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ENGINEERING EVALUATION COST ANALYSIS D 9 SKEET RANGE SOIL REMOVAL

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Final

Engineering Evaluation/Cost Analysis
D-9 Skeet Range Soil Removal

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

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Executive Summary

This report presents an Engineering Evaluation/Cost Analysis (EE/CA) for a Non-time-critical Removal Action (NTCRA) at the D-9 Skeet Range, at Marine Corps Base Camp Lejeune (MCB CampLej) in Onslow County, North Carolina. The D-9 Skeet Range is located west of Holcomb Boulevard and north of Parachute Tower Road and encompasses approximately 187 acres. This EE/CA is intended to address the impacted surface soil in the vicinity of the theoretical shot fall zone at the D-9 Skeet Range.

Previous site investigations identified potential unacceptable risks to human health and the environment posed by exposure to lead and localized polycyclic aromatic hydrocarbons (PAHs) in impacted surface soil in the vicinity of the theoretical shot fall zone. The removal area is approximately 16 acres to a depth of 1 foot below ground surface (bgs), with an estimated volume of 25,835 cubic yards (yd^3). The purpose of this EE/CA is to develop and analyze removal action alternatives for contaminant mass removal or treatment at the identified removal area. Five alternatives were evaluated:

1. Alternative 1—No action
2. Alternative 2—Excavation and Offsite Disposal
3. Alternative 3—Particle Separation and Backfill
4. Alternative 4— *In Situ* Soil Stabilization with Excavation and Offsite Disposal
5. Alternative 5—*In Situ* Soil Stabilization

Each technology was evaluated based on effectiveness, implementability, and cost, as summarized in **Table E-1.** The technology to be implemented for the D-9 Skeet Range NTCRA will be chosen by the Partnering Team, based on information presented in this EE/CA. The Partnering Team is comprised of representatives from MCB CamLej, Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division, the North Carolina Department of Environment and Natural Resources (NCDENR), and the United States Environmental Protection Agency (USEPA) Region 4.

TABLE E-1
Summary of Technical Evaluation

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Excavation and Offsite Disposal	Alternative 3 Excavation with Particle Separation and Backfill	Alternative 4 *In Situ* Soil Stabilization with Excavation and Offsite Disposal	Alternative 5 In Situ Soil Stabilization
Effectiveness					
Overall Protection of human health and the environment	Does not meet RAOs	Meets RAOs through removal of soil from the site	Meets RAOs through removal of the lead and PAHs in soil	Meets RAOs through removal of the soil from the site	Partially meets RAOs. Lead mobility will be significantly decreased, but risks to human health and ecological receptors will remain.
Compliance with ARARs	Does not trigger ARARs	Implementation would require compliance with location- and action-specific ARARs. Includes requirements relating to stormwater runoff, dust emissions, management of hazardous and non-hazardous waste, and on-site staging piles.	Implementation would require compliance with location-, action- and chemical-specific ARARs. Includes requirements relating to stormwater runoff, dust emissions, management of hazardous and non-hazardous waste, on-site staging piles, and land disposal.	Implementation would require compliance with location- and action-specific ARARs. Includes requirements relating to stormwater runoff, dust emissions, management of non-hazardous waste, and on-site staging piles.	Implementation would require compliance with location- and action-specific ARARs. Includes requirements relating to stormwater runoff, dust emissions, and management of non-hazardous waste.
Long-term effectiveness and permanence	Not effective in the long-term.	All soil with COCs above RAOs removed from the site. Residual site risk is acceptable.	Lead and PAHs removed from the soil. Residual site risk is acceptable. Lead particles reclaimed through particle separation are recycled.	All soil with COCs above RAOs removed from the site. Residual site risk is acceptable	All soil with PAHs above RAOs will be removed from the site. Lead will remain at the site, but will be in a form that limits leaching. Risks to human health and ecological receptors will remain. LUCs will be required indefinitely.
Reduction of toxicity, mobility or volume through treatment	Does not reduce toxicity, mobility, and volume.	Reduces toxicity, mobility, and volume through soil removal. Contaminants are not destroyed, but rather moved to an appropriate permitted disposal facility.	Reduces toxicity, mobility, and volume through removal of the COCs from the soil. Treated soil is used as backfill and lead and PAHs are recycled or disposed of in accordance with appropriate regulations.	Reduces toxicity, mobility, and volume through soil removal. Stabilization reduces lead mobility in soil. Contaminants are not destroyed, but rather moved to an appropriate permitted disposal facility.	Reduces toxicity, mobility, and volume of PAHs through soil removal. Eliminates mobility of lead, but does not address toxicity or volume. Lead remains in place.

TABLE E-1
Summary of Technical Evaluation

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Excavation and Offsite Disposal	Alternative 3 Excavation with Particle Separation and Backfill	Alternative 4 *In Situ* Soil Stabilization with Excavation and Offsite Disposal	Alternative 5 In Situ Soil Stabilization
Short-term effectiveness	Not effective in the short-term.	Increased risks to site workers and the nearby community due to construction activity. Rail will be used to minimize truck traffic. Potential dust emission issues associated with excavation requiring engineering controls. Action will require ten weeks in the field to complete.	Increased risks to site workers and the nearby community due to construction activity. Potential dust emission issues associated with excavation, mechanical screening, and particle separation process requiring engineering controls. Action will require 26 weeks in the field to complete.	Increased risks to site workers and the nearby community due to construction activity. Increased truck traffic. Potential dust emission issues associated with excavation and reagent mixing requiring engineering controls. Action will require ten weeks in the field to complete	Increased risks to site workers due to construction activity. Potential dust emission issues associated with reagent mixing. Action will require six week in the field to complete
Implementability					
Technical Feasibility	Feasible	Excavation is a standard and reliable technology. Monitoring the technical aspects easily done.	Excavation and particle separation are reliable technologies. Monitoring the technical aspects easily done.	Excavation and *in situ* stabilization are reliable technologies. Monitoring the technical aspects easily done.	*In situ* stabilization is a reliable technology. Monitoring the technical aspects easily done.
Administrative Feasibility	Feasible	Disposal of excavated material may require the use of rail and could require additional permitting.	No specific issues identified.	Treated waste is nonhazardous and additional permitting is not necessary for transport or disposal.	LUCs will be required indefinitely.
Availability of Services and Materials	Not applicable	Services and materials are readily available. Limited number of disposal facilities.	There are a limited number of suppliers that perform this work.	Services and materials are readily available.	Services and materials are readily available.
State and Community Acceptance	Unlikely	To be determined	To be determined	To be determined	Not accepted by State as is
Cost					
Capital Cost	$0	$11,210,000	$5,444,000	$5,243,000	$2,276,000

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Acronyms and Abbreviations

ARAR	applicable or relevant and appropriate requirement
ASR	Archive Search Report
bgs	below ground surface
CERCLA	Comprehensive Environmental Restoration, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	contaminant of potential concern
CSM	conceptual site model
CTO	Contract Task Order
°F	degrees Fahrenheit
EE/CA	Engineering Evaluation/Cost Analysis
ERS	Ecological Risk Screening
FS	Feasibility Study
HHRS	Human Health Risk Screening
HI	hazard index
HQ	hazard quotient
IR	Installation Restoration
IRIS	Integrated Risk Information System
LDR	Land Disposal Requirements
LUC	land use control
MCB CamLej	Marine Corps Base Camp Lejeune
MCCS	Marine Corps Community Services
MCL	maximum contaminant level
µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
MILCON	military construction
mm	millimeter
MMRP	Military Munitions Response Program
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NC SSL	North Carolina Soil Screening Level
NCDENR	North Carolina Department of Environment and Natural Resources
NCGWQS	North Carolina Groundwater Quality Standards
NCP	National Oil and Hazardous Substance Pollutions Contingency Plan
NTCRA	Non-time-critical Removal Action

O&M	operation and maintenance
PA/SI	Preliminary Assessment/Site Inspection
PAH	polycyclic aromatic hydrocarbons
RA	Remedial Action
RAO	removal action objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
SI	Site Investigation
TBC	to-be-considered
TCLP	Toxicity Characteristic Leaching Procedure
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
UTS	Universal Treatment Standards
UXO	unexploded ordnance
XRF	X-ray fluorescence
yd^3	cubic yards

SECTION 1

Introduction

This report presents an Engineering Evaluation/Cost Analysis (EE/CA) for a Non-time-critical Removal Action (NTCRA) at the theoretical shot fall zone of the D-9 Skeet Range (Archive Search Report [ASR] number 2.82) (hereinafter referred to as the D-9 Skeet Range), Marine Corps Base Camp Lejeune (MCB CamLej) in Onslow County, North Carolina (**Figure 1-1**). The D-9 Skeet Range is located west of Holcomb Boulevard and north of Parachute Tower Road and encompasses approximately 187 acres (**Figure 1-2**). The D-9 Skeet Range was closed in July 2011 and was assigned to the Military Munitions Response Program (MMRP) as Site Unexploded Ordnance (UXO) - 23.

Previous site investigations identified potential unacceptable risks to human health and the environment posed by exposure to lead and polycyclic aromatic hydrocarbons (PAHs) in surface soil in the vicinity of the theoretical shot fall zone at the D-9 Skeet Range.

This EE/CA was prepared by CH2M HILL under the Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, Contract N62470-08-D-1000, Contract Task Orders (CTO) 109 and WE55.

The removal alternatives presented in this EE/CA are designed to address lead and PAHs in surface soil in the vicinity of the theoretical shot fall zone of the D-9 Skeet Range. The actions are intended to manage the unacceptable risks posed by exposure to lead and PAHs and are evaluated with respect to effectiveness, implementability, and cost.

1.1 Regulatory Background

This document is issued by the Department of the Navy (Navy), lead agency responsible for remediation of the D-9 Skeet Range, with the assistance of the United States Environmental Protection Agency (USEPA) Region 4 and the North Carolina Department of Environment and Natural Resources (NCDENR), under Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA).

A removal action is being considered for the portion of the D-9 Skeet Range where lead and PAHs have been identified. This removal action is not time-critical. NTCRAs are defined in Title 40 of the Code of Federal Regulations (CFR) Section 300.415(b)(4) as actions pertaining to a less imminent threat to human health and the environment and that have planning periods of 6 months or more.

Section 104 of CERCLA and SARA allows an authorized agency to take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release relating to hazardous substances, pollutants, or contaminants at any time, or to take any other response measures consistent with 40 CFR 300, the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), as deemed necessary to protect public health or welfare and the environment.

The NCP provides regulations for implementing CERCLA and SARA, and regulations specific to removal actions. The NCP defines a removal action as:

> . . . cleanup or removal of released hazardous substances from the environment, such actions as may be necessary to monitor, assess, and evaluate the threat of release of hazardous substances; the disposal of removed material; or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release.

40 CFR Section 300.415 requires the lead agency to conduct an EE/CA when a NTCRA is planned for a site. The goals of an EE/CA are to identify the objectives of the removal action and to analyze the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives. An EE/CA documents the removal action alternatives and selection process.

Community involvement requirements for NTCRAs include preparing an EE/CA and making it available for public review and comment for a period of 30 days. An announcement of the 30-day public comment period on the EE/CA is required in a local newspaper. Written responses to significant comments will be summarized in an Action Memorandum and included in the Administrative Record.

1.2 Purpose and Objectives

According to USEPA guidance entitled *Conducting Non-Time Critical Removal Actions Under CERCLA* (1993):

> . . . an EE/CA is a flexible document tailored to the scope, goals, and objectives of the NTCRA. It should contain only those data necessary to support the selection of a response alternative, and rely upon existing documentation whenever possible.

The following are the goals of an EE/CA:

1. Satisfy environmental review and public information requirements for removal actions.
2. Satisfy Administrative Record requirements for improved documentation of the removal action selection.
3. Provide a framework for evaluating and selecting alternative technologies.

The guidance further notes the following:

1. A separate risk assessment is not necessary.
2. Data collection to characterize the nature and extent of contamination should be limited to those needed to support the objectives of the NTCRA.
3. Only a few viable alternatives relevant to the EE/CA objectives should be identified and analyzed.

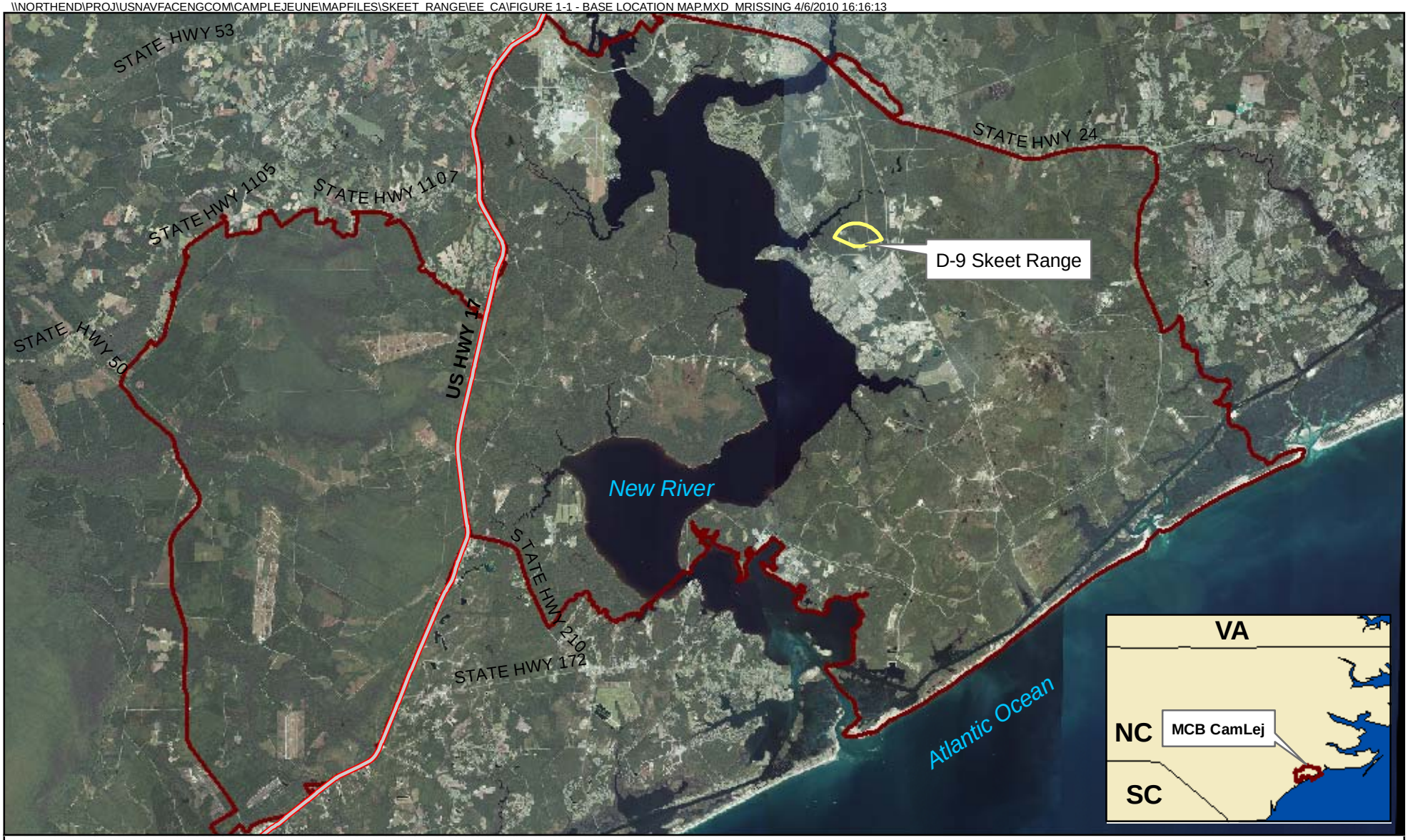
An EE/CA must be completed for all NTCRAs under CERCLA, as required by section 300.415(b)(4)(i) of the NCP. An EE/CA serves an analogous function to the Remedial Investigation/Feasibility Study (RI/FS) conducted for removal actions, but is more focused and streamlined.

1.3 Organization of the EE/CA

The following information is presented within this EE/CA:

- Section 2—Site Characterization
- Section 3—Identification of Removal Action Objectives (RAOs)
- Section 4—Identification of Removal Action Alternatives
- Section 5—Detailed Analysis of Removal Action Alternatives
- Section 6—Comparative Analysis of Removal Action Alternatives
- Section 7—References

\\NORTHEND\PROJ\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SKEET_RANGE\EE_CA\FIGURE 1-1 - BASE LOCATION MAP.MXD MRISSING 4/6/2010 16:16:13



Legend

- Highways
- D-9 Skeet Range
- Installation Boundary

N

0 7,500 15,000 30,000 Feet

1 inch = 15,000 feet

Figure 1-1
Base Location Map
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej
North Carolina

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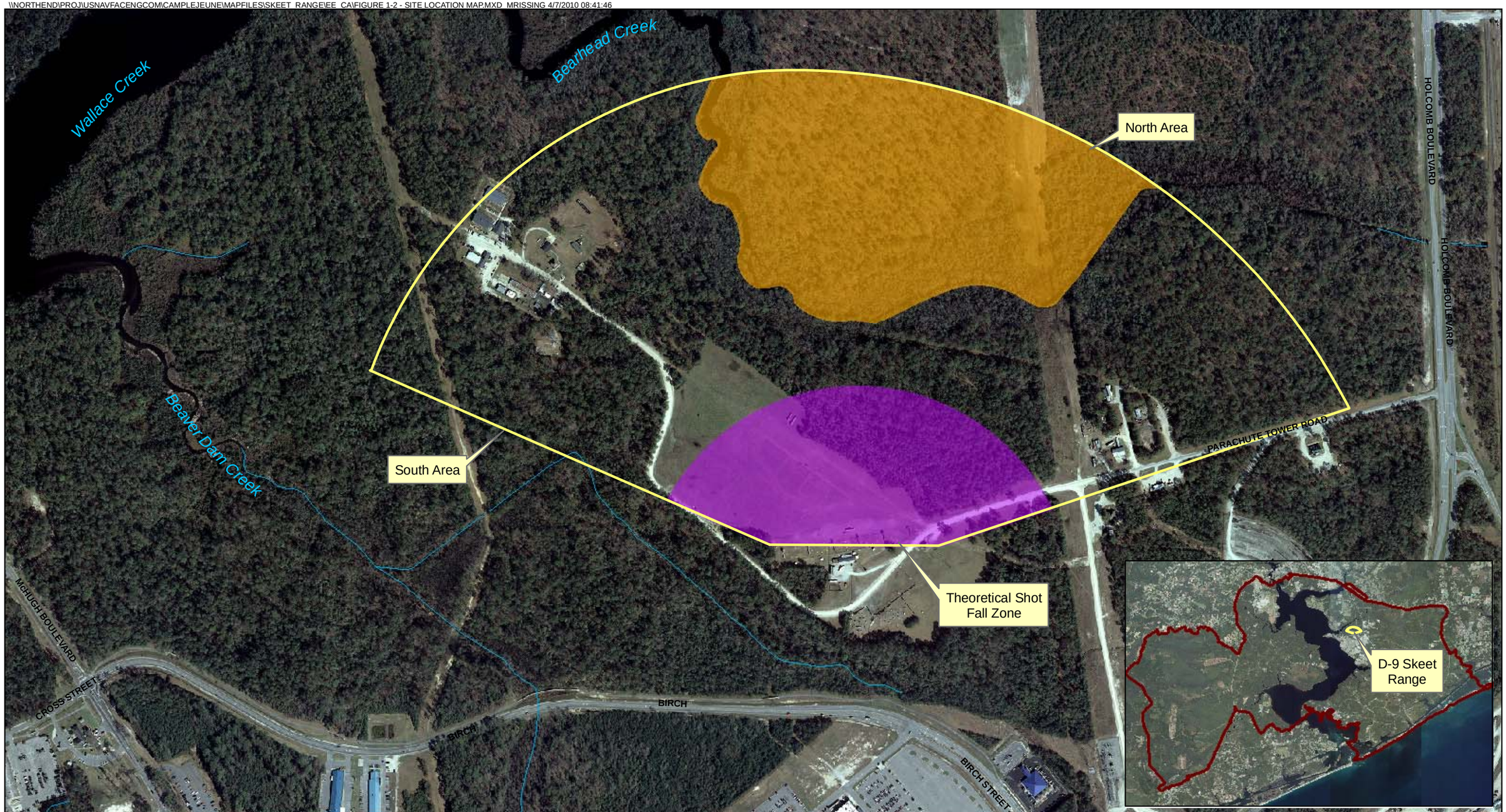
\\NORTHEND\PROJ\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SKEET_RANGE\EE_CA\FIGURE 1-2 - SITE LOCATION MAP.MXD MRISSING 4/7/2010 08:41:46



Legend

- Surface Water Course Centerline
- D-9 Skeet Range
- D-9 Skeet Range North Area
- Theoretical Shot Fall Zone

N

0 250 500 1,000 Feet

1 inch = 500 feet

Figure 1-2
Site Location Map
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej
North Carolina

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Prepared By: *Lauren Petty/CLT* Checked By: *Monica Fulkerson/CLT*

SECTION 2

Site Characterization

This section contains site characterization information including the site description, nature and extent of contamination, risk evaluation and determination of removal area in the vicinity of the theoretical shot fall zone of the D-9 Skeet Range.

