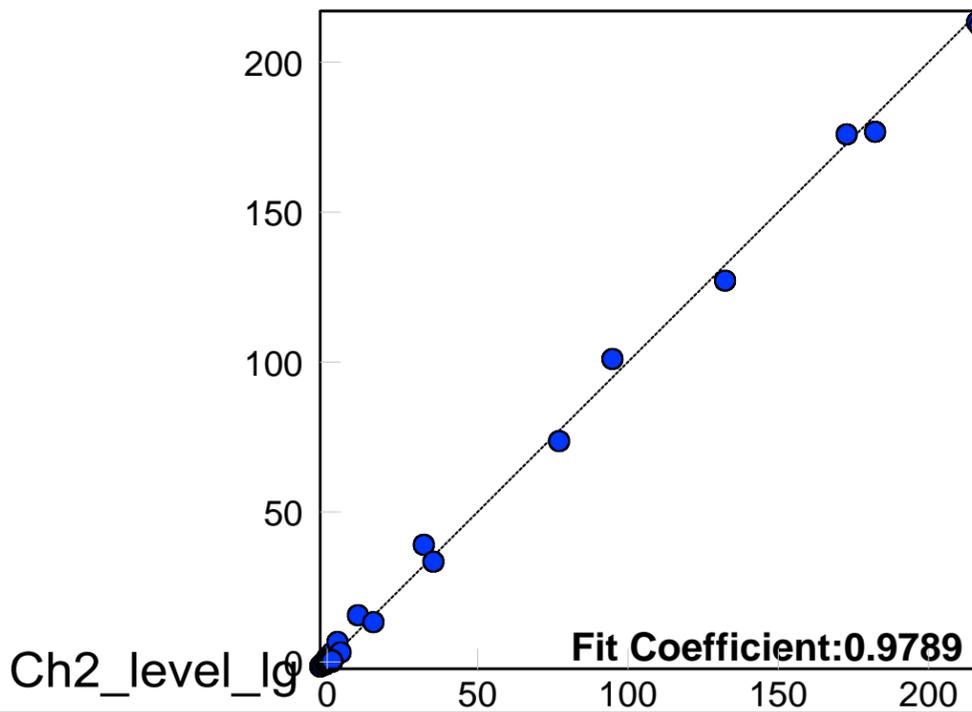
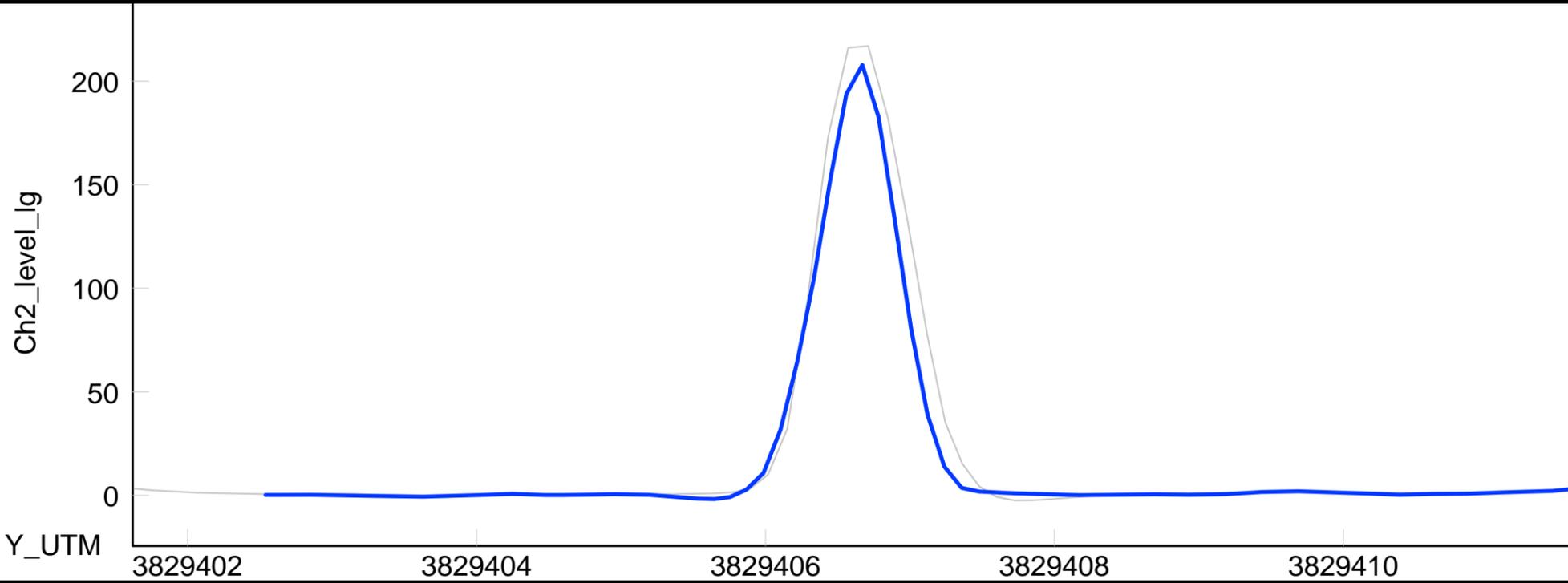
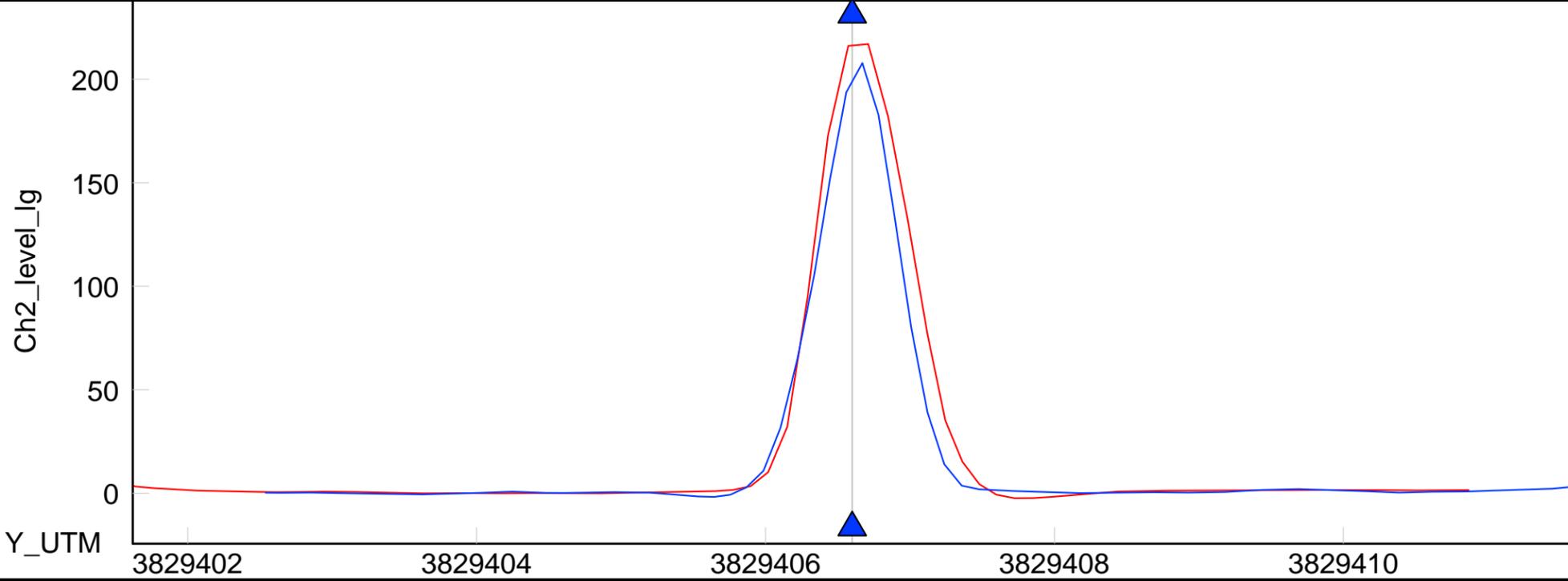


# Dynamic Response Test

Peak Tolerance(Value): 20(%)  
 Operator: GeoA  
 Project: TO-09 Camp Lejeune  
 Equipment: EM-61 Mark II  
 Grid/Location: Localized QC Area

Previous Profiles  
 Reference Profile  
 Comparison Profile

△ Top:First/Bottom:Second Profile  
 ▲ Target Value ≤ Tolerance  
 ▲ Target Value > Tolerance  
 ▲ No Data at Target

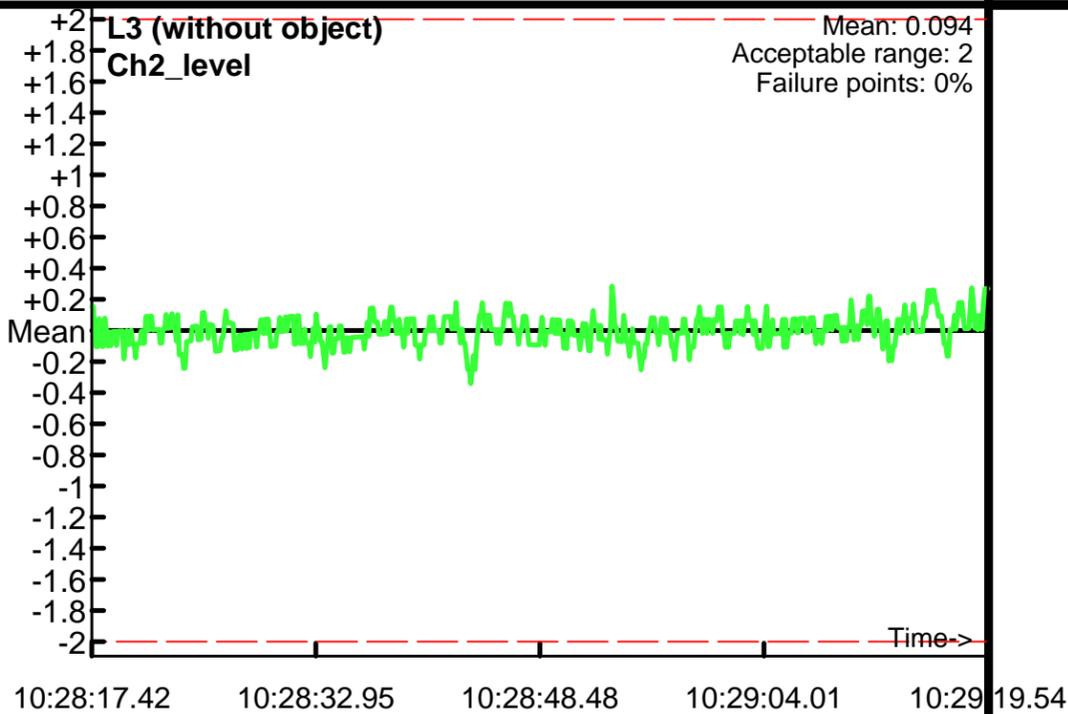
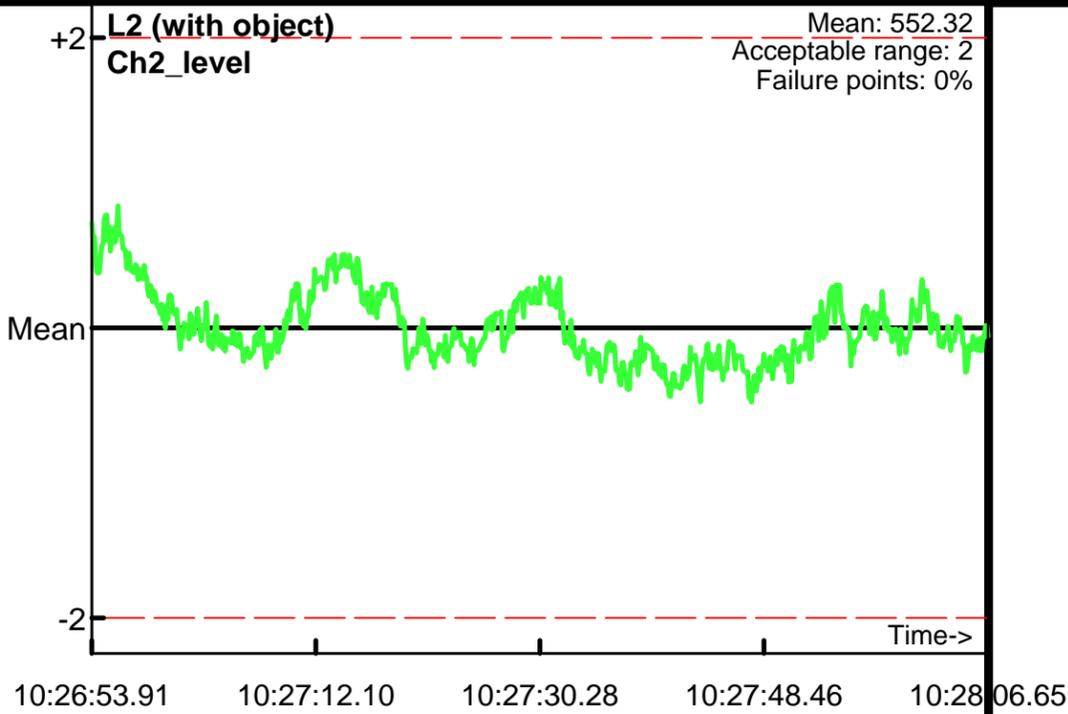
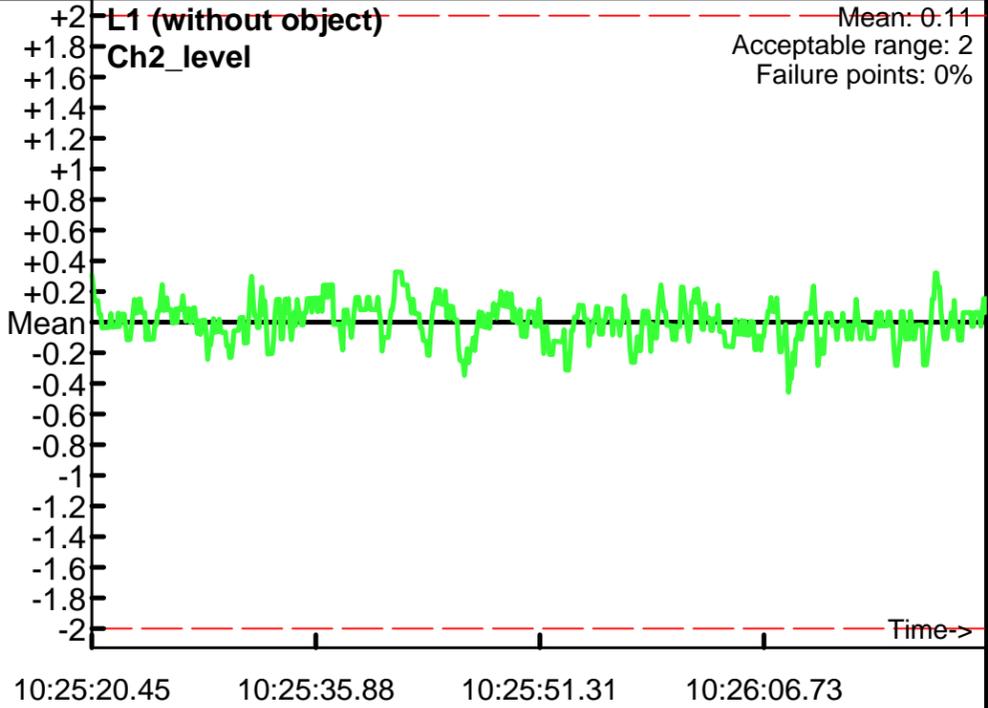


# Static Calibration Test

Project: TO-09 Camp Lejeune  
Equipment: EM-61 Mark II  
Grid/Location: Localized QC Area

Instrument Threshold: 20%  
● Outside range  
--- Acceptable limits

QC2 test  
Operator: GeoA  
Date: 2008/04/11



Appendix C  
CD-ROM Containing EM61 Data, Grid Maps,  
Target Lists

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**Appendix D**  
**Raw Analytical Data**

---

TABLE D-1  
Validated Multi Incremental Surface Soil  
Raw Analytical Results  
Former Gun Position 41A and 41B  
MCB Camp Lejeune, North Carolina

Station ID Sample ID Sample Date	ASR2.212-GP41-DU01			ASR2.212-GP41-DU02			
	ASR2.212-GP41-DU01-SS01 04/15/08	ASR2.212-GP41-DU01-SS02 04/16/08	ASR2.212-GP41-DU01-SS03 04/16/08	ASR2.212-GP41-DU02-SS01 04/16/08	ASR2.212-GP41-DU02-SS01D 04/16/08	ASR2.212-GP41-DU02-SS02 04/16/08	ASR2.212-GP41-DU02-SS03 04/16/08
<b>Chemical Name</b>							
<b>Explosives (UG/KG)</b>							
1,3,5-Trinitrobenzene	620 U	620 U	620 U				
1,3-Dinitrobenzene	620 U	620 U	620 U				
2,4,6-Trinitrotoluene	620 U	620 U	620 U				
2,4-Dinitrotoluene	1,200 U	1,200 U	1,200 U				
2,6-Dinitrotoluene	1,200 U	1,200 U	1,200 U				
2-Amino-4,6-dinitrotoluene	1,200 U	1,200 U	1,200 U				
2-Nitrotoluene	1,200 U	1,200 U	1,200 U				
3-Nitrotoluene	1,200 U	1,200 U	1,200 U				
4-Amino-2,6-dinitrotoluene	1,200 U	1,200 U	1,200 U				
4-Nitrotoluene	1,200 U	1,200 U	1,200 U				
HMX	620 U	620 U	620 U				
Nitrobenzene	620 U	620 U	620 U				
Perchlorate	2.8 U	2.6 U	2.5 U	2.4 U	2.4 U	2.3 U	2.4 U
RDX	620 U	620 U	620 U				
Tetryl	1,200 R	1,200 R	1,200 R				
<b>Total Metals (MG/KG)</b>							
Arsenic	0.44 U	0.42 U	0.41 U	0.61 J	0.47 J	0.66 J	0.42 J
Barium	6 J	6.4 J	5.1 J	5.7 J	6.3 J	6.7 J	6.6 J
Cadmium	0.12 U	0.12 U	0.11 U	0.11 U	0.1 U	0.1 U	0.1 U
Chromium	2.9	2.8	3.3	2.6	2.6	2.6	2.7
Lead	4.2	4.4	3.7	6.6	6.7	9	8.4
Mercury	0.023 U	0.022 U	0.022 U	0.02 U	0.018 U	0.019 U	0.022 J
Selenium	0.62 J	0.91 J	0.57 UJ	0.52 UJ	0.51 UJ	0.49 UJ	0.48 UJ
Silver	0.07 U	0.07 U	0.07 U	0.06 U	0.06 U	0.06 U	0.06 U
<b>Wet Chemistry (MG/KG)</b>							
% Solids	71	76.3	78.8	83.3	83.8	86.4	83.3

**Notes:**  
J - Analyte present, value may or may not be accurate or precise  
MG/KG - Milligrams per kilogram  
NA - Not analyzed  
R - Unreliable Result  
U - The material was analyzed for, but not detected  
UG/KG - Micrograms per kilogram  
UJ - Analyte not detected, quantitation limit may be inaccurate

TABLE D-1  
Validated Multi Incremental Surface Soil  
Raw Analytical Results  
Former Gun Position 41A and 41B  
MCB Camp Lejeune, North Carolina

Station ID	ASR2.212-GP41-DU03				ASR2.212-GP41-DU04		
	ASR2.212-GP41-DU03-SS01	ASR2.212-GP41-DU03-SS01D	ASR2.212-GP41-DU03-SS02	ASR2.212-GP41-DU03-SS03	ASR2.212-GP41-DU04-SS01	ASR2.212-GP41-DU04-SS02	ASR2.212-GP41-DU04-SS03
Sample ID							
Sample Date	04/16/08	04/16/08	04/17/08	04/17/08	04/17/08	04/17/08	04/17/08
Chemical Name							
<b>Explosives (UG/KG)</b>							
1,3,5-Trinitrobenzene	620 U	620 U	620 U	620 U	620 U	620 U	620 U
1,3-Dinitrobenzene	620 U	620 U	620 U	620 U	620 U	620 U	620 U
2,4,6-Trinitrotoluene	620 U	620 U	620 U	620 U	620 U	620 U	620 U
2,4-Dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
2,6-Dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
2-Amino-4,6-dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
2-Nitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
3-Nitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
4-Amino-2,6-dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
4-Nitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
HMX	620 U	620 U	620 U	620 U	620 U	620 U	620 U
Nitrobenzene	620 U	620 U	620 U	620 U	620 U	620 U	620 U
Perchlorate	2.4 U	2.4 U	2.5 U	2.4 U	2.6 U	2.5 U	2.4 U
RDX	620 U	620 U	620 U	620 U	620 U	620 U	620 U
Tetryl	1,200 R	1,200 R	1,200 R	1,200 R	1,200 R	1,200 R	1,200 R
<b>Total Metals (MG/KG)</b>							
Arsenic	0.75 J	1.2	0.95 J	1.4	0.38 U	0.42 J	0.49 J
Barium	8.4 J	8.7 J	12.9 J	7.8 J	10.5 J	11.9 J	9 J
Cadmium	0.1 U	0.1 U	0.11 U	0.11 U	0.11 U	0.11 U	0.1 U
Chromium	3.4	5.1	4.6	6	4	4.8	4.3
Lead	9.3	8.4	9.5	5.9	12.9	13.7	11.3
Mercury	0.019 J	0.02 U	0.026 J	0.021 J	0.024 J	0.025 J	0.019 U
Selenium	0.57 J	0.51 UJ	0.58 J	0.53 UJ	0.83 J	0.55 UJ	0.6 J
Silver	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U
<b>Wet Chemistry (MG/KG)</b>							
% Solids	83.9	83.2	80	82.9	78.4	79.5	82.8

**Notes:**  
J - Analyte present, value may or may not be accurate or precise  
MG/KG - Milligrams per kilogram  
NA - Not analyzed  
R - Unreliable Result  
U - The material was analyzed for, but not detected  
UG/KG - Micrograms per kilogram  
UJ - Analyte not detected, quantitation limit may be inaccurate

TABLE D-2  
Validated Subsurfaces Soil Raw Analytical Results  
Former Gun Position 41A and 41B  
MCB Camp Lejeune, North Carolina

Station ID	ASR2.212-GP41-IS01	ASR2.212-GP41-IS02	ASR2.212-GP41-IS03		ASR2.212-GP41-IS04
Sample ID	ASR2.212-GP41-IS01-1-3	ASR2.212-GP41-IS02-1-3	ASR2.212-GP41-IS03-1-3	ASR2.212-GP41-IS03D-1-3	ASR2.212-GP41-IS04-1-3
Sample Date	04/22/08	04/21/08	04/22/08	04/22/08	04/21/08
<b>Chemical Name</b>					
<b>Explosives (UG/KG)</b>					
1,3,5-Trinitrobenzene	620 U	620 U	620 U	620 U	620 U
1,3-Dinitrobenzene	620 U	620 U	620 U	620 U	620 U
2,4,6-Trinitrotoluene	620 U	620 U	620 U	620 U	620 U
2,4-Dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
2,6-Dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
2-Amino-4,6-dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
2-Nitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
3-Nitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
4-Amino-2,6-dinitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
4-Nitrotoluene	1,200 U	1,200 U	1,200 U	1,200 U	1,200 U
HMX	620 U	620 U	620 U	620 U	620 U
Nitrobenzene	620 U	620 U	620 U	620 U	620 U
Perchlorate	2.7 U	2.5 U	2.5 U	2.4 U	2.3 U
RDX	620 U	620 U	620 U	620 U	620 U
Tetryl	1,200 R	1,200 R	1,200 R	1,200 R	1,200 R
<b>Total Metals (MG/KG)</b>					
Arsenic	0.68 J	0.35 U	0.85 J	0.37 J	0.35 U
Barium	16.5 J	5 J	5.3 J	3.3 J	4.5 J
Cadmium	0.12 U	0.1 U	0.1 U	0.1 U	0.1 U
Chromium	24	6.2	2.4	3.8	4.5
Lead	11.8	4.1	3.1	3.6	3.3
Mercury	0.021 U	0.018 U	0.023 J	0.019 U	0.017 U
Selenium	0.59 U	0.48 U	0.52 U	0.49 U	0.48 U
Silver	0.07 U	0.54 U	0.06 U	0.06 U	0.06 U
<b>Wet Chemistry (MG/KG)</b>					
% Solids	74.4	80.9	80.6	81.7	86.7

**Notes:**  
J - Analyte present, value may or may not be accurate or precise  
MG/KG - Milligrams per kilogram  
NA - Not analyzed  
R - Unreliable Result  
U - The material was analyzed for, but not detected  
UG/KG - Micrograms per kilogram

**TABLE D-3**  
Validated Groundwater Raw Analytical Results  
Fomer Gun Position 41A and 41B  
MCB Camp Lejeune, North Carolina

Station ID	ASR2.212-GP41-TW01		ASR2.212-GP41-TW02	ASR2.212-GP41-TW03	ASR2.212-GP41-TW04
	ASR2.212-GP41-TW01-2-12	ASR2.212-GP41-TW01D-2-12	ASR2.212-GP41-TW02-2-12	ASR2.212-GP41-TW03-2-12	ASR2.212-GP41-TW04-2-12
Sample ID					
Sample Date	04/22/08	04/22/08	04/21/08	04/22/08	04/22/08
Chemical Name					
<b>Explosives (UG/L)</b>					
1,3,5-Trinitrobenzene	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
1,3-Dinitrobenzene	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
2,4,6-Trinitrotoluene	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
2,4-Dinitrotoluene	5 U	5 U	5 U	5 U	5 U
2,6-Dinitrotoluene	5 U	5 U	5 U	5 U	5 U
2-Amino-4,6-dinitrotoluene	5 U	5 U	5 U	5 U	5 U
2-Nitrotoluene	5 U	5 U	5 U	5 U	5 U
3-Nitrotoluene	5 U	5 U	5 U	5 U	5 U
4-Amino-2,6-dinitrotoluene	5 U	5 U	5 U	5 U	5 U
4-Nitrotoluene	5 U	5 U	5 U	5 U	5 U
HMX	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Nitrobenzene	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Perchlorate	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
RDX	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Tetryl	5 U	5 U	5 U	5 U	5 U
<b>Total Metals (UG/L)</b>					
Arsenic	18.8	9.6	3	7.8	4.6 J
Barium	79.4	81.1	94.4	118	87.4
Cadmium	0.17 J	0.1 J	0.089 J	0.22 J	0.11 U
Chromium	6.8 J	2 J	21.3 J	62.3 J	12.1 J
Lead	8.7 J	5.3 J	16.3 J	56.9 J	14.3 J
Mercury	0.1 U	0.1 U	0.1 U	0.28	0.1 U
Selenium	0.94 J	0.63 U	0.91 J	5.4 J	3.2 U
Silver	0.054 U	0.054 U	0.054 U	0.27 U	0.27 U
<b>Dissolved Metals (UG/L)</b>					
Arsenic	14.7	10.4	1.7	0.8 J	3
Barium	67.8	66.2	84.7	76.9	82.3
Cadmium	1 U	1 U	1 U	1 U	1 U
Chromium	2	2 U	6.1	3.4	2 U
Lead	3.2 J	2.5 J	4.4 J	2.3 J	26.6 J
Mercury	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Selenium	0.64 J	0.63 U	0.63 U	0.65 J	0.85 J
Silver	0.054 U	0.054 U	0.064 J	0.054 U	0.054 U

