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FINAL TIME CRITICAL REMOVAL ACTION IMPLEMENTATION PLAN FOR SITE 6 STORAGE LOTS 201 AND 203 MCB CAMP LEJEUNE NC

05/01/2011

CH2M HILL

Final

Time-Critical Removal Action Implementation Plan Site 6 Storage Lots 201 and 203

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Prepared for

Department of the Navy

Naval Facilities Engineering Command Mid-Atlantic

Contract No.
N62470-08-D-1000
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May 2011

Prepared by

CH2MHILL

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Time-Critical Removal Action Implementation Plan Site 6 Storage Lots 201 and 203

Marine Corps Base Camp Lejeune Jacksonville, North Carolina

Contract Task Order 0129

May 2011

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 1000 Program
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Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
bgs	below ground surface
CERCLA	Comprehensive, Environmental Response, Compensation and Liability Act
CLEAN	Comprehensive Long-term Environmental Action—Navy
DDD	dichlorodiphenyldichloroethane
DDT	dichlorodiphenyltrichloroethane
DRMO	Defense Reutilization and Marketing Office
EMD	Environmental Management Division
EOD	Explosive Ordnance Disposal
ESS	Explosives Safety Submission
ft	feet/foot
HASP	health and safety plan
HE	high explosive
HEAT	high explosive anti-tank
IAS	Initial Assessment Study
IP	Implementation Plan
LDR	land disposal restriction
LTM	long-term monitoring
LUC	land use control
MARCORSYSCOM	Marine Corps System Command
MC	Munitions Constituents
MCB CamLej	Marine Corps Base Camp Lejeune
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mm	millimeter
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard
MR	munitions response
NAVFAC	Naval Facilities Engineering Command
NCAC	North Carolina Administrative Code
NCGWQS	North Carolina Groundwater Quality Standard

OCP	organochlorine pesticide
Osage	Osage of Virginia
OSR	Off-site Rule
OU	operable unit
OVA	organic vapor analyzer
PA/SI	Preliminary Assessment/Site Inspection
PCB	polychlorinated biphenyls
P.E.	Professional Engineer
P.G.	Professional Geologist
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
QA	quality assurance
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SVOC	semi-volatile organic compound
TAL	target analyte list
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time-Critical Removal Action
USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance
VOC	volatile organic compound

SECTION 1

Introduction

1.1 Project Overview

This Implementation Plan (IP) describes the objectives and site work for a Time Critical Removal Action (TCRA) for Site 6 Storage Lots 201 and 203 at Marine Corps Base Camp Lejeune (MCB CamLej), in Onslow County, North Carolina. This IP will provide information and the technical approach for the removal action selected in the *Action Memorandum Site 6 Storage Lots 201 and 203* (CH2M HILL, 2011d) hereinafter referred to as the Site 6 Action Memorandum. The cleanup goal for this TCRA is to remove the grossly contaminated chlorobenzene soil and buried waste equaling up to 42 cubic yards of material. Samples will be collected from the excavation prior to backfilling. The analytical results will be evaluated after the TCRA has been completed as part of the ongoing supplemental groundwater investigation. The overall remedy for Site 6 will be revisited to ensure continued protection of human health and the environment.

1.2 Contractual Setting

CH2M HILL has been tasked with submitting this Site 6 TCRA IP to the Naval Facilities Engineering Command (NAVFAC) Atlantic, under Comprehensive Long-term Environmental Action—Navy (CLEAN) 1000 Contract N62470-08-D-1000, Contract Task Order 129.

Implementation of the Site 6 TCRA will be conducted by Osage of Virginia (Osage). Osage is responsible for providing a site-specific health and safety plan to the Navy for review and approval. Osage is also responsible for complying with the requirements described in this Implementation Plan. CH2M HILL will provide engineering support and construction oversight.

1.3 Work Plan Organization

This IP consists of six sections. Brief descriptions of the sections are presented as follows:

- **Section 1, Introduction—**Presents an overview of the project and implementation plan.
- **Section 2, Site Background—**Discusses the site location, history, and previous investigations.
- **Section 3, Removal Action Design and Implementation—**Presents the design for the removal action and discusses how the removal action will be conducted.
- **Section 4, Reporting—**Provides information on the reports that will be submitted as part of the project.
- **Section 5, Schedule and Project Organization—**Presents the schedule for the project and provides information on the project management, team, and organization.

- **Section 6, References—**Presents complete citations for other documents and publications cited in this document.
- Figures accompanying the main text of this work plan are at the end of each section.

SECTION 2

Site Background

This section contains site characterization information including site description, background, and nature and extent of contamination.

2.1 Facility and Site Description

MCB CamLej is a training facility for the United States Marine Corps located on the coastal plain in Onslow County, North Carolina and covers approximately 236 square miles, (**Figure 2-1**). The New River flows southeast, bisecting the Base and forms a large estuary before entering the Atlantic Ocean. The Base is bounded on the southeast by the Atlantic Ocean, on the west by U.S. Route 17, and on the northeast by State Highway 24. The City of Jacksonville, North Carolina is located north of the Base.

2.1.1 Facility and Site Physical Setting

Site 6 is a part of Operable Unit (OU) 2 located along Piney Green Road on the Mainside of the Base. OU 2 covers approximately 210 acres and consists of three sites (Sites 6, 9, and 82) that have been grouped together because of their proximity to one another. Site 6 originally consisted of Storage Lots 201 and 203 and large wooded areas that surrounded both lots. A large portion of this formerly wooded area has since been cleared and is currently used for storage. The Base scales are operated in Lot 201 and Lot 203 is used by the Defense Reutilization and Marketing Office (DRMO) for metal staging operations. The fenced area between Lots 201 and 203 is used to store shipping containers.

As a result of the discovery of material potentially presenting an explosive hazard (MPPEH) during investigation activities at OU 2, specifically Site 6, the area has been included in the Military Munitions Response Program (MMRP) and designated as Site Unexploded Ordnance (UXO)-22. Site 6 is located within the boundaries of UXO-22 (**Figure 2-2**).

2.1.2 Site 6 History

From the 1940s to the late 1980s, Site 6 was reportedly used for disposal and storage of wastes and supplies, including pesticides, transformers containing polychlorinated biphenyls (PCBs), solvents, electrolytes from used batteries, waste oils, and munitions debris (MD). Pesticides were reportedly stored in the northeast and southeast portions of Lot 201. Transformers containing PCBs were reportedly stored in the southwest portion of Lot 201. Pesticides were reported to have been stored in a trailer on Lot 203 as well as in the southeast portion of the lot. Lot 203 previously served as a waste disposal and storage area and there is little indication as to the types and quantities of material disposed of (Baker, 1993a).

The previous investigations and actions conducted at Site 6 are listed in Section 2.2 below. A Record of Decision (ROD) is in-place for OU 2 that includes Site 6. The remedial action components listed below were completed pursuant to the ROD (Baker, 1993d).

- Extraction and treatment of chlorinated volatile organic compounds (VOCs) in groundwater
- Long-term monitoring (LTM) for groundwater and surface water
- Land use controls (LUCs) for Non-Industrial Use and Intrusive Activities Control - Soil
- LUCs for Intrusive Activities Control - Groundwater
- LUCs for Aquifer Use Control

2.1.3 Site UXO-22 History

In 2008, MPPEH was discovered in the central portion of Site 6 during vegetation clearance. Since the site was not part of the MMRP, Base Explosive Ordnance Disposal (EOD) was contacted upon discovery of several 3.5-inch practice rockets entangled in communication wire. Due to the quantity of material discovered, EOD determined that further action was necessary and beyond the scope of EOD emergency response. The identification and designation of UXO-22 occurred after the submission and approval of the Explosives Safety Submission (ESS) and first ESS Amendment; therefore, the ESS and ESS Amendments reference Site 6 or OU 2 rather than UXO-22.

The *Explosives Safety Submission for Munitions Response Activities, Site 6 (Operable Unit 2)* (CH2M HILL, 2009a) was submitted by MCB CamLej to Marine Corps Systems Command (MARCORSYSCOM) in December 2008 to address demilitarization and disposal of MPPEH removed from a disposal pit at IR Site 6 by the MCB CamLej EOD Team. The ESS was approved in June 2009.

To address surface clearance and future intrusive investigations at Site 6 within UXO-22, the *Amendment No. 1, Explosives Safety Submission for Munitions Response Activities, Installation Restoration Site 6 and Site 82 (Operable Unit 2)* (ESS-107) (CH2M HILL, 2009b) was submitted to MARCORSYSCOM in May 2009 and approved on August 19, 2009.

To address the discovery of munitions and explosives of concern (MEC) not previously included in the ESS, the *Amendment No. 2, Explosives Safety Submission for Munitions Response Activities, Installation Restoration Site 6 and Site 82 (Operable Unit 2)* (ESS-107) (CH2M HILL, 2010c) was submitted to MARCORSYSCOM in September 2010 and approved on September 27, 2010.

Amendment No. 3, Explosives Safety Submission for Munitions Response Activities, Installation Restoration Site 6 and Site 82 (Operable Unit 2) (ESS-120) (CH2M HILL, 2010d) was approved on May 11, 2011. This amendment allows for limited mechanized processing during munitions response (MR) activities.

All ESS documents and amendments are provided as **Appendix A**.

A Preliminary Assessment/Site Inspection (PA/SI) is planned at UXO-22 in 2011-2012.

2.2 Previous Environmental Investigations

Site 6 has a long history of previous environmental investigations, beginning in 1983. However, it was the recent investigation activities, focused on finding the source of chlorobenzene at the site that identified the two buried drums and associated soil contamination during test pitting activities. A summary of the previous investigations, findings, and actions are listed in **Table 2-1** below.

TABLE 2-1
Previous Investigations

Previous Investigation/Action	Date	Activities and Findings
Initial Assessment Study (IAS) (Water and Air Resources, Inc., 1983)	1983	The IAS was conducted to identify potential hazardous sites at MCB CamLej. Wastes present reportedly originated from dumping and storage activities and the IAS recommended that a Confirmation Study be conducted to verify the presence of contamination.
Site Assessment Study (Environmental Science and Engineering, Inc., 1992)	1984 - 1991	Field activities including soil, groundwater, surface water, and sediment sampling, were conducted to verify the presence or absence of contamination. Soil samples were analyzed for pesticides, and all other media were analyzed for VOCs and pesticides. Low levels of pesticides were detected in soil samples. Groundwater samples collected from shallow monitoring wells revealed low levels of VOCs and benzene.
Soil Gas Survey (1989)	1989	A soil gas survey was conducted to identify the presence of VOCs that may potentially affect personnel working within Lot 203. No imminent hazards were identified with the results of the survey.
Remedial Investigation/Feasibility Study (RI/FS) (Baker,1993a; Baker, 1993b)	1992 - 1993	Field activities consisted of a preliminary site survey, a geophysical survey, a soil investigation including drilling and sampling, a groundwater investigation including monitoring well installation and sampling, drum waste sampling, test pit investigation, a surface water and sediment investigation, soil gas sampling, and an aquatic and ecological survey. Pesticides/PCBs, VOCs, semi-volatile organic compounds (SVOCs), and metals were identified in soil, groundwater, surface water, and sediment across the OU. Potential human health risks were identified due to exposure to soil and groundwater. Potential adverse ecological impacts were identified for Wallace Creek and Bear Head Creek. The FS developed and screened remedial alternatives for addressing groundwater and soil contamination.
Proposed Remedial Action Plan (PRAP) and ROD (Baker, 1993c; Baker, 1993d)	1993	A PRAP was to solicit public input on the preferred alternative (soil removal, groundwater extraction and treatment, LTM, and LUCs) and a public meeting was held. The Final ROD was issued and signed in September 1993.
Remedy-in-Place (Baker, 1993d; OHM, 1997)	1993 – present	The selected remedy identified in the ROD was conducted as TCRAs from 1993 to 1997, during which drums (some containing the pesticide dichlorodiphenyltrichloroethane [DDT]), batteries, and communications wire were removed and contaminated soil was excavated. Groundwater extraction and treatment and LTM for VOCs were implemented in 1996 and are ongoing. LUCs were implemented in 2001 and updated in 2002. Elevated, fluctuating levels of chlorobenzene have been detected during groundwater LTM resulting in additional field investigations to determine the potential source.
Basewide Vapor Intrusion Evaluation (CH2M HILL, AGVIQ, 2009)	2007 - 2010	A Basewide Vapor Intrusion Study was conducted from 2007 through 2009 to determine if complete or significant exposure pathways exist for vapor intrusion into buildings. At OU 2, no buildings were identified within 100 feet (ft) of monitoring wells containing VOC concentrations above screening values. If buildings are planned for construction in the vicinity of the VOC groundwater plume, the potential for a vapor intrusion pathway will be evaluated and mitigated if needed.

TABLE 2-1
Previous Investigations

Previous Investigation/Action	Date	Activities and Findings
Chlorobenzene Summary Report (CH2M HILL, 2010a)	2004 - 2010	After elevated concentrations were reported in samples collected from monitoring well IR06-GW16 during LTM activities (up to 57,000 micrograms per liter [µg/L] in 2000), a series of investigations to assess the source and delineate any downgradient groundwater chlorobenzene impacts was initiated. In 2009, during vegetation clearing activities for a geophysical investigation, MD was discovered and an ESS was submitted to remove and dispose of the MD. The geophysical survey results indicated the presence of several linear features, potentially representing trenches containing metallic debris (**Figure 2-3**). Chlorobenzene concentrations in groundwater continue to fluctuate, the dissolved chlorobenzene is migrating downgradient, and the chlorobenzene plume had not been fully delineated vertically and horizontally. A test pit investigation and additional groundwater delineation was recommended.
Chlorobenzene Source Area Investigation (CH2M HILL, 2011b)	2010-present	As a follow-up to the recommendations of the Chlorobenzene Summary Report, test pit activities to investigate the large geophysical anomalies were conducted. 12 test pit excavations (approximately 5' x 5' x 5') were completed and cultural debris, MD, drums, buckets, communication batteries, communication wires, and scrap metal were uncovered (**Figure 2-3**). At Test Pit 10, two drums were uncovered resulting in elevated breathing zone measurements of VOCs. No munitions-related items were encountered during the initial Test Pit 10 excavation. Soil samples were collected from the test pits. The results from Test Pit 10 indicated chlorobenzene concentrations in soil at 70,000,000 micrograms per kilogram (µg/kg). No explosives compounds were detected and no metals were detected at concentrations exceeding background and regulatory screening levels. Based on the results of previous groundwater results and the test pit investigation and soil sampling, groundwater monitoring wells were installed to further delineate the groundwater plume and sampling is ongoing.

2.3 Previous Removal Actions

Time-Critical Removal Action (OHM, 1997)

The OU 2 ROD was signed in 1993, which included a series of TCRAs from 1993 to 1997 to remove drums, batteries, communication wire, and MD from the central portion of Site 6.

Four trenches were excavated at Site 6 in the vicinity of the buried drums uncovered during the 2011 test pit investigation (**Figure 2-3**). Approximately 1,355 cubic yards of waste and contaminated soil were excavated and removed from the Site. Materials excavated included: 55-gallon drums, small (5 gallon or less) containers, batteries, shell casings, communication wire, wood, and miscellaneous debris. A composite sample collected from approximately 31 excavated drums exhibited elevated concentrations of pesticides 4,4'-DDT (50,600 milligrams per kilogram [mg/kg]) and 4,4'-dichlrodiphenyldichloroethane (DDD) (15,600 mg/kg) and VOCs acetone (8,180 J mg/kg), 1,1,1-trichlorethane (8,240 J mg/kg), toluene (3,840 J mg/kg), and chlorobenzene (5,760 J mg/kg).

Empty drums and metal containers were triple rinsed and sent to the DRMO for recycling or disposal. Hazardous and non-hazardous solid waste disposed of off-site included: petroleum contaminated soils, pesticide contaminated wastes, batteries, battery debris, grease cans, wire, hazardous liquids and solids of various types, and a mixture of kerosene, motor oil, diesel fuel, and water.

Munitions Debris Removal (CH2M HILL, 2008 - 2010)

In 2008, a Supplemental Site Investigation was initiated to assess the source of chlorobenzene impacts to groundwater at Site 6. During vegetation clearing activities MPPEH was discovered on the ground surface and in a pit located north of Test Pit 10 (**Figure 2-3**). Base EOD was notified and conducted an emergency response in December 2009 that included removing several MPPEH items entangled in communications wire and the discovery of a disposal pit containing MPPEH (CH2M HILL, 2009c).

After the EOD response, surface clearance activities were conducted in October 2009 within the wooded area to remove all surface MPPEH. No MEC were identified during the surface clearing activities and all MPPEH was inspected and independently re-inspected and was reclassified as material documented as safe (MDAS).

The MPPEH disposal pit was investigated in October 2010, four MEC items were discovered and 13,500 pounds of MPPEH were removed from the pit (CH2M HILL, 2010b). The items and quantities discovered during the 2008 to 2010 MR actions at Site 6 are summarized in **Table 2-2** below.

TABLE 2-2
Munitions Response Removal Actions Summary

Item	Quantity	Classification
EOD Response - December 2008		
M-2 antipersonnel mine, bounding	4	MPPEH
57millimeter (mm) brass cartridge	5	MPPEH
M-29 rockets, practice warhead only	22	MPPEH
3.5-inch rocket motor	40	MPPEH
M-29 rockets, 3,5-inch with M-405 fuze	5	MPPEH
Surface Clearing - October 2009		
M48 trip flare (empty), practice	8	MDAS
105mm shipping containers (full and partial)	8	MDAS
105mm cartridge (empty)	1	MDAS
75mm recoilless rifle cartridge (empty)	1	MDAS
3.5-inch rocket warhead, practice	1	MDAS
shipping containers (empty)	6	MDAS
MPPEH Disposal Pit Investigation - October 2010		
81mm mortar, High Explosive (HE), M43 with fuze M45	1	MEC
60mm mortar, HE, M49 without fuze	1	MEC
3.5-inch rocket, High Explosive Anti-Tank (HEAT), M28	1	MEC
60mm mortar, practice, M50A2	unknown[1]	MPPEH
hand grenades, MK21, practice	unknown[1]	MPPEH
M-29 rockets, practice warhead only	unknown[1]	MPPEH
mortar fuzes, M45, expended	unknown[1]	MPPEH
rocket fuzes	unknown[1]	MPPEH

[1]MPPEH from the October 2010 investigation has not been classified for final disposition, the total quantity and final classification is currently unknown.

2.4 Nature and Extent of Contamination

The current nature and extent of contamination is based on the results of the 2009 groundwater sampling and the 2011 test pit investigation.

Groundwater

Groundwater samples were collected from monitoring wells in the surficial and upper Castle Hayne aquifers December 2009 and analyzed for chlorobenzene and organochlorine pesticides (OCPs). Chlorobenzene was detected in five groundwater samples in the surficial aquifer, with only one sample, collected from IR06-GW53, exceeding the North Carolina Groundwater Quality Standard (NCGWQS) of 70 µg/L with a concentration of 3,500 µg/L. Monitoring well IR06-MW53 is located immediately downgradient of the geophysical anomaly that, when investigated in 2011, was found to contain chlorobenzene contaminated soil and unmarked drums (**Figure 2-3**). Samples collected from monitoring wells installed immediately downgradient of the other geophysical anomalies did not contain chlorobenzene at concentrations exceeding the NCGWQS. Dieldrin was the only OCP reported at concentrations exceeding the NCGWQS of 0.002 µg/L ranging from 0.0042 µg/L to 0.06 µg/L. Dieldrin was only detected in samples collected from surficial monitoring wells.

Groundwater samples collected from monitoring wells screened in the upper Castle Hayne aquifer (approximately 50 feet below ground surface [bgs]) and downgradient of the suspected source area had reported chlorobenzene concentrations ranging from 480 µg/L to 1,100 µg/L. Based on the 2009 results, the downgradient and vertical extents of the chlorobenzene plume had not been delineated. Deeper monitoring wells in the middle Castle Hayne (approximately 90 ft bgs) and downgradient upper Castle Hayne monitoring wells were installed and sampled in 2011 to further assess the extent of the chlorobenzene plume. Results of this sampling event are pending.

Buried Waste

The 2009 geophysical investigation indicated that there are several large anomalies indicative of potential buried debris (and potential contaminant sources) in the eastern portion of the open lot between Lots 201 and 203. The test pit investigation conducted in January 2011 investigated the nature of buried waste in the anomalies and collected soil samples to assess the potential for materials to impact groundwater (**Figure 2-3**). All soil samples were analyzed for VOCs (United States Environmental Protection Agency [USEPA] Method 8260B), SVOCs (USEPA Method 8270C), PCBs (USEPA Method 8082), organophosphorus pesticides (USEPA Method 8141A), OCPs (USEPA Method 8081A), Target Analyte List (TAL) Metals (USEPA Method 6010B), and hexavalent chromium (USEPA Method 7196A).

Debris uncovered in the test pits included communication wire, communication batteries, metal debris, metal roofing material, MPPEH, small containers with unknown materials, and two intact drums. Soil samples were collected in each test pit where unique material was found (if a test pit contained identical material to another test pit a sample was not collected). **Table 2-3** provides a summary of materials found in each test pit and soil contaminants that exceeded Base Background concentrations (CH2M HILL, 2011a) and North Carolina Soil Screening Levels (NCDENR, 2010).

TABLE 2-3
Test Pit Excavation Summary

Test Pit Number	Test Pit Identification	Material Uncovered	Soil Contaminants
1	IR06-TP01	2 spools of communication wire, loose communication wire	Antimony Cobalt Benzo(a)pyrene Dibenze(a,h)anthracene Dieldrin 4,4'-DDD
2	IR06-TP02	dry cell communications batteries (intact, large quantity), projectile cartridge case	Dieldrin
3	IR06-TP03	spools of communication wire	No exceedances
4	IR06-TP04	metal roofing material (approximately 200 lbs)	Dieldrin Benzo(a)pyrene
5	IR06-TP05	minor metallic debris, batteries	Not sampled
6	IR06-TP06	minor debris	Dieldrin
7	IR06-TP07	wire spools	Dieldrin
8	IR06-TP08	minor debris, 3.5-inch rocket motors (three, MPPEH)	No exceedances
9	IR06-TP09	metallic debris (screws, metal rods, nails, hinges), suspected former fire pit	Antimony Chromium (total and hexavalent) Cobalt Lead Manganese Dieldrin
10	IR06-TP10	2 55-gallon drums (corroded, unlabeled), communication wire, 5-gallon bucket (contents unknown), 2 ft by 2 ft wooden crate containing white powder	Chlorobenzene Benzo(a)pyrene 2-methylnaphthalene Naphthalene Pentachlorophenol 4,4'-DDD beta-BHC Dieldrin
11	IR06-TP11	minor debris, communication wire	Not sampled
12	IR06-TP12	minor debris, communication wire, rusted 5 gallon buckets	No exceedances

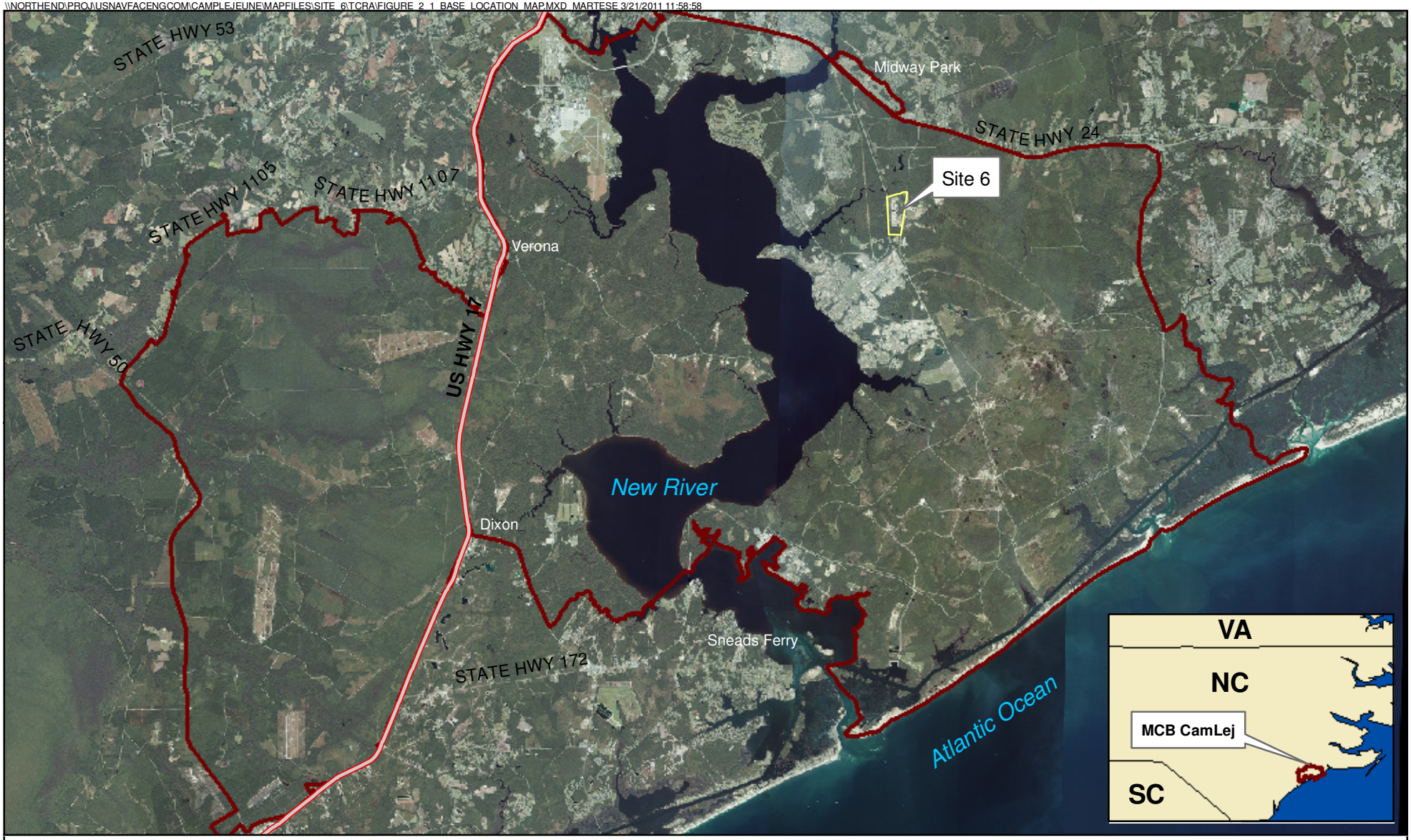
The chlorobenzene concentration detected in the soil sample collected from Test Pit 10 was 70,000,000 µg/kg, indicating a continuous source of contamination and posing a potentially immediate unacceptable risk to human health and the environment. The chlorobenzene concentration was detected in a sample from the test pit containing the buried drums. During test pit excavation activities, sustained photoionization detector (PID) readings between 5 and 10 parts per million (ppm) were reported in the breathing zone outside of the test pit, with PID readings in excess of 130 ppm. Excavation in Test Pit 10 was halted based on the PID readings that exceeded action levels for personal protective equipment (PPE) upgrade in the Site-Specific Health and Safety Plan (HASP) and the test pit was backfilled and secured. The wooden crate containing white powder was excavated, placed in a 65-gallon drum overpack and sampled for VOCs, SVOCs, Pesticides/PCBs, metals, using the toxicity characteristic leaching procedure (TCLP) by A&D Environmental, Inc. The results of the samples indicated that the material was non-hazardous and the crate will be disposed of as non-hazardous waste.

Based on the results of adjacent test pits and groundwater samples collected from monitoring wells installed immediately downgradient of the large geophysical anomalies, the chlorobenzene source area is assumed to be confined to Test Pit 10 and the area immediately adjacent to it (**Figure 2-4**).

2.5 Removal Area

To prevent further migration and eliminate unacceptable risks to public health, welfare, and/or the environment, removal of the buried drums and chlorobenzene-impacted soil will be conducted at Test Pit 10 (**Figure 2-4**). The original test pit was a 5ft long by 5-ft wide by 5-ft deep area. During the removal action, if additional drums are encountered, the drums and any contaminated soil will also be removed. In order to account for additional drums and contaminated soil during the removal action a 10-ft buffer was added around the original test pit, resulting in a 15-ft by 15-ft removal area. The vertical extent of the removal area is determined by the depth to groundwater which has been impacted with chlorobenzene. Groundwater is typically encountered at approximately 5 ft bgs. The approximate volume of soil and drums to be removed is 42 cubic yards.

\\NORTHEND\PROJ\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SITE_6\TCRA\FIGURE_2_1_BASE_LOCATION_MAP.MXD MARTESE 3/21/2011 11:58:58



Legend

- Highways
- Operable Unit 2, Site 6
- Installation Boundary

N

0 7,500 15,000 30,000 Feet

1 inch = 15,000 feet

Figure 2-1
Base Location Map
Site 6 Time-Critical Removal Action
MCB CamLej
North Carolina

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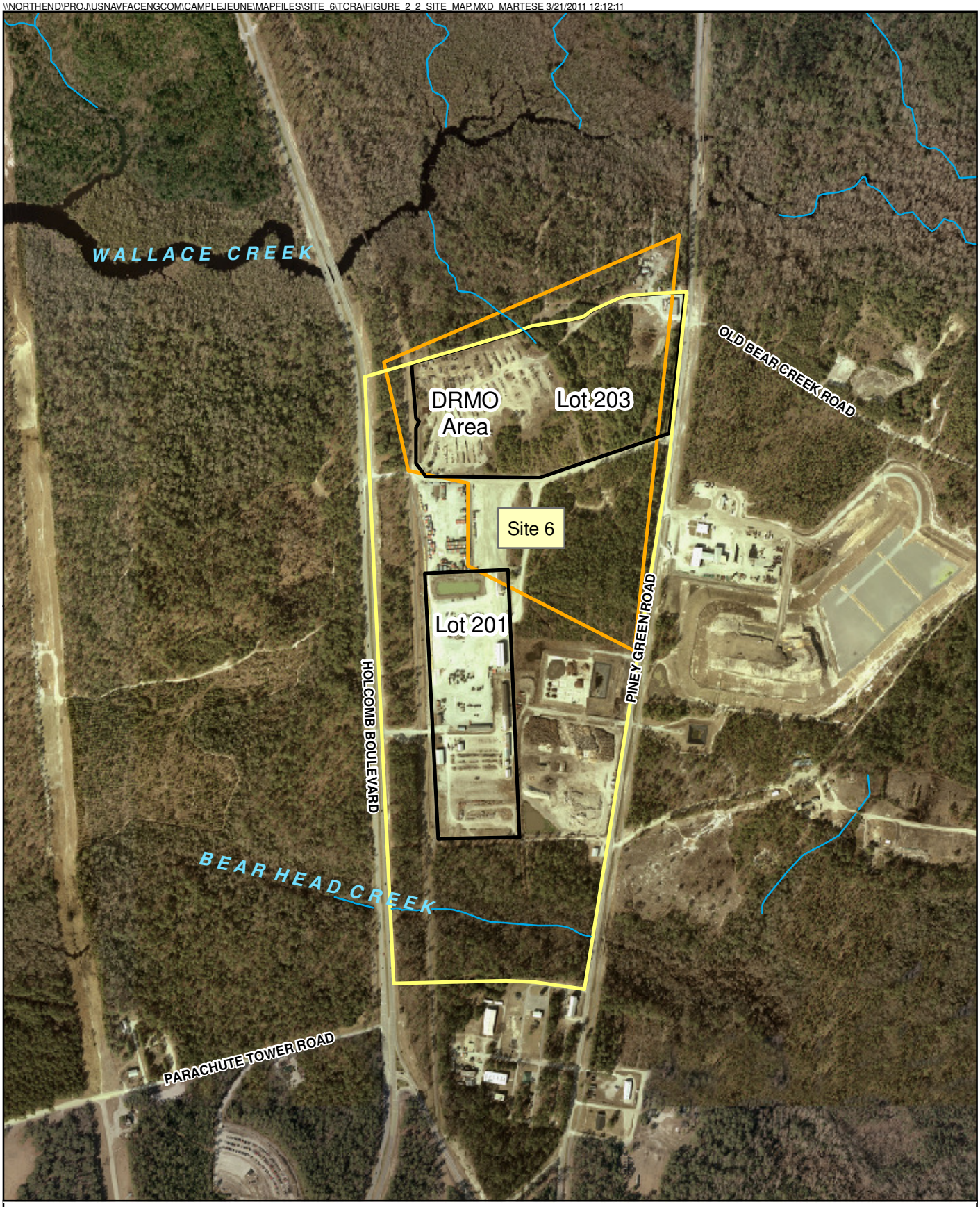

Legend
- Surface Water Centerline
- Site 6 Boundary
- Lots 201 and 203
- UXO-22 Boundary

N

0 450 900 1,800 Feet

1 inch = 900 feet

Figure 2-2
Site Map
Site 6 Time-Critical Removal Action
MCB CamLej
North Carolina

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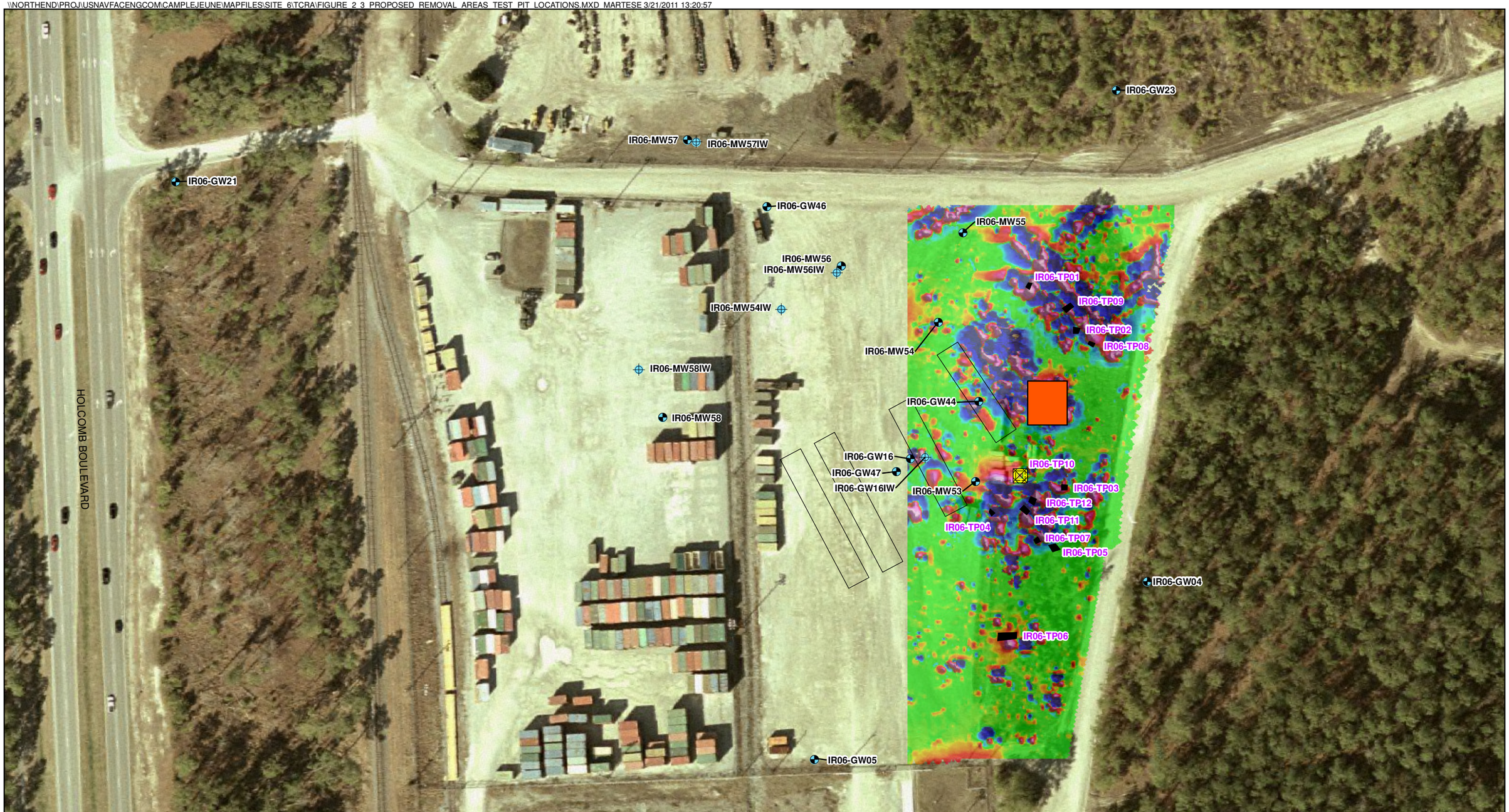
\\NORTHEND\PROJ\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SITE_6\TCRA\FIGURE_2_3_PROPOSED_REMOVAL_AREAS_TEST_PIT_LOCATIONS.MXD MARTESE 3/21/2011 13:20:57



Legend

- Surficial Aquifer Monitoring Well
- Upper Castle Hayne Aquifer Monitoring Well
- Test Pit Locations
- Source Removal Trenches (OHM, 1997)
- MPPEH Disposal Pit (CH2M Hill, 2010b)
- Estimated TCRA Excavation Area
- Fence

Vertical Gradient

nT/m

-13147 -276 -112 -51 -24 -10 -0 7 14 34 76 190 878

N

0 50 100 200 Feet

1 inch = 100 feet

Note:
Geophysical survey instrument: Geometrics G-858 magnetometer

Figure 2-3
Previous Removal Areas and Test Pit Locations
Site 6 Time-Critical Removal Action
MCB CamLej
North Carolina

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Legend

- Surficial Aquifer Monitoring Well
- Upper Castle Hayne Aquifer Monitoring Well
- Electrical Utility Line
- Estimated Excavation Area
- Fence

N

0 40 80 160 Feet

1 inch = 80 feet

Figure 2-4
Excavation Layout
Site 6 Time-Critical Removal Action
MCB CamLej
North Carolina

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SECTION 3

Removal Action Design and Implementation

This section presents the conceptual removal action design and provides the details associated with implementation.