2.1 Facility and Site Description

The D-9 Skeet Range is located west of Holcomb Boulevard and north of Parachute Tower Road and encompasses approximately 187 acres (**Figure 1-2**). Based on site use and site features, the D-9 Skeet Range was divided into three areas: the north area (north of Bearhead Creek), the south area (south of Bearhead Creek and excluding the theoretical shot fall zone), and the theoretical shot fall zone. This EE/CA only addresses surface soil within the theoretical shot fall zone. In the north area, potential risks have been identified as a result of PAHs in shallow groundwater and metals and PAHs in surface water and sediment within Bearhead Creek and associated wetlands and drainages. This will be further investigated and addressed separately under the MMRP.

On a skeet range, the area in which most shot will fall (and is expected to have the highest skeet-related contamination) is approximately 375 to 600 feet from the firing position (ITRC, 2005). The theoretical shot fall zone is a fan-shaped area that extends a maximum distance of 680 feet from the shooting position, based on the load, angle at which the shot was fired, wind, and other factors. The theoretical shot fall zone on **Figure 1-2** is based on historical shooting positions at the D-9 Skeet Range.

The majority of the total range area is wooded; however, there are cleared areas near the firing position and theoretical shot fall zone, along the power line corridor that runs north-south through the range, and around the developed portions. The D-9 Skeet Range is bisected by Bearhead Creek, which flows from east to west across the site. Bearhead Creek flows into Wallace Creek, which flows into the New River. Several smaller drainage features are also present throughout the D-9 Skeet Range. The topography generally slopes toward Bearhead Creek from both the north and south, with a change in elevation of approximately 20 feet and 15 feet, respectively, between the north and south boundaries to the creek.

2.1.1 Site History

The D-9 Skeet Range began operation in 1953 (United States Army Corps of Engineers, 2001) and was one of four live-fire ranges within a training area known as Area D. The range was used for recreational shooting and is operated by the Marine Corp Community Services (MCCS). The weapons historically accommodated include 12-, 16-, 20-, 28-, and 410-gauge shotguns. The sizes of lead shot used on the range include 7.5 millimeters (mm), 8mm, 8.5mm, and 9mm. Although the total amounts of ammunition used on the skeet ranges are not available, it is estimated that several hundred thousand rounds are fired each year (Singhas, 2007).

There were 10 firing points and eight skeet houses on the D-9 Skeet Range. The types of sporting clays used included White Flyer and, within the last five years, biodegradable targets. The fields were raked at a minimum of every 6 months to clear the clay pieces, which were disposed of offsite. The D-9 Skeet Range was closed in July 2011.

2.1.2 Soil and Lithologic Information

The soils in the theoretical shot fall zone investigated during the Focused Site Investigation (SI) and the supplemental investigation in 2009 were generally characterized as poorly graded sands to silty sands within the top five feet. Sandy clays were observed below 5 feet bgs throughout the area and varied in thickness from 4 to 12 ft. The sandy clays are underlain by poorly-graded sand (CH2M HILL, 2010a).

2.1.3 Hydrologic and Hydrogeologic Information

Based on previous subsurface investigations conducted at the D-9 Skeet Range, groundwater was encountered at depths ranging from 18 to 20 feet bgs. Based on groundwater measurements collected during the Focused PA/SI, site topography and the location of surface water bodies, shallow groundwater in the surficial aquifer is estimated to flow towards Bearhead Creek in the north area and towards Beaver Dam Creek and Wallace Creek in the south area.

2.1.4 Surrounding Land Use and Populations

The majority of the area north of the theoretical shot fall zone is wooded. There is a power line corridor that runs north-south east of the D-9 Skeet Range. Developed areas of the D-9 Skeet Range include a contractor's field trailer and a waste holding / characterization facility east of the power line corridor and a K9 unit facility, graveyard, former research laboratory, and a dump site to the northwest. The Wallace Creek military construction (MILCON) project, consisting of barracks, an armory, a mess hall, a fitness center, and other facilities, is underway to the west of the D-9 Skeet Range. Upon completion of the NTCRA, construction is scheduled to begin in the vicinity of the theoretical shot fall zone area, and is expected to include barracks, a parking garage, an armory, and a road. Planned and future construction details are depicted on **Figure 2-1**.

Based on the information provided in the Wellhead Protection Plan – 2002 Update (AH Environmental Consultants, 2002), there are no water supply wells within 1,500 feet of the D-9 Skeet Range. The closest water supply well, PSWHP-642, is located 6,300 feet southeast of the D-9 Skeet Range.

Potable water to MCB CampLej and the surrounding residential area is provided by water supply wells that pump groundwater from the Castle Hayne aquifer. Although freshwater is present within the surficial, Castle Hayne, Beaufort, and Peedee aquifers, all of which are located below MCB CampLej, only the Castle Hayne aquifer is used by MCB CampLej as a water supply source (Cardinell, et al., 1993). No wells between the D-9 Skeet Range and groundwater discharge points reportedly utilize the Castle Hayne Aquifer for domestic potable supply or any other uses. MCB CampLej controls all the land between the D-9 Skeet Range and associated groundwater discharge points.

2.1.5 Sensitive Ecosystems

No rare species have been identified within the theoretical shot fall zone. However, wetlands and watercourses are located to the north and the south, which receive drainage from the area. The watercourses lead to tidal Bearhead Creek to the north and tidal Beaver Dam Creek to the south. Appropriate erosion and sediment control measures will be applied to minimize transport of site soils into these systems during and after the removal action is complete.

2.1.6 Meteorology

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

2.2 Nature and Extent of Contamination

Four soil investigations were conducted in the vicinity of the theoretical shot fall zone between 2007 and 2011 (Focused SI in 2007, Focused PA/SI in 2008, the supplemental investigation in 2009, and the environmental update conducted in 2011) to evaluate the horizontal and vertical extents of PAH, perchlorate, and metal impacts. Surface and subsurface soil samples were collected for field screening by x-ray fluorescence (XRF) and laboratory analysis.

Fifty-nine 50-meter by 50-meter grids were established in the vicinity of the theoretical shot fall zone, as shown on **Figure 2-2**. A soil sample was collected from zero to one foot bgs in each grid and screened for lead impacts using an Innov-X® portable XRF. Based on the screening results, the highest concentrations of lead were generally found to correspond with the center of theoretical shot fall zone, as shown on **Figure 2-2**.

Twenty-seven surface soil and twelve subsurface soil samples were collected within the theoretical shot fall zone, as shown on **Figure 2-2,** and analyzed for lead only. Lead was detected in 16 surface soil samples at concentrations exceeding the North Carolina Soil Screening Level (NC SSL) (270 milligrams per kilogram [mg/kg]), in 16 surface soil samples at concentrations exceeding the Adjusted Residential Soil Regions Screening Level (RSL) (400 mg/kg), and in 13 surface soil samples at concentrations exceeding the Adjusted Industrial RSL (800 mg/kg). A maximum concentration of 66,800 mg/kg was detected in the soil sample collected from SR-SS13. Lead was not detected in subsurface soil samples at concentrations exceeding regulatory criteria. Lead soil exceedances in the theoretical shot fall zone are shown on **Figure 2-2.**

Four surface soil samples and one subsurface soil sample were collected and analyzed for perchlorate, PAHs, and metals. Analytical results indicated that arsenic, benzo(a)anthracene, benzo(a)pyrene benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected in surface soil samples at concentrations exceeding their respective Adjusted Residential Soil RSLs in surface soil

samples, as shown on **Figure 2-2**. Arsenic was also detected in the subsurface soil sample (ASR2.82-IS05).

Four of the six PAHs (benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene) only exceeded the Adjusted Residential Soil RSL in the sample collected from ASR2.82-SS28. Benzo(a)pyrene exceeded the Adjusted Residential Soil RSLs in three surface soil samples, with a maximum concentration of 4,400 micrograms per kilogram (µg/kg) in the sample collected from ASR2.82-SS28. Dibenz(a,h)anthracene exceeded the Adjusted Residential Soil RSL in three surface soil samples, with a maximum concentration of 700 µg/kg in the sample collected from ASR2.82-SS28. PAH exceedances were limited to surface soil in the vicinity of the firing position. PAHs are found in the petroleum pitch used to bind clay targets and are likely the source of the localized PAH detections.

Arsenic was detected at concentrations exceeding the Adjusted Residential Soil RSL (0.39 mg/kg) in surface soil samples collected from locations ASR2.82-SS28, ASR2.82-SS29, and ASR2.82-SS30 and above the Industrial Soil RSL (1.6 mg/kg) in the surface soil sample collected from location ASR2.82-SS28. With the exception of ASR2.82-SS28, surface soil results for arsenic were detected at concentrations below two times the mean Base background concentration (2.12 mg/kg). Arsenic was detected above the Adjusted Industrial Soil RSL and two times the mean Base background concentration (0.626 mg/kg) in subsurface soil sample location ASR2.82-IS05. None of the detected arsenic concentrations exceeded the NC SSL (5.8 mg/kg).

Perchlorate was not detected in surface or subsurface soil samples collected in the vicinity of the theoretical shot fall zone at concentrations greater than laboratory reporting limits.

In June 2010, fill was placed and graded in the northwestern portion of the D-9 Skeet Range. This fill was spread into the proposed removal area. As a result, additional investigation was conducted in 2011 to verify and update the planned NTCRA removal area. The graded area was divided into 75-foot by 75-foot grids, as shown on **Figure 2-3**. A composite surface soil sample was collected from each grid that had graded material overlying the native material, a total of 102 grids. A composite subsurface soil sample was collected from each grid that contained more than one foot of graded material. Since the depth of material was less than a foot in many places, subsurface soil samples were collected from only 58 grids.

Based on XRF results, surface soil samples collected from four grids contained lead at concentrations exceeding the clean-up level of 400 mg/kg. Of these, only three grids were located outside the NTCRA area presented in the Draft EE/CA (CH2M HILL, 2010b). Surface soil samples collected from grids G04, H03, and H04 contained lead at concentrations of 558 mg/kg, 476 mg/kg, and 463 mg/kg, respectively (**Figure 2-3)**. Confirmation samples collected from these locations confirmed the presence of lead in exceedance of the clean-up level.

Four PAHs, including benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene, were detected at concentrations exceeding clean-up levels in the surface soil sample collected from SR-SSM07; however, this location was within the NTCRA area presented in the Draft EE/CA (CH2M HILL, 2010b). No subsurface soil samples

collected in the graded area contained lead or PAHs at concentrations exceeding the clean-up levels.

In the vicinity of the proposed armory, sixteen discrete surface soil samples were collected from zero to one foot bgs and 16 discrete subsurface samples were collected from one to three feet bgs. Three surface soil samples contained lead at concentrations exceeding the clean-up level of 400 mg/kg. Surface soil samples collected from locations SR-SS55, SR-SS56, and SR-SS57 contained lead at concentrations of 717 mg/kg, 83,700 mg/kg, and 411 mg/kg respectively (**Figure 2-4**). These surface soil sample locations were located on the western-most transect within the proposed removal area and outside of the proposed project limits (**Figure 2-4**). No PAHs were detected in the surface soil samples collected from within the proposed armory area at concentrations exceeding the clean-up levels. No subsurface soil samples collected in the proposed armory area contained lead or PAHs at concentrations exceeding the clean-up levels.

Based on the results of the 2011 investigation, the NTCRA area was expanded in the graded area to include the three grids that exceeded lead clean-up levels. The NTCRA area was reduced in the vicinity of the proposed armory to only include those locations where samples contained lead in exceedance of clean-up levels (CH2M HILL, 2011).

2.3 Risk Evaluation

A Human Health Risk Screening (HHRS) was conducted for soil within the theoretical shot fall zone to evaluate the potential for unacceptable risks. Nine constituents of potential concern (COPCs) were identified during the HHRS, comprising arsenic, chromium, lead, and six PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene). Lead and PAH concentrations pose the greatest risk to human health. Arsenic is most likely related to background at the site and chromium has been identified due to the risk screening procedure for chromium (**Appendix A**). The risk screening procedure assumes a high percentage of hexavalent chromium, which is not anticipated to be at this site due to historical site activities. Hexavalent chromium is typically from plating operations or other metals processing activities, which did not occur at the D-9 Skeet Range. Removal actions to address lead and PAH impacted surface soil will reduce the risk that arsenic and chromium pose to an acceptable level for residential exposure. The data evaluated during the risk screening are presented in **Appendix A**.

An Ecological Risk Screening (ERS) was not conducted for soil within the theoretical shot fall zone. Rather, unacceptable risks to ecological receptors were assumed based on the identification of potential unacceptable risks to human health. Remediation for human residential use, the implementation of best management practices to minimize the transport of COPCs during and after the removal action, and the future developed land use will result in no significant risk to populations of ecological receptors associated with surface soil in the remediation footprint.

Site-specific Clean-up Levels

Since MILCON activities proposed for the theoretical shot fall zone include the construction of barracks, a parking garage, a road, and an armory, site-specific risk-based clean-up levels

are based on residential future land use. The clean-up level for lead is the Residential Soil RSL (400 mg/kg). Average lead concentrations of less than 400 mg/kg in soil at a site are considered adequately protective of human health under residential land use scenarios (USEPA, 1994). The site-specific clean up levels for the six PAHs are the Residential Soil RSLs adjusted to target risk of $1x10^{-5}$ so that the cumulative risk associated with exposure to the PAHs is below $1x10^{-4}$, the upper end of EPA's acceptable risk range of 10^{-4} to 10^{-6}. Each RSL is multiplied by 10. A summary of site-specific clean-up levels for lead and PAHs detected during previous investigations are tabulated in **Table 2-1**.

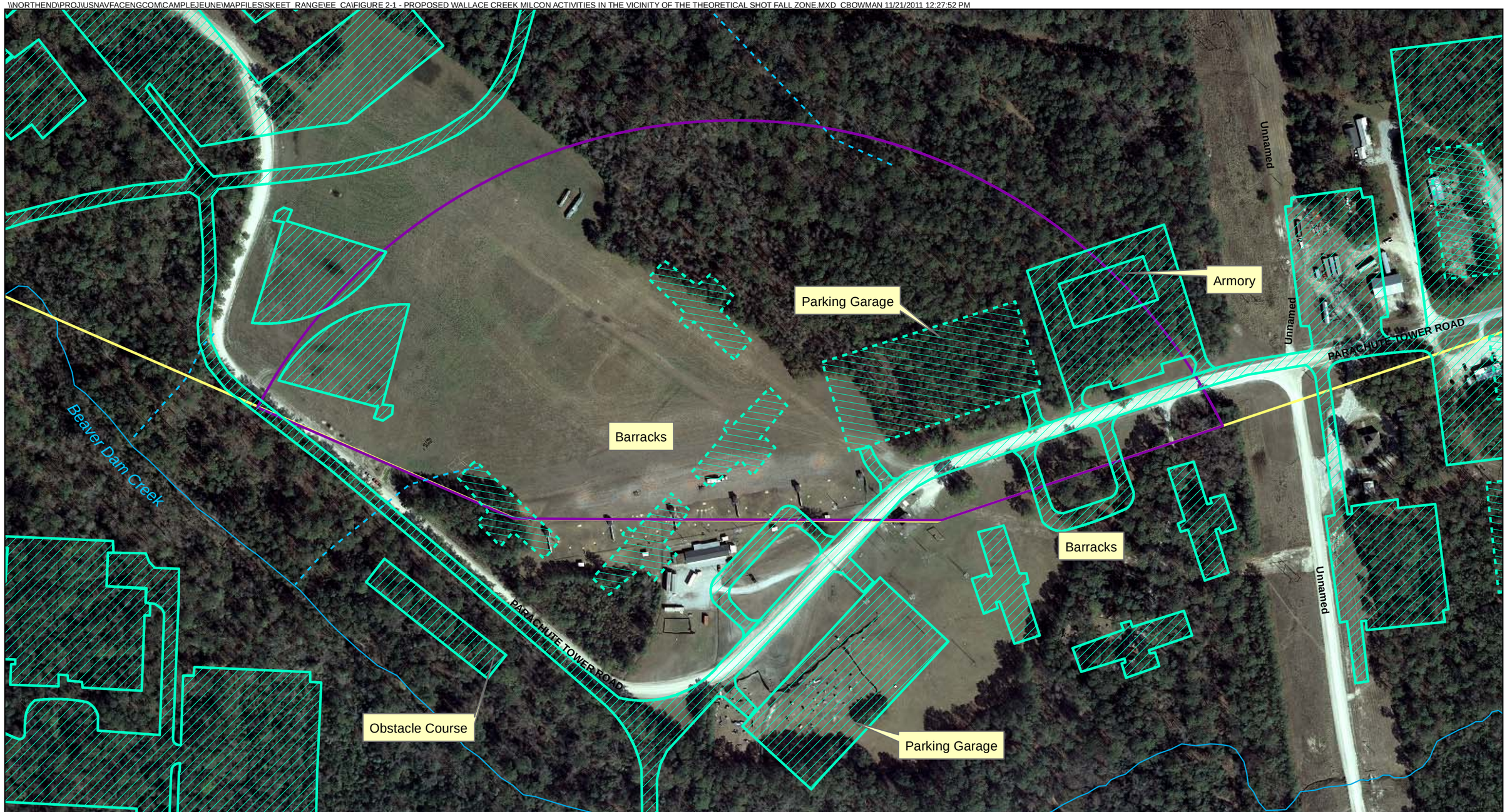
TABLE 2-1
Summary of Site Specific Clean-up Levels

Soil Screening Criteria	Clean-up Levels
Metals (mg/kg)	
Lead	400
PAHs (mg/kg)	
Benzo(a)anthracene	1.5
Benzo(a)pyrene	0.15
Benzo(b)fluoranthene	1.5
Dibenz(a,h)anthracene	0.15
Indeno(1,2,3-cd)pyrene	1.5

2.4 Determination of Removal Area

Based on XRF survey and analytical data gathered during historical investigation activities, lead and PAHs have been detected in surface soil in the vicinity of the theoretical shot fall zone. The area identified for treatment under this NTCRA is based on exceedances of the site-specific clean-up levels defined in **Table 2-1**. A total of 16 acres of impacted surface soil to a depth of 1 foot bgs are recommended for removal action, as shown on **Figure 2-5** and the Conceptual Site Model (CSM) on **Figure 2-6.** The volume of soil within the removal area is estimated to be 25,835 cubic yards (yd^3). Confirmation samples will be collected at the limits of the removal area (side walls and base, if applicable) for any removal action selected to confirm that the full extent of impacted soil is addressed. This will include the southernmost drainage feature; however, the NTCRA will not include surface water bodies (e.g., Bearhead Creek or Beaver Dam Creek).