**Notes:**  
J - Analyte present, value may or may not be accurate or precise  
NA - Not analyzed  
U - The material was analyzed for, but not detected  
UG/L - Micrograms per liter

Appendix E  
Intrusive Investigation Results

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TABLE E-1

Phase I DGM Intrusive Investigation Results  
Former Gun Positions 41A and 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Class	Quantity	Depth (inches)	Comment
1	C3J1C0	09/09/08	C3J1C0-00001	275337.7	3829456.2	227.7	Cultural Debris	1	6	
2	C3J1C0	09/16/08	C3J1C0-00002	275349	3829452.4	92.6	Cultural Debris	1	0	Scrap
3	C3J1C0	09/16/08	C3J1C0-00003	275343.2	3829458.8	16.7	Munitions Debris	1	0	Signal, Illum, Ground, Cluster, M125A1, expended
4	C3J1C7	09/11/08	C3J1C7-00001	275336.8	3829340.4	64.2	Cultural Debris	1	0	
5	C3J1C7	09/16/08	C3J1C7-00002	275345.3	3829342.1	26.6	Munitions Debris	1	0	Signal, Illum, Ground, Cluster, M125A1, expended
6	C3J1C7	09/16/08	C3J1C7-00003	275345	3829344.7	22.6	Cultural Debris	1	0	Scrap
7	C3J1C8		C3J1C8-00001	275339.1	3829378.9	112.9		0	0	See footnote
8	C3J1C8	09/10/08	C3J1C8-00002	275338.3	3829376.6	23.8	Cultural Debris	1	0	
9	C3J1C8	09/16/08	C3J1C8-00003	275336.8	3829388.2	23.5	Cultural Debris	1	0	Scrap
10	C3J1C8		C3J1C8-00004	275339.3	3829399.9	14.4		0	0	See footnote
11	C3J1C8	09/16/08	C3J1C8-00006	275335.9	3829354.5	3.7	Cultural Debris	1	0	Scrap
12	C3J1C9		C3J1C9-00001	275348.1	3829439.4	116.8		0	0	See footnote
13	C3J1C9	09/16/08	C3J1C9-00002	275341	3829434.6	112.5	Cultural Debris	1	0	Tent Stake
14	C3J1C9	09/10/08	C3J1C9-00004	275336.7	3829423.5	6.9	Cultural Debris	1	8	
15	C3J1C9		C3J1C9-00008	275329	3829422.2	3.5		0	0	See footnote
16	C3J1D0	09/09/08	C3J1D0-00001	275363.6	3829452.4	366.3	Cultural Debris	1	2	
17	C3J1D0	09/09/08	C3J1D0-00002	275399.2	3829451.1	203.1	Cultural Debris	2	4	
18	C3J1D0	09/09/08	C3J1D0-00003	275354.9	3829456.4	44.3	Cultural Debris	1	2	15 ft cable w/eye
19	C3J1D0	09/09/08	C3J1D0-00004	275393	3829459.8	26.5	Cultural Debris	1	4	
20	C3J1D7	09/11/08	C3J1D7-00003	275388.8	3829342	326.2	Cultural Debris	11	2	trash pit >24 inches
21	C3J1D7	09/11/08	C3J1D7-00004	275394.2	3829349.6	88.6	Cultural Debris	2	6	
22	C3J1D7	09/11/08	C3J1D7-00006	275360.8	3829336.9	38.2	Cultural Debris	1	0	survey pin
23	C3J1D7	09/11/08	C3J1D7-00007	275394.9	3829342.1	20.2	Cultural Debris	1	0	
24	C3J1D7	09/11/08	C3J1D7-00008	275397.6	3829335.8	17.1	Cultural Debris	1	0	
25	C3J1D7	09/11/08	C3J1D7-00009	275379.7	3829346.6	15.3	Cultural Debris	1	1	
26	C3J1D8	09/11/08	C3J1D8-00001	275351.4	3829374.4	1229.2	Cultural Debris	1	0	
27	C3J1D8	09/11/08	C3J1D8-00003	275387.6	3829382.8	146.8	Cultural Debris	10	24	trash pit > 24 inches
28	C3J1D8	09/11/08	C3J1D8-00004	275384	3829381.4	122.9	Cultural Debris	20	24	trash pit > 24 inches
29	C3J1D8	09/10/08	C3J1D8-00006	275397	3829395.4	96.8	Cultural Debris	1	6	concrete
30	C3J1D8	09/11/08	C3J1D8-00008	275397	3829385.4	49.3	Cultural Debris	1	3	
31	C3J1D8	09/15/08	C3J1D8-00010	275377.3	3829392.6	45.9	Cultural Debris	1	1	
32	C3J1D8	09/11/08	C3J1D8-00011	275393.8	3829364.2	45.8	Cultural Debris	1	3	
33	C3J1D8	09/11/08	C3J1D8-00013	275389.4	3829385.6	41	Cultural Debris	2	2	
34	C3J1D8	09/11/08	C3J1D8-00016	275396.2	3829391.2	35.3	Cultural Debris	1	12	
35	C3J1D8	09/16/08	C3J1D8-00018	275386.7	3829367.6	27.5	Cultural Debris	1	0	Tent Stake
36	C3J1D8	09/11/08	C3J1D8-00019	275397.6	3829370.9	27	Cultural Debris	1	0	concrete
37	C3J1D8	09/11/08	C3J1D8-00020	275383.4	3829356.2	24.9	Cultural Debris	1	0	
38	C3J1D8	09/11/08	C3J1D8-00022	275383.4	3829359.8	22.3	Cultural Debris	5	3	
39	C3J1D8	09/16/08	C3J1D8-00026	275372.6	3829373.9	18.5	Cultural Debris	1	0	Bar
40	C3J1D8	09/16/08	C3J1D8-00074	275367.5	3829357.8	3	No Find	0	0	No Find
41	C3J1D9	09/09/08	C3J1D9-00001	275376	3829429.8	430	Cultural Debris	1	1	
42	C3J1D9	09/15/08	C3J1D9-00002	275375.1	3829404.8	66.6	Cultural Debris	1	1	

TABLE E-1

Phase I DGM Intrusive Investigation Results  
Former Gun Positions 41A and 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Class	Quantity	Depth (inches)	Comment
43	C3J1D9	09/09/08	C3J1D9-00003	275399.2	3829406.9	46.6	Cultural Debris	1	2	
44	C3J1D9	09/15/08	C3J1D9-00004	275376.6	3829402.8	40.6	Cultural Debris	1	0	survey point
45	C3J1D9	09/09/08	C3J1D9-00005	275391.6	3829436.6	23.2	Cultural Debris	1	6	
46	C3J1D9	09/09/08	C3J1D9-00006	275397	3829403.2	19.8	Cultural Debris	1	3	
47	C3J1D9	09/15/08	C3J1D9-00007	275374.2	3829426.4	17.1	Munitions Debris	1	12	Signal, Illum, Ground, Cluster, M125A1, expended
48	C3J1D9	09/09/08	C3J1D9-00008	275367.4	3829443.4	14.5	Cultural Debris	1	1.5	
49	C3J1D9	09/16/08	C3J1D9-00011	275351.8	3829411.7	8.8	Cultural Debris	1	0	Can
50	C3J1D9	09/09/08	C3J1D9-00012	275377.4	3829436.8	8.7	Cultural Debris	2	2	
51	C3J1D9	09/10/08	C3J1D9-00023	275353	3829404.6	3.8	Cultural Debris	1	4	
52	C3J1D9	09/09/08	C3J1D9-00027	275362	3829442.4	3.4	Cultural Debris	1	6	
53	C3J1D9	09/09/08	C3J1D9-00030	275388.6	3829448.2	3.3	Small Arms Ammunition	8	1	7.62 linked blanks
54	C3J1D9	09/16/08	C3J1D9-00044	275389.4	3829411	3	Cultural Debris	1	0	Can
55	C3J1E0	09/09/08	C3J1E0-00001	275413.8	3829451.4	335	Cultural Debris	1	3	
56	C3J1E0	09/09/08	C3J1E0-00002	275401	3829450.1	200.3	Cultural Debris	1	4	
57	C3J1E0	09/09/08	C3J1E0-00003	275436	3829458.8	153	Cultural Debris	1	4	
58	C3J1E0	09/09/08	C3J1E0-00005	275441.9	3829454.7	34.5	Cultural Debris	1	6	
59	C3J1E0	09/09/08	C3J1E0-00007	275440.3	3829451.5	20.3	Cultural Debris	1	1	
60	C3J1E0	09/09/08	C3J1E0-00008	275410.7	3829460.1	19.2	Cultural Debris	1	1	
61	C3J1E0	09/16/08	C3J1E0-00015	275418.9	3829454.4	4.7	Cultural Debris	1	0	Stake
62	C3J1E7		C3J1E7-00001	275434.6	3829334.6	643.1		0	0	See footnote
63	C3J1E7	09/11/08	C3J1E7-00002	275445	3829349.7	472.5	Cultural Debris	1	1	
64	C3J1E7	09/11/08	C3J1E7-00003	275427.4	3829347.8	368.3	Seed	1	2	seed item
65	C3J1E7	09/11/08	C3J1E7-00004	275430.4	3829330.4	276.1	Cultural Debris	1	0	
66	C3J1E7	09/11/08	C3J1E7-00005	275430.2	3829347.7	67.9	Cultural Debris	1	1	
67	C3J1E7	09/11/08	C3J1E7-00006	275431.6	3829340.8	56.9	Cultural Debris	1	0	survey pin
68	C3J1E7	09/11/08	C3J1E7-00007	275434.6	3829331.6	49.4	Cultural Debris	1	6	
69	C3J1E7	09/11/08	C3J1E7-00008	275435.6	3829348.4	49.1	Cultural Debris	1	3	
70	C3J1E7	09/16/08	C3J1E7-00009	275411.3	3829338.8	39.8	Cultural Debris	1	0	Tent Stake
71	C3J1E7	09/11/08	C3J1E7-00010	275407.4	3829347.2	33.7	Cultural Debris	1	1	
72	C3J1E7	09/11/08	C3J1E7-00012	275440.6	3829346.2	20.6	Cultural Debris	9	12	
73	C3J1E7	09/11/08	C3J1E7-00015	275421.5	3829330.2	16.5	Cultural Debris	1	0	
74	C3J1E7	09/11/08	C3J1E7-00054	275425.6	3829338.6	3	Cultural Debris	2	6	
75	C3J1E8	09/15/08	C3J1E8-00002	275434.8	3829377.2	2684.8	Cultural Debris	1	0	
76	C3J1E8	09/10/08	C3J1E8-00003	275402.4	3829395.2	1261.9	Cultural Debris	1	0	concrete
77	C3J1E8	09/11/08	C3J1E8-00004	275418.2	3829374	976	Cultural Debris	3	24	trash > 24 inches
78	C3J1E8	09/10/08	C3J1E8-00005	275434.2	3829387.6	898.1	Cultural Debris	5	24	trash pit
79	C3J1E8	09/10/08	C3J1E8-00006	275412	3829399.4	810.1	Cultural Debris	1	24	
80	C3J1E8	09/11/08	C3J1E8-00009	275413.6	3829384.4	581.4	Cultural Debris	1	12	same hit as E8-40 com cable
81	C3J1E8	09/16/08	C3J1E8-00010	275442.4	3829378	423.6	Cultural Debris	1	0	Tent Stakes & Log with metal > 24 inches
82	C3J1E8	09/16/08	C3J1E8-00011	275437.2	3829378.2	399.4	Cultural Debris	1	0	Poles
83	C3J1E8	09/10/08	C3J1E8-00012	275437.2	3829385.4	377.6	Cultural Debris	1	6	

TABLE E-1

Phase I DGM Intrusive Investigation Results  
 Former Gun Positions 41A and 41B  
 MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Class	Quantity	Depth (inches)	Comment
84	C3J1E8	09/16/08	C3J1E8-00014	275438.6	3829374.8	330.4	Cultural Debris	1	0	Poles
85	C3J1E8	09/15/08	C3J1E8-00015	275446.5	3829376.4	261	Cultural Debris	3	6	concrete
86	C3J1E8	09/10/08	C3J1E8-00017	275409	3829395.6	249.3	Cultural Debris	1	3	
87	C3J1E8	09/11/08	C3J1E8-00019	275416.6	3829381.4	239.6	Cultural Debris	1	18	
88	C3J1E8	09/15/08	C3J1E8-00020	275444.9	3829363.9	208.9	Cultural Debris	1	0	
89	C3J1E8	09/15/08	C3J1E8-00021	275439.9	3829378.9	202.9	Cultural Debris	1	6	
90	C3J1E8	09/10/08	C3J1E8-00022	275425.6	3829392.4	190.1	Cultural Debris	1	3	
91	C3J1E8	09/10/08	C3J1E8-00024	275431.2	3829381.4	179.5	Cultural Debris	1	6	
92	C3J1E8	09/10/08	C3J1E8-00026	275436.6	3829398.4	174.1	Cultural Debris	1	18	
93	C3J1E8	09/10/08	C3J1E8-00027	275437	3829387.5	154.8	Cultural Debris	4	8	
94	C3J1E8	09/11/08	C3J1E8-00028	275434.2	3829360.2	149.4	Cultural Debris	1	4	
95	C3J1E8	09/11/08	C3J1E8-00029	275440.6	3829365.6	131.5	Cultural Debris	1	0.25	
96	C3J1E8	09/11/08	C3J1E8-00030	275413.6	3829388.8	121.3	Cultural Debris	1	8	
97	C3J1E8	09/11/08	C3J1E8-00031	275409.2	3829377.2	113.3	Cultural Debris	1	3	
98	C3J1E8		C3J1E8-00032	275410.6	3829383.4	113.3		0	0	See footnote
99	C3J1E8	09/11/08	C3J1E8-00033	275415.2	3829357	92.6	Cultural Debris	1	24	
100	C3J1E8	09/15/08	C3J1E8-00035	275425	3829377.8	69.6	Cultural Debris	1	4	
101	C3J1E8	09/10/08	C3J1E8-00036	275426.6	3829389.4	68.7	Cultural Debris	1	1	survey traverse point
102	C3J1E8	09/15/08	C3J1E8-00038	275425.8	3829376.4	65.7	Cultural Debris	4	6	
103	C3J1E8	09/11/08	C3J1E8-00040	275413.5	3829382	64.2	Cultural Debris	1	12	same hit as E8-09 com cable and wire rope > 24 inches
104	C3J1E8	09/11/08	C3J1E8-00041	275413	3829370	62.8	Cultural Debris	1	2	
105	C3J1E8	09/11/08	C3J1E8-00042	275439.6	3829355.4	61	Cultural Debris	1	0	concrete
106	C3J1E8	09/11/08	C3J1E8-00043	275421.4	3829371.8	60.4	Cultural Debris	1	2	
107	C3J1E8	09/10/08	C3J1E8-00045	275433.6	3829382	59.3	Cultural Debris	2	6	
108	C3J1E8	09/15/08	C3J1E8-00046	275439.6	3829351.1	58.8	Cultural Debris	2	12	
109	C3J1E8	09/10/08	C3J1E8-00048	275400.1	3829397	57	Cultural Debris	1	6	
110	C3J1E8	09/16/08	C3J1E8-00049	275435	3829367.8	56.8	Cultural Debris	1	0	Pipe
111	C3J1E8	09/16/08	C3J1E8-00052	275419.8	3829371.8	53.6	Cultural Debris	1	0	Scrap > 24 inches
112	C3J1E8	09/16/08	C3J1E8-00053	275409	3829398	53.5	Cultural Debris	1	0	Scrap
113	C3J1E8	09/10/08	C3J1E8-00054	275428	3829380.4	52.9	Munitions Debris	3	6	genade spoon / trash
114	C3J1E8	09/16/08	C3J1E8-00057	275431.4	3829351.8	48.2	Cultural Debris	1	0	Tent Stake
115	C3J1E8	09/16/08	C3J1E8-00059	275448.3	3829371.2	47.4	Cultural Debris	1	0	Fence Post
116	C3J1E8	09/15/08	C3J1E8-00060	275428.2	3829375.6	46.2	Cultural Debris	1	3	
117	C3J1E8	09/11/08	C3J1E8-00061	275426.6	3829369.6	45.7	Cultural Debris	1	3	
118	C3J1E8	09/16/08	C3J1E8-00062	275441	3829385.4	44.9	Munitions Debris	1	0	Signal, Illum, Ground, Cluster, M125A1, expended
119	C3J1E8	09/11/08	C3J1E8-00064	275442.4	3829353.1	43.6	Cultural Debris	1	12	
120	C3J1E8	09/11/08	C3J1E8-00065	275441	3829357.8	43.1	Cultural Debris	1	2	concrete
121	C3J1E8	09/11/08	C3J1E8-00066	275416	3829372.6	42.7	Cultural Debris	1	0	concrete
122	C3J1E8	09/10/08	C3J1E8-00067	275444.6	3829398.3	42.2	Cultural Debris	1	6	concrete
123	C3J1E8	09/10/08	C3J1E8-00068	275422.8	3829391.6	41	Cultural Debris	1	3	
124	C3J1E8	09/16/08	C3J1E8-00069	275440.2	3829388.2	38.6	No Find	0	0	No Find

TABLE E-1

Phase I DGM Intrusive Investigation Results  
Former Gun Positions 41A and 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Class	Quantity	Depth (inches)	Comment
125	C3J1E8	09/10/08	C3J1E8-00070	275423.8	3829395.2	38.4	Cultural Debris	1	12	
126	C3J1E8	09/11/08	C3J1E8-00071	275436.4	3829366	38	Cultural Debris	1	5	
127	C3J1E8	09/10/08	C3J1E8-00073	275438.8	3829398.4	35.5	Cultural Debris	5	18	
128	C3J1E8	09/11/08	C3J1E8-00074	275422.3	3829360.6	35.4	Cultural Debris	1	10	
129	C3J1E8	09/11/08	C3J1E8-00075	275432.6	3829367	34.5	Cultural Debris	2	6	
130	C3J1E8	09/11/08	C3J1E8-00076	275425.2	3829371.4	33.6	No Find	0	24	> 24 inches
131	C3J1E8	09/10/08	C3J1E8-00077	275449.2	3829388.4	32.5	Cultural Debris	2	6	concrete slab
132	C3J1E8	09/15/08	C3J1E8-00079	275444.7	3829370.5	31.7	Cultural Debris	3	6	
133	C3J1E8	09/16/08	C3J1E8-00080	275432.7	3829383.9	31.7	Cultural Debris	1	0	Tent Stake
134	C3J1E8	09/11/08	C3J1E8-00081	275430.4	3829362.8	31.4	Cultural Debris	1	3	
135	C3J1E8	09/10/08	C3J1E8-00083	275448.6	3829384.9	30.7	Cultural Debris	1	12	
136	C3J1E8	09/16/08	C3J1E8-00084	275445.6	3829383.6	30.6	Cultural Debris	1	0	Spike
137	C3J1E8	09/11/08	C3J1E8-00086	275429.3	3829352.7	30.3	Cultural Debris	1	3	
138	C3J1E8	09/11/08	C3J1E8-00087	275424.9	3829372.4	29.9	No Find	0	24	> 24 inches
139	C3J1E8	09/11/08	C3J1E8-00088	275423.6	3829371.2	29	Cultural Debris	1	4	
140	C3J1E8	09/15/08	C3J1E8-00089	275444.8	3829374.6	28.8	Cultural Debris	1	6	
141	C3J1E8	09/11/08	C3J1E8-00091	275421.8	3829378	26.8	Cultural Debris	1	1	concrete
142	C3J1E8	09/11/08	C3J1E8-00092	275424.4	3829366.4	26.7	Cultural Debris	1	2	
143	C3J1E8	09/11/08	C3J1E8-00094	275400.1	3829369.6	24.9	Cultural Debris	1	0	survey point
144	C3J1E8	09/15/08	C3J1E8-00095	275443.6	3829360.6	24	Cultural Debris	1	3	
145	C3J1E8	09/10/08	C3J1E8-00098	275431.9	3829387.4	22.8	Cultural Debris	1	6	
146	C3J1E8	09/11/08	C3J1E8-00099	275425	3829351.8	22.6	Cultural Debris	1	0	survey pin
147	C3J1E8	09/16/08	C3J1E8-00101	275409.9	3829374.3	22.2	No Find	0	0	No Find
148	C3J1E8	09/11/08	C3J1E8-00102	275409.1	3829371.9	21.8	Cultural Debris	4	8	
149	C3J1E8	09/10/08	C3J1E8-00104	275406	3829395.6	21.5	Cultural Debris	1	4	
150	C3J1E8	09/11/08	C3J1E8-00106	275411.4	3829374.8	20.5	Munitions Debris	3	12	MD and scrap
151	C3J1E8	09/11/08	C3J1E8-00107	275406.7	3829376.8	20.4	Cultural Debris	3	3	
152	C3J1E8	09/15/08	C3J1E8-00108	275426.5	3829378.9	20.3	Cultural Debris	2	4	
153	C3J1E8	09/16/08	C3J1E8-00115	275414.4	3829397.8	18.8	Cultural Debris	1	0	Scrap
154	C3J1E8	09/16/08	C3J1E8-00148	275413	3829360.8	12.5	Cultural Debris	1	0	Melted Aluminum
155	C3J1E8	09/10/08	C3J1E8-00151	275442.8	3829389.4	12.3	Cultural Debris	1	6	
156	C3J1E8	09/11/08	C3J1E8-00178	275401.4	3829358	9.3	Cultural Debris	2	8	
157	C3J1E8	09/16/08	C3J1E8-00256	275421.2	3829381.4	4.8	No Find	0	0	No Find
158	C3J1E8	09/11/08	C3J1E8-00289	275406.8	3829369.8	3.7	Cultural Debris	2	8	
159	C3J1E8	09/16/08	C3J1E8-00328	275406.8	3829352.2	3	No Find	0	0	No Find
160	C3J1E9	09/10/08	C3J1E9-00001	275406.8	3829418.4	3587.1	Cultural Debris	1	0	
161	C3J1E9	09/10/08	C3J1E9-00002	275402.2	3829416.8	2146.8	Cultural Debris	1	0	
162	C3J1E9	09/09/08	C3J1E9-00004	275417.2	3829429.1	485.3	Cultural Debris	1	2	
163	C3J1E9	09/10/08	C3J1E9-00005	275445.4	3829406.2	374.6	Cultural Debris	1	2	
164	C3J1E9	09/10/08	C3J1E9-00007	275422.2	3829416.6	336.9	Cultural Debris	1	1	
165	C3J1E9	09/10/08	C3J1E9-00009	275438	3829403	233.8	Cultural Debris	1	4	
166	C3J1E9	09/10/08	C3J1E9-00011	275445.6	3829403.8	182.1	Cultural Debris	1	0	concrete
167	C3J1E9	09/10/08	C3J1E9-00012	275421.7	3829400.5	182.1	Cultural Debris	1	2	concrete
168	C3J1E9	09/16/08	C3J1E9-00013	275446.2	3829409.6	153.4	Cultural Debris	1	0	Scrap

TABLE E-1  
Phase I DGM Intrusive Investigation Results  
Former Gun Positions 41A and 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Class	Quantity	Depth (inches)	Comment
169	C3J1E9	09/10/08	C3J1E9-00015	275422.5	3829449.4	143.2	Small Arms Ammunition	10	8	ammo can parts
170	C3J1E9		C3J1E9-00016	275426.6	3829447	142.5		0	0	See footnote
171	C3J1E9	09/10/08	C3J1E9-00017	275420.5	3829437.7	126.7	Cultural Debris	1	6	
172	C3J1E9	09/10/08	C3J1E9-00018	275441.1	3829407.2	121.3	Cultural Debris	1	6	concrete
173	C3J1E9	09/10/08	C3J1E9-00019	275419	3829401.4	118	Cultural Debris	1	12	
174	C3J1E9	09/10/08	C3J1E9-00020	275428	3829445.6	112.5	Small Arms Ammunition	11	3	linked 7.62 blanks
175	C3J1E9	09/09/08	C3J1E9-00021	275413.8	3829434.8	108.4	Cultural Debris	1	2	
176	C3J1E9	09/10/08	C3J1E9-00022	275419.8	3829418	105.3	Cultural Debris	3	6	
177	C3J1E9	09/10/08	C3J1E9-00025	275441.6	3829442.7	96.3	Seed	1	1	seed item
178	C3J1E9	09/10/08	C3J1E9-00026	275416.8	3829418	93	Cultural Debris	1	0	survey traverse point
179	C3J1E9	09/10/08	C3J1E9-00027	275443	3829419.4	92.8	Munitions Debris	1	6	Signal, Illum, Ground, Cluster, M125A1, expended
180	C3J1E9	09/09/08	C3J1E9-00028	275419	3829425.2	89.9	Cultural Debris	1	6	
181	C3J1E9	09/10/08	C3J1E9-00029	275447.8	3829402	88.9	Cultural Debris	1	4	
182	C3J1E9	09/10/08	C3J1E9-00030	275420.6	3829412.2	88	Cultural Debris	1	1	survey traverse point
183	C3J1E9	09/10/08	C3J1E9-00032	275416.6	3829405.6	74.1	Cultural Debris	1	8	
184	C3J1E9	09/10/08	C3J1E9-00033	275418.2	3829405.2	66.8	Cultural Debris	2	24	
185	C3J1E9	09/10/08	C3J1E9-00034	275414.2	3829407.7	65.7	Cultural Debris	1	2	
186	C3J1E9	09/10/08	C3J1E9-00035	275403	3829406.8	63.4	Cultural Debris	1	1	
187	C3J1E9	09/16/08	C3J1E9-00036	275449.4	3829438	60.5	Munitions Debris	1	0	Blanks & Signal, Illum, Ground, Cluster, M125A1, expended
188	C3J1E9	09/09/08	C3J1E9-00037	275413.1	3829429.1	56	Cultural Debris	1	0	concrete slab
189	C3J1E9	09/16/08	C3J1E9-00038	275402.2	3829429.2	50.2	Munitions Debris	1	0	Signal, Illum, Ground, Cluster, M125A1, expended
190	C3J1E9	09/10/08	C3J1E9-00039	275425.3	3829407	47.9	Cultural Debris	1	6	
191	C3J1E9	09/10/08	C3J1E9-00041	275425.6	3829402.5	46.2	Cultural Debris	1	8	
192	C3J1E9	09/10/08	C3J1E9-00042	275405.4	3829406.8	45.6	Small Arms Ammunition	1	3	7.62 cartridge case
193	C3J1E9	09/09/08	C3J1E9-00043	275410.6	3829449.2	45.5	Cultural Debris	1	6	concrete in road
194	C3J1E9	09/10/08	C3J1E9-00045	275404.6	3829420.2	43.1	Cultural Debris	1	2	
195	C3J1E9	09/16/08	C3J1E9-00046	275401.1	3829401.1	41.7	Cultural Debris	1	0	Hoe
196	C3J1E9	09/10/08	C3J1E9-00047	275448.1	3829405.4	41.3	Cultural Debris	1	0	concrete
197	C3J1E9	09/09/08	C3J1E9-00050	275411.4	3829445.6	35.3	Cultural Debris	1	12	
198	C3J1E9	09/10/08	C3J1E9-00054	275440	3829408.3	24.1	Cultural Debris	1	6	concrete
199	C3J1E9	09/10/08	C3J1E9-00055	275431	3829407.8	23.4	Cultural Debris	3	8	
200	C3J1E9	09/10/08	C3J1E9-00068	275445.2	3829413	16.1	Cultural Debris	2	3	
201	C3J1E9	09/09/08	C3J1E9-00083	275428.8	3829417.6	10.4	Cultural Debris	1	14	
202	C3J1E9	09/09/08	C3J1E9-00085	275426	3829424.8	10.3	Cultural Debris	1	8	
203	C3J1E9	09/10/08	C3J1E9-00099	275426.2	3829442	8.3	Cultural Debris	1	2	
204	C3J1E9	09/09/08	C3J1E9-00101	275406.8	3829446	8.2	Cultural Debris	2	4	2nd item nail 1 m nw
205	C3J1E9	09/09/08	C3J1E9-00107	275409.4	3829431	7.3	Cultural Debris	1	2	