3.1 Project Overview

As described in the Site 6 Action Memorandum, the removal action for the chlorobenzene-impacted soil and buried drums at Site 6 will include excavation of contaminated soil and drums based on the concentration of chlorobenzene in the test pit sample (70,000,000 µg/kg) (CH2M HILL, 2011d). This removal action is easily implementable and cost-effective, using conventional equipment and standard construction methods. Implementation of this removal action will provide a permanent method of removing an identified source area and eliminating migration of contamination and risks to human health and the environment.

3.2 Project Objective and Goal

The primary objective of this TCRA is to remove the chlorobenzene source (drums) and grossly contaminated chlorobenzene soil equaling up to 42 cubic yards of material. Samples will be collected from the excavation prior to backfilling. The analytical results will be evaluated after the TCRA has been completed as part of the ongoing supplemental groundwater investigation. The overall remedy for Site 6 will be revisited to ensure continued protection of human health and the environment.

3.3 Removal Action Implementation

Implementation of the Site 6 TCRA will be conducted by Osage, with engineering support and construction oversight provided by CH2M HILL. Since the removal action is located within the boundary of a MMRP Site, MR support is required during all intrusive activities. Osage is responsible for subcontracting appropriate MR support and qualified UXO technicians to conduct the work in accordance with the approved ESS and ESS Amendments. The following discussion provides details associated with the implementation of excavation with offsite disposal and includes:

- **Site Preparation –** includes buried utility location, and establishment of exclusion zones for hazardous waste operations and munitions response activities
- **MR Support –** includes reporting and disposition of MEC and MPPEH items, personnel responsibility, overall safety precautions, and required engineering controls
- **Excavation –** includes excavation limits, general health and safety requirements, and disposition of excavated waste
- **Confirmatory Sampling –** includes general requirements for confirmatory sampling

- **Site Restoration –** includes backfilling, compaction, and grading requirements
- **Offsite Disposal –** includes requirements for offsite disposal

Osage will be responsible for the submittal of a Site-Specific HASP to the Navy for approval. All site operations will be implemented as presented in the Final Site 6 TCRA IP.

3.3.1 Site Preparation

The North Carolina One Call Center, Base personnel, and a professional underground utility locator will be consulted to identify any subsurface utilities within 20 feet of the removal area. **Figure 2-4** depicts known utilities in the vicinity of Test Pit 10. One overhead electrical line crosses from north to south immediately to the west of Test Pit 10.

Since hazardous materials, including potential MEC and chlorobenzene, will be exposed and removed from this excavation, appropriate exclusion zones shall be set up in accordance with the site-specific HASP and all ESS documents.

3.3.2 Munitions Response Support

All intrusive work conducted at Site 6 will be conducted by qualified UXO technicians in accordance with the ESS and ESS Amendments. All debris removed from the excavation will be inspected by a UXO technician and segregated into one of three categories: 1) MEC, 2) MPPEH, or 3) non-MPPEH debris. MEC will be disposed of in accordance with the ESS and its amendments. MEC and MPPEH will be demilitarized as necessary. One-hundred percent inspection and re-inspection of MPPEH will be conducted to reclassify MPPEH as MDAS, which will be disposed of off-site. Inspections will be documented on Department of Defense Forms 1348-1, which will accompany all off-site shipments of MDAS.

No MEC or MPPEH will be removed from Site UXO-22; only MDAS and non-MPPEH debris will be moved outside of the Site UXO-22 boundaries.

3.3.3 Excavation

A total of approximately 42 cubic yards of soil and buried debris will be removed by the UXO subcontractor in accordance with the ESS and ESS amendments from the area around Test Pit 10. A 15-ft by 15-ft area will be excavated to the water table, approximately 5 ft bgs. The current approved ESS and ESS amendments require excavation by hand. The total estimated removal area is less than 0.1 acre. Since the excavation will extend to approximately 5 ft bgs, a trained excavation-competent person will be required to be onsite to ensure that appropriate shoring or sloping measures are in place for all excavations that would require entry.

All debris uncovered in the excavation will be inspected and segregated as described in Section 3.3.2 and the ESS and ESS amendments. Waste will be characterized and disposed of as outlined in Section 3.3.6.

Excavation activities will be conducted with the appropriate personal protective equipment and engineering controls to provide protection against chlorobenzene exposure as prescribed in the site-specific HASP. Real-time air monitoring for VOCs, specifically chlorobenzene, and appropriate management of emissions will be conducted in accordance with North Carolina Administrative Code (NCAC) 15A NCAC 02D .1104, Toxic Air

Pollutant Guidelines. Since the excavation is being conducted in an open lot, fugitive dust emission control measures will be managed in accordance with 15A NCAC 02D .0540(c), Particulates from Fugitive Dust Emissions Sources.

Removal will be considered complete when all visible drums have been removed and the planned limits of the excavation have been reached.

Since the scope of this TCRA is the removal of drums and grossly contaminated soils, chlorobenzene impacts may remain outside the limits of the excavation. Confirmatory samples will be collected to assess the concentration of remaining impacts and support the path forward for the overall remedy at Site 6.

3.3.4 Confirmatory Sampling

Confirmatory sidewall and bottom samples will be collected from the excavation prior to backfilling to provide information on whether chlorobenzene concentrations remain in-place. Each sidewall and the bottom will be divided into quadrants and screened with an organic vapor analyzer (OVA). A discrete confirmatory sample will be collected from each sidewall from the soil exhibiting the highest VOC reading. If no elevated VOC readings are detected, the sample will be collected from the soil showing the highest degree of staining or, in the absence of staining, from the center of each sidewall. The depth of the sidewall sample will be at minimum of 1 ft above the apparent water table. If no VOC readings are detected and no staining is observed to the soils in the base of the excavation the confirmatory sample will be collected from the location where the drums were removed.

Confirmatory samples will be sent to a fixed-base laboratory and analyzed for chlorobenzene by USEPA Method 8260B on a standard turn-around-time. The analytical results will be evaluated after the TCRA has been completed as part of the ongoing supplemental groundwater investigation. The overall remedy for Site 6 will be revisited to ensure continued protection of human health and the environment.

Confirmatory soil samples will be collected for munitions constituent (MC) analysis if MEC or MPPEH is found and exhibit signs of MC being released to the environment. Confirmatory soil samples will also be collected if a controlled detonation is conducted on safe-to-move MEC or for the demilitarization of MPPEH.

3.3.5 Site Restoration

After the excavation limits have been achieved, Osage will restore the site by backfilling the excavation with clean fill, compacting it, and covering with gravel to prevent erosion as described below.

The overburden and imported clean fill material and gravel will be placed to achieve final grade. The soil fill will be placed smoothly and evenly in maximum 12-inch lifts. Each lift will be compacted to 95 percent relative compaction. Osage will perform field tests to verify that 95 percent of relative density is achieved in each soil lift. Quality assurance (QA) testing for backfill compaction will be performed as described in Specification 2316, American Society for Testing and Materials (ASTM) D2922 for in-place density tests.

3.3.6 Offsite Disposal

Due to high concentrations of chlorobenzene, it is assumed that the soil will be considered Resource Conservation and Recovery Act (RCRA) hazardous waste for toxicity characteristic and carry the Code (D021). In addition, the concentrations of chlorobenzene that are present may trigger land disposal restrictions (LDRs). In order to minimize the volume of hazardous waste to be disposed and treated if LDRs apply, highly contaminated soil will be segregated from less contaminated soil, along with segregation of other debris. Soil segregation will be based on field conditions and OVA readings. Once the excavation is complete, waste characterization samples will be collected to determine the proper disposal of the contaminated soil. Osage will coordinate the transportation of the excavated soil offsite for disposal. Hazardous waste will be disposed in a Subtitle C Hazardous Waste Landfill that has been a valid USEPA Comprehensive, Environmental Response, Compensation and Liability Act (CERCLA) Off-site Rule (OSR) approval (40 CFR 300.440). If the soil does not meet the LDRs, the soil will be treated via incineration with the post-incinerated material being disposed of at a Subtitle C facility. MEC, MPPEH, MDAS, and other debris will be managed in accordance with the requirements of the ESS, ESS Amendments, and the MCB CamLej Waste Management Plan (CH2M HILL, 2011c).

Recovered drums will be segregated, placed in overpacks, and sampled using onsite testing equipment (e.g., field HAZCAT analysis) to determine basic waste characteristics. Drums will be secured onsite until further waste characterization is complete. Waste characterization will include collecting a representative sample from each drum and analyzing its contents for VOCs, SVOCs, PCBs, metals, and pesticides by the Toxicity Characteristic Leaching Procedure (TCLP); ignitability by Pensky Martens; corrosivity by Method 9045C; reactivity by cyanide; and reactivity by sulfide.

A licensed hazardous waste transportation contractor will be retained to transport materials to the disposal facility. Documentation will be provided for each load. Manifests will be signed by a MCB CamLej Environmental Management Division (EMD) representative.

SECTION 4

Reporting

A Removal Action Summary Memorandum will be prepared by CH2M HILL to document the removal action. The Removal Action Summary Memorandum will include:

- Summary of excavation activities
- Results of confirmatory sampling
- Disposal confirmation
- Project photographs

The Draft Removal Action Summary Memorandum will be submitted to the Partnering Team for review. Review comments will be addressed in the Final Removal Action Summary Memorandum.

SECTION 5

Schedule and Project Organization

This section of the IP provides the schedule, project management organization, and responsibilities of project personnel.

5.1 Schedule

The proposed schedule for implementing the Site 6 TCRA is presented in **Table 5-1**. The tasks presented in the schedule correspond to the tasks identified in this Work Plan. Some dates may change due to regulatory review, Base access, or weather issues.

TABLE 5-1
Time Critical Removal Action Schedule

Activities	Dates	
	Anticipated Date of Initiation	Anticipated Date of Completion
Action Memorandum	3/03/2011	4/30/2011
Implementation Plan	3/09/2011	4/30/2011
Field Work	5/09/2011	6/09/2011
Report	5/15/2011	6/15/2011
Public Notice	6/15/2011	6/15/2011
Public Comment Period	6/15/2011	7/15/2011

5.2 Project Organization

The removal action will be performed by Osage with construction oversight provided by CH2M HILL.

Mr. Shaun Whitworth, Professional Geologist (P.G.), is the Osage Project Manager for the Site 6 TCRA. Osage is responsible for implementation of the removal action as described herein.

Mr. Theron Grim, P.G., is the CH2M HILL Project Manager for the Site 6 TCRA.

SECTION 6

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Appendix A
ESS and ESS Amendments

Explosives Safety Submission for Munitions Response Activities Site 6 (Operable Unit 2)

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Task Order 039

Revision 1 – April 2009

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

Under the

Navy CLEAN 1000 Program
Contract No. N62470-08-D-1000

Prepared by

CH2MHILL

Charlotte, North Carolina

Response to DDESB Comments
Explosive Safety Submission Site 6 (Operable Unit No. 2)
MCB Camp Lejeune, North Carolina

PREPARED FOR:	Bob Lowder, MCB Camp Lejeune Gary Tysor, NAVFAC Mid-Atlantic
PREPARED BY:	CH2M HILL
DATE:	March 9, 2009

The purpose of this document is to address Department of Defense Explosives Safety Board (DDESB) comments to the Explosives Safety Submission (ESS) for Installation Restoration (IR) Site 6 in Operable Unit (OU) 2, Marine Corps Base (MCB) Camp Lejeune, North Carolina. The DDESB provided the comments listed below. Responses to comments are provided in **bold type**.

Department of Defense Explosives Safety Board
(dated February 11, 2009)

Specific Comments

1. Change section 3.1 to reflect the information contained in section 1.6. Section 1.6 identifies that previous studies have encountered MEC. Section 3.1 states there are no records of MEC being encountered.

The following text will be added to paragraph one of Section 3.1 of the ESS:

"As discussed in Section 1.6, surface and subsurface reconnaissance performed during the RI (Baker, 1993) resulted in the discovery of three Mk II grenades, ammunition, practice rockets and expended cartridges. During the TCRA removal action (1994) and the EOD Response (2008), only practice, inert or expended munitions items were recovered. There is no documentation that Site 6 was ever an active range, impact area or open burn/open detonation area."

2. In section 3.2.1, it needs to be clearly stated only practice, inert, or expended items have been discovered at Site 6. This way it is acceptable to use the 3.5" practice rocket as the MGFD, [use 0.44 lbs HD 1.1 nonfragmenting] otherwise the MGFD would be a 3.5" high explosive rocket [1.88 lbs HD 1.1 fragmenting]. Include a statement explaining that the explosive safety distances for explosives venting of inert 3.5" rockets to verify inert filler will assume a high explosive 3.5" rocket is being vented for added safety. MSD for nonessential personnel will be based on the MFD of the high explosive 3.5" rocket. Include frag data sheet.

The following text will be added to paragraph one of Section 3.2.1 of the ESS:

"Only practice, inert, or expended items have been discovered at Site 6. All rockets historically recovered from Site 6 have been practice rockets. Since work at this site will involve the recovery and inspection of MPPEH, it is assumed that some MPPEH items, specifically M 29 practice 3.5 inch rockets, may require explosive venting to gain access and verify that the filler is inert. Out of an abundance of caution, when 3.5 inch rockets are explosively vented, the exclusion zone parameters (including the team separation distance and minimum separation distance for public and non-essential personnel) will be calculated based on the contingency munition with the greatest fragmentation distance (MGFD), the high explosive 3.5 inch rocket. The Fragmentation Data Sheet for the contingency 3.5 inch high explosive rocket is attached. Based on these findings and assumptions, the primary MGFD assumed for the site is a 3.5-inch practice rocket for intrusive investigation activities. The 3.5-inch high-explosive (HE) rocket is the contingency MGFD. The exclusion zone parameters for intentional detonations will be calculated based on the contingency MGFD. Use of engineering controls is requested for intentional detonations to reduce the explosive arcs."

Consolidated shots might be considered as you might find a whole bunch of rockets and it's much more effective to shot consolidated vice single shots. For this the range limit needs to be calculated assuming all live rounds plus NEW of donor charges. K328*That NEW cannot exceed the MFD of the MGFD (1,420 ft). At 80 lbs MCE, that would permit a consolidated shot of ~ 40 rockets. (Note that the BEM can be used for consolidated shots but the sandbag/water bags are for single shots only.)

The ESQD tables were updated to reflect consolidation of five M 28 HE Rockets, using engineering controls (BEM output included as an attachment).

3. Redo the explosive arcs and maps to show distances without the use of engineering controls. Request the use of engineering controls to reduce the explosive arcs. Reduced arcs can be shown if desired.

The figures were updated.

4. For clarity, the DDESB has requested that the following information be provided per the example provided:
   - The contingency munition with the greatest fragmentation distance (MGFD) expected to be encountered is the 3.5" high explosive rocket. The calculated maximum fragmentation distance is feet. The calculated hazardous fragment distance is feet.

The following text was added to Section 3.2.2 of the ESS

"The calculated maximum fragmentation distance is 1,420 feet. The calculated hazardous fragmentation distance is 235 feet."

- If a MEC item with a greater fragmentation distance is encountered the Minimum Separation Distance (MSD) will be adjusted per Department of Defense Explosives

Safety Board (DDESB) TP 16, work will continue, and an amendment to this ESS will be expeditiously submitted.

The above text was added to Section 3.2.2 of the ESS.

- Q-D MEC Area Unintentional Detonation: MSD feet (use K40 since MGFD is nonfragmenting) and Team Separation Distance: feet.

Calculations of 31 feet for both MSD and TSD will be added to Table 3.2. The following text was added to Section 3.2.1.

The quantity distances (Q-D) for MEC area unintentional detonation are:

- **MSD (based on the K40 since the primary MGFD is nonfragmenting) 31 feet**
- **TSD (based on the K40 since the primary MGFD is nonfragmenting) 31 feet**

  - Q-D Intentional Detonation Activities: separation distance without engineering controls: feet (Maximum Fragment Range) and with engineering controls (Sandbag enclosure or water mitigation, BEM) separation distance feet.

The following text will be added to Section 3.2.2 of the ESS.

The minimum separation distance (MSD) for the contingency MGFD without engineering controls for intentional detonation activities is 1,420 feet. Using engineering controls, based on the buried explosion module output which is included as Attachment 3, the MSD for the intentional detonation of a consolidated intentional demolition shot of five (5) M28 HE rockets is 288 feet. An additional safety factor of 33% will be applied to the MSD for intentional detonation of the consolidated demolition shot using engineering controls, resulting in an MSD of 383 feet for intentional detonation using engineering controls.

The Q-D for intentional detonation activities are:

- **MSD without engineering controls is 1,420 feet**
- **MSD with engineering controls based on BEM (Attachment 3) is 288 feet**

  - Q-D Demolition Explosives Storage Magazines: Donor explosives will be delivered on an as-needed basis and used the same day. No explosives will be stored on site therefore a magazine will not be required.

The above text was added to the last paragraph of Section 3.2.2.

5. In section 8.2.1. include a statement that MEC items will be disposed of using design mode initiation or that a safety factor of times 33% will be applied to the explosives arcs.

The following text was added to Section 3.2.2

"An additional safety factor of 33% will be applied to the MSD for intentional detonation of the consolidated demolition shot using engineering controls, resulting in an MSD of 383 feet for intentional detonation using engineering controls. Figure 2-2 shows the ESQD arcs for the contingency MGFD."

The following text was added to Section 8.2.1

"a safety factor of 33% will be applied to the explosive arcs."

6. There is confusing and contradictory language between section 8.3 which states no MEC will be stored on site and section 8.4.3 which states that if a MEC item is found on site it will be secured in a locked container until it can be demiled. Provide clarification.

The following revisions were made to Section 8.4.3 of the ESS:

The statement "If a MEC item is found at the site, the item will be secured in a locked container until demilitarization. The storage unit will remain secured until disposal operations can be performed. The gravel drives located north and east of the MPPEH Scrap Collection Point (Figure 2-1) can be closed when MEC items are stored" will be replaced with the text below:

"If a MEC item is found at the site, the item will be demilitarized through controlled detonation on-site."

7. In sections 8 and 10 include a statement that reads something like Base EOD personnel are available on-call as needed to assist the contactor.

The following text was added to Section 8.4.3 of the ESS:

"Base EOD personnel will be available on-call to assist CH2M HILL and its subcontractors."

The following text was added to Section 10.1 of the ESS:

"Base EOD will be notified if potential MEC is found and Base EOD are available on-call as needed to assist CH2M HILL."

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8-1 MPPEH Logic Diagram

Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
ASR	Archives Search Report
ATF	Alcohol, Tobacco, and Firearms
CAP	Corrective Action Plan
CAR	Corrective Action Request
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DDESB	Department of Defense Explosives Safety Board
DFOW	definable feature of work
DGM	digital geophysical mapping
DMM	discarded military munitions
DOD	U.S. Department of Defense
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
DQO	data quality objective
DRMO	Defense Reutilization and Marketing Office
ECA	equipment check area
EOD	explosive ordnance disposal
ESQD	explosives safety quantity-distance
ESS	Explosives Safety Submission
EZ	exclusion zone
ft	feet/foot
GIS	geographic information system
GPS	global positioning system
HE	high explosive
HSP	Health and Safety Plan
IBD	inhabited building distance
lb	pound
MARCORSYSCOM	Marine Corps System Command
MCB	Marine Corps Base
MD	munitions debris
MEC	munitions and explosives of concern
MGFD	munition with the greatest fragmentation distance
MILCON	military construction
mm	millimeter
MPPEH	material potentially presenting an explosive hazard

MR	munitions response
MRA	munitions response area
MRS	munitions response site
MRSIMS	Munitions Response Site Information Management System
MSD	minimum separation distance
MTSQ	Mechanical Time Super Quick
mV	millivolt
NAVFAC	Naval Facilities Engineering Command
NAVSEA	Naval Sea Systems Command
NCDENR	North Carolina Department of Environment and Natural Resources
NEW	net explosives weight
NOSSA	Naval Ordnance Safety and Security Activity
NRCS	Natural Resources Conservation Service
OSHA	Occupational Safety and Health Act
PA/SI	Preliminary Assessment/Site Inspection
PM	Project Manager
PTR	public transportation route
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QCP	Quality Control Plan
RDX	hexahydrotrinitrotriazine
RI	Remedial Investigation
RTK	real-time kinematic
SUXOS	Senior UXO Supervisor
TCRA	time critical removal action
TO	task order
TSD	team separation distance
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Corps of Engineers, Huntsville Center
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Specialist
UXOSO	UXO Safety Officer

SECTION 1

Background

This Explosives Safety Submission (ESS) was prepared in support of the munitions response (MR) activities to recover and dispose of material potentially presenting an explosive hazard (MPPEH) in support of a Supplemental Investigation for Marine Corps Installation Restoration Site 6 in Operable Unit 2 at Marine Corps Base (MCB) Camp Lejeune, Jacksonville, North Carolina. This MR action is being implemented by CH2M HILL, Inc. (CH2M HILL) for the Naval Facilities Engineering Command (NAVFAC) Atlantic Division under the Comprehensive Long-term Environmental Action Navy (CLEAN) program, Contract No. N62470-08-D-1000, Contract Task Order (CTO) 039.

1.1 Responsible Project Manager

The responsible project manager for this project is:

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1.2 Munitions Response Site Identifier and Description

The subject of the proposed MR action is an area of Site 6 where a pit containing MPPEH was recently discovered. The MCB Camp Lejeune Explosive Ordnance Disposal (EOD) team responded to the discovery of surface MPPEH on December 12, 2008, and subsequently removed various types of MPPEH, which are identified in Section 3.1, below, that had been buried in a pit. Additional MPPEH remains in the pit.

The munitions response site (MRS) is located west of Piney Green Road and east of Holcomb Boulevard, just south the Defense Reutilization and Marketing Office (DRMO) Lot 203 operations. The *MPPEH, which consisted of* munitions debris (MD) was located in a wooded strip of vegetation bounded by gravel lots and gravel roads. The topography of Site 6 is flat with little elevation relief. No water features are present within the site boundaries.

Site 6 is part of Operable Unit (OU) 2 at MCB Camp Lejeune. OU 2 also includes Sites 9 and 82. MCB Camp Lejeune is an active military installation that covers approximately 236 square miles. Site 6 covers an area of approximately 177 acres that include Storage Lots 201 and 203, a wooded area between the storage lots, and a ravine. Historically, Site 6 was used for disposal and storage of wastes and supplies, including pesticides, transformers containing polychlorinated biphenyls (PCBs), solvents, electrolytes, and waste oils. Currently, Lot 201 is used to store military equipment, vehicles, hydraulic oils, and other "non-hazardous" supplies. Lot 203 is no longer an active storage area. The overall current

land use at Site 6 is industrial. Land use is not anticipated to change in the foreseeable future.

1.3 Regional Maps

Figure 1-1 shows the regional location of MCB Camp Lejeune and the location of Site 6 within MCB Camp Lejeune.

1.4 Scope of Munitions Response

This MR action is being conducted to recover and dispose of MPPEH remaining in the pit and to dispose of MPPEH that was recovered by the Base EOD team. The MPPEH removal, demilitarization and disposal activities will be performed to significantly reduce the risk of encountering MEC during future activities within the MRS. The remainder of OU #2 will be investigated for potential MPPEH during a future phase of work. No construction activity is currently underway or scheduled at the Site.

Since the Site includes suspected disposal areas where discarded material was buried in trenches, the maximum depth of intrusive investigation will extend to the limit of the former disposal trench. Groundwater in the area is encountered between 8 and 10 feet below ground surface. It is not expected that disposal trenches will extend below the groundwater table.

1.5 History of MEC Use

No former range activities are known to have occurred at the MRS. According to the *Remedial Investigation Report for Operable Unit No. 2(Sites 6 and 9)* (Baker, 1993), disposal trenches containing munitions debris (including expended 105 mm cartridges), communication wire, graphite battery packs, containers of petroleum, oil, and lubricants, and metal 55-gallon drums were discovered at Site 6. In 1994, a Time Critical Removal Action (TCRA) was performed at Site 6. During the TCRA, four removal trenches were excavated in order to remove disposed material from the site. Disposed material that was excavated and reportedly removed from the site included expended 105 mm cartridge cases, communication wire, graphite battery packs, grease containers, metal drums, and contaminated soil (OHM, 1997). In December 2008, Base EOD responded to the discovery of surface MPPEH and subsequently removed various types of MPPEH, which are identified in Section 3.1, below, from a pit. Additional MPPEH remains in the pit.

1.6 Previous Studies of Extent of MEC Contamination

1.6.1 UXO Surface and Subsurface Investigation and Removal from Remedial Investigation Report (1993)

During the RI (Baker, 1993), a surface and subsurface UXO investigation was performed to search for, identify, and clear MEC at Site 6. The UXO survey report in the RI states that the following items were collected (quantities in parentheses): Mk II grenade (3), 7.62 mm ammunition (100), 3.5"

practice rockets (15), 20 mm cartridge cases (10), 30 mm cartridge cases (23), 40 mm cartridge cases (54), and 105 mm cartridge cases (more than 1,000). The grenades and 7.62 mm ammunition were reportedly turned over to Base EOD. The final disposition of the remaining munitions debris was not documented in the report; however, the report indicated that the remaining material would be disposed as scrap metal.

1.6.2 Time Critical Removal Action (1994)

According to the Contractor's Closeout Report for Sites 6 and 82 Source Removal (OHM, March 1997), four source removal trenches were excavated in February 1994 at Site 6. The excavation of the two southern trenches removed 930 cubic yards of material consisting of drums, communication wire, batteries and expended 105mm cartridges. Over 1,300 cubic yards of soil and debris were removed from two northern excavations. The debris in these trenches consisted of batteries, drums and communication wire. Approximately 425 cubic yards of material were removed from the two southern trenches, of which batteries comprised one-third of the total; totaling over 100 tons.

1.6.3 2008 EOD Emergency Response

In December 2008, munitions debris was discovered in the central area of Site 6 during vegetation clearing. The vegetation clearing was underway to prepare for a geophysical survey investigating possible waste disposal areas. Base EOD was contacted upon discovery of several 3.5-inch practice rockets entangled in communication wire. Base EOD responded and subsequently removed various types of MPPEH. During the EOD response, the following items (and quantities) were removed from a pit beneath the communication wire:

- *Four M-2 antipersonnel mines, bounding*
- *Five 57mm brass cartridges*
- *Twenty-two M-29 rockets, practice warhead only*
- *Forty rocket motors, 3.5-inch*
- *Five M-29 rockets, 3.5-inch with M-405 fuze*

These items were put into secure temporary storage onsite and will be demilitarized and disposed of under this ESS. The initial observation by EOD was that all of these items are expended/inert, however the certification and verification procedures necessary to classify these item as material documented as safe (MDAS) have not been completed. The certification and verification procedures will be accomplished under this ESS.

1.7 Regulatory Statute, Phase, and Oversight

The supplemental investigation of Site 6 will be conducted under the CERCLA framework with input provided by the United States (U.S.) Environmental Protection Agency (USEPA) Region 4 and the North Carolina Department of Environment and Natural Resources (NCDENR). Regulatory oversight from environmental agencies is not being provided for MR activities related to excavation, demilitarization and disposal of MPPEH.

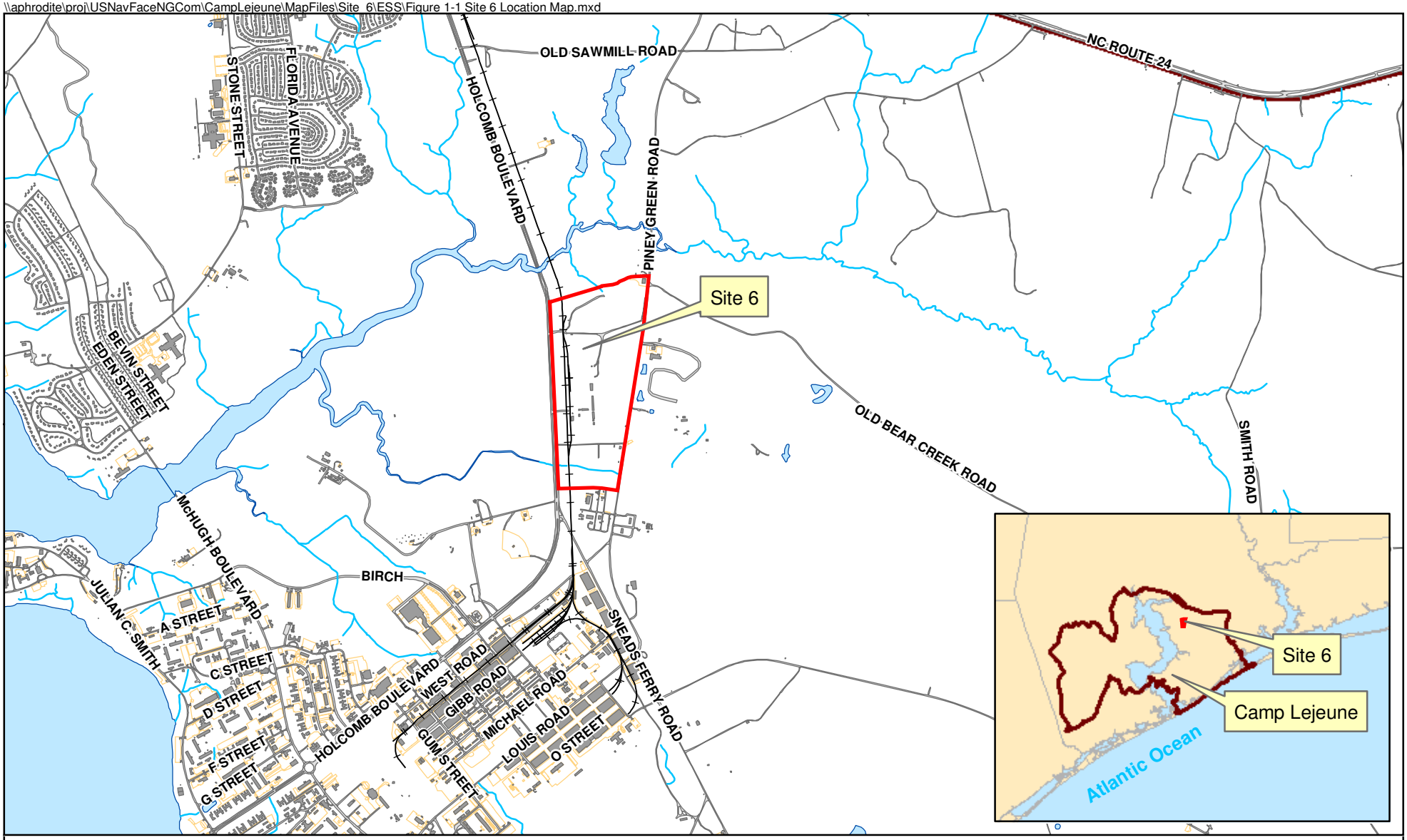
The response action will be conducted in accordance with the following health and safety regulations and requirements, in addition to the MEC-specific regulations and requirements to be provided in a Munitions Response Work Plan (CH2M HILL, under development):

- 29 Code of Federal Regulations (CFR), Occupational Safety and Health Act (OSHA) Regulations: Construction (29 CFR 1926) and General Industry (29 CFR 1910), applicable sections
- U.S. Army Corps of Engineers (USACE), 2008, EM 385-1-1, *Safety – Safety and Health Requirements*

1.8 Justification for NDAI/NFA Decision

Not applicable.

\\aphrodite\proj\USNavFaceNGCom\CampLejeune\MapFiles\Site_6\ESS\Figure 1-1 Site 6 Location Map.mxd



Legend

- Railroad Centerline
- Stream
- Road Area
- Buildings
- Vehicle Parking Area
- OU 2 Boundary - MRS Boundary
- Installation Boundary

N

0 1,500 3,000 6,000 Feet

1 inch equals 3,000 feet

Figure 1-1
Location Map
Site 6
MCB Camp Lejeune, North Carolina

CH2MHILL

SECTION 2

Site Approval Request

2.1 NAVFAC Form 11010/31, "Request for Project Site Approval"

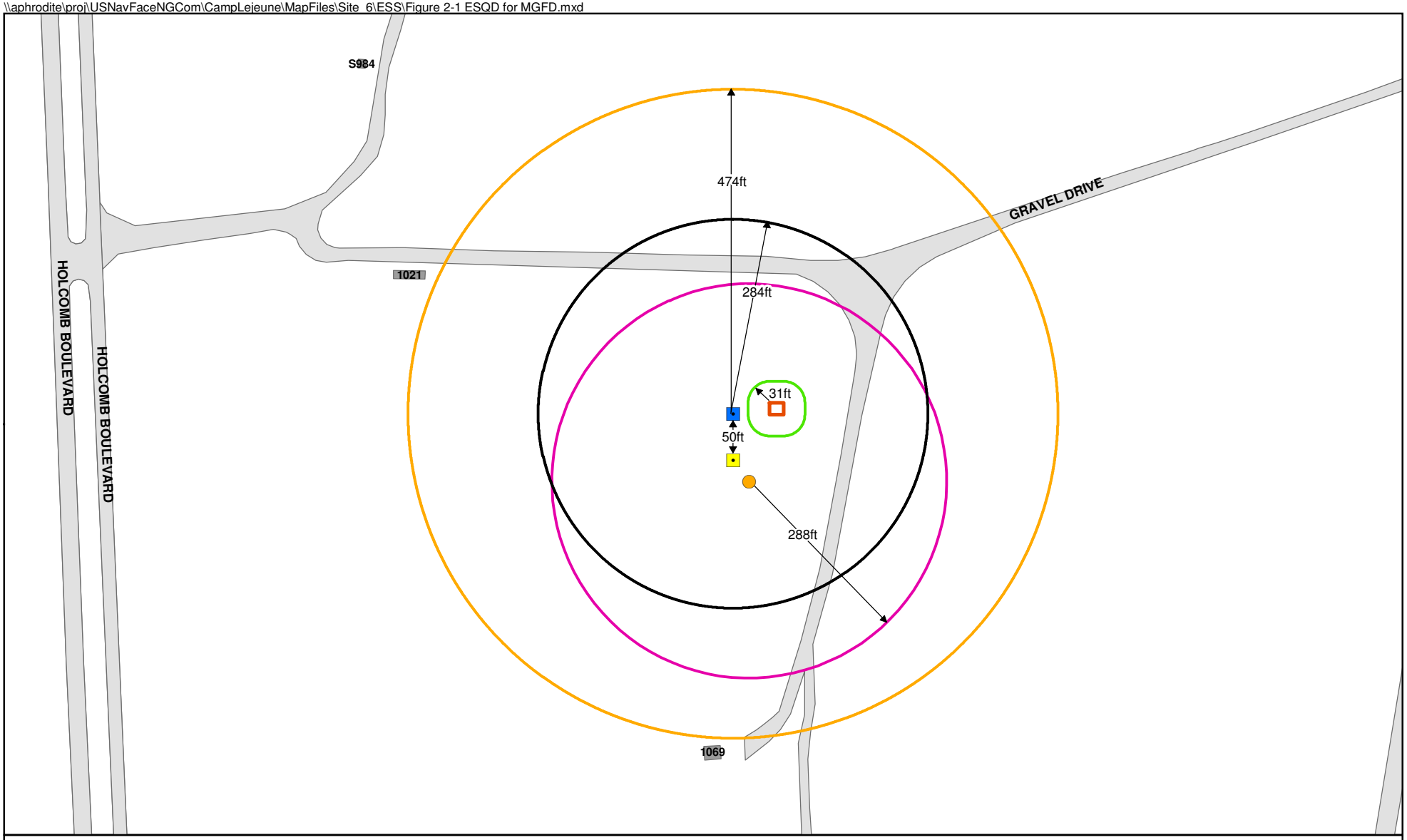
NAVFAC Form 11010/31 is included as Attachment 1. The associated explosives safety quantity-distance (ESQD) arcs maps are presented as **Figures 2-1** and **2-2**.