\\NORTHEND\PROJ\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SKEET_RANGE\EE_CA\FIGURE 2-1 - PROPOSED WALLACE CREEK MILCON ACTIVITIES IN THE VICINITY OF THE THEORETICAL SHOT FALL ZONE.MXD CBOWMAN 11/21/2011 12:27:52 PM



Legend

- Surface Water Course Centerline
- Approximate Drainage Feature Location
- Future Construction Area
- Proposed Construction Area
- Theoretical Shot Fall Zone
- D-9 Skeet Range

N

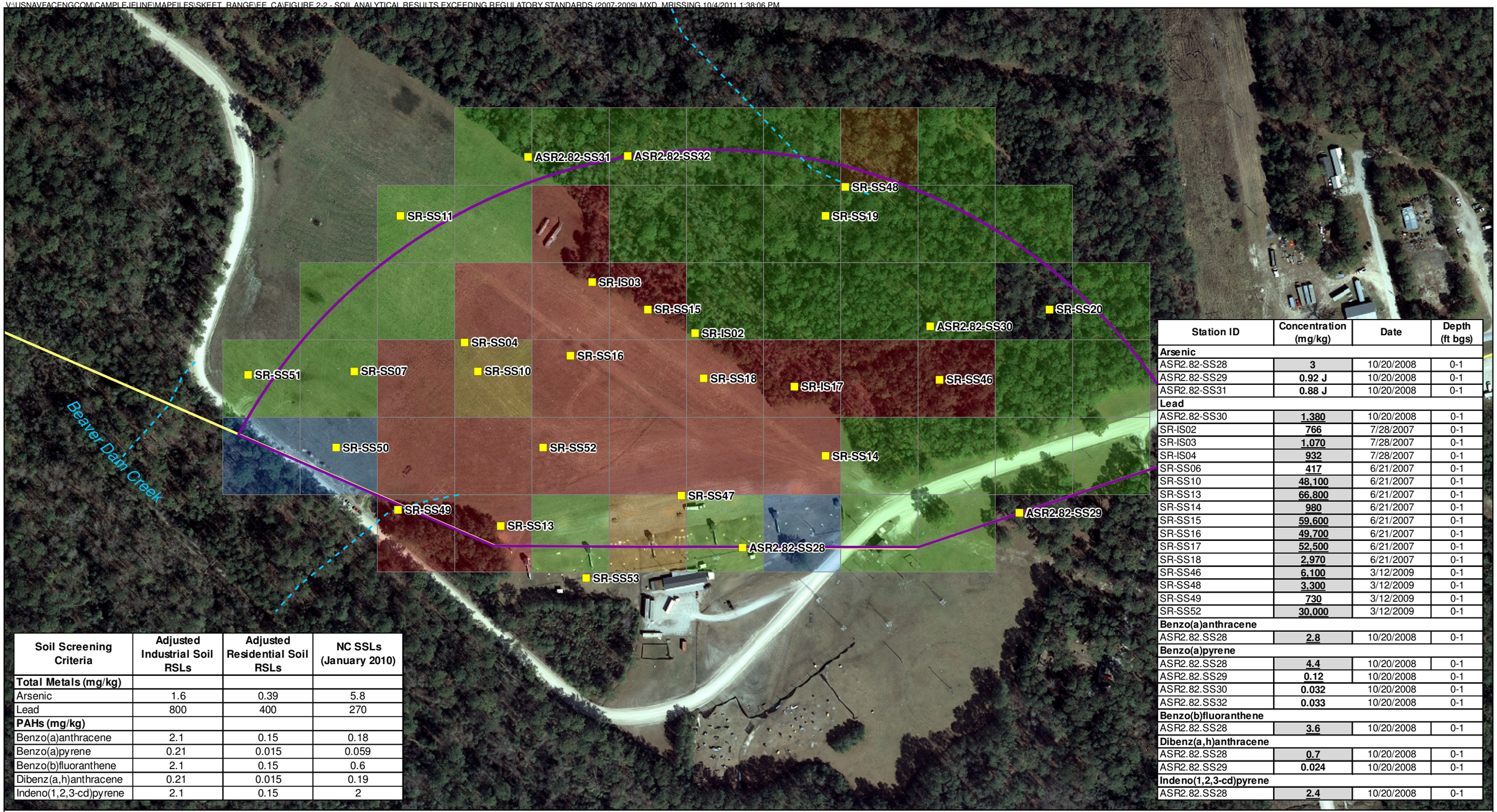
0 100 200 400 Feet

1 inch = 200 feet

Figure 2-1
Proposed Wallace Creek MILCON Activities in the vicinity of the Theoretical Shot Fall Zone
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej
North Carolina

CH2MHILL

V:\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SKEET_RANGE\EE_CA\FIGURE 2-2 - SOIL ANALYTICAL RESULTS EXCEEDING REGULATORY STANDARDS (2007-2009).MXD, MBISSING 10/4/2011 1:38:06 PM



Station ID	Concentration (mg/kg)	Date	Depth (ft bgs)
Arsenic			
ASR2.82-SS28	**3**	10/20/2008	0-1
ASR2.82-SS29	**0.92 J**	10/20/2008	0-1
ASR2.82-SS31	**0.88 J**	10/20/2008	0-1
Lead			
ASR2.82-SS30	**1,380**	10/20/2008	0-1
SR-IS02	**766**	7/28/2007	0-1
SR-IS03	**1,070**	7/28/2007	0-1
SR-IS04	**932**	7/28/2007	0-1
SR-SS06	**417**	6/21/2007	0-1
SR-SS10	**48,100**	6/21/2007	0-1
SR-SS13	**66,800**	6/21/2007	0-1
SR-SS14	**980**	6/21/2007	0-1
SR-SS15	**59,600**	6/21/2007	0-1
SR-SS16	**49,700**	6/21/2007	0-1
SR-SS17	**52,500**	6/21/2007	0-1
SR-SS18	**2,970**	6/21/2007	0-1
SR-SS46	**6,100**	3/12/2009	0-1
SR-SS48	**3,300**	3/12/2009	0-1
SR-SS49	**730**	3/12/2009	0-1
SR-SS52	**30,000**	3/12/2009	0-1
Benzo(a)anthracene			
ASR2.82.SS28	**2.8**	10/20/2008	0-1
Benzo(a)pyrene			
ASR2.82.SS28	**4.4**	10/20/2008	0-1
ASR2.82.SS29	**0.12**	10/20/2008	0-1
ASR2.82.SS30	**0.032**	10/20/2008	0-1
ASR2.82.SS32	**0.033**	10/20/2008	0-1
Benzo(b)fluoranthene			
ASR2.82.SS28	**3.6**	10/20/2008	0-1
Dibenz(a,h)anthracene			
ASR2.82.SS28	**0.7**	10/20/2008	0-1
ASR2.82.SS29	**0.024**	10/20/2008	0-1
Indeno(1,2,3-cd)pyrene			
ASR2.82.SS28	**2.4**	10/20/2008	0-1

Soil Screening Criteria	Adjusted Industrial Soil RSLs	Adjusted Residential Soil RSLs	NC SSLs (January 2010)
Total Metals (mg/kg)			
Arsenic	1.6	0.39	5.8
Lead	800	400	270
PAHs (mg/kg)			
Benzo(a)anthracene	2.1	0.15	0.18
Benzo(a)pyrene	0.21	0.015	0.059
Benzo(b)fluoranthene	2.1	0.15	0.6
Dibenz(a,h)anthracene	0.21	0.015	0.19
Indeno(1,2,3-cd)pyrene	2.1	0.15	2

Legend

- Sample Location
- Surface Water Course Centerline
- Approximate Drainage Feature Location
- Theoretical Shot Fall Zone
- D-9 Skeet Range
- XRF Screening Grid
- Wetlands

Soil Lead Concentration (mg/kg)
Discrete Sample/XRF

- 0 - 8
- 9 - 269
- 270 - 399
- 400 - 799
- >= 800

Notes:
mg/kg - milligrams per kilogram
XRF Screening Grids are 50 meters by 50 meters
Shading indicates exceedance of Adjusted Industrial Soil RSL
Bold text indicated exceedance of Adjusted Residential Soil RSL
Underlined text indicating exceedance of NC SSL

N

0 100 200 400 Feet

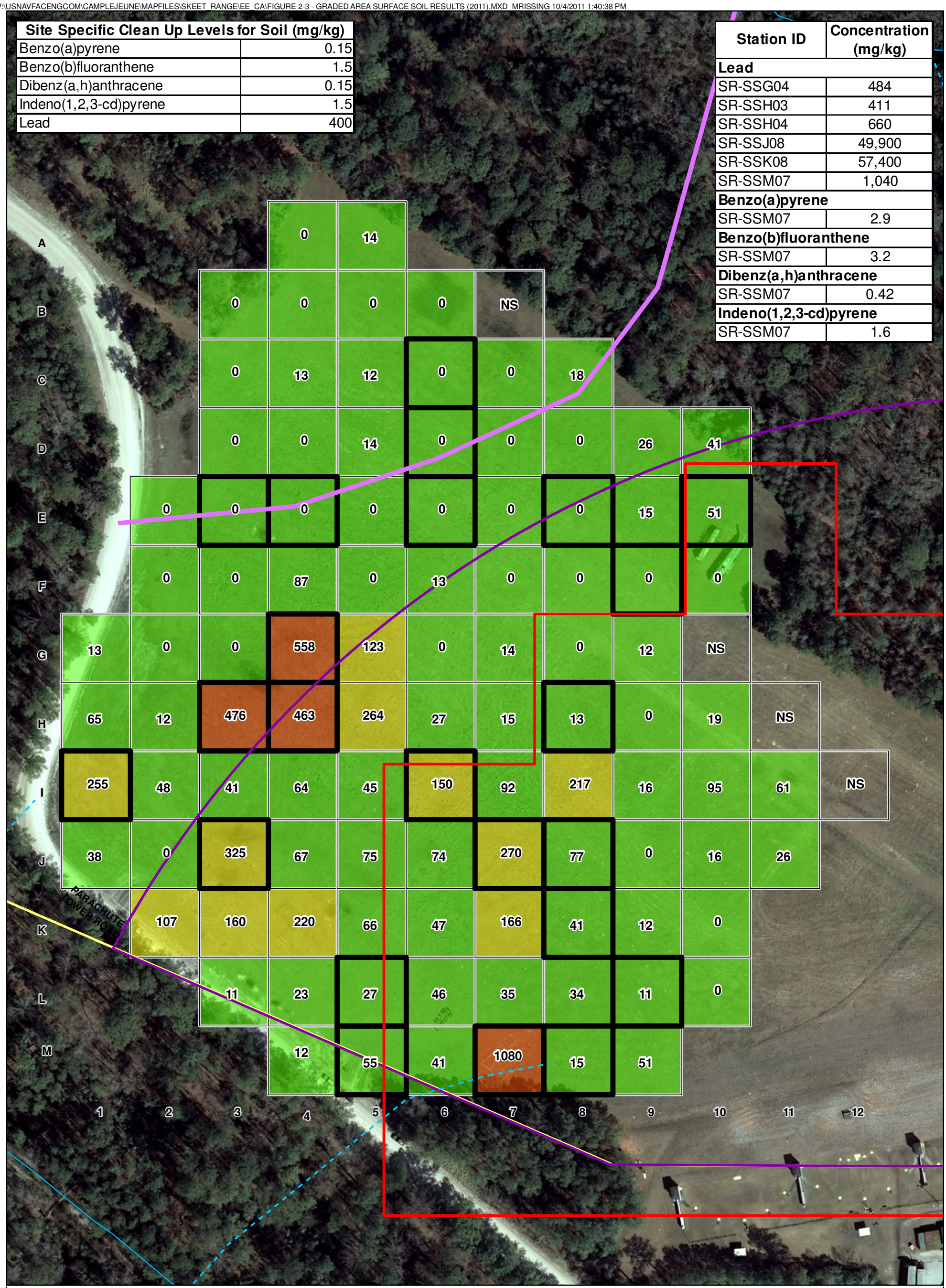
1 inch = 200 feet

Figure 2-2
Soil Analytical Results Exceeding Regulatory Standards (2007-2009)
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej
North Carolina

CH2MHILL

Prepared By: *Lauren Petty/CLT* Checked By: *Monica Fulkerson/CLT*

V:\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SKEET_RANGE\EE_CA\FIGURE 2-3 - GRADED AREA SURFACE SOIL RESULTS (2011).MXD MRISSING 10/4/2011 1:40:38 PM



Site Specific Clean Up Levels for Soil (mg/kg)	
Benzo(a)pyrene	0.15
Benzo(b)fluoranthene	1.5
Dibenz(a,h)anthracene	0.15
Indeno(1,2,3-cd)pyrene	1.5
Lead	400

Station ID	Concentration (mg/kg)
Lead	
SR-SSG04	484
SR-SSH03	411
SR-SSH04	660
SR-SSJ08	49,900
SR-SSK08	57,400
SR-SSM07	1,040
Benzo(a)pyrene	
SR-SSM07	2.9
Benzo(b)fluoranthene	
SR-SSM07	3.2
Dibenz(a,h)anthracene	
SR-SSM07	0.42
Indeno(1,2,3-cd)pyrene	
SR-SSM07	1.6

Legend

- Proposed Road
- Approximate Drainage Feature Location
- Surface Water Course Centerline
- Proposed Removal Area (2010 EE/CA)
- Theoretical Shot Fall Zone
- D-9 Skeet Range
- Confirmatory sample collected from this location
- 75ft Grid
- Lead concentrations below 100 mg/kg (XRF results)
- Lead concentrations greater than 100 mg/kg (XRF results)
- Lead concentrations greater than 400 mg/kg (XRF results)
- NS - Not Sampled

Note:
Tabulated analytical results show exceedances of site-specific clean-up levels in samples submitted to the laboratory

N

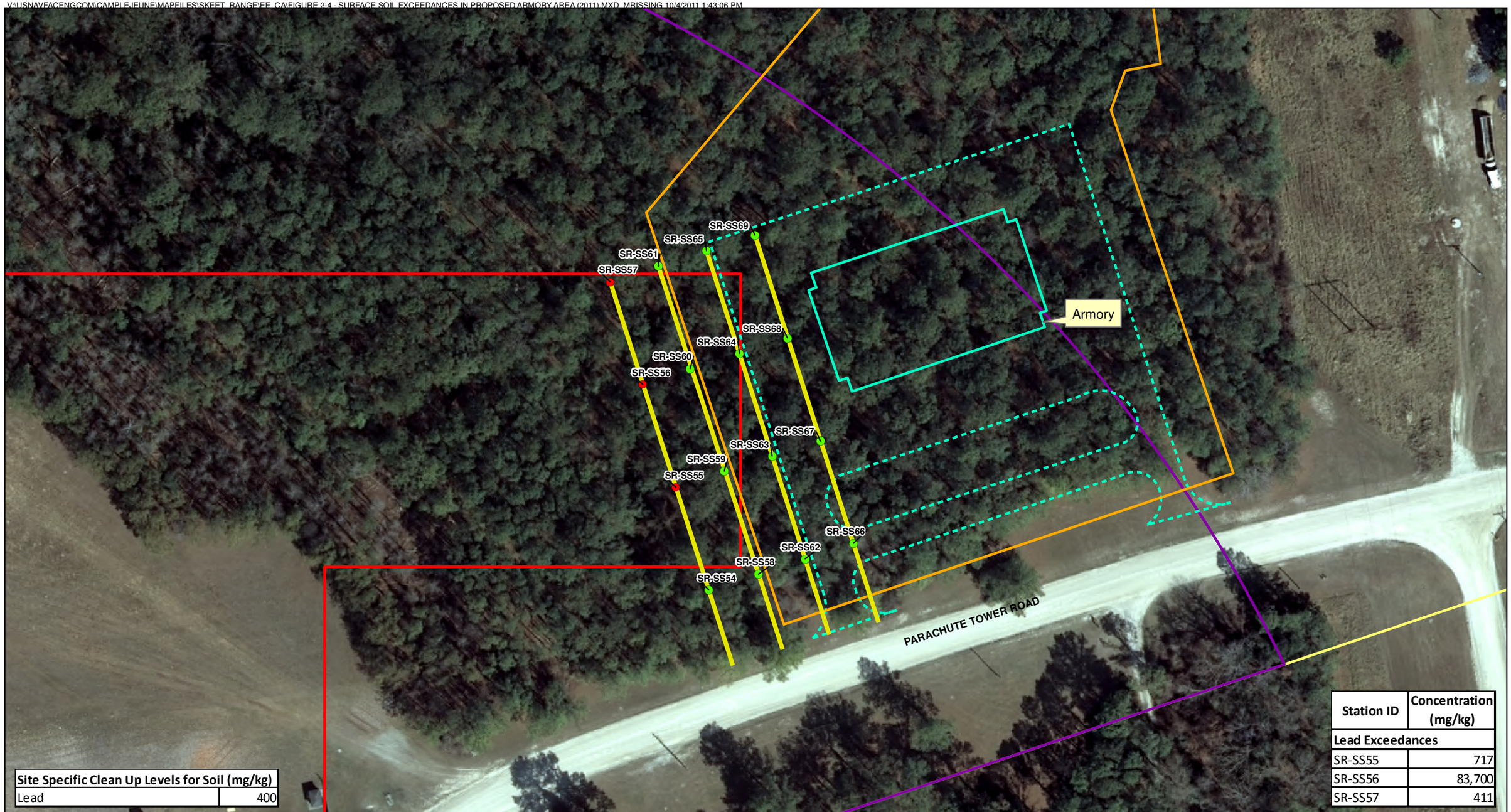
0 50 100 200 Feet

1 inch = 100 feet

CH2MHILL

Figure 2-3
Graded Area Surface Soil Results (2011)
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej
North Carolina

V:\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SKEET_RANGE\EE_CA\FIGURE 2-4 - SURFACE SOIL EXCEEDANCES IN PROPOSED ARMORY AREA (2011).MXD, MBISSING 10/4/2011 1:43:06 PM



Site Specific Clean Up Levels for Soil (mg/kg)	
Lead	400

Station ID	Concentration (mg/kg)
Lead Exceedances	
SR-SS55	717
SR-SS56	83,700
SR-SS57	411

Legend

- Surface Soil Sample did not Contain Lead in Exceedance of Clean-up Level (400 mg/kg)
- Surface Soil Sample Contained Lead in Exceedance of Clean-up Level (400 mg/kg)
- Vegetation Clearance Transects
- Project Limits
- Armory
- Parking
- Proposed Removal Area (2010 EE/CA)
- Theoretical Shot Fall Zone
- D-9 Skeet Range

N

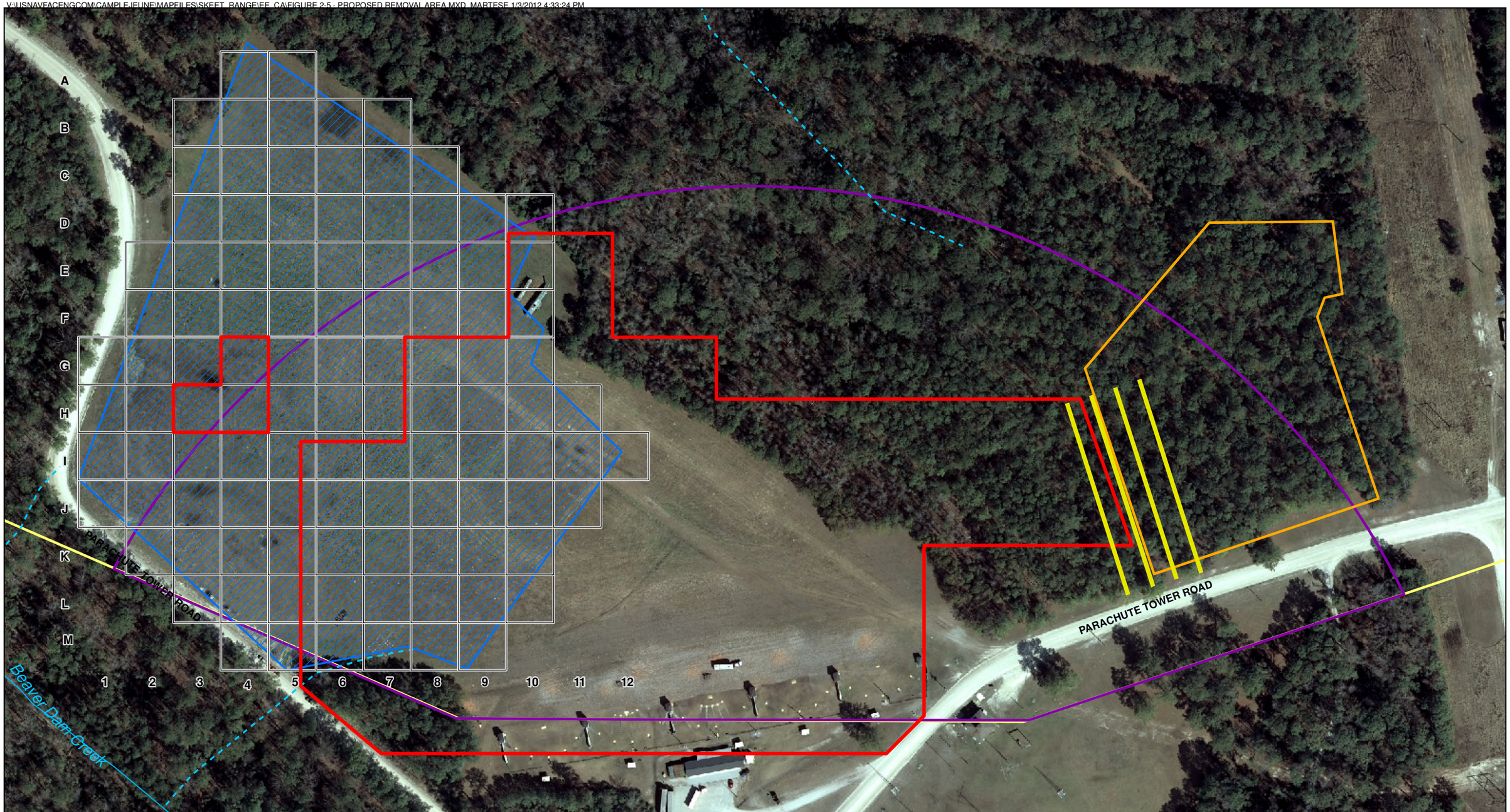
0 37.5 75 150 Feet

1 inch = 75 feet

Figure 2-4
Surface Soil Exceedances in Proposed Armory Area (2011)
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej
North Carolina