TABLE E-1  
Phase I DGM Intrusive Investigation Results  
Former Gun Positions 41A and 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Class	Quantity	Depth (inches)	Comment
206	C3J1E9	09/10/08	C3J1E9-00118	275437.8	3829436.2	6	Munitions Debris	1	12	grenade spoon piece
207	C3J1E9	09/16/08	C3J1E9-00123	275429.6	3829406	5.8	Cultural Debris	1	0	Wire
208	C3J1E9	09/10/08	C3J1E9-00165	275409.2	3829420.2	3.4	Cultural Debris	1	12	
209	C3J1E9	09/16/08	C3J1E9-00185	275409.2	3829439.2	3	Cultural Debris	1	0	License plate
210	C3J1F0	09/09/08	C3J1F0-00001	275458	3829450.1	79.1	Munitions Debris	1	4	
211	C3J1F0	09/09/08	C3J1F0-00003	275453.9	3829453.8	8.9	Cultural Debris	1	0	
212	C3J1F7	09/16/08	C3J1F7-00001	275455.6	3829329.8	29.4	Cultural Debris	1	0	Scrap
213	C3J1F8	09/15/08	C3J1F8-00001	275450.2	3829400	549.8	Cultural Debris	8	1	concrete
214	C3J1F8	09/10/08	C3J1F8-00002	275457.8	3829389.5	164.7	Cultural Debris	1	0	
215	C3J1F8	09/10/08	C3J1F8-00003	275453.8	3829392.6	159.1	Cultural Debris	1	0	concrete slab
216	C3J1F8	09/16/08	C3J1F8-00005	275451.1	3829374.9	53.3	Cultural Debris	1	0	Scrap
217	C3J1F8	09/10/08	C3J1F8-00006	275453.8	3829385.6	35.7	Cultural Debris	1	3	
218	C3J1F8	09/15/08	C3J1F8-00008	275450.6	3829392	20.9	Cultural Debris	2	6	concrete
219	C3J1F8	09/16/08	C3J1F8-00019	275451	3829367.6	6.1	Cultural Debris	1	0	Scrap
220	C3J1F9	09/10/08	C3J1F9-00001	275451.6	3829401	3026.2	Cultural Debris	1	0	
221	C3J1F9	09/10/08	C3J1F9-00002	275457.2	3829424.8	132.1	Munitions Debris	1	2	Signal, Illum, Ground, Cluster, M125A1, expended
222	C3J1F9	09/15/08	C3J1F9-00003	275458	3829449.9	60.1	Cultural Debris	1	6	
223	C3J1F9	09/15/08	C3J1F9-00009	275456.8	3829407.4	3.7	Cultural Debris	1	8	
224	C3J1F9	09/10/08	C3J1F9-00014	275454.8	3829415.8	3	Cultural Debris	1	2	

Note: The intrusive investigation data from the anomalies that are highlighted was lost during Phase I so these locations were re-investigated during Phase II.

TABLE E-2

Phase I Magnetometer Intrusive Investigation Results

*Former Gun Positions 41A and 41B*

*MCB Camp Lejeune, North Carolina*

<b>X Coordinate</b>	<b>Y Coordinate</b>	<b>Comments</b>
275379.8	3829405.8	Signal, Illum, Ground, Cluster, M125A1, expended
275369.8	3829396.7	full SAW drum, 202 blanks
275370.2	3829390.3	M18 Grenade, Smoke, expended
275359.3	3829368.2	Signal, Illum, Ground, Cluster, M125A1, expended
275355.3	3829348.1	linked 7.62 - 211 blanks

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
 Former Gun Positions 41A & 41B  
 MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
1	C3J1C0	10/23/08	C3J1C0-00004	275326	3829462.8	13.3	Cultural Debris	1	0	
2	C3J1C0	10/23/08	C3J1C0-00005	275335.8	3829458.9	12.8	Cultural Debris	1	1	
3	C3J1C0	10/23/08	C3J1C0-00006	275333.2	3829462.8	10.5	Cultural Debris	1	0	
4	C3J1C0	10/23/08	C3J1C0-00007	275328.4	3829459.8	7.3	Cultural Debris	1	4	
5	C3J1C0	10/23/08	C3J1C0-00008	275333.8	3829458.6	5.2	Cultural Debris	2	0	
6	C3J1C0	10/22/08	C3J1C0-00009	275349.6	3829462.7	5.1	No Find	0		
7	C3J1C0	10/27/08	C3J1C0-00010	275346.8	3829454.6	3.9	Cultural Debris	0		
8	C3J1C0	10/22/08	C3J1C0-00011	275341.4	3829460.8	3.8	Cultural Debris	1	0	
9	C3J1C0	10/23/08	C3J1C0-00012	275330.6	3829462.4	3.3	Cultural Debris	1	2	
10	C3J1C0	10/23/08	C3J1C0-00013	275345.6	3829454.8	3.1	No Find	0		
11	C3J1C0	10/23/08	C3J1C0-00014	275333.9	3829452.9	3	Cultural Debris	1	0	
12	C3J1C7	10/23/08	C3J1C7-00004	275346.6	3829329.8	3.2	Cultural Debris	1	2	
13	C3J1C8	10/23/08	C3J1C8-00001	275339.1	3829378.9	112.9	No Find	0		Phase I Dig Location
14	C3J1C8	10/23/08	C3J1C8-00004	275339.3	3829399.9	14.4	No Find	0		Phase I Dig Location
15	C3J1C8	10/23/08	C3J1C8-00005	275345.8	3829384	7.8	Cultural Debris	1	0	
16	C3J1C8	10/23/08	C3J1C8-00007	275332.9	3829396.7	3.2	No Find	0		
17	C3J1C8	10/23/08	C3J1C8-00008	275348.9	3829365.2	3.1	Cultural Debris	1	2	
18	C3J1C8	10/23/08	C3J1C8-00009	275332.2	3829399.4	3	Cultural Debris	1	0	
19	C3J1C8	10/23/08	C3J1C8-00010	275349.6	3829374.8	3	Cultural Debris	1	0	
20	C3J1C8	10/23/08	C3J1C8-00011	275339.8	3829372.4	3	Cultural Debris	1	0	
21	C3J1C8	10/23/08	C3J1C8-00012	275331.4	3829381.9		No Find	0		
22	C3J1C8	10/23/08	C3J1C8-00013	275344.3	3829361.6		No Find	0		
23	C3J1C8	10/23/08	C3J1C8-00014	275334.4	3829378.2		No Find	0		
24	C3J1C8	10/23/08	C3J1C8-00015	275334.4	3829398.6		Cultural Debris	1	1	
25	C3J1C8	10/23/08	C3J1C8-00016	275333.6	3829383.3		No Find	0		
26	C3J1C9	10/23/08	C3J1C9-00001	275348.1	3829439.4	116.8	No Find	0		Phase I Dig Location
27	C3J1C9	10/23/08	C3J1C9-00003	275341.2	3829426.4	12.7	No Find	0		
28	C3J1C9	10/23/08	C3J1C9-00005	275342	3829425.4	6	No Find	0		
29	C3J1C9	10/23/08	C3J1C9-00006	275340.4	3829425.4	4.5	Cultural Debris	1	10	
30	C3J1C9	10/23/08	C3J1C9-00007	275326.8	3829414	4.3	Cultural Debris	1	1	
31	C3J1C9	10/23/08	C3J1C9-00008	275329	3829422.2	3.5	No Find	0		Phase I Dig Location
32	C3J1C9	10/23/08	C3J1C9-00009	275328.3	3829425.5	3.3	No Find	0		
33	C3J1C9	10/23/08	C3J1C9-00010	275338.2	3829428.4	3	Cultural Debris	1	0	
34	C3J1C9	10/23/08	C3J1C9-00011	275339.7	3829422.6	3	Cultural Debris	1	1	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
 Former Gun Positions 41A & 41B  
 MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
35	C3J1C9	10/23/08	C3J1C9-00012	275333.6	3829418.4		No Find	0		
36	C3J1C9	10/23/08	C3J1C9-00013	275332.9	3829415.3		No Find	0		
37	C3J1C9	10/23/08	C3J1C9-00014	275333.6	3829417.1		No Find	0		
38	C3J1C9	10/22/08	C3J1C9-00015	275349.6	3829423.9		No Find	0		
39	C3J1D0	10/21/08	C3J1D0-00005	275394.2	3829461.4	18.2	Cultural Debris	2	5	
40	C3J1D0	10/22/08	C3J1D0-00006	275353.8	3829455.2	16.1	Cultural Debris	1	1	
41	C3J1D0	10/22/08	C3J1D0-00007	275360	3829450.1	10.5	Cultural Debris	1	3	
42	C3J1D0	10/21/08	C3J1D0-00008	275384	3829460.6	8.3	Cultural Debris	1	4	
43	C3J1D0	10/21/08	C3J1D0-00009	275389.4	3829458.2	5.8	Cultural Debris	1	4	
44	C3J1D0	10/21/08	C3J1D0-00010	275383.8	3829462	5.3	No Find	0		
45	C3J1D0	10/22/08	C3J1D0-00011	275350.6	3829462.7	4.9	No Find	0		
46	C3J1D0	10/22/08	C3J1D0-00012	275357.8	3829455.8	4.8	Cultural Debris	2	4	
47	C3J1D0	10/22/08	C3J1D0-00013	275365.4	3829450.6	4	Cultural Debris	2	3	
48	C3J1D0	10/21/08	C3J1D0-00014	275380.8	3829460.4	3.9	Cultural Debris	2	2	
49	C3J1D0	10/22/08	C3J1D0-00015	275390.6	3829456.4	3.7	Cultural Debris	1	2	
50	C3J1D0	10/22/08	C3J1D0-00016	275379.2	3829452.8	3.7	Cultural Debris	1	0	
51	C3J1D0	10/22/08	C3J1D0-00017	275353	3829456	3.7	Cultural Debris	1	1	
52	C3J1D0	10/21/08	C3J1D0-00018	275389.8	3829459.8	3.4	Cultural Debris	1	3	
53	C3J1D0	10/21/08	C3J1D0-00019	275378.6	3829460	3.2	Cultural Debris	1	3	
54	C3J1D0	10/22/08	C3J1D0-00020	275378.6	3829458.8	3.1	Cultural Debris	1	0	
55	C3J1D0	10/22/08	C3J1D0-00021	275393.4	3829455	3	Cultural Debris	1	2	
56	C3J1D7	10/23/08	C3J1D7-00001	275361.4	3829329	6153.4	Cultural Debris	1	0	
57	C3J1D7	10/23/08	C3J1D7-00002	275358.6	3829330.6	1218.3	Cultural Debris	1	0	
58	C3J1D7	10/23/08	C3J1D7-00005	275389.3	3829343.5	38.7	Cultural Debris	1	0	
59	C3J1D7	10/23/08	C3J1D7-00010	275390.2	3829342	15.1	Cultural Debris	3	3	
60	C3J1D7	10/23/08	C3J1D7-00011	275384.2	3829330.6	14	Cultural Debris	1	12	
61	C3J1D7	10/23/08	C3J1D7-00012	275387.7	3829330.6	13.7	Cultural Debris	1	12	
62	C3J1D7	10/23/08	C3J1D7-00013	275390	3829349.6	12.3	Cultural Debris	1	12	
63	C3J1D7	10/23/08	C3J1D7-00014	275399.4	3829331.2	11.2	Cultural Debris	1	6	
64	C3J1D7	10/23/08	C3J1D7-00015	275387.9	3829343.5	11.1	Cultural Debris	1	3	
65	C3J1D7	10/23/08	C3J1D7-00016	275385	3829331.2	9.6	Cultural Debris	1	4	
66	C3J1D7	10/23/08	C3J1D7-00017	275399.4	3829329.1	9.2	Cultural Debris	1	0	
67	C3J1D7	10/23/08	C3J1D7-00018	275396.4	3829332.8	8.6	Cultural Debris	1	5	
68	C3J1D7	10/23/08	C3J1D7-00019	275399.4	3829338.2	7.7	Cultural Debris	1	2	
69	C3J1D7	10/23/08	C3J1D7-00020	275396	3829345.8	7.5	Cultural Debris	1	1	
70	C3J1D7	10/23/08	C3J1D7-00021	275392.8	3829329.7	7.4	Cultural Debris	1	2	
71	C3J1D7	10/23/08	C3J1D7-00022	275351.6	3829330.6	6.9	Cultural Debris	1	2	
72	C3J1D7	10/23/08	C3J1D7-00023	275397	3829345.8	6.8	Cultural Debris	1	8	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
73	C3J1D7	10/23/08	C3J1D7-00024	275377	3829329.8	6.7	Cultural Debris	1	1	
74	C3J1D7	10/23/08	C3J1D7-00025	275392.7	3829344.2	6.6	Cultural Debris	1	2	
75	C3J1D7	10/23/08	C3J1D7-00026	275392.2	3829345	6.3	Cultural Debris	1	4	
76	C3J1D7	10/23/08	C3J1D7-00027	275394.8	3829345.3	5.9	Cultural Debris	3	0	
77	C3J1D7	10/23/08	C3J1D7-00028	275398.6	3829335.2	5.7	Cultural Debris	1	0	
78	C3J1D7	10/23/08	C3J1D7-00029	275393.4	3829332	4.9	Cultural Debris	1	2	
79	C3J1D7	10/23/08	C3J1D7-00030	275391.8	3829339	4.8	Cultural Debris	1	6	
80	C3J1D7	10/23/08	C3J1D7-00031	275363.2	3829332	4	Cultural Debris	1	0	
81	C3J1D7	10/23/08	C3J1D7-00032	275388	3829348	4	Cultural Debris	1	0	
82	C3J1D7	10/23/08	C3J1D7-00033	275399.4	3829342	3.6	Cultural Debris	1	6	
83	C3J1D7	10/23/08	C3J1D7-00034	275386	3829339	3.6	Cultural Debris	1	3	
84	C3J1D7	10/23/08	C3J1D7-00035	275397.8	3829331.4	3.3	Cultural Debris	1	0	
85	C3J1D7	10/23/08	C3J1D7-00036	275390.8	3829336.6	3.2	Cultural Debris	2	4	
86	C3J1D7	10/23/08	C3J1D7-00037	275391.7	3829348.1	3.2	Cultural Debris	1	0	
87	C3J1D7	10/23/08	C3J1D7-00038	275396.5	3829341.2	3.2	Cultural Debris	1	4	
88	C3J1D7	10/23/08	C3J1D7-00039	275373.8	3829330.5	3.1	Cultural Debris	1	0	
89	C3J1D7	10/23/08	C3J1D7-00040	275398.6	3829337.4	3	Cultural Debris	1	3	
90	C3J1D7	10/23/08	C3J1D7-00041	275399.8	3829336.6	3	Cultural Debris	1	3	
91	C3J1D8	10/23/08	C3J1D8-00002	275352.4	3829372.6	643.1	Cultural Debris	1	0	
92	C3J1D8	10/23/08	C3J1D8-00005	275387	3829383.6	118.8	Cultural Debris	2	3	
93	C3J1D8	10/23/08	C3J1D8-00007	275385	3829380.9	94	Cultural Debris	7	4	
94	C3J1D8	10/23/08	C3J1D8-00009	275388.2	3829384.6	47	Cultural Debris	5	24	
95	C3J1D8	10/23/08	C3J1D8-00012	275394.8	3829350.1	43.6	Cultural Debris	2	8	
96	C3J1D8	10/22/08	C3J1D8-00014	275399.8	3829397	39.3	No Find	0		
97	C3J1D8	10/20/08	C3J1D8-00015	275395	3829364.1	38.5	Cultural Debris	2	2	
98	C3J1D8	10/23/08	C3J1D8-00017	275395.2	3829391.2	28.3	Cultural Debris	2	2	
99	C3J1D8	10/21/08	C3J1D8-00021	275399.9	3829369.8	24.3	Cultural Debris	1	0	
100	C3J1D8	10/22/08	C3J1D8-00023	275386.4	3829385.3	19.3	Cultural Debris	1	0	
101	C3J1D8	10/21/08	C3J1D8-00024	275399.9	3829365.9	18.9	Cultural Debris	1	3	
102	C3J1D8	10/23/08	C3J1D8-00025	275389.3	3829383.8	18.6	Cultural Debris	4	24	
103	C3J1D8	10/20/08	C3J1D8-00027	275386	3829357.7	17.4	Cultural Debris	1	4	
104	C3J1D8	10/23/08	C3J1D8-00028	275385.5	3829386.6	16.8	Cultural Debris	1	5	
105	C3J1D8	10/20/08	C3J1D8-00029	275397.8	3829363	15.7	Cultural Debris	1	6	
106	C3J1D8	10/21/08	C3J1D8-00030	275378.2	3829358.4	12.5	Cultural Debris	1	3	
107	C3J1D8	10/20/08	C3J1D8-00031	275399.2	3829363.2	12.2	Cultural Debris	1	6	
108	C3J1D8	10/22/08	C3J1D8-00032	275388.2	3829388.2	11.2	Cultural Debris	1	3	
109	C3J1D8	10/23/08	C3J1D8-00033	275391	3829383	10.9	Cultural Debris	5	24	
110	C3J1D8	10/20/08	C3J1D8-00034	275386.4	3829359	10.5	Cultural Debris	1	2	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
 Former Gun Positions 41A & 41B  
 MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
111	C3J1D8	10/23/08	C3J1D8-00035	275390.8	3829354	10	Cultural Debris	1	6	
112	C3J1D8	10/23/08	C3J1D8-00036	275358.4	3829368.8	9.2	Cultural Debris	1	1	
113	C3J1D8	10/20/08	C3J1D8-00037	275390.1	3829384.8	9	Cultural Debris	2	3	
114	C3J1D8	10/22/08	C3J1D8-00038	275399.4	3829388.8	8.8	Cultural Debris	1	2	
115	C3J1D8	10/20/08	C3J1D8-00039	275387	3829358.4	8.6	Cultural Debris	1	0	
116	C3J1D8	10/23/08	C3J1D8-00040	275390.6	3829354.8	8.4	Cultural Debris	1	6	
117	C3J1D8	10/20/08	C3J1D8-00041	275386.9	3829380.1	7.4	Cultural Debris	3	6	
118	C3J1D8	10/23/08	C3J1D8-00042	275391.1	3829384.4	7.2	Cultural Debris	4	24	
119	C3J1D8	10/20/08	C3J1D8-00043	275383.9	3829361.4	7.1	Cultural Debris	2	2	
120	C3J1D8	10/23/08	C3J1D8-00044	275387	3829388	7	Cultural Debris	1	5	
121	C3J1D8	10/20/08	C3J1D8-00045	275392.6	3829364.4	6.3	Cultural Debris	1	8	
122	C3J1D8	10/21/08	C3J1D8-00046	275398.6	3829377.2	5.9	Cultural Debris	1	3	
123	C3J1D8	10/20/08	C3J1D8-00047	275399.9	3829360.6	5.7	Cultural Debris	2	6	
124	C3J1D8	10/27/08	C3J1D8-00048	275395.4	3829385.6	5.2	Cultural Debris	1	2	
125	C3J1D8	10/21/08	C3J1D8-00049	275379.8	3829359.2	5	Cultural Debris	1	0	
126	C3J1D8	10/23/08	C3J1D8-00050	275350.1	3829350.1	4.9	No Find	0		
127	C3J1D8	10/21/08	C3J1D8-00051	275396.8	3829368.8	4.6	Cultural Debris	3	6	
128	C3J1D8	10/20/08	C3J1D8-00052	275390.5	3829365.4	4.4	Cultural Debris	1	3	
129	C3J1D8	10/21/08	C3J1D8-00053	275400	3829374.8	4.3	Cultural Debris	1	4	
130	C3J1D8	10/21/08	C3J1D8-00054	275398.1	3829376.5	4.2	Cultural Debris	1	3	
131	C3J1D8	10/20/08	C3J1D8-00055	275399.4	3829353.4	4.1	Cultural Debris	1	6	
132	C3J1D8	10/20/08	C3J1D8-00056	275399.8	3829352.3	4.1	Cultural Debris	1	4	
133	C3J1D8	10/21/08	C3J1D8-00057	275393.5	3829365.9	3.8	Cultural Debris	2	12	
134	C3J1D8	10/27/08	C3J1D8-00058	275390.4	3829394.8	3.7	Cultural Debris	0		
135	C3J1D8	10/23/08	C3J1D8-00059	275378.2	3829379.2	3.5	Munitions Debris	1	0	M-22 ground signal flare expended
136	C3J1D8	10/20/08	C3J1D8-00060	275388.5	3829358.1	3.5	Cultural Debris	2	3	
137	C3J1D8	10/23/08	C3J1D8-00061	275396.4	3829353.6	3.5	Cultural Debris	1	6	
138	C3J1D8	10/20/08	C3J1D8-00062	275382.6	3829355	3.3	Cultural Debris	2	1	
139	C3J1D8	10/21/08	C3J1D8-00063	275397.7	3829368.3	3.3	Cultural Debris	2	2	
140	C3J1D8	10/22/08	C3J1D8-00064	275398.6	3829393	3.3	Cultural Debris	1	4	
141	C3J1D8	10/21/08	C3J1D8-00065	275376.8	3829357.8	3.2	Cultural Debris	1	3	
142	C3J1D8	10/23/08	C3J1D8-00066	275364.5	3829384.1	3.1	Cultural Debris	2	4	
143	C3J1D8	10/23/08	C3J1D8-00067	275355.3	3829390.9	3.1	No Find	0		
144	C3J1D8	10/23/08	C3J1D8-00068	275372.9	3829386.6	3.1	Cultural Debris	1	3	
145	C3J1D8	10/21/08	C3J1D8-00069	275398.4	3829366.8	3.1	Cultural Debris	1	3	
146	C3J1D8	10/21/08	C3J1D8-00070	275376.7	3829356.5	3	Cultural Debris	1	3	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
 Former Gun Positions 41A & 41B  
 MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
147	C3J1D8	10/23/08	C3J1D8-00071	275374.4	3829389.4	3	Munitions Debris	1	0	expended smoke grenade components
148	C3J1D8	10/23/08	C3J1D8-00072	275354.6	3829374.8	3	Cultural Debris	1	0	
149	C3J1D8	10/23/08	C3J1D8-00073	275377.4	3829371.1	3	Cultural Debris	1	2	
150	C3J1D9	10/22/08	C3J1D9-00009	275383.8	3829433.7	11.3	Cultural Debris	2	2	
151	C3J1D9	10/22/08	C3J1D9-00010	275359	3829444.6	11	Cultural Debris	2	0	
152	C3J1D9	10/22/08	C3J1D9-00013	275368.2	3829444.1	8.4	No Find	0		
153	C3J1D9	10/22/08	C3J1D9-00014	275359	3829427.8	7.7	No Find	0		
154	C3J1D9	10/22/08	C3J1D9-00015	275359.7	3829449.1	7.2	Cultural Debris	1	6	
155	C3J1D9	10/27/08	C3J1D9-00016	275399.6	3829418.4	6.8	Cultural Debris	0		
156	C3J1D9	10/22/08	C3J1D9-00017	275361.4	3829446.6	6.4	Cultural Debris	2	6	
157	C3J1D9	10/22/08	C3J1D9-00018	275399.9	3829411.4	6	Cultural Debris	1	1	
158	C3J1D9	10/22/08	C3J1D9-00019	275393.5	3829400.6	6	Munitions Debris	1	6	M18 grenade, smoke, practice, with M201A1 fuze expended
159	C3J1D9	10/22/08	C3J1D9-00020	275359.3	3829445.7	5.8	Cultural Debris	2	0	
160	C3J1D9	10/22/08	C3J1D9-00021	275361.4	3829445.4	4.7	Cultural Debris	2	3	
161	C3J1D9	10/22/08	C3J1D9-00022	275398.5	3829450	3.9	Cultural Debris	1	1	
162	C3J1D9	10/22/08	C3J1D9-00024	275396.8	3829440.8	3.6	Cultural Debris	1	0	
163	C3J1D9	10/22/08	C3J1D9-00025	275366	3829440.6	3.5	No Find	0		
164	C3J1D9	10/21/08	C3J1D9-00026	275398.2	3829402.4	3.5	Cultural Debris	1	6	
165	C3J1D9	10/22/08	C3J1D9-00028	275372	3829441	3.3	No Find	0		
166	C3J1D9	10/27/08	C3J1D9-00029	275399.9	3829416.4	3.3	Cultural Debris	0		
167	C3J1D9	10/22/08	C3J1D9-00031	275370.7	3829414.3	3.2	No Find	1		
168	C3J1D9	10/22/08	C3J1D9-00032	275355.2	3829448	3.2	Cultural Debris	1	6	
169	C3J1D9	10/22/08	C3J1D9-00033	275398.1	3829433.7	3.2	No Find	0		
170	C3J1D9	10/22/08	C3J1D9-00034	275362.2	3829448.6	3.1	Cultural Debris	1	1	
171	C3J1D9	10/21/08	C3J1D9-00035	275391.5	3829410.1	3.1	Cultural Debris	1	3	
172	C3J1D9	10/22/08	C3J1D9-00036	275381.8	3829445.3	3.1	Cultural Debris	1	1	
173	C3J1D9	10/22/08	C3J1D9-00037	275384	3829419.9	3	Cultural Debris	1	2	
174	C3J1D9	10/22/08	C3J1D9-00038	275383.4	3829441.8	3	Cultural Debris	1	2	
175	C3J1D9	10/27/08	C3J1D9-00039	275398.2	3829400.8	3	Cultural Debris	0		
176	C3J1D9	10/22/08	C3J1D9-00040	275396.6	3829439.8	3	Cultural Debris	1	0	
177	C3J1D9	10/22/08	C3J1D9-00041	275387.6	3829425.6	3	No Find	0		
178	C3J1D9	10/22/08	C3J1D9-00042	275353.8	3829419.2	3	Cultural Debris	1	2	
179	C3J1D9	10/22/08	C3J1D9-00043	275385.6	3829428.8	3	Cultural Debris	1	6	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
180	C3J1E0	10/22/08	C3J1E0-00004	275422.6	3829450.1	39.2	Cultural Debris	2	0	
181	C3J1E0	10/21/08	C3J1E0-00006	275410.4	3829450.1	26.8	Cultural Debris	2	1	
182	C3J1E0	10/22/08	C3J1E0-00009	275421.2	3829456	10	Munitions Debris	1	6	MK1 grenades, practice, no fuze, expended
183	C3J1E0	10/22/08	C3J1E0-00010	275427.4	3829454.2	6.7	Cultural Debris	1	6	
184	C3J1E0	10/21/08	C3J1E0-00011	275400.4	3829462	5.7	Cultural Debris	1	24	utility
185	C3J1E0	10/22/08	C3J1E0-00012	275405.5	3829462.2	5.5	Cultural Debris	1	3	
186	C3J1E0	10/21/08	C3J1E0-00013	275401.2	3829455	5.3	Cultural Debris	1	3	
187	C3J1E0	10/22/08	C3J1E0-00014	275421.8	3829451.6	5.3	Cultural Debris	1	1	
188	C3J1E0	10/22/08	C3J1E0-00016	275413	3829457.6	4.2	Cultural Debris	1	0	
189	C3J1E0	10/22/08	C3J1E0-00017	275417	3829460.6	3.6	Cultural Debris	1	1	
190	C3J1E0	10/22/08	C3J1E0-00018	275439.2	3829454.6	3.5	Cultural Debris	1	1	
191	C3J1E0	10/21/08	C3J1E0-00019	275408	3829452.2	3.2	Cultural Debris	2	4	
192	C3J1E0	10/22/08	C3J1E0-00020	275447.3	3829451.3	3.2	No Find	0		
193	C3J1E0	10/21/08	C3J1E0-00021	275400.1	3829453.8	3.1	No Find	0		
194	C3J1E0	10/21/08	C3J1E0-00022	275402.2	3829451.6	3	No Find	0		
195	C3J1E7	10/23/08	C3J1E7-00001	275434.6	3829334.6	643.1	Cultural Debris	1	12	Phase I Dig Location
196	C3J1E7	10/23/08	C3J1E7-00011	275444.2	3829348.4	21.5	No Find	0		
197	C3J1E7	10/16/08	C3J1E7-00013	275435.7	3829349.8	17.5	Cultural Debris	20	8	
198	C3J1E7	10/16/08	C3J1E7-00014	275427.1	3829349.9	17.2	Cultural Debris	1	4	
199	C3J1E7	10/14/08	C3J1E7-00016	275437	3829346.2	16	Cultural Debris	1	2	nail
200	C3J1E7	10/16/08	C3J1E7-00017	275432.5	3829342.6	13.4	Cultural Debris	1	4	
201	C3J1E7	10/14/08	C3J1E7-00018	275440.5	3829349.9	12.7	Cultural Debris	1	12	
202	C3J1E7	10/14/08	C3J1E7-00019	275438.4	3829349.9	11.6	Cultural Debris	1	4	
203	C3J1E7	10/23/08	C3J1E7-00020	275448.4	3829341.8	10.5	Cultural Debris	1	3	
204	C3J1E7	10/20/08	C3J1E7-00021	275400.7	3829348.2	9.2	Munitions Debris	2	12	1ea 40mm flare cartridge expended, and scrap
205	C3J1E7	10/14/08	C3J1E7-00022	275438.9	3829347.6	9.1	Cultural Debris	1	5	wire
206	C3J1E7	10/23/08	C3J1E7-00023	275447.6	3829342.6	8.8	Cultural Debris	1	24	
207	C3J1E7	10/20/08	C3J1E7-00024	275410.4	3829345	8.7	Cultural Debris	1	6	
208	C3J1E7	10/23/08	C3J1E7-00025	275407	3829340.4	8.6	Cultural Debris	2	6	
209	C3J1E7	10/16/08	C3J1E7-00026	275428.7	3829349.8	7.1	Cultural Debris	4	2	
210	C3J1E7	10/16/08	C3J1E7-00027	275423.4	3829346.4	6.2	Cultural Debris	1	6	
211	C3J1E7	10/14/08	C3J1E7-00028	275439.2	3829332	6.1	Cultural Debris	1	0	
212	C3J1E7	10/20/08	C3J1E7-00029	275404	3829349.6	5.9	Cultural Debris	2	6	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
213	C3J1E7	10/20/08	C3J1E7-00030	275411.9	3829349.2	5.8	Cultural Debris	3	6	
214	C3J1E7	10/16/08	C3J1E7-00031	275435.4	3829343.4	5.5	Cultural Debris	1	3	
215	C3J1E7	10/20/08	C3J1E7-00032	275404.8	3829347.8	5.3	Cultural Debris	1	3	
216	C3J1E7	10/16/08	C3J1E7-00033	275422.8	3829341.8	4.9	Cultural Debris	1	3	
217	C3J1E7	10/23/08	C3J1E7-00034	275401.4	3829332.8	4.8	No Find	0		
218	C3J1E7	10/16/08	C3J1E7-00035	275433.4	3829343.8	4.5	Cultural Debris	2	6	
219	C3J1E7	10/23/08	C3J1E7-00036	275413.2	3829329.1	4.1	Cultural Debris	1	1	
220	C3J1E7	10/27/08	C3J1E7-00037	275439.2	3829334.8	4	Cultural Debris	0		
221	C3J1E7	10/14/08	C3J1E7-00038	275441.5	3829329.1	3.8	Cultural Debris	1	0	
222	C3J1E7	10/23/08	C3J1E7-00039	275406.6	3829335.8	3.8	Cultural Debris	1	0	
223	C3J1E7	10/23/08	C3J1E7-00040	275406.7	3829329.1	3.7	Cultural Debris	1	2	
224	C3J1E7	10/20/08	C3J1E7-00041	275410.8	3829346.6	3.5	Cultural Debris	2	6	
225	C3J1E7	10/14/08	C3J1E7-00042	275443.4	3829329.2	3.3	Cultural Debris	1	0	
226	C3J1E7	10/16/08	C3J1E7-00043	275430.7	3829343.4	3.3	Cultural Debris	1	4	
227	C3J1E7	10/23/08	C3J1E7-00044	275441.7	3829345.3	3.3	Cultural Debris	2	2	
228	C3J1E7	10/23/08	C3J1E7-00045	275400.2	3829329.8	3.2	Cultural Debris	1	2	
229	C3J1E7	10/23/08	C3J1E7-00046	275414.9	3829330.5	3.2	Cultural Debris	1	2	
230	C3J1E7	10/16/08	C3J1E7-00047	275425.7	3829341.9	3.2	Cultural Debris	2	3	
231	C3J1E7	10/20/08	C3J1E7-00048	275440	3829337.8	3.2	Cultural Debris	1	2	
232	C3J1E7	10/20/08	C3J1E7-00049	275438.6	3829334.1	3.1	Cultural Debris	1	2	
233	C3J1E7	10/16/08	C3J1E7-00050	275425.3	3829345.8	3.1	Cultural Debris	2	2	
234	C3J1E7	10/14/08	C3J1E7-00051	275434.8	3829336.4	3.1	Cultural Debris	1	2	
235	C3J1E7	10/20/08	C3J1E7-00052	275439.7	3829340	3	Cultural Debris	1	2	
236	C3J1E7	10/23/08	C3J1E7-00053	275418.9	3829336.6	3	Cultural Debris	1	4	
237	C3J1E7	10/23/08	C3J1E7-00055	275425.4	3829330.2	3	Cultural Debris	1	2	
238	C3J1E8	10/21/08	C3J1E8-00001	275431.2	3829374.3	6026.4	Munitions Debris	1	8	m49a1 flare mount
239	C3J1E8	10/15/08	C3J1E8-00007	275445	3829350.1	726.6	No Find	0		
240	C3J1E8	10/22/08	C3J1E8-00008	275437.2	3829379.4	623.8	Cultural Debris	1	10	
241	C3J1E8	10/21/08	C3J1E8-00013	275436.5	3829377.2	356.8	Cultural Debris	1	6	
242	C3J1E8	10/21/08	C3J1E8-00016	275414.4	3829385	253.3	Cultural Debris	2	4	
243	C3J1E8	10/16/08	C3J1E8-00018	275435	3829361	239.6	Cultural Debris	2	4	
244	C3J1E8	10/20/08	C3J1E8-00023	275410.6	3829398.6	186.8	Cultural Debris	2	2	
245	C3J1E8	10/21/08	C3J1E8-00025	275433.3	3829377.2	176.2	Cultural Debris	1	8	
246	C3J1E8	10/21/08	C3J1E8-00032	275410.6	3829383.4	113.3	Cultural Debris	1	6	Phase I Dig Location
247	C3J1E8	10/20/08	C3J1E8-00034	275410.6	3829377	86.6	Cultural Debris	1	3	
248	C3J1E8	10/22/08	C3J1E8-00037	275448.7	3829398.7	65.8	Cultural Debris	1		
249	C3J1E8	10/21/08	C3J1E8-00039	275436	3829379.2	65.7	Cultural Debris	1	3	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
250	C3J1E8	10/15/08	C3J1E8-00044	275443.6	3829363.4	59.7	Cultural Debris	2	6	
251	C3J1E8	10/21/08	C3J1E8-00047	275412.2	3829389	57.3	Cultural Debris	2	2	
252	C3J1E8	10/15/08	C3J1E8-00050	275436	3829387	56.3	Cultural Debris	2	10	
253	C3J1E8	10/14/08	C3J1E8-00051	275438.2	3829350.6	55.3	Cultural Debris	1	4	
254	C3J1E8	10/14/08	C3J1E8-00055	275440.2	3829386.1	50.3	Cultural Debris	1	4	
255	C3J1E8	10/20/08	C3J1E8-00056	275408.4	3829396.4	48.2	Cultural Debris	1	5	
256	C3J1E8	10/21/08	C3J1E8-00058	275435	3829379.6	47.9	Cultural Debris	1	4	
257	C3J1E8	10/15/08	C3J1E8-00063	275423.5	3829396.4	44.2	Cultural Debris	2	4	
258	C3J1E8	10/14/08	C3J1E8-00072	275438.8	3829354.8	35.6	Cultural Debris	1	12	rebar
259	C3J1E8	10/22/08	C3J1E8-00078	275446.2	3829399.6	31.8	Cultural Debris	1		
260	C3J1E8	10/22/08	C3J1E8-00082	275447.1	3829398.3	31.1	Cultural Debris	1		
261	C3J1E8	10/16/08	C3J1E8-00085	275416.2	3829373.6	30.4	Cultural Debris	1	18	
262	C3J1E8	10/14/08	C3J1E8-00090	275449.9	3829385.4	27.9	Cultural Debris	1	10	
263	C3J1E8	10/22/08	C3J1E8-00093	275444	3829399.8	26.3	Cultural Debris	1		
264	C3J1E8	10/15/08	C3J1E8-00096	275425	3829379.2	23.2	Cultural Debris	1	6	
265	C3J1E8	10/20/08	C3J1E8-00097	275423.5	3829377.5	23.2	Cultural Debris	1	10	
266	C3J1E8	10/21/08	C3J1E8-00100	275413.2	3829386.9	22.5	Munitions Debris	2	4	m583a1 40mm flare expended, and a can elevated in mound
267	C3J1E8	10/15/08	C3J1E8-00103	275449.8	3829375	21.6	Cultural Debris	1	4	
268	C3J1E8	10/14/08	C3J1E8-00105	275448.6	3829387	21.4	Cultural Debris	1	12	
269	C3J1E8	10/15/08	C3J1E8-00109	275444	3829378.6	19.8	Cultural Debris	1	6	
270	C3J1E8	10/20/08	C3J1E8-00110	275401.6	3829392.6	19.8	Cultural Debris	1	12	
271	C3J1E8	10/15/08	C3J1E8-00111	275446.8	3829371.7	19.5	Cultural Debris	1	6	
272	C3J1E8	10/23/08	C3J1E8-00112	275445.2	3829371.2	19.4	Cultural Debris	2	2	
273	C3J1E8	10/21/08	C3J1E8-00113	275400.1	3829365.8	19.3	Cultural Debris	1	3	
274	C3J1E8	10/21/08	C3J1E8-00114	275433.8	3829373.8	18.9	Cultural Debris	2	6	
275	C3J1E8	10/22/08	C3J1E8-00116	275449.8	3829391.9	18.6	Cultural Debris	1		
276	C3J1E8	10/20/08	C3J1E8-00117	275408.4	3829365.1	18.4	Cultural Debris	1	18	
277	C3J1E8	10/14/08	C3J1E8-00118	275441.9	3829388.9	17.8	Cultural Debris	1	3	
278	C3J1E8	10/15/08	C3J1E8-00119	275448	3829369.6	17.7	Cultural Debris	1	6	
279	C3J1E8	10/14/08	C3J1E8-00120	275443.4	3829384.8	17.5	Cultural Debris	1	5	
280	C3J1E8	10/15/08	C3J1E8-00121	275427.8	3829377.9	17.2	Munitions Debris	4	4	grenade spoon
281	C3J1E8	10/16/08	C3J1E8-00122	275435.9	3829350.1	17	Cultural Debris	20	8	
282	C3J1E8	10/21/08	C3J1E8-00123	275432.6	3829379.2	16.7	Cultural Debris	3	4	
283	C3J1E8	10/15/08	C3J1E8-00124	275443.2	3829391.5	16.5	Cultural Debris	1	6	
284	C3J1E8	10/21/08	C3J1E8-00125	275408.2	3829378.1	16.4	Munitions Debris	1	6	m583a1 flare expended