2.2 Additional Information

No buildings are located within the primary ESQD arcs *(Figure 2-1).* The nearest building is Building 1069 which is located 380′ south of the proposed controlled detonation trench. Building 1069 is a two-room field office for the *Base vehicle scales and the* DRMO storage lot south of Site 6.

The intent of this ESS is to address the MPPEH recovered by Base EOD and remaining in the pit. An amendment to this ESS will address MR activities at the remainder of the Site.

\\aphrodite\proj\USNavFaceNGCom\CampLejeune\MapFiles\Site_6\ESS\Figure 2-1 ESQD for MGFD.mxd



Legend

- Non-MPPEH Scrap Collection Point
- MPPEH Scrap Collection Point
- Controlled Detonation Area
- Unintentional Detonation TSD and MSD = 31 ft
- PTR = 284 ft
- MPPEH Scrap Collection Point IBD = 474 ft
- Intentional Detonation MSD for Public and All Personnel = 288 ft
- Burial Pit Containing MPPEH
- Road Area
- Structure Existing Area

N

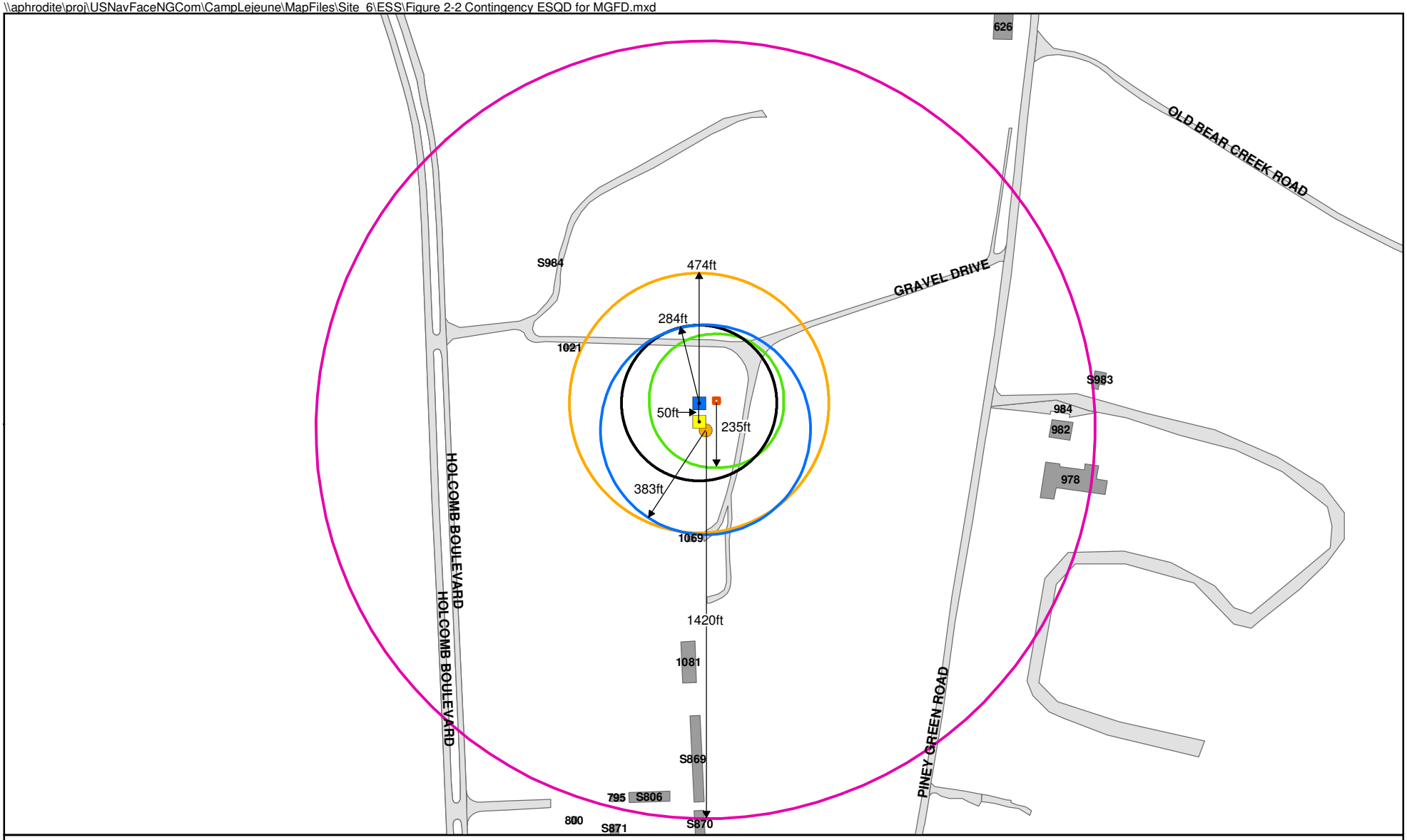
0 100 200 400 Feet

1 inch = 200 feet

Figure 2-1
Explosives Safety Quantity Distance (ESQD) Arcs
for Primary MGFD (3.5" Practice Rocket)
Site 6
MCB Camp Lejeune, North Carolina

CH2MHILL

\\aphrodite\proj\USNavFaceNGCom\CampLejeune\MapFiles\Site_6\ESS\Figure 2-2 Contingency ESQD for MGFD.mxd



Legend

- Non-MPPEH Scrap Collection Point
- MPPEH Scrap Collection Point
- Controlled Detonation Area
- Unintentional Detonation MSD = 235 ft
- PTR = 284 ft
- MPPEH Scrap Collection Point IBD = 474 ft
- Intentional Detonation for Public and All Personnel without engineering controls = 1,420 ft
- Intentional Detonation MSD using Engineering controls based on BEM plus 33% safety factor = 383 ft
- Burial Pit Containing MPPEH
- Road Area
- Structure Existing Area

N

0 125 250 500 Feet

1 inch = 500 feet

Figure 2-2
Explosives Safety Quantity Distance (ESQD) Arcs for Contingency MGFD (3.5" HE Rocket)
Site 6
MCB Camp Lejeune, North Carolina

CH2MHILL

SECTION 3

Types of MEC *and MPPEH*

3.1 Types and Quantities of MEC, Including MPPEH

As discussed in Section 1.6, surface and subsurface reconnaissance performed during the RI (Baker, 1993) resulted in the discovery of Mk II grenades, small arms ammunition, practice rockets and expended cartridges. During the TCRA removal action (1994) and the EOD Response (2008), only practice, inert or expended munitions items were recovered. There is no documentation that Site 6 was ever an active range, impact area or open burn/open detonation area.

Site 6 has a history of various uses, including the disposal and storage of wastes and supplies. Pesticides have reportedly been stored in the northeast and southeast portions of Lot 201. Transformers containing PCBs were reportedly stored in the southwest portion of Lot 201. Open storage Lot 203 previously served as a waste disposal and storage area from as early as the 1940s to the late 1980s. Reports detailing disposal activities within Lot 203 are vague; there is little indication as to the types and quantities of material disposed of throughout the lot, with the exception of pesticides. Pesticides were reported to have been stored in a trailer on Lot 203 as well as in the southeast portion of the lot.

The types of munitions that have historically been discovered at Site 6 are presented in **Table 3-1**.

TABLE 3-1
Site 6 Potential Munitions

Ordnance	Quantity Recovered	*Investigation*
M-2 Antipersonnel, mine, bounding, *inert,*	4	*2008 EOD Response*
57mm brass *expended* cartridge cases	5	*2008 EOD Response*
M-29 Rocket, practice warhead only	22	*2008 EOD Response*
Expended Rocket motors, 3.5”	40	*2008 EOD Response*
M-*29 Practice* Rocket, 3.5” with M-405 *Practice* Fuze	5	*2008 EOD Response*
105 mm *expended* cartridge cases	>1,000	*1993 RI and 1997 TCRA*
MK II Grenades	*3*	*1993 RI*
7.62 mm ammunition	*100*	*1993 RI*
3.5” practice rockets	*15*	*1993 RI*
20 mm expended cartridge case	*10*	*1997 TCRA*
30 mm expended cartridges	*23*	*1994 Excavation- TCRA*
40 mm expended cartridges	*54*	*1994 Excavation- TCRA*

3.2 Munition with the Greatest Fragmentation Distance

3.2.1 Primary MGFD

*Only practice, inert, or expended items have been discovered at Site 6. All rockets historically recovered from Site 6 have been practice rockets. Since work at this site will involve the recovery and inspection of MPPEH, it is assumed that some MPPEH items, specifically M 29 practice 3.5-inch rockets, may require explosive venting to gain access and verify that the filler is inert. Out of an abundance of caution, when 3.5-inch rockets are explosively vented, the exclusion zone parameters (including the team separation distance and minimum separation distance for public and non-essential personnel) will be calculated based on the contingency munition with the greatest fragmentation distance (MGFD), the high explosive (HE) 3.5-inch rocket. The Fragmentation Data Sheet for the contingency 3.5-inch HE rocket is included as Attachment 2. Based on these findings and assumptions, t*he primary *MGFD* assumed for the site is a 3.5-inch practice rocket for intrusive investigation activities. *The* 3.5-inch high-explosive (HE) rocket *is the contingency MGFD. The exclusion zone parameters* for intentional detonations will *be calculated based on the contingency MGFD. Use of engineering controls is requested for intentional detonations to reduce the explosive arcs.***Table 3-2** identifies the exclusion zones (EZ) for the primary MGFD *which is a 3.5-inch practice rocket*. The EZs include the team separation distance (TSD) for personnel conducting intrusive operations within the site, the minimum separation distance (MSD) for non-essential personnel, the public transportation route (PTR) distance, and the inhabited building distance (IBD) for the 3.5-inch practice rocket and MPPEH under specified scenarios. ***Figure 2-1*** *shows the explosives safety quantity distance arcs for the primary MGFD which is the 3.5-inch practice rocket.*

The quantity distances (Q-D) for MEC area unintentional detonation are:

- *MSD (based on the K40 since the primary MGFD is nonfragmenting) 31 feet*
- *TSD (based on the K40 since the primary MGFD is nonfragmenting) 31 feet*

If during the course of this project, a MEC item is encountered that has a greater fragmentation range than the primary MGFD but an equal to or lower fragmentation range than the contingency MGFD (see **Section 3.2.2** below), the ESQD arcs for the contingency MGFD will be used. Additionally, MARCORSYSCOM will be notified if a contingency MGFD is encountered, and the contingency MGFD used will be documented in the After Action Report. Documentation of any EOD MEC responses will be submitted to MARCORSYSCOM. *If a MEC item with a greater fragmentation distance is encountered the MSD will be adjusted per Department of Defense Explosives Safety Board (DDESB) TP 16, work will continue, and an amendment to this ESS will be expeditiously submitted.*

TABLE 3-2
Primary MGFD Exclusion Zone Parameters

Scenario	Item	NEW (lb)	TSD (ft)	MSD for Public & Non-Essential Personnel (ft)	IBD (ft)	PTR (ft)
Unintentional Detonation	Practice 3.5-inch rocket	.44 LBS M 7 Propellant	31 feet	31 feet[a]	N/A	N/A
Shot Set-Up	Practice 3.5-inch rocket	.56 LBS M 7 Propellant plus donor	33 feet	33 feet[a]	N/A	N/A
Intentional Detonation for public and alll personnel	Practice 3.5-inch rocket	.56 LBS M 7 Propellant plus donor.	N/A	288 feet[b]	N/A	N/A
Onsite Consolidation, Storage, and Re-inspection	MPPEH	10 lb	N/A	N/A	474 feet	284 feet

NOTES:
a Based on K 40 of NEW

b Based K328 single Practice Rocket No engineering controls

All exclusion zone parameters are based on calculating the appropriate K factor. For unintentional detonations, shot setup and TSD = D=40W1/3. Intentional detonation = D =328W1/3.
IBD – Inhabited Building Distance; MPPEH – Material Presenting a Potential Explosive Hazard; MSD – Minimum Separation Distance; NA – Not Applicable; PTR – Public Transportation Route; TSD – Team Separation Distance

3.2.2 Contingency MGFD

The contingency MGFD expected to be encountered is the 3.5-inch HE rocket. The calculated maximum fragmentation distance is 1,420 feet. The calculated hazardous fragmentation distance is 235 feet.

If a MEC item with a greater fragmentation distance is encountered the MSD will be adjusted per DDESB TP 16, work will continue, and an amendment to this ESS will be expeditiously submitted.

The minimum separation distance (MSD) for the contingency MGFD without engineering controls for intentional detonation activities is 1,420 feet. Using engineering controls, based on the buried explosion module output which is included as Attachment 3, the MSD for the intentional detonation of a consolidated intentional demolition shot of five (5) M28 HE rockets is 288 feet. An additional safety factor of 33% will be applied to the MSD for intentional detonation of the consolidated demolition shot using engineering controls, resulting in an MSD of 383 feet for intentional detonation using engineering controls.

The Q-D for intentional detonation activities are:

- *MSD without engineering controls is 1,420 feet*
- *MSD with engineering controls based on BEM (Attachment 3) is 288 feet*

Figure 2-2 shows the ESQD arcs for the contingency MGFD.
Table 3-3 identifies the EZ for the contingency MGFD. The EZs include the TSD for personnel conducting intrusive operations within the site, the MSD for non-essential personnel, the PTR distance, and the IBD for the 3.5-inch HE rocket and MPPEH under specified scenarios. *Donor explosives will be delivered on an as-needed basis and used the same day. No explosives will be stored on site therefore a magazine will not be required.*

TABLE 3-3
Contingency MGFD Exclusion Zone Parameters

Scenario	Item	NEW (lb)	TSD (ft)	MSD for Public & Non-essential Personnel (ft)	IBD (ft)	PTR (ft)
Unintentional Detonation	3.5-inch HE rocket	1.88 LBS Comp B	56 feet[a]	235 feet[a]	N/A	N/A
Shot Set-Up	3.5-inch HE rocket	1.88 LBS Comp B	56 feet[a]	235 feet[a]	N/A	N/A
Intentional Detonation for public and all personnel	3.5-inch HE rocket	1.88 LBS Comp B	N/A	1420 feet[a] Single HE rocket no engineering controls	N/A	N/A
Intentional Detonation for public and all personnel	3.5 inch HE rocket 5 each	1.88 LBS Comp B		383 feet 5 rockets using engineered control Buried Explosion Module *plus 33% safety factor*		
Onsite Consolidation, Storage, and Re-inspection	MPPEH	10 lb	N/A	N/A	474 feet	284 feet

NOTES:

a From DDESB TP 16
All exclusion zone parameters are based on the fragmentation distances in DDESB TP 16
IBD – Inhabited Building Distance; MPPEH – Material Presenting a Potential Explosive Hazard; MSD – Minimum Separation Distance; NA – Not Applicable; PTR – Public Transportation Route; TSD – Team Separation Distance

3.3 Explosive Soil and Contaminated Buildings

Not applicable.

SECTION 4

Project Dates

4.1 Project Dates

Mobilization and site work in the Site 6 MRS work area will be conducted upon approval of this ESS. The project is anticipated to be completed within two months of the start date. An After Action Report will be submitted to the DDESB via MARCORSYSCOM within six months of the project completion date.

SECTION 5

MEC Migration

According to Mr. James Gagnon of the Natural Resources Conservation Service (NRCS) Edenton Technical Services Office, frost upheaval in the coastal plain region of North Carolina is considered unlikely since the climate only allows frost action to occur to a maximum depth of approximately 6 inches. No other natural phenomena (e.g., drought, flooding, erosion, tidal changes) exist for this area. Therefore, migration of MEC (other than through human transport) is not considered likely.

SECTION 6

Quality Control/Quality Assurance

6.1 Quality Documentation

The Munitions Response Work Plan (CH2M HILL, under development) will include a Quality Control Plan (QCP) that discusses all aspects of project quality control (QC).

6.2 Personnel Qualifications

All MEC operations personnel will be qualified and certified in accordance with terms outlined by U.S. Department of Labor (DOL) Employment Standards Administration Wage Hour Division for UXO Personnel and the Department of Defense Explosive Safety Board (DDESB) TP-18, *Minimum Qualifications for UXO Technicians and Personnel*.

6.3 QC Implementation

An extensive QC program will be applied to the project and, in particular, to the field operations and data processing. Controls QC will be implemented strictly through the establishment of data quality objectives (DQOs), QC tests, and acceptance criteria and monitoring of those items by CH2M HILL's UXO QC Specialist (UXOQCS). Any QC failure will result in immediate notification of the CH2M HILL Project Manager (PM), who will promptly notify the NAVFAC PM. The failure will then be analyzed through a root-cause analysis process and the results and recommended corrective action(s) will be discussed with NAVFAC prior to implementation.

QC will be monitored through the Definable Features of Work (DFOW) using a three-phase control process.

6.3.1 Definable Features of Work

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

1. **Planning**
   - Pre-Mobilization Activities - System setup for geographic information system (GIS), document management and control, data management and subcontracting
   - Preparing Work Plan
2. **Field Operations**
   - Site preparation - Mobilization
   - Intrusive excavation of the identified disposal pit
   - Demilitarization and disposal of MEC or MPPEH
   - Demobilization

3. Final Project Reports and Closeout

- Preparation and approval of draft and final reports
- Data archiving and project closeout

6.3.2 Three Phases of Control

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

Preparatory Phase

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

- Confirm that the appropriate technical procedures are incorporated into the project Work Plan and review procedures
- Confirm that adequate testing is called for to ensure quality delivery
- Confirm qualifications/training of personnel and verify roles/responsibilities are well-defined and communicated
- Confirm with the UXO Safety Officer (UXOSO) that the site Health and Safety Plan (HSP) adequately addresses the work operations and that applicable safety requirements have been incorporated into the plan
- Discuss methods to be employed during the field activities
- Confirm that any required permits and other regulatory requirements are met
- Verify that lessons learned during previous similar work have been incorporated as appropriate into the project procedures to prevent recurrence of past problems

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

Results of the activity are to be documented in a Preparatory Inspection Checklist specific for the DFOW.

Initial Phase

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

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

- Establish the quality of work required to properly deliver the project in accordance with contractual requirements. The UXOQCS will ensure that the field teams are aware of expectations associated with the field methods established under the Preparatory Phase by observing the initial work activities and interacting with the PM, Senior UXO Supervisor (SUXOS) and responsible subcontractors' supervisors.
- Resolve conflicts. The UXOQCS will guide the PM and responsible supervisor(s) in resolving conflicts. Should conflicts arise in establishing the baseline quality for the DFOW, the responsibility to resolve the conflict falls to the PM. Should the conflict not be resolved in a manner that satisfies the project requirements, the UXOQCS must elevate the conflict to the corporate level (i.e., the Corporate QC Manager) and issue a non-conformance report. The UXOQCS may direct a cessation of work activity when a non-conformance to a DFOW is observed. The UXOQCS will determine whether retraining of personnel, adjustment of equipment and/or plans and procedures are necessary.
- Verify with the UXOSO that the site HSP was developed to ensure that the identified hazards adequately address field conditions. Confirm that applicable safety requirements are being implemented during field activities.

Upon completion of Initial Phase activities, the results are to be documented in an Initial Phase Inspection Checklist and a QC logbook. Should results be unsatisfactory, the Initial Phase will be rescheduled and performed again.

Follow-up Phase

Completion of the Initial Phase of QC activity leads directly into the Follow-up Phase, which addresses the routine day-to-day activities at the site. Inspection and audit activities associated with each DFOW are addressed in **Section 6.3.3**. Specific concerns associated with the Follow-up Phase include:

- Inspection of the work activity to ensure work complies with the Scope of Work and Work Plan
- Evaluation and confirmation that the quality of work is being maintained at least at the level established during the Initial Phase
- Evaluation and confirmation that required testing is being performed in accordance with procedures established during the Preparatory Phase and confirmed during the Initial Phase

- Confirmation that nonconforming work is being corrected promptly and in accordance with the direction provided by the UXOQCS

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

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

Additional Audits

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

Final Acceptance Audit

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

6.3.3 Audit Procedures

The UXOQCS is responsible for verifying compliance with the QCP through audits and surveillance. A table of each DFOW auditing procedures and responsibilities is presented as **Table 6-1**. The UXOQCS is to inspect/audit the quality of work being performed for the DFOW. The UXOQCS is to verify that procedures conform to applicable specifications stated in the project work plan or other applicable guidance. Identified deficiencies are to be communicated to the responsible individual and documented in a QC logbook and Weekly QC Report. Corrective actions are to be verified by the UXOQCS and recorded in the Weekly QC Report.

Detailed QC procedures for DGM activities will be outlined in the project work plan.

6.3.4 Corrective/Preventive Action Procedures

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

Preventive Measures

While the entire QC program is directed toward problem prevention, certain elements of the program have greater potential to be proactive. Should preventive measures fail, tracking and communicating deficiencies provide a mechanism for preventing their recurrence.

Continual Improvement

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

Deficiency Identification and Resolution

While deficiency identification and resolution occurs primarily at the operational level, QC audits provide a backup mechanism to address problems that either are not identified or cannot be resolved at the operational level. Through implementation of the audit program prescribed in the QCP, the UXOQCS is responsible for verifying that deficiencies are identified, documented as prescribed herein, and corrected in a timely manner. Deficiencies identified by the UXOQCS are to be corrected by the PM and SUXOS and documented by the UXOQCS.

Corrective Action Request

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

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

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

Deficiency and Corrective Action Tracking

Each CAR must be given a unique identification number and tracked until corrective actions have been taken and documented and the CAR is submitted to the UXOQCS for verification and closure.

6.4 QA Implementation

CH2M HILL will perform QA checks on subcontractors performing the various activities. The QC audits described in **Section 6.3** are performed by CH2M HILL quality personnel after QC has been performed by the various subcontractors on their own services and products. A QA audit may also be performed by Marine Corps Systems Command (MARCORSYSCOM) to validate that the work was done in accordance with the ESS.

TABLE 6-1
Definable Features of Work Auditing Procedures
Explosives Safety Submission for Site 6
MCB Camp Lejeune
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Planning						
Document management and control (Pre-mobilization Activities)	Project Manager/Site Manager	Verify appropriate measures are in place to manage and control project documents.	PP	O	Appropriate measures are in place to manage and control project documents.	Do not proceed with field activities until criterion is passed.
Data Management (Pre-mobilization Activities)	Project Manager	Verify appropriate measures are in place to manage and control project data.	PP	O	Appropriate measures are in place to manage and control project data.	Do not proceed with field activities until criterion is passed.
Subcontracting (Pre-mobilization Activities)	Project Manager, Site Manager	Verify subcontractor qualifications, training, and licenses.	PP/IP	O	Subcontractors' qualifications, training, and licenses are up to date and acceptable.	Ensure subcontractor provides the qualifications, training, and licenses or change subcontractor.
Technical and Operational approach (Project Planning)	Project Manager/Site Manager	Verify technical and operational approaches have been agreed on by the project team.	PP/IP	O	Technical and operational approaches have been agreed on by project team and incorporated into the Work Plans.	Do not proceed with field activities until criterion is passed
Work Plan preparation and approval	Project Manager	Verify Work Plan prepared and approved.	PP/IP	O	Work Plan has been approved	Do not proceed with field activities (excluding site mobilization) until criterion is passed.
Field Operations						
Site preparation (Mobilization)	Project Manager, Site Manager	Verify local agencies are coordinated.	PP/IP	O	Local agencies are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Project Manager, Site Manager	Verify equipment has been inspected and tested.	PP/IP	E	Equipment passes inspection and testing.	Proceed only with activities for which equipment has passed inspection and testing.
Site preparation (Mobilization)	Project Manager, Site Manager	Verify communications and other logistical support are coordinated.	PP/IP	O	Communications and other logistical support are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Project Manager, Site Manager	Verify emergency services have been coordinated.	PP/IP	O	Emergency services are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	UXOQCS, Project Manager, Site Manager	Verify site-specific training is performed and acknowledged.	PP/IP	O	Site-specific training is performed and acknowledged	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	UXOQCS, Project Manager, Site Manager	Hold pre-mobilization meeting and Operations Readiness Review (ORR) with the project team.	PP/IP	O	Project plans are reviewed and acknowledged by team members.	Do not proceed with field activities until criterion is passed.
Intrusive Investigation	UXOQCS	Verify equipment tested	IP/FP	D	Equipment testing performed and tests passed	Repair or replace instrument.
Intrusive Investigation	UXOQCS	Verify team separation distance is as established in ESS	IP/FP	D	Team separation distance is appropriate for work being performed	Stop activities until appropriate separation distance is being followed
Intrusive Investigation	UXOQCS	Verify operations are conducted IAW Work Plan, MEC Removal SOPs, and the HSP: - Analog Detection and Removal Actions - Storage of Removed MPPEH - Explosives Transportation - Explosives Storage and Accountability - Disposal/Demolition Operations - Scrap Inspection Operations	IP/FP	D	Work performed IAW Work Plan, referenced MEC SOPs, and the HSP.	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
MPPEH/MD Management	UXOQCS	Verify inspections conducted IAW Work Plan	IP/FP	D/E	Inspections being conducted IAW Work Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
MPPEH/MD Management	UXOQCS	Verify certification conducted IAW Work Plan	IP/FP	D/E	Certification is conducted IAW Work Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
MPPEH/MD Management	UXOQCS	Verify disposal is conducted IAW Work Plan	IP/FP	D/E	Disposal is conducted IAW Work Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
Site Restoration	Site Manager	Verify the damage caused by excavation is backfilled and laid to original grade and completed IAW Work Plan.	FP	O	Disturbance caused by excavation is backfilled and laid to original grade	Ensure that disturbance caused by excavation and removal of MPPEHanom is backfilled and laid to original grade

TABLE 6-1
Definable Features of Work Auditing Procedures
Explosives Safety Submission for Site 6
MCB Camp Lejeune
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Demobilization	Project Manager, Site Manager	Verify facilities-support infrastructures are dismantled and shipped to appropriate location and area is returned to original condition.	FP	O	Facilities-support infrastructures are dismantled and shipped to appropriate location and site is returned to original condition.	Ensure that all support facilities are removed and that the site is returned to original condition
Final Project Reports and Closeout						
Site Specific Final Report preparation and approval	Site Manager	Verify tabulations of all material identified/demilitarized and disposed during the field actions are accurate and complete.	IP	O	Tabulations of all material identified/recovered during the field actions are accurate and complete.	Ensure tabulations of all material identified/recovered during the field actions are accurate and complete.
Archiving	GIS Manager	Verify data back-up systems are in place.	IP	O	Data back-up systems are in place	Ensure data back-up systems are in place
Project Closeout	Project Manager	Verify purchase orders have been closed out.	IP	O	Purchase orders have been closed out	Ensure purchase orders are closed out
Project Closeout	Project Manager	Verify invoices completed and approved.	IP	O	Invoices completed and approved	Ensure invoices are completed and approved

Notes:
IAW = in accordance with

QC Phase
PP = Preparatory Phase
IP = Initial Phase
FP = Follow-up Phase

Frequency
O = Once
D = Daily
W = Weekly
E = Each occurrence

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

SECTION 7

Detection Techniques

7.1 Detection Equipment, Method, and Standards

To assist in determining the extent of the disposal pit, UXO technicians will use Schonstedt GA-52Cx fluxgate gradiometers or equivalent. The Schonstedt GA-52Cx is a handheld analog magnetometer which detects ferrous objects and ferromagnetic minerals. The instrument provides an audible signal representing the magnitude and direction of the local magnetic field. In application, the operator sweeps the instrument back and forth in the area of interest and monitors the change in pitch of the sound emanating from the instrument. The change in pitch is the magnetometer response to a secondary magnetic field produced by a ferrous metallic item in the area of interest.

7.2 Equipment Check-Out and Calibration

Daily equipment checks will be performed over static items in an equipment check area (ECA) on the Schonstedt magnetometers to ensure the equipment is operating appropriately. Equipment checks will be documented in the system described in **Section 7.3**. Any equipment not passing system checks will be fixed or removed from site.

7.3 Data Collection and Storage

CH2M HILL strictly controls the entire MR project process, documentation, and QC through the use of the Munitions Response Site Information Management System (MRSIMS). MRSIMS is a "cradle-to-grave" data-management system designed to track and query all data for MR projects. MRSIMS digitally captures, tracks, and creates automated reports on:

- Project Information (e.g., personnel, teams, instrument serial numbers, grid IDs, locations)
- Field Team Leader Notes (e.g., safety meetings, logbooks, field requests to management)
- DGM and UXO Team notes (e.g., grids, files, personnel, methods, instruments, GPS coordinates, descriptions of items found)
- DGM Data Processing Notes and Delivery Data (e.g., file names, processing performed, QC of data, delivery dates)
- Grid Statuses (e.g., activities performed by grid and by area, percents, quantities complete or remaining)
- Demolition Tracking
- QC (e.g., QC on notes, processing, data, comparison of DGM Results to intrusive results and field activities)

Depending on the number of field teams and the size of the MRS, field operations data is captured either using GPS-enabled handheld devices running mobile GIS/Forms-based software (CartoPac) or hard copy paper forms. The data is transferred to a centralized relational database, where it is then validated (QC checks). Data elements are not allowed to progress to the next stage of the process until appropriate QC is performed, digitally "signed," and dated as checked.

SECTION 8

Response Actions

8.1 Response Technique

This section describes the techniques used to detect, recover, and dispose of any MEC discovered at the site during the project, and discusses associated elements of the field work.

8.1.1 MEC Processes

Excavation of the disposal pit will be performed using manual methods by qualified UXO technicians supervised by a Technician III. Excavation will proceed until all MPPEH, MEC and MD in the pit is removed.

Precautions will be taken to ensure that the width of the excavation is sufficient to allow for stable side wall slopes. If necessary, shoring may be utilized. Small hand tools, such as shovels, spades, trowels, and pry bars, will be used to access potential MEC/MPPEH. Hand tools will be used for the majority of the items. The following basic technique will be used for excavation of the pit:

- Excavation will be initiated adjacent to the suspected edge of the disposal pit. The excavation will continue until the excavated area has reached a depth below the top of suspected MEC or MD as determined by frequent inspection with a Schonstedt magnetometer or equivalent instrument.
- Using progressively smaller and more delicate tools to remove the soil carefully, the excavation team will expand the sidewall to expose the metallic item for inspection and identification without moving or disturbing the item.
- Once the item is exposed for inspection, the excavation team will determine whether the item is MEC/MPPEH. If the item is MPPEH, the logic diagram presented as **Figure 8-1** (and discussed in **Section 8.4**) will be followed.
- Excavation will continue until all MPPEH in the disposal pit is removed.
- Following excavation, the area will be rechecked with the Schonstedt GA-52Cx or equivalent instrument to ensure that other items were not hidden beneath the removed item. The excavation team will then annotate the results of the excavation on the dig sheet, and backfill the hole.
- MEC will not be shipped over public highways from this project site.

Onsite MEC Destruction and Munitions-related Scrap Metal Certification and Verification

This task includes destruction of MEC recovered during site activities and the inspection and certification of MD that it is free from explosives hazards. Additional discussion on this task is provided in **Section 8.4**, *MEC and MPPEH Disposition Processes*.

8.1.2 Munitions Handling Equipment

Not applicable.

8.2 Operational Risk Management

8.2.1 Process

All MEC items will be disposed of by electrically initiated detonation utilizing engineering controls designed in compliance with DDESB TP-16, Chapter 6, *Determining the fragment hazards due to detonation of a buried munition*, and HNC-ED-CS-S-98-7, *Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonation of Munitions. MEC items will be disposed of using design mode initiation or a safety factor of 33% will be applied to the explosive arcs.*

8.2.2 Process Outline and Preliminary Hazards List Associated with Process

Steps involved in the process of dealing with MEC are outlined in the following text along with preliminary hazards associated with each step of the process. **Table 8-1** presents the Operations Hazard Analysis Matrix in accordance with OPNAVINST 3500.39A.

TABLE 8-1
Operational Hazard Analysis Matrix.

		Mishap Probability			
		A	**B**	**C**	**D**
Hazard Severity	**I**	1	1	2	3
	II	1	2	3	4
	III	2	3	4	5
	IV	3	4	5	5

Mishap Probability:	**Hazard Severity:**	**Risk Assessment Codes:**
A Likely to occur immediately	**I** May cause death	**1** Critical
B Probably will occur in time	**II** May cause severe injury	**2** Serious
C May occur in time	**III** May cause minor injury	**3** Moderate
D Unlikely to occur	**IV** Presents a minimal threat	**4** Minor
		5 Negligible

The Hazard Severity assessment of the worst credible consequence which can result as a result of the hazard posed by the process identified in **Section 8.1** is judged as **"Category I" - hazard may cause death**. This determination was based on the possibility of accidental detonation of MEC or donor explosives while MEC is being prepared for demolition.

The Mishap Probability that a hazard will result in a mishap or loss for this site is recommended to be judged as "Category D" - unlikely to occur. All MEC and explosives operations will be conducted by experienced and qualified UXO technicians following established safety protocols.

The Operational Hazard Analysis Matrix results in a RAC of **"3" – Moderate Risk** – for the combination of Hazard Severity and Mishap Probability recommended above.

8.3 MEC Hazard Classification, Storage and Transportation

All MEC that is found during the course of the investigation at Site 6 will be demilitarized through controlled detonation on-site. No MEC will be stored or transported.

8.4 MEC, MPPEH, and Non-MPPEH Disposition Processes

8.4.1 Inspection and Segregation

A systematic approach will be used for collecting, inspecting, and segregating site debris. The approach is designed so that materials undergo a continual evaluation/inspection process from the time they are excavated until the time they are removed from the site. Site debris will be classified and segregated into one of three categories: 1) MEC, 2) MPPEH, or 3) non-MPPEH debris.