CH2MHILL

V:\USNAVFACENGCOM\CAMPLEJEUNE\MAPFILES\SKEET_RANGE\EE_CA\FIGURE 2-5 - PROPOSED REMOVAL AREA.MXD, MARTESE 1/3/2012 4:33:24 PM



Legend

- Vegetation Clearance Transects
- Approximate Drainage Feature Location
- Surface Water Course Centerline
- Updated Proposed Removal Area
- 75ft Grid
- Graded Area
- Armory Project Limits
- Theoretical Shot Fall Zone
- D-9 Skeet Range

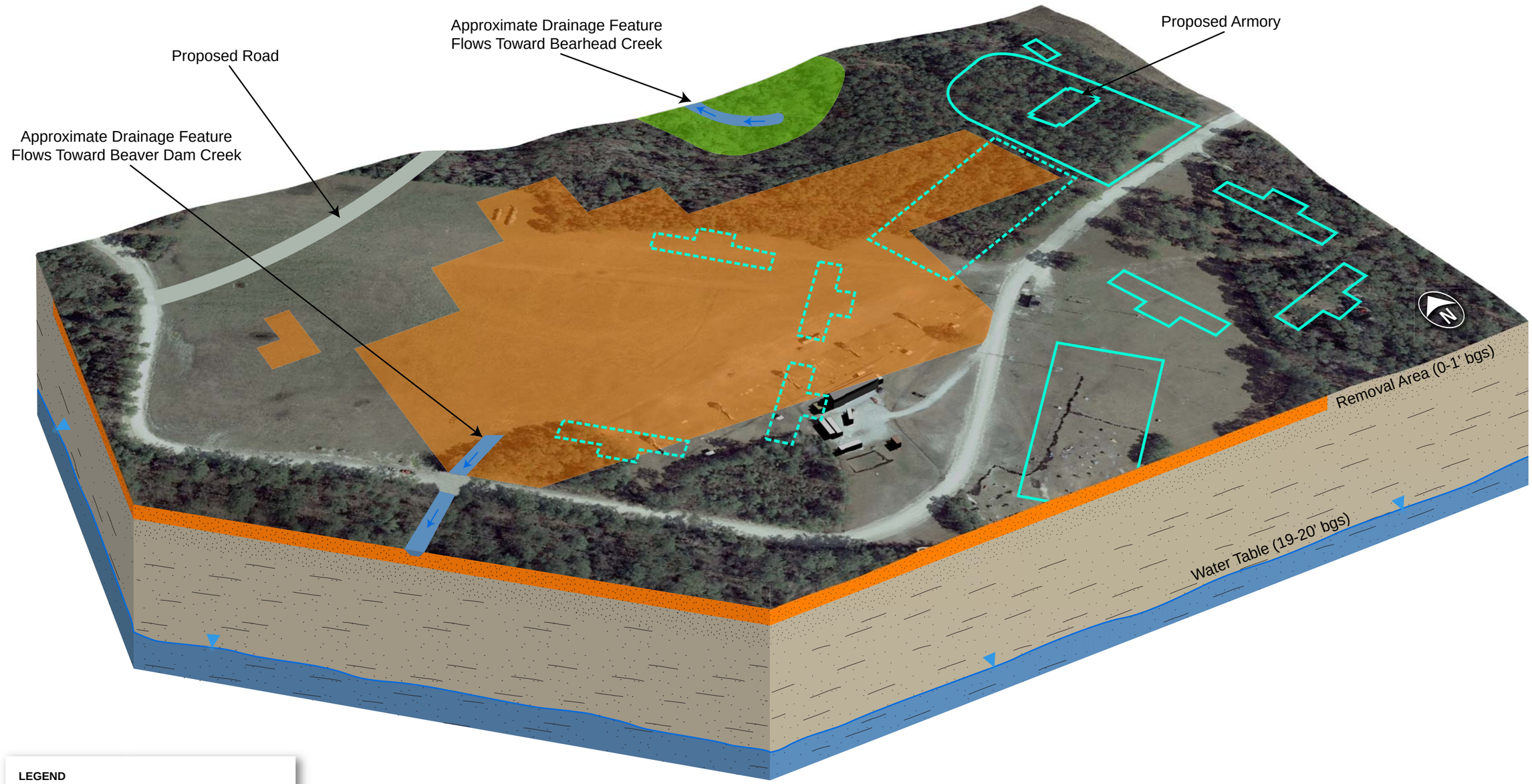
N

0 75 150 300 Feet

1 inch = 150 feet

Figure 2-5
Proposed Removal Area
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej
North Carolina

CH2MHILL



LEGEND

- Treatment Area
- Future Construction Area
- Proposed Construction Area
- Groundwater Table
- Surface Water Flow Direction
- Sand/Silty Sand
- Sand/Clayey Sand
- Wetland Area

NOTE: Not to Scale

FIGURE 2-6
Conceptual Site Model
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej
North Carolina

CH2MHILL

ES040510012057WDC CL_Skeet_Range_CSM_v10.ai 1.03.12 cat/aeg

SECTION 3

Identification of Removal Action Objectives

This section identifies the objectives for the NTCRA at the D-9 Skeet Range. The objectives for the proposed removal area are based on the threat posed by the presence of lead and PAHs in the surface soil.

The following are the RAOs for the theoretical shot fall zone of the D-9 Skeet Range NTCRA:

- Implement measures that mitigate potential unacceptable risk to human health and the environment posed by exposure to impacted surface soil with lead and PAHs at concentrations exceeding the site-specific clean-up levels provided on **Table 2-1**.
- Reduce the potential for contamination migration from the soil to groundwater and surface water.

3.1 Statutory Limits on Removal Actions

NCTRAs funded by the USEPA have a $2 million and a 12-month statutory limit pursuant to Section 104(c)(1) of CERCLA fund-financed removal actions, with statutory exemptions for emergencies and actions consistent with the removal action to be taken. This removal action will not be USEPA fund-financed; it will be financed by the Navy. The Navy/Marine Corps Installation Restoration (IR) Manual does not limit the cost or duration of the removal action; however, cost-effectiveness is a recommended criterion for the evaluation of removal action alternatives.

3.2 Determination of Removal Action Scope

The selected removal action is intended to be an interim corrective action implemented within the theoretical shot fall zone to reduce the amount of contaminant mass present, to the extent practicable, in order to minimize potential unacceptable risk to human health and the environment and reduce the potential for contaminant migration from soil to groundwater and surface water.

Potential risks have been identified in the north area as a result of PAHs in shallow groundwater and metals and PAHs in surface water and sediment within Bearhead Creek and associated wetlands and drainages. This will be further investigated under the MMRP. Future actions will be conducted, if needed.

3.3 Determination of Removal Action Schedule

Implementation of the removal action is anticipated to require two to six months based on the recommended remedy. Each alternative will have different implementation timeframes. Factors that may affect the removal action schedule primarily relate to site conditions,

requirements of the removal technologies, availability of vendors and supplies, MCB CampLej mission requirements, and inclement weather.

3.4 Applicable or Relevant and Appropriate Requirements

As required by Section 121 of CERCLA, removal actions carried out onsite under Section 104 or secured under Section 106 must attain the levels of standards of control for hazardous substances, pollutants, or contaminants specified by the applicable or relevant and appropriate requirements (ARARs) of federal and state environmental laws and state facility-siting laws, unless waivers are obtained. The elements of the removal action, carried out offsite are subject to all applicable regulations, rather than ARARs. The requirements of CERCLA generally apply as a matter of law only to removal actions. However, as required by 40 CFR Section 300.415(j), ARARs will be identified and attained for removal actions to the extent practicable. The following three factors will be applied to determine whether the identification and attainment of ARARs is practicable in a particular removal situation:

1. Exigencies of the situation
2. Scope of the removal action
3. Effect of ARAR attainment on the statutory limits for removal action duration and cost

ARARs are identified by the USEPA as either being applicable to a situation or relevant and appropriate to it. These distinctions are critical to understanding the constraints imposed on response alternatives by environmental regulations other than CERCLA while operating onsite. The definitions of ARARs below are from the USEPA guidance (USEPA, 1988).

"Applicable requirements" are standards and other environmental protection requirements of federal or state law dealing with a hazardous substance, pollutant, contaminant, action being taken, location, or other circumstance at a CERCLA site.

"Relevant and appropriate requirements" are standards and environmental protection criteria of federal or state law that, although not "applicable" to a hazardous substance, pollutant, contaminant, action being taken, location, or other circumstance, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. The procedure to determine if a requirement is relevant and appropriate is a two-step process. A requirement is "relevant" if it addresses problems or situations sufficiently similar to the circumstances of the proposed response action. A requirement is "appropriate" if it would also be well suited to the conditions of the site.

A requirement may be "relevant" to a particular situation but not "appropriate," given site specific circumstances; such a requirement would not be an ARAR for the site. A requirement that is relevant and appropriate must be met as if it were applicable. Relevant and appropriate requirements that are more stringent than applicable requirements take precedence. However, more discretion is allowed in determining relevant and appropriate requirements than in determining applicable requirements.

"To-be-considered" (TBCs) are non-promulgated advisories or guidance issued by federal or state government that are not legally binding, and do not have the status of potential

ARARs. TBCs are evaluated along with ARARs and may be implemented by USEPA when ARARs are not fully protective of human health and the environment.

Another factor in determining which response requirement must be met is whether the requirement is substantive or administrative. Onsite CERCLA response actions must meet substantive requirements of ARARs but not administrative requirements. This distinction applies to onsite actions only, as offsite response actions are subject to all applicable standards and regulations, including administrative requirements such as permits, rather than ARARs. Substantive requirements are those dealing directly with actions or with conditions in the environment. Administrative requirements implement the substantive requirements by prescribing procedures such as fees, permitting, and inspection that make substantive requirements effective.

Three classifications of requirements are defined by USEPA in the ARAR determination process: chemical-specific, location-specific, and action-specific.

Chemical-specific ARARs are health or risk management-based numbers or methodologies that result in the establishment of numerical values for a given medium that would meet the NCP "threshold criterion" of overall protection of human health and the environment. These requirements generally set protective clean-up concentrations for the chemicals of concern (COCs) in the designated media, or set safe concentrations of discharge for response activity. Chemical-specific requirements are generally set for a single chemical or closely related group of chemicals and do not typically consider mixtures of chemicals. When chemical-specific requirements do not adequately protect human health or the environment, clean-up goals may be set below the TBC value. Federal and North Carolina chemical-specific regulations that have been reviewed are summarized in **Appendix B**.

Location-specific ARARs restrict response activities and media concentrations based on the characteristics of the surrounding environments. Location-specific ARARs may include restrictions on response actions within wetlands or floodplains, near locations of known endangered species, or on protected waterways. Federal and North Carolina location-specific regulations that have been reviewed are summarized in **Appendix B**.

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances. Federal and North Carolina action-specific ARARs that may affect the development and conceptual arrangement of response alternatives are summarized in **Appendix B**.

Not all potential ARARs identified in **Appendix B** apply to every remedial alternative. A discussion concerning which ARARs may apply to each specific response action is included in Section 5. The work plan for the selected alternative will provide additional detail on how the ARARs for that action will be met.

SECTION 4

Identification of Removal Action Alternatives

General response actions that may be used to satisfy RAOs include institutional controls, removal, containment, treatment, and disposal. In accordance with USEPA guidance (1993), treatment technologies are more favorable than containment. Technologies with demonstrated effectiveness in significantly reducing lead mass in soil are few. These technologies include:

- Excavation and backfill
- Particle separation
- Soil stabilization (*in situ* and *ex situ*)

4.1 Technology Descriptions

The following is a short description of the technologies considered for further evaluation.

Excavation and Backfill

Excavation and backfill involves the excavation of the removal area using conventional earth moving equipment. The area of excavation is typically backfilled to original grade with imported clean fill or excavated soil that meets the site-specific clean-up levels. Excavation and backfill allows site closure or reuse within a short time frame, without long-term environmental monitoring.

All excavated soil would require disposal sampling in accordance with RCRA disposal requirements. The results of this sampling would determine the final designation of the excavated soil as hazardous or not. Non-hazardous soil would be transported to a regional Subtitle D landfill facility for disposal. Hazardous soil would be transported to a permitted, RCRA Subtitle C treatment, storage, or disposal facility.

Additional activities associated with excavation and backfill include: site surveying and clearing, construction of appropriate erosion and sediment controls to prevent contaminants from leaving the site, dust control, confirmation sampling on the sidewalls and base of the excavation, and restoration of excavated areas.

Particle Separation

Particle separation, or soil washing, uses physical separation techniques to remove lead from the soil matrix of material excavated from the identified removal area. Separation processes can include: physical sizing, hydrodynamic separation (classification), density (gravity) separation, and froth flotation. A soil washing process flow diagram is shown on **Figure 4-1**. Photographs showing typical soil washing operations are shown on **Figure 4-2**.

Particle separation techniques are described below (IRTC, 2003):

- Physical sizing employs sequential screening steps using screens, sieves, or trommels to partition the particulate lead into narrow size fractions to facilitate effective gravity

separation. In sandy soils, dry screening is generally sufficient to recover lead in a state appropriate for recycling.

- Hydrodynamic separation or classification uses a clarifier, elutriator, or hydrocyclones to segregate material of different settling rates in water based on particle density, size or shape.
- Density separation uses shaking tables, spiral concentrator, or jigging for particulate removal of same-sized soil matrices based on particle density.
- Froth flotation uses air flotation columns or cells to separate particles based on a particles affinity for air (in the form of bubbles) after reagent conditioning to render lead particles hydrophobic. The technique is most effective in removing very fine particles present at low concentrations within the soil matrix. The hydrophobic lead particles are transported up the column by bubbles and form froth on the surface of the column or cell. The lead-rich froth is removed for disposal.

Particle separation is a proven technology that allows site closure or reuse within a short time frame, without long-term environmental monitoring (IRTC, 2003). Reclaimed particulate lead is recycled and excavated soil typically meets site-specific clean-up levels and can be used as backfill. In general, lead separation occurs more readily in sandy soils; however a bench-scale treatability study is recommended prior to implementing this technology. Additional activities associated with particle separation include: site surveying and clearing, construction of erosion and sediment controls to prevent contaminants from leaving the site, excavation of removal area using conventional construction equipment, confirmation sampling, and restoration of excavated areas.

Soil Stabilization

Soil stabilization is a process by which material within the identified removal area is mixed with a reagent that chemically binds and immobilizes lead in soil (USEPA, 2005). Lead binds readily with inorganic salts such as phosphate or sulfate and forms less soluble compounds, such as lead phosphate and lead sulfate. Lead is least soluble (and thereby immobile) when the pH of soil is maintained between 6 and 9 (IRTC, 2003). A buffering compound, such as lime or manganese oxide, reduces the leachability of lead. Reagents are typically buffered phosphate, sulfate, hydroxide, or carbonate compounds. Known soil stabilization reagents include Apatite ™, EcoBond®, EnviroBlend®, and Portland cement.

The reagent is either applied to the ground surface and mixed into the shallow subsurface (*in situ*) or applied to excavated material and mixed thoroughly prior to disposal (*ex situ*). In both cases, conventional construction equipment can be used to apply and mix the reagent. During *ex situ* application, the excavated material can be mechanically screened to recover lead, as described above.

Material treated and excavated would be managed in accordance with RCRA disposal requirements.

A bench-scale treatability study is recommended prior to implementing this technology at larger sites in order to accurately determine stabilization reagent dosing. Additional activities associated with soil stabilization include: site surveying and clearing, dust control,

construction of erosion and sediment controls to prevent contaminants from leaving the site, confirmation sampling, and restoration of excavated and/or disturbed areas.

4.2 Development of Removal Action Alternatives

Five alternatives have been developed that draw on the technologies described in Section 4.1. A discussion of each alternative is provided below.

4.2.1 Alternative 1—No Action

Alternative 1 implies that no removal work would be done. The no action alternative is the baseline against which the effectiveness of other removal action alternatives is compared. The area would be left as it currently exists, leaving the impacted surface soil in place. Under this alternative, no controls or removal technologies would be implemented. CERCLA (Section 121(c)), as amended by SARA (1986), requires that the site be reviewed every 5 years since the impacted surface soil remains on site.

4.2.2 Alternative 2—Excavation and Offsite Disposal

Alternative 2 involves the excavation of 25,835 yd^3 of material from the removal area. Excavated material would be transported offsite for treatment and disposal. The excavation would be backfilled with surplus soil associated with nearby MILCON activities and will be graded and seeded to promote drainage.

On April 6, 2010, four surface soil samples were collected from the theoretical shot fall zone to correlate lead concentrations to Toxicity Characteristic Leaching Procedure (TCLP) results. Analytical results are tabulated in **Table 4-1.** The data indicates that there is no correlation between lead concentrations and TCLP; therefore, all site material should be managed as hazardous waste unless treated.

TABLE 4-1
Toxicity Characteristic Leaching Procedure Results

Total Lead (mg/kg) 4/6/2010	TCLP Lead (mg/L) 4/6/2010
43,500	**36**
1,400	**188**
1,910	**104**
367	**38**

Bold exceeds clean-up level (400 mg/kg)
Bold underline exceeds 5.0 mg/L in TCLP test

Soil classified as hazardous would be transported by rail to permitted, RCRA Subtitle C treatment, storage, or disposal facility. Any non-hazardous material would be disposed of at an approved Subtitle D landfill. Offsite disposal of excavated material would require 3,230 truckloads (assuming 10 yd^3 per truck and 25% additional volume for fluff) or 388 rail cars (assuming 100 tons per rail car). The closest rail spur to the site is located on Ash Road, southeast of Holcomb Boulevard. Trucks would transport the excavated material from

Parachute Tower Road to Holcomb Boulevard to the rail spur, approximately 1.5 miles from the site.

Confirmation samples would be collected from the side walls and base of the excavation and analyzed for COCs and compared to the clean-up levels identified in **Table 2-1** to verify that the horizontal and vertical extent of the contamination was removed. The excavation area will be divided into 75 ft by 75 ft grids. A base sample will be composited from four aliquots collected within each grid. If the grid is along a sidewall, a sidewall sample will be composited from four aliquots collected within each grid. This is expected to result in analysis of 179 confirmation samples.

All excavated soils would be managed in accordance with RCRA disposal requirements. Approximately 1 sample would be collected per 500 tons of soil excavated for waste characterization. Samples for off-site disposal characterization will be collected in accordance with the MCB CamLej Waste Management Plan and requirements of the disposal facility.

The following components are also included in this alternative:

- Site survey of excavation boundary, site clearing, and utility location
- Construction of erosion and sediment controls
- Site restoration with grading, soil backfilling, and seeding

4.2.3 Alternative 3—Excavation with Particle Separation and Backfill

Alternative 3 involves the excavation of 25,835 yd^3 of material from the removal area. Excavated material would be mechanically screened to separate clay target and organic debris, rocks, and larger diameter lead material from finer soil particles. The mechanical screening of the clay targets is expected to remove PAH-impacted material. Lead particles not captured during mechanical screening would be separated from finer soil particles through physical particle separation techniques, as shown on **Figure 4-1**. The resulting contaminated sludge will be containerized and managed in accordance with the MCB CamLej Waste Management Plan and requirements of the disposal facility. The excavation would then be backfilled with the treated soil and will be graded and seeded to promote drainage.

Confirmation samples would be collected from the side walls and base of the excavation and analyzed for COCs and compared to the clean-up levels identified in **Table 2-1** to verify that the horizontal and vertical extent of the contamination was removed. The excavation area will be divided into 75 ft by 75 ft grids. A base sample will be composited from four aliquots collected within each grid. If the grid is along a sidewall, a sidewall sample will be composited from four aliquots collected within each grid. This is expected to result in analysis of 179 confirmation samples.

Since treated soil will be used as backfill, the treated material will require analysis for COCs to verify that the site-specific clean-up levels have been achieved prior to backfilling the excavated area. Approximately 1 composite sample would be collected per 500 tons of treated soil excavated for backfill characterization. Each composite sample would consist of at least ten representative aliquot samples collected from the treated soil.