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
285	C3J1E8	10/16/08	C3J1E8-00126	275425.8	3829366.2	16.2	Cultural Debris	1	2	
286	C3J1E8	10/20/08	C3J1E8-00127	275408.2	3829388.4	16	Munitions Debris	1	4	m49 mounting bracket
287	C3J1E8	10/15/08	C3J1E8-00128	275449.8	3829368	16	Munitions Debris	1	6	M-22 ground signal flare tube
288	C3J1E8	10/21/08	C3J1E8-00129	275415.9	3829383.3	15.8	Cultural Debris	2	4	
289	C3J1E8	10/15/08	C3J1E8-00130	275445.6	3829374	15.7	Cultural Debris	1	12	
290	C3J1E8	10/20/08	C3J1E8-00131	275407.7	3829392.1	15.6	Cultural Debris	1	2	
291	C3J1E8	10/16/08	C3J1E8-00132	275427.2	3829350.1	15.5	Cultural Debris	1	7	
292	C3J1E8	10/15/08	C3J1E8-00133	275428.8	3829397.7	15.4	Cultural Debris	1	6	
293	C3J1E8	10/20/08	C3J1E8-00134	275430.4	3829363.8	15.4	Cultural Debris	7	4	
294	C3J1E8	10/20/08	C3J1E8-00135	275404	3829395.2	15.1	Cultural Debris	1	1	
295	C3J1E8	10/23/08	C3J1E8-00136	275443.4	3829368	14.9	Cultural Debris	1	4	
296	C3J1E8	10/22/08	C3J1E8-00137	275442.9	3829399.1	14.8	Cultural Debris	1		
297	C3J1E8	10/16/08	C3J1E8-00138	275424.4	3829354.8	14.7	Cultural Debris	1	4	
298	C3J1E8	10/16/08	C3J1E8-00139	275414.7	3829364.8	14.6	Cultural Debris	3	4	
299	C3J1E8	10/20/08	C3J1E8-00140	275410.6	3829396.8	14.2	Cultural Debris	1	2	
300	C3J1E8	10/16/08	C3J1E8-00141	275418.2	3829376.8	13.6	Cultural Debris	1	14	
301	C3J1E8	10/20/08	C3J1E8-00142	275407.6	3829397.6	13.3	Cultural Debris	2	2	
302	C3J1E8	10/23/08	C3J1E8-00143	275449.8	3829384	13.1	Cultural Debris	1	24	
303	C3J1E8	10/14/08	C3J1E8-00144	275440.4	3829350.1	13	Cultural Debris	1	12	
304	C3J1E8	10/16/08	C3J1E8-00145	275427.9	3829362.4	12.8	Cultural Debris	1	4	
305	C3J1E8	10/20/08	C3J1E8-00146	275413.6	3829374.8	12.7	Cultural Debris	1	18	
306	C3J1E8	10/21/08	C3J1E8-00147	275432.6	3829370.2	12.7	Cultural Debris	1	3	
307	C3J1E8	10/15/08	C3J1E8-00149	275443.2	3829358	12.3	Cultural Debris	1	3	
308	C3J1E8	10/23/08	C3J1E8-00150	275438.7	3829399.9	12.3	Cultural Debris	5	6	
309	C3J1E8	10/15/08	C3J1E8-00152	275432.8	3829385.6	12.1	Cultural Debris	2	8	
310	C3J1E8	10/15/08	C3J1E8-00153	275431.8	3829380	12	Cultural Debris	3	6	
311	C3J1E8	10/21/08	C3J1E8-00154	275418.2	3829398.2	12	Cultural Debris	11	3	
312	C3J1E8	10/15/08	C3J1E8-00155	275431.4	3829364.3	11.8	Cultural Debris	2	8	
313	C3J1E8	10/20/08	C3J1E8-00156	275402.2	3829393.4	11.7	Cultural Debris	3	12	
314	C3J1E8	10/27/08	C3J1E8-00157	275419	3829382	11.6	Cultural Debris	0		
315	C3J1E8	10/15/08	C3J1E8-00158	275432.6	3829365.8	11.4	Cultural Debris	3	8	
316	C3J1E8	10/20/08	C3J1E8-00159	275406.5	3829362.9	11.4	Cultural Debris	1	6	
317	C3J1E8	10/14/08	C3J1E8-00160	275438.1	3829353.9	11.3	Cultural Debris	1	2	wire
318	C3J1E8	10/15/08	C3J1E8-00161	275446.6	3829374.9	11.3	Cultural Debris	1	6	
319	C3J1E8	10/21/08	C3J1E8-00162	275412.8	3829377.8	11.1	Munitions Debris	1	3	m49a1 trip flare mounting bracket