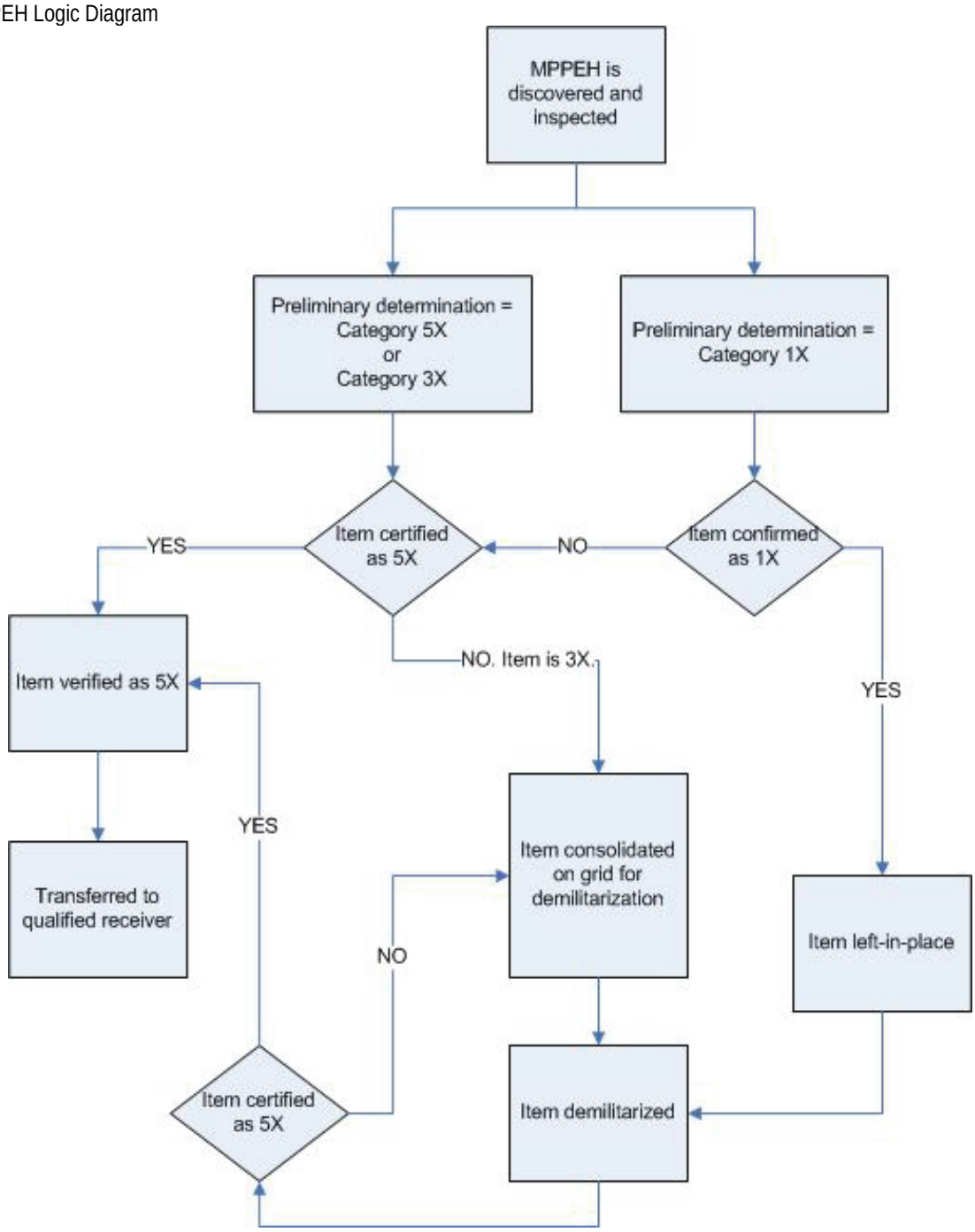
Segregation procedures begin at the time the metal item is discovered by the UXO technician. At this point, the UXO technician makes a preliminary determination as to the classification of the item. If the item is identified as non-MPPEH debris, it is placed at a temporary Non-MPPEH debris accumulation point located near the excavation area. If the item is identified as MPPEH, it is placed in a temporary MPPEH accumulation point near the excavation area. If the item is identified as MEC, it is handled as described in **Section 8.4.3**.

8.4.2 Inspection, Certification, and Verification

The MEC Team will collect the scrap piles deposited near the excavation area and will perform an inspection to confirm that segregation of the items according to proper classification has occurred. The MPPEH items will be inspected and divided into three groups: 1) MPPEH items that require treatment/demilitarization, 2) MPPEH-Safe items that require further demilitarization, and 3) MPPEH-Safe items that do not require further demilitarization. **Figure 8-1** is a logic diagram for the collection and disposition of MPPEH-related scrap.

Two locked and secured scrap metal containers will be positioned at the site as shown on **Figure 2-1**. One container will be marked "Non-MPPEH Scrap Metal Debris" and will be used to collect general metal debris. The other container will be marked "MPPEH-Safe Scrap Metal" and will be used to collect munitions-related scrap metal that has been inspected and is awaiting certification and verification that the material is free of explosives (i.e., metal components that do not contain any explosives that would present an explosives safety hazard) as described below. The two collection containers will be located a minimum of 50 ft apart, as shown on **Figure 2-1**. MPPEH that cannot be certified and verified as "Safe" will remain at the excavation collection point and will be treated in the same manner as MEC (see **Section 8.4.3**).

FIGURE 8-1
MPPEH Logic Diagram



MPPEH will be inspected, certified, and verified in accordance with the requirements of Department of Defense (DOD) 4160.21-M (Chapter 4, Paragraph B) and Ordnance Publication (OP)-5 Volume 1 (Chapter 13-15) and demilitarized, if necessary, in accordance with DOD 4160.21-M-1. Following the required certifications and verifications, all cultural debris (CD) will be disposed in accordance with Ordnance Publication (OP)-5 (NAVSEA. 2004).

After certifications and verifications, the recovered MD will be disposed of at a smelting facility where the smelting can be observed and verified by CH2M HILL.

CH2M HILL will confirm that MPPEH is properly inspected in accordance with the procedures in the project Work Plans. Only UXO-qualified personnel will perform these inspections. The Tech III will certify that the scrap metal is free of explosive hazards. The SUXOS (per OP-5, Section 13-15.7.2) will verify that the scrap metal is free of explosive hazards. The certifier and verifier must act independently of each other. DD Form 1348-1 (series) will be used as certification/verification documentation. All DD Form 1348-1 (series) forms will clearly show the following information in typed or printed letters:

- Name of CH2M HILL's SUXOS and the Government representative
- Organization
- Signatures
- CH2M HILL's home office
- Field office phone number(s) of the persons certifying and verifying the scrap metal

For cultural debris scrap metal, the DD Form 1348-1 (series) will clearly indicate the following:

- Basic material content (type of metal - for example, steel or mixed)
- Estimated weight
- Unique identification of each sealed container
- Location where MPPEH was obtained
- Seal identification, if different from the unique identification of the sealed container

As part of the transfer of MPPEH-Safe material for final disposition, the following certification/verification will be entered on each DD Form 1348-1 (series) and will be signed by the SUXOS and the qualified Government representative.

> "*This certifies that the material potentially presenting an explosives hazard listed has been 100 percent properly inspected and to the best of our knowledge and belief, is inert and/or free of explosives or related material.*"

CH2M HILL will arrange for maintaining the chain of custody and final disposition of the certified and verified materials. The certified and verified material will be released only to an organization that will:

- Provide signed documentation stating that the organization has received the containers, that each container has an unbroken seal and unique identification, and that after reviewing the documentation accompanying the containers, agrees that the sealed containers contained no explosive hazards when received. This documentation will be signed on company letterhead and state that the contents of these sealed containers will

not be sold, traded, or otherwise given to another party until the contents have been smelted and are identifiable only by their basic content.

- Send notification and supporting documentation to the generating contractor (CH2M HILL) documenting that the sealed containers have been smelted and are now identifiable only by their basic content. These documents will be incorporated into the final report.

8.4.3 Treatment of MEC and MPPEH

If a MEC item is found at the site, the item will be *demilitarized through controlled detonation on-site.* Disposal will be conducted in accordance with EODB 60A 1-1-31 and OP-5 Volume I. If engineering controls are used, they will conform to DDESB TP-16 Revision 2 and U.S. Army Corps of Engineers, Huntsville Center (USAESCH), *Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7* dated August 1998 and approved by DDESB on February 23, 1999. Excavated MEC items will be placed in a separate controlled detonation excavation approximately 3 ft by 6 ft by 3 ft deep and covered with earth. The MEC items will be cracked open using a shaped charge.

A local vendor will provide *donor* explosives on an *as-needed basis and used the same day. Base EOD personnel will be available on-call to assist CH2M HILL and its subcontractors. All* unused explosives *will be removed* from the site following demolition activities. No explosives will be stored onsite, *therefore a magazine will not be required*. The explosives vendor will follow all applicable U.S. Department of Transportation (DOT) regulations regarding the transportation of explosives, and the vendor's employees will have the proper training and certifications. CH2M HILL and its UXO subcontractor will not transport explosives. CH2M HILL will coordinate with the installation's Explosives Safety Officer to obtain proper approvals to bring civilian explosives onto the installation.

All MEC items will be disposed of by controlled detonation methods. The danger area will be marked off and evacuated.

CH2M HILL will confirm that MPPEH is properly inspected in accordance with the procedures in the project work plan and in accordance with Section 13-15.7.2 of OP-5 Volume 1 (NAVSEA, 2006). Only UXO-qualified personnel will perform these inspections. DD Form 1348-1 (series) will be used as certification/verification documentation. All DD Form 1348-1 (series) forms will clearly show the following information in typed or printed letters:

- Name of CH2M HILL's SUXOS
- Organization
- Signature
- CH2M HILL's home office
- Field office phone number(s) of the persons certifying and verifying the scrap metal

For scrap metal, the DD Form 1348-1 (series) will clearly indicate the following:

- Basic material content (type of metal - for example, steel or mixed)
- Estimated weight
- Unique identification of each sealed container

- Location where MD or range-related debris was obtained
- Seal identification, if different from the unique identification of the sealed container

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

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

CH2M HILL will arrange for maintaining the chain of custody and final disposition of the certified and verified materials. The certified and verified material will be released only to an organization that will:

- Provide signed documentation stating that the organization has received the containers, that each container has an unbroken seal and unique identification, and that after reviewing the documentation accompanying the containers, agrees that the sealed containers contained no explosive hazards when received. This documentation will be signed on company letterhead and state that the contents of these sealed containers will not be sold, traded or otherwise given to another party until the contents have been smelted and are identifiable only by their basic content.

- Send notification and supporting documentation to the generating contractor (CH2M HILL) documenting that the sealed containers have been smelted and are now identifiable only by their basic content. These documents will be incorporated into the final report.

8.5 EZ Access

In general, access to the EZ is limited to personnel essential to the operation being conducted. However, under specific conditions and on a case-by-case basis, authorized visitors may be granted access to the EZ when operations are being conducted. In addition to general MRS access requirements, formal written procedures addressing EZ access, including authorized visitor access, must be developed in support of response actions involving MEC and must address the following requirements:

- Access to an EZ while MR operations are occurring is limited to essential personnel and authorized visitors.

- The UXOSO is responsible for conducting an operational risk management assessment in accordance with OPNAVINST 3500.39 (series) prior to initiating response actions involving MEC. In addition, the UXOSO must determine the maximum number of persons (essential personnel and authorized visitors) that can be in the EZ at one time. The ratio of UXO-qualified escorts to visitors will be determined by the UXOSO based on this site-specific operational risk analysis.

- Based on the risk posed by the MR operation underway, the UXOSO may determine that access to the EZ is unsafe for visitors. However, every effort should be made to accommodate the authorized visitor's needs.

- With concurrence of the responsible PM, the UXOSO will grant EZ access to authorized visitors. Access to the site will be based upon the operational risk analysis of the scheduled MEC operations and availability of escorts, as well as a demonstrated visitor need and subsequent completion of visitor safety briefings.
- Persons requiring access to the EZ must demonstrate a legitimate need for access and obtain authorization from the responsible project manager and UXOSO. At a minimum, the request for authorization will include: names of the individual requesting access, the identification of emergency contacts for these individuals, purpose of visit; task(s) to be performed; and rationale to support EZ access. Persons requesting access must submit their request to the responsible project manager and UXOSO prior to the proposed date of the site visit. This advance notice will allow time for the UXOSO to support the visit request by assigning a qualified escort, conducting an operational risk analysis on the operations planned for the date of the site visit, and preparing a visitor site-specific safety briefing for the planned operations.
- Prior to entry, all authorized visitors must receive a site-specific safety briefing describing the specific hazards and safety procedures to be followed within the EZ for operations underway that work day. Each authorized visitor must acknowledge receipt of this briefing in writing.
- Authorized visitors to the EZ must be escorted at all times by a UXO-qualified person.
- Any authorized visitor that violates the established safety procedures will be immediately escorted out of the EZ and/or site for their own protection and to protect essential personnel working at the site.

8.6 Mechanized MEC Processing Operations

Not applicable.

8.7 Explosives Soil

Not applicable.

8.8 Contaminated Buildings

Not applicable.

SECTION 9

Environmental, Ecological, Cultural and Other Considerations Related to Management of MEC

Section 121(d) of CERCLA requires that remedial actions implemented at CERCLA sites attain any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be Applicable or Relevant and Appropriate Requirements (ARARs). Potential ARARs for the MEC response action at the site will be developed as part of the planning process and will be discussed in detail in the Work Plan (CH2M HILL, under development). Site 6, a part of Operable Unit 2 is under a Record of Decision. Land use controls for soil intrusive activities are in place for the MRS. These controls prohibit construction at the Site. Intrusive soil activity must be performed by health and safety trained staff utilizing appropriate personal protective equipment (Level D).

No sensitive habitats, threatened or endangered species, or cultural sites are known or suspected to be at Site 6.

SECTION 10

Technical Support

This section summarizes the UXO contractor personnel qualifications for the project. Explosive Ordnance Disposal (EOD) support is not anticipated to be required.

10.1 EOD, UXO Contractor, or Other Munitions Response Personnel

All MEC operations personnel will be qualified and certified in accordance with MCO 8023.3A, *Personnel Qualification and Certification Program for Class V Munitions and Explosives*; terms outlined by DOL Employment Standards Administration Wage Hour Division for UXO Personnel; and DDESB TP-18, *Minimum Qualifications for UXO Technicians and Personnel*. CH2M HILL and their UXO subcontractor responsibilities will include performing excavation, demilitarization and disposal activities. Base EOD will be notified if potential MEC is found and base EOD are available on-call as needed to assist CH2M HILL.

10.2 Physical Security

Access to the MRS will be controlled during all intrusive and demolition operations by CH2M HILL or UXO subcontractor personnel stationed on the roads leading into the site. CH2M HILL will coordinate site control issues with MCB Camp Lejeune facility and security personnel prior to the start of field activities. No explosives will be stored onsite.

SECTION 11

Residual Risk Management

11.1 Land Use Controls

Following completion of MEC removal activities, the Supplemental Investigation of groundwater contamination will proceed. Soil intrusive land use controls are currently in place as part of the Operable Unit 2 Record of Decision.

11.2 Long-term Management

Long-term site management decisions will be made following the conclusion of the MEC removal and the Supplemental Investigation.

SECTION 12

Safety Education Program

A safety education program is not considered applicable for this project.

SECTION 13

Stakeholder Involvement

The only stakeholders for the intrusive investigation and removal of MEC at this MRS are U.S. Marine Corps and NAVFAC. Regulatory agencies are not involved in the NRP activities. The USEPA and NCDENR are involved in the supplemental groundwater investigation conducted under the CERCLA process.

SECTION 14

Contingencies

There are currently no anticipated contingencies required.

SECTION 15

References

The following references were consulted during the preparation of this ESS. Not all are cited in the text.

Baker Environmental, Incorporated (Baker). 1993. Remedial Investigation Report for Operable Unit No. 2(Sites 6 and 9) Marine Corps Base Camp Lejeune, North Carolina. Final.

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Attachment 1
Site Approval Request
and NAVFAC Form 11010/31

ATTACHMENT 1

NAVSEA OP 5, "Ammunition and Explosives Safety Ashore," Requirements of Section 8-1.2.5, Final Safety Review

a. Anticipated personnel limits for Site 6.

Munitions Response/On-Site support: Up to 4 proposed contractor UXO personnel conducting excavation may be exposed during munitions operations. All non-essential personnel will be evacuated from within the minimum separation distance (MSD) for non-essential personnel during munitions response intrusive operations.

Detonation Area: Up to 2 proposed contractor UXO personnel conducting controlled detonation may be exposed during munitions operations. All nonessential personnel will be evacuated from within the MSD for non-essential personnel for detonation operations.

MPPEH Holding Area: Up to 4 proposed contractor UXO personnel may be present within the MPPEH holding area during MPPEH handling operations.

b. General details regarding dividing walls, vent walls, fire walls, roofs, operational shields, barricades, exits, types of floor finish, fire protection system installations, electrical systems and equipment, ventilation systems and equipment, hazardous waste disposal systems, lightning protection systems, all grounding systems, process equipment, and auxiliary support structures as well as general materials of construction unless approved definitive drawings are being used.

Not applicable.

c. A brief summary of the design procedures if engineered protection is used to reduce quantity-distance requirements. This summary shall include a statement of the design objectives in terms of protection categories (as defined in NAVFAC P-397) to be attained, explosives quantities involved, design loads applied, material properties and structural behavior assumptions, references, and sources of methods used. Detailed calculations need not be submitted. Design of explosion resistant facilities shall be accomplished by an organization or individual experienced in the field of structural dynamics using design procedures accepted by professionals in the field.

Engineering controls to be used during intentional detonation operations will conform to DDESB Technical Paper 16, Revision 1 and U.S. Army Corps of Engineers, Engineering and Support Center, Huntsville, Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7 dated August 1998, and approved by DDESB February 23, 1999. Intentional detonations involving the use of sandbags as an engineering control will not exceed 11.4 lb. NEW HD 1.1.

d. Information on the type and arrangement of explosives operation or chemical processing equipment.

All MEC items will be disposed of by controlled detonation methods. The danger area will be marked off and evacuated. Disposal will be conducted in accordance with EODB 60A 1-1-31, OP-5 Volume I. Engineering controls used for intentional detonations will conform to DDESB TP-16 Revision 2 and USAESCH, *Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7* dated August 1998 and approved by DDESB on February 23, 1999.

A local vendor will provide explosives on an on-call basis and will remove all unused explosives from the site following demolition activities. No explosives will be stored onsite. The explosives vendor will follow all applicable DOT regulations regarding the transportation of explosives, and the vendor's employees will have the proper training and certifications. CH2M HILL and its MEC subcontractor will not transport explosives. CH2M HILL will coordinate with the installation's Explosives Safety Officer to obtain proper approvals to bring civilian explosives onto the installation.

e. Topography map with appropriate contours when terrain features are considered to constitute natural barricading, or when topography otherwise influences layout.

Not applicable. The MRA has little topographic relief. Terrain and topographic features are not expected to influence site operations or layout.

f. A hazard analysis of risk performed in accordance with paragraph 7-7.3 shall be included.

Operational Hazard Analysis Matrix.

		Mishap Probability			
		A	**B**	**C**	**D**
Hazard Severity	**I**	1	1	2	3
	II	1	2	3	4
	III	2	3	4	5
	IV	3	4	5	5

Mishap Probability:	**Hazard Severity:**	**Risk Assessment Codes:**
A Likely to occur immediately	**I** May cause death	**1** Critical
B Probably will occur in time	**II** May cause severe injury	**2** Serious
C May occur in time	**III** May cause minor injury	**3** Moderate
D Unlikely to occur	**IV** Presents a minimal threat	**4** Minor
		5 Negligible

The Hazard Severity assessment of the worst credible consequence which can result as a result of the hazard posed by the process identified in Section8.1 is judged as **"Category I" - hazard may cause death**. This determination was based on the possibility of accidental detonation of MEC or donor explosives while MEC is being prepared for demolition.

The Mishap Probability that a hazard will result in a mishap or loss for this site is recommended to be judged as "Category D" - unlikely to occur. All MEC and explosives operations will be conducted by experienced and qualified UXO technicians following established safety protocols.

The Operational Hazard Analysis Matrix results in a RAC of **"3" – Moderate Risk** – for the combination of Hazard Severity and Mishap Probability recommended above.

g. When chemical agents are involved, information regarding personnel protective clothing and equipment, treatment of effluent and waste materials to ensure absence of chemical agents, adequacy of medical support, average wind speed and direction, other support facilities pertinent to chemical safety, warning and detection systems, and hazard analysis.

Not applicable. Chemical agents are not anticipated at this MRA.

h. Explanation of any deviations from pertinent safety standards due to local conditions.

Not applicable. Local conditions are not anticipated to require any deviations from pertinent safety standards.

i. Explanation of any changes that may have occurred with this project or with any of the previous information submitted since submission of the preliminary site approval request.

Not applicable. No previous site approval requests have been submitted.

j. Lightning protection design drawings and associated zone of protection diagrams showing the masts and the building(s) protected, in plan and elevation views.

Not applicable. Explosives will not be stored at the MRA and lightning protection is not required.

REQUEST FOR PROJECT SITE APPROVAL/EXPLOSIVES SAFETY CERTIFICATION NAVFAC 11010/31 (REV. 5-2001)

PART I

INSTRUCTIONS IN NAVFACINST 11010.45

SECTION A – INSTALLATION SUBMISSION

1. To: Naval Ordnance Safety and Security Activity (N7)

2. From: NAVFAC MIDLANT

3. Program Year: 2007

4. Cost ($000):

5. Type Funding

6. Activity UIC

7. Date: December 19, 2008

8. Category Code and Project Title: **Construction Support for Gun Position Firing Point #2 MILCON Area**

9. Project Number: N/A

10. Type of Project:

- ☐ New Construction
- ☐ Change Use
- ☐ Addition to Existing Facility
- ☐ Major Modification to Existing Facility
- ☐ Relocation of Structure
- ☐ Maintenance and/or Repairs
- ☐ Repair by Replacement
- ☐ Demolition
- ☒ **Other**

11. Type of Request:

- ☐ Airfield Safety Site Approval
- ☒ **Explosives Site/Safety Certification**
- ☐ EMR Site Approval
- ☐ Resubmittal or Standard Site Approval (No Safety Criteria Involved)

12. Project Description

This MR action is being conducted to recover and dispose of MPPEH remaining in the pit and to dispose of MPPEH that was recovered by the Base EOD team. The MPPEH removal, demilitarization and disposal activities will be performed to significantly reduce the risk of encountering MEC during future activities within the MRS. The remainder of OU #2 will be investigated for potential MPPEH during a future phase of work. No construction activity is currently underway or scheduled at the Site.

13. 1 Set of Project Maps Attached

14. 1 Sets Part II Division(s) A Attached

SECTION B – EFD REVIEW

1. Name/Code/Phone No. of Reviewer/E-Mail Address:

2. Date Received:

3. Evaluation:

4. Safety Review Requested: (check appropriate box(es))

☒ **NOSSA** ☐ DDESB ☐ SPAWAR ☐ NAVAIR ☐ CNO ☐ OTHER

5. Date Forwarded:

6. Date of Safety Certification: _____ NOSSA _____ DDESB _____ SPAWAR _____ NAVAIR _____ CNO _____ OTHER

SECTION C – FINAL SITE APPROVAL ACTION

1. Approvals:

- ☐ Site Approved
- ☐ Site Disapproved
- ☐ Deferred/Returned
- ☐ Explosives Safety Certification Approved
- ☐ Explosives Safety Certification DISAPPROVED
- ☐ Interim Construction Waiver Approved

2. Certification Identification:

3. Remarks

4. Other Approvals Required

- ☐ Airfield Safety Waiver Required
- ☐ Final Explosives Safety Review Required

5. Approving Official:

6. Date:

REQUEST FOR PROJECT SITE APPROVAL/EXPLOSIVES SAFETY CERTIFICATION NAVFAC 11010/31 (REV. 5-2001)

PART II DIVISION A-EXPLOSIVES SAFETY

INSTRUCTIONS IN NAVFACINST 11010.45

1. NEW/Class/Division/ESQD arcs of project:

a. Site 6 MRS Work Area: NEW = 0.44 lbs M 7 Propellant based on Practice 3.5-inch rocket; ESQD Arc 31-ft for nonessential personnel and for TSD. The location of the area is shown in Figure 2-1.

b. Intentional Detonation Area: Out of an abundance of caution, when 3.5 inch rockets are explosively vented, the exclusion zone parameters (including the team separation distance and minimum separation distance for public and non-essential personnel) will be calculated based on the contingency munition with the greatest fragmentation distance (HE 3.5 inch rocket). NEW = 1.88 lbs Comp B based on 3.5-inch HE rocket; ESQD Arc 383-ft EZ with engineering controls and 33% BEM safety factor. The location of the area is shown in Figure 2-2.

c. Unintentional Detonation Area: NEW = 0.44 lbs M 7 Propellant based on Practice 3.5-inch rocket; ESQD Arc 31-ft for nonessential personnel and for TSD. The location of the area is shown in Figure 2-1.

d. MPPEH Holding Area: NEW = 10 lb; RDX; ESQD Arc 474-ft IBD. The location of the area is shown in Figure 2-1.

* IBD/TSD based on fragmentation distances (OP-5, Volume 1, Chapter 7).

Engineering controls used will conform with DDESB Technical Paper 16, Revision 1 and U.S. Army Corps of Engineers, Engineering and Support Center, Huntsville, Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7 dated August 1998, and approved by DDESB February 23, 1999.

Security measures will be implemented during MPPEH-related operations during the project. The location of the area is shown in Figure 2-1.

2. CNO Waivers and Exemptions: N/A

3. Personnel (numbers):

Munitions Response/On-Site Construction Support: The number of personnel that may be located within the ESQD during operations includes the 4-man proposed contractor UXO team operating in the MRS work area.

Detonation Area: Up to 4 proposed contractor UXO personnel conducting controlled detonation may be exposed during munitions operations. All nonessential personnel will be evacuated from within the IBD ESQD/EZ for detonation operations.

MEC Disposal by Detonation Operations: Up to 4 proposed contractor personnel conducting MEC disposal operations will be exposed during such operations.

NOTE: All personnel are the same persons relocating from one ESQD to another.

	Proposed	Existing
Military:		
Civilian:	4	
Other:		
Total:	4	

4. Facility Number/Type	Personnel	NEW	Class/Division	Distance
Site 6	4	1.88 lb	1.1	1,420 feet
MPPEH Holding Area	4	10 lb	1.1	474 feet

5. Siting Rationale: The location of the munitions response support area has been determined based on location of burial pit. An exclusion zone of 346 feet based on fragmentation distances in OP-5, Volume 1, Chapter 7 is depicted on Figure 2-1. Access to the work will be restricted by site personnel during intrusive and detonation operations.

The closest inhabited building is approximately 380 feet south of the proposed location of the intentional detonation trench.

The closest PTR is approximately 300 feet north of the site footprint.

MPPEH holding area will be within the exclusion zone.

* Distance from project. Specify IB (Inhabited Building); IL (Intraline); IM (Intermagazine); PTR (Public Transportation Route); B (Barricaded); UB (Unbarricaded)

6. Signature of Public Works/Base Civil Engineer (Name/Code) Incl E-Mail Address		9. Signature of Explosive Safety Officer/Installation Safety Officer Incl. E-Mail Address	
7. Telephone Numbers: ( ) DSN	8. Date:	10. Telephone Numbers: ( ) DSN	11. Date:

Attachment 2
Fragmentation Data Sheet

FRAGMENTATION DATA REVIEW FORM

Database Revision Date 9/30/07

Category:	HE Rounds	DODIC:	H600
Munition:	3.5" M28A2 Rocket Case	Date Record Created:	7/30/2004
		Last Date Record Updated:	7/30/2004
Primary Database Category:	rocket	Individual Last Updated Record:	Crull
Secondary Database Category:	3.5 in	Date Record Retired:	
Munition Case Classification:	Robust		

Munition Information and Fragmentation Characteristics

Explosive Type:	Comp B
Explosive Weight (lb):	1.88000
Diameter (in):	3.5000
Max Fragment Weight (lb):	0.052420
Critical Fragment Velocity (fps):	6126

Theoretical Calculated Fragment Range

HFD [Range to No More Than 1 Hazardous Fragment per 600 Square Feet] (ft):	235
MFR-V [Vertical Range of Max Weight Fragment] (ft):	1128
MFR-H [Horizontal Range of Maximum Weight Fragment] (ft):	1420

Overpressure Distances

Inhabited Building Distance (12 psi), K40 Distance:	56
Inhabited Building Distance (09 psi), K50 Distance:	70
Intentional MSD (0065 psi), K328 Distance:	457

Minimum Thickness to Prevent Perforation

4000 psi Concrete (Prevent Spall):	3.92
Mild Steel:	0.71
Hard Steel:	0.59
Aluminum:	1.53
LEXAN:	4.52
Plexi-glass:	3.00
Bullet Resist Glass:	2.37

Required Sandbag Thickness

Max Fragment Weight (lb)SB:	0.052420
Critical Fragment Velocity (fps)SB:	6126
Kinetic Energy 106 (lb-ft2/s2)SB:	0.9836
Required Wall Roof Sandbag Thickness (in)SB:	24
Expected Maximum Sandbag Throw Distance (ft)SB:	125
Minimum Separation Distance (ft)SB:	200

Water Containment System and Minimum Separation Distance:

Max Fragment Weight (lb)W:	0.052420
Critical Fragment Velocity (fps)W:	6126
Kinetic Energy 106 (lb-ft2/s2)W:	0.9836
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft)W:	200

◄ ► Print This Form Close Form

Attachment 3
Buried Explosive Module

BURIED EXPLOSION MODULE

(Version 4.0)

Based on DDESB Technical Paper 16, Revision 2

(ENGLISH UNITS)

SELECT ITEM DESCRIPTION

3.5" M28A2 Rocket Case

SINGLE ITEM NEW (lbs)	1.88
SINGLE ITEM TNT EQUIVALENCE (lbs)	2.18
MAXIMUM FRAGMENT WEIGHT (lbs)	0.0524
MAXIMUM FRAGMENT VELOCITY (ft/s)	6,126
ENTER TOTAL NUMBER OF ITEMS	5
ENTER WEIGHT OF BOOSTER (lbs)	0.50
TOTAL TNT WEIGHT (lbs)	11.40
ENTER DEPTH OF BURIAL (ft)	3.000

SELECT SOIL TYPE

(See TP 16, Revision 2 for soil details)

Dry Sand

CRATER OR CAMOUFLET?

CRATER

TRUE CRATER RADIUS (ft)	5.31
MAXIMUM SOIL EJECTA RANGE (ft)	288
FRAGMENT EXIT VELOCITY (ft/s)	105
FRAGMENT LAUNCH ANGLE (°)	29.4
MAXIMUM FRAGMENT RANGE (ft)	235
FRAGMENT HAZARD RANGE (ft)	288

Amendment No. 1
Explosives Safety Submission for Munitions Response Activities Installation Restoration Site 6 and Site 82 (Operable Unit 2)

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Contract Task Order 039

May 2009

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

Under the

Navy CLEAN 1000 Program
Contract No. N62470-08-D-1000

Prepared by

CH2MHILL

Charlotte, North Carolina

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3-1 Potential Munitions at the MRS

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2-2 Explosives Safety Quantity Distance (ESQD) Arcs for Contingency MGFD (3.5" HE Rocket)

8-1 MPPEH Logic Diagram

Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
ASR	Archives Search Report
ATF	Alcohol, Tobacco, and Firearms
BEM	Buried Explosion Module
CAP	Corrective Action Plan
CAR	Corrective Action Request
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DDESB	Department of Defense Explosives Safety Board
DFOW	definable feature of work
DGM	digital geophysical mapping
DMM	discarded military munitions
DOD	U.S. Department of Defense
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
DQO	data quality objective
DRMO	Defense Reutilization and Marketing Office
ECA	equipment check area
EOD	explosive ordnance disposal
ESQD	explosives safety quantity-distance
ESS	Explosives Safety Submission
EZ	exclusion zone
ft	feet/foot
GIS	geographic information system
GPS	global positioning system
HE	high explosives
HSP	Health and Safety Plan
HTRW	Hazardous, Toxic, Radioactive Waste
IBD	inhabited building distance
IR	installation restoration
lb	pound
MARCORSYSCOM	Marine Corps System Command
MCB	Marine Corps Base
MD	munitions debris
MEC	munitions and explosives of concern

MGFD	munition with the greatest fragmentation distance
MILCON	military construction
mm	millimeter
MPPEH	material potentially presenting an explosive hazard
MR	munitions response
MRA	munitions response area
MRS	munitions response site
MRSIMS	Munitions Response Site Information Management System
MSD	minimum separation distance
MTSQ	Mechanical Time Super Quick
mV	millivolt
NAVFAC	Naval Facilities Engineering Command
NAVSEA	Naval Sea Systems Command
NCDENR	North Carolina Department of Environment and Natural Resources
NEW	net explosives weight
NOSSA	Naval Ordnance Safety and Security Activity
NRCS	Natural Resources Conservation Service
OSHA	Occupational Safety and Health Act
OU	Operable Unit
PA/SI	Preliminary Assessment/Site Inspection
PM	Project Manager
PTR	public transportation route
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QCP	Quality Control Plan
RDX	hexahydrotrinitrotriazine
RI	Remedial Investigation
RTK	real-time kinematic
SUXOS	Senior UXO Supervisor
TCRA	time critical removal action
TO	task order
TSD	team separation distance
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Corps of Engineers, Huntsville Center
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Specialist
UXOSO	UXO Safety Officer

SECTION 1

Background

1.1 Responsible Project Manager

The responsible project manager for this project is:

David T. Cleland, P.G.
NAVFAC ATLANTIC
757-322-4851 (voice)
(757) 322-8280 (fax)
david.t.cleland@navy.mil

1.2 Munitions Response Site Identifier and Description

This Explosives Safety Submission (ESS) Amendment addresses munitions response (MR) investigation/characterization activities at Installation Restoration (IR) Site 6 and IR Site 82, which together form the munitions response site (MRS) that is the subject of this ESS Amendment. This MRS is located within Marine Corps Base (MCB) Camp Lejeune, an active installation

Site 6 and Site 82 are part of Operable Unit (OU) 2 at MCB Camp Lejeune. Site 6 covers an area of approximately 177 acres that include Storage Lots 201 and 203, a wooded area between the storage lots, and a ravine. Historically, Site 6 was used for disposal and storage of wastes and supplies, including pesticides, transformers containing polychlorinated biphenyls (PCBs), solvents, electrolytes, and waste oils. Currently, Lot 201 is used to store military equipment, vehicles, hydraulic oils, and other "non-hazardous" supplies. Lot 203 is no longer an active storage area. The overall current land use at Site 6 is industrial. Land use is not anticipated to change in the foreseeable future.

Site 82 encompasses approximately 30 acres, and is predominantly covered by woodlands. Site 82 was reportedly used for disposal of miscellaneous debris from Lot 203, located southeast of Site 82 (Baker, 1993). No organized disposal operations were documented at the Site; however, Site 82 was found to be randomly littered with debris including drums, communication wire and spent ammunition casings during the RI (Baker, 1993).

Sites 6 and 82 are located west of Piney Green Road and east of Holcomb Boulevard and include the Defense Reutilization and Marketing Office (DRMO) operations. Site 82 is bordered on the north by Wallace Creek. The topography of Sites 6 and 82 is flat with little elevation relief, except on the northern edge of Site 82 near the bank of Wallace Creek and in the ravine located in the wooded area north of Lot 203 that drains to Wallace Creek. The upper reach of Bear Head Creek flows from east to west across the southern end of Site 6.

1.3 Regional Maps

Figure 1-1 shows the regional location of MCB Camp Lejeune and the locations of Sites 6 and 82 within MCB Camp Lejeune.

1.4 Scope of Munitions Response

The scope of work to be conducted at the MRS includes the following tasks:

- Land surveying
- Vegetation clearance
- Digital geophysical mapping (DGM)
- Remove material potentially presenting an explosive hazard (MPPEH) that is found on the ground surface
- Intrusive investigation of possible waste disposal trenches identified by geophysical methods

1.5 History of MEC Use

No former range activities are known to have occurred at the MRS, but MPPEH has been discovered in pits at the MRS, as discussed in Section 1.6 below.

1.6 Previous Studies of Extent of MEC Contamination

1.6.1 UXO Surface and Subsurface Investigation and Removal from Remedial Investigation Report (1993)

During the RI (Baker, 1993), surface and sub-surface UXO reconnaissance was performed to search for, identify, and clear MEC at OU-2. The UXO survey report in the RI states the following items were collected (quantities in parentheses): Mk II grenade (3), 7.62 mm ammunition (100), 3.5" practice rockets (15), 20 mm cartridge cases (10), 30 mm cartridge cases (23), 40 mm cartridge cases (54), and 105 mm cartridge cases (more than 1,000). The three grenades and the one-hundred 7.62 mm ammunition were reportedly turned over to Base EOD. The final disposition of the remaining MD was not documented in the report; however, the report indicated that the remaining material would be disposed as scrap metal.