The following components are also included in this alternative:

- Site survey of excavation boundary, site clearing, and utility location
- Construction of erosion and sediment controls
- Designation of covered remedial-derived waste staging area within secondary containment
- Process water disposal (approximately 126,000 gallons of non-hazardous water)
- Site restoration by grading, soil backfill and seeding

4.2.4 Alternative 4—*In Situ* Soil Stabilization with Excavation and Offsite Disposal

Alternative 4 involves *in situ* mixing of a stabilization reagent to render the contaminated soil non-hazardous, followed by excavation of the treated material from the removal area. A stabilization reagent would be distributed across the 16-acre removal area using a spreader truck, then tilled into the underlying soil using conventional equipment to a depth of 1 foot bgs. Approximately 26,870 yd^3 of stabilized material would then be excavated and managed as non-hazardous waste and transported offsite for disposal. The excavation will be backfilled with surplus soil associated with nearby MILCON activities and will be graded and seeded to promote drainage.

The stabilization reagent is assumed to be either Portland cement or EnviroBlend, which would be applied at a dose of three to five percent by weight. EnviroBlend® is a buffered phosphate that will bind and immobilize the lead. EnviroBlend® is recommended for *in situ* stabilization because it is more persistent over time and does not impede grass growth in the area of application. A bench-scale treatability study would be conducted to identify and optimize the stabilization reagent dosage during the design phase.

All excavated and treated soils would be analyzed to determine if soil has been rendered a non-hazardous waste so that it can be disposed of as solid waste, in accordance with RCRA disposal requirements. Approximately one sample would be collected per 500 tons of stabilized material for waste characterization. Samples for off-site disposal characterization will be collected in accordance with the MCB CamLej Waste Management Plan and requirements of the disposal facility. It is assumed that incorporation of the stabilization reagent will result in the characterization of all treated waste as non-hazardous. Non-hazardous material would be transported offsite, requiring 3,360 truckloads (assuming 10 yd^3 per truck and 25% additional volume for fluff) for disposal at an approved Subtitle D Landfill. Trucks would transport the excavated material from Parachute Tower Road to Holcomb Boulevard off Base to the disposal facility. If waste characterization indicates that excavated material remains hazardous, the material will be handled as such and disposed of according to RCRA hazardous waste requirements.

Confirmation samples would be collected from the side walls and base of the excavation and analyzed for COCs and compared to the clean-up levels identified in **Table 2-1** to verify that the horizontal and vertical extent of the contamination was removed. The excavation area will be divided into 75 ft by 75 ft grids. A base sample will be composited from four aliquots collected within each grid. If the grid is along a sidewall, a sidewall sample will be composited from four aliquots collected within each grid. This is expected to result in analysis of 179confirmation samples.

The following components are also included in this alternative:

- Site survey of excavation boundary, site clearing and utility location;
- Construction of erosion and sediment controls;
- Designation of covered remedial-derived waste staging area within secondary containment; and
- Site restoration by grading, soil backfill and seeding.

4.2.5 Alternative 5—*In Situ* Soil Stabilization

Alternative 5 involves *in situ* mixing of a stabilization reagent to treat 25,835 yd^3 of material in place. The stabilization reagent would be distributed across the 16-acre removal area using a spreader truck, then tilled into the underlying soil using conventional equipment to a depth of 1 foot bgs.

The stabilization reagent is assumed to be EnviroBlend® 90/10, which will be applied at a dose of four percent by weight. A bench-scale treatability study would be required to refine the stabilization reagent dosage during the design phase.

The stabilization reagent is designed to bind and immobilize lead and would not address PAH concentrations in soil. Excavation of approximately 4,195 yd^3 of soil impacted with PAHs would be required to achieve the site-specific clean-up levels in **Table 2-1.** All excavated soil would be managed in accordance with RCRA disposal requirements. Approximately one sample would be collected per 500 tons of stabilized material for waste characterization. Samples for off-site disposal characterization will be collected in accordance with the MCB CamLej Waste Management Plan and requirements of the disposal facility. It is assumed that incorporation of the stabilization reagent will result in the characterization of all treated waste as non-hazardous. Non-hazardous material would be transported offsite, requiring 525 truckloads (assuming 10 yd^3 per truck and 25% additional volume for fluff) for disposal at an approved Subtitle D Landfill. Trucks would transport the excavated material from Parachute Tower Road to Holcomb Boulevard off Base to the disposal facility.

Although the lead in soil will be immobilized after treatment, lead-impacted soil will remain on site. Risks to residential and ecological receptors will still be present. As a result, land use controls (LUCs) will be required indefinitely.

The following components are also included in this alternative:

- Site survey of treatment boundary, site clearing, and utility location
- Construction of erosion and sediment controls
- Site restoration through grading the treated soil and seeding

SOIL WASHING PROCESS FLOW DIAGRAM

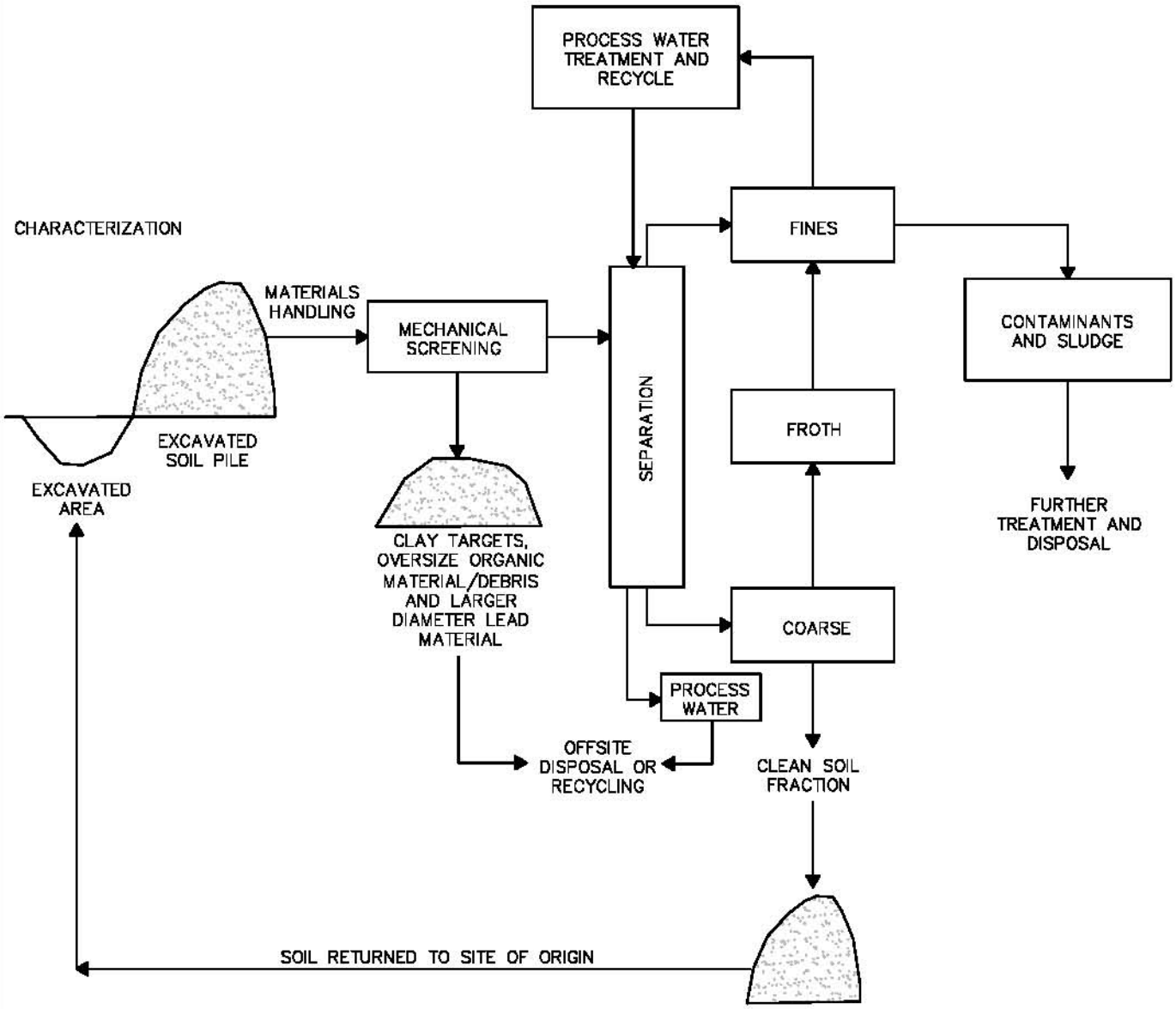


Figure 4-1
Soil Washing Process Flow Diagram
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej, North Carolina

DRAWN BY: L. Hartley
CHECKED BY: L. Petty

CH2MHILL

Upper left: Soil washing plant overview
Upper right: Lead shot for recycling
Left: Clean product for backfill

Figure 4-2
Example Soil Washing Operations
Engineering Evaluation/Cost Analysis
D-9 Skeet Range
MCB CamLej, North Carolina

CH2MHILL

Photos courtesy of ART Engineering, LLC

SECTION 5

Detailed Analysis of Removal Action Alternatives

The alternatives analysis uses the three main evaluation criteria of effectiveness, implementability, and cost in accordance with the USEPA guidance (1993). Each evaluation criterion is described in **Table 5-1.** Anticipated ARARs are listed in **Appendix B**. **Table 5-2** summarizes the evaluation for each technology.

TABLE 5-1
Evaluation Criteria

Effectiveness	
Protection of human health and the environment	The assessment describes how the action achieves and maintains protection of human health and the environment and achieves site-specific objectives both during and after implementation.
Compliance with ARARs	An alternative is assessed in terms of its compliance with ARARs, or if a waiver is required, how it is justified.
Short-term effectiveness	An action is assessed in terms of its effectiveness in protecting human health and the environment during the construction and implementation of a remedy before response action objectives have been met. The duration of time until the response objectives are met is also factored into this criterion.
Long-term effectiveness and permanence	An action is assessed in terms of its long-term effectiveness in maintaining protection of human health and the environment after response action objectives have been met. The magnitude of residual risk and adequacy and reliability of post-removal site controls are taken into consideration.
Reduction of toxicity, mobility or volume through treatment	An action is assessed in terms of anticipated performance of the specific treatment technologies it employs. Factors such as volume of materials destroyed or treated, the degree of expected reductions, the degree to which treatment is irreversible, and the type and quantity of remaining residuals are taken into consideration.
Implementability	
Technical feasibility	The ability of the technology to implement the remedy is evaluated.
Administrative feasibility	The administrative feasibility factor evaluates requirements for permits, zoning variances, impacts on adjoining property, and the ability to impose institutional controls.
Availability of services and materials	The availability of offsite treatment, storage, and disposal capacity, personnel, services and materials, and other resources necessary to implement the alternative will be evaluated.
State and community acceptance	The acceptability of an alternative to the state agency and the community is evaluated.
Cost	
Direct and indirect capital costs	Includes costs for construction, equipment and materials, analytical services, engineering and design, and permit/licenses.

TABLE 5-2
Summary of Technical Evaluation

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Excavation and Offsite Disposal	Alternative 3 Excavation with Particle Separation and Backfill	Alternative 4 *In Situ* Soil Stabilization with Excavation and Offsite Disposal	Alternative 5 In Situ Soil Stabilization
Effectiveness					
Overall Protection of human health and the environment	Does not meet RAOs	Meets RAOs through removal of soil from the site	Meets RAOs through removal of the lead and PAHs in soil	Meets RAOs through removal of the soil from the site	Partially meets RAOs. Lead mobility will be significantly decreased, but risks to human health and ecological receptors will remain.
Compliance with ARARs	Does not trigger ARARs	Implementation would require compliance with location- and action-specific ARARs. Includes requirements relating to stormwater runoff, dust emissions, management of hazardous and non-hazardous waste, and on-site staging piles.	Implementation would require compliance with location-, action- and chemical-specific ARARs. Includes requirements relating to stormwater runoff, dust emissions, management of hazardous and non-hazardous waste, on-site staging piles, and land disposal.	Implementation would require compliance with location- and action-specific ARARs. Includes requirements relating to stormwater runoff, dust emissions, management of non-hazardous waste, and on-site staging piles.	Implementation would require compliance with location- and action-specific ARARs. Includes requirements relating to stormwater runoff, dust emissions, and management of non-hazardous waste.
Long-term effectiveness and permanence	Not effective in the long-term.	All soil with COCs above RAOs removed from the site. Residual site risk is acceptable.	Lead and PAHs removed from the soil. Residual site risk is acceptable. Lead particles reclaimed through particle separation are recycled.	All soil with COCs above RAOs removed from the site. Residual site risk is acceptable	All soil with PAHs above RAOs will be removed from the site. Lead will remain at the site, but will be in a form that limits leaching. Risks to human health and ecological receptors will remain. LUCs will be required indefinitely.

TABLE 5-2
Summary of Technical Evaluation

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Excavation and Offsite Disposal	Alternative 3 Excavation with Particle Separation and Backfill	Alternative 4 *In Situ* Soil Stabilization with Excavation and Offsite Disposal	Alternative 5 In Situ Soil Stabilization
Reduction of toxicity, mobility or volume through treatment	Does not reduce toxicity, mobility, and volume.	Reduces toxicity, mobility, and volume through soil removal. Contaminants are not destroyed, but rather moved to an appropriate permitted disposal facility.	Reduces toxicity, mobility, and volume through removal of the COCs from the soil. Treated soil is used as backfill and lead and PAHs are recycled or disposed of in accordance with appropriate regulations.	Reduces toxicity, mobility, and volume through soil removal. Stabilization reduces lead mobility in soil. Contaminants are not destroyed, but rather moved to an appropriate permitted disposal facility.	Reduces toxicity, mobility, and volume of PAHs through soil removal. Eliminates mobility of lead, but does not address toxicity or volume. Lead remains in place.
Short-term effectiveness	Not effective in the short-term.	Increased risks to site workers and the nearby community due to construction activity. Rail will be used to minimize truck traffic. Potential dust emission issues associated with excavation requiring engineering controls. Action will require ten weeks in the field to complete.	Increased risks to site workers and the nearby community due to construction activity. Potential dust emission issues associated with excavation, mechanical screening, and particle separation process requiring engineering controls. Action will require 26 weeks in the field to complete.	Increased risks to site workers and the nearby community due to construction activity. Increased truck traffic. Potential dust emission issues associated with excavation and reagent mixing requiring engineering controls. Action will require ten weeks in the field to complete.	Increased risks to site workers due to construction activity. Potential dust emission issues associated with reagent mixing. Action will require six week in the field to complete
Implementability					
Technical Feasibility	Feasible	Excavation is a standard and reliable technology. Monitoring the technical aspects easily done.	Excavation and particle separation are reliable technologies. Monitoring the technical aspects easily done.	Excavation and *in situ* stabilization are reliable technologies. Monitoring the technical aspects easily done.	*In situ* stabilization is a reliable technology. Monitoring the technical aspects easily done.
Administrative Feasibility	Feasible	Disposal of excavated material may require the use of rail and could require additional permitting.	No specific issues identified.	Treated waste is nonhazardous and additional permitting is not necessary for transport or disposal.	LUCs will be required indefinitely.

TABLE 5-2
Summary of Technical Evaluation

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Excavation and Offsite Disposal	Alternative 3 Excavation with Particle Separation and Backfill	Alternative 4 *In Situ* Soil Stabilization with Excavation and Offsite Disposal	Alternative 5 In Situ Soil Stabilization
Availability of Services and Materials	Not applicable	Services and materials are readily available. Limited number of disposal facilities.	There are a limited number of suppliers that perform this work.	Services and materials are readily available.	Services and materials are readily available.
State and Community Acceptance	Unlikely	To be determined	To be determined	To be determined	Not accepted by State as is
Cost					
Capital Cost	$0	$11,210,000	$5,444,000	$5,243,000	$2,276,000

5.1 Alternative 1—No Action

Effectiveness

Alternative 1, no action, implies that no work would be done; therefore, this alternative is not capable of meeting the RAOs presented in Section 3. Alternative 1 does not address or mitigate the potential identified risks to human health and the environment or reduce the potential for horizontal and vertical contaminant migration. Alternative 1 does not reduce the long-term risk associated with lead and PAH-impacted surface soil and would not result in site closure under CERCLA with no further action.

This alternative would not involve any construction or operation and maintenance (O&M) activities and, therefore, would not trigger any action-specific of location-specific ARARs that control such activities. The clean-up goals for surface soil are based on minimizing unacceptable risks to human health. Alternative 1 does not achieve the clean-up levels established in Section 2.

The risks associated with contaminated surface soil would not be mitigated. Alternative 1 is ineffective in the long-term, as it would not provide any reduction of toxicity, mobility, or volume.

Implementability

Alternative 1, no action, does not have construction or monitoring components. This alternative is technically and administratively feasible. There are no implementability concerns posed by this remedy. State and community acceptance of this alternative is unlikely.

Cost

There are no costs posed by Alternative 1, no action.

5.2 Alternative 2—Excavation and Offsite Disposal

Effectiveness

Alternative 2, excavation with offsite disposal, is considered protective of human health and the environment. Through physical removal of the soil, Alternative 2 is suitable for bulk removal of lead and PAH-impacted surface soil above the site-specific clean-up levels. Alternative 2 will require ten weeks of field work to achieve RAOs.

Alternative 2 would have to comply with ARARs. All location-specific ARARs presented in **Appendix B** are applicable to Alternative 2. Action-specific ARARs applicable to Alternative 2 include requirements relating to the management of stormwater runoff from land disturbing activities, the management of fugitive dust emissions, the management of hazardous and non-hazardous waste on site, and the management of on-site staging piles. Chemical-specific ARARs to be considered include the USEPA Residential Soil RSLs, as these criteria were evaluated to identify the target treatment area and will be considered during the removal action to determine the extent of treatment.

Alternative 2 is effective in the long-term, as all soil with concentrations above their action levels would be physically removed and long-term environmental monitoring and LUCs would not be necessary. However, contaminants are not destroyed, but rather moved to a permitted facility. Alternative 2 eliminates toxicity, mobility, and volume of lead and PAHs from the site through removal.

Alternative 2 would raise overall site risk for the period that the action took place. Risks to site workers and the nearby community would increase due to construction activity. Engineering controls would be implemented to control dust, sediment and erosion control, and stormwater management. There would be an increase in truck traffic transporting the soil from the site to the nearest rail spur that could cause a greater risk of injury or accidents. The health and safety issues with Alternative 2 are due to dust emissions, lead and PAH exposure, and heavy equipment used for excavation.

Implementability

Alternative 2, excavation with offsite disposal, is technically feasible and easily implementable. Shallow subsurface utilities in the excavation area may be relocated or abandoned. Monitoring the removal effectiveness is easily completed. Transportation and disposal of excavated material may require the use of rail and could require additional permitting. Services and materials associated with implementation of Alternative 2 are standard and readily available; however, there are a limited number of disposal facilities. State acceptance of this alternative is subject to review. Community acceptance of this alternative is unknown and would be determined during the public comment period.

Cost

Alternative 2, excavation with offsite disposal, is estimated to cost $11,210,000 (a +50%/ -30% range of $7.9 million to $16.8 million). This is equivalent to $434/yd^3. There are no O&M costs associated with this alternative.

5.3 Alternative 3—Excavation with Particle Separation and Backfill

Effectiveness

Alternative 3, excavation with particle separation and backfill, is considered protective of human health and the environment. Through physical particle removal, Alternative 3 is suitable for bulk removal of lead and PAH-impacted surface soil above the site-specific clean-up levels. Alternative 3 will require 26 weeks of field work to achieve RAOs.

Alternative 3 would have to comply with ARARs. All location-specific ARARs presented in **Appendix B** are applicable to Alternative 3. Action-specific ARARs applicable to Alternative 3 include requirements relating to the management of stormwater runoff from land disturbing activities, the management of fugitive dust emissions, the management of hazardous and non-hazardous waste on site, and the management of on-site staging piles. Chemical-specific ARARs to be considered include the USEPA Residential Soil RSLs, as these criteria were evaluated to identify the target treatment area and will be considered during the removal action to determine the extent of treatment, and Land Disposal

Restrictions (LDRs) for backfilling with treated material. During treatment, the hazardous constituent, lead, would be removed from the soil. Therefore, once treated, the soil would no longer contain hazardous waste. Treated soil will be utilized as backfill if the Universal Treatment Standards (UTS) were met. The UTS for lead is 0.75 mg/L by TCLP.