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
320	C3J1E8	10/21/08	C3J1E8-00163	275401.4	3829376.7	11	Cultural Debris	1	2	
321	C3J1E8	10/16/08	C3J1E8-00164	275418	3829372.2	10.8	Cultural Debris	1	12	
322	C3J1E8	10/21/08	C3J1E8-00165	275416	3829379.2	10.8	Cultural Debris	2	24	
323	C3J1E8	10/23/08	C3J1E8-00166	275437.7	3829399.1	10.8	Cultural Debris	5	6	
324	C3J1E8	10/15/08	C3J1E8-00167	275444	3829394.2	10.6	Cultural Debris	1	5	
325	C3J1E8	10/16/08	C3J1E8-00168	275429.6	3829359.3	10.6	Cultural Debris	1	6	
326	C3J1E8	10/20/08	C3J1E8-00169	275407.5	3829398.8	10.5	Munitions Debris	1	12	40mm flare cartridge expended
327	C3J1E8	10/21/08	C3J1E8-00170	275409	3829379.8	10.3	Cultural Debris	1	6	
328	C3J1E8	10/21/08	C3J1E8-00171	275434.2	3829380.4	10.2	Cultural Debris	2	6	
329	C3J1E8	10/21/08	C3J1E8-00172	275435	3829374.9	10.2	Cultural Debris	1	6	
330	C3J1E8	10/15/08	C3J1E8-00173	275428.2	3829397	9.9	Cultural Debris	1	6	
331	C3J1E8	10/15/08	C3J1E8-00174	275443.6	3829390.6	9.9	Cultural Debris	1	6	
332	C3J1E8	10/15/08	C3J1E8-00175	275432.6	3829363.6	9.8	Cultural Debris	1	6	
333	C3J1E8	10/21/08	C3J1E8-00176	275433.7	3829368.7	9.4	Cultural Debris	2	4	
334	C3J1E8	10/15/08	C3J1E8-00177	275427.4	3829371.2	9.3	Cultural Debris	2	6	
335	C3J1E8	10/15/08	C3J1E8-00179	275424.3	3829389.4	9.2	Cultural Debris	1	6	
336	C3J1E8	10/20/08	C3J1E8-00180	275413.1	3829375.8	9	Cultural Debris	3	2	
337	C3J1E8	10/16/08	C3J1E8-00181	275426.6	3829368.4	9	Cultural Debris	3	6	
338	C3J1E8	10/16/08	C3J1E8-00182	275414.5	3829369.2	8.9	Cultural Debris	1	5	
339	C3J1E8	10/15/08	C3J1E8-00183	275449.9	3829370.7	8.9	Cultural Debris	1		
340	C3J1E8	10/16/08	C3J1E8-00184	275426	3829357.6	8.9	Cultural Debris	1	6	
341	C3J1E8	10/15/08	C3J1E8-00185	275446.2	3829396.8	8.8	Cultural Debris	2	10	
342	C3J1E8	10/20/08	C3J1E8-00186	275420.5	3829394.5	8.7	Cultural Debris	1	6	
343	C3J1E8	10/16/08	C3J1E8-00187	275420.6	3829353.4	8.5	Cultural Debris	1	6	
344	C3J1E8	10/15/08	C3J1E8-00188	275446.6	3829360.2	8.5	Cultural Debris	1	6	
345	C3J1E8	10/15/08	C3J1E8-00189	275444.2	3829377	8.4	Cultural Debris	1	6	
346	C3J1E8	10/14/08	C3J1E8-00190	275439.2	3829387.6	8.4	Cultural Debris	1	2	
347	C3J1E8	10/15/08	C3J1E8-00191	275437.8	3829356.8	8.4	Cultural Debris	1	6	
348	C3J1E8	10/16/08	C3J1E8-00192	275426.6	3829355.2	8.4	Cultural Debris	1	6	
349	C3J1E8	10/16/08	C3J1E8-00193	275421.9	3829355.8	8.3	Cultural Debris	1	6	
350	C3J1E8	10/16/08	C3J1E8-00194	275424.9	3829357.4	8.3	Cultural Debris	2	0	
351	C3J1E8	10/23/08	C3J1E8-00195	275444.6	3829367.8	8.2	No Find	0		
352	C3J1E8	10/15/08	C3J1E8-00196	275447.8	3829360.2	8.2	Cultural Debris	1	6	
353	C3J1E8	10/16/08	C3J1E8-00197	275420.5	3829374.7	8.1	Cultural Debris	1	3	
354	C3J1E8	10/22/08	C3J1E8-00198	275449.1	3829390.2	8.1	Cultural Debris	1		
355	C3J1E8	10/14/08	C3J1E8-00199	275441.3	3829389.8	8	Cultural Debris	2	2	
356	C3J1E8	10/15/08	C3J1E8-00200	275422.6	3829387.9	7.6	Cultural Debris	2	6	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
357	C3J1E8	10/21/08	C3J1E8-00201	275408.2	3829382	7.5	Cultural Debris	1	1	
358	C3J1E8	10/15/08	C3J1E8-00202	275429.6	3829366.3	7.4	Cultural Debris	1	6	
359	C3J1E8	10/15/08	C3J1E8-00203	275424.2	3829381.4	7.4	Cultural Debris	1	4	
360	C3J1E8	10/16/08	C3J1E8-00204	275431.2	3829358.4	7.3	Cultural Debris	2	4	
361	C3J1E8	10/15/08	C3J1E8-00205	275430	3829367.3	7.2	Cultural Debris	1	4	
362	C3J1E8	10/16/08	C3J1E8-00206	275424.2	3829351.2	7.2	Cultural Debris	1	4	
363	C3J1E8	10/21/08	C3J1E8-00207	275402.2	3829382.2	7	Cultural Debris	1	3	
364	C3J1E8	10/21/08	C3J1E8-00208	275434.1	3829370.3	7	Cultural Debris	2	1	
365	C3J1E8	10/15/08	C3J1E8-00209	275443.4	3829393.4	7	Cultural Debris	2	12	
366	C3J1E8	10/16/08	C3J1E8-00210	275423.6	3829358.8	6.9	Cultural Debris	2	4	
367	C3J1E8	10/16/08	C3J1E8-00211	275419.9	3829360.3	6.6	Cultural Debris	2	12	
368	C3J1E8	10/14/08	C3J1E8-00212	275442.4	3829386.4	6.6	Cultural Debris	1	4	
369	C3J1E8	10/20/08	C3J1E8-00213	275406.8	3829355.4	6.4	Cultural Debris	1	6	
370	C3J1E8	10/16/08	C3J1E8-00214	275436	3829351.6	6.3	Cultural Debris	1	6	
371	C3J1E8	10/23/08	C3J1E8-00215	275445.8	3829372.5	6.2	Cultural Debris	1	14	
372	C3J1E8	10/21/08	C3J1E8-00216	275409.6	3829386.9	6.2	Cultural Debris	1	3	
373	C3J1E8	10/16/08	C3J1E8-00217	275428.8	3829350	6.1	Cultural Debris	4	2	
374	C3J1E8	10/20/08	C3J1E8-00218	275407.6	3829356.2	6.1	Cultural Debris	1	4	
375	C3J1E8	10/15/08	C3J1E8-00219	275445.5	3829392.1	6.1	Cultural Debris	1	8	
376	C3J1E8	10/15/08	C3J1E8-00220	275442.6	3829363.2	6	Cultural Debris	1	6	
377	C3J1E8	10/14/08	C3J1E8-00221	275447.4	3829387.4	5.9	Cultural Debris	2	2	
378	C3J1E8	10/16/08	C3J1E8-00222	275426.6	3829364.2	5.9	Cultural Debris	2	3	
379	C3J1E8	10/21/08	C3J1E8-00223	275435	3829370.8	5.8	Cultural Debris	2	4	
380	C3J1E8	10/16/08	C3J1E8-00224	275419.6	3829380	5.8	Cultural Debris	3	10	
381	C3J1E8	10/20/08	C3J1E8-00225	275420.4	3829395.8	5.7	Cultural Debris	1	4	
382	C3J1E8	10/23/08	C3J1E8-00226	275445.5	3829381	5.7	Cultural Debris	1	3	
383	C3J1E8	10/21/08	C3J1E8-00227	275408.2	3829387	5.6	Cultural Debris	1	3	
384	C3J1E8	10/15/08	C3J1E8-00228	275430.4	3829369.6	5.6	Cultural Debris	6	10	
385	C3J1E8	10/15/08	C3J1E8-00229	275426.6	3829372	5.5	Small Arms Ammunition	2	8	.50 cal links
386	C3J1E8	10/15/08	C3J1E8-00230	275449.2	3829373.2	5.4	Cultural Debris	1	1	in mound
387	C3J1E8	10/16/08	C3J1E8-00231	275413	3829371.4	5.4	Cultural Debris	1	4	
388	C3J1E8	10/21/08	C3J1E8-00232	275432.6	3829371	5.4	Cultural Debris	1	3	
389	C3J1E8	10/23/08	C3J1E8-00233	275449.9	3829394.9	5.3	No Find	0		
390	C3J1E8	10/20/08	C3J1E8-00234	275419	3829352	5.3	Cultural Debris	1	2	
391	C3J1E8	10/16/08	C3J1E8-00235	275428	3829351	5.3	Cultural Debris	2	6	
392	C3J1E8	10/23/08	C3J1E8-00236	275449.9	3829381.7	5.2	Cultural Debris	2	0	
393	C3J1E8	10/21/08	C3J1E8-00237	275411.4	3829394.4	5.2	Cultural Debris	2	4	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
394	C3J1E8	10/16/08	C3J1E8-00238	275435.8	3829353.2	5.2	Cultural Debris	3	4	
395	C3J1E8	10/20/08	C3J1E8-00239	275403	3829362.4	5.2	Cultural Debris	2	12	
396	C3J1E8	10/14/08	C3J1E8-00240	275441.4	3829352.6	5.2	Cultural Debris	1	0	wire
397	C3J1E8	10/14/08	C3J1E8-00241	275438.1	3829358.4	5.1	Cultural Debris	1	4	
398	C3J1E8	10/20/08	C3J1E8-00242	275403	3829357	5.1	Cultural Debris	1	10	
399	C3J1E8	10/16/08	C3J1E8-00243	275416.8	3829371.6	5.1	Cultural Debris	1	8	
400	C3J1E8	10/21/08	C3J1E8-00244	275435.2	3829373.6	5.1	Cultural Debris	2	3	
401	C3J1E8	10/16/08	C3J1E8-00245	275412.2	3829367.4	5.1	Cultural Debris	1	2	
402	C3J1E8	10/16/08	C3J1E8-00246	275426.8	3829354.3	5	Cultural Debris	1	12	
403	C3J1E8	10/27/08	C3J1E8-00247	275442.4	3829366	5	Cultural Debris	0		
404	C3J1E8	10/15/08	C3J1E8-00248	275444.5	3829354.9	5	Cultural Debris	1	2	
405	C3J1E8	10/22/08	C3J1E8-00249	275436.4	3829382.6	5	Cultural Debris	3	6	
406	C3J1E8	10/15/08	C3J1E8-00250	275421	3829383.6	5	Cultural Debris	1	8	
407	C3J1E8	10/15/08	C3J1E8-00251	275428.2	3829392.4	5	Cultural Debris	1	10	
408	C3J1E8	10/15/08	C3J1E8-00252	275427.4	3829391.7	4.9	Cultural Debris	1	3	
409	C3J1E8	10/20/08	C3J1E8-00253	275400	3829352.2	4.8	Cultural Debris	1	4	
410	C3J1E8	10/16/08	C3J1E8-00254	275428	3829357	4.8	Cultural Debris	1	4	
411	C3J1E8	10/15/08	C3J1E8-00255	275440.2	3829380.6	4.8	Cultural Debris	1	6	
412	C3J1E8	10/21/08	C3J1E8-00257	275418.8	3829377.7	4.7	Cultural Debris	8	4	
413	C3J1E8	10/15/08	C3J1E8-00258	275445.8	3829357.6	4.7	Cultural Debris	1	3	
414	C3J1E8	10/16/08	C3J1E8-00259	275430.4	3829361	4.7	Cultural Debris	2	10	
415	C3J1E8	10/16/08	C3J1E8-00260	275428.2	3829365.8	4.6	Cultural Debris	3	4	
416	C3J1E8	10/20/08	C3J1E8-00261	275400.1	3829360.8	4.6	Cultural Debris	2	6	
417	C3J1E8	10/20/08	C3J1E8-00262	275419.8	3829350.8	4.5	Cultural Debris	1	6	
418	C3J1E8	10/15/08	C3J1E8-00263	275429.4	3829376.8	4.5	Munitions Debris	1	8	m49a1 trip fuze expended
419	C3J1E8	10/27/08	C3J1E8-00264	275440.3	3829397.8	4.4	Cultural Debris	0		
420	C3J1E8	10/21/08	C3J1E8-00265	275416	3829386	4.4	Cultural Debris	1	4	
421	C3J1E8	10/21/08	C3J1E8-00266	275400.1	3829375	4.3	Cultural Debris	1	4	
422	C3J1E8	10/21/08	C3J1E8-00267	275401.6	3829369.6	4.3	Cultural Debris	1	2	
423	C3J1E8	10/20/08	C3J1E8-00268	275408.2	3829359.5	4.2	Cultural Debris	1	6	
424	C3J1E8	10/23/08	C3J1E8-00269	275449.4	3829394	4.2	Cultural Debris	1	2	
425	C3J1E8	10/15/08	C3J1E8-00270	275448.4	3829353.2	4.2	Cultural Debris	1	8	
426	C3J1E8	10/16/08	C3J1E8-00271	275415.2	3829362.8	4.2	Cultural Debris	1	8	
427	C3J1E8	10/20/08	C3J1E8-00272	275428.2	3829373.4	4.2	Cultural Debris	2	13	
428	C3J1E8	10/27/08	C3J1E8-00273	275423.4	3829385.8	4.1	Cultural Debris	1	6	
429	C3J1E8	10/15/08	C3J1E8-00274	275443.4	3829372.9	4.1	Cultural Debris	1	12	
430	C3J1E8	10/15/08	C3J1E8-00275	275431	3829399.6	4.1	Cultural Debris	1	12	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
431	C3J1E8	10/21/08	C3J1E8-00276	275415.7	3829395.7	4.1	Cultural Debris	1	24	
432	C3J1E8	10/23/08	C3J1E8-00277	275447.9	3829377.6	4.1	Cultural Debris	1	0	
433	C3J1E8	10/15/08	C3J1E8-00278	275441.9	3829371.3	4	Cultural Debris	1	4	
434	C3J1E8	10/15/08	C3J1E8-00279	275427.4	3829399	4	Cultural Debris	1	7	
435	C3J1E8	10/20/08	C3J1E8-00280	275400.8	3829351.4	3.9	Cultural Debris	1	6	
436	C3J1E8	10/16/08	C3J1E8-00281	275412.2	3829365.6	3.8	Cultural Debris	1	2	
437	C3J1E8	10/15/08	C3J1E8-00282	275424.2	3829384.2	3.8	Munitions Debris	1	10	trip flare expended
438	C3J1E8	10/22/08	C3J1E8-00283	275439.4	3829369.6	3.8	No Find	0		
439	C3J1E8	10/20/08	C3J1E8-00284	275414.4	3829353	3.7	Cultural Debris	1	6	
440	C3J1E8	10/14/08	C3J1E8-00285	275440	3829390.4	3.7	Cultural Debris	1	2	
441	C3J1E8	10/15/08	C3J1E8-00286	275440.2	3829383.4	3.7	Cultural Debris	1	6	
442	C3J1E8	10/20/08	C3J1E8-00287	275400.1	3829353.5	3.7	Cultural Debris	1	6	
443	C3J1E8	10/21/08	C3J1E8-00288	275416.8	3829397.6	3.7	Cultural Debris	1	0	
444	C3J1E8	10/16/08	C3J1E8-00290	275431.4	3829350.6	3.7	Cultural Debris	1	2	
445	C3J1E8	10/16/08	C3J1E8-00291	275419	3829359.2	3.7	Cultural Debris	2	6	
446	C3J1E8	10/20/08	C3J1E8-00292	275413.4	3829357.2	3.6	Cultural Debris	2	0	
447	C3J1E8	10/14/08	C3J1E8-00293	275446.2	3829386.8	3.5	Cultural Debris	1	8	
448	C3J1E8	10/15/08	C3J1E8-00294	275446.6	3829361.6	3.5	Cultural Debris	1	6	
449	C3J1E8	10/14/08	C3J1E8-00295	275436.6	3829360.5	3.5	Cultural Debris	1	2	nail
450	C3J1E8	10/16/08	C3J1E8-00296	275411.4	3829368.2	3.5	Cultural Debris	1	4	
451	C3J1E8	10/15/08	C3J1E8-00297	275429.6	3829379.8	3.5	Cultural Debris	1	6	
452	C3J1E8	10/15/08	C3J1E8-00298	275438	3829371.4	3.5	Cultural Debris	1	5	
453	C3J1E8	10/16/08	C3J1E8-00299	275422.2	3829358.8	3.4	Cultural Debris	3	6	
454	C3J1E8	10/16/08	C3J1E8-00300	275427.2	3829366.2	3.4	Cultural Debris	2	6	
455	C3J1E8	10/16/08	C3J1E8-00301	275427.3	3829367.1	3.4	Cultural Debris	1	2	
456	C3J1E8	10/16/08	C3J1E8-00302	275416	3829359	3.4	Cultural Debris	1	6	
457	C3J1E8	10/14/08	C3J1E8-00303	275439	3829367.2	3.4	Small Arms Ammunition	1	2	5.56 cartridge
458	C3J1E8	10/15/08	C3J1E8-00304	275448.2	3829356.8	3.4	Cultural Debris	1	2	
459	C3J1E8	10/16/08	C3J1E8-00305	275422.1	3829374.9	3.4	Cultural Debris	3	3	
460	C3J1E8	10/15/08	C3J1E8-00306	275429.6	3829394.6	3.4	Cultural Debris	1	8	
461	C3J1E8	10/16/08	C3J1E8-00307	275433.4	3829357.2	3.3	Cultural Debris	2	4	
462	C3J1E8	10/15/08	C3J1E8-00308	275433.6	3829399.4	3.3	Cultural Debris	1	5	
463	C3J1E8	10/16/08	C3J1E8-00309	275416	3829362.2	3.3	Cultural Debris	1	6	
464	C3J1E8	10/15/08	C3J1E8-00310	275445.8	3829355.4	3.3	Cultural Debris	1	3	
465	C3J1E8	10/15/08	C3J1E8-00311	275441	3829375.4	3.3	Cultural Debris	1	6	
466	C3J1E8	10/15/08	C3J1E8-00312	275443	3829374.4	3.3	Cultural Debris	1	0	
467	C3J1E8	10/15/08	C3J1E8-00313	275445.4	3829394	3.3	Cultural Debris	1	4	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
468	C3J1E8	10/22/08	C3J1E8-00314	275442.8	3829396.6	3.3	Cultural Debris	1		
469	C3J1E8	10/21/08	C3J1E8-00315	275416.8	3829384.8	3.3	Cultural Debris	1	6	
470	C3J1E8	10/21/08	C3J1E8-00316	275400.8	3829368.2	3.2	Cultural Debris	1	3	
471	C3J1E8	10/21/08	C3J1E8-00317	275405.2	3829396.2	3.2	Cultural Debris	1	6	
472	C3J1E8	10/16/08	C3J1E8-00318	275428.9	3829367.8	3.2	Cultural Debris	2	3	
473	C3J1E8	10/15/08	C3J1E8-00319	275426.6	3829387.8	3.1	Cultural Debris	1	4	
474	C3J1E8	10/16/08	C3J1E8-00320	275416.8	3829360.4	3.1	Cultural Debris	1	2	
475	C3J1E8	10/27/08	C3J1E8-00321	275416	3829391	3.1	Cultural Debris	1	6	brass, and previous dig
476	C3J1E8	10/15/08	C3J1E8-00322	275434.4	3829396.8	3.1	Cultural Debris	1	6	
477	C3J1E8	10/14/08	C3J1E8-00323	275443.4	3829366	3.1	Cultural Debris	1	2	
478	C3J1E8	10/15/08	C3J1E8-00324	275440	3829368	3.1	Cultural Debris	1	3	
479	C3J1E8	10/15/08	C3J1E8-00325	275425	3829382	3	Cultural Debris	1	5	
480	C3J1E8	10/14/08	C3J1E8-00326	275445	3829385.2	3	Cultural Debris	1	4	
481	C3J1E8	10/16/08	C3J1E8-00327	275419.9	3829355.7	3	No Find	0		
482	C3J1E8	10/15/08	C3J1E8-00329	275449.6	3829358	3	Cultural Debris	1	3	
483	C3J1E8	10/20/08	C3J1E8-00330	275406	3829359.9	3	Cultural Debris	1	4	
484	C3J1E8	10/16/08	C3J1E8-00331	275420.6	3829354.8	3	Cultural Debris	1	1	
485	C3J1E8	10/22/08	C3J1E8-00332	275403.6	3829391.8	3	Cultural Debris	3	4	
486	C3J1E8	10/15/08	C3J1E8-00333	275448	3829374.4	3	Munitions Debris	1	4	hand grenade pin
487	C3J1E8	10/20/08	C3J1E8-00334	275405.4	3829364.2	3	Cultural Debris	3	8	
488	C3J1E8	10/20/08	C3J1E8-00335	275410.6	3829371	3	Cultural Debris	1	12	
489	C3J1E8	10/16/08	C3J1E8-00336	275422.2	3829367.4	3	Cultural Debris	1	2	
490	C3J1E8	10/16/08	C3J1E8-00337	275431	3829360.2	3	Cultural Debris	2	5	
491	C3J1E8	10/20/08	C3J1E8-00338	275413.6	3829354.6	3	Cultural Debris	1	4	
492	C3J1E8	10/15/08	C3J1E8-00339	275432.6	3829398.8	3	Cultural Debris	1	7	
493	C3J1E8	10/15/08	C3J1E8-00340	275435.8	3829390.2	3	Cultural Debris	2	8	
494	C3J1E9	10/22/08	C3J1E9-00003	275449.7	3829400.1	597.8	Cultural Debris	1		
495	C3J1E9	10/21/08	C3J1E9-00006	275405.2	3829418	344.3	Cultural Debris	1	6	
496	C3J1E9	10/22/08	C3J1E9-00008	275401.4	3829418.1	265.4	No Find	0		
497	C3J1E9	10/22/08	C3J1E9-00010	275448.8	3829401.4	199.7	Cultural Debris	1		
498	C3J1E9	10/21/08	C3J1E9-00014	275408.3	3829418.7	145.7	No Find	0		
499	C3J1E9	10/22/08	C3J1E9-00016	275426.6	3829447	142.5	Cultural Debris	4	4	Phase I Dig Location
500	C3J1E9	10/22/08	C3J1E9-00023	275400.7	3829449.9	104.3	Cultural Debris	1	0	
501	C3J1E9	10/22/08	C3J1E9-00024	275442.5	3829407.3	96.8	Cultural Debris	1		
502	C3J1E9	10/21/08	C3J1E9-00031	275404.5	3829418.7	74.8	Cultural Debris	1	6	
503	C3J1E9	10/23/08	C3J1E9-00040	275449.9	3829402.2	47.5	Cultural Debris	1	1	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
504	C3J1E9	10/16/08	C3J1E9-00044	275444.4	3829407.5	43.3	Cultural Debris	1	3	
505	C3J1E9	10/23/08	C3J1E9-00048	275400.1	3829406.6	38.3	Cultural Debris	3	1	
506	C3J1E9	10/21/08	C3J1E9-00049	275418.8	3829418.7	37.4	Cultural Debris	1	5	
507	C3J1E9	10/21/08	C3J1E9-00051	275404.5	3829417.3	34.2	Cultural Debris	1	6	
508	C3J1E9	10/22/08	C3J1E9-00052	275443.4	3829406.6	29.5	Cultural Debris	1		
509	C3J1E9	10/22/08	C3J1E9-00053	275444.8	3829400.4	27.2	Cultural Debris	1		
510	C3J1E9	10/21/08	C3J1E9-00056	275409.8	3829449.6	21.8	Cultural Debris	1	2	
511	C3J1E9	10/15/08	C3J1E9-00057	275441.7	3829401.9	19.8	Cultural Debris	1	6	
512	C3J1E9	10/20/08	C3J1E9-00058	275426.4	3829405.8	18.8	Cultural Debris	1	24	
513	C3J1E9	10/15/08	C3J1E9-00059	275423.6	3829402.8	18.3	Cultural Debris	1	6	
514	C3J1E9	10/20/08	C3J1E9-00060	275419.6	3829412.8	17.9	Cultural Debris	2	2	
515	C3J1E9	10/22/08	C3J1E9-00061	275405.4	3829421.1	17.4	Cultural Debris	1	2	
516	C3J1E9	10/21/08	C3J1E9-00062	275419	3829415.8	17.3	Cultural Debris	2	10	
517	C3J1E9	10/21/08	C3J1E9-00063	275413.7	3829400.2	17.1	Cultural Debris	1	12	
518	C3J1E9	10/16/08	C3J1E9-00064	275427.7	3829435	17	Cultural Debris	1	3	
519	C3J1E9	10/21/08	C3J1E9-00065	275401.6	3829413.4	16.9	No Find	0		> 24 inches
520	C3J1E9	10/20/08	C3J1E9-00066	275425	3829405.3	16.8	Cultural Debris	1	24	
521	C3J1E9	10/21/08	C3J1E9-00067	275409	3829417	16.6	Cultural Debris	1	5	
522	C3J1E9	10/21/08	C3J1E9-00069	275441.6	3829427.4	15.5	Cultural Debris	3	4	
523	C3J1E9	10/22/08	C3J1E9-00070	275401	3829414.2	15.1	Cultural Debris	1	18	
524	C3J1E9	10/15/08	C3J1E9-00071	275441.6	3829400.8	15	Cultural Debris	1	6	
525	C3J1E9	10/21/08	C3J1E9-00072	275416	3829406.5	14.6	Cultural Debris	1	4	
526	C3J1E9	10/22/08	C3J1E9-00073	275415.2	3829426	14.4	Cultural Debris	1	4	
527	C3J1E9	10/16/08	C3J1E9-00074	275422.1	3829437.7	14.3	Cultural Debris	1	0	
528	C3J1E9	10/21/08	C3J1E9-00075	275415.2	3829412.2	14.2	Cultural Debris	1	2	
529	C3J1E9	10/20/08	C3J1E9-00076	275426.8	3829403	14	Cultural Debris	1	12	
530	C3J1E9	10/20/08	C3J1E9-00077	275428.2	3829415	13.7	Cultural Debris	4	8	
531	C3J1E9	10/21/08	C3J1E9-00078	275405.4	3829405.6	12.9	Cultural Debris	3	4	
532	C3J1E9	10/20/08	C3J1E9-00079	275428.2	3829422.8	12.2	Cultural Debris	3	8	
533	C3J1E9	10/15/08	C3J1E9-00080	275432.6	3829409.4	12	Cultural Debris	1	0	
534	C3J1E9	10/27/08	C3J1E9-00081	275444.2	3829404.6	10.8	Cultural Debris	0		
535	C3J1E9	10/22/08	C3J1E9-00082	275400.1	3829418.7	10.5	Cultural Debris	1	8	
536	C3J1E9	10/15/08	C3J1E9-00084	275438	3829412	10.4	Cultural Debris	1	3	
537	C3J1E9	10/21/08	C3J1E9-00086	275412.9	3829407.6	10.3	No Find	0		
538	C3J1E9	10/15/08	C3J1E9-00087	275423.6	3829408.2	10.2	Cultural Debris	2	4	
539	C3J1E9	10/22/08	C3J1E9-00088	275445	3829437.4	10.1	Munitions Debris	2	10	MK1 grenade, practice, no fuze, expended

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
540	C3J1E9	10/21/08	C3J1E9-00089	275409.3	3829408.1	9.8	Cultural Debris	1	4	
541	C3J1E9	10/21/08	C3J1E9-00090	275405.2	3829413.2	9.8	Cultural Debris	1	2	
542	C3J1E9	10/21/08	C3J1E9-00091	275404.9	3829402.3	9.5	Cultural Debris	2	2	
543	C3J1E9	10/21/08	C3J1E9-00092	275412.2	3829417	9.5	Cultural Debris	1	3	
544	C3J1E9	10/15/08	C3J1E9-00093	275433.6	3829408.8	9.3	Munitions Debris	6	12	expended smoke grenade components
545	C3J1E9	10/21/08	C3J1E9-00094	275408.4	3829408.6	9.1	Cultural Debris	2	2	
546	C3J1E9	10/20/08	C3J1E9-00095	275432.8	3829421.6	8.8	Cultural Debris	1	12	
547	C3J1E9	10/22/08	C3J1E9-00096	275426	3829429.8	8.4	Cultural Debris	1	3	
548	C3J1E9	10/21/08	C3J1E9-00097	275406	3829401	8.3	Cultural Debris	4	0	
549	C3J1E9	10/21/08	C3J1E9-00098	275415.2	3829414.2	8.3	Cultural Debris	1	8	
550	C3J1E9	10/15/08	C3J1E9-00100	275419.8	3829408.2	8.3	Cultural Debris	4	8	
551	C3J1E9	10/21/08	C3J1E9-00102	275407	3829404.6	8	Cultural Debris	1	3	
552	C3J1E9	10/20/08	C3J1E9-00103	275427.2	3829422.3	8	Cultural Debris	3	8	
553	C3J1E9	10/21/08	C3J1E9-00104	275403	3829404.4	7.9	Cultural Debris	1	6	
554	C3J1E9	10/21/08	C3J1E9-00105	275411.7	3829423.7	7.7	Cultural Debris	1	6	
555	C3J1E9	10/21/08	C3J1E9-00106	275414.2	3829426.6	7.4	Cultural Debris	1	6	
556	C3J1E9	10/21/08	C3J1E9-00108	275417.6	3829420.4	7.3	Cultural Debris	2	3	
557	C3J1E9	10/21/08	C3J1E9-00109	275406.6	3829416.4	7.2	Cultural Debris	1	10	
558	C3J1E9	10/20/08	C3J1E9-00110	275434	3829422.2	7	Cultural Debris	1	0	
559	C3J1E9	10/16/08	C3J1E9-00111	275438.4	3829425.6	6.9	No Find	0		no find (in road)
560	C3J1E9	10/15/08	C3J1E9-00112	275443.2	3829402.2	6.8	Cultural Debris	1	0	
561	C3J1E9	10/22/08	C3J1E9-00113	275430.2	3829441.6	6.7	Cultural Debris	2	2	
562	C3J1E9	10/21/08	C3J1E9-00114	275402.2	3829400.2	6.6	Cultural Debris	2	4	
563	C3J1E9	10/21/08	C3J1E9-00115	275415.2	3829404.8	6.3	Cultural Debris	1	6	
564	C3J1E9	10/22/08	C3J1E9-00116	275442.7	3829404.4	6.3	Cultural Debris	1		
565	C3J1E9	10/15/08	C3J1E9-00117	275436.2	3829412	6.1	Cultural Debris	1	3	
566	C3J1E9	10/21/08	C3J1E9-00119	275411.4	3829419.8	5.9	Cultural Debris	1	4	
567	C3J1E9	10/22/08	C3J1E9-00120	275423.5	3829400.9	5.9	Munitions Debris	1	12	flare cartridge expended
568	C3J1E9	10/22/08	C3J1E9-00121	275441.3	3829403.3	5.9	Cultural Debris	1		
569	C3J1E9	10/22/08	C3J1E9-00122	275400.8	3829419.7	5.8	Cultural Debris	1	10	
570	C3J1E9	10/21/08	C3J1E9-00124	275408.4	3829406.4	5.7	Cultural Debris	1	3	
571	C3J1E9	10/16/08	C3J1E9-00125	275448.6	3829404.2	5.7	Cultural Debris	1	8	
572	C3J1E9	10/21/08	C3J1E9-00126	275420.6	3829415.5	5.6	Cultural Debris	4	5	
573	C3J1E9	10/16/08	C3J1E9-00127	275422.8	3829439.2	5.5	Cultural Debris	1	5	
574	C3J1E9	10/15/08	C3J1E9-00128	275428.8	3829401.2	5.4	Cultural Debris	1	4	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
575	C3J1E9	10/16/08	C3J1E9-00129	275442.3	3829420.3	5.3	Cultural Debris	3	0	
576	C3J1E9	10/21/08	C3J1E9-00130	275413	3829413.2	5.3	Cultural Debris	1	0	
577	C3J1E9	10/21/08	C3J1E9-00131	275412.2	3829412.4	5	Cultural Debris	1	4	
578	C3J1E9	10/15/08	C3J1E9-00132	275431	3829401.6	5	Cultural Debris	1	4	
579	C3J1E9	10/15/08	C3J1E9-00133	275428.3	3829408.1	5	Cultural Debris	3	0	
580	C3J1E9	10/21/08	C3J1E9-00134	275408.4	3829421.2	4.9	Cultural Debris	2	0	
581	C3J1E9	10/22/08	C3J1E9-00135	275402.3	3829447.8	4.8	Munitions Debris	1	0	m159 flare expended
582	C3J1E9	10/21/08	C3J1E9-00136	275420.6	3829421.8	4.7	Cultural Debris	2	3	
583	C3J1E9	10/22/08	C3J1E9-00137	275440.2	3829402.4	4.7	Cultural Debris	1		
584	C3J1E9	10/22/08	C3J1E9-00138	275426	3829446	4.6	Cultural Debris	2	5	
585	C3J1E9	10/21/08	C3J1E9-00139	275403.8	3829412	4.6	Cultural Debris	2	6	
586	C3J1E9	10/21/08	C3J1E9-00140	275406.8	3829401.8	4.5	Cultural Debris	1	3	
587	C3J1E9	10/22/08	C3J1E9-00141	275411	3829429	4.5	Cultural Debris	1	2	
588	C3J1E9	10/21/08	C3J1E9-00142	275408.8	3829404.2	4.5	Cultural Debris	1	2	
589	C3J1E9	10/15/08	C3J1E9-00143	275428	3829402	4.4	Cultural Debris	1	8	
590	C3J1E9	10/16/08	C3J1E9-00144	275429.8	3829434.8	4.4	Cultural Debris	1	2	
591	C3J1E9	10/16/08	C3J1E9-00145	275439	3829429.8	4.4	Cultural Debris	1	3	
592	C3J1E9	10/22/08	C3J1E9-00146	275449.8	3829449.8	4.3	No Find	1		
593	C3J1E9	10/22/08	C3J1E9-00147	275402	3829419.5	4.2	Cultural Debris	1	5	
594	C3J1E9	10/16/08	C3J1E9-00148	275444.4	3829415.8	4	Munitions Debris	1	5	grenade fuze expended
595	C3J1E9	10/21/08	C3J1E9-00149	275408.4	3829413.2	4	Cultural Debris	2	6	
596	C3J1E9	10/21/08	C3J1E9-00150	275414.4	3829416.4	4	Cultural Debris	1	4	
597	C3J1E9	10/21/08	C3J1E9-00151	275422.8	3829425.4	3.9	Cultural Debris	2	12	
598	C3J1E9	10/16/08	C3J1E9-00152	275424.4	3829412	3.9	Cultural Debris	1	3	
599	C3J1E9	10/21/08	C3J1E9-00153	275407.6	3829412.4	3.8	Cultural Debris	2	6	
600	C3J1E9	10/16/08	C3J1E9-00154	275431.1	3829432.3	3.8	Cultural Debris	2	4	
601	C3J1E9	10/22/08	C3J1E9-00155	275449	3829433.8	3.8	Cultural Debris	1	6	
602	C3J1E9	10/20/08	C3J1E9-00156	275431.2	3829416.8	3.8	Cultural Debris	2	5	
603	C3J1E9	10/22/08	C3J1E9-00157	275436.2	3829437.8	3.8	Cultural Debris	1	1	
604	C3J1E9	10/27/08	C3J1E9-00158	275422.8	3829429.6	3.8	Cultural Debris	0		
605	C3J1E9	10/16/08	C3J1E9-00159	275425	3829414	3.7	Cultural Debris	1	2	
606	C3J1E9	10/22/08	C3J1E9-00160	275420.2	3829433.6	3.6	Cultural Debris	1	0	
607	C3J1E9	10/16/08	C3J1E9-00161	275432	3829414	3.6	Cultural Debris	1	3	
608	C3J1E9	10/22/08	C3J1E9-00162	275406.6	3829441.2	3.6	No Find	0		
609	C3J1E9	10/16/08	C3J1E9-00163	275446.7	3829415.8	3.5	Cultural Debris	1	8	
610	C3J1E9	10/16/08	C3J1E9-00164	275428.2	3829412.6	3.5	Cultural Debris	1	5	