1.6.2 Time Critical Removal Action (1994)

According to the Contractor's Closeout Report for Sites 6 and 82 Source Removal (OHM, March 1997), four source removal trenches were excavated in February 1994 at Site 6and one trench excavated at Site 82. The excavation activity removed a total of 2,655 cubic yards of soil and debris consisting of drums; communication wire; batteries; containers of petroleum, oils, and lubricants; and expended 105mm cartridges. Over 100 tons of discarded batteries were removed from the trenches at Site 6.

1.6.3 2008 EOD Emergency Response

In December 2008, munitions debris was discovered in the central area of Site 6 during vegetation clearing. The vegetation clearing was underway to prepare for a geophysical survey investigating possible waste disposal areas. Base EOD was contacted upon discovery of several 3.5-inch practice rockets entangled in communication wire. Base EOD responded and subsequently removed various types of MPPEH. During the EOD response, the following items (and quantities) were removed from a pit beneath the communication wire:

- Four M-2 antipersonnel mines, bounding
- Five 57mm brass cartridges
- Twenty-two M-29 rockets, practice warhead only
- Forty rocket motors, 3.5-inch
- Five M-29 rockets, 3.5-inch with M-405 fuze

These items were put into secure temporary storage onsite and were demilitarized and disposed of under the April 2009 ESS. All items placed in the secured storage were demilitarized, then received two independent 100% inspections and were disposed of off-Base as material documented as safe (MDAS). Additional MPPEH remains in the pit.

1.7 Regulatory Statute, Phase, and Oversight

The supplemental investigation of the MRS will be conducted under the CERCLA framework with input provided by the United States (U.S.) Environmental Protection Agency (USEPA) Region 4 and the North Carolina Department of Environment and Natural Resources (NCDENR). Regulatory oversight from environmental agencies is not being provided for MR activities related to excavation, demilitarization and disposal of MPPEH.

The response action will be conducted in accordance with the following health and safety regulations and requirements, in addition to the MEC-specific regulations and requirements to be provided in a Munitions Response Work Plan:

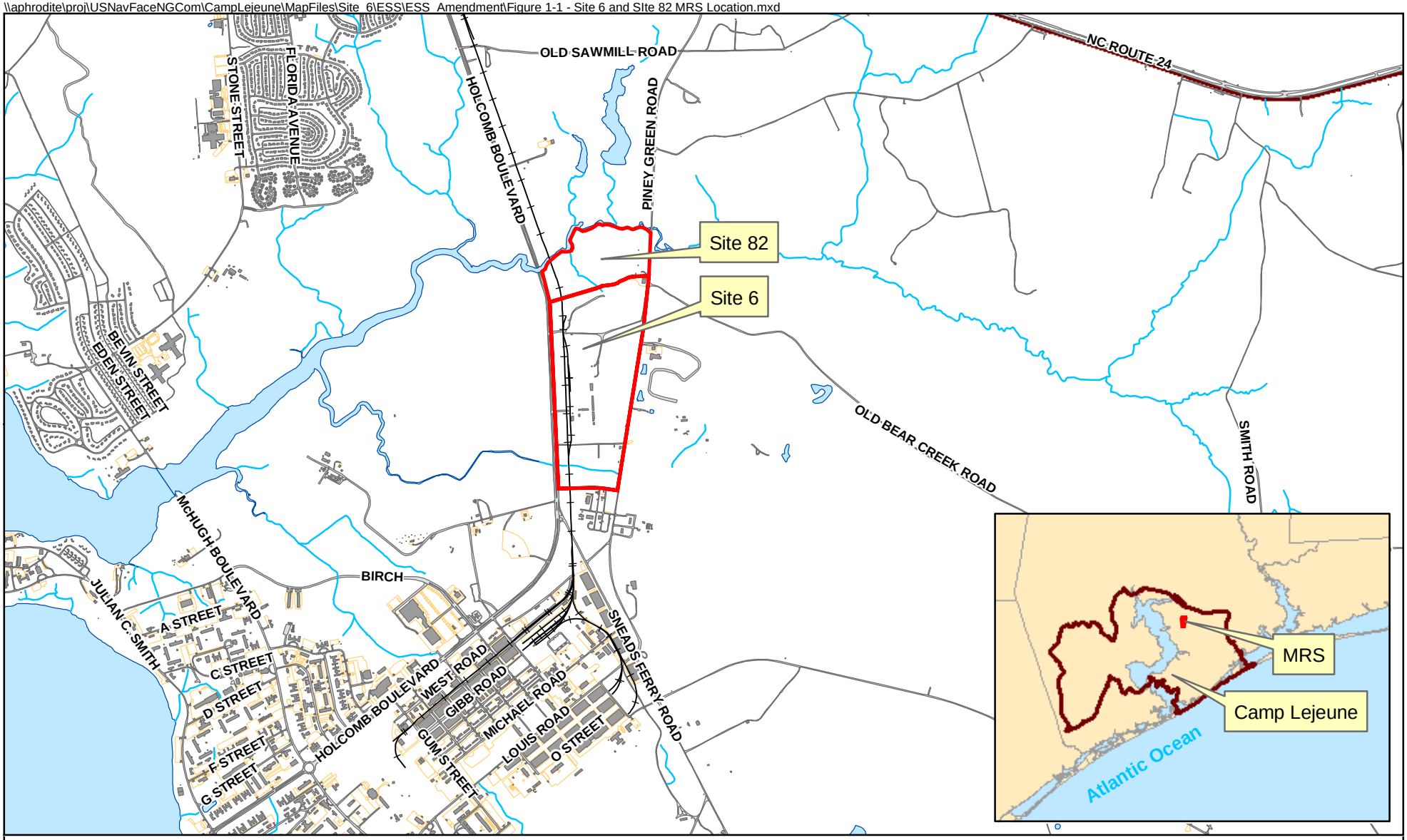
- 29 Code of Federal Regulations (CFR), Occupational Safety and Health Act (OSHA) Regulations: Construction (29 CFR 1926) and General Industry (29 CFR 1910), applicable sections

- U.S. Army Corps of Engineers (USACE), 2008, EM 385-1-1, *Safety – Safety and Health Requirements*

1.8 Justification for NDAI/NFA Decision

Not applicable.

\\aphrodite\proj\USNavFaceNGCom\CampLejeune\MapFiles\Site_6\ESS\ESS_Amendment\Figure 1-1 - Site 6 and SIte 82 MRS Location.mxd



Legend

- Railroad Centerline
- Stream
- Road Area
- Buildings
- Vehicle Parking Area
- MRS Boundary
- Installation Boundary

N

0 1,500 3,000 6,000 Feet

1 inch = 3,000 feet

Figure 1-1
Site 6 and Site 82 MRS Location
Site 6 ESS Amendment
MCB Camp Lejeune, North Carolina

CH2MHILL

SECTION 2

Site Approval Request

2.1 NAVFAC Form 11010/31, "Request for Project Site Approval"

An amended NAVFAC Form 11010/31 is included as Attachment 1. The associated explosives safety quantity-distance (ESQD) arcs maps are presented as **Figures 2-1** and **2-2**.

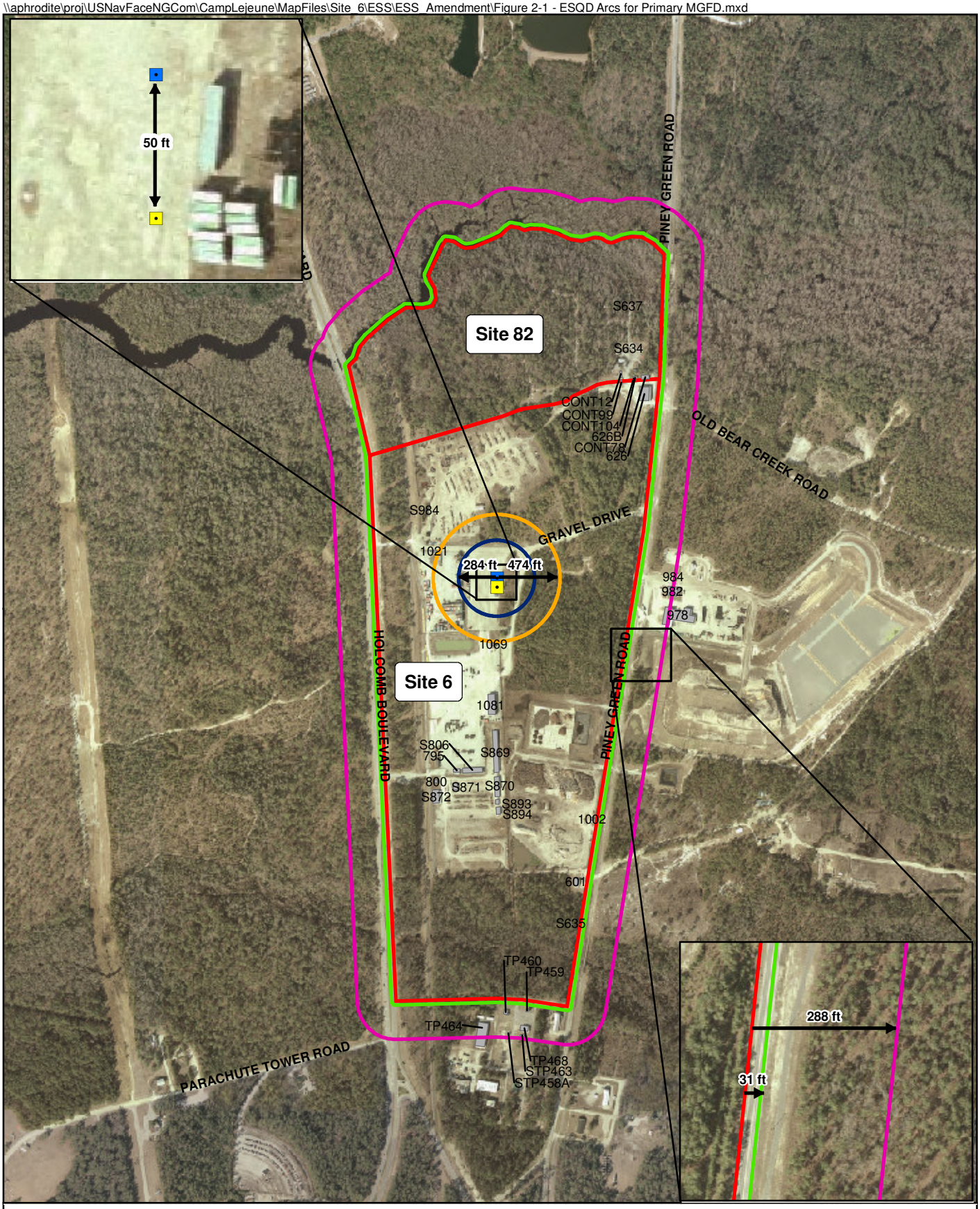
2.2 Additional Information

TABLE 2-1
Buildings Potentially Impacted by the Primary MGFD ESQD Arcs

Building Number	Building Description	Estimated Number of Occupants
601	Storage	
626	Groundwater Treatment System	**0**
626B	Equipment Storage	**0**
795	General Storage Shed	**0**
800	Administrative Office	**10-15**
984	Weigh Facility	**2**
982	Administrative Office	**5**
978	Recycling Facility	**5**
1002	Scale House	**3**
1021	Trailer	**5**
1069	Administrative Office	**5**
1081	Equipment Storage Facility	**2**
CONT12	Contractor Field Office	**2**
CONT78	Contractor Field Office	**5**
CONT99	Contractor Field Office	**2**
CONT104	Equipment Storage	**0**
S634	Groundwater Treatment Facility	**0**
S635	WWPS Control Panels	**0**
S637	Groundwater Treatment Facility	**0**
S806	Storage	**0**
S869	Storage Shelter	**0**

TABLE 2-1
Buildings Potentially Impacted by the Primary MGFD ESQD Arcs

Building Number	Building Description	Estimated Number of Occupants
S870	General Storage Shed	**0**
S871	PAV/GRNDS EQ SH	**0**
S984	Scale Shelter	**0**
S872	General Storage Shed	**0**
S893	Storage	**0**
S894	Weigh Facility	**0**
STP458A	Fire Training Structure	**0**
STP463	Land Use Study	**0**
STP464A	HAZMAT Storage	**0**
STP464B	HAZMAT Storage	**0**
STP464G	Storage	**0**
TP459	Fire Training Tower	**0**
TP460	Fire Training/Rescue Smokehouse	**0**
TP464	General Warehouse	**15-20**
TP468	Fire Training Classroom	**15-20**



Legend

- Non-MPPEH Scrap Collection Point
- MPPEH Scrap Collection Point
- Unintentional detonation TSD and MSD = 31 ft
- Intentional detonation for public and all personnel without engineering controls = 288 ft
- MPPEH Scrap Collection Point IBD = 474 ft
- PTR = 284 ft
- Structure Existing Area
- MRS Boundary

N

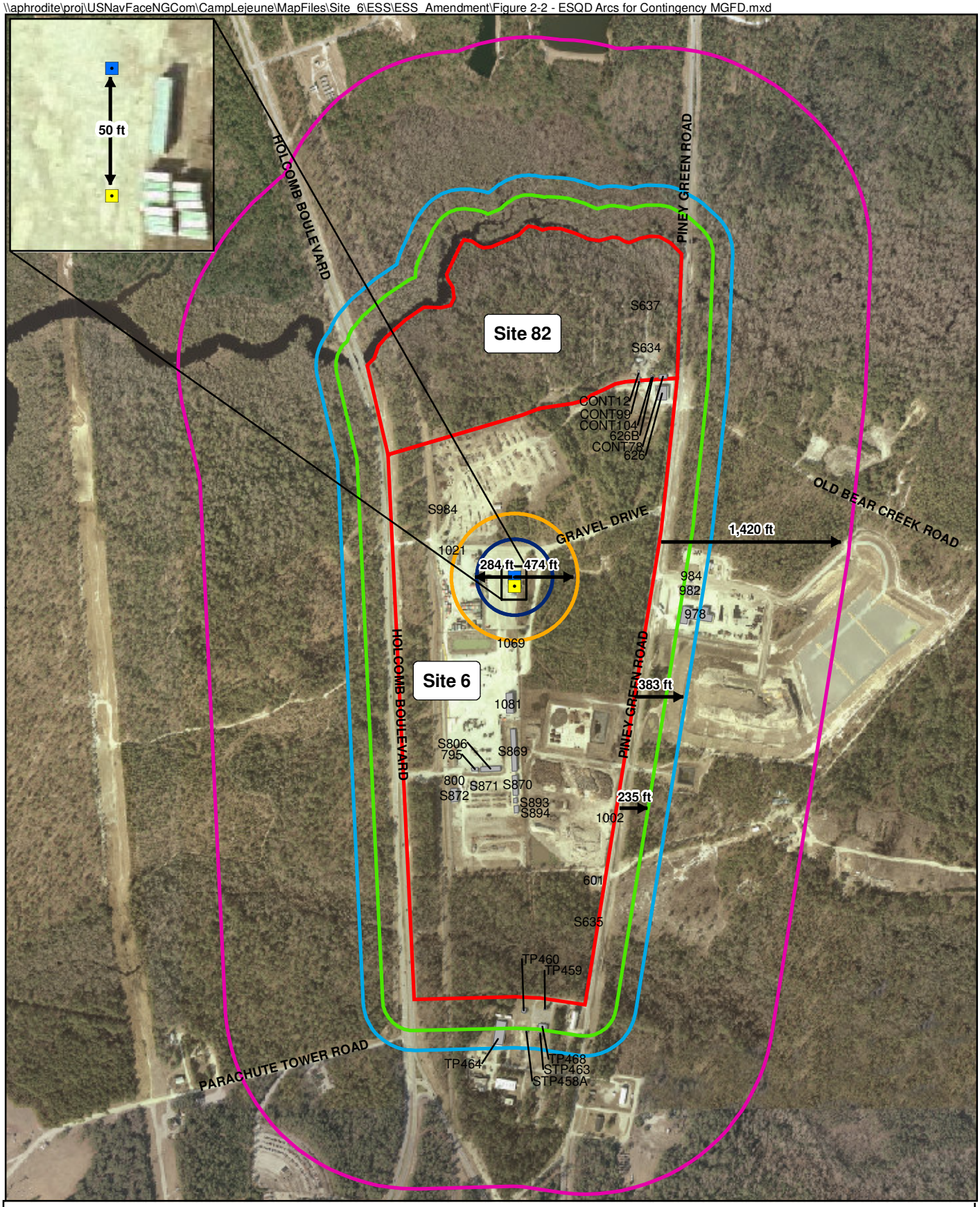
0 500 1,000 Feet

1 inch = 1,000 feet

Figure 2-1
Explosive Safety Quantity Distance (ESQD) Arcs for Primary MGFD (3.5" Practice Rocket)
Site 6 ESS Amendment
MCB Camp Lejeune, North Carolina

CH2MHILL

\\aphrodite\proj\USNavFaceNGCom\CampLejeune\MapFiles\Site_6\ESS\ESS_Amendment\Figure 2-2 - ESQD Arcs for Contingency MGFD.mxd



Legend

- Non-MPPEH Scrap Collection Point
- MPPEH Scrap Collection Point
- Unintentional Detonation = 235 ft
- Engineering controls based on BEM plus 33% safety factor = 383 ft
- Intentional detonation for public and all personnel without engineering controls = 1,420 ft
- MPPEH Scrap Collection Point IBD = 474 ft
- PTR = 284 ft
- Structure Existing Area
- MRS Boundary

N

0 500 1,000 Feet

1 inch = 1,000 feet

Figure 2-2
Explosive Safety Quantity Distance (ESQD) Arcs for Contingency MGFD (3.5" HE Rocket)
Site 6 ESS Amendment
MCB Camp Lejeune, North Carolina

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SECTION 3

Types of MEC and MPPEH

3.1 Types and Quantities of MEC, Including MPPEH

As discussed in Section 1.6, surface and subsurface reconnaissance performed during the RI (Baker, 1993) resulted in the discovery of three Mk II grenades, ammunition, practice rockets and expended cartridges. During the TCRA removal action (1997) and the EOD Response (2008), only practice, inert or expended munitions items were recovered. There is no documentation that Site 6 and Site 82 were ever an active range, impact area or open burn/ open detonation area.

Sites 6 and 82 have a history of various uses, including the disposal and storage of wastes and supplies. Pesticides have reportedly been stored in the northeast and southeast portions of Lot 201. Transformers containing PCBs were reportedly stored in the southwest portion of Lot 201. Open storage Lot 203 previously served as a waste disposal and storage area from as early as the 1940s to the late 1980s. Reports detailing disposal activities within Lot 203 are vague; there is little indication as to the types and quantities of material disposed of throughout the lot, with the exception of pesticides. Pesticides were reported to have been stored in a trailer on Lot 203 as well as in the southeast portion of the lot. Site 82, prior to remediation, was randomly littered with debris including communication wire, spent ammunition casings, and drums.

The types of munitions that have historically been discovered within the MRS are presented in **Table 3-1**.

TABLE 3-1
Potential Munitions at the MRS

Ordnance	Quantity Recovered	Investigation
M-2 Antipersonnel, mine, bounding, inert	4	2008 EOD Response
57mm brass cartridge cases, expended	5	2008 EOD Response
M-29 Rocket, practice warhead only	22	2008 EOD Response
Expended Rocket motors, 3.5”	40	2008 EOD Response
M-29 Rocket, 3.5” with M-405 Fuze, inert	5	2008 EOD Response
105 mm cartridge cases, expended	>1,000	1993 RI and 1997 TCRA
MK II Grenades	3	1993 RI
7.62 mm ammunition	100	1993 RI
3.5” practice rockets	15	1993 RI
20 mm cartridge case	10	1997 TCRA
30 mm cartridges, expended	23	1997 TCRA
40 mm cartridges, expended	54	1997 TCRA

3.2 Munition with the Greatest Fragmentation Distance

No changes have been made to this section.

3.3 Explosive Soil and Contaminated Buildings

No changes have been made to this section.

SECTION 4

Project Dates

4.1 Project Dates

Mobilization and site work for the CH2M HILL portion of the MR work in the central area of Site 6 will be conducted upon approval of this ESS Amendment. The project is anticipated to be completed within 2 months of the start date. An After Action Report will be submitted to the DDESB via MARCORSYSCOM within 6 months of the project completion date.

SECTION 5

MEC Migration

No changes have been made to this section.

SECTION 6

Quality Control/Quality Assurance

6.1 Quality Documentation

No changes have been made to this section.

6.2 Personnel Qualifications

No changes have been made to this section.

6.3 QC Implementation

An extensive QC program will be applied to the project and, in particular, to the field operations and data processing. Controls QC will be implemented strictly through the establishment of data quality objectives (DQOs), QC tests, and acceptance criteria and monitoring of those items by CH2M HILL's UXO QC Specialist (UXOQCS). Any QC failure will result in immediate notification of the CH2M HILL Project Manager (PM), who will promptly notify the NAVFAC PM. The failure will then be analyzed through a root-cause analysis process and the results and recommended corrective action(s) will be discussed with NAVFAC prior to implementation.

QC will be monitored through the Definable Features of Work (DFOW) using a three-phase control process.

6.3.1 Definable Features of Work

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

1. **Planning**
   - Pre-Mobilization Activities - System setup for geographic information system (GIS), document management and control, data management and subcontracting
   - Preparing Work Plan
2. **Field Operations**
   - Site preparation – Mobilization
   - Intrusive excavation of the disposal pit located at Site 6 originally excavated by EOD during the 2008 emergency response, and possible additional disposal trenches at Sites 6 and 82
   - Removal of surface debris which may include MPPEH
   - Demilitarization and disposal of MEC or MPPEH
   - Vegetation clearing

- Digital Geophysical Mapping (DGM)
- Demobilization

3. Final Project Reports and Closeout

- Preparation and approval of draft and final reports
- Data archiving and project closeout

6.3.2 Three Phases of Control

No changes have been made to this section.

6.3.3 Audit Procedures

No changes have been made to this section.

6.3.4 Corrective/Preventive Action Procedures

No changes have been made to this section.

6.4 QA Implementation

No changes have been made to this section.

TABLE 6-1
Definable Features of Work Auditing Procedures
Site 6 ESS Amendment
MCB Camp Lejeune
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Planning						
Geographical Information System (GIS) Setup (Pre-mobilization Activities)	Project GIS Manager	Verify GIS system has been set up and is ready for site data.	PP	O	GIS system has been set up and is ready for site data.	Do not proceed with field activities until criterion is passed.
Document management and control (Pre-mobilization Activities)	Project Manager	Verify appropriate measures are in place to manage and control project documents.	PP	O	Appropriate measures are in place to manage and control project documents.	Do not proceed with field activities until criterion is passed.
Data Management (Pre-mobilization Activities)	Project Manager, Data Manager	Verify appropriate measures are in place to manage and control project data.	PP	O	Appropriate measures are in place to manage and control project data.	Do not proceed with field activities until criterion is passed.
Subcontracting (Pre-mobilization Activities)	Project Manager, Site Manager	Verify subcontractor qualifications, training, and licenses.	PP/IP	O	Subcontractors' qualifications, training, and licenses are up to date and acceptable.	Ensure subcontractor provides the qualifications, training, and licenses or change subcontractor.
Technical and Operational approach (Technical Project Planning)	Project Manager	Verify technical and operational approaches have been agreed on by the project team.	PP/IP	O	Technical and operational approaches have been agreed on by project team and incorporated into the Work Plans.	Do not proceed with field activities until criterion is passed
Work Plan preparation and approval	Project Manager	Verify Work Plan prepared and approved.	PP/IP	O	Work Plan has been approved	Do not proceed with field activities (excluding site mobilization) until criterion is passed.
Field Operations						
Site preparation (Mobilization)	Site Manager	Verify local agencies are coordinated.	PP/IP	O	Local agencies are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Site Manager	Verify equipment has been inspected and tested.	PP/IP	E	Equipment passes inspection and testing.	Proceed only with activities for which equipment has passed inspection and testing.
Site preparation (Mobilization)	Site Manager	Verify communications and other logistical support are coordinated.	PP/IP	O	Communications and other logistical support are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Site Manager	Verify emergency services have been coordinated.	PP/IP	O	Emergency services are coordinated.	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Site Manager	Verify site-specific training is performed and acknowledged.	PP/IP	O	Site-specific training is performed and acknowledged	Do not proceed with field activities until criterion is passed.
Site preparation (Mobilization)	Site Manager	Hold pre-mobilization meeting and Operations Readiness Review (ORR) with the project team.	PP/IP	O	Project plans are reviewed and acknowledged by team members.	Do not proceed with field activities until criterion is passed.
Site Preparation (Site Survey)	Project Manager	Verify surveyor qualifications.	PP/IP	O	Surveyor's qualifications are up to date and acceptable.	Ensure surveyor provides the qualifications prior to starting work or change surveyor.
Site Preparation – (Vegetation Removal)	Site Manager	Verify personnel qualifications and training.	PP/IP	O	Personnel qualifications and training are appropriate.	Ensure subcontractor provides appropriately trained and qualified personnel or replace with properly trained personnel.
Site Preparation (Vegetation Removal)	Site Manager	Verify environmental controls are correct and functional.	IP/FP	O	Environmental controls are correct and functional.	Ensure that appropriate environmental controls are in place prior to proceeding with vegetation removal.
Site Preparation (Vegetation Removal)	Site Manager	Verify vegetation removal is conducted according to the Field Investigation Plan (Chapter 3 of Work Plan).	FP	D	Verify vegetation removal is conducted according to the Field Investigation Plan (Chapter 3 of Work Plan).	Stop vegetation removal activities until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary.

TABLE 6-1
Definable Features of Work Auditing Procedures
Site 6 ESS Amendment
MCB Camp Lejeune
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
DGM Survey	Project Geophysicist	Verify DGM Survey conducted in accordance with Geophysical Investigation Plan (Appendix C) and DGM SOPs: EM61-MK2 Metal Detection Munition Response Surveys Geophysical Surveying with EM61-MK2 Configuration and Operation of the GPS Base-Station System Configuration and Operation of the GPS Rover System Field Methodology and Survey Setup	IP/FP	O/D	DGM Survey conducted in accordance with Geophysical Investigation Plan (Appendix C) and DGM SOPs.	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
DGM Survey	Project Geophysicist	Check results of QC tests performed as specified in the QCP and DGM SOPS.	FP	E	QC tests must pass in accordance with standards determined during the GPO and referenced SOPs.	If a QC test does not pass, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Survey	Project Geophysicist	Confirm that DGM survey DQOs established during GPO are being met.	FP	E	DGM survey DQOs are being met.	If the DQOs are not being met, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Data processing	Project Geophysicist	Verify data checks specified in QCP and SOPs: EM61-MK2 Data Processing and Database management Uploading and Downloading Data to the FTP Site	FP	E	Data checks must pass in accordance with standards determined during the GPO and referenced SOPs.	If a QC test does not pass, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
Reacquisition Accuracy	Project Geophysicist	Confirm that anomalies are located within a 1-meter radius of flagged location as selected by DGM.	FP	E	Anomaly located within 1-meter radius of flag	If anomalies are being located beyond 1-meter radius of flag or are not being located within 1-meter radius of the flag, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
Intrusive Investigation	UXOQCS	Verify equipment tested IAW Section 7.0 of the Work Plan	IP/FP	D	Equipment testing performed and tests passed	Repair or replace instrument.
Intrusive Investigation	UXOQCS	Verify team separation distance is as established in Section 4.6.5 of the Work Plan	IP/FP	D	Team separation distance is appropriate for work being performed	Stop activities until appropriate separation distance is being followed
Intrusive Investigation	UXOQCS	Verify that the anomaly recovered during intrusive excavations is appropriate to the amplitude of the initial anomaly detected during the DGM.	IP/FP	D	Recovered anomaly is appropriate to the amplitude of the initial anomaly detected during the DGM.	Return to the location of the anomaly excavation to determine if additional anomalies are present. If anomalies being recovered continue to be inappropriate for the amplitude as detected during the DGM, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
Intrusive Investigation	QC Geophysicist	QC seed items to be placed at detectable depths IAW GPO Work Plan	IP/FP	E	All QC seed items in area of operation recovered.	A root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action
Intrusive Investigation	UXOQCS	Verify operations are conducted IAW Work Plan, MEC Removal SOPs, and the HSP: - Survey/Sweeps - MEC Surface Sweeps - Analog Detection and Removal Actions - DGM Anomaly Investigation - Ammunition and Explosives Transportation - Explosives Storage and Accountability - Disposal/Demolition Operations - Scrap Inspection Operations	IP/FP	D	Work performed IAW Work Plan, referenced MEC SOPs, and the HSP.	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
MPPEH/MD Management	UXOQCS	Verify inspections conducted IAW Work Plan	IP/FP	D/E	Inspections being conducted IAW Work Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
MPPEH/MD Management	UXOQCS	Verify certification conducted IAW Work Plan	IP/FP	D/E	Certification is conducted IAW Work Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary

TABLE 6-1
Definable Features of Work Auditing Procedures
Site 6 ESS Amendment
MCB Camp Lejeune
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
MPPEH/MD Management	UXOQCS	Verify disposal is conducted IAW Work Plan	IP/FP	D/E	Disposal is conducted IAW Work Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
Site Restoration	Site Manager	Verify the damage caused by excavation and removal of anomalies is backfilled and laid to original grade and completed IAW Work Plan.	FP	O	Damage caused by excavation and removal of anomalies is backfilled and laid to original grade	Ensure that damage caused by excavation and removal of anomalies is backfilled and laid to original grade
Demobilization	Project Manager	Verify facilities-support infrastructures are dismantled and shipped to appropriate location and area is returned to original condition.	FP	O	Facilities-support infrastructures are dismantled and shipped to appropriate location and site is returned to original condition.	Ensure that all support facilities are removed and that the site is returned to original condition.
Final Project Reports and Closeout						
Site Specific Final Report preparation and approval	Project Manager	Verify all phases of environmental investigation were performed correctly and are complete.	FP	O	Investigation performed is accurate and complete.	investigation performed is accurate and complete
Archiving	GIS Manager	Verify data back-up systems are in place.	IP	O	Data back-up systems are in place	Ensure data back-up systems are in place
Project Closeout	Project Manager	Verify purchase orders have been closed out.	IP	O	Purchase orders have been closed out	Ensure purchase orders are closed out
Project Closeout	Project Manager	Verify invoices completed and approved.	IP	O	Invoices completed and approved	Ensure invoices are completed and approved

Notes:
IAW = in accordance with

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

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

SECTION 7

Detection Techniques

No changes have been made to this section.

SECTION 8

Response Actions

8.1 Response Technique

No changes have been made to this section.

8.1.1 MEC Processes

No changes have been made to this section.

8.1.2 Onsite MEC Destruction and Munitions-related Scrap Metal Certification and Verification

This task includes destruction of MEC recovered during site activities and the inspection and certification of MD that it is free from explosives hazards. Additional discussion on this task is provided in **Section 8.4**, *MEC and MPPEH Disposition Processes*.

8.1.3 Munitions Handling Equipment

Not applicable.

8.2 Operational Risk Management

8.2.1 Process

No changes have been made to this section.

8.2.2 Process Outline and Preliminary Hazards List Associated with Process

No changes have been made to this section.

8.3 MEC Hazard Classification, Storage and Transportation

All MEC that is found during the course of the investigation within the MRS will be demilitarized through controlled detonation on-site. No MEC will be stored or transported.

8.4 MEC, MPPEH, and Non-MPPEH Disposition Processes

8.4.1 Inspection and Segregation

No changes have been made to this section.

8.4.2 Inspection, Certification, and Verification

The MEC Team will collect the scrap piles deposited near the excavation area and will perform an inspection to confirm that segregation of the items according to proper

classification has occurred. The MPPEH items will be inspected and divided into three groups: 1) MPPEH items that require treatment/demilitarization, 2) MPPEH-Safe items that require further demilitarization, and 3) MPPEH-Safe items that do not require further demilitarization. **Figure 8-1** is a logic diagram for the collection and disposition of MPPEH-related scrap.

Two locked and secured scrap metal containers will be positioned at the site as shown on **Figure 2-1** and **Figure 2-2**. One container will be marked "Non-MPPEH Scrap Metal Debris" and will be used to collect general metal debris. The other container will be marked "MPPEH-Safe Scrap Metal" and will be used to collect munitions-related scrap metal that has been inspected and is awaiting certification and verification that the material is free of explosives (i.e., metal components that do not contain any explosives that would present an explosives safety hazard) as described below. The two collection containers will be located a minimum of 50 feet apart, as shown on **Figure 2-1** and **Figure 2-2**. MPPEH that cannot be certified and verified as "Safe" will remain at the excavation collection point and will be treated in the same manner as MEC (see **Section 8.4.3**).

MPPEH will be inspected, certified, and verified in accordance with the requirements of Department of Defense (DOD) 4160.21-M (Chapter 4, Paragraph B) and Ordnance Publication (OP)-5 Volume 1 (Chapter 13-15) and demilitarized, if necessary, in accordance with DOD 4160.21-M-1. Following the required certifications and verifications, all cultural debris (CD) will be disposed in accordance with Ordnance Publication (OP)-5 (NAVSEA. 2004).

After certifications and verifications, the recovered MD will be disposed of at a smelting facility where the smelting can be observed and verified by CH2M HILL.

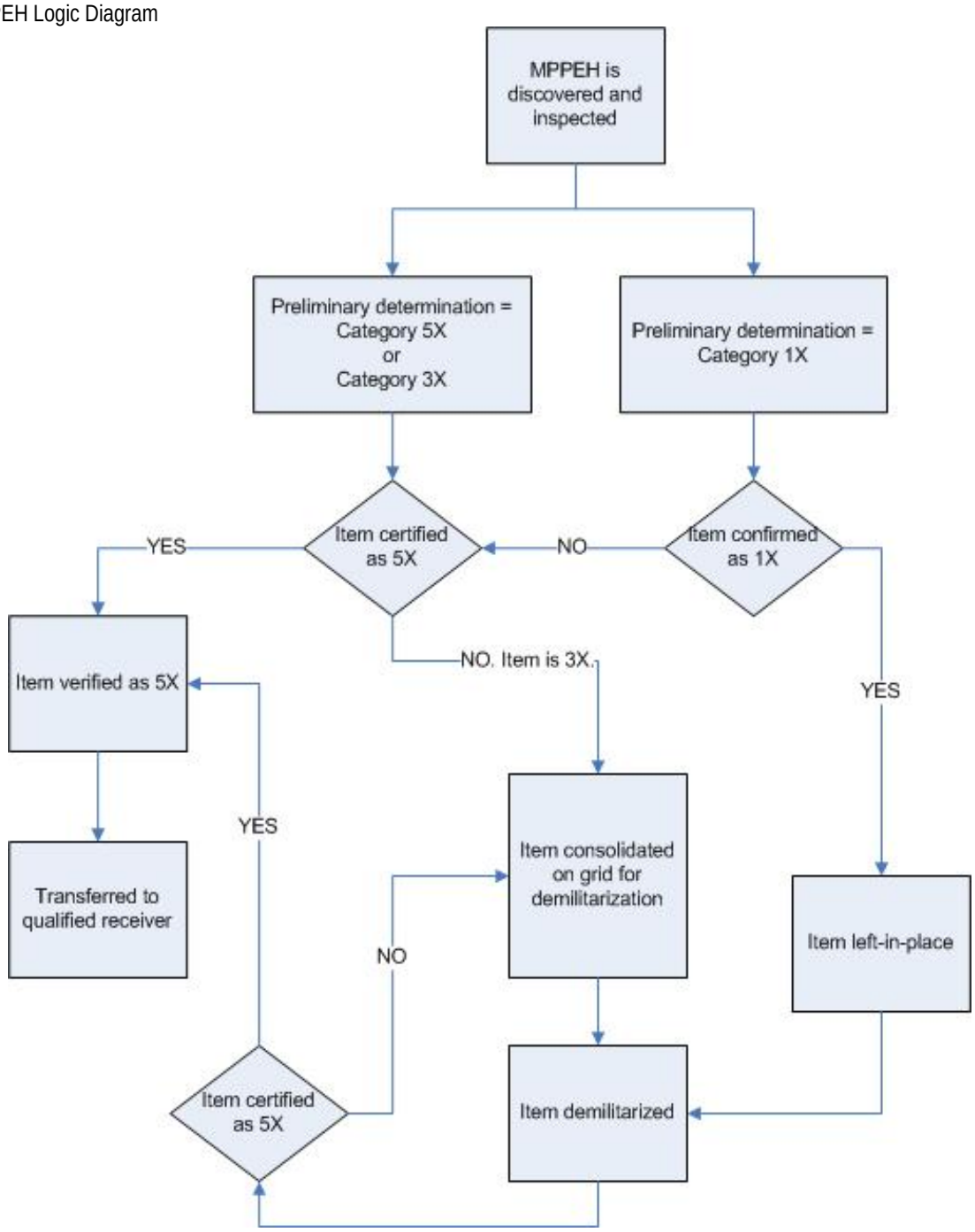
CH2M HILL will confirm that MPPEH is properly inspected in accordance with the procedures in the project Work Plans. Only UXO-qualified personnel will perform these inspections. The Tech III will certify that the scrap metal is free of explosive hazards. The SUXOS (per OP-5, Section 13-15.7.2) will verify that the scrap metal is free of explosive hazards. The certifier and verifier must act independently of each other. DD Form 1348-1 (series) will be used as certification/verification documentation. All DD Form 1348-1 (series) forms will clearly show the following information in typed or printed letters:

- Name of CH2M HILL's SUXOS and the Government representative
- Organization
- Signatures
- CH2M HILL's home office
- Field office phone number(s) of the persons certifying and verifying the scrap metal

For cultural debris scrap metal, the DD Form 1348-1 (series) will clearly indicate the following:

- Basic material content (type of metal - for example, steel or mixed)
- Estimated weight
- Unique identification of each sealed container
- Location where MPPEH was obtained
- Seal identification, if different from the unique identification of the sealed container

FIGURE 8-1
MPPEH Logic Diagram



As part of the transfer of MPPEH-Safe material for final disposition, the following certification/verification will be entered on each DD Form 1348-1 (series) and will be signed by the SUXOS and the qualified Government representative.