Alternative 3 is effective in the long-term, as the soil would be physically removed and managed accordingly. Contaminants are removed from the soil through the particle separation process and lead is recycled. Alternative 3 eliminates toxicity, mobility, and volume of lead and PAHs from the site and long-term environmental monitoring and LUCs would not be necessary.

Alternative 3 would raise overall site risk for the period that the action took place. Risks to site workers would increase due to construction activity. Engineering controls would be implemented for dust control, sediment and erosion control, and stormwater management. The health and safety issues with Alternative 3 are due to dust emissions, lead and PAH exposure, and heavy equipment use.

Implementability

Alternative 3, excavation with particle separation and backfill, is technically feasible and has been performed on other skeet ranges. The action can be easily monitored to ensure the removal goals are being met. Shallow subsurface utilities in the excavation area may be relocated or abandoned. There are a limited number of suppliers in the United States that perform this work. State acceptance of this alternative is subject to review. Community acceptance of this alternative is unknown and would be determined during the public comment period.

Cost

Alternative 3, excavation with particle separation, is estimated to cost $5,444,000 (a +50%/-30% range of $3.8 million to $8.2 million). This is equivalent to $211/yd^3. There are no O&M costs associated with Alternative 3.

5.4 Alternative 4— *In Situ* Soil Stabilization with Excavation and Offsite Disposal

Effectiveness

Alternative 4, *in situ* soil stabilization with excavation and offsite disposal, is protective of human health and the environment. Through physical removal of the soil, Alternative 4 is suitable for bulk removal of lead and PAH-impacted surface soil above the site-specific clean-up levels. Alternative 4 would require ten weeks of field work to achieve RAOs.

Alternative 4 would have to comply with ARARs All location-specific ARARs presented in **Appendix B** are applicable to Alternative 4. Action-specific ARARs applicable to Alternative 4 include requirements relating to the management of stormwater runoff from land disturbing activities, the management of fugitive dust emissions, the management of non-hazardous waste on site, and the management of on-site staging piles. Because soil will be treated prior to excavation, requirements associated with the management of hazardous

waste on site are not applicable. Chemical-specific ARARs to be considered include the USEPA Residential Soil RSLs, as these criteria were evaluated to identify the target treatment area and will be considered during the removal action to determine the extent of treatment.

Alternative 4 is effective and protective in the long-term, as the soil would be physically removed. However, stabilization does not destroy contaminants, but rather it makes them resistant to chemical weathering so the excavated material can be transported offsite and disposed of as non-hazardous waste at an appropriate disposal facility. Alternative 4 eliminates toxicity, mobility, and volume of lead and PAHs from the site. Long-term environmental monitoring and LUCs would not be necessary.

Alternative 4 would raise overall site risk for the period that the action took place. Risks to site workers and the nearby community would increase due to construction activity. Engineering controls would be implemented for dust control, sediment and erosion control, and stormwater management. There would be an increase in truck traffic that could cause a greater risk of injury or accidents. The health and safety issues with Alternative 4 are due to dust emissions, lead and PAH exposure, and heavy equipment used for excavation.

Implementability

Alternative 4, *in situ* soil stabilization with excavation and offsite disposal, is technically feasible and easily monitored. Shallow subsurface utilities in the excavation area may be relocated or abandoned. Treated material would need to be transported offsite for disposal. Services and materials associated with implementation of Alternative 4 are readily available. State acceptance of this alternative is subject to review. Community acceptance of this alternative is unknown and would be determined during the public comment period.

Cost

Alternative 4, *in situ* soil stabilization with excavation and offsite disposal, is estimated to cost $5,243,000 (a +50%/-30% range of $3.7 million to $7.9 million). This is equivalent to $203/yd^3. There are no O&M costs associated with Alternative 4.

5.5 Alternative 5—*In Situ* Soil Stabilization

Effectiveness

Alternative 5, *in situ* soil stabilization, primarily addresses the mobility of lead in surface soil. The toxicity and volume of lead-impacted material is not reduced. All soil with PAHs above RAOs would be physically removed from the site, eliminating the toxicity, mobility, and volume associated with PAH-impacted soil. Alternative 5 would require six weeks of field work to complete. This alternative would eliminate the potential for lead contaminant migration; however, all RAOs would not be achieved. Since lead and PAH-impacted surface soil is left in place, Alternative 5 does not reduce the long-term risks to human health and the environment. LUCs would be required be required indefinitely.

Alternative 5 would have to comply with ARARs. All location-specific ARARs presented in **Appendix B** are applicable to Alternative 5. Action-specific ARARs applicable to Alternative 5 include requirements relating to the management of stormwater runoff from land

disturbing activities, the management of fugitive dust emissions, and the management of non-hazardous waste on site. Chemical-specific ARARs to be considered include the USEPA Residential Soil RSLs, as these criteria were evaluated to identify the target treatment area and will be considered during the removal action to determine the extent of treatment.

Alternative 5 would raise overall site risk for the period that the action took place. Risks to site workers would increase due to removal activity. Engineering controls would be implemented for dust control. The health and safety issues with Alternative 5 are due to dust emissions associated with reagent mixing, lead and PAH exposure, and heavy equipment.

Implementability

Alternative 5, *in situ* soil stabilization, is technically feasible. Shallow subsurface utilities in the treatment area may be relocated or abandoned. Alternative 5 is administratively feasible; however, LUCs would be required indefinitely, since the RAOs would not be fully achieved. Services and materials associated with implementation of Alternative 5 are readily available. The State does not accept this alternative without additional measures to achieve the RAOs. Community acceptance of this alternative is unknown and would be determined during the public comment period.

Cost

Alternative 5, *in situ* soil stabilization, is estimated to cost $2,276,000 (a +50%/-30% range of $1.6 million to $3.4 million). This is equivalent to $88/yd^3. There are no O&M costs associated with this alternative.

SECTION 6

Comparative Analysis of Removal Action Alternatives

Section 5 provided an evaluation of the alternatives based on their effectiveness, ease of implementation, and cost. In this section, the alternatives are directly compared to one another for each of these three criteria. This analysis clarifies which alternative is preferable in each category. The removal actions are summarized for comparison in **Table 5-2**.

6.1 Effectiveness

6.1.1 Protection of Human Health and the Environment

Alternatives 2, 3, and 4 can achieve the RAOs specified in Section 3. Alternatives 2 and 4 are similar in protectiveness because they each involve the complete excavation and offsite transport of impacted soil, eliminating risks to human health and ecological receptors at the site. Alternative 3 provides slightly less protection to human health and the environment because risks are mitigated but not eliminated. Alternative 5 has the potential to partially achieve the RAOs; however, risks to human health and the environment may not be mitigated. All soil with PAHs above site-specific clean-up levels would be removed from the site and lead mobility would be significantly reduced; however, lead-impacted soil would be left in place following treatment. Risks to human health and ecological receptors would remain and LUCs would be required indefinitely. Alternative 1 is not considered protective of human health or the environment and does not achieve the RAOs of this EE/CA because contamination would remain in place without administrative controls.

6.1.2 Compliance with ARARs and Other Criteria, Advisories, and Guidance

Alternatives 1 through 5 are expected to comply with all ARARs at the completion of implementation.

Action-Specific ARARs

Action-specific ARARs are applicable to each alternative presented, as summarized in **Appendix B**.

Alternatives 2, 3, 4, and 5 would be implemented in compliance with requirements relating to the management of stormwater runoff from land disturbing activities, the management of fugitive dust emissions, and the management of non-hazardous solid waste onsite. If Alternate Design Criteria for construction management techniques, best management practices for sediment and erosion controls, and stormwater management measures, as specified in 15A NCAC 02H .1008(h), are utilized, then the substantive requirements included in that provision will be met and documented either in a work plan or design document. Administrative reviews are not required for actions taken under CERCLA. Requirements pertaining to the management of fugitive dust emissions beyond the facility

boundary specified in 15A NCAC 02D .0540 (g) will be met. Land disturbing activities are exempt from this regulation; however, since soil is contaminated, dust will be controlled to prevent spread beyond the site boundary.

Alternatives 2, 3, and 4 will additionally be implemented in compliance with requirements regarding on-site staging piles, since each of these alternatives involves excavating material for onsite storage. Storage includes mixing, sizing, blending or other similar physical operations so long as the action is intended to prepare the waste for subsequent management or treatment. The substantive requirements regarding design, operation, and closure of staging piles associated with a corrective action will be met. Administrative reviews are not required for CERCLA actions and a permit will not be required.

Alternatives 2 and 3 involve the excavation of hazardous waste; therefore, these alternatives would need to be implemented in accordance with requirements regarding hazardous waste management in containers onsite.

Location-Specific ARARs

Location-specific ARARs are applicable to Alternatives 2, 3, 4, and 5 based on the location of the treatment area near a wetland, within the Atlantic Migratory Flyway, and within the coastal zone, as summarized in **Appendix B**. None of the alternatives presented include the discharge of dredged material in a wetland. Wetlands will not be disturbed during remedial action. Activities at the D-9 Skeet Range that will affect North Carolina's coastal zone will be consistent to the maximum extent practicable with North Carolina's enforceable policies. Activities performed on-site and in compliance with CERCLA are not subject to administrative review; however, substantive requirements of making a consistency determination will be met.

Chemical-Specific ARARs

Chemical-specific ARARs will be considered for each of the alternatives presented, as summarized in **Appendix B**. USEPA Residential Soil RSLs were evaluated to identify the target treatment area and will be considered during the removal action to determine the extent of treatment.

Because Alternative 3 includes backfilling with treated soil, this alternative would be implemented in accordance with LDRs. Once treated, the soil would no longer contain hazardous waste and would meet the UTS. To determine if the treated soil meets the standards of 40 CFR 268.40, a sample of the waste will be tested. If the waste contains constituents in excess of applicable UTS, backfilling with treated material will be prohibited.

6.1.3 Long-term Effectiveness and Permanence

Once RAOs have been achieved, Alternatives 2, 3, and 4 are expected to have residual risks of approximately the same magnitude, since contaminants would be physically removed from the site. Alternatives 2 and 4 are similar in long-term effectiveness because they each involve the complete excavation and offsite transport of impacted soil, eliminating all future risks at the site. Alternative 3 provides slightly less long-term effectiveness because contaminants are physically removed from the soil to the extent that site-specific clean-up levels are achieved, and then the treated soil is used to backfill the site. Residual

contamination may remain. Alternative 5 is not expected to provide long-term effectiveness. Although Alternative 5 will remove PAHs above site-specific clean-up levels and reduce the mobility of lead in the long-term through stabilization, lead-impacted soil would be left in place following treatment. Risks to human health and ecological receptors would remain and LUCs would be required indefinitely. Alternative 1 will not provide long-term effectiveness because contamination would remain in place without administrative controls.

6.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative 3 would be the most successful in reducing toxicity, mobility, and volume. Particle separation irreversibly removes the contaminants from soil through a physical process. Treated soil would be used as backfill and recovered lead would be recycled, minimizing the volume of waste to be transported offsite for disposal. Alternatives 2 and 4 would reduce toxicity, mobility, and volume at the site since the impacted soil would be excavated; however, contaminants would not be destroyed. With Alternative 2, the full volume of soil would require offsite disposal as hazardous waste, with no overall reduction in toxicity, mobility, or volume. With Alternative 4, the full volume of soil would require offsite disposal as non-hazardous waste. Stabilization of the excavated material would reduce the mobility of lead in the landfill; however, the overall toxicity and volume would not be reduced. Alternative 5 would reduce the mobility of lead in soil through stabilization; however, lead-impacted soil would be left in place following treatment. The volume and toxicity of lead-impacted material would not be reduced. PAH-impacted soil would be excavated, which would reduce the toxicity, mobility, and volume at the site; however, contaminants would not be destroyed. The excavated volume would require offsite disposal as non-hazardous waste, with no overall reduction in toxicity, mobility, or volume. Alternative 1 provides no reduction in toxicity, mobility, or volume because contamination would remain in place.

6.1.5 Short-term Effectiveness

Risks to workers, the community, and the environment are minimized for Alternative 5. Risks to site workers are less than other alternatives because impacted soil would be treated *in situ* rather than excavated, requiring less heavy equipment and minimizing exposure to site contaminants. Alternative 5 would involve a slight increase in risks to the community, resulting from truck traffic associated with the excavation and offsite disposal of PAH-impacted soil. Alternative 5 requires the least amount of time in the field to complete (six weeks). Alternative 3 would be slightly less effective than Alternative 5 in the short-term. Risks to site workers are higher because impacted soil would be excavated, then treated onsite, requiring heavy equipment and material handling. Truck traffic is minimized with Alternative 3. Alternative 3 requires the most amount of time in the field to complete (26 weeks). Alternative 4 would be less effective than Alternatives 3 and 5 in the short-term. Site workers would be at risk due to the use of heavy equipment to mix the stabilization agent *in situ* and excavate the impacted soil. The full volume of excavated material would be transported offsite as non-hazardous waste, resulting in increased truck traffic. Alternative 4 would require 10 weeks in the field to complete. Alternative 2 has the highest short-term risk to workers, the community, and the environment. Risks to site workers are higher because impacted soil would be excavated, requiring heavy equipment. The full volume of excavated soil would be transported offsite as hazardous waste, resulting in increased truck

traffic, the use of rail and potential exposure to the surrounding communities. Alternative 2 would require 10 weeks in the field to complete. Alternative 1 involves no action, so there would be no implementation time or impacts to site workers, the community, or the environment.

6.2 Implementability

Alternative 1 involves no action and, therefore, is easy to implement. Of the active alternatives, Alternative 4 is the most easily implementable. Stabilization and excavation are proven and reliable technologies, with equipment and materials readily available. Excavated waste is non-hazardous and would not require any additional permitting. Because all impacted soil would be removed from the site, no future remedial actions for soil are anticipated. Alternatives 2 and 3 are similarly implementable. Both excavation and particle separation are proven and reliable technologies. Because all impacted soil would be removed from the site or treated, no future remedial actions for soil are anticipated for either alternative. However, the disposal of hazardous waste in Alternative 2 may require additional permitting and there are a limited number of suppliers that can perform Alternative 3. Alternative 5 is the least implementable alternative. Although *in situ* stabilization is proven to prevent leaching of lead in soil, it has not been proven to reduce toxicity. Lead-impacted soil would remain in place, therefore, LUCs would be required indefinitely and future remedial actions may be necessary.

6.3 Cost of Alternatives

The costs estimates for the alternatives are provided in **Appendix C** and summarized in **Table 6-1**. Alternative 1 has no cost and is thereby the least expensive. Alternative 5, *in situ* soil stabilization, has the lowest cost at $2,276,000 or $88/yd^3. Alternative 4, *in situ* stabilization with excavation and offsite disposal, has the next lowest cost at $5,243,000 or $203/ yd^3, closely followed by Alternative 3, excavation with particle separation and backfill, at $5,444,000 or $211/ yd^3. Alternative 2, excavation with offsite disposal, has the highest cost at $11,210,000 or $434/yd^3.

TABLE 6-1
Cost Estimates for Removal Action Alternatives

Alternative	Capital Costs	+50% / -30% Range	Cost per Cubic Yard
Alternative 1 - No Action	$0		$0
Alternative 2 - Excavation with Offsite Disposal	$11,210,000	$7.9 M / $168 M	$434
Alternative 3 - Excavation with Particle Separation and Backfill	$5,444,000	$3.8M / $8.2M	$211
Alternative 4 - Ex Situ Stabilization and Offsite Disposal	$5,243,000	$3.7M / $7.8M	$203
Alternative 5 - In Situ Stabilization	$2,276,000	$1.6M / $3.4M	$88

Note: Costs presented herein are for comparison purposes on and are not a guarantee of fixed cost for the specific alternative. The cost estimate is accurate to +50%-30%.

SECTION 7

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Appendix A
Human Health Risk Screening

APPENDIX A

Human Health Risk Screening

The data were evaluated as two separate exposure groupings: surface soil, and combined surface and subsurface soil. The data included in the risk evaluation were all validated. The validated data were evaluated to determine the reliability of the data for use in the HHRS. A review of the data identified the following criteria for data usability:

Estimated values flagged with a J qualifier were treated as detected concentrations.

For duplicate samples, the maximum concentration between the two samples was used as the sample concentration.

TABLE A-1
Summary of Samples Evaluated in the Human Health Risk Evaluation

Date of Sampling	Sample	Parameters (Surface Soil)
10/20/08	ASR2_82-SS28-08D	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS29-08D	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS29D-08D[1]	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS30-08D	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS31-08D	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS32-08D	SVOCs, Perchlorate, Metals
07/28/07	SR-IS03-0-1-07C	Lead
07/28/07	SR-IS04-0-1-07C	Lead
06/21/07	SR-SS11-0-1	Lead
06/21/07	SR-SS13-0-1	Lead
06/21/07	SR-SS14-0-1	Lead
06/21/07	SR-SS15-0-1	Lead
06/21/07	SR-SS16-0-1	Lead
06/21/07	SR-SS17-0-1	Lead
06/21/07	SR-SS18-0-1	Lead
06/21/07	SR-SS19-0-1	Lead
06/21/07	SR-SS20-0-1	Lead
03/12/09	SR-SS46-09A	Lead
03/12/09	SR-SS47-09A	Lead
03/12/09	SR-SS48-09A	Lead
03/12/09	SR-SS49-09A	Lead

TABLE A-1
Summary of Samples Evaluated in the Human Health Risk Evaluation

Date of Sampling	Sample	Parameters (Surface Soil)
03/12/09	SR-SS50-09A	Lead
03/12/09	SR-SS51-09A	Lead
03/12/09	SR-SS52-09A	Lead
03/12/09	SR-SS52D-09A[1]	Lead
03/12/09	SR-SS53-09A	Lead
10/23/08	ASR2_82-IS05-13-14-08D	SVOCs, Perchlorate, Metals
10/23/08	ASR2_82-IS05D-13-14-08D[1]	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS28-08D	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS29-08D	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS29D-08D[1]	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS30-08D	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS31-08D	SVOCs, Perchlorate, Metals
10/20/08	ASR2_82-SS32-08D	SVOCs, Perchlorate, Metals
07/28/07	SR-IS03-0-1-07C	Lead
07/28/07	SR-IS04-0-1-07C	Lead
03/12/09	SR-IS10-09A	Lead
03/12/09	SR-IS13-09A	Lead
03/12/09	SR-IS13D-09A[1]	Lead
03/12/09	SR-IS15-09A	Lead
03/12/09	SR-IS17-09A	Lead
03/12/09	SR-IS46-09A	Lead
03/12/09	SR-IS47-09A	Lead
03/12/09	SR-IS50-09A	Lead
03/12/09	SR-IS52-09A	Lead
06/21/07	SR-SS11-0-1	Lead
06/21/07	SR-SS13-0-1	Lead
06/21/07	SR-SS14-0-1	Lead
06/21/07	SR-SS15-0-1	Lead
06/21/07	SR-SS16-0-1	Lead
06/21/07	SR-SS17-0-1	Lead
06/21/07	SR-SS18-0-1	Lead
06/21/07	SR-SS19-0-1	Lead

TABLE A-1
Summary of Samples Evaluated in the Human Health Risk Evaluation

Date of Sampling	Sample	Parameters (Surface Soil)
06/21/07	SR-SS20-0-1	Lead
03/12/09	SR-SS46-09A	Lead
03/12/09	SR-SS47-09A	Lead
03/12/09	SR-SS48-09A	Lead
03/12/09	SR-SS49-09A	Lead
03/12/09	SR-SS50-09A	Lead
03/12/09	SR-SS51-09A	Lead
03/12/09	SR-SS52-09A	Lead
03/12/09	SR-SS52D-09A[1]	Lead
03/12/09	SR-SS53-09A	Lead

[1] Duplicate of preceding sample

The HHRS was conducted in three steps using the following risk ratio technique (Navy, 2000):

Step 1

The maximum detected constituent concentrations in soil were screened against the USEPA adjusted residential RSLs (USEPA, 2009a), and two times the mean surface and subsurface soil Base background concentration (for metals only) (Baker, 2001). Residential soil RSLs are used for screening since they are more conservative than industrial soil RSLs. RSLs are based on default exposure parameters under Reasonable Maximum Exposure (RME) conditions for oral, inhalation, and dermal exposures (USEPA, 2009a). For RSLs based on noncarcinogenic effects, the value presented in the RSL table for a hazard quotient (HQ) of 1.0 was divided by 10 (resulting in an HQ = 0.1) to conservatively account for exposure to multiple constituents. RSLs based on carcinogenic effects were used as presented in the RSL table, and are based on an excess lifetime cancer risk (ELCR) of 1×10^{-6}.

If the maximum detected concentration of an analyte exceeded its RSL and two times the mean Base background value (if available), the analyte was identified as a contaminant of potential concern (COPC) and carried to Step 2.