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
611	C3J1E9	10/22/08	C3J1E9-00166	275419	3829433.4	3.4	Cultural Debris	1		
612	C3J1E9	10/20/08	C3J1E9-00167	275432.6	3829420	3.3	Cultural Debris	3	3	
613	C3J1E9	10/21/08	C3J1E9-00168	275413.8	3829423.4	3.3	Cultural Debris	1	1	
614	C3J1E9	10/16/08	C3J1E9-00169	275436.2	3829432.2	3.2	Cultural Debris	1	4	
615	C3J1E9	10/22/08	C3J1E9-00170	275446.7	3829428.2	3.2	Cultural Debris	1	6	
616	C3J1E9	10/16/08	C3J1E9-00171	275429.8	3829430.2	3.2	Cultural Debris	2	2	
617	C3J1E9	10/22/08	C3J1E9-00172	275416.8	3829416.8	3.2	Cultural Debris	1	2	
618	C3J1E9	10/21/08	C3J1E9-00173	275415.9	3829411.2	3.1	Cultural Debris	3	6	
619	C3J1E9	10/21/08	C3J1E9-00174	275404.6	3829404.4	3.1	Cultural Debris	1	3	
620	C3J1E9	10/15/08	C3J1E9-00175	275420.6	3829410.3	3.1	Cultural Debris	1	6	
621	C3J1E9	10/22/08	C3J1E9-00176	275402.1	3829440.2	3.1	Cultural Debris	1	2	
622	C3J1E9	10/15/08	C3J1E9-00177	275425.9	3829400.1	3.1	Cultural Debris	1	10	
623	C3J1E9	10/22/08	C3J1E9-00178	275403.8	3829423.6	3.1	No Find	0		
624	C3J1E9	10/22/08	C3J1E9-00179	275448.2	3829428.6	3.1	Munitions Debris	1	4	grenade fuze expended
625	C3J1E9	10/21/08	C3J1E9-00180	275406.8	3829410.4	3.1	Cultural Debris	3	2	
626	C3J1E9	10/22/08	C3J1E9-00181	275411.6	3829437.8	3	Cultural Debris	1	1	
627	C3J1E9	10/22/08	C3J1E9-00182	275409.8	3829423.2	3	Cultural Debris	1	0	
628	C3J1E9	10/16/08	C3J1E9-00183	275442.6	3829411	3	Munitions Debris	1	4	grenade fuze expended
629	C3J1E9	10/22/08	C3J1E9-00184	275445.8	3829430	3	Cultural Debris	1	4	
630	C3J1E9	10/27/08	C3J1E9-00186	275428.8	3829407.2	3	Cultural Debris	0		
631	C3J1E9	10/15/08	C3J1E9-00187	275434.2	3829406.4	3	Cultural Debris	2	12	
632	C3J1E9	10/22/08	C3J1E9-00188	275442.8	3829440.2	3	Cultural Debris	1	1	
633	C3J1E9	10/16/08	C3J1E9-00189	275433.8	3829434.5	3	Cultural Debris	1		axe head 4'E at 590mv
634	C3J1E9	10/16/08	C3J1E9-00190	275437.2	3829425.8	3	No Find	0		no find (in road)
635	C3J1E9	10/16/08	C3J1E9-00191	275434.2	3829414	3	Cultural Debris	1	6	
636	C3J1E9	10/21/08	C3J1E9-00192	275419	3829410.8	3	Cultural Debris	1	2	
637	C3J1F0	10/27/08	C3J1F0-00002	275453.5	3829462.3	16.2	Munitions Debris	1	10	M-22 ground signal flare, expended
638	C3J1F7	10/27/08	C3J1F7-00002	275450.6	3829338.2	9.6	Cultural Debris	0		
639	C3J1F7	10/14/08	C3J1F7-00003	275459.5	3829341.3	3.5	Cultural Debris	1	0	
640	C3J1F7	10/23/08	C3J1F7-00004	275456.7	3829346.1	3.5	Cultural Debris	1	2	
641	C3J1F7	10/23/08	C3J1F7-00005	275452	3829344.6	3.5	Cultural Debris	1	3	
642	C3J1F7	10/23/08	C3J1F7-00006	275452.3	3829349.7	3.3	No Find	0		
643	C3J1F8	10/15/08	C3J1F8-00004	275456.8	3829389.8	127.4	Small Arms Ammunition	200	6	pm ammo

**TABLE E-3**

Phase II DGM Intrusive Investigation Results  
Former Gun Positions 41A & 41B  
MCB Camp Lejeune, North Carolina

Dig Event ID	Grid	Date	ID	X Coordinates	Y Coordinates	Amplitude (mV)	Type	Quantity	Depth (inches)	Comment
644	C3J1F8	10/14/08	C3J1F8-00007	275450.2	3829385.4	27.8	Cultural Debris	1	10	
645	C3J1F8	10/15/08	C3J1F8-00009	275450.1	3829368.1	16	Munitions Debris	1		M-22 ground signal flare tube
646	C3J1F8	10/23/08	C3J1F8-00010	275451.7	3829393.4	14.3	Cultural Debris	1	1	
647	C3J1F8	10/14/08	C3J1F8-00011	275452.2	3829390	14.1	Cultural Debris	1	12	
648	C3J1F8	10/23/08	C3J1F8-00012	275450.2	3829384	12.8	Cultural Debris	1	24	
649	C3J1F8	10/15/08	C3J1F8-00013	275451.2	3829357.6	10.5	Cultural Debris	1	6	
650	C3J1F8	10/14/08	C3J1F8-00014	275459.6	3829364.5	9.9	Cultural Debris	1	4	
651	C3J1F8	10/14/08	C3J1F8-00015	275458.4	3829394.6	9.8	Cultural Debris	1	6	
652	C3J1F8	10/15/08	C3J1F8-00016	275450.3	3829370.8	9.1	Cultural Debris	1	12	
653	C3J1F8	10/22/08	C3J1F8-00017	275450.2	3829390.2	6.8	Cultural Debris	1		
654	C3J1F8	10/14/08	C3J1F8-00018	275452.6	3829386.2	6.1	Cultural Debris	1	0	
655	C3J1F8	10/14/08	C3J1F8-00020	275452.8	3829365	5.9	Cultural Debris	3	18	
656	C3J1F8	10/23/08	C3J1F8-00021	275450.2	3829394.6	5.1	Cultural Debris	2	0	
657	C3J1F8	10/23/08	C3J1F8-00022	275450.2	3829381.6	5.1	Cultural Debris	2	0	
658	C3J1F8	10/15/08	C3J1F8-00023	275452.8	3829363.7	4.5	Cultural Debris	2	3	
659	C3J1F8	10/14/08	C3J1F8-00024	275454.1	3829383.9	4	Cultural Debris	1	5	
660	C3J1F8	10/14/08	C3J1F8-00025	275453.4	3829388.8	3.8	Cultural Debris	1	4	
661	C3J1F8	10/15/08	C3J1F8-00026	275452.4	3829362.4	3.6	No Find	0		
662	C3J1F8	10/23/08	C3J1F8-00027	275453.6	3829395.2	3.5	Cultural Debris	1	1	
663	C3J1F8	10/14/08	C3J1F8-00028	275454.6	3829384.8	3.5	Cultural Debris	1	4	
664	C3J1F8	10/23/08	C3J1F8-00029	275452.4	3829395.2	3.4	Cultural Debris	1	2	
665	C3J1F8	10/15/08	C3J1F8-00030	275450.9	3829362.1	3.2	Cultural Debris	1	5	
666	C3J1F8	10/15/08	C3J1F8-00031	275452.6	3829376.4	3	Cultural Debris	1	3	
667	C3J1F8	10/14/08	C3J1F8-00032	275451.8	3829383.2	3	Cultural Debris	1	2	
668	C3J1F8	10/23/08	C3J1F8-00033	275452.7	3829399	3	Cultural Debris	1	1	
669	C3J1F8	10/27/08	C3J1F8-00034	275451.8	3829377.4	3	Cultural Debris	0		
670	C3J1F9	10/27/08	C3J1F9-00004	275450.8	3829402.2	57.5	Cultural Debris	0		
671	C3J1F9	10/14/08	C3J1F9-00005	275454.8	3829420.6	9.2	Small Arms Ammunition	1	6	40mm cartridge
672	C3J1F9	10/22/08	C3J1F9-00006	275450.3	3829437.9	8.2	Cultural Debris	1	4	
673	C3J1F9	10/23/08	C3J1F9-00007	275452.8	3829400.9	7.3	Cultural Debris	2	0	
674	C3J1F9	10/22/08	C3J1F9-00008	275453.2	3829438.4	5.2	Cultural Debris	1	6	
675	C3J1F9	10/14/08	C3J1F9-00010	275456	3829406.6	3.5	Cultural Debris	1	8	
676	C3J1F9	10/16/08	C3J1F9-00011	275453.1	3829404.5	3.3	Cultural Debris	2	5	
677	C3J1F9	10/14/08	C3J1F9-00012	275457	3829418.6	3.1	No Find	0		
678	C3J1F9	10/16/08	C3J1F9-00013	275450.1	3829405.4	3.1	Cultural Debris	1	4	

**Appendix F**  
**Human Health Risk Tables**

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**TABLE 1**  
 Selection of Exposure Pathways  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway		
Current	Groundwater	Groundwater	Tap Water	Resident	Adult	Dermal Absorption	On-site	None	Groundwater not currently used on site as a water supply.		
						Ingestion	On-site	None	Groundwater not currently used on site as a water supply.		
					Child	Dermal Absorption	On-site	None	Groundwater not currently used on site as a water supply.		
						Ingestion	On-site	None	Groundwater not currently used on site as a water supply.		
Current/Future	Combined Surface and Subsurface Soil	Combined Surface and Subsurface Soil	Site Soil	Resident	Adult	Dermal	On-site	Quant	On-site residents may contact soil on site.		
						Ingestion	On-site	Quant	On-site residents may contact soil on site.		
					Child	Dermal	On-site	Quant	On-site residents may contact soil on site.		
						Ingestion	On-site	Quant	On-site residents may contact soil on site.		
					Industrial Worker	Dermal	On-site	Quant	Site workers may contact soil on site.		
						Ingestion	On-site	Quant	Site workers may contact soil on site.		
				Construction Worker	Dermal	On-site	Quant	Construction workers may contact soil on site.			
					Ingestion	On-site	Quant	Construction workers may contact soil on site.			
				Air	Emissions from Site Soil	Resident	Adult	Inhalation	On-site	None	VOC contamination not expected based on past site use.
							Child	Inhalation	On-site	None	VOC contamination not expected based on past site use.
						Industrial Worker	Adult	Inhalation	On-site	None	VOC contamination not expected based on past site use.
						Construction Worker	Adult	Inhalation	On-site	None	VOC contamination not expected based on past site use.

**TABLE 1**  
 Selection of Exposure Pathways  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway	
Future	Groundwater	Groundwater	Tap Water	Resident in Barracks	Adult	Dermal Absorption	On-site	Quant	Although unlikely, groundwater could be used as a potable water supply for residents of barracks in the future.	
						Ingestion	On-site	Quant	Although unlikely, groundwater could be used as a potable water supply for residents of barracks in the future.	
				Resident	Adult	Ingestion	On-site	Quant	Although unlikely, site could be developed for future residential use and groundwater could be used as future potable water supply.	
						Dermal	On-site	Quant	Although unlikely, site could be developed for future residential use and groundwater could be used as future potable water supply. The adult is assumed to shower.	
					Child	Ingestion	On-site	Quant	Although unlikely, site could be developed for future residential use and groundwater could be used as future potable water supply.	
						Dermal	On-site	Quant	Although unlikely, site could be developed for future residential use and groundwater could be used as future potable water supply. The child is assumed to bathe.	
					Child/Adult	Ingestion	On-site	Quant	Although unlikely, site could be developed for future residential use and groundwater could be used as future potable water supply.	
						Dermal	On-site	Quant	Although unlikely, site could be developed for future residential use and groundwater could be used as future potable water supply.	
				Water in Excavation Pit	Construction Worker	Adult	Dermal Absorption	On-site	Quant	Construction worker may contact shallow groundwater during excavation activities.
							Ingestion	On-site	None	Construction worker not expected to incidentally ingest significant amounts of groundwater during construction activities.
		Air	Water Vapors at Showerhead	Resident in Barracks	Adult	Inhalation	On-site	None	VOC contamination not expected based on past site use.	
						Resident	Adult	Inhalation	On-site	None
				Child	Inhalation	On-site		None	VOC contamination not expected based on past site use.	
				Child/Adult	Inhalation	On-site	None	VOC contamination not expected based on past site use.		
				Water Vapors in Excavation Pit	Construction Worker	Adult	Inhalation	On-site	None	VOC contamination not expected based on past site use.

TABLE 2.1

Occurrence, Distribution and Selection of Chemicals of Potential Concern  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Current/Future  
 Medium: Combined Surface and Subsurface Soil  
 Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Site Soil	7440-38-2	Arsenic	4.2E-01 J	1.4E+00	MG_KG	ASR2.212-GP41-DU03-SS03	10/16	1.1 - 1.4	1.4E+00	6.3E-01	3.9E-01 ca	3.0E+01	NC SSL	YES	ASL
	7440-39-3	Barium	4.5E+00 J	1.7E+01 J	MG_KG	ASR2.212-GP41-IS01-1-3	16/16	21.7 - 27.2	1.7E+01	1.4E+01	1.5E+03 nc	8.5E+02	NC SSL	NO	BSL
	7440-47-3	Chromium	2.6E+00	2.4E+01	MG_KG	ASR2.212-GP41-IS01-1-3	16/16	1.1 - 1.4	2.4E+01	6.1E+00	2.8E+02 ca	2.7E+01	NC SSL	NO	BSL
	7439-92-1	Lead	3.3E+00	1.4E+01	MG_KG	ASR2.212-GP41-DU04-SS02	16/16	0.33 - 0.41	1.4E+01	8.5E+00	4.0E+02 nc	2.7E+02	NC SSL	NO	BSL
	7439-97-6	Mercury	1.9E-02 J	2.6E-02 J	MG_KG	ASR2.212-GP41-DU03-SS02	7/16	0.034 - 0.045	2.6E-02	7.1E-02	2.3E+00 nc	1.5E-02	NC SSL	NO	BSL
	7782-49-2	Selenium	5.7E-01 UJ	9.1E-01 J	MG_KG	ASR2.212-GP41-DU01-SS02	6/16	0.54 - 0.68	9.1E-01	5.0E-01	3.9E+01 nc	1.2E+01	NC SSL	NO	BSL

\* Surface soil & subsurface soil combined

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values are the lower of two times the arithmetic mean basewide background surface soil or subsurface soil concentrations. Background values are from *Final Base Background Soil Study Report, Marine Corps Base Camp Lejeune, North Carolina*, Baker Environmental, April 25, 2001.

[4] Oak Ridge National Laboratory (ORNL), August, 2008. Regional Screening Levels for Chemical Contaminants at Superfund Sites. [Online]. Available: <http://epa-prgs.ornl.gov/chemicals/index.shtml>

RSL value for Mercury (inorganic salts) used for mercury.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)  
 Deletion Reason: No Toxicity Information (NTX)  
 Essential Nutrient (NUT)  
 Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/  
 To Be Considered

J = Estimated Value

K = Biased High

L = Biased Low

ca = Carcinogenic

nc = Noncarcinogenic

NCSSL = North Carolina Soil Screening Levels (NCDENR, June 2008)

TABLE 2.1a

Risk Ratio Screening for Combined Surface and Subsurface Soil, Maximum Detected Concentration

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample	EPA Regional Screening Level	Acceptable Risk Level	Corresponding Hazard Index <sup>a</sup>	Corresponding Cancer Risk <sup>b</sup>	Target Organ
<b>Metals (mg/kg)</b>								
Arsenic	10 / 16	1.4E+00	ASR2.212-GP41-DU03-SS03	3.9E-01	1E-06		4E-06	
<b>Cumulative Corresponding Hazard Index<sup>c</sup></b>								
<b>Cumulative Corresponding Cancer Risk<sup>d</sup></b>							4E-06	

<sup>a</sup> Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

<sup>b</sup> Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

<sup>c</sup> Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

<sup>d</sup> Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05,

otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern

HI = Hazard Index

mg/kg = Milligrams per kilogram

TABLE 2.2

Occurrence, Distribution and Selection of Chemicals of Potential Concern  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future Medium: Groundwater Exposure Medium: Groundwater
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Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Tap Water	7440-38-2	Arsenic	3.0E+00	1.9E+01	UG_L	ASR2.212-GP41-TW01-2-12	4/4	1 - 5	1.9E+01	5.8E+00	4.5E-02 ca	1.0E+01 5.0E+01	MCL NCGWQS	YES	ASL
	7440-39-3	Barium	8.1E+01	1.2E+02	UG_L	ASR2.212-GP41-TW03-2-12	4/4	5 - 25	1.2E+02	8.6E+01	7.3E+02 nc	2.0E+03	MCL, NCGWQS	NO	BSL
	7440-43-9	Cadmium	8.9E-02 J	2.2E-01 J	UG_L	ASR2.212-GP41-TW03-2-12	3/4	1 - 5	2.2E-01	3.6E-01	1.8E+00 nc	5.0E+00 1.8E+00	MCL NCGWQS	NO	BSL
	7440-47-3	Chromium	6.8E+00 J	6.2E+01 J	UG_L	ASR2.212-GP41-TW03-2-12	4/4	2 - 10	6.2E+01	3.1E+00	1.1E+01 nc	1.0E+02 5.0E+01	MCL NCGWQS	YES	ASL
	7439-92-1	Lead	8.7E+00 J	5.7E+01 J	UG_L	ASR2.212-GP41-TW03-2-12	4/4	1 - 5	5.7E+01	2.8E+00	1.5E+01 M	1.5E+01	MCL, NCGWQS	YES	ASL
	7439-97-6	Mercury	2.8E-01	2.8E-01	UG_L	ASR2.212-GP41-TW03-2-12	1/4	0.2 - 0.2	2.8E-01	1.0E-01	1.1E+00 nc	2.0E+00 1.1E+00	MCL NCGWQS	NO	BSL
	7782-49-2	Selenium	9.1E-01 J	5.4E+00 J	UG_L	ASR2.212-GP41-TW03-2-12	3/4	5 - 25	5.4E+00	3.1E+00	1.8E+01 nc	5.0E+01	MCL, NCGWQS	NO	BSL

[1] Minimum/Maximum detected concentration. Unfiltered results for metals since in general no significant difference between filtered and unfiltered results.

[2] Maximum concentration is used for screening.

[3] Background values are two times the arithmetic mean basewide background shallow groundwater concentrations. Background values are from *Baker Environmental, Draft Base Background Groundwater Study, Marine Corps Base, MCB Camp Lejeune, North Carolina, August 2002*

[4] Oak Ridge National Laboratory (ORNL). September 12, 2008. Regional Screening Levels for Chemical Contaminants at Superfund Sites. [Online]. Available: <http://epa-prgs.ornl.gov/chemicals/index.shtml>  
 The tap water value of 15 ug/L for lead is the action level provided in the Drinking Water Regulations and Health Advisories.  
 RSL value for Mercury (inorganic salts) used for mercury.

[5] Rationale Codes  
 Selection Reason: Above Screening Levels (ASL)  
 Deletion Reason: No Toxicity Information (NTX)  
 Essential Nutrient (NUT)  
 Below Screening Level (BSL)

COPC = Chemical of Potential Concern  
 ARAR/TBC = Applicable or Relevant and Appropriate Requirement/  
 To Be Considered  
 J = Estimated Value  
 K = Biased High  
 L = Biased Low  
 ca = Carcinogenic  
 nc = Noncarcinogenic  
 M = Action level for lead from Federal Drinking Water MCLs  
 15A NCAC 2L - Classifications and Groundwater Quality Standards, Amended April 1, 2005.  
 MCL = Maximum Contaminant Level from EPA's National Primary Drinking Water Standards

TABLE 2.2a

Risk Ratio Screening for Unfiltered Groundwater, Maximum Detected Concentration

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample	EPA Regional Screening Level	Acceptable Risk Level	Corresponding Hazard Index <sup>a</sup>	Corresponding Cancer Risk <sup>b</sup>	Target Organ
<b>Metals (ug/L)</b>								
Arsenic	4 / 4	1.9E+01	ASR2.212-GP41-TW01-2-12	4.5E-02	1E-06		4.2E-04	
Chromium	4 / 4	6.2E+01	ASR2.212-GP41-TW03-2-12	1.1E+02	1.0	0.6		None reported
<b>Cumulative Corresponding Hazard Index<sup>c</sup></b>						<b>0.6</b>		
<b>Cumulative Corresponding Cancer Risk<sup>d</sup></b>							<b>4.2E-04</b>	

<sup>a</sup> Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

<sup>b</sup> Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

<sup>c</sup> Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

<sup>d</sup> Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern

HI = Hazard Index

J = Estimated Value

ug/L = micrograms per liter

**TABLE 3.1.RME**

Medium-Specific Exposure Point Concentration Summary  
*Former Gun Position 41A & 41B*  
*MCB Camp Lejeune, North Carolina*

Scenario Timeframe: Future  
 Medium: Groundwater  
 Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Tap Water and Water in Excavation Pit	Arsenic	UG/L	8.6E+00	NA	NP	1.9E+01	1.9E+01	UG/L	Max	1
	Chromium	UG/L	2.6E+01	NA	NP	6.2E+01 J	6.2E+01	UG/L	Max	1
	Lead	UG/L	2.4E+01	NA	NP	5.7E+01	5.7E+01	UG/L	Max	1

Options: Mean of data assuming normal distribution (Mean-N)

Total inorganic data used for groundwater because no significant difference between total and dissolved data.

(1) Maximum detected concentration conservatively used as exposure point concentration as only four samples are available and there is no groundwater contamination plume.

UG/L = micrograms per liter

J = Estimated Value

**TABLE 3.1.CTE**  
 Medium-Specific Exposure Point Concentration Summary  
*Former Gun Position 41A & 41B*  
*MCB Camp Lejeune, North Carolina*

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Tap Water and Water in Excavation Pit	Arsenic	UG/L	8.6E+00	NA	NP	1.9E+01	8.6E+00	UG/L	Mean-N	1
	Chromium	UG/L	2.6E+01	NA	NP	6.2E+01 J	2.6E+01	UG/L	Mean-N	1
	Lead	UG/L	2.4E+01	NA	NP	5.7E+01	2.4E+01	UG/L	Mean-N	1

Options: Mean of data assuming normal distribution (Mean-N)

Total inorganic data used for groundwater because no significant difference between total and dissolved data.

(1) Following EPA Region 4 risk assessment guidance, average concentration used as EPC.