> "This certifies that the material potentially presenting an explosive hazard listed has been 100 percent properly inspected and to the best of our knowledge and belief, is inert and/or free of explosives or related material."

CH2M HILL will arrange for maintaining the chain of custody and final disposition of the certified and verified materials. The certified and verified material will be released only to an organization that will:

- Provide signed documentation stating that the organization has received the containers, that each container has an unbroken seal and unique identification, and that after reviewing the documentation accompanying the containers, agrees that the sealed containers contained no explosive hazards when received. This documentation will be signed on company letterhead and state that the contents of these sealed containers will not be sold, traded, or otherwise given to another party until the contents have been smelted and are identifiable only by their basic content.
- Send notification and supporting documentation to the generating contractor (CH2M HILL) documenting that the sealed containers have been smelted and are now identifiable only by their basic content. These documents will be incorporated into the final report.

8.4.3 Treatment of MEC and MPPEH

No changes have been made to this section.

8.5 EZ Access

No changes have been made to this section.

8.6 Mechanized MEC Processing Operations

No changes have been made to this section.

8.7 Explosives Soil

No changes have been made to this section.

8.8 Contaminated Buildings

No changes have been made to this section.

SECTION 9

Environmental, Ecological, Cultural and Other Considerations Related to Management of MEC

Section 121(d) of CERCLA requires that remedial actions implemented at CERCLA sites attain any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be Applicable or Relevant and Appropriate Requirements (ARARs). Potential ARARs for the MEC response action at the site will be developed as part of the planning process and will be discussed in detail in the Work Plan (CH2M HILL, under development). Sites 6 and 82, a part of Operable Unit 2, are under a Record of Decision. Land use controls for soil intrusive activities are in place for the MRS. These controls prohibit construction at the Sites. Intrusive soil activity must be performed by health and safety trained staff utilizing appropriate personal protective equipment (Level D).

No sensitive habitats, threatened or endangered species, or cultural sites are known or suspected to lie within the MRS boundary.

SECTION 10

Technical Support

No changes have been made to this section.

SECTION 11

Residual Risk Management

No changes have been made to this section.

SECTION 12

Safety Education Program

No changes have been made to this section.

SECTION 13

Stakeholder Involvement

No changes have been made to this section.

SECTION 14

Contingencies

No changes have been made to this section.

SECTION 15

References

No changes have been made to this section.

Attachment 1
Site Approval Request
and NAVFAC Form 11010/31

ATTACHMENT 1

NAVSEA OP 5, "Ammunition and Explosives Safety Ashore," Requirements of Section 8-1.2.5, Final Safety Review

a. Anticipated personnel limits for Site 6 and 82.

Munitions Response/On-Site support: Up to 4 proposed contractor UXO personnel conducting excavation may be exposed during munitions operations. All non-essential personnel will be evacuated from within the minimum separation distance (MSD) for non-essential personnel during munitions response intrusive operations.

Detonation Area: Up to 2 proposed contractor UXO personnel conducting controlled detonation may be exposed during munitions operations. All nonessential personnel will be evacuated from within the MSD for non-essential personnel for detonation operations.

MPPEH Holding Area: Up to 4 proposed contractor UXO personnel may be present within the MPPEH holding area during MPPEH handling operations.

b. General details regarding dividing walls, vent walls, fire walls, roofs, operational shields, barricades, exits, types of floor finish, fire protection system installations, electrical systems and equipment, ventilation systems and equipment, hazardous waste disposal systems, lightning protection systems, all grounding systems, process equipment, and auxiliary support structures as well as general materials of construction unless approved definitive drawings are being used.

Not applicable.

c. A brief summary of the design procedures if engineered protection is used to reduce quantity-distance requirements. This summary shall include a statement of the design objectives in terms of protection categories (as defined in NAVFAC P-397) to be attained, explosives quantities involved, design loads applied, material properties and structural behavior assumptions, references, and sources of methods used. Detailed calculations need not be submitted. Design of explosion resistant facilities shall be accomplished by an organization or individual experienced in the field of structural dynamics using design procedures accepted by professionals in the field.

Engineering controls to be used during intentional detonation operations will conform to DDESB Technical Paper 16, Revision 1 and U.S. Army Corps of Engineers, Engineering and Support Center, Huntsville, *Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7* dated August 1998, and approved by DDESB February 23, 1999. Intentional detonations involving the use of sandbags as an engineering control will not exceed 11.4 lb. NEW HD 1.1.

d. Information on the type and arrangement of explosives operation or chemical processing equipment.

All MEC items will be disposed of by controlled detonation methods. The danger area will be marked off and evacuated. Disposal will be conducted in accordance with EODB 60A 1-1-31, OP-5 Volume I. Engineering controls used for intentional detonations will conform to DDESB TP-16 Revision 2 and USAESCH, *Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7* dated August 1998 and approved by DDESB on February 23, 1999.

A local vendor will provide explosives on an on-call basis and will remove all unused explosives from the site following demolition activities. No explosives will be stored onsite. The explosives vendor will follow all applicable DOT regulations regarding the transportation of explosives, and the vendor's employees will have the proper training and certifications. CH2M HILL and its MEC subcontractor will not transport explosives. CH2M HILL will coordinate with the installation's Explosives Safety Officer to obtain proper approvals to bring civilian explosives onto the installation.

e. Topography map with appropriate contours when terrain features are considered to constitute natural barricading, or when topography otherwise influences layout.

Not applicable. The MRA has little topographic relief. Terrain and topographic features are not expected to influence site operations or layout.

f. A hazard analysis of risk performed in accordance with paragraph 7-7.3 shall be included.

Operational Hazard Analysis Matrix.

		Mishap Probability			
		A	**B**	**C**	**D**
Hazard Severity	**I**	1	1	2	3
	II	1	2	3	4
	III	2	3	4	5
	IV	3	4	5	5

Mishap Probability:	**Hazard Severity:**	**Risk Assessment Codes:**
A Likely to occur immediately	**I** May cause death	**1** Critical
B Probably will occur in time	**II** May cause severe injury	**2** Serious
C May occur in time	**III** May cause minor injury	**3** Moderate
D Unlikely to occur	**IV** Presents a minimal threat	**4** Minor
		5 Negligible

The Hazard Severity assessment of the worst credible consequence which can result as a result of the hazard posed by the process identified in Section8.1 is judged as **"Category I" - hazard may cause death**. This determination was based on the possibility of accidental detonation of MEC or donor explosives while MEC is being prepared for demolition.

The Mishap Probability that a hazard will result in a mishap or loss for this site is recommended to be judged as "Category D" - unlikely to occur. All MEC and explosives operations will be conducted by experienced and qualified UXO technicians following established safety protocols.

The Operational Hazard Analysis Matrix results in a RAC of **"3" – Moderate Risk** – for the combination of Hazard Severity and Mishap Probability recommended above.

g. When chemical agents are involved, information regarding personnel protective clothing and equipment, treatment of effluent and waste materials to ensure absence of chemical agents, adequacy of medical support, average wind speed and direction, other support facilities pertinent to chemical safety, warning and detection systems, and hazard analysis.

Not applicable. Chemical agents are not anticipated at this MRA.

h. Explanation of any deviations from pertinent safety standards due to local conditions.

Not applicable. Local conditions are not anticipated to require any deviations from pertinent safety standards.

i. Explanation of any changes that may have occurred with this project or with any of the previous information submitted since submission of the preliminary site approval request.

Not applicable. No previous site approval requests have been submitted.

j. Lightning protection design drawings and associated zone of protection diagrams showing the masts and the building(s) protected, in plan and elevation views.

Not applicable. Explosives will not be stored at the MRA and lightning protection is not required.

Attachment 2
Fragmentation Data Sheet

FRAGMENTATION DATA REVIEW FORM

Database Revision Date 9/30/07

Category:	HE Rounds	DODIC:	H600
Munition:	3.5" M28A2 Rocket Case	Date Record Created:	7/30/2004
		Last Date Record Updated:	7/30/2004
Primary Database Category:	rocket	Individual Last Updated Record:	Crull
Secondary Database Category:	3.5 in	Date Record Retired:	
Munition Case Classification:	Robust		

Munition Information and Fragmentation Characteristics

Explosive Type:	Comp B
Explosive Weight (lb):	1.88000
Diameter (in):	3.5000
Max Fragment Weight (lb):	0.052420
Critical Fragment Velocity (fps):	6126

Theoretical Calculated Fragment Range

HFD [Range to No More Than 1 Hazardous Fragment per 600 Square Feet] (ft):	235
MFR-V [Vertical Range of Max Weight Fragment] (ft):	1128
MFR-H [Horizontal Range of Maximum Weight Fragment] (ft):	1420

Overpressure Distances

Inhabited Building Distance (12 psi), K40 Distance:	56
Inhabited Building Distance (09 psi), K50 Distance:	70
Intentional MSD (0065 psi), K328 Distance:	457

Minimum Thickness to Prevent Perforation

4000 psi Concrete (Prevent Spall):	3.92
Mild Steel:	0.71
Hard Steel:	0.59
Aluminum:	1.53
LEXAN:	4.52
Plexi-glass:	3.00
Bullet Resist Glass:	2.37

Required Sandbag Thickness

Max Fragment Weight (lb)SB:	0.052420
Critical Fragment Velocity (fps)SB:	6126
Kinetic Energy 106 (lb-ft2/s2)SB:	0.9836
Required Wall Roof Sandbag Thickness (in)SB:	24
Expected Maximum Sandbag Throw Distance (ft)SB:	125
Minimum Separation Distance (ft)SB:	200

Water Containment System and Minimum Separation Distance:

Max Fragment Weight (lb)W:	0.052420
Critical Fragment Velocity (fps)W:	6126
Kinetic Energy 106 (lb-ft2/s2)W:	0.9836
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft)W:	200

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Attachment 3
Buried Explosive Module

BURIED EXPLOSION MODULE

(Version 4.0)

Based on DDESB Technical Paper 16, Revision 2

(ENGLISH UNITS)

SELECT ITEM DESCRIPTION

3.5" M28A2 Rocket Case

SINGLE ITEM NEW (lbs)	1.88
SINGLE ITEM TNT EQUIVALENCE (lbs)	2.18
MAXIMUM FRAGMENT WEIGHT (lbs)	0.0524
MAXIMUM FRAGMENT VELOCITY (ft/s)	6,126
ENTER TOTAL NUMBER OF ITEMS	5
ENTER WEIGHT OF BOOSTER (lbs)	0.50
TOTAL TNT WEIGHT (lbs)	11.40
ENTER DEPTH OF BURIAL (ft)	3.000

SELECT SOIL TYPE

(See TP 16, Revision 2 for soil details)

Dry Sand

CRATER OR CAMOUFLET?

CRATER

TRUE CRATER RADIUS (ft)	5.31
MAXIMUM SOIL EJECTA RANGE (ft)	288
FRAGMENT EXIT VELOCITY (ft/s)	105
FRAGMENT LAUNCH ANGLE (°)	29.4
MAXIMUM FRAGMENT RANGE (ft)	235
FRAGMENT HAZARD RANGE (ft)	288

Amendment No. 2
Explosives Safety Submission for Munitions Response Activities Installation Restoration Site 6 and Site 82 (Operable Unit 2)
ESS-119

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Contract Task Order 039

September 2010

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

Under the

Navy CLEAN 1000 Program
Contract No. N62470-08-D-1000

Prepared by

CH2MHILL

Charlotte, North Carolina

3.2 Munition with the Greatest Fragmentation Distance

Only practice, inert, or expended items had been discovered at Site 6 until September 20, 2010. During intrusive investigation activities on September 20, 2010, a Projectile, 81-mm, HE, M362A1, was discovered. Since the fragmentation distance of this projectile is greater than the fragmentation distance of both the primary and contingency munition with the greatest fragmentation distance (MGFD), this ESS is amended to use the Projectile, 81-mm, HE, M362A1as the primary MGFD.

The exclusion zone parameters will be calculated based on the *primary* MGFD. *The minimum separation distance (MSD) for the MGFD without engineering controls for intentional detonation activities is 1,299 feet.* Use of engineering controls is requested for intentional detonations to reduce the explosive arcs. *Using engineering controls, based on sandbag mitigation, the MSD for the intentional detonation of one 81 mm HE M362A1 projectile is 200 feet.* **Table 3-2** identifies the exclusion zones (EZ) for the primary MGFD. The EZs include the team separation distance (TSD) for personnel conducting intrusive operations within the site, the minimum separation distance (MSD) for non-essential personnel, the public transportation route (PTR) distance, and the inhabited building distance (IBD) for the *primary MGFD* and MPPEH under specified scenarios. **Figure 2-1** shows the explosives safety quantity distance *(ESQD)* arcs for the primary MGFD *and MPPEH collection point*.

The quantity distances (Q-D) for MEC area unintentional detonation are:

- MSD *243* feet
- TSD *58* feet

Documentation of any EOD MEC responses will be submitted to MARCORSYSCOM. If a MEC item with a greater fragmentation distance is encountered the MSD will be adjusted per Department of Defense Explosives Safety Board (DDESB) TP 16, *MARCORSYSCOM will be contacted*, and an amendment to this ESS will be expeditiously submitted. *Donor explosives will be delivered on an as-needed basis and used the same day. No explosives will be stored on site therefore a magazine will not be required.*

3.3 Explosive Soil and Contaminated Buildings

Not applicable.

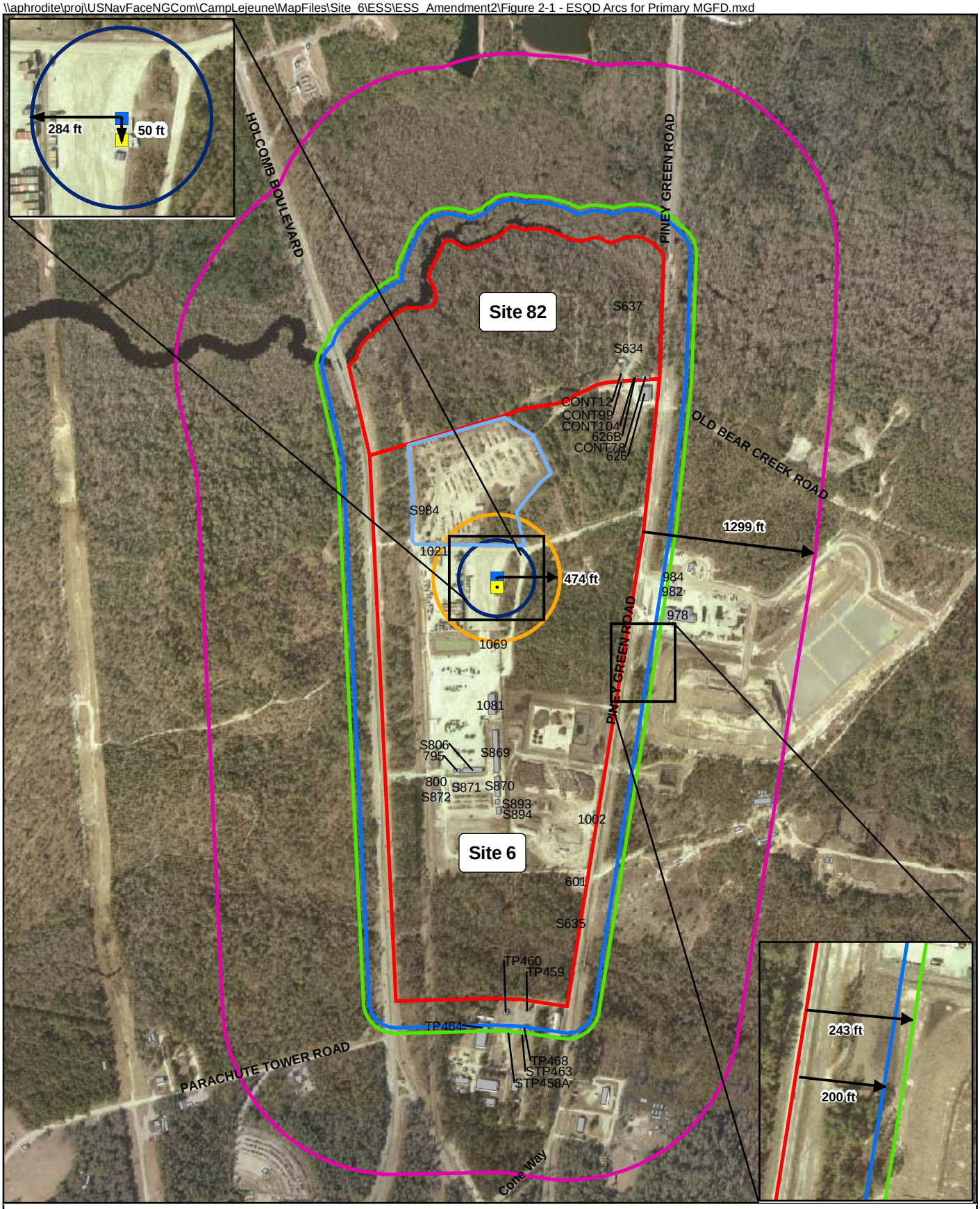
TABLE 3-2
Primary MGFD Exclusion Zone Parameters

Scenario	Item	NEW (lb)	TSD (ft)	MSD for Public & Non-Essential Personnel (ft)	IBD (ft)	PTR (ft)
Unintentional Detonation	*Projectile 81-mm HE M362A1*	*2.1*	*58 feet*	*243 feet*	N/A	N/A
Shot Set-Up	*Projectile 81-mm HE M362A1*	*2.1 lbs plus donor*	*58 feet*	*243 feet*	N/A	N/A
Intentional Detonation for public and all personnel	*Projectile 81-mm HE M362A1*	*2.1 lbs plus donor.*	N/A	*1,299 feet*[a] *200 feet (with sandbag mitigation)*	N/A	N/A
Onsite Consolidation, Storage, and Re-inspection	MPPEH	10 lb	N/A	N/A	474 feet	284 feet

NOTES:
a No engineering controls

All exclusion zone parameters are based on calculating the appropriate K factor. For unintentional detonations, shot setup and TSD = D=40W1/3. Intentional detonation = D =328W1/3.
IBD – Inhabited Building Distance; MPPEH – Material Presenting a Potential Explosive Hazard; MSD – Minimum Separation Distance; NA – Not Applicable; PTR – Public Transportation Route; TSD – Team Separation Distance

\\aphrodite\proj\USNavFaceNGCom\CampLejeune\MapFiles\Site_6\ESS\ESS_Amendment2\Figure 2-1 - ESQD Arcs for Primary MGFD.mxd



Legend

- Non-MPPEH Scrap Collection Point
- MPPEH Scrap Collection Point
- Intentional detonation for public and all personnel with sandbag mitigation = 200 ft
- Unintentional detonation TSD and MSD = 243 ft
- Intentional detonation for public and all personnel without engineering controls = 1299 ft
- MPPEH Scrap Collection Point IBD = 474 ft
- PTR = 284 ft
- Structure Existing Area
- Area of Test Pits
- MRS Boundary

N

0 500 1,000 Feet

1 inch = 1,000 feet

Figure 2-1
Explosive Safety Quantity Distance (ESQD) Arcs for Primary MGFD (81 mm HE M362A1 projectile)
Site 6 ESS Amendment 2
MCB CamLej
North Carolina

CH2MHILL

FRAGMENTATION DATA REVIEW FORM

Database Revision Date 8/15/09

Category:	HE Rounds	DODIC:	C222
Munition:	81 mm M362A1	Date Record Created:	7/30/2004
		Last Date Record Updated:	7/30/2004
Primary Database Category:	mortar	Individual Last Updated Record:	Crull
Secondary Database Category:	81 mm	Date Record Retired:	
Munition Case Classification:	Robust		

Munition Information and Fragmentation Characteristics

Explosive Type:	Comp B
Explosive Weight (lb):	2.10000
Diameter (in):	3.1890
Max Fragment Weight (lb):	0.038399
Critical Fragment Velocity (fps):	6252

Theoretical Calculated Fragment Range

HFD [Distance to No More Than 1 Hazardous Fragment per 600 Square Feet] (ft):	243
MFD-V [Vertical Distance of Max Weight Fragment] (ft):	1034
MFD-H [Horizontal Distance of Maximum Weight Fragment] (ft):	1299

Overpressure Distances

Inhabited Building Distance (12 psi), K40 Distance:	58
Inhabited Building Distance (09 psi), K50 Distance:	72
Intentional MSD (0065 psi), K328 Distance:	474

Minimum Thickness to Prevent Perforation

4000 psi Concrete (Prevent Spall):	3.64
Mild Steel:	0.66
Hard Steel:	0.54
Aluminum:	1.43
LEXAN:	4.30
Plexi-glass:	2.81
Bullet Resist Glass:	2.20

Required Sandbag Thickness

Max Fragment Weight (lb)SB:	0.038400
Critical Fragment Velocity (fps)SB:	6252
Kinetic Energy 106 (lb-ft2/s2)SB:	0.7505
Required Wall Roof Sandbag Thickness (in)SB:	24
Expected Maximum Sandbag Throw Distance (ft)SB:	125
Minimum Separation Distance (ft)SB:	200

Water Containment System and Minimum Separation Distance:

Max Fragment Weight (lb)W:	0.038400
Critical Fragment Velocity (fps)W:	6252
Kinetic Energy 106 (lb-ft2/s2)W:	0.7505
Water Containment System:	5 gallon carboys/ inflatable pool
Minimum Separation Distance (ft)W:	264/200

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Distribution authorized to the Department of Defense and U.S. DoD contractors only for Administrative-Operational Use (17 October 2002). Other requests shall be referred to the Chairman, Department of Defense Explosives Safety Board, Room 856C, Hoffman Building I, 2461 Eisenhower Avenue, Alexandria, VA 22331-0600.

Amendment No. 3
Explosives Safety Submission for Munitions Response Activities
Site UXO-22 (Site 6 and Site 82)
ESS-120

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Task Order 039

November 2010

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

Under the

Navy CLEAN 1000 Program
Contract No. N62470-08-D-1000

Prepared by

CH2MHILL

Charlotte, North Carolina

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2-1 Explosives Safety Quantity Distance (ESQD) Arcs for Primary MGFD (81 mm HE *M43* projectile)

Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
ATF	Alcohol, Tobacco, and Firearms
BEM	*buried explosion module*
BIP	*blow in place*
CAP	Corrective Action Plan
CAR	Corrective Action Request
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DDESB	Department of Defense Explosives Safety Board
DFOW	definable feature of work
DGM	digital geophysical mapping
DOD	U.S. Department of Defense
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
DQO	data quality objective
DRMO	Defense Reutilization and Marketing Office
ECA	equipment check area
EOD	explosive ordnance disposal
ESQD	explosives safety quantity-distance
ESS	Explosives Safety Submission
EZ	exclusion zone
ft	feet/foot
GIS	geographic information system
GPS	global positioning system
HE	high explosive
HSP	Health and Safety Plan
IBD	inhabited building distance
lb	pound
MARCORSYSCOM	Marine Corps System Command
MCB *CamLej*	Marine Corps Base *Camp Lejeune*
MD	munitions debris
MDAS	*material documented as safe*
MEC	munitions and explosives of concern
MGFD	munition with the greatest fragmentation distance
mm	millimeter

MPPEH	material potentially presenting an explosive hazard
MR	munitions response
MRA	munitions response area
MRS	munitions response site
MRSIMS	Munitions Response Site Information Management System
MSD	minimum separation distance
mV	millivolt
NAVFAC	Naval Facilities Engineering Command
NAVSEA	Naval Sea Systems Command
NCDENR	North Carolina Department of Environment and Natural Resources
NEW	net explosives weight
NOSSA	Naval Ordnance Safety and Security Activity
NRCS	Natural Resources Conservation Service
OSHA	Occupational Safety and Health Act
PM	Project Manager
PTR	public transportation route
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QCP	Quality Control Plan
RI	Remedial Investigation
RTK	real-time kinematic
SUXOS	Senior UXO Supervisor
TCRA	time critical removal action
TSD	team separation distance
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Corps of Engineers, Huntsville Center
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Specialist
UXOSO	UXO Safety Officer

SECTION 1

Background

This Explosives Safety Submission (ESS) *Amendment 3 (ESS-120)* was prepared in support of munitions response (MR) activities *at unexploded ordnance (UXO) Site UXO-22 (located within the Site 6 and Site 82 boundaries) at Marine Corps Base Camp Lejeune (MCB CamLej), Jacksonville, North Carolina.*

This amendment updates previous versions of the ESS and includes usage of mechanized munitions and explosives of concern (MEC) processing, material potentially presenting an explosive hazard (MPPEH) processing, engineering controls for intentional detonation, and updates tasks related to construction support and intrusive investigation operations.

1.1 Responsible Project Manager

The responsible project manager for this project is:

David T. Cleland, P.G.
NAVFAC ATLANTIC
757-322-4851 (voice)
(757) 322-8280 (fax)
david.t.cleland@navy.mil

1.2 Munitions Response Site Identifier and Description

This Explosives Safety Submission (ESS) Amendment addresses MR investigation/characterization activities at *Site UXO-22.* This MRS is located within *MCB CamLej,* an active installation ***(Figure 1-1)***.

*Site UXO-22 is composed of portions of Installation Restoration (IR) Site 6 and IR Site 82 (**Figure 1-2**). Site UXO-22 covers an area of approximately 75 acres that incorporates portions of Storage Lots 201 and 203, and wooded areas between the storage lots. Historically, Site UXO-22 was used for disposal and storage of wastes and supplies, including pesticides, transformers containing polychlorinated biphenyls (PCBs), solvents, electrolytes, and waste oils. Currently, Lot 201 is used to store military equipment, vehicles, hydraulic oils, and other "non-hazardous" supplies. Open storage Lot 203 previously served as a waste disposal and storage area from as early as the 1940s to the late 1980s. Most of Lot 203 remains an open field, with 21 acres temporarily used by the Defense Reutilization Marketing Office as a scrap and surplus storage lot.* The topography of *Site UXO-22* is flat with little elevation relief.

1.3 Regional Maps

Figure 1-1 shows the regional location of MCB CamLej. ***Figure 1-2*** *shows the* locations of Sites 6 and 82 *in relation to Site UXO-22 within MCB CamLej.*

1.4 Scope of Munitions Response

The scope of work to be conducted at the MRS includes the following tasks:

- Land surveying
- Vegetation clearance
- Digital geophysical mapping (DGM)
- Remove MPPEH that is found on the ground surface
- Intrusive investigation of possible waste disposal trenches *and/or geophysical anomalies* identified by geophysical methods
- *Construction support*
- *Subsurface utility locating*
- *Environmental sampling*

1.5 History of MEC Use

No former range activities are known to have occurred at the MRS, but *MEC*/MPPEH ha*ve* been discovered in pits at the MRS, as discussed in Section 1.6 below.

1.6 Previous Studies of Extent of MEC Contamination

1.6.1 UXO Surface and Subsurface Investigation and Removal from Remedial Investigation Report (1993)

During the *Remedial Investigation (RI),* surface and sub-surface UXO reconnaissance was performed to search for, identify, and clear MEC at Operable Unit 2 *(Baker, 1993).* The UXO survey report in the RI states the following items were collected (quantities in parentheses): Mk II grenade (3), 7.62 mm ammunition (100), 3.5" practice rockets (15), 20 mm cartridge cases (10), 30 mm cartridge cases (23), 40 mm cartridge cases (54), and 105 mm cartridge cases (more than 1,000). The three grenades and the one-hundred 7.62 mm ammunition were reportedly turned over to Base *Explosive Ordnance Disposal (*EOD*).* The final disposition of the remaining MD was not documented in the report; however, the report indicated that the remaining material would be disposed as scrap metal.

1.6.2 Time Critical Removal Action (1994)

According to the Contractor's Closeout Report for Sites 6 and 82 Source Removal (OHM, March 1997), four source removal trenches were excavated in February 1994 at Site 6and one trench excavated at Site 82. The excavation activity removed a total of 2,655 cubic yards of soil and debris consisting of drums; communication wire; batteries; containers of petroleum, oils, and lubricants; and expended 105mm cartridges. Over 100 tons of discarded batteries were removed from the trenches at Site 6.

1.6.3 2008 EOD Emergency Response

In December 2008, munitions debris was discovered in the central area of Site 6 during vegetation clearing. The vegetation clearing was underway to prepare for a geophysical survey investigating possible waste disposal areas. Base EOD was contacted upon discovery of several 3.5-inch practice rockets entangled in communication wire. Base EOD responded and subsequently removed various types of MPPEH. During the EOD response, the following items (and quantities) were removed from a pit beneath the communication wire:

- Four M-2 antipersonnel mines, bounding
- Five 57mm brass cartridges
- Twenty-two M-29 rockets, practice warhead only
- Forty rocket motors, 3.5-inch
- Five M-29 rockets, 3.5-inch with M-405 fuze

These items were put into secure temporary storage onsite and were demilitarized and disposed of under the April 2009 ESS. All items placed in the secured storage were demilitarized, then received two independent 100% inspections and were disposed of off-Base as material documented as safe (MDAS).

1.6.4 2010 Site UXO-22 Intrusive Investigation

In October 2010, the excavation started by EOD in December 2008 was further investigated. During this intrusive investigation, MEC items were discovered which required the preparation of Amendment 2 of the ESS (ESS-119). The following MEC items (and quantities) were removed from the excavation:

- *One Mortar, 81 mm, HE, M43 with fuze M45*
- *One Mortar, 60 mm, HE, M49 without fuze*
- *One Rocket, 3.5-inch, HEAT, M28*

In addition to these MEC items, approximately 14,000 pounds of MPPEH items were removed from the excavation, including the following:

- *Mortars, 60 mm, practice, M50A2*
- *Hand grenades, MK21, practice*
- *M-29 rockets, practice warhead only*
- *Mortar fuzes, M45, expended*
- *Rocket fuzes*

1.7 Regulatory Statute, Phase, and Oversight

The *ongoing* supplemental investigation of the MRS will be conducted under the CERCLA framework with input provided by the United States (U.S.) Environmental Protection Agency (USEPA) Region 4 and the North Carolina Department of Environment and Natural Resources (NCDENR). Regulatory oversight from environmental agencies is not being provided for MR activities related to excavation, demilitarization and disposal of MPPEH.

The response action will be conducted in accordance with the following health and safety regulations and requirements, in addition to the MEC-specific regulations and requirements to be provided in a Munitions Response Work Plan:

- 29 Code of Federal Regulations (CFR), Occupational Safety and Health Act (OSHA) Regulations: Construction (29 CFR 1926) and General Industry (29 CFR 1910), applicable sections
- U.S. Army Corps of Engineers (USACE), 2008, EM 385-1-1, *Safety – Safety and Health Requirements*

1.8 Justification for NDAI/NFA Decision

Not applicable.

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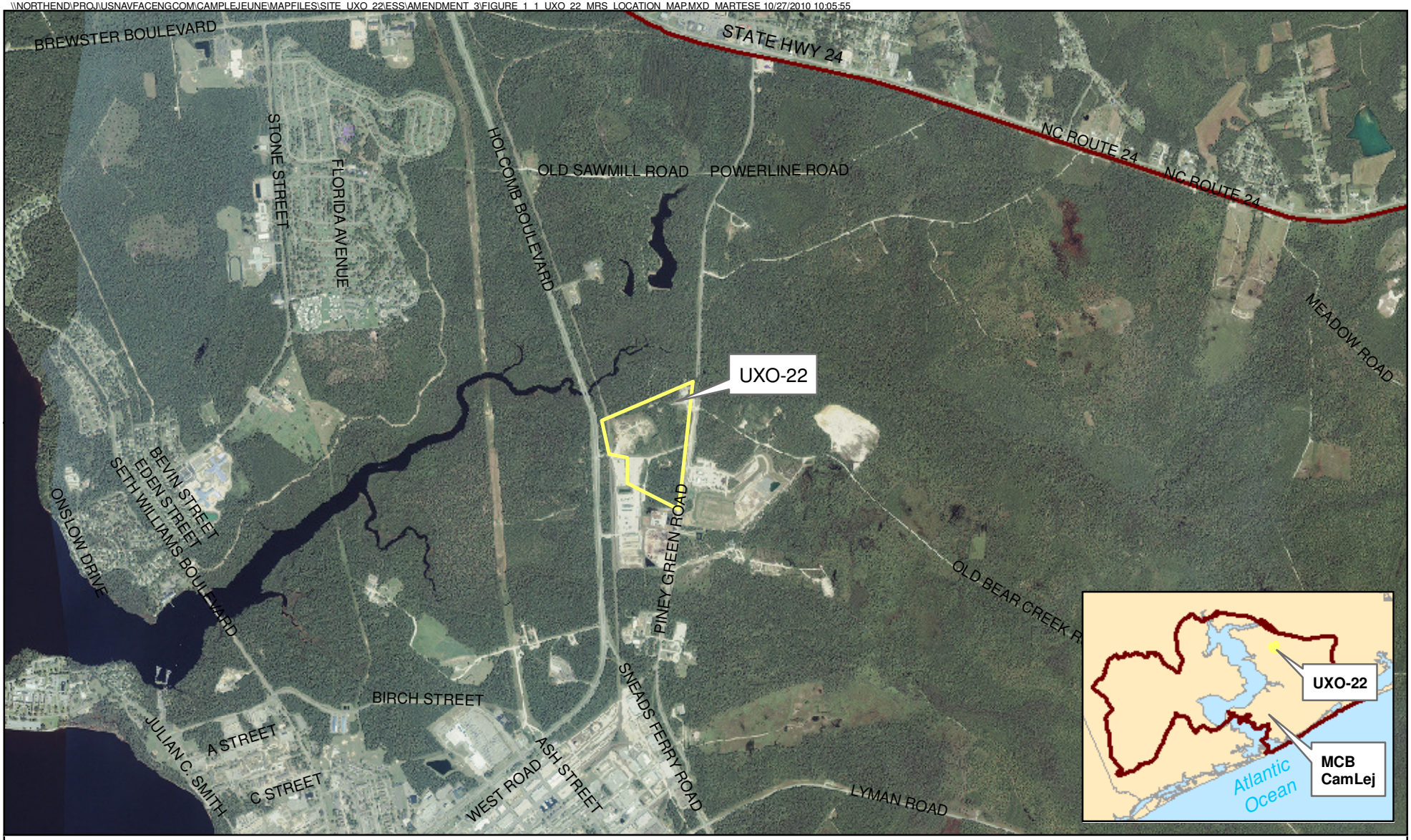

Legend

- Highways
- UXO-22 Boundary
- Installation Boundary

N

0 1,500 3,000 6,000 Feet

1 inch = 3,000 feet

Figure 1-1
UXO-22 MRS Location
UXO-22 ESS Amendment 3
MCB CamLej
North Carolina

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SITE_UXO_22\ESS\AMENDMENT_3\FIGURE_1_2_UXO_22_SITE_MAP.MXD MARTESE 10/27/2010 10:58:18

Legend

- Surface Water Course Centerline
- Burial Pit Containing MPPEH
- Lots 201, 203, and DRMO
- UXO-22 Boundary
- Site 6 and 82 Boundary (OU2)

N

0 225 450 900 Feet

1 inch = 450 feet

Figure 1-2
UXO-22 Site Map
UXO-22 ESS Amendment 3
MCB CamLej
North Carolina

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SECTION 2

Site Approval Request

2.1 NAVFAC Form 11010/31, "Request for Project Site Approval"

An amended NAVFAC Form 11010/31 is included as Attachment 1. The associated explosives safety quantity-distance (ESQD) arcs maps are presented as **Figures 2-1**.