Step 2

The Step 2 HHRS involved calculating corresponding risk levels, cumulative corresponding hazard indices (HIs) for the noncarcinogenic COPCs, and cumulative corresponding cancer risk levels for the carcinogenic COPCs identified in Step 1. The corresponding risk level was calculated for each COPC, as follows:

$$\textit{corresponding risk level} = \frac{\textit{concentration x acceptable risk level}}{\textit{RSL}}$$

The acceptable risk level is an HQ of 1 for noncarcinogenic COPCs or a carcinogenic risk of 1×10^{-6} for carcinogenic COPCs, based on Navy risk-ratio evaluation methodology (2000). The USEPA RSLs for residential soil were used in the calculation. The RSL was not adjusted as was done in Step 1. The corresponding risk level for each COPC was calculated using the equation above. All of the corresponding risk values for each COPC were summed to calculate the cumulative corresponding HI (for noncarcinogens) and cumulative corresponding cancer risk (for carcinogens). A cumulative corresponding HI was also calculated for each target organ/critical effect. If the cumulative corresponding HI for a target organ/critical effect was greater than 0.5 or the cumulative corresponding cancer risk was greater than 5×10^{-5}, the risk evaluation proceeded to Step 3. Only those constituents evaluated in Step 2 that contributed to the hazard or risk were carried to Step 3.

Step 3

The corresponding risk level for each COPC was re-calculated (as discussed above) using the upper confidence limit (UCL) on the mean in place of the maximum detected concentration (if more than five samples were available) to obtain a more site-specific risk ratio. If the cumulative corresponding HI by target organ/critical effect was greater than 0.5 or the cumulative corresponding cancer risk was greater than 5×10^{-5}, then constituents contributing to these values were considered COPCs. The most current version of the ProUCL software program (USEPA, 2009b), was used to test the data distribution and calculate UCL exposure point concentrations used for the Step 3 risk ratio calculations. In cases where there was less than five samples in the data set, or the recommended UCL exceeded the maximum detected concentration, the maximum concentration was used as the exposure point concentration (EPC).

Human Health Risk Screening Results

Surface Soil

Tables A-1 and A-1a present the risk-based screening and risk ratio evaluation for surface soil within the site. As shown on Table A-1, PAHs and three metals (arsenic, chromium, and lead) exceeded the first step of the screening and were selected as COPCs for evaluation in Step 2.

Based on Step 2 of the screening process (Table A-1a), all Step 1 surface soil COPCs were identified as Step 3 COPCs. Step 3 could not be performed for the surface soil as there were less than five samples. Therefore, the maximum concentration from the data set was used as the EPC.

Surface and Subsurface Soil

Tables A-2, A-2a, and A-2b, present the risk-based screening and risk ratio evaluation for surface and subsurface soil within the site. As shown on Table A-2, PAHs and three metals (arsenic, chromium, and lead) exceeded the first step of the screening and were selected as COPCs for evaluation in Step 2.

Based on Step 2 of the screening process (Table A-2a), all Step 1 surface soil COPCs were identified as Step 3 COPCs. Based on Step 3 of the screening process (Table A-2b), none of the COPCs could be eliminated.

Based on the HHRS for both surface and subsurface soil, all of the potentially unacceptable risks associated with the PAH concentrations are detected in one sample, ASR2.82-SS28. Therefore, the risk ratio screening (Step 2) was performed for the soil for all samples with the exception of ASR2.82-SS28. As shown on Table A-3, none of the COPCs identified for the surface soil or combined surface and subsurface soil would be COPCs for soil if sample ASR2.82-SS28 is not included in the data set.

The screening assessment assumed that all of the chromium present in the soil is in the hexavalent form of chromium and that hexavalent chromium is carcinogenic by ingestion. Beginning in December 2009, USEPA began calculating RSLs in soil and groundwater based on the assumption that hexavalent chromium is carcinogenic by ingestion. Assessment of ingestion cancer risks has been based on a chronic drinking water exposure bioassay, completed by the National Toxicology Program in 2008. Based on the results from this study, both the California Environmental Protection Agency (Cal EPA) and the New Jersey Department of Environmental Protection (NJDEP) developed criterion based on protection of human health from carcinogenic effects from exposure to hexavalent chromium. Currently, USEPA's Integrated Risk Information System (IRIS) profile for hexavalent chromium does not reflect these new findings regarding ingestion carcinogenicity. USEPA's formal position (as stated on IRIS) currently is that carcinogenicity of hexavalent chromium by ingestion cannot be determined. Under the cancer risk assessment guidelines in effect at the time that determination was made, hexavalent chromium is considered "not classifiable as a human carcinogen" by ingestion. The values developed by state agencies are still advisory in nature, and in the case of California, are still undergoing review. Additionally, as hexavalent chromium is not associated with historic use of the site, it is unlikely that the all of chromium detected in the soil is in the hexavalent form. Therefore, the risks associated with the chromium detected it the site are over-estimated, and are most likely much lower than those identified in the HHRS.

Table A-1
Occurance, Distribution, and Selection of Chemicals of Potential Concern
D-9 Skeet Range, Theorteical Shot Fall Zone, MCB CampLej, North Carolina

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface Soil	90-12-0	1-Methylnaphthalene	1.2E-03 J	1.5E-02	MG/KG	ASR2_82-SS28-08D	2/5	0.009 - 0.01	1.5E-02	N/A	2.2E+01 C	N/A		NO	BSL
Shot fall area	91-57-6	2-Methylnaphthalene	1.7E-03 J	3.6E-02	MG/KG	ASR2_82-SS28-08D	2/5	0.009 - 0.01	3.6E-02	N/A	3.1E+01 N	1.6E+00	NCPSRG	NO	BSL
	83-32-9	Acenaphthene	1.5E-03 J	1.9E-01	MG/KG	ASR2_82-SS28-08D	4/5	0.009 - 0.78	1.9E-01	N/A	3.4E+02 N	8.4E+00	NCPSRG	NO	BSL
	208-96-8	Acenaphthylene	6.5E-04 J	6.4E-03 J	MG/KG	ASR2_82-SS28-08D	3/5	0.009 - 0.01	6.4E-03	N/A	3.4E+02 N	1.1E+01	NCPSRG	NO	BSL
	120-12-7	Anthracene	5.0E-04 J	3.0E-01	MG/KG	ASR2_82-SS28-08D	5/5	0.009 - 0.78	3.0E-01	N/A	1.7E+03 N	6.6E+02	NCPSRG	NO	BSL
	56-55-3	**Benzo(a)anthracene**	**4.7E-03 J**	**2.8E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/5**	**0.009 - 0.78**	**2.8E+00**	**N/A**	**1.5E-01 C**	**1.8E-01**	**NCPSRG**	**YES**	**ASL**
	50-32-8	**Benzo(a)pyrene**	**6.2E-03 J**	**4.4E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/5**	**0.009 - 0.78**	**4.4E+00**	**N/A**	**1.5E-02 C**	**5.9E-02**	**NCPSRG**	**YES**	**ASL**
	205-99-2	**Benzo(b)fluoranthene**	**6.2E-03 J**	**3.6E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/5**	**0.009 - 0.78**	**3.6E+00**	**N/A**	**1.5E-01 C**	**6.0E-01**	**NCPSRG**	**YES**	**ASL**
	191-24-2	Benzo(g,h,i)perylene	5.1E-03 J	2.5E+00 J	MG/KG	ASR2_82-SS28-08D	5/5	0.009 - 0.78	2.5E+00	N/A	1.7E+02 N	3.6E+02	NCPSRG	NO	BSL
	207-08-9	**Benzo(k)fluoranthene**	**5.4E-03 J**	**3.0E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/5**	**0.009 - 0.78**	**3.0E+00**	**N/A**	**1.5E+00 C**	**5.9E+00**	**NCPSRG**	**YES**	**ASL**
	218-01-9	Chrysene	6.5E-03 J	3.7E+00	MG/KG	ASR2_82-SS28-08D	5/5	0.009 - 0.78	3.7E+00	N/A	1.5E+01 C	1.8E+01	NCPSRG	NO	BSL
	53-70-3	**Dibenz(a,h)anthracene**	**1.1E-03 J**	**7.0E-01**	**MG/KG**	**ASR2_82-SS28-08D**	**5/5**	**0.009 - 0.78**	**7.0E-01**	**N/A**	**1.5E-02 C**	**1.9E-01**	**NCPSRG**	**YES**	**ASL**
	206-44-0	Fluoranthene	7.7E-03 J	3.2E+00	MG/KG	ASR2_82-SS28-08D	5/5	0.009 - 0.78	3.2E+00	N/A	2.3E+02 N	3.3E+02	NCPSRG	NO	BSL
	86-73-7	Fluorene	7.6E-04 J	7.0E-02	MG/KG	ASR2_82-SS28-08D	4/5	0.009 - 0.01	7.0E-02	N/A	2.3E+02 N	5.6E+01	NCPSRG	NO	BSL
	193-39-5	**Indeno(1,2,3-cd)pyrene**	**5.4E-03 J**	**2.4E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/5**	**0.009 - 0.78**	**2.4E+00**	**N/A**	**1.5E-01 C**	**2.0E+00**	**NCPSRG**	**YES**	**ASL**
	91-20-3	Naphthalene	8.7E-04 J	3.7E-02	MG/KG	ASR2_82-SS28-08D	3/5	0.009 - 0.01	3.7E-02	N/A	3.6E+00 C*	2.1E-01	NCPSRG	NO	BSL
	85-01-8	Phenanthrene	1.8E-03 J	1.5E+00	MG/KG	ASR2_82-SS28-08D	5/5	0.009 - 0.78	1.5E+00	N/A	1.7E+03 N	5.7E+01	NCPSRG	NO	BSL
	129-00-0	Pyrene	6.8E-03 J	3.9E+00	MG/KG	ASR2_82-SS28-08D	5/5	0.009 - 0.78	3.9E+00	N/A	1.7E+02 N	2.2E+02	NCPSRG	NO	BSL
	14797-73-0	Perchlorate	2.2E-03	3.0E-03	MG/KG	ASR2_82-SS32-08D	5/5	0.0022 - 0.003	3.0E-03	N/A	5.5E+00 N	N/A		NO	BSL
	7440-38-2	**Arsenic**	**8.8E-01 J**	**3.0E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**3/5**	**1 - 1.2**	**3.0E+00**	**6.3E-01**	**3.9E-01 C***	**5.8E+00**	**NCPSRG**	**YES**	**ASL**
	7440-39-3	Barium	2.8E+00 J	2.4E+01	MG/KG	ASR2_82-SS28-08D	5/5	20.9 - 23.6	2.4E+01	1.5E+01	1.5E+03 N	5.8E+02	NCPSRG	NO	BSL
	7440-47-3	**Chromium**	**2.5E+00**	**9.6E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/5**	**1 - 1.2**	**9.6E+00**	**6.1E+00**	**2.9E-01 C**	**3.8E+00**	**NCPSRG**	**YES**	**ASL**
	7439-92-1	**Lead**	**4.4E+00**	**6.7E+04**	**MG/KG**	**SR-SS13-0-1**	**24/24**	**0.31 - 28**	**6.7E+04**	**1.2E+01**	**4.0E+02 NL**	**2.7E+02**	**NCPSRG**	**YES**	**ASL**
	7439-97-6	Mercury	2.1E-02 J	4.8E-02 J	MG/KG	ASR2_82-SS32-08D	5/5	0.034 - 0.04	4.8E-02	8.1E-02	2.3E+00 N	1.0E+00	NCPSRG	NO	BSL

[1] Minimum/Maximum detected concentrations.
[2] Maximum concentration is used for screening.
[3] Background values are two times the arithmetic mean basewide background concentrations for surface soil.
Background values are from *Final Base Background Soil Study Report, Marine Corps Base Camp Lejeune, North Carolina*, Baker Environmental, April 25, 2001.
[4] Oak Ridge National Laboratory (ORNL). December, 2009. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (nc RSLs adjusted by dividing by 10) residential soil RSLs.
RSL value for acenaphthene used as surrogate for acenaphthylene.
RSL value for pyrene used as surrogate for benzo(g,h,i)perylene.
RSL value for anthracene used as surrogate for phenanthrene.
The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.
RSL value for mercury (inorganic salts) used as surrogate for mercury.
[5] Rationale Codes

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

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
C* = Carcinogenic, where N screening level < 100 x C screening level
N = Noncarcinogenic
NCPSRG = North Carolina Soil Remediation Goal, January 2010

TABLE A-1a
Risk Ratio Screening for Surface Soil, Maximum Detected Concentration
D-9 Skeet Range, Theroetical Shot Fall Zone, MCB CampLej, North Carolina

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Benzo(a)anthracene	5 - 5	2.8E+00	ASR2_82-SS28-08D	1.5E-01	1E-06	NA	2E-05	NA
Benzo(a)pyrene	5 - 5	4.4E+00	ASR2_82-SS28-08D	1.5E-02	1E-06	NA	3E-04	NA
Benzo(b)fluoranthene	5 - 5	3.6E+00	ASR2_82-SS28-08D	1.5E-01	1E-06	NA	2E-05	NA
Benzo(k)fluoranthene	5 - 5	3.0E+00	ASR2_82-SS28-08D	1.5E+00	1E-06	NA	2E-06	NA
Dibenz(a,h)anthracene	5 - 5	7.0E-01	ASR2_82-SS28-08D	1.5E-02	1E-06	NA	5E-05	NA
Indeno(1,2,3-cd)pyrene	5 - 5	2.4E+00	ASR2_82-SS28-08D	1.5E-01	1E-06	NA	2E-05	NA
Arsenic	3 - 5	3.0E+00	ASR2_82-SS28-08D	3.9E-01	1E-06	NA	8E-06	NA
Chromium	5 - 5	9.6E+00	ASR2_82-SS28-08D	2.9E-01	1E-06	NA	3E-05	NA
Lead	24 - 24	6.7E+04	SR-SS13-0-1	4.0E+02	NA	NA	NA	NA
Cumulative Corresponding Hazard Index[c]								
Cumulative Corresponding Cancer Risk[d]							**4E-04**	

[a] Corresponding Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[b] Corresponding Cancer Risk equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.
[d] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.
Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.
Constituents selected as COPCs are indicated by shading.
COPC = Constituent of Potential Concern
HI = Hazard Index
mg/kg = milligrams per kilogram
NA = Not available/not applicable.

Table A-2
Occurance, Distribution, and Selection of Chemicals of Potential Concern
D-9 Skeet Range, Theorteical Shot Fall Zone, MCB CampLej, North Carolina

Scenario Timeframe: Future
Medium: Soil*
Exposure Medium: Soil*

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Soil*	90-12-0	1-Methylnaphthalene	1.2E-03 J	1.5E-02	MG/KG	ASR2_82-SS28-08D	2/6	0.009 - 0.01	1.5E-02	N/A	2.2E+01 C	N/A		NO	BSL
Shot fall area	91-57-6	2-Methylnaphthalene	1.7E-03 J	3.6E-02	MG/KG	ASR2_82-SS28-08D	2/6	0.009 - 0.01	3.6E-02	N/A	3.1E+01 N	1.6E+00	NCPSRG	NO	BSL
	83-32-9	Acenaphthene	1.5E-03 J	1.9E-01	MG/KG	ASR2_82-SS28-08D	4/6	0.009 - 0.78	1.9E-01	N/A	3.4E+02 N	8.4E+00	NCPSRG	NO	BSL
	208-96-8	Acenaphthylene	6.5E-04 J	6.4E-03 J	MG/KG	ASR2_82-SS28-08D	3/6	0.009 - 0.01	6.4E-03	N/A	3.4E+02 N	1.1E+01	NCPSRG	NO	BSL
	120-12-7	Anthracene	5.0E-04 J	3.0E-01	MG/KG	ASR2_82-SS28-08D	5/6	0.009 - 0.78	3.0E-01	N/A	1.7E+03 N	6.6E+02	NCPSRG	NO	BSL
	56-55-3	**Benzo(a)anthracene**	**4.7E-03 J**	**2.8E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/6**	**0.009 - 0.78**	**2.8E+00**	**N/A**	**1.5E-01 C**	**1.8E-01**	**NCPSRG**	**YES**	**ASL**
	50-32-8	**Benzo(a)pyrene**	**6.2E-03 J**	**4.4E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/6**	**0.009 - 0.78**	**4.4E+00**	**N/A**	**1.5E-02 C**	**5.9E-02**	**NCPSRG**	**YES**	**ASL**
	205-99-2	**Benzo(b)fluoranthene**	**6.2E-03 J**	**3.6E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/6**	**0.009 - 0.78**	**3.6E+00**	**N/A**	**1.5E-01 C**	**6.0E-01**	**NCPSRG**	**YES**	**ASL**
	191-24-2	Benzo(g,h,i)perylene	5.1E-03 J	2.5E+00 J	MG/KG	ASR2_82-SS28-08D	5/6	0.009 - 0.78	2.5E+00	N/A	1.7E+02 N	3.6E+02	NCPSRG	NO	BSL
	207-08-9	**Benzo(k)fluoranthene**	**5.4E-03 J**	**3.0E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/6**	**0.009 - 0.78**	**3.0E+00**	**N/A**	**1.5E+00 C**	**5.9E+00**	**NCPSRG**	**YES**	**ASL**
	218-01-9	Chrysene	6.5E-03 J	3.7E+00	MG/KG	ASR2_82-SS28-08D	5/6	0.009 - 0.78	3.7E+00	N/A	1.5E+01 C	1.8E+01	NCPSRG	NO	BSL
	53-70-3	**Dibenz(a,h)anthracene**	**1.1E-03 J**	**7.0E-01**	**MG/KG**	**ASR2_82-SS28-08D**	**5/6**	**0.009 - 0.78**	**7.0E-01**	**N/A**	**1.5E-02 C**	**1.9E-01**	**NCPSRG**	**YES**	**ASL**
	206-44-0	Fluoranthene	7.7E-03 J	3.2E+00	MG/KG	ASR2_82-SS28-08D	5/6	0.009 - 0.78	3.2E+00	N/A	2.3E+02 N	3.3E+02	NCPSRG	NO	BSL
	86-73-7	Fluorene	7.6E-04 J	7.0E-02	MG/KG	ASR2_82-SS28-08D	4/6	0.009 - 0.01	7.0E-02	N/A	2.3E+02 N	5.6E+01	NCPSRG	NO	BSL
	193-39-5	**Indeno(1,2,3-cd)pyrene**	**5.4E-03 J**	**2.4E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**5/6**	**0.009 - 0.78**	**2.4E+00**	**N/A**	**1.5E-01 C**	**2.0E+00**	**NCPSRG**	**YES**	**ASL**
	91-20-3	Naphthalene	8.7E-04 J	3.7E-02	MG/KG	ASR2_82-SS28-08D	3/6	0.009 - 0.01	3.7E-02	N/A	3.6E+00 C*	2.1E-01	NCPSRG	NO	BSL
	85-01-8	Phenanthrene	1.8E-03 J	1.5E+00	MG/KG	ASR2_82-SS28-08D	5/6	0.009 - 0.78	1.5E+00	N/A	1.7E+03 N	5.7E+01	NCPSRG	NO	BSL
	129-00-0	Pyrene	6.8E-03 J	3.9E+00	MG/KG	ASR2_82-SS28-08D	5/6	0.009 - 0.78	3.9E+00	N/A	1.7E+02 N	2.2E+02	NCPSRG	NO	BSL
	14797-73-0	Perchlorate	2.2E-03	3.0E-03	MG/KG	ASR2_82-SS32-08D	5/6	0.0022 - 0.003	3.0E-03	N/A	5.5E+00 N	N/A		NO	BSL
	7440-38-2	**Arsenic**	**8.8E-01 J**	**3.0E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**4/6**	**1 - 1.2**	**3.0E+00**	**6.3E-01**	**3.9E-01 C***	**5.8E+00**	**NCPSRG**	**YES**	**ASL**
	7440-39-3	Barium	2.8E+00 J	2.4E+01	MG/KG	ASR2_82-SS28-08D	6/6	20.9 - 23.6	2.4E+01	1.5E+01	1.5E+03 N	5.8E+02	NCPSRG	NO	BSL
	7440-47-3	**Chromium**	**2.5E+00**	**9.6E+00**	**MG/KG**	**ASR2_82-SS28-08D**	**6/6**	**1 - 1.2**	**9.6E+00**	**6.1E+00**	**2.9E-01 C**	**3.8E+00**	**NCPSRG**	**YES**	**ASL**
	7439-92-1	**Lead**	**3.8E+00**	**6.7E+04**	**MG/KG**	**SR-SS13-0-1**	**33/33**	**0.31 - 28**	**6.7E+04**	**8.5E+00**	**4.0E+02 NL**	**2.7E+02**	**NCPSRG**	**YES**	**ASL**
	7439-97-6	Mercury	2.1E-02 J	4.8E-02 J	MG/KG	ASR2_82-SS32-08D	5/6	0.034 - 0.04	4.8E-02	7.1E-02	2.3E+00 N	1.0E+00	NCPSRG	NO	BSL

* Surface soil & subsurface soil combined

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

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

[4] Oak Ridge National Laboratory (ORNL). December, 2009. Regional Screening Levels for Chemical Contaminants at Superfund Sites.
http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (nc RSLs adjusted by dividing by 10) residential soil RSLs.
RSL value for Acenaphthene used as surrogate for Acenaphthylene.
RSL value for pyrene used as surrogate for benzo(g,h,i)perylene.
RSL value for anthracene used as surrogate for phenanthrene.
The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.
RSL value for Mercury (inorganic salts) used as surrogate for mercury.