UG/L = micrograms per liter

J = Estimated Value

TABLE 4.1.RME  
 Values Used for Daily Intake Calculations  
 Reasonable Maximum Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name
Ingestion	Resident in Barracks	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	Chronic Daily Intake (CDI) (mg/kg-day) = CW x IR-W x EF x ED x CF1 x 1/BW x 1/AT
				IR-W	Ingestion Rate of Water	2	liters/day	EPA, 1997	
				EF	Exposure Frequency	350	days/year	EPA, 1991	
				ED	Exposure Duration	4	years	(1)	
				CF1	Conversion Factor 1	0.001	mg/µg	--	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	1,460	days	(1)	
	Resident	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	Chronic Daily Intake (CDI) (mg/kg-day) = CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT
				IR-W	Ingestion Rate of Water	2	liters/day	EPA, 1997	
				EF	Exposure Frequency	350	days/year	EPA, 1991	
				ED	Exposure Duration	24	years	EPA, 1991	
				CF2	Conversion Factor 2	0.001	mg/µg	--	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	EPA, 1989	
		Child	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	CDI (mg/kg-day) = CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT
				IR-W	Ingestion Rate of Water	1	liters/day	EPA, 1997	
				EF	Exposure Frequency	350	days/year	EPA, 1991	
				ED	Exposure Duration	6	years	EPA, 1991	
	Child/Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	CDI (mg/kg-day) = CW x IR-W-Adj x EF x CF2 x 1/AT  IR-W-Adj (liter-year/kg-day) = (ED-C x IR-W-C / BW-C) + (ED-A x IR-W-A / BW-A)	
			IR-W-A	Ingestion Rate of Water, Adult	2	liters/day	EPA, 1997		
			IR-W-C	Ingestion Rate of Water, Child	1	liters/day	EPA, 1997		
			IR-W-Adj	Ingestion Rate of Water, Age-adjusted	1.09	liter-year/kg-day	calculated		
			EF	Exposure Frequency	350	days/year	EPA, 1991		
			ED-A	Exposure Duration, Adult	24	years	EPA, 1991		
			ED-C	Exposure Duration, Child	6	years	EPA, 1991		
			CF2	Conversion Factor 2	0.001	mg/µg	--		
BW-A	Body Weight, Adult	70	kg	EPA, 1991					
BW-C	Body Weight, Child	15	kg	EPA, 1991					
AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989					

TABLE 4.1.RME  
 Values Used for Daily Intake Calculations  
 Reasonable Maximum Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name
Dermal	Resident in Barracks	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	$CDI \text{ (mg/kg-day)} = DA_{event} \times SA \times EV \times EF \times ED \times 1/BW \times 1/AT$  $Inorganics: DA_{event} \text{ (mg/cm}^2\text{-event)} = K_p \times CW \times t_{event} \times CF2 \times CF3$  $Organics:$ $t_{event} < t^*: DA_{event} \text{ (mg/cm}^2\text{-event)} = 2 \times FA \times K_p \times CW \times (\sqrt{(6 \times \tau \times t_{event})/\pi}) \times CF2 \times CF3$  $t_{event} > t^*: DA_{event} \text{ (mg/cm}^2\text{-event)} = FA \times K_p \times CW \times (t_{event}/(1+B) + 2 \times \tau \times ((1 + 3B + 3B^2)/(1+B)^2)) \times CF2 \times CF3$
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm <sup>2</sup> -event	calculated	
FA				Fraction absorbed water	chemical specific	dimensionless	EPA, 2004		
K <sub>p</sub>				Permeability Coefficient	chemical specific	cm/hr	EPA, 2004		
τ				Lag Time	chemical specific	hr/event	EPA, 2004		
t*				Time to Reach Steady-state Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	hours	EPA, 2004		
B				Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004		
t <sub>event</sub>				Event Time	0.58	hr/event	EPA, 2004		
SA				Skin Surface Area Available for Contact	18,000	cm <sup>2</sup>	EPA, 2004		
EV				Event Frequency	1	events/day	EPA, 2004		
EF				Exposure Frequency	350	days/year	EPA, 2004		
ED				Exposure Duration	4	years	(1)		
BW				Body Weight	70	kg	EPA, 1991		
AT-C				Averaging Time (Cancer)	25,550	days	EPA, 1989		
AT-N				Averaging Time (Non-Cancer)	1,460	days	(1)		
CF2				Conversion Factor 2	0.001	mg/µg	--		
CF3				Conversion Factor 3	0.001	l/cm <sup>3</sup>	--		
	Resident	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	$CDI \text{ (mg/kg-day)} = DA_{event} \times SA \times EV \times EF \times ED \times 1/BW \times 1/AT$  $Inorganics: DA_{event} \text{ (mg/cm}^2\text{-event)} = K_p \times CW \times t_{event} \times CF2 \times CF3$  $Organics:$ $t_{event} < t^*: DA_{event} \text{ (mg/cm}^2\text{-event)} = 2 \times FA \times K_p \times CW \times (\sqrt{(6 \times \tau \times t_{event})/\pi}) \times CF2 \times CF3$  $t_{event} > t^*: DA_{event} \text{ (mg/cm}^2\text{-event)} = FA \times K_p \times CW \times (t_{event}/(1+B) + 2 \times \tau \times ((1 + 3B + 3B^2)/(1+B)^2)) \times CF2 \times CF3$
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm <sup>2</sup> -event	calculated	
FA				Fraction absorbed water	chemical specific	dimensionless	EPA, 2004		
K <sub>p</sub>				Permeability Coefficient	chemical specific	cm/hr	EPA, 2004		
τ				Lag Time	chemical specific	hr/event	EPA, 2004		
t*				Time to Reach Steady-state	chemical specific	hours	EPA, 2004		
B				Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004		
t <sub>event</sub>				Event Time	0.58	hr/event	EPA, 2004		
SA				Skin Surface Area Available for Contact	18,000	cm <sup>2</sup>	EPA, 2004		
EV				Event Frequency	1	events/day	EPA, 2004		
EF				Exposure Frequency	350	days/year	EPA, 2004		
ED				Exposure Duration	24	years	EPA, 2004		
BW				Body Weight	70	kg	EPA, 1991		
AT-C				Averaging Time (Cancer)	25,550	days	EPA, 1989		
AT-N				Averaging Time (Non-Cancer)	8,760	days	EPA, 1989		
CF2				Conversion Factor 2	0.001	mg/µg	--		
CF3				Conversion Factor 3	0.001	l/cm <sup>3</sup>	--		

TABLE 4.1.RME  
 Values Used for Daily Intake Calculations  
 Reasonable Maximum Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future  
 Medium: Groundwater  
 Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name
Dermal	Resident	Child	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	$CDI (mg/kg\text{-}day) = DA_{event} \times SA \times EV \times EF \times ED \times 1/BW \times 1/AT$  $Inorganics: DA_{event} (mg/cm^2\text{-}event) = K_p \times CW \times t_{event} \times CF2 \times CF3$  $Organics:$ $t_{event} < t^*: DA_{event} (mg/cm^2\text{-}event) = 2 \times FA \times K_p \times CW \times (\sqrt{t_{event}} / \sqrt{6 \times \tau \times t_{event}}) \times CF2 \times CF3$  $t_{event} > t^*: DA_{event} (mg/cm^2\text{-}event) = FA \times K_p \times CW \times (t_{event} / (1+B) + 2 \times \tau \times ((1 + 3B + 3B^2) / (1+B)^2)) \times CF2 \times CF3$
		DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm <sup>2</sup> -event	calculated			
FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2004					
K <sub>p</sub>	Permeability Coefficient	chemical specific	cm/hr	EPA, 2004					
τ	Lag Time	chemical specific	hr/event	EPA, 2004					
t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2004					
B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004					
t <sub>event</sub>	Event Time	1.0	hr/event	EPA, 2004					
SA	Skin Surface Area Available for Contact	6,600	cm <sup>2</sup>	EPA, 2004					
EV	Event Frequency	1	events/day	EPA, 2004					
EF	Exposure Frequency	350	days/year	EPA, 2004					
ED	Exposure Duration	6	years	EPA, 2004					
BW	Body Weight	15	kg	EPA, 1991					
AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989					
AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989					
CF2	Conversion Factor 2	0.001	mg/µg	--					
CF3	Conversion Factor 3	0.001	l/cm <sup>3</sup>	--					
Dermal	Resident	Child/Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	$CDI (mg/kg\text{-}day) = DA\text{-}Adj \times EF \times 1/AT$  $DA\text{-}Adj = (DA_{event\text{-}A} \times SA\text{-}A \times ED\text{-}A \times 1/BW\text{-}A) + (DA_{event\text{-}C} \times SA\text{-}C \times ED\text{-}C \times 1/BW\text{-}C)$  $Inorganics: DA_{event} (mg/cm^2\text{-}event) = K_p \times CW \times t_{event} \times CF2 \times CF3$  $Organics:$ $t_{event} < t^*: DA_{event} (mg/cm^2\text{-}event) = 2 \times FA \times K_p \times CW \times (\sqrt{t_{event}} / \sqrt{6 \times \tau \times t_{event}}) \times CF2 \times CF3$  $t_{event} > t^*: DA_{event} (mg/cm^2\text{-}event) = FA \times K_p \times CW \times (t_{event} / (1+B) + 2 \times \tau \times ((1 + 3B + 3B^2) / (1+B)^2)) \times CF2 \times CF3$
		DAevent-A	Dermally Absorbed Dose per Event, Adult	calculated	mg/cm <sup>2</sup> -event	calculated			
DAevent-C	Dermally Absorbed Dose per Event, Child	calculated	mg/cm <sup>2</sup> -event	calculated					
DA-Adj	Dermally Absorbed Dose, Age-adjusted	calculated	mg-year/event-kg	calculated					
FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2004					
K <sub>p</sub>	Permeability Coefficient	chemical specific	cm/hr	EPA, 2004					
τ	Lag Time	chemical specific	hr/event	EPA, 2004					
t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2004					
B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004					
t <sub>event</sub> -A	Event Time, Adult	0.58	hr/event	EPA, 2004					
t <sub>event</sub> -C	Event Time, Child	1.0	hr/event	EPA, 2004					
SA-A	Skin Surface Area, Adult	18,000	cm <sup>2</sup>	EPA, 2004					
SA-C	Skin Surface Area, Child	6,600	cm <sup>2</sup>	EPA, 2004					
EV	Event Frequency	1	events/day	EPA, 2004					
EF	Exposure Frequency	350	days/year	EPA, 2004					
ED-A	Exposure Duration, Adult	24	years	EPA, 2004					
ED-C	Exposure Duration, Child	6	years	EPA, 2004					
BW-A	Body Weight, Adult	70	kg	EPA, 1991					
BW-C	Body Weight, Child	15	kg	EPA, 1991					
AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989					
CF2	Conversion Factor 2	0.001	mg/µg	--					
CF3	Conversion Factor 3	0.001	l/cm <sup>3</sup>	--					

**TABLE 4.1.RME**  
 Values Used for Daily Intake Calculations  
 Reasonable Maximum Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Construction Worker	Adult	Excavation Pit	CW	Chemical Concentration in Water	See Table 3.1.RME	µg/l	See Table 3.1.RME	$CDI \text{ (mg/kg-day)} = DA_{event} \times SA \times EV \times EF \times ED \times 1/BW \times 1/AT$  Inorganics: $DA_{event} \text{ (mg/cm}^2\text{-event)} = Kp \times CW \times t_{event} \times CF1 \times CF2$  Organics : $t_{event} < t^* : DA_{event} \text{ (mg/cm}^2\text{-event)} = 2 \times FA \times Kp \times CW \times (\sqrt{6 \times \tau \times t_{event}}/\pi)$ $\times CF1 \times CF2$  $t_{event} > t^* : DA_{event} \text{ (mg/cm}^2\text{-event)} = FA \times Kp \times CW \times ( t_{event}/(1+B) + 2 \times \tau \times ((1 + 3B + 3B^2)/(1+B)^2)) \times CF1 \times CF2$
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm <sup>2</sup> -event	calculated	
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2004	
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2004	
				τ	Lag Time	chemical specific	hr/event	EPA, 2004	
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004	
				t <sub>event</sub>	Event Time	4	hr/day	(2)	
				SA	Skin Surface Area Available for Contact	5,700	cm <sup>2</sup>	EPA, 1997 (3)	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	30	days/year	(4)	
				ED	Exposure Duration	1	years	EPA, 1991	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
AT-N	Averaging Time (Non-Cancer)	365	days	EPA, 1989					
CF1	Conversion Factor 1	0.001	mg/µg	--					
CF2	Conversion Factor 2	0.001	l/cm <sup>3</sup>	--					

- Notes:
- (1) Professional Judgement based on typical tour of duty.
  - (2) Professional Judgement based on construction activities that would result in contact with groundwater would occur 4 hrs per day for the RME.
  - (3) Skin surface area in contact with groundwater assumed to be hands, forearms, lower legs, and feet.
  - (4) Assumes contact with groundwater during construction could occur 30 days per year (using same assumptions used in Tetra Tech RI, November 2002).

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.  
 EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.  
 EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.  
 EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

TABLE 4.1.CTE

Values Used for Daily Intake Calculations

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name	
Ingestion	Resident in Barracks	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	Chronic Daily Intake (CDI) (mg/kg-day) = CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT	
				IR-W	Ingestion Rate of Water	1.4	liters/day	EPA, 1997		
				EF	Exposure Frequency	234	days/year	EPA, 2003		
				ED	Exposure Duration	4	years	(1)		
				CF2	Conversion Factor 2	0.001	mg/µg	--		
				BW	Body Weight	70	kg	EPA, 1991		
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989		
				AT-N	Averaging Time (Non-Cancer)	1,460	days	EPA, 1989		
	Ingestion	Resident	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	Chronic Daily Intake (CDI) (mg/kg-day) = CW x IR-W x EF x ED x CF2 x 1/BW x 1/AT
					IR-W	Ingestion Rate of Water	1.4	liters/day	EPA, 1997	
					EF	Exposure Frequency	234	days/year	EPA, 2003	
					ED	Exposure Duration	9	years	EPA, 2004	
CF2					Conversion Factor 2	0.001	mg/µg	--		
BW					Body Weight	70	kg	EPA, 1991		
AT-C					Averaging Time (Cancer)	25,550	days	EPA, 1989		
AT-N					Averaging Time (Non-Cancer)	3,285	days	EPA, 1989		
Ingestion		Child	Child	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) = CW x IR-W x EF x ED x CF1 x 1/BW x 1/AT
					IR-W	Ingestion Rate of Water	1	liters/day	EPA, 1997	
					EF	Exposure Frequency	234	days/year	EPA, 2003	
					ED	Exposure Duration	6	years	EPA, 2004	
	CF1				Conversion Factor 1	0.001	mg/µg	--		
	BW				Body Weight	15	kg	EPA, 1991		
	AT-C				Averaging Time (Cancer)	25,550	days	EPA, 1989		
	AT-N				Averaging Time (Non-Cancer)	2,190	days	EPA, 1989		
	Ingestion	Child/Adult	Child/Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) = CW x IR-W-Adj x EF x CF1 x 1/AT  IR-W-Adj (liter-year/kd-day) = (ED-C x IR-W-C / BW-C) + (ED-A x IR-W-A / BW-A)
					IR-W-A	Ingestion Rate of Water, Adult	1.4	liters/day	EPA, 1997	
					IR-W-C	Ingestion Rate of Water, Child	1	liters/day	EPA, 1997	
					IR-W-Adj	Ingestion Rate of Water, Age-adjusted	0.58	liter-year/kg-day	calculated	
EF					Exposure Frequency	234	days/year	EPA, 2003		
ED-A					Exposure Duration, Adult	9	years	EPA, 2004		
ED-C					Exposure Duration, Child	6	years	EPA, 2004		
CF1					Conversion Factor 1	0.001	mg/µg	--		
BW-A					Body Weight, Adult	70	kg	EPA, 1991		
BW-C					Body Weight, Child	15	kg	EPA, 1991		
AT-C					Averaging Time (Cancer)	25,550	days	EPA, 1989		

TABLE 4.1.CTE

Values Used for Daily Intake Calculations

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name					
Dermal	Resident in Barracks	Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) = $DA_{event} \times SA \times EV \times EF \times ED \times 1/BW \times 1/AT$  Inorganics: $DA_{event} \text{ (mg/cm}^2\text{-event)} = K_p \times CW \times t_{event} \times CF2 \times CF3$  Organics : $t_{event} < t^*$ : $DA_{event} \text{ (mg/cm}^2\text{-event)} = 2 \times FA \times K_p \times CW \times (\sqrt{6 \times \tau \times t_{event}}/\pi) \times CF2 \times CF3$  $t_{event} > t^*$ : $DA_{event} \text{ (mg/cm}^2\text{-event)} = FA \times K_p \times CW \times (t_{event}/(1+B) + 2 \times \tau \times ((1 + 3B + 3B^2)/(1+B)^2)) \times CF2 \times CF3$					
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm <sup>2</sup> -event	calculated						
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2004						
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2004						
				τ	Lag Time	chemical specific	hr/event	EPA, 2004						
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2004						
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2004						
				t <sub>event</sub>	Event Time	0.25	hr/event	EPA, 2004						
				SA	Skin Surface Area Available for Contact	18,000	cm <sup>2</sup>	EPA, 2004						
				EV	Event Frequency	1	events/day	EPA, 2004						
				EF	Exposure Frequency	234	days/year	EPA, 1993						
				ED	Exposure Duration	4	years	(1)						
				BW	Body Weight	70	kg	EPA, 1991						
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989						
				AT-N	Averaging Time (Non-Cancer)	1,460	days	(1)						
				CF2	Conversion Factor 2	0.001	mg/µg	--						
				CF3	Conversion Factor 3	0.001	l/cm <sup>3</sup>	--						
					Resident	Adult	Tap Water	CW		Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	CDI (mg/kg-day) = $DA_{event} \times SA \times EV \times EF \times ED \times 1/BW \times 1/AT$  Inorganics: $DA_{event} \text{ (mg/cm}^2\text{-event)} = K_p \times CW \times t_{event} \times CF2 \times CF3$  Organics : $t_{event} < t^*$ : $DA_{event} \text{ (mg/cm}^2\text{-event)} = 2 \times FA \times K_p \times CW \times (\sqrt{6 \times \tau \times t_{event}}/\pi) \times CF2 \times CF3$  $t_{event} > t^*$ : $DA_{event} \text{ (mg/cm}^2\text{-event)} = FA \times K_p \times CW \times (t_{event}/(1+B) + 2 \times \tau \times ((1 + 3B + 3B^2)/(1+B)^2)) \times CF2 \times CF3$
								DAevent		Dermally Absorbed Dose per Event	calculated	mg/cm <sup>2</sup> -event	calculated	
								FA		Fraction absorbed water	chemical specific	dimensionless	EPA, 2004	
Kp	Permeability Coefficient	chemical specific	cm/hr					EPA, 2004						
τ	Lag Time	chemical specific	hr/event					EPA, 2004						
t*	Time to Reach Steady-state	chemical specific	hours					EPA, 2004						
B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless					EPA, 2004						
t <sub>event</sub>	Event Time	0.25	hr/event					EPA, 2004						
SA	Skin Surface Area Available for Contact	18,000	cm <sup>2</sup>					EPA, 2004						
EV	Event Frequency	1	events/day					EPA, 2004						
EF	Exposure Frequency	234	days/year					EPA, 1993						
ED	Exposure Duration	9	years					EPA, 2004						
BW	Body Weight	70	kg					EPA, 1991						
AT-C	Averaging Time (Cancer)	25,550	days					EPA, 1989						
AT-N	Averaging Time (Non-Cancer)	3,285	days					(1)						
CF2	Conversion Factor 2	0.001	mg/µg					--						
CF3	Conversion Factor 3	0.001	l/cm <sup>3</sup>					--						

TABLE 4.1.CTE

Values Used for Daily Intake Calculations

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Resident	Child	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	$CDI (mg/kg\text{-}day) = DA_{event} \times SA \times EV \times EF \times ED \times 1/BW \times 1/AT$  Inorganics: $DA_{event} (mg/cm^2\text{-}event) = K_p \times CW \times t_{event} \times CF2 \times CF3$  Organics : $t_{event} < t^* : DA_{event} (mg/cm^2\text{-}event) = 2 \times FA \times K_p \times CW \times (\sqrt{t_{event} \times \tau} / \pi) \times CF2 \times CF3$  $t_{event} > t^* : DA_{event} (mg/cm^2\text{-}event) = FA \times K_p \times CW \times ( t_{event} / (1+B) + 2 \times \tau \times ((1 + 3B + 3B^2) / (1+B)^2) ) \times CF2 \times CF3$
		Child/Adult	Tap Water	CW	Chemical Concentration in Water	See Table 3.1.CTE	µg/l	See Table 3.1.CTE	
				DAevent	Dermally Absorbed Dose per Event	Calculated	mg/cm <sup>2</sup> -event	calculated	
				FA	Fraction absorbed water	Chemical specific	dimensionless	EPA, 2004	
				K <sub>p</sub>	Permeability Coefficient	Chemical specific	cm/hr	EPA, 2004	
				τ	Lag Time	Chemical specific	hr/event	EPA, 2004	
				t*	Time to Reach Steady-state	Chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	Chemical specific	dimensionless	EPA, 2004	
				t <sub>event</sub>	Event Time	0.33	hr/event	EPA, 2004	
				SA	Skin Surface Area Available for Contact	6,600	cm <sup>2</sup>	EPA, 2004	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	234	days/year	EPA, 1993	
				ED	Exposure Duration	6	years	EPA, 2004	
				BW	Body Weight	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	--	
				CF3	Conversion Factor 3	0.001	l/cm <sup>3</sup>	--	
				DAevent-A	Dermally Absorbed Dose per Event, Adult	Calculated	mg/cm <sup>2</sup> -event	calculated	
				DAevent-C	Dermally Absorbed Dose per Event, Child	Calculated	mg/cm <sup>2</sup> -event	calculated	
				DA-Adj	Dermally Absorbed Dose, Age-adjusted	Calculated	mg-year/event-kg	calculated	
				FA	Fraction absorbed water	Chemical specific	dimensionless	EPA, 2004	
				K <sub>p</sub>	Permeability Coefficient	Chemical specific	cm/hr	EPA, 2004	
				τ	Lag Time	Chemical specific	hr/event	EPA, 2004	
				t*	Time to Reach Steady-state	Chemical specific	hours	EPA, 2004	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	Chemical specific	dimensionless	EPA, 2004	
				t <sub>event</sub> -A	Event Time, Adult	0.25	hr/event	EPA, 2004	
				t <sub>event</sub> -C	Event Time, Child	0.33	hr/event	EPA, 2004	
				SA-A	Skin Surface Area, Adult	18,000	cm <sup>2</sup>	EPA, 2004	
				SA-C	Skin Surface Area, Child	6,600	cm <sup>2</sup>	EPA, 2004	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	234	days/year	EPA, 1993	
				ED-A	Exposure Duration, Adult	9	years	EPA, 2004	
				ED-C	Exposure Duration, Child	6	years	EPA, 2004	
				BW-A	Body Weight, Adult	70	kg	EPA, 1991	
				BW-C	Body Weight, Child	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				CF2	Conversion Factor 2	0.001	mg/µg	--	
				CF3	Conversion Factor 3	0.001	l/cm <sup>3</sup>	--	

**TABLE 4.1.CTE**

Values Used for Daily Intake Calculations

Central Tendency Exposure

*Former Gun Position 41A & 41B*

*MCB Camp Lejeune, North Carolina*

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/Reference	Intake Equation/Model Name
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(1) Professional Judgement based on typical tour of duty.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2003: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure, Draft.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

**TABLE 5.1**

Non-Cancer Toxicity Data - Oral/Dermal  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	3.0E-04	mg/kg-day	Skin, Vascular	3/1	IRIS	11/13/2008
	Subchronic	3.0E-04	mg/kg-day	95%	3.0E-04	mg/kg-day	Skin, Vascular	3	HEAST	7/1/1997
Chromium (VI)	Chronic	3.0E-03	mg/kg-day	2.5%	7.5E-05	mg/kg-day	Not identified	300/3	IRIS	11/13/2008
	Subchronic	2.0E-02	mg/kg-day	2.5%	5.0E-04	mg/kg-day	Not identified	100	HEAST	7/1/1997

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment (Final).

Section 4.2 and Exhibit 4-1. USEPA recommends that the oral RfD should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%.

(2) Adjusted Dermal RfD = RfD (oral) x Absorption Efficiency or ABS<sub>GI</sub>

(3) For IRIS values, the date IRIS was searched.

For HEAST values, the date of HEAST.

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

**TABLE 5.2**  
 Non-Cancer Toxicity Data - Inhalation  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
Arsenic	Chronic Subchronic	3.0E-05 N/A	mg/m <sup>3</sup> N/A	8.6E-06 N/A	mg/kg-day N/A	Developmental, Cardiovascular, Nervous System N/A	3/1 N/A	Cal-EPA N/A	06/13/08 N/A
Chromium (VI)	Chronic Subchronic	1.0E-04 NA	mg/m <sup>3</sup>	2.9E-05	mg/kg-day NA	Respiratory System NA	300/1 NA	IRIS NA	11/13/2008 NA

(1) Provide equation used for derivation in text.

IRIS = Integrated Risk Information System

CalEPA = California EPA

**TABLE 6.1**  
 Cancer Toxicity Data - Oral/Dermal  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	EPA Carcinogen Group	Source	Date (2) (MM/DD/YY)
Arsenic	1.5E+00	95%	1.5E+00	(mg/kg-day) <sup>-1</sup>	A	IRIS	11/13/2008
Chromium (VI)	NA		NA		D	IRIS	11/13/2008

NA-Not available

IRIS = Integrated Risk Information System

EPA Carcinogen Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

(1) Refer to RAGS, Part E. July 2004.

(2) For IRIS values, provide the date IRIS was searched.

**TABLE 6.2**

Cancer Toxicity Data - Inhalation  
*Former Gun Position 41A & 41B*  
*MCB Camp Lejeune, North Carolina*

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guidance Description	Source	Date (2) (MM/DD/YY)
Arsenic	4.3E-03	(ug/m3) <sup>-1</sup>	3500	1.5E+01	(mg/kg-day) <sup>-1</sup>	A	IRIS	11/13/2008
Chromium (VI)	1.2E-02	(ug/m3) <sup>-1</sup>	3500	4.2E+01	(mg/kg-day) <sup>-1</sup>	A	IRIS	11/13/2008

IRIS = Integrated Risk Information System

EPA Group:

- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data are available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen
- E - Evidence of noncarcinogenicity

(1) Adjustment Factor applied to Unit Risk to calculate Inhalation Slope Factor =  
 70kg x 1/20m3/day x 1000ug/mg

(2) For IRIS values, provide the date IRIS was searched.  
 For HEAST values, provide the date of HEAST.

For RBC values, provide the date of last change in the Tables.

TABLE 7.1.RME

Calculation of Chemical Cancer Risks and Non-Cancer Hazards

Reasonable Maximum Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident in Barracks
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RID/RFC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	1.9E+01	µg/L	2.9E-05	mg/kg/day	1.5E+00	mg/kg/day	4.4E-05	5.2E-04	mg/kg/day	3.0E-04	mg/kg/day	1.7E+00
				Chromium	6.2E+01	µg/L	9.8E-05	mg/kg/day	NA	mg/kg/day	NA	1.7E-03	mg/kg/day	3.0E-03	mg/kg/day	5.7E-01
			Exp. Route Total							4.4E-05					2.3E+00	
			Dermal	Arsenic	1.9E+01	µg/L	1.5E-07	mg/kg/day	1.5E+00	mg/kg/day	2.3E-07	2.7E-06	mg/kg/day	3.0E-04	mg/kg/day	9.0E-03
		Chromium	6.2E+01	µg/L	1.0E-06	mg/kg/day	NA	mg/kg/day	NA	1.8E-05	mg/kg/day	7.5E-05	mg/kg/day	2.4E-01		
		Exp. Route Total							2.3E-07					2.5E-01		
		Exposure Point Total							4.4E-05					2.5E+00		
		Exposure Medium Total							4.4E-05					2.5E+00		
		Groundwater Total							4.4E-05					2.5E+00		
		Total of Receptor Risks Across All Media										4.4E-05	Total of Receptor Hazards Across All Media			

Notes-

NA = Not applicable.

DAevent for dermal exposure to groundwater calculated on Table 7.1.RME/7.2.RME Supplement A.