2.2 Additional Information

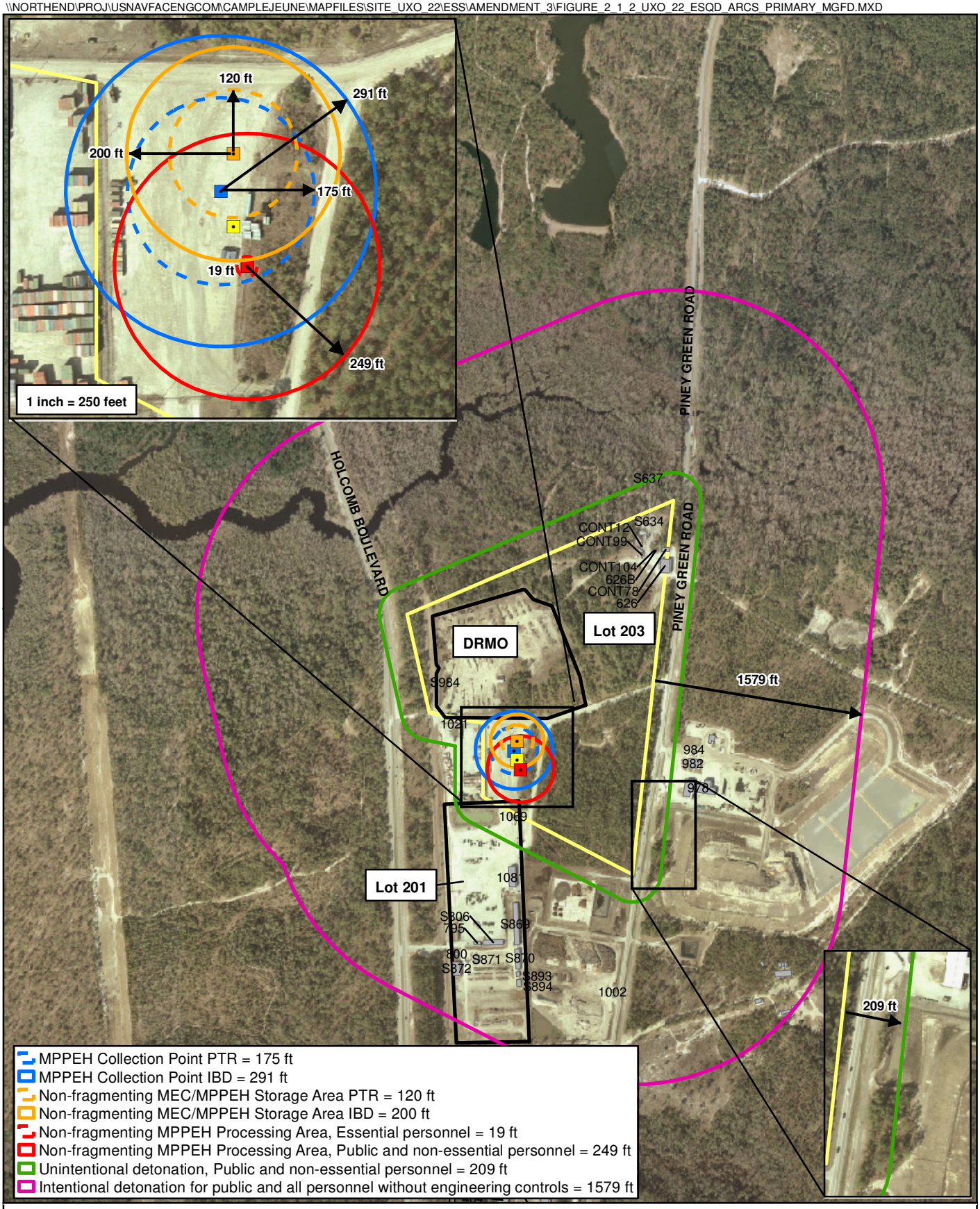
TABLE 2-1
Buildings Potentially Impacted by the Primary MGFD ESQD Arcs

Building Number	Building Description	Estimated Number of Occupants
601	Storage	
626	Groundwater Treatment System	**0**
626B	Equipment Storage	**0**
795	General Storage Shed	**0**
800	Administrative Office	**10-15**
984	Weigh Facility	**2**
982	Administrative Office	**5**
978	Recycling Facility	**5**
1002	Scale House	**3**
1021	Trailer	**5**
1069	Administrative Office	**5**
1081	Equipment Storage Facility	**2**
CONT12	Contractor Field Office	**2**
CONT78	Contractor Field Office	**5**
CONT99	Contractor Field Office	**2**
CONT104	Equipment Storage	**0**
S634	Groundwater Treatment Facility	**0**
S635	WWPS Control Panels	**0**
S637	Groundwater Treatment Facility	**0**
S806	Storage	**0**
S869	Storage Shelter	**0**

TABLE 2-1
Buildings Potentially Impacted by the Primary MGFD ESQD Arcs

Building Number	Building Description	Estimated Number of Occupants
S870	General Storage Shed	**0**
S871	PAV/GRNDS EQ SH	**0**
S984	Scale Shelter	**0**
S872	General Storage Shed	**0**
S893	Storage	**0**
S894	Weigh Facility	**0**
STP458A	Fire Training Structure	**0**
STP463	Land Use Study	**0**
STP464A	HAZMAT Storage	**0**
STP464B	HAZMAT Storage	**0**
STP464G	Storage	**0**
TP459	Fire Training Tower	**0**
TP460	Fire Training/Rescue Smokehouse	**0**
TP464	General Warehouse	**15-20**
TP468	Fire Training Classroom	**15-20**

\\NORTHEND\PROJ\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SITE_UXO_22\ESS\AMENDMENT_3\FIGURE_2_1_2_UXO_22_ESQD_ARCS_PRIMARY_MGFD.MXD



Legend

- MPPEH Collection Point
- MEC/MPPEH Storage Area, ATF Type II Magazine
- Non-Fragmenting MPPEH Processing Area
- MDAS Collection Point
- Structure Existing Area
- UXO-22 Boundary

N

0 500 1,000 Feet

1 inch = 1,000 feet

Figure 2-1
Explosive Safety Quantity Distance (ESQD) Arcs
for Primary MGFD (81 mm HE M43 projectile)
UXO-22 ESS Amendment 3
MCB CamLej
North Carolina

CH2MHILL

SECTION 3

Types of MEC and MPPEH

3.1 Types and Quantities of MEC, Including MPPEH

As discussed in Section 1.6, surface and subsurface reconnaissance performed during the RI (Baker, 1993) resulted in the discovery of three Mk II grenades, ammunition, practice rockets and expended cartridges. During the TCRA removal action (1997) and the EOD Response (2008), only practice, inert or expended munitions items were recovered. *During the 2010 intrusive investigation of the excavation originated by EOD, three MEC items were recovered as explained in Section 1.6.4.* There is no documentation that Site *UXO-22 was* ever an active range, impact area or open burn/ open detonation area.

The types of munitions that have historically been discovered within the MRS are presented in **Table 3-1**.

TABLE 3-1
Site UXO-22 Potential Munitions

Ordnance	Quantity Recovered	Investigation
Mortar, 81 mm, HE, M43 with fuze M45	*1*	*2010 Intrusive Investigation*
Mortar, 60 mm, HE, M49 without fuze	*1*	*2010 Intrusive Investigation*
Rocket, 3.5-inch, HEAT, M28	*1*	*2010 Intrusive Investigation*
MK 21 practice hand grenades	*35*	*2010 Intrusive Investigation*
60 mm Mortar, practice, M50A2	*4*	*2010 Intrusive Investigation*
M-2 Antipersonnel, mine, bounding, inert,	4	2008 EOD Response
57mm brass expended cartridge cases	5	2008 EOD Response
M-29 Rocket, practice warhead only	22 *>1,000*	2008 EOD Response *2010 Intrusive Investigation*
Expended Rocket motors, 3.5”	40 *>1,200*	2008 EOD Response *2010 Intrusive Investigation*
M-29 Practice Rocket, 3.5” with M-405 Practice Fuze	5	2008 EOD Response
105 mm expended cartridge cases	>1,000	1993 RI and 1997 TCRA
MK II Grenades	3	1993 RI
7.62 mm ammunition	100	1993 RI
3.5” practice rockets	15	1993 RI
20 mm expended cartridge cases	10	1997 TCRA
30 mm expended cartridge cases	23	1994 Excavation- TCRA
40 mm expended cartridge cases	54	1994 Excavation- TCRA

3.2 Munition with the Greatest Fragmentation Distance

ESS-*119 (Amendment No. 2) was* amended to use the Projectile, 81-mm, HE, M362A1as the primary *munition with the greatest fragmentation distance (*MGFD*). This ESS Amendment (ESS-120) updates the MGFD to use the high explosive (HE) M43 81-mm as the primary MGFD.*

The exclusion zone parameters will be calculated based on the primary MGFD. The minimum separation distance (MSD) for the MGFD without engineering controls for intentional detonation activities is *1,579* feet. Use of engineering controls is requested for intentional detonations to reduce the explosive arcs. Using engineering controls, based on sandbag mitigation, the MSD for the intentional detonation of one *M43 81-mm* projectile is 200 feet. **Table 3-2** identifies the exclusion zones (EZ) for the primary MGFD. The EZs include:

- the team separation distance (TSD) for personnel conducting intrusive operations within the site,
- the MSD for non-essential personnel,
- the public transportation route (PTR) distance, and the inhabited building distance (IBD) for
  - *MPPEH Storage,* and
  - *Non-Fragmenting MEC/MPPEH storage in an Alcohol, Tobacco, and Firearms (ATF) Type II magazine and*
- *other* specified scenarios*, including*
  - *Consolidated shots of 3.5-inch rockets,*
  - *Non-fragmenting MPPEH shredder/chop saw operation for M29 3.5-inch practice rockets, and*
  - *Mechanized MEC high input processing operations for construction/intrusive activities conducted without MEC avoidance.*

Figure 2-1 shows the ESQD arcs for the primary MGFD and MPPEH collection *point, and the non-fragmenting MPPEH shredder/shop saw operations.*

The quantity distances (Q-D) for MEC area unintentional detonation are:

- MSD *209* feet
- TSD *43* feet

Since recent work at this site involved the recovery and inspection of thousands of 3.5-inch rockets, it is assumed that some MPPEH items, specifically 3.5-inch rockets, may require explosive venting to gain access and verify that the filler is inert. When 3.5-inch rockets are explosively vented, the exclusion zone parameters (including the team separation distance and minimum separation distance for public and non-essential personnel) will be calculated based on the HE 3.5-inch rocket. The MSD for the 3.5-inch HE rocket without engineering controls for intentional detonation activities is 1,420 feet. Using engineering controls, based on the buried explosion module (BEM) output that is included as Attachment 3, the MSD for the intentional detonation of a consolidated intentional demolition shot of five (5) M28 HE rockets is 293 feet. An additional safety factor of 33% will be

applied to the MSD for intentional detonation of the consolidated demolition shot using engineering controls, resulting in an MSD of 390 feet for intentional detonation using engineering controls.

Documentation of any EOD MEC responses will be submitted to MARCORSYSCOM. If a MEC item with a greater fragmentation distance is encountered, the MSD will be adjusted per Department of Defense Explosives Safety Board (DDESB) TP 16, MARCORSYSCOM will be contacted, and an amendment to this ESS will be expeditiously submitted. Donor explosives will be delivered on an as-needed basis and used the same day.

TABLE 3-2
Primary MGFD Exclusion Zone Parameters

Scenario	Item	NEW (lb)	TSD *or K24* (ft)	MSD for Public & Non-Essential Personnel (ft)	IBD (ft)	PTR (ft)
Unintentional Detonation	Projectile 81-mm HE *M43*	*1.23*	*43*[a] feet	*209* feet	N/A	N/A
Mechanized[b] *MEC Processing Operations – High Input Processing*	*Projectile 81-mm HE M43*	*1.23*	*26*[c] *feet*	*1579 feet*	*N/A*	*N/A*
Intentional Detonation for public and all personnel	Projectile 81-mm HE *M43*	*1.23* lbs	N/A	*1579 feet*[d] 200 feet (with sandbag mitigation)	N/A	N/A
Non-Fragmenting MPPEH Shredder/Chop Saw[e] *(High Input MEC Processing Operations)*	*M29 practice 3.5-inch rocket*	*0.44 lb*[f]	*19*[g] *feet*	*249 feet*	*N/A*	*N/A*
Intentional Detonation for public and all personnel	*3.5 inch HE rocket M28A2* *5 each*	*1.88 LBS Comp B*[h]		*390 feet* *5 rockets using engineered control Buried Explosion Module plus 33% safety factor*		
Onsite Consolidation, Storage, and Re-inspection	MPPEH	*1 lb*	N/A	N/A	*291*[i] feet	*175*[i] feet
Onsite Consolidation, Storage, and Re-inspection	*Non-Fragmenting MEC/MPPEH in an ATF Type II Magazine*	*30 lb*	*N/A*	*N/A*	*200*[j] *feet*	*120*[j] *feet*

NOTES:

Exclusion zone parameters for the Projectile 81-mm HE M43 are based on the Fragmentation Data Review Database Revision Date 9/30/10

[a] *TSD is calculated by* $D = 40W^{1/3}$

[b] *DoD 6055.09-M-V7 February 29, 2008, Reissued August 4, 2010, Section V7.E4.5.8.3.5.2.1.1 states that during high-input processing operations, non-essential personnel shall be provided protection based on the intentional detonation (MSD) of the MGFD.*

[c] *K24 calculated distance by* $D = 24W^{1/3}$ *Essential personnel must be the K24 distance away from the operation for overpressure protection.*

[d] No engineering controls

[e] *The MPPEH Shredder/Chop Saw is a high input mechanized MEC Processing operation and will utilize the MSD =* $D = 328W^{1/3}$ *because practice rockets are non-fragmenting items. No fragmenting items will be treated by the MPPEH Shredder/Chop Saw. The essential personnel operating the MPPEH Shredder/Chop Saw will be at the K24 distance (19 feet), and for added protection, behind shielding equivalent to Section 8.6.*

[f] *From TM 43-0001-30 Army Data Sheets for Rockets*

[g] *K24 calculated distance by* $D = 24W^{1/3}$

[h] *Based on the Fragmentation Data Review Form Database Revision Date 9/30/10 for the 3.5 in M28A2 Rocket*

[i] *Based on Table 7-9, Ordnance Publication (OP)-5, Volume 1, 7th Revision (NAVSEA, 2007). PTR is 60 percent of IBD.*

[j] *Based on Table 7-9, Ordnance Publication (OP)-5, Volume 1, 7th Revision (NAVSEA, 2007). PTR is 60 percent of IBD.*

IBD – Inhabited Building Distance; MPPEH – Material Presenting a Potential Explosive Hazard; MSD – Minimum Separation Distance; NA – Not Applicable; PTR – Public Transportation Route; TSD – Team Separation Distance

3.3 Explosive Soil and Contaminated Buildings

Not applicable.

SECTION 4

Project Dates

4.1 Project Dates

Several MR actions are currently scheduled for Site UXO-22. The demilitarization of 3.5-inch rocket motors removed during the 2010 intrusive investigation will be completed upon approval of Amendment 3 of the ESS. Test pits will be excavated to investigate other potential disposal pits in the central portion of Site UXO-22 in early 2011. Grading and storm water pond installation requiring construction support is also planned for late 2010 and early 2011. An After Action Report will be submitted to the DDESB via MARCORSYSCOM within 6 months of the completion *of MR actions at the MRS.*

SECTION 5

MEC Migration

According to Mr. James Gagnon of the Natural Resources Conservation Service (NRCS) Edenton Technical Services Office, frost upheaval in the coastal plain region of North Carolina is considered unlikely since the climate only allows frost action to occur to a maximum depth of approximately 6 inches. No other natural phenomena (e.g., drought, flooding, erosion, tidal changes) exist for this area. Therefore, migration of MEC (other than through human transport) is not considered likely.

SECTION 6

Quality Control/Quality Assurance

6.1 Quality Documentation

The Munitions Response Work Plan (CH2M HILL, under development) will include a Quality Control Plan (QCP) that discusses all aspects of project quality control (QC).

6.2 Personnel Qualifications

All MEC operations personnel will be qualified and certified in accordance with terms outlined by U.S. Department of Labor (DOL) Employment Standards Administration Wage Hour Division for UXO Personnel and the Department of Defense Explosive Safety Board (DDESB) TP-18, *Minimum Qualifications for UXO Technicians and Personnel*.

6.3 QC Implementation

An extensive QC program will be applied to the project and, in particular, to the field operations and data processing. Controls QC will be implemented strictly through the establishment of data quality objectives (DQOs), QC tests, and acceptance criteria and monitoring of those items by CH2M HILL's UXO QC Specialist (UXOQCS). Any QC failure will result in immediate notification of the CH2M HILL Project Manager (PM), who will promptly notify the NAVFAC PM. The failure will then be analyzed through a root-cause analysis process and the results and recommended corrective action(s) will be discussed with NAVFAC prior to implementation.

QC will be monitored through the Definable Features of Work (DFOW) using a three-phase control process.

6.3.1 Definable Features of Work

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

1. **Planning**
   - Pre-Mobilization Activities - System setup for geographic information system (GIS), document management and control, data management and subcontracting
   - Preparing Work Plan
2. **Field Operations**
   - Site preparation – Mobilization
   - Intrusive excavation of the disposal pit located at Site 6 originally excavated by EOD during the 2008 emergency response, and possible additional disposal trenches at *Site UXO-22*
   - Removal of surface debris which may include MPPEH

- Demilitarization and disposal of MEC or MPPEH
- Vegetation clearing
- Digital Geophysical Mapping (DGM)
- *Anomaly Investigation*
- *Construction Support*
- Demobilization

3. Final Project Reports and Closeout

- Preparation and approval of draft and final reports
- Data archiving and project closeout

6.3.2 Three Phases of Control

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

Preparatory Phase

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

- Confirm that the appropriate technical procedures are incorporated into the project Work Plan and review procedures
- Confirm that adequate testing is called for to ensure quality delivery
- Confirm qualifications/training of personnel and verify roles/responsibilities are well-defined and communicated
- Confirm with the UXO Safety Officer (UXOSO) that the site Health and Safety Plan (HSP) adequately addresses the work operations and that applicable safety requirements have been incorporated into the plan
- Discuss methods to be employed during the field activities
- Confirm that any required permits and other regulatory requirements are met
- Verify that lessons learned during previous similar work have been incorporated as appropriate into the project procedures to prevent recurrence of past problems

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

Results of the activity are to be documented in a Preparatory Inspection Checklist specific for the DFOW.

Initial Phase

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

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

- Establish the quality of work required to properly deliver the project in accordance with contractual requirements. The UXOQCS will ensure that the field teams are aware of expectations associated with the field methods established under the Preparatory Phase by observing the initial work activities and interacting with the PM, Senior UXO Supervisor (SUXOS) and responsible subcontractors' supervisors.
- Resolve conflicts. The UXOQCS will guide the PM and responsible supervisor(s) in resolving conflicts. Should conflicts arise in establishing the baseline quality for the DFOW, the responsibility to resolve the conflict falls to the PM. Should the conflict not be resolved in a manner that satisfies the project requirements, the UXOQCS must elevate the conflict to the corporate level (i.e., the Corporate QC Manager) and issue a non-conformance report. The UXOQCS may direct a cessation of work activity when a non-conformance to a DFOW is observed. The UXOQCS will determine whether retraining of personnel, adjustment of equipment and/or plans and procedures are necessary.
- Verify with the UXOSO that the site HSP was developed to ensure that the identified hazards adequately address field conditions. Confirm that applicable safety requirements are being implemented during field activities.

Upon completion of Initial Phase activities, the results are to be documented in an Initial Phase Inspection Checklist and a QC logbook. Should results be unsatisfactory, the Initial Phase will be rescheduled and performed again.

Follow-up Phase

Completion of the Initial Phase of QC activity leads directly into the Follow-up Phase, which addresses the routine day-to-day activities at the site. Inspection and audit activities associated with each DFOW are addressed in **Section 6.3.3**. Specific concerns associated with the Follow-up Phase include:

- Inspection of the work activity to ensure work complies with the Scope of Work and Work Plan
- Evaluation and confirmation that the quality of work is being maintained at least at the level established during the Initial Phase

- Evaluation and confirmation that required testing is being performed in accordance with procedures established during the Preparatory Phase and confirmed during the Initial Phase
- Confirmation that nonconforming work is being corrected promptly and in accordance with the direction provided by the UXOQCS

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

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

Additional Audits

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

Final Acceptance Audit

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

6.3.3 Audit Procedures

The UXOQCS is responsible for verifying compliance with the QCP through audits and surveillance. A table of each DFOW auditing procedures and responsibilities is presented as **Table 6-1**. The UXOQCS is to inspect/audit the quality of work being performed for the DFOW. The UXOQCS is to verify that procedures conform to applicable specifications stated in the project work plan or other applicable guidance. Identified deficiencies are to be communicated to the responsible individual and documented in a QC logbook and Weekly QC Report. Corrective actions are to be verified by the UXOQCS and recorded in the Weekly QC Report.

Detailed QC procedures for DGM activities will be outlined in the project work plan.

6.3.4 Corrective/Preventive Action Procedures

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

Preventive Measures

While the entire QC program is directed toward problem prevention, certain elements of the program have greater potential to be proactive. Should preventive measures fail, tracking and communicating deficiencies provide a mechanism for preventing their recurrence.

Continual Improvement

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

Deficiency Identification and Resolution

While deficiency identification and resolution occurs primarily at the operational level, QC audits provide a backup mechanism to address problems that either are not identified or cannot be resolved at the operational level. Through implementation of the audit program prescribed in the QCP, the UXOQCS is responsible for verifying that deficiencies are identified, documented as prescribed herein, and corrected in a timely manner. Deficiencies identified by the UXOQCS are to be corrected by the PM and SUXOS and documented by the UXOQCS.

Corrective Action Request

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

In addition to observing actual work operations, CARs are to be reviewed during follow-up QC/QA audits. The purposes of this review are as follows: to ensure that established protocols are implemented properly; to verify that corrective action commitments are met; to ensure that corrective actions are effective in resolving problems; to identify trends within

and among similar work units; and to facilitate system root cause analysis of larger problems. Particular attention is to be given by the UXOQCS to work units that generate either an unusually large or unusually small number of CARs.

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

Deficiency and Corrective Action Tracking

Each CAR must be given a unique identification number and tracked until corrective actions have been taken and documented and the CAR is submitted to the UXOQCS for verification and closure.

6.4 QA Implementation

CH2M HILL will perform QA checks on subcontractors performing the various activities. The QC audits described in **Section 6.3** are performed by CH2M HILL quality personnel after QC has been performed by the various subcontractors on their own services and products. A QA audit may also be performed by MARCORSYSCOM to validate that the work was done in accordance with the ESS.

TABLE 6-1
Definable Features of Work Auditing Procedures
Explosives Safety Submission Amendment 3
Site UXO-22
MCB CamLej
Jacksonville, North Carolina

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

TABLE 6-1
Definable Features of Work Auditing Procedures
Explosives Safety Submission Amendment 3
Site UXO-22
MCB CamLej
Jacksonville, North Carolina

Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Site Preparation (Site Survey)	Site Manager	Verify surveyor notes are legible, accurate, and complete.	IP	O	Surveyor notes are legible, accurate and complete.	Ensure surveyor replaces deficient notes with legible, accurate and complete notes.
Site Preparation – (Vegetation Removal)	Site Manager	Verify personnel qualifications and training.	PP/IP	O	Personnel qualifications and training are appropriate.	Ensure subcontractor provides appropriately trained and qualified personnel or replace with properly trained personnel.
Site Preparation (Vegetation Removal)	Site Manager	Verify environmental controls are correct and functional.	IP/FP	O	Environmental controls are correct and functional.	Ensure that appropriate environmental controls are in place prior to proceeding with vegetation removal.
Site Preparation (Vegetation Removal)	Site Manager	Verify vegetation removal is conducted according to Work Plan.	FP	D	Verify vegetation removal is conducted according to the Field Investigation Plan (Chapter 3 of Work Plan).	Stop vegetation removal activities until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
GSV Execution	Project Manager, Project Geophysicist	Verify DQOs established in GSV Plan have been accomplished.	PP/IP	O	DQOs identified in GSV Plan have been achieved.	Continue with GSV until DQOs are achieved.
DGM Survey	Project Geophysicist	Verify DGM Survey conducted in accordance with Geophysical Investigation Plan (Appendix C) and DGM SOPs: EM61-MK2 Metal Detection Munition Response Surveys Geophysical Surveying with EM61-MK2 Configuration and Operation of the GPS Base-Station System Configuration and Operation of the GPS Rover System Field Methodology and Survey Setup	IP/FP	O/D	DGM Survey conducted in accordance with Geophysical Investigation Plan (Appendix C) and DGM SOPs.	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
DGM Survey	Project Geophysicist	Check results of QC tests performed as specified in the QCP and DGM SOPS.	FP	E	QC tests must pass in accordance with standards determined during the GSV and referenced SOPs.	If a QC test does not pass, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Survey	Project Geophysicist	Confirm that DGM survey DQOs established during GSV are being met.	FP	E	DGM survey DQOs are being met.	If the DQOs are not being met, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
DGM Data processing	Project Geophysicist	Verify data checks specified in QCP and SOPs: EM61-MK2 Data Processing and Database management Uploading and Downloading Data to the FTP Site	FP	E	Data checks must pass in accordance with standards determined during the GSV and referenced SOPs.	If a QC test does not pass, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
Reacquisition Accuracy	Project Geophysicist	Confirm that anomalies are located within a 1-meter radius of flagged location as selected by DGM.	FP	E	Anomaly located within 1-meter radius of flag	If anomalies are being located beyond 1-meter radius of flag or are not being located within 1-meter radius of the flag, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
Intrusive Investigation	UXOQCS	Verify equipment tested IAW the Work Plan	IP/FP	D	Equipment testing performed and tests passed	Repair or replace instrument.
Intrusive Investigation	UXOQCS	Verify team separation distance is as established per the ESS	IP/FP	D	Team separation distance is appropriate for work being performed	Stop activities until appropriate separation distance is being followed
Intrusive Investigation	UXOQCS	Verify that the anomaly recovered during intrusive excavations is appropriate to the amplitude of the initial anomaly detected during the DGM.	IP/FP	D	Recovered anomaly is appropriate to the amplitude of the initial anomaly detected during the DGM.	Return to the location of the anomaly excavation to determine if additional anomalies are present. If anomalies being recovered continue to be inappropriate for the amplitude as detected during the DGM, a root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
Intrusive Investigation	QC Geophysicist	QC seed items to be placed at detectable depths IAW GSV and/or Work Plan	IP/FP	E	All QC seed items in area of operation recovered.	A root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action

TABLE 6-1
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Definable Feature of Work with Auditable Function	Responsible Person(s)[1]	Audit Procedure[2]	QC Phase[3]	Freq. of Audit	Pass/Fail Criteria	Action if Failure Occurs
Intrusive Investigation	UXOQCS	Verify operations are conducted IAW ESS, Work Plan, MEC Removal SOPs, and the HSP: - Survey/Sweeps - MEC Surface Sweeps - Analog Detection and Removal Actions - DGM Anomaly Investigation - Ammunition and Explosives Transportation - Explosives Storage and Accountability - Disposal/Demolition Operations - Scrap Inspection Operations	IP/FP	D	Work performed IAW Work Plan, referenced MEC SOPs, and the HSP.	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
MPPEH/MD Management	UXOQCS	Verify inspections conducted IAW ESS and Work Plan	IP/FP	D/E	Inspections being conducted IAW Work Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
MPPEH/MD Management	UXOQCS	Verify certification conducted IAW ESS and Work Plan	IP/FP	D/E	Certification is conducted IAW Work Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
MPPEH/MD Management	UXOQCS	Verify disposal is conducted IAW ESS and Work Plan	IP/FP	D/E	Disposal is conducted IAW Work Plan	Stop activity until full compliance can be assured and any activities not performed within compliance are re-evaluated and re-performed if necessary
Site Restoration	Site Manager	Verify the damage caused by excavation and removal of anomalies is backfilled and laid to original grade and completed IAW Work Plan.	FP	O	Damage caused by excavation and removal of anomalies is backfilled and laid to original grade	Ensure that damage caused by excavation and removal of anomalies is backfilled and laid to original grade
Demobilization	Project Manager	Verify facilities-support infrastructures are dismantled and shipped to appropriate location and area is returned to original condition.	FP	O	Facilities-support infrastructures are dismantled and shipped to appropriate location and site is returned to original condition.	Ensure that all support facilities are removed and that the site is returned to original condition.
Final Project Reports and Closeout						
Site Specific Final Report preparation and approval	Project Manager	Verify all phases of environmental investigation were performed correctly and are complete.	FP	O	Investigation performed is accurate and complete.	investigation performed is accurate and complete
Archiving	GIS Manager	Verify data back-up systems are in place.	IP	O	Data back-up systems are in place	Ensure data back-up systems are in place
Project Closeout	Project Manager	Verify purchase orders have been closed out.	IP	O	Purchase orders have been closed out	Ensure purchase orders are closed out
Project Closeout	Project Manager	Verify invoices completed and approved.	IP	O	Invoices completed and approved	Ensure invoices are completed and approved

Notes:
IAW = in accordance with

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

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

SECTION 7

Detection Techniques

This section describes the detection techniques that will be employed at the MRS.

7.1 Detection Equipment, Method, and Standards

7.1.1 Analog

To assist in MEC avoidance and refining the location of the sources of geophysical anomalies at the reacquired anomaly locations, UXO technicians will use Schonstedt GA-52Cx fluxgate gradiometers, or equivalent, and/or the EM61-MK2 as described in ***Section 7.1.2****. The Schonstedt GA-52CX is a handheld analog magnetometer which detects ferrous objects and ferromagnetic minerals. The instrument provides an audible signal representing the magnitude and direction of the local magnetic field. In application, the operator sweeps the instrument back and forth in the area of interest and monitors the change in pitch of the sound emanating from the instrument. The change in pitch is the magnetometer response to a secondary magnetic field produced by a ferrous metallic item in the area of interest.*

7.1.2 Digital

DGM will be performed using the Geonics EM61-MK2 time-domain metal detector to validate that the source of the anomaly has been removed from the anomaly location. The EM61-MK2 is a high-resolution time-domain electromagnetic instrument designed to detect, with high spatial resolution, shallow ferrous and non-ferrous metallic objects. The Standard EM61-MK2 system consists of two air-cored coils, a digital data recorder, batteries and processing electronics. The EM61-MK2's transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. Each of the two spatially separated receiver coils measures these eddy currents. The EM61-MK2 offers the ability measure the eddy currents at three distinct time intervals in the bottom coil or four intervals if no top coil measurements are recorded. Earlier time gates provide enhanced detection of smaller metallic objects. Secondary voltages induced in both coils are measured in millivolts (mV). The arrangement of coils is such that there is a vertical separation of 40 cm.

Detection capabilities of the EM61-MK2 are well established and documented through various studies and empirical data across the munitions response industry. In general, industry standards (and the system's capabilities) are to detect items to a depth equal to 11 times an MEC item's diameter from the USACE's Data Item Description (DID) MR-005-05.01 (USACE, 2007). This relationship reflects the fact that MEC detection capability is reduced with greater item depth and/or decreased item size. The equation assumes worst-case orientations for ordnance items, a ratio of length to width of at least 2:1, and that the item is not thin-walled. Smaller items, such as 20 millimeter (mm) or 37mm projectiles, do not, however, fit within this standard. 20mm projectiles are difficult to detect and are rarely detected to the 11× depth (SERDP/ESTCP/ITRC, 2006).

A geophysical systems verification (GSV) will be used to demonstrate that the specific system being utilized at the specific MRS will be validated as being within industry standard quality control parameters and capable of detecting MEC items comparably to general industry demonstrated capabilities for that type of system. The performance standard for detection will be to detect MEC items 40mm or larger to a depth of 11 times their diameter.

7.2 Navigational Equipment, Method, and Standards

Depending on the conditions within MRS, anomaly locations will be reacquired either through the use of Real-Time Kinematic (RTK) Global Positioning System (GPS), conventional Total Station survey equipment, or fiducial positioning (if necessary, depending on vegetation cover). Accuracies of each system are sub-meter.

7.3 Equipment Check-Out and Calibration

Daily equipment checks will be performed over static items in an equipment check area (ECA) on the Schonstedt magnetometers to ensure the equipment is operating appropriately. Equipment checks will be documented in the system described in **Section 7.4**. Any equipment not passing system checks will be fixed or removed from site.

7.4 Data Collection and Storage

Field data will be collected using either forms or an electronic data management system using handheld devices to track and query all data for MR projects.

Regardless of the collection method, the following data will be collected:

- *Project Information (e.g., personnel, teams, instrument serial numbers, grid/transect IDs, locations)*
- *Field Team Leader Notes (e.g., safety meetings, logbooks, field requests to management)*
- *DGM and UXO Team notes [e.g., grids/transects, files, personnel, methods, instruments, GPS coordinates, descriptions of items found]*
- *DGM Data Processing Notes and Delivery Data (e.g., file names, processing performed, QC of data, delivery dates)*
- *Grid/transect Statuses (e.g., activities performed by grid/transect and by area, percents, quantities complete or remaining)*
- *Demolition Tracking*
- *QC (e.g., QC on notes, processing, data, comparison of DGM Results to intrusive results and field activities)*

All data will be reviewed by the UXOQCS for completeness and accuracy. Completed and QC-accepted forms will be maintained by the SUXOS or UXOQCS. The data will be transcribed to an electronic database and the original forms will be scanned and saved as PDF files.

SECTION 8

Response Actions

8.1 Response Technique

This section describes the techniques used to detect, recover, and dispose of any MEC/*MPPEH* discovered at the site during the project, and discusses associated elements of the field work.

MEC avoidance will be utilized for munitions response-related site preparation activities (such as vegetation removal, subsurface utility location, site survey, environmental sampling, and DGM tasks) and may also be used for construction support-related site activities. MEC avoidance includes the visual observation of the ground surface by UXO Technicians prior to and during the above tasks, and, where needed, instrument-assisted detection using an appropriate metal detector. The instrument will be used to check inside heavy vegetation (e.g., a thick bush), if necessary, where it is not possible for the UXO Technician to visually check the area.

After DGM, an intrusive investigation of the geophysical anomalies potentially representing subsurface MEC/MPPEH will be conducted where applicable. The process by which the UXO technicians intrusively investigate and recover MC/MPPEH is discussed in Section 8.1.

The specific tasks utilizing MEC avoidance and the tasks associated with the intrusive investigation are described below. Other non-specified tasks that result in subsurface soil disturbance will also be conducted under MEC avoidance.

8.1.1 MEC Avoidance Processes

Vegetation Removal

MEC avoidance will be conducted during vegetation removal. The investigation area may be cleared of vegetation where necessary to facilitate DGM or other activities. If vegetation removal is necessary, a vegetation removal subcontractor will remove vegetation and trees less than six inches in diameter to within six inches of ground surface.

Subsurface Utility Locating

Prior to initiation of intrusive sampling activities, all buried utilities will be identified within a 20-foot radius of the proposed boring location (e.g., for groundwater and subsurface soil sampling). MEC avoidance will be performed during buried utility clearance activities.

Site Survey

A Professional Land Surveyor registered in the State of North Carolina may perform a boundary survey and may place stakes within the MRS for fidicual positioning during anomaly reacquisition. The boundary survey will include placement of colored flagging on stakes along the perimeter of the site to establish work area limits for field personnel. MEC avoidance will be performed during survey activities. UXO Technicians will escort surveying personnel while onsite and will clear all locations where stakes are driven.

Digital Geophysical Mapping

Where necessary, DGM will be completed using a single coil EM61-MK2 to map geophysical anomalies that represent potential subsurface MEC within the subject site. MEC avoidance will be performed during DGM activities.

8.1.2 Munitions Response Techniques

The proposed MR techniques are described in this section.

Anomaly Acquisition

All geophysical anomalies that are identified from the DGM for excavation within the project area will be reacquired by a member of the intrusive investigation team to an exact location using a RTK GPS or conventional Total Station survey equipment. Using a polyvinyl chloride (PVC) flag with the unique identifier number recorded in indelible ink, a location 1 foot north of the actual field location of each reacquired anomaly shown on the tracking sheet will be flagged.

Subsurface Anomaly Investigation

Intrusive investigation will involve the excavation of all geophysical anomalies that are identified from the DGM as potentially representing subsurface MEC, these may be single anomalies or locations identified as potential disposal pits.

In areas where DGM cannot be conducted due to site conditions or in areas that are more feasible for 'mag and dig' operations, handheld magnetometers (Section 7.1.1) will be used to locate anomalies. The anomalies will be immediately investigated or will be marked with pin flags for later intrusive investigation.

Anomaly investigation involves soil removal to identify the source of the anomaly. The maximum depth of intrusive investigation of the anomaly/disposal pit will extend to the expected depth of soil disturbance due to construction related activities or to the maximum detection of the geophysical instrumentation as specified in Section 7.1.

Excavations in most locations will be by manual methods, with several areas utilizing earth moving equipment (EME) operating under MEC avoidance. Qualified UXO personnel will conduct mag and dig operations until the area is determined to be clear of anomalies. Once an area has been cleared of anomalies, EME may be used to aid the intrusive investigation. In areas where EME operation with MEC avoidance is not feasible, EME with shielding may be utilized (see Section 8.6).

Intrusive operations may be scheduled for off-hours, such as weekends, holidays, and evenings, due to the potential presence of active military personnel and the close proximity of major roadways (Holcomb Boulevard and Piney Green Road). In some instances, it may be necessary to conduct intrusive operations in non-daylight hours. Under these circumstances, operations will have at least 10 candles of illumination per square foot of operational area (not including personnel's own illumination devices).

Verification of Anomaly Source Removal

After performing intrusive investigation at each anomaly location, an EM61-MK2 will be used to check the location and confirm that only background amplitude responses remain. If the instrument response suggests that the anomaly source was not entirely removed the location will either be reinvestigated or a comment entered along with the investigation result indicating the reason. (For example, "Anomaly location consists of multiple small pieces of rusted barbed wire that cannot be

completely removed without removing all soils from location.") Results of intrusive investigations will also be reviewed against the original anomaly amplitudes by the CH2M HILL Project Geophysicist. For construction related activities, it is only necessary to verify that the depth of anomaly clearance is equal or greater than the depth of construction activities

8.1.3 MEC Processes

The UXO team performing this work will be composed of qualified UXO Technicians supervised by a Technician III. All MR work will be under the guidance of a SUXOS. Safety will be overseen by a UXOSO and quality control requirements will be implemented by a UXOQCS.

Excavation of *individual anomalies will be performed by qualified UXO technicians using hand-excavation tools where possible. Where hand-excavation tools are insufficient to excavate individual anomalies (e.g.,* disposal pits*, construction debris) EME may be used operating under MEC avoidance or armored for safety as described in Section 8.6.* Excavation will proceed until all *MEC/MPPEH* in the *disposal pit or construction area are* removed.

Precautions will be taken to ensure that the width of the excavation is sufficient to allow for stable side wall slopes. If necessary, shoring may be utilized. Small hand tools, such as shovels, spades, trowels, and pry bars, will be used to access potential MEC/MPPEH. Hand tools will be used for the majority of the items. The following basic technique will be used for excavation *anomalies/disposal pits*:

- Excavation will be initiated adjacent to the suspected edge of the disposal pit. The excavation will continue until the excavated area has reached a depth below the top of suspected MEC*/MPPEH* as determined by frequent inspection with a Schonstedt magnetometer or equivalent instrument.
- Using progressively smaller and more delicate tools to remove the soil carefully, the excavation team will expand the sidewall to expose the metallic item for inspection and identification without moving or disturbing the item.
- Once the item is exposed for inspection, the excavation team will determine whether the item is MEC/MPPEH.
- Excavation will continue until all *MEC/*MPPEH in the disposal pit is removed*; or until the depth of construction support has been reached.*
- Following excavation, the area will be rechecked with the Schonstedt GA-52Cx or equivalent instrument to ensure that other items were not hidden beneath the removed item. The excavation team will then annotate the results of the excavation on the dig sheet, and backfill the hole*; or leave as is for construction to continue.*
- MEC will not be shipped over public highways from this project site.

Onsite MEC Destruction and Munitions-related Scrap Metal Certification and Verification

This task includes destruction of MEC recovered during site activities and the inspection and certification of MD*AS* that it is free from explosives hazards. Additional discussion on this task is provided in **Section 8.4**, MEC and MPPEH Disposition Processes.

8.1.4 Munitions Handling Equipment

Not applicable.

8.2 Operational Risk Management

8.2.1 Process

All MEC items will be disposed of by electrically initiated detonation utilizing engineering controls designed in compliance with DDESB TP-16, Chapter 6, Determining the fragment hazards due to detonation of a buried munition, and HNC-ED-CS-S-98-7, Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonation of Munitions. MEC items will be disposed of using design mode initiation or a safety factor of 33% will be applied to the explosive arcs.

8.2.2 Process Outline and Preliminary Hazards List Associated with Process

Steps involved in the process of dealing with MEC are outlined in the following text along with preliminary hazards associated with each step of the process. **Table 8-1** presents the Operations Hazard Analysis Matrix in accordance with OPNAVINST 3500.39A.

TABLE 8-1
Operational Hazard Analysis Matrix.

		Mishap Probability			
		A	**B**	**C**	**D**
Hazard Severity	**I**	1	1	2	3
	II	1	2	3	4
	III	2	3	4	5
	IV	3	4	5	5

Mishap Probability:	**Hazard Severity:**	**Risk Assessment Codes:**
A Likely to occur immediately	**I** May cause death	**1** Critical
B Probably will occur in time	**II** May cause severe injury	**2** Serious
C May occur in time	**III** May cause minor injury	**3** Moderate
D Unlikely to occur	**IV** Presents a minimal threat	**4** Minor
		5 Negligible

The Hazard Severity assessment of the worst credible consequence which can result as a result of the hazard posed by the process identified in **Section 8.1** is judged as **"Category I" - hazard may cause death**. This determination was based on the possibility of accidental detonation of MEC or donor explosives while MEC is being prepared for demolition.

The Mishap Probability that a hazard will result in a mishap or loss for this site is recommended to be judged as "Category D" - unlikely to occur. All MEC and explosives operations will be conducted by experienced and qualified UXO technicians following established safety protocols.

The Operational Hazard Analysis Matrix results in a RAC of **"3" – Moderate Risk** – for the combination of Hazard Severity and Mishap Probability recommended above.

8.3 MEC Hazard Classification, Storage and Transportation

All MEC/MPPEH will be classified as class/division (C/D) 1.1 explosives. All MEC that is found during the course of the investigation within the MRS will be demilitarized through controlled detonation on-site. No MEC will be transported *off-site*.

To provide operational flexibility, a non-fragmenting MEC/MPPEH storage area, utilizing an ATF Type II magazine, may be utilized if it is determined that operations will proceed more efficiently with this storage capacity on-site. If the non-fragmenting MEC/MPPEH storage area is utilized, then non-fragmenting MEC/MPPEH that is safe to move may be moved to the MEC/MPPEH Storage Area. Non-fragmenting MEC/MPPEH may be stored in a locked, secured, ATF Type II magazine at the non-fragmenting MEC/MPPEH Storage Area shown on ***Figure 2-1.*** *This container will be labeled "Non-Fragmenting MEC/MPPEH". EZs for the non-fragmenting MEC/MPPEH Storage Area are based on a NEW of 30 pounds of C/D 1.1 explosives. Therefore, the IBD EZ associated with the non-fragmenting MEC/MPPEH collection area is 200 feet, while the PTR has an EZ of 120 feet (OP 5 Paragraphs 14-11.11.3.c(2) and 7-6.2.1.6, Table 7-9, and Table 7-15 [NAVSEA, 2004]). The magazine will be grounded for lightning protection in accordance with OP-5, Chapter 6 (NAVSEA, 2007) and secured by a 10x10x10 ft fence.*

MPPEH may be collected at temporary MPPEH collection areas within each active grid or transect. If temporary collection points are used, the MPPEH will be moved to the sited MPPEH Collection Point upon conclusion of work at the grid or transect, or at the end of the work day, whichever is sooner. MPPEH will not be left on the grid or transect overnight and the appropriate ESQD arcs will remain in effect until the MPPEH has been removed from the grid or transect.

MPPEH will be stored in a locked and secured container at the MPPEH Collection Point shown on ***Figure 2-1****. This container will be labeled "MPPEH". EZs for the MPPEH Collection Point are based on a NEW of 1 pound of C/D 1.1 explosives. Therefore, the IBD EZ associated with the MPPEH collection area is 291feet, while the PTR has an EZ of 175 feet (OP 5 Paragraphs 14-11.11.3.c(2) and 7-6.2.1.6, Table 7-9, and Table 7-15 [NAVSEA, 2004]). MPPEH may also be stored in the MEC/MPPEH Storage Area (magazine). The non-fragmenting MEC/MPPEH Storage Area and MPPEH Collection Point will be separated by a minimum of 34 ft (K11) (OP-5, Table 7-13, [NAVSEA, 2007]).*

A separate locked and secured container will be used for storage MDAS. This container will be labeled "MDAS" and will be separated from the MEC/MPPEH and MPPEH Storage containers by a minimum of 50 ft. Items in the MDAS container will only contain items that have undergone two 100% visual inspections by qualified personnel (see Section 8.4.2) and have been documented as not presenting an explosive hazard. Chain of custody will be maintained on the MDAS container until it is transported off-Base.

8.4 MEC, MPPEH, and Non-MPPEH Disposition Processes

8.4.1 Inspection and Segregation

A systematic approach will be used for collecting, inspecting, and segregating site debris. The approach is designed so that materials undergo a continual evaluation/inspection process from the time they are excavated until the time they are removed from the site.

Segregation procedures begin at the time the metal item is discovered by the UXO technician. At this point, the UXO technician makes a preliminary determination as to the classification of the item *into one of three categories and the UXO Technician III confirms the item to be MEC, MPPEH or other debris.*

8.4.2 Inspection, Certification, and Verification

8.4.2.1 MEC

MEC will be disposed of by explosive demolition. If the item is not safe to move, it will be blown in place (BIP). If the item is safe to move, it may be may be transferred to another location within the MRS for demolition, or it may be stored at the non-fragmenting MEC/MPPEH storage area.

For MEC that is not safe to move and must be BIP, every effort will be made to complete explosive demolition operations by the end of the day. If explosive demolition operations cannot be completed, guards will be posted to secure the item, and the disposal will occur as soon as possible.

Demolition operations will be conducted in accordance with EODB 60A 1-1-31 and OP-5 Volume I (NAVSEA, 2007). If engineering controls are used, they will conform to DDESB TP-16 Revision 2 and the United States Army Corps of Engineers, Huntsville Center (USAESCH), Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7, dated August 1998 and approved by DDESB on February 23, 1999.

Because of the quantity of potential 3.5-inch rockets, these items determined to be MEC/MPPEH may be consolidated for detonation. Using engineering controls, based on the BEM output that is included as Attachment 3, the MSD for the intentional detonation of a consolidated intentional demolition shot of five (5) M28 HE rockets is 293 feet. An additional safety factor of 33% will be applied to the MSD for intentional detonation of the consolidated demolition shot using engineering controls, resulting in an MSD of 390 feet for intentional detonation using engineering controls.

Donor explosives will not be stored on-site. A local vendor will provide explosives on an on-call basis and will remove all unused explosives from the site following demolition activities. The explosives vendor will follow all applicable United States Department of Transportation (DOT) regulations regarding the transportation of explosives, and the vendor's employees will have the proper training and certifications. The contractor (or their UXO subcontractor) will not transport explosives. The contractor will coordinate with the installation's Explosives Safety Officer to obtain proper approvals to bring civilian explosives onto the installation.

Prior to intentional detonation, the exclusion zone will be marked off and evacuated. Appropriate personnel will be notified to block any roads that may be impacted.

8.4.2.2 MPPEH Disposition

Due to the high volume of non-fragmenting MPPEH at the MRS, a MPPEH processing shredder/chop saw will be sited for the non-explosive demolition of non-fragmenting MPPEH and other debris, as necessary. The ESQD arcs for the shredder/chop saw operation will be based on a MGFD for a M29 practice 3.5-inch rocket with a NEW of 0.44 pounds. A minimum distance of 19 feet will be maintained between the shredder and essential personnel based on the K24 value, and 250 feet between the shredder/chop saw and non-essential personnel based on the K328 value. The essential personnel at the K24 distance will be behind shielding equivalent to the shielding described in Section 8.6. ***Figure 2-1*** *shows the location of the shredder/chop saw operations.*

MPPEH will be visually inspected and independently re-inspected for explosives hazards in accordance with the requirements of DoDI 4140.62 (DoD, 2008), DoD 4160.21-M, Chapter 4, Paragraph B (DoD, 1997a), and OP-5 Volume 1, Chapters 13–15 (NAVSEA, 2004).

Only UXO-qualified personnel will perform these inspections. A UXO Technician III will perform the 100% inspection and document that the MPPEH is free of explosive hazards. Per OP-5, Section 13-15.7.2 (NAVSEA, 2007) and/or DoDI 4140.62 (DoD, 2008), the UXOQCS will conduct the re-inspection and document that the MPPEH is free of explosive hazards. With these two visual inspections, the MPPEH becomes MDAS.

If necessary, demilitarization of the MDAS will be conducted. DD Form 1348-1 (series) will be used as 100% inspection/100% re-inspection documentation. All DD Form 1348-1 (series) forms will clearly show the following information in typed or printed letters:

- *Name of SUXOS and the Government representative*
- *Organization*
- *Two signatures not in the same chain of command (i.e., UXO Technician III and the UXO Quality Control Specialist [UXOQCS])*
- *Contractor's office*
- *Field office phone number(s) of the persons certifying and verifying the MDAS*
- *Basic material content (type of metal - for example, steel or mixed)*
- *Estimated weight*
- *Unique identification of each sealed container*
- *Location where MDAS was obtained*

Seal identification, if different from the unique identification of the sealed container.

- As part of the transfer of MDAS to an off-Base facility for final disposition, the following statement will be entered on each DD Form 1348-1 (series) and will be signed by the SUXOS and the UXOQCS:

  "*This certifies that materially potentially presenting an explosive hazard listed has been 100 percent properly inspected and to the best of our knowledge and belief, is inert and/or free of explosives or related materials.*"

8.5 EZ Access

In general, access to the EZ is limited to personnel essential to the operation being conducted. However, under specific conditions and on a case-by-case basis, authorized visitors may be granted access to the EZ when operations are being conducted. In addition to general MRS access requirements, formal written procedures addressing EZ access, including authorized visitor access, must be developed in support of response actions involving MEC and must address the following requirements:

- Access to an EZ while MR operations are occurring is limited to essential personnel and authorized visitors.
- The UXOSO is responsible for conducting an operational risk management assessment in accordance with OPNAVINST 3500.39 (series) prior to initiating response actions involving MEC. In addition, the UXOSO must determine the maximum number of persons (essential personnel and authorized visitors) that can be in the EZ at one time. The ratio of UXO-qualified escorts to visitors will be determined by the UXOSO based on this site-specific operational risk analysis.
- Based on the risk posed by the MR operation underway, the UXOSO may determine that access to the EZ is unsafe for visitors. However, every effort should be made to accommodate the authorized visitor's needs.
- With concurrence of the responsible PM, the UXOSO will grant EZ access to authorized visitors. Access to the site will be based upon the operational risk analysis of the scheduled MEC operations and availability of escorts, as well as a demonstrated visitor need and subsequent completion of visitor safety briefings.
- Persons requiring access to the EZ must demonstrate a legitimate need for access and obtain authorization from the responsible project manager and UXOSO. At a minimum, the request for authorization will include: names of the individual requesting access, the identification of emergency contacts for these individuals, purpose of visit; task(s) to be performed; and rationale to support EZ access. Persons requesting access must submit their request to the responsible project manager and UXOSO prior to the proposed date of the site visit. This advance notice will allow time for the UXOSO to support the visit request by assigning a qualified escort, conducting an operational risk analysis on the operations planned for the date of the site visit, and preparing a visitor site-specific safety briefing for the planned operations.
- Prior to entry, all authorized visitors must receive a site-specific safety briefing describing the specific hazards and safety procedures to be followed within the EZ for

operations underway that work day. Each authorized visitor must acknowledge receipt of this briefing in writing.

- Authorized visitors to the EZ must be escorted at all times by a UXO-qualified person.
- Any authorized visitor that violates the established safety procedures will be immediately escorted out of the EZ and/or site for their own protection and to protect essential personnel working at the site.

8.6 Mechanized MEC Processing Operations

EME conducted without MEC avoidance will be required to use shielding and TSD as described below.

Mechanized MEC processing operations utilizing EME may be conducted to assist with the subsurface intrusive investigation of disposal pits (including at depths under the water table) or with construction operations where EME is utilized without MEC avoidance or prior MEC clearance. These operations are sited as high input MEC processing operations (DoD 6055.09-M-V7). EME will be equipped with shielding, the operator will maintain a K24 distance away from the excavation area, and the non-essential personnel/public will be at a distance of the MSD (1,579 ft).

The EME will be equipped with shielding to prevent the penetration of a fragment from a Projectile 81-mm HE M43. To prevent perforation, the frontal transparent shield will be constructed out of one of the following materials with the stated minimum thicknesses (as taken for DDESB, Fragmentation Data Review Form Database Updated 9/30/2010):

- *Lexan – 5.05inches*
- *Plexi-glass – 3.49 inches*
- *Bullet Resistant Glass – 2.87 inches*

In addition to the shielding, the EME operator will maintain the required (calculated) K24 separation distance (26 feet) or greater from the point of the excavation to protect the EME operator from blast overpressure from a Projectile 81-mm HE M43.

8.7 Explosives Soil

Not applicable.

8.8 Contaminated Buildings

Not applicable.

SECTION 9

Environmental, Ecological, Cultural and Other Considerations Related to Management of MEC

Section 121(d) of CERCLA requires that remedial actions implemented at CERCLA sites attain any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be Applicable or Relevant and Appropriate Requirements (ARARs). Potential ARARs for the MEC response action at the site will be developed as part of the planning process and will be discussed in detail in the Work Plan (CH2M HILL, under development). Sites 6 and 82, a part of Operable Unit 2, are under a Record of Decision. Land use controls for soil intrusive activities are in place for the MRS. These controls prohibit construction at the Sites. Intrusive soil activity must be performed by health and safety trained staff utilizing appropriate personal protective equipment (Level D).

No sensitive habitats, threatened or endangered species, or cultural sites are known or suspected to lie within the MRS boundary.

SECTION 10

Technical Support

This section summarizes the UXO contractor personnel qualifications for the project. EOD support is not anticipated to be required.

10.1 EOD, UXO Contractor, or Other Munitions Response Personnel

All MEC operations personnel will be qualified and certified in accordance with MCO 8023.3A, *Personnel Qualification and Certification Program for Class V Munitions and Explosives*; terms outlined by DOL Employment Standards Administration Wage Hour Division for UXO Personnel; and DDESB TP-18, *Minimum Qualifications for UXO Technicians and Personnel*. CH2M HILL and their UXO subcontractor responsibilities will include performing excavation, demilitarization and disposal activities. Base EOD will be notified if potential MEC is found and base EOD are available on-call as needed to assist CH2M HILL.

10.2 Physical Security

Access to the MRS will be controlled during all intrusive and demolition operations by CH2M HILL or UXO subcontractor personnel stationed on the roads leading into the site. CH2M HILL will coordinate site control issues with MCB Camp Lejeune facility and security personnel prior to the start of field activities. No explosives will be stored onsite.

SECTION 11

Residual Risk Management

11.1 Land Use Controls

Following completion of MEC removal activities, the Supplemental Investigation of groundwater contamination will proceed. Soil intrusive land use controls are currently in place as part of the Operable Unit 2 Record of Decision.

11.2 Long-term Management

Long-term site management decisions will be made following the conclusion of the MEC removal and the Supplemental Investigation.

SECTION 12

Safety Education Program

A safety education program is not considered applicable for this project.

SECTION 13

Stakeholder Involvement

The only stakeholders for the intrusive investigation and removal of MEC at this MRS are U.S. Marine Corps and NAVFAC. Regulatory agencies are not involved in the MRP activities. The USEPA and NCDENR are involved in the supplemental groundwater investigation conducted under the CERCLA process.

SECTION 14

Contingencies

There are currently no anticipated contingencies required.

SECTION 15

References

The following references were consulted during the preparation of this ESS. Not all are cited in the text.

Baker Environmental, Incorporated (Baker). 1993. Remedial Investigation Report for Operable Unit No. 2(Sites 6 and 9) Marine Corps Base Camp Lejeune, North Carolina. Final.

CH2M HILL. 2007. *Draft Site-Specific Work Plan Addendum for Environmental Investigation, Marine Corps Base Camp Lejeune, Jacksonville, North Carolina*. Prepared for Department of the Navy, Naval Facilities Engineering Command. December.

Department of Defense Explosive Safety Board (DDESB). *TP-18, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel.* Current version.

DDESB. October 17, 2005. Technical Paper 16, Revision 2, *Methodologies for Calculating Primary Fragment Distances.*

Department of Defense (DOD). 1991. *DOD 4160.21-M-1, Defense Demilitarization Manual*. October 21.

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Marine Corps Order 8023.3A. 2002. Personnel Qualification and Certification Program for Class V Munitions and Explosives.

Naval Facilities Engineering Command (NAVFAC). 1990. *P-397, Structures to Resist the Effects of Accidental Explosions.*

Naval Ordnance Safety and Security Activity (NOSSA). 2007. Instruction 8020.15A, *Explosives Safety Review, Oversight, and Verification of Munitions Responses*.

Naval Sea Systems Command (NAVSEA). 1994. *Publication SW060-AA-MMA-010, Volumes I and II, Technical Manual Explosive Ordnance Disposal Procedures*, *Naval Explosive Ordnance Disposal Technology Center.* Revised. May.

NAVSEA. 2001. *SWO20-AF-ABK-010, Motor Vehicle Driver and Shipping Inspector's Manual for Ammunition, Explosives, and Related Hazardous Materials*. January 15.

NAVSEA. 2004. *SW023-AG-WHM-010, On-Station Movement of Ammunition and Explosives by Truck and Railcar*

NAVSEA. 2006. *Ordnance Publication 5 Volume 1, Ammunition and Explosives Ashore: Safety Regulations for Handling, Storing, Production, Renovation, and Shipping of Ammunition and Explosives Ashore, Seventh Revision.*

OHM Remediation Services Corporation, 1997. Final Contractor's Closeout Report for Sites 6 and 82 Source Removal, Operable Unit No. 2, MCB Camp Lejeune, Jacksonville, NC.

SERDP/ESTCP/ITRC. 2006. *Survey of Munitions Response Technologies*

U.S. Army Corps of Engineers (USACE). 2007. *Engineering and Design, Ordnance and Explosives Response* (EM 1110-1-4009). June 15.

U.S. Army Corps of Engineers, Engineering and Support Center, Huntsville (USAESCH). 1998. *Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonation of Munitions* (HNC-ED-CS-S-98-7). August.

U.S. Bureau of Alcohol, Tobacco, and Firearms (ATF) and U.S. Department of the Treasury. 2007. *ATF P 5400.7, ATF Explosives Laws and Regulations. November.*

U.S. Department of the Navy, Chief of Naval Operations. 1999. *OPNAVINST 8020.14, Department of the Navy Explosives Safety Policy.*

Attachment 1
Site Approval Request
and NAVFAC Form 11010/31

ATTACHMENT 1

NAVSEA OP 5, "Ammunition and Explosives Safety Ashore," Requirements of Section 8-1.2.5, Final Safety Review

a. Anticipated personnel limits for Site 6 and 82.

Munitions Response/On-Site support: Up to 4 proposed contractor UXO personnel conducting excavation may be exposed during munitions operations. All non-essential personnel will be evacuated from within the minimum separation distance (MSD) for non-essential personnel during munitions response intrusive operations.

Detonation Area: Up to 2 proposed contractor UXO personnel conducting controlled detonation may be exposed during munitions operations. All nonessential personnel will be evacuated from within the MSD for non-essential personnel for detonation operations.

MPPEH Holding Area: Up to 4 proposed contractor UXO personnel may be present within the MPPEH holding area during MPPEH handling operations.

b. General details regarding dividing walls, vent walls, fire walls, roofs, operational shields, barricades, exits, types of floor finish, fire protection system installations, electrical systems and equipment, ventilation systems and equipment, hazardous waste disposal systems, lightning protection systems, all grounding systems, process equipment, and auxiliary support structures as well as general materials of construction unless approved definitive drawings are being used.

Not applicable.

c. A brief summary of the design procedures if engineered protection is used to reduce quantity-distance requirements. This summary shall include a statement of the design objectives in terms of protection categories (as defined in NAVFAC P-397) to be attained, explosives quantities involved, design loads applied, material properties and structural behavior assumptions, references, and sources of methods used. Detailed calculations need not be submitted. Design of explosion resistant facilities shall be accomplished by an organization or individual experienced in the field of structural dynamics using design procedures accepted by professionals in the field.

Engineering controls to be used during intentional detonation operations will conform to DDESB Technical Paper 16, Revision 1 and U.S. Army Corps of Engineers, Engineering and Support Center, Huntsville, *Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7* dated August 1998, and approved by DDESB February 23, 1999. Intentional detonations involving the use of sandbags as an engineering control will not exceed 11.4 lb. NEW HD 1.1.

d. Information on the type and arrangement of explosives operation or chemical processing equipment.

All MEC items will be disposed of by controlled detonation methods. The danger area will be evacuated. Disposal will be conducted in accordance with EODB 60A 1-1-31, OP-5 Volume I. Engineering controls used for intentional detonations will conform to DDESB TP-16 Revision 2 and USAESCH, *Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7* dated August 1998 and approved by DDESB on February 23, 1999.

A local vendor will provide explosives on an on-call basis and will remove all unused explosives from the site following demolition activities. No explosives will be stored onsite. The explosives vendor will follow all applicable DOT regulations regarding the transportation of explosives, and the vendor's employees will have the proper training and certifications. CH2M HILL and its MEC subcontractor will not transport explosives. CH2M HILL will coordinate with the installation's Explosives Safety Officer to obtain proper approvals to bring civilian explosives onto the installation.

e. Topography map with appropriate contours when terrain features are considered to constitute natural barricading, or when topography otherwise influences layout.

Not applicable. The MRA has little topographic relief. Terrain and topographic features are not expected to influence site operations or layout.

f. A hazard analysis of risk performed in accordance with paragraph 7-7.3 shall be included.

Operational Hazard Analysis Matrix.

		Mishap Probability			
		A	**B**	**C**	**D**
Hazard Severity	**I**	1	1	2	3
	II	1	2	3	4
	III	2	3	4	5
	IV	3	4	5	5

Mishap Probability:	**Hazard Severity:**	**Risk Assessment Codes:**
A Likely to occur immediately	**I** May cause death	**1** Critical
B Probably will occur in time	**II** May cause severe injury	**2** Serious
C May occur in time	**III** May cause minor injury	**3** Moderate
D Unlikely to occur	**IV** Presents a minimal threat	**4** Minor
		5 Negligible

The Hazard Severity assessment of the worst credible consequence which can result as a result of the hazard posed by the process identified in Section8.1 is judged as **"Category I" - hazard may cause death**. This determination was based on the possibility of accidental detonation of MEC or donor explosives while MEC is being prepared for demolition.

The Mishap Probability that a hazard will result in a mishap or loss for this site is recommended to be judged as "Category D" - unlikely to occur. All MEC and explosives operations will be conducted by experienced and qualified UXO technicians following established safety protocols.

The Operational Hazard Analysis Matrix results in a RAC of **"3" – Moderate Risk** – for the combination of Hazard Severity and Mishap Probability recommended above.

g. When chemical agents are involved, information regarding personnel protective clothing and equipment, treatment of effluent and waste materials to ensure absence of chemical agents, adequacy of medical support, average wind speed and direction, other support facilities pertinent to chemical safety, warning and detection systems, and hazard analysis.

Not applicable. Chemical agents are not anticipated at this MRA.

h. Explanation of any deviations from pertinent safety standards due to local conditions.

Not applicable. Local conditions are not anticipated to require any deviations from pertinent safety standards.

i. Explanation of any changes that may have occurred with this project or with any of the previous information submitted since submission of the preliminary site approval request.

Not applicable. No previous site approval requests have been submitted.

j. Lightning protection design drawings and associated zone of protection diagrams showing the masts and the building(s) protected, in plan and elevation views.

The MEC/MPPEH storage magazine (if used) will be grounded for lightning protection in accordance with OP-5, Chapter 6 (NAVSEA, 2007).

Attachment 2
Fragmentation Data Sheets

Fragmentation Data Review Form

Database Revision Date 9/30/10

Category:	Surface-Launched HE Rounds	DODIC:	C225
Munition:	81 mm M43		
Case Material:	Steel, Mild	Date Record Created:	9/21/2004
		Record Created By:	MC
Fragmentation Method:	Naturally Fragmenting	Last Date Record Updated:	3/10/2010
Secondary Database Category:	Mortar	Individual Last Updated Record:	SDH
Munition Case Classification:	Robust	Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	1.23
Diameter (in):	3.1890
Maximum Fragment Weight (Intentional) (lb):	0.1096
Design Fragment Weight (95%) (Unintentional) (lb):	0.0377
Critical Fragment Velocity (fps):	3776

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	209
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1579
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1215

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	1.230
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	19
Public Traffic Route Distance (2.3 psi); K24 Distance:	26
Inhabited Building Distance (1.2 psi), K40 Distance:	43
Intentional MSD (0.0655 psi), K328 Distance:	351

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	6.61	3.98
Mild Steel:	1.27	0.77
Hard Steel:	1.04	0.63
Aluminum:	2.59	1.60
LEXAN:	6.62	5.05
Plexi-glass:	4.99	3.49
Bullet Resist Glass:	4.22	2.87

Required Sandbag Thickness

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	1.230
Kinetic Energy 10^6 (lb-ft²/s²):	0.7813
Required Wall & Roof Sandbag Thickness (in)	24
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	1.230
Kinetic Energy 106 (lb-ft²/s²):	0.7813
Water Containment System:	1100 gal tank
Minimum Separation Distance (ft):	200

Item Notes

Distribution authorized to the Department of Defense and U.S. DoD contractors only for Administrative-Operational Use (17 October 2002). Other requests shall be referred to the Chairman, Department of Defense Explosives Safety Board, Room 856C, Hoffman Building I, 2461 Eisenhower Avenue, Alexandria, VA 22331-0600.

Fragmentation Data Review Form

Database Revision Date 9/30/10

Category:	Surface-Launched HE Rounds	DODIC:	H600
Munition:	3.5 in M28A2 Rocket		
Case Material:	Steel, Mild	Date Record Created:	9/21/2004
		Record Created By:	MC
Fragmentation Method:	Naturally Fragmenting	Last Date Record Updated:	3/8/2010
Secondary Database Category:	Rocket	Individual Last Updated Record:	SDH
Munition Case Classification:	Robust	Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	1.88
Diameter (in):	3.5000
Maximum Fragment Weight (Intentional) (lb):	0.0054
Design Fragment Weight (95%) (Unintentional) (lb):	0.0007
Critical Fragment Velocity (fps):	9261

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	157
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	772
MFD-V [Maximum Fragment Distance, Vertical] (ft):	628

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	2.181
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	23
Public Traffic Route Distance (2.3 psi); K24 Distance:	31
Inhabited Building Distance (1.2 psi), K40 Distance:	52
Intentional MSD (0.0655 psi), K328 Distance:	425

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	5.80	2.43
Mild Steel:	0.96	0.42
Hard Steel:	0.79	0.35
Aluminum:	2.08	0.96
LEXAN:	5.15	3.10
Plexi-glass:	3.56	1.81
Bullet Resist Glass:	2.82	1.33

Required Sandbag Thickness

TNT Equivalent (Impulse):	1.16
TNT Equivalent Weight - Impulse (lbs):	2.181
Kinetic Energy 10^6 (lb-ft²/s²):	0.2316
Required Wall & Roof Sandbag Thickness (in)	20
Expected Maximum Sandbag Throw Distance (ft):	125
Minimum Separation Distance (ft):	200

Water Containment System and Minimum Separation Distance:

TNT Equivalent (Impulse):	1.16
TNT Equivalent Weight - Impulse (lbs):	2.181
Kinetic Energy 106 (lb-ft²/s²):	0.2316
Water Containment System:	5 gal carboys/ inflatable pool
Minimum Separation Distance (ft):	264/200

Item Notes

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Attachment 3
Buried Explosion Module

BURIED EXPLOSION MODULE

(Version 6.2)

Based on DDESB Technical Paper 16 Revision 3, EARTHEX software, and NSWCDD/TR-92/196

(ENGLISH UNITS)

SELECT BURIAL MEDIUM	Soil	SELECT ITEM DESCRIPTION	
SELECT SOIL TYPE *(See TP 16, Revision 3 for soil details)*	Dry Sand	OTHER (User Defined)	

USER DEFINED FRAGMENT CHARACTERISTICS

	FRAGMENT WEIGHT (lbs)	0.005
ENTER	FRAGMENT VELOCITY (ft/s)	9,261.00
	SINGLE ITEM TNT EQUIVALENT WEIGHT (lbs)	2.18

ENTER TOTAL NUMBER OF ITEMS	5
ENTER TOTAL WEIGHT OF ALL DONOR CHARGES (lbs)	1.00

SINGLE ITEM NEW (lbs)	2.18
SINGLE ITEM MAXIMUM FRAGMENT WEIGHT (lbs)	0.0054
FRAGMENT WEIGHT USED IN CALCULATIONS (lbs)	0.0054
SINGLE ITEM MAXIMUM FRAGMENT VELOCITY (ft/s)	9,261
FRAGMENT VELOCITY USED IN CALCULATIONS (ft/s)	9,261
TOTAL TNT WEIGHT USED (lbs)	12.21

ENTER DEPTH OF BURIAL (ft)	3.00
ENTER HORIZONTAL RANGE (for pressure calculation) (ft)	600

CRATER OR CAMOUFLET?

CRATER

TRUE CRATER RADIUS (ft)	5.42
MAXIMUM SOIL EJECTA DISTANCE (ft)	293

FRAGMENT EXIT VELOCITY (ft/s)	1.6	FRAGMENT LAUNCH ANGLE (°)	29.0
MAXIMUM FRAGMENT DISTANCE (ft)	11.0		

*Distance at which pressure is 0.066 psi=	Blast Withdrawal Distance (buried/undex) (ft)*		118.5
Open Air Withdrawal Distance, K328 (ft) 755.2	Fragment Hazard Distance (ft)		292.9
	Pressure at Fragment Hazard Distance	(psi)	0.0235 ****
		(dB)	138.2
	Pressure at Range Entered	(psi)	0.0104
		(dB)	131.1

****Hazard range out of limits--extrapolated