**TABLE 7.1.RME/7.2.RME Supplement A**

Calculation of DAevent

Resident Adult Ground Water

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Chemical of Potential Concern	Water Concentration (CW) (µg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ <sub>event</sub> ) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm <sup>2</sup> -event)	Eq
Arsenic	1.9E+01	1.0E-03	NA	NA	NA	NA	0.58	1.1E-08	1
Chromium	6.2E+01	2.0E-03	NA	NA	NA	NA	0.58	7.2E-08	1

**Inorganics: DAevent (mg/cm<sup>2</sup>-event) =**

$Kp \times CW \times t_{event} \times 0.001 \text{ mg/ug} \times 0.001 \text{ l/cm}^3$  (eq 1)

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t\* - Time to reach steady-state

**TABLE 7.2.RME**  
 Calculation of Chemical Cancer Risks and Non-Cancer Hazards  
 Reasonable Maximum Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	1.9E+01	µg/L	NA		NA		NA	5.2E-04	mg/kg/day	3.0E-04	mg/kg/day	1.7E+00
				Chromium	6.2E+01	µg/L	NA		NA		NA	1.7E-03	mg/kg/day	3.0E-03	mg/kg/day	5.7E-01
			Exp. Route Total					0.0E+00							2.3E+00	
			Dermal	Arsenic	1.9E+01	µg/L	NA		NA		NA	2.7E-06	mg/kg/day	3.0E-04	mg/kg/day	9.0E-03
				Chromium	6.2E+01	µg/L	NA		NA		NA	1.8E-05	mg/kg/day	7.5E-05	mg/kg/day	2.4E-01
			Exp. Route Total					0.0E+00							2.5E-01	
			Exposure Point Total					0.0E+00							2.5E+00	
			Exposure Medium Total					0.0E+00							2.5E+00	
			Groundwater Total					0.0E+00							2.5E+00	
			Total of Receptor Risks Across All Media										0.0E+00	Total of Receptor Hazards Across All Media		

Notes-  
 NA = Not applicable.  
 DAevent for dermal exposure to groundwater calculated on Table 7.1.RME/7.2.RME Supplement A.

**TABLE 7.3.RME**  
 Calculation of Chemical Cancer Risks and Non-Cancer Hazards  
 Reasonable Maximum Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	1.9E+01	µg/L	NA		NA		NA	1.2E-03	mg/kg/day	3.0E-04	mg/kg/day	4.0E+00
				Chromium	6.2E+01	µg/L	NA		NA		NA	4.0E-03	mg/kg/day	3.0E-03	mg/kg/day	1.3E+00
			Exp. Route Total						0.0E+00						5.3E+00	
			Dermal	Arsenic	1.9E+01	µg/L	NA		NA		NA	7.9E-06	mg/kg/day	3.0E-04	mg/kg/day	2.6E-02
				Chromium	6.2E+01	µg/L	NA		NA		NA	5.3E-05	mg/kg/day	7.5E-05	mg/kg/day	7.0E-01
			Exp. Route Total						0.0E+00						7.3E-01	
			Exposure Point Total						0.0E+00						6.1E+00	
			Exposure Medium Total						0.0E+00						6.1E+00	
			Groundwater Total						0.0E+00						6.1E+00	
			Total of Receptor Risks Across All Media										0.0E+00	Total of Receptor Hazards Across All Media		

Notes-  
 NA = Not applicable.  
 DAevent for dermal exposure to groundwater calculated on Table 7.3.RME Supplement A.

**TABLE 7.3.RME Supplement A**  
 Calculation of DAevent  
 Resident Child Ground Water  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Chemical of Potential Concern	Water Concentration (CW) (µg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time ( $\tau_{event}$ ) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm <sup>2</sup> -event)	Eq
Arsenic	1.9E+01	1.0E-03	NA	NA	NA	NA	1	1.9E-08	1
Chromium	6.2E+01	2.0E-03	NA	NA	NA	NA	1	1.2E-07	1

**Inorganics: DAevent (mg/cm<sup>2</sup>-event) =**

$Kp \times CW \times \tau_{event} \times 0.001 \text{ mg/}\mu\text{g} \times 0.001 \text{ l/cm}^3$  (eq 1)

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t\* - Time to reach steady-state

**TABLE 7.4.RME**  
 Calculation of Chemical Cancer Risks and Non-Cancer Hazards  
 Reasonable Maximum Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RID/RIC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	1.9E+01	µg/L	2.8E-04	mg/kg/day	1.5E+00	mg/kg/day	4.2E-04	NA		NA		NA	
				Chromium	6.2E+01	µg/L	9.3E-04	mg/kg/day	NA		NA		NA		NA		
				Exp. Route Total					4.2E-04						0.0E+00		
				Dermal	Arsenic	1.9E+01	µg/L	1.6E-06	mg/kg/day	1.5E+00	mg/kg/day	2.4E-06	NA		NA		NA
					Chromium	6.2E+01	µg/L	1.1E-05	mg/kg/day	NA		NA		NA		NA	
			Exp. Route Total					2.4E-06						0.0E+00			
			Exposure Point Total					4.2E-04						0.0E+00			
			Exposure Medium Total					4.2E-04						0.0E+00			
			Groundwater Total					4.2E-04						0.0E+00			
			Total of Receptor Risks Across All Media										4.2E-04	Total of Receptor Hazards Across All Media			

Notes-  
 NA = Not applicable.  
 DAevent for dermal exposure to groundwater calculated on Table 7.1.RME/7.2.RME and 7.3.RME Supplement A.

TABLE 7.5.RME

Calculation of Chemical Cancer Risks and Non-Cancer Hazards  
 Reasonable Maximum Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future  
 Receptor Population: Construction Worker  
 Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Excavation Pit	Dermal	Arsenic	1.9E+01	µg/L	7.2E-09	mg/kg/day	1.5E+00	mg/kg/day	1.1E-08	5.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.7E-03
				Chromium	6.2E+01	µg/L	4.8E-08	mg/kg/day	NA	mg/kg/day	NA	3.3E-06	mg/kg/day	5.0E-04	mg/kg/day	6.7E-03
				Exp. Route Total							1.1E-08					8.3E-03
				Exposure Point Total							1.1E-08					8.3E-03
				Exposure Medium Total							1.1E-08					8.3E-03
Groundwater Total											1.1E-08				8.3E-03	
Total of Receptor Risks Across All Media										1.1E-08	Total of Receptor Hazards Across All Media					8.3E-03

Notes-

NA = Not applicable.

DAevent for dermal exposure to groundwater calculated on Table 7.5.RME Supplement A

**Table 7.5 RME Supplement A**  
 Calculation of DAevent  
 Construction Worker Ground Water  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Chemical of Potential Concern	Water Concentration (CW) (µg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ <sub>event</sub> ) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm <sup>2</sup> -event)	Eq
Arsenic	1.9E+01	1.0E-03	NA	NA	NA	NA	4	7.5E-08	1
Chromium	6.2E+01	2.0E-03	NA	NA	NA	NA	4	5.0E-07	1

**Inorganics: DAevent (mg/cm<sup>2</sup>-event) =**

$Kp \times CW \times t_{event} \times 0.001 \text{ mg/ug} \times 0.001 \text{ l/cm}^3 \text{ (eq 1)}$

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t\* - Time to reach steady-state

**TABLE 7.1.CTE**  
 Calculation of Chemical Cancer Risks and Non-Cancer Hazards  
 Central Tendency Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident in Barracks
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RID/RIC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	8.6E+00	µg/L	6.3E-06	mg/kg/day	1.5E+00	mg/kg/day	9.4E-06	1.1E-04	mg/kg/day	3.0E-04	mg/kg/day	3.7E-01
				Chromium	2.6E+01	µg/L	1.9E-05	mg/kg/day	NA	mg/kg/day	NA	3.3E-04	mg/kg/day	3.0E-03	mg/kg/day	1.1E-01
			Exp. Route Total						9.4E-06						4.7E-01	
			Dermal	Arsenic	8.6E+00	µg/L	2.0E-08	mg/kg/day	1.5E+00	mg/kg/day	3.0E-08	3.5E-07	mg/kg/day	3.0E-04	mg/kg/day	1.2E-03
				Chromium	2.6E+01	µg/L	1.2E-07	mg/kg/day	NA	mg/kg/day	NA	2.1E-06	mg/kg/day	7.5E-05	mg/kg/day	2.8E-02
			Exp. Route Total							3.0E-08					2.9E-02	
		Exposure Point Total							9.4E-06						5.0E-01	
		Exposure Medium Total							9.4E-06						5.0E-01	
		Groundwater Total							9.4E-06						5.0E-01	
		Total of Receptor Risks Across All Media										9.4E-06	Total of Receptor Hazards Across All Media			

Notes-  
 NA = Not applicable.  
 DAEvent for dermal exposure to groundwater calculated on Table 7.1.CTE/7.2.CTE Supplement A.

**TABLE 7.1.CTE/7.2.CTE Supplement A**

Calculation of DAevent

Resident Adult Ground Water

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Chemical of Potential Concern	Water Concentration (CW) (µg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ <sub>event</sub> ) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm <sup>2</sup> -event)	Eq
Arsenic	8.6E+00	1.0E-03	NA	NA	NA	NA	0.25	2.1E-09	1
Chromium	2.6E+01	2.0E-03	NA	NA	NA	NA	0.25	1.3E-08	1

**Inorganics: DAevent (mg/cm<sup>2</sup>-event) =**

$Kp \times CW \times \tau_{event} \times 0.001 \text{ mg/ug} \times 0.001 \text{ l/cm}^3$  (eq 1)

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t\* - Time to reach steady-state

TABLE 7.2.CTE  
 Calculation of Chemical Cancer Risks and Non-Cancer Hazards  
 Central Tendency Exposure  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future  
 Receptor Population: Resident  
 Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	8.6E+00	µg/L	NA		NA		NA	1.1E-04	mg/kg/day	3.0E-04	mg/kg/day	3.7E-01
				Chromium	2.6E+01	µg/L	NA		NA		NA	3.3E-04	mg/kg/day	3.0E-03	mg/kg/day	1.1E-01
			Exp. Route Total						0.0E+00						4.7E-01	
			Dermal	Arsenic	8.6E+00	µg/L	NA		NA		NA	3.5E-07	mg/kg/day	3.0E-04	mg/kg/day	1.2E-03
				Chromium	2.6E+01	µg/L	NA		NA		NA	2.1E-06	mg/kg/day	7.5E-05	mg/kg/day	2.8E-02
			Exp. Route Total						0.0E+00						2.9E-02	
			Exposure Point Total						0.0E+00						5.0E-01	
			Exposure Medium Total						0.0E+00						5.0E-01	
			Groundwater Total						0.0E+00						5.0E-01	
			Total of Receptor Risks Across All Media										0.0E+00	Total of Receptor Hazards Across All Media		

Notes-  
 NA = Not applicable.  
 DAEvent for dermal exposure to groundwater calculated on Table 7.1.CTE/7.2.CTE Supplement A.

**TABLE 7.3.CTE Supplement A**  
 Calculation of DAevent  
 Resident Child Ground Water  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Chemical of Potential Concern	Water Concentration (CW) (µg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time ( $\tau_{event}$ ) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm <sup>2</sup> -event)	Eq
Arsenic	8.6E+00	1.0E-03	NA	NA	NA	NA	0.33	2.8E-09	1
Chromium	2.6E+01	2.0E-03	NA	NA	NA	NA	0.33	1.7E-08	1

**Inorganics: DAevent (mg/cm<sup>2</sup>-event) =**

$Kp \times CW \times \tau_{event} \times 0.001 \text{ mg/ug} \times 0.001 \text{ l/cm}^3 \text{ (eq 1)}$

Notes:

NA - Not applicable

Permeability constants from EPA 2004, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Final)*. EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.

B - Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (dimensionless).

t\* - Time to reach steady-state

**TABLE 7.3.CTE**

Calculation of Chemical Cancer Risks and Non-Cancer Hazards

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations					
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RID/RFC		Hazard Quotient	
							Value	Units	Value	Units		Value	Units	Value	Units		
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	8.6E+00	µg/L	NA		NA		NA		3.7E-04	mg/kg/day	3.0E-04	mg/kg/day	1.2E+00
				Chromium	2.6E+01	µg/L	NA		NA		NA		1.1E-03	mg/kg/day	3.0E-03	mg/kg/day	3.7E-01
			Exp. Route Total						0.0E+00								1.6E+00
Groundwater	Groundwater	Tap Water	Dermal	Arsenic	8.6E+00	µg/L	NA		NA		NA		8.0E-07	mg/kg/day	3.0E-04	mg/kg/day	2.7E-03
				Chromium	2.6E+01	µg/L	NA		NA		NA		4.8E-06	mg/kg/day	7.5E-05	mg/kg/day	6.4E-02
			Exp. Route Total						0.0E+00							6.6E-02	
			Exposure Point Total						0.0E+00							1.6E+00	
Exposure Medium Total							0.0E+00							1.6E+00			
Groundwater Total							0.0E+00							1.6E+00			
Total of Receptor Risks Across All Media										0.0E+00	Total of Receptor Hazards Across All Media				1.6E+00		

Notes-

NA = Not applicable.

DAevent for dermal exposure to groundwater calculated on Table 7.3.RME Supplement A.

TABLE 7.4.CTE  
 Calculation of Chemical Cancer Risks and Non-Cancer Hazards  
 Central Tendency Exposure  
 Former Gun Position 41A& 41B  
 MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future  
 Receptor Population: Resident  
 Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Tap Water	Ingestion	Arsenic	8.6E+00	µg/L	4.5E-05	mg/kg/day	1.5E+00	mg/kg/day	6.8E-05	NA		NA		NA
				Chromium	2.6E+01	µg/L	1.4E-04	mg/kg/day	NA		NA		NA		NA	
			Exp. Route Total					6.8E-05						0.0E+00		
			Dermal													
		Ingestion	Arsenic	8.6E+00	µg/L	1.1E-07	mg/kg/day	1.5E+00	mg/kg/day	1.7E-07	NA		NA		NA	
			Chromium	2.6E+01	µg/L	6.8E-07	mg/kg/day	NA		NA		NA		NA		
		Exp. Route Total							1.7E-07					0.0E+00		
		Exposure Point Total							6.8E-05					0.0E+00		
		Exposure Medium Total							6.8E-05					0.0E+00		
		Groundwater Total								6.8E-05					0.0E+00	
Total of Receptor Risks Across All Media										6.8E-05	Total of Receptor Hazards Across All Media				0.0E+00	

Notes-  
 NA = Not applicable.  
 DAevent for dermal exposure to groundwater calculated on Table 7.1.RME/7.2.RME and 7.3.RME Supplement A.

TABLE 9.1.RME

Summary of Receptor Risks and Hazards for COPCs

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident in Barracks
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap Water	Arsenic	4.4E-05	NA	2.3E-07	4.4E-05	Skin, Vascular	1.7E+00	NA	9.0E-03	1.7E+00
			Chromium	NA	NA	NA	Not identified		5.7E-01	NA	2.4E-01	8.1E-01
			Chemical Total	4.4E-05	0.0E+00	2.3E-07	4.4E-05		2.3E+00	0.0E+00	2.5E-01	2.5E+00
			Exposure Point Total				4.4E-05				2.5E+00	
Exposure Medium Total						4.4E-05				2.5E+00		
Medium Total							4.4E-05				2.5E+00	
Receptor Total							4.4E-05	Receptor HI Total			2.5E+00	

HI - Hazard Index

Total Skin HI Across All Media =	1.7E+00
Total Vascular HI Across All Media =	1.7E+00

**TABLE 9.2.RME**

Summary of Receptor Risks and Hazards for COPCs

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient					
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total	
Groundwater	Groundwater	Tap Water	Arsenic	NA	NA	NA	NA	Skin, Vascular	1.7E+00	NA	9.0E-03	1.7E+00	
			Chromium	NA	NA	NA	NA		Not identified	5.7E-01	NA	2.4E-01	8.1E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		2.3E+00	0.0E+00	2.5E-01	2.5E+00	
		Exposure Point Total								2.5E+00			
		Exposure Medium Total								2.5E+00			
Medium Total							0.0E+00		2.5E+00				
Receptor Total							0.0E+00		Receptor HI Total 2.5E+00				

HI - Hazard Index

Total Skin HI Across All Media =	1.7E+00
Total Vascular HI Across All Media =	1.7E+00

TABLE 9.3.RME

Summary of Receptor Risks and Hazards for COPCs

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient					
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total	
Groundwater	Groundwater	Tap Water	Arsenic	NA	NA	NA	NA	Skin, Vascular	4.0E+00	NA	2.6E-02	4.0E+00	
			Chromium	NA	NA	NA	NA		Not identified	1.3E+00	NA	7.0E-01	2.0E+00
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		5.3E+00	0.0E+00	7.3E-01	6.1E+00	
			Exposure Point Total					0.0E+00					6.1E+00
			Exposure Medium Total					0.0E+00					6.1E+00
Medium Total					0.0E+00					6.1E+00			
Receptor Total					0.0E+00					Receptor HI Total	6.1E+00		

HI - Hazard Index

Total Skin HI Across All Media =	4.0E+00
Total Vascular HI Across All Media =	4.0E+00

TABLE 9.4.RME

Summary of Receptor Risks and Hazards for COPCs

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient					
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total	
Groundwater	Groundwater	Tap Water	Arsenic	4.2E-04	NA	2.4E-06	4.2E-04	Skin, Vascular	NA	NA	NA	0.0E+00	
			Chromium	NA	NA	NA	NA		Not identified	NA	NA	NA	0.0E+00
			Chemical Total	4.2E-04	0.0E+00	2.4E-06	4.2E-04		0.0E+00	0.0E+00	0.0E+00	0.0E+00	
		Exposure Point Total											0.0E+00
		Exposure Medium Total											0.0E+00
Medium Total												0.0E+00	
Receptor Total								Receptor HI Total				0.0E+00	

HI - Hazard Index

TABLE 9.5.RME

Summary of Receptor Risks and Hazards for COPCs

Reasonable Maximum Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Excavation Pit	Arsenic	NA	NA	1.1E-08	1.1E-08	Skin, Vascular	NA	NA	1.7E-03	1.7E-03
			Chromium	NA	NA	NA	NA		Not identified	NA	NA	6.7E-03
			Chemical Total	NA	NA	1.1E-08	1.1E-08		NA	NA	8.3E-03	8.3E-03
		Exposure Point Total					1.1E-08					8.3E-03
		Exposure Medium Total					1.1E-08					8.3E-03
Medium Total					1.1E-08					8.3E-03		
Receptor Total					1.1E-08	Receptor HI Total				8.3E-03		

HI - Hazard Index

Total Skin HI Across All Media =	1.7E-03
Total Vascular HI Across All Media =	1.7E-03

TABLE 9.1.CTE

Summary of Receptor Risks and Hazards for COPCs

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident in Barracks
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient					
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total	
Groundwater	Groundwater	Tap Water	Arsenic	9.4E-06	NA	3.0E-08	9.4E-06	Skin, Vascular	3.7E-01	NA	1.2E-03	3.7E-01	
			Chromium	NA	NA	NA	NA		Not identified	1.1E-01	NA	2.8E-02	1.4E-01
			Chemical Total	9.4E-06	0.0E+00	3.0E-08	9.4E-06		4.7E-01	0.0E+00	2.9E-02	5.0E-01	
			Exposure Point Total					9.4E-06					5.0E-01
			Exposure Medium Total					9.4E-06					5.0E-01
Medium Total					9.4E-06					5.0E-01			
Receptor Total					9.4E-06					Receptor HI Total	5.0E-01		

HI - Hazard Index

Total Skin HI Across All Media =	3.7E-01
Total Vascular HI Across All Media =	3.7E-01

TABLE 9.2.CTE

Summary of Receptor Risks and Hazards for COPCs

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient					
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total	
Groundwater	Groundwater	Tap Water	Arsenic	NA	NA	NA	0.0E+00	Skin, Vascular	3.7E-01	NA	1.2E-03	3.7E-01	
			Chromium	NA	NA	NA	NA		Not identified	1.1E-01	NA	2.8E-02	1.4E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		4.7E-01	0.0E+00	2.9E-02	5.0E-01	
			Exposure Point Total					0.0E+00					5.0E-01
			Exposure Medium Total					0.0E+00					5.0E-01
Medium Total					0.0E+00					5.0E-01			
Receptor Total					0.0E+00					Receptor HI Total	5.0E-01		

HI - Hazard Index

Total Skin HI Across All Media =	3.7E-01
Total Vascular HI Across All Media =	3.7E-01

TABLE 9.3.CTE

Summary of Receptor Risks and Hazards for COPCs

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient					
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total	
Groundwater	Groundwater	Tap Water	Arsenic	NA	NA	NA	0.0E+00	Skin, Vascular	1.2E+00	NA	2.7E-03	1.2E+00	
			Chromium	NA	NA	NA	NA		Not identified	3.7E-01	NA	6.4E-02	4.3E-01
			Chemical Total	0.0E+00	0.0E+00	0.0E+00	0.0E+00		1.6E+00	0.0E+00	6.6E-02	1.6E+00	
			Exposure Point Total					0.0E+00					1.6E+00
			Exposure Medium Total					0.0E+00					1.6E+00
Medium Total					0.0E+00					1.6E+00			
Receptor Total					0.0E+00	Receptor HI Total				1.6E+00			

HI - Hazard Index

Total Skin HI Across All Media =	1.2E+00
Total Vascular HI Across All Media =	1.2E+00

TABLE 9.4.CTE

Summary of Receptor Risks and Hazards for COPCs

Central Tendency Exposure

Former Gun Position 41A & 41B

MCB Camp Lejeune, North Carolina

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient					
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total	
Groundwater	Groundwater	Tap Water	Arsenic	6.8E-05	NA	1.7E-07	6.8E-05	Skin, Vascular	NA	NA	NA	0.0E+00	
			Chromium	NA	NA	NA	NA					0.0E+00	
			Chemical Total	6.8E-05	0.0E+00	1.7E-07	6.8E-05		0.0E+00	0.0E+00	0.0E+00	0.0E+00	
			Exposure Point Total					6.8E-05					0.0E+00
			Exposure Medium Total					6.8E-05					0.0E+00
Medium Total					6.8E-05					0.0E+00			
Receptor Total					6.8E-05	Receptor HI Total				0.0E+00			

HI - Hazard Index

Appendix G  
Ecological Risk Screening Tables

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**TABLE G-1**

Surface Soil Analytical Results  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Exposure Medium	Chemical	Maximum Detected Concentration <sup>a</sup>	Units	Location of Maximum Detection	Detection Frequency	Ecological Screening Value	HQ	Camp Lejeune Background SS 2X Mean
Surface Soil	<b>Total Metals</b>							
	Arsenic	1.4	mg/kg	ASR2.212-GP41-DU03-SS03	10/14	18	0.08	0.626
	Barium	12.9	mg/kg	ASR2.212-GP41-DU03-SS02	14/14	330	0.04	14.5
	Chromium	6	mg/kg	ASR2.212-GP41-DU03-SS03	14/14	26	0.23	6.05
	Lead	<b>13.7</b>	mg/kg	ASR2.212-GP41-DU04-SS02	14/14	11	1.25	12.3
	Mercury	0.026	mg/kg	ASR2.212-GP41-DU03-SS02	6/14	0.67	0.04	0.081
	Selenium	<b>0.91</b>	mg/kg	ASR2.212-GP41-DU01-SS02	6/14	0.63	1.44	0.563

**Notes:**

<sup>a</sup>**Bolded** numbers indicate concentration exceeds Ecological Screening Value

HQ (Hazard Quotient) = Maximum Concentration Detected / Ecological Screening Value

NA = Not Available

MG/KG = Milligram per kilogram

SS = surface soil

TABLE G-2

Groundwater Analytical Results  
 Former Gun Position 41A & 41B  
 MCB Camp Lejeune, North Carolina

Exposure Medium	Chemical	Maximum Detected Concentrations <sup>a</sup>	Units	Location of Maximum Concentration	Detection Frequency	Ecological Screening Values	HQ	Camp Lejeune Background GW 2X Mean
Groundwater	<b>Dissolved Metals (UG/L)</b>							
	Arsenic	14.7	ug/L	ASR2.212-GP41-TW01	5/5	150	0.10	5.77
	Barium	84.7	ug/L	ASR2.212-GP41-TW02	5/5	NA	NA	86.2
	Chromium	6.1	ug/L	ASR2.212-GP41-TW02	3/5	11	0.55	3.13
	Lead	<b>26.6</b>	ug/L	ASR2.212-GP41-TW04	5/5	2.5	10.64	2.8
	Selenium	0.85	ug/L	ASR2.212-GP41-TW04	3/5	5	0.17	3.14
	Silver	<b>0.064</b>	ug/L	ASR2.212-GP41-TW02	1/5	0.012	5.33	0.77

Notes:

<sup>a</sup> **Bolded** numbers indicate concentration exceeds Ecological Screening Value

HQ (Hazard Quotient) = Maximum Concentration Detected / Ecological Screening Value

NA = Not Available

UG/L = Micrograms per liter

GW = groundwater

Appendix H  
USEPA and NCDENR Concurrence Letters

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**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**

**REGION 4  
SAM NUNN ATLANTA FEDERAL CENTER  
61 FORSYTH STREET, S.W.  
ATLANTA, GEORGIA 30303**

May 27, 2009

NAVFAC Atlantic  
Attn: Bryan Beck NAVFAC Midlant Environmental RPM,  
Camp Lejeune Marine Corps North Carolina IPT  
6506 Hampton Blvd  
Norfolk, VA 23508-1273

SUBJ: MCB Camp Lejeune  
Focused PA/SI Report  
Former Gun Positions 41A and 41B

Dear Mr. Beck:

The Environmental Protection Agency (EPA) has completed its review of the above subject document, dated March 2009 and has no additional comments. Based on the information provided by the Navy, concluding that there is no anticipated risk to human health and the environment, this document can be finalized and the Former Gun Positions 41A and 41B can be given a no further action determination (NFA).

If there are any questions, I can be reached at (404) 562-8538.

Sincerely,

Gena D. Townsend  
Senior Project Manager

cc: Randy McElveen, NCDENR  
Robert Lowder, MCB Camp Lejeune



North Carolina Department of Environment and Natural Resources  
Division of Waste Management

Beverly Eaves Perdue  
Governor

Dexter R. Matthews  
Director

Dee Freeman  
Secretary

July 30, 2009

Mr. Bryan Beck  
NAVFAC Mid-Atlantic  
Code: OPCEV  
NC/Caribbean IPT, EV Business Line  
6506 Hampton Blvd  
Norfolk, VA 23508-1273

RE: Final PA/SI Report, Former Gunnery Positions 41A and 41B, UXO-16 at Camp Lejeune, dated March 2009, Surface and Subsurface Soil and Groundwater  
Permit Number NC6170022580  
MCB Camp Lejeune  
Jacksonville, Onslow County, North Carolina

Dear Mr. Beck:

The NC Superfund Section has received and reviewed the responses to comments on the Draft Preliminary Assessment/Site Inspection (PA/SI) Report for the Former Gunnery Positions 41A and 41B at MCB, Camp Lejeune, located in Jacksonville, NC. Responses to comments are acceptable and the NC Superfund Section concurs with the conclusions and recommendations of the Report with the understanding that future precautionary measures will be taken if construction activities are initiated at the site as stated in the recommendations section of the Report.

If you have any questions or comments, please contact me, at (919) 508-8467 or email [randy.mcelveen@ncdenr.gov](mailto:randy.mcelveen@ncdenr.gov)

Sincerely,

Randy McElveen  
Environmental Engineer  
NC Superfund Section

Cc: Dave Lown, NC Superfund Section, Electronic only  
Bob Lowder, EMD/IR  
David Cleland, NAVFAC  
Gena Townsend, EPA Region IV