[5] Rationale Codes

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

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
C* = Carcinogenic, where N screening level < 100 x C screening level
N = Noncarcinogenic
NCPSRG = North Carolina Soil Remediation Goal, January 2010

TABLE A-2a
Risk Ratio Screening for Surface and Subsurface Soil, Maximum Detected Concentration
D-9 Skeet Range, Theroetical Shot Fall Zone, MCB CampLej, North Carolina

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Benzo(a)anthracene	5 - 6	2.8E+00	ASR2_82-SS28-08D	1.5E-01	1E-06	NA	2E-05	NA
Benzo(a)pyrene	5 - 6	4.4E+00	ASR2_82-SS28-08D	1.5E-02	1E-06	NA	3E-04	NA
Benzo(b)fluoranthene	5 - 6	3.6E+00	ASR2_82-SS28-08D	1.5E-01	1E-06	NA	2E-05	NA
Benzo(k)fluoranthene	5 - 6	3.0E+00	ASR2_82-SS28-08D	1.5E+00	1E-06	NA	2E-06	NA
Dibenz(a,h)anthracene	5 - 6	7.0E-01	ASR2_82-SS28-08D	1.5E-02	1E-06	NA	5E-05	NA
Indeno(1,2,3-cd)pyrene	5 - 6	2.4E+00	ASR2_82-SS28-08D	1.5E-01	1E-06	NA	2E-05	NA
Arsenic	4 - 6	3.0E+00	ASR2_82-SS28-08D	3.9E-01	1E-06	NA	8E-06	NA
Chromium	6 - 6	9.6E+00	ASR2_82-SS28-08D	2.9E-01	1E-06	NA	3E-05	NA
Lead	33 - 33	6.7E+04	SR-SS13-0-1	4.0E+02	NA	NA	NA	NA
Cumulative Corresponding Hazard Index[c]								
Cumulative Corresponding Cancer Risk[d]							**4E-04**	

[a] Corresponding Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[b] Corresponding Cancer Risk equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.
[d] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.
Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.
Constituents selected as COPCs are indicated by shading.
COPC = Constituent of Potential Concern
HI = Hazard Index
mg/kg = milligrams per kilogram
NA = Not available/not applicable.

TABLE A-2b
Risk Ratio Screening for Surface and Subsurface Soil, 95 Percent UCL
D-9 Skeet Range, Theroetical Shot Fall Zone, MCB CampLej, North Carolina

Analyte	Detection Frequency	95% UCL	95% UCL Rationale	95% UCLStatistic	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Benzo(a)anthracene	5 - 6	2.5E+00	(1, 3)	95% KM-c	1.5E-01	1E-06	NA	2E-05	NA
Benzo(a)pyrene	5 - 6	4.0E+00	(1, 3)	95% KM-c	1.5E-02	1E-06	NA	3E-04	NA
Benzo(b)fluoranthene	5 - 6	3.3E+00	(1, 3)	95% KM-c	1.5E-01	1E-06	NA	2E-05	NA
Benzo(k)fluoranthene	5 - 6	2.7E+00	(1, 3)	95% KM-c	1.5E+00	1E-06	NA	2E-06	NA
Dibenz(a,h)anthracene	5 - 6	6.4E-01	(1, 3)	95% KM-c	1.5E-02	1E-06	NA	4E-05	NA
Indeno(1,2,3-cd)pyrene	5 - 6	2.2E+00	(1, 3)	95% KM-c	1.5E-01	1E-06	NA	1E-05	NA
Arsenic	4 - 6	2.2E+00	(1, 2, 3)	95% KM-t	3.9E-01	1E-06	NA	6E-06	NA
Chromium	6 - 6	7.7E+00	(1, 3)	App. Gamma	2.9E-01	1E-06	NA	3E-05	NA
Lead	33 - 33	8.4E+03	(4)	Mean	4.0E+02	NA	NA	NA	NA
Cumulative Corresponding Hazard Index[c]									
Cumulative Corresponding Cancer Risk[d]								**4E-04**	

[a] Corresponding Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[b] Corresponding Cancer Risk equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.
[d] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.
Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.
Constituents selected as COPCs are indicated by shading.
COPC = Constituent of Potential Concern
HI = Hazard Index
mg/kg = milligrams per kilogram
NA = Not available/not applicable.

TABLE A-3

Risk Ratio Screening for Surface and Subsurface Soil, Maximim Detected Concentration without Sample ASR2_82-SS28-08D

D-9 Skeet Range, Theroetical Shot Fall Zone, MCB CampLej, North Carolina

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Benzo(a)anthracene	5 - 6	8.0E-02	ASR2_82-SS29-08D	1.5E-01	1E-06	NA	5E-07	NA
Benzo(a)pyrene	5 - 6	1.2E-01	ASR2_82-SS29-08D	1.5E-02	1E-06	NA	8E-06	NA
Benzo(b)fluoranthene	5 - 6	1.0E-01	ASR2_82-SS29-08D	1.5E-01	1E-06	NA	7E-07	NA
Benzo(k)fluoranthene	5 - 6	8.9E-02	ASR2_82-SS29-08D	1.5E+00	1E-06	NA	6E-08	NA
Dibenz(a,h)anthracene	5 - 6	2.4E-02	ASR2_82-SS29-08D	1.5E-02	1E-06	NA	2E-06	NA
Indeno(1,2,3-cd)pyrene	5 - 6	7.6E-02	ASR2_82-SS29-08D	1.5E-01	1E-06	NA	5E-07	NA
Arsenic	4 - 6	9.2E-01 J	ASR2_82-SS29-08D	3.9E-01	1E-06	NA	2E-06	NA
Chromium	6 - 6	5.0E+00	ASR2_82-SS31-08D	2.9E-01	1E-06	NA	2E-05	NA
Lead	33 - 33	6.7E+04	SR-SS13-0-1	4.0E+02		NA		
Cumulative Corresponding Hazard Index[c]								
Cumulative Corresponding Cancer Risk[d]							**3E-05**	

[a] Corresponding Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.

[b] Corresponding Cancer Risk equals maximum detected concentration divided by the RBC divided by the acceptable risk level.

[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

[d] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

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

Constituents selected as COPCs are indicated by shading.

COPC = Constituent of Potential Concern

HI = Hazard Index

mg/kg = milligrams per kilogram

NA = Not available/not applicable.

Appendix B
Anticipated Applicable or Relevant and Appropriate Regulations

TABLE B-1
Action-Specific Applicable or Relevant and Appropriate Requirements
Engineering Evaluation/Cost Assessment
D-9 Skeet Range
MCB CamLej, North Carolina

Action	Requirements	Prerequisite	Citation
General Construction Standards — All Land-disturbing Activities (i.e., excavation, clearing, grading, etc.)			
Managing stormwater runoff from land-disturbing activities	Shall install erosion and sedimentation control devices and practices sufficient to retain the sediment generated by the land-disturbing activity within the boundaries of the tract during construction.	Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-53) of more than 1 acre of land - **applicable**	N.C.G.S. Ch.113A-157(3)
	Shall plant or otherwise provide permanent ground cover sufficient to restrain erosion after completion of construction.		N.C.G.S. Ch.113A-157(3)
	Shall take all reasonable measures to protect all public and private property from damage caused by such activities.	Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-52) of more than 1 acre of land - **applicable**	15A NCAC 4B.0105
	Erosion and sedimentation control plan must address the following basic control objectives: (1) Identify areas subject to severe erosion, and offsite areas especially vulnerable to damage from erosion and sedimentation. (2) Limit the size of the area exposed at any one time. (3) Limit exposure to the shortest feasible time. (4) Control surface water runoff originating upgrade of exposed areas (5) Plan and conduct land-disturbing activity so as to prevent offsite sedimentation damage. (6) Include measures to control velocity of storm water runoff to the point of discharge.		15A NCAC 4B.0106
	Erosion and sedimentation control measures, structures, and devices shall be planned, designed, and constructed to provide protection from the runoff of 10-year storm.	Land-disturbing activity (as defined in N.C.G.S. Ch. 113A-52) of more than 1 acre of land --**applicable**	15A NCAC 4B.0108
	Shall conduct activity so that the post-construction velocity of the 10-year storm runoff in the receiving		15A NCAC 4B.0109,

TABLE B-1
Action-Specific Applicable or Relevant and Appropriate Requirements
Engineering Evaluation/Cost Assessment
D-9 Skeet Range
MCB CamLej, North Carolina

Action	Requirements	Prerequisite	Citation
	watercourse to the discharge point does not exceed the parameters provided in this Rule.		
Managing fugitive dust emissions	Shall not cause or allow fugitive dust emissions to cause or contribute to substantive complaints, or visible emissions in excess of that allowed under paragraph (e) of this Rule.	Activities within facility boundary that will generate fugitive dust emissions -- **relevant and appropriate**	15A NCAC 02D .0540(c)
	Implement methods (e.g. wetting dry soils) to control dust emissions that could travel beyond the facility boundary.		15A NCAC 02D .0540(g)
Managing toxic air pollutant emissions	A facility shall not emit toxic air pollutants in such quantities that can cause or contribute beyond the premises (adjacent property boundary) to any significant ambient air concentration that may adversely affect human health.	Activities within facility boundary that will generate toxic air pollutant emissions – **relevant and appropriate**	15A NCAC 02D.1104
Waste Characterization and Storage — Primary Wastes (i.e., excavated contaminated soils)			
Characterization of solid waste (e.g. contaminated soil and drums)	Must determine if solid waste is hazardous waste or if waste is excluded under 40 CFR 261.4(b); and	Generation of solid waste as defined in 40 CFR 261.2 and which is not excluded under 40 CFR 261.4(A) - **applicable**	40 CFR 262.11(a) 15A NCAC 13A.0107
	Must determine if waste is listed under 40 CFR Part 261; or		40 CFR 262.11(b) 15A NCAC 13A.0107
	Must determine whether the waste is (characteristic waste) identified in subpart C of 40 CFR part 261 by either: (1) Testing the waste according to the methods set forth in subpart C of 40 CFR part 261. Or according to an equivalent method approved by the Administrator under 40 CFR 260.21; or (2) Applying knowledge of the hazard characteristic of the waste in light of the materials or	Generation of solid waste which is not excluded under 40 CFR 261.4(a) -**applicable**	40 CFR 262.11(c) 15A NCAC 13A.0717

TABLE B-1
Action-Specific Applicable or Relevant and Appropriate Requirements
Engineering Evaluation/Cost Assessment
D-9 Skeet Range
MCB CamLej, North Carolina

Action	Requirements	Prerequisite	Citation
	processes used.		
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste which is determined to be hazardous - **applicable**	40 CFR 262.11(d) 15A NCAC 13A.0107
Storage of solid waste (e.g., contaminated soil)	All solid waste shall be stored in such a manner as to prevent the creation of a nuisance, insanitary conditions, or a potential public health hazard.	Generation of solid waste which is determined not to be hazardous-- **relevant and appropriate**	15A NCAC 13B .0104(f)
	Containers for the storage of solid waste shall be maintained in such a manner as to prevent the creation of a nuisance or insanitary conditions. Containers that are broken or that otherwise fail to meet this rule shall be replaced with acceptable containers.		15A NCAC 13B .0104(e)
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 CFR 264 and 268.	Generation of RCRA-hazardous waste for storage treatment or disposal - **applicable**	40 CFR 264.13(a)1) 15A NCAC 13A.0109
Determinations for management of hazardous waste	Must determine each EPA Waste Number (waste code) applicable to the waste in order to determine the applicable treatment standards under 40 CFR 268 *et seq.*. *Note:* This determination may be made concurrently with the hazardous waste determination required in Sec. 262.11 of this chapter.	Generation of hazardous waste for storage treatment or disposal – **applicable**	40 CFR 268.9(a) 15A NCAC 13A.0112
	Must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the characteristic waste	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST RORGS, POLYM of Section 268.42 Table 1) for storage, treatment or disposal – **applicable**	40 CFR 268.9(a) 15A NCAC 13A.0112

TABLE B-1
Action-Specific Applicable or Relevant and Appropriate Requirements
Engineering Evaluation/Cost Assessment
D-9 Skeet Range
MCB CamLej, North Carolina

Action	Requirements	Prerequisite	Citation
	Must determine if the hazardous waste meets the treatment standards in 40 CFR 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste. *Note:* This determination can be made concurrently with the hazardous waste determination required in 40 CFR 262.11.	Generation of hazardous waste for storage treatment or disposal – **applicable**	40 CFR 268.7(a) 15A NCAC 13A.0112
Temporary Storage of hazardous waste in containers	A generator may accumulate hazardous waste in containers at the facility provided that: • Waste is placed in containers that comply with 40 CFR 265.171-173; and	Accumulation of RCRA hazardous waste on site as defined in 40 CFR 260.10 -- **applicable**	40 CFR 262.34(a) 40 CFR 262.34(a)(1)(i) 15A NCAC 13A.0107
	• The date upon which accumulation begins must be clearly marked and visible for inspection on each container.		40 CFR 262.34(a)(2) 15A NCAC 13A.0107
	• Container is marked with the words “hazardous waste;” or		40 CFR 262.34(a)(3) 15A NCAC 13A.0107
	• Container may be marked with other words that identify the contents	Accumulation of 55 gal. or less of RCRA hazardous waste <u>or</u> one quart of acutely hazardous waste listed in 261.33(e) at or near any point of generation -- **applicable**	40 CFR 262.34(c)(1) 15A NCAC 13A.0107
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 CFR 264.175(b)	Storage of RCRA hazardous waste in containers *with free liquids* - ***applicable***	40 CFR 264.175(a)

TABLE B-1
Action-Specific Applicable or Relevant and Appropriate Requirements
Engineering Evaluation/Cost Assessment
D-9 Skeet Range
MCB CamLej, North Carolina

Action	Requirements	Prerequisite	Citation
			15A NCAC 13A.0109
	Area must be sloped or otherwise designed and operated to drain liquid resulting from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid.	Storage of RCRA-hazardous waste in containers that *do not contain free liquids (*other than F020, F021, F022, F023, F026, and F027) - **applicable**	40 CFR 264.175(c)(1) and(2) 15A NCAC 13A.0109
Closure performance standard for RCRA container storage unit	Must close the facility (e.g., container storage unit) in a manner that: • Minimizes the need for further maintenance; • Controls, minimizes, or eliminates to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or the atmosphere; and • Complies with the closure requirements of subpart, but not limited to, the requirements of 40 CFR 264.178	Storage of RCRA hazardous waste in containers **-applicable**	40 CFR 264.111 15A NCAC 13A.0109
Temporary on-site management of remediation waste in staging pile (e.g., excavated soils)	Staging pile must be designed to prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross-media transfer as necessary to protect human health and the environment (e.g. use of liners, covers, run-off/run-on controls).	Management of remediation waste in a staging pile **- applicable**	15A NCAC 13A.0109(s) only as it incorporates 40 CFR 264.554(d)(1) (ii)
	In setting standards and design criteria must consider the following factors: • Length of time pile will be in operation; • Volumes of waste you intend to store in the pile; • Physical and chemical characteristics of the wastes	Storage of remediation waste in a staging pile - **applicable**	15A NCAC 13A.0109(s) only as it incorporates 40 CFR 264.554(d)(2)(i) –(vi)

Action	Requirements	Prerequisite	Citation
	to be stored in the unit; • Potential for releases from the unit; • Hydrogeological and other relevant environmental conditions at the facility that may influence the migration of any potential releases; and Potential for human and environmental exposure to potential releases from the unit.		
	Must be closed within 180 days after the operating term by removing or decontaminating all remediation waste, contaminated containment system components, and structures and equipment contaminated with waste and leachate.	Management of remediation waste in staging pile in *previously contaminated area* - **applicable**	15A NCAC 13A.0109(s) only as it incorporates 40 CFR 264.554(j)(1)
	Must decontaminate contaminated sub-soils in a manner that EPA determines will protect human and the environment.		15A NCAC 13A.0109(s) only as it incorporates 40 CFR 264.554(j)(2)
Waste Treatment and Disposal – Primary Wastes (excavated contaminated soils)			
Disposal of solid waste (e.g., contaminated soil not considered RCRA hazardous waste)	Shall ensure that waste is disposed of at a site or facility which is permitted to receive the waste.	Generation of solid waste intended for off-site disposal – **relevant and appropriate**	15A NCAC 13B.0106(b)
Disposal of RCRA hazardous waste in a land-based unit (i.e., landfill)	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted RCRA waste - **applicable**	40 CFR 268.40(a) 15A NCAC 13A.0112
	All underlying hazardous constituents [as defined in 40 CFR 268.2(i)] must meet the Universal Treatment Standards, found in 40 CFR 268.48 Table UTS prior to land disposal.	Land disposal of restricted RCRA characteristic wastes (D001-D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class 1 nonhazardous	40 CFR 268.40(e) 15A NCAC 13A.0112

Action	Requirements	Prerequisite	Citation
		injection well –**applicable**	
Disposal of RCRA-*hazardous waste soil* in a land-based unit (i.e. landfill)	Must be treated according to the alternative treatment standards of 40 CFR 268.49(c) or Must be treated according to the UTSs [specified in 40 CFR 268.48 Table UTS] applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted RCRA hazardous soils –**applicable**	40 CFR 268.49(b) 15A NCAC 13A.0112
Disposal of RCRA *hazardous waste debris* in a land-based unit (i.e. landfill)	Must be treated prior to land disposal as provided in 40 CFR 268.45(a)(1)-(5) unless EPA determines under 40 CFR 261.3(f)(2) that the debris is no longer contaminated with hazardous waste or the debris is treated to the waste-specific treatment standards provided in 40 CFR 268.40 for the waste contaminating the debris.	Land disposal, as defined in 40 CFR 268.2, of restricted RCRA-hazardous debris **-applicable**	40 CFR 268.45(a) 15A NCAC 13A.0112
Disposal of *treated hazardous debris*	Debris treated by one of the specified extraction or destruction technologies on Table 1 of 40 CFR 268.45 and which no longer exhibits a characteristic is not a hazardous waste and need not be managed in RCRA Subtitle C facility. Hazardous debris contaminated with listed waste that is treated by immobilization technology must be managed in a RCRA Subtitle C facility.	Treated debris contaminated with RCRA-listed of characteristic waste - **applicable**	40 CFR 268.45(c) 15A NCAC 13A.0112
Disposal of *hazardous debris treatment residues*	Except as provided in 268.45(d)(2) and (d)(4), must be separated from debris by simple physical or mechanical means, and such residues are subject to the waste –specific treatment standards for the waste contaminating the debris	Residue from treatment of hazardous debris -**applicable**	40 CFR 268.45(d)(1) 15A NCAC 13A.0112
Transportation of Wastes			
Transportation of hazardous waste *on-site*	The generator manifesting requirements of 40 CFR 262.20-262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 CFR 263.30 and 263.31 in the event of a discharge of	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such	40 CFR 262.20(f) 15A NCAC 13A.0107

TABLE B-1
Action-Specific Applicable or Relevant and Appropriate Requirements
Engineering Evaluation/Cost Assessment
D-9 Skeet Range
MCB CamLej, North Carolina

Action	Requirements	Prerequisite	Citation
	hazardous waste on a private or public right-of-way.	contiguous property is divided by a public or private right-of-way - **applicable**	
Transportation of hazardous waste *off-site*	Must comply with the generator standards of Part 262 including 40 CFR 262.20-23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect 262.32 for marking, Sect. 262.33 for placarding.	Preparation and initiation of shipment of hazardous waste off-site **– applicable**	40 CFR 262.10(h) 15A NCAC 13A.0107
Transportation of *hazardous materials*	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at 49 CFR 171-180 related to marking, labeling, placarding, packaging, emergency response, etc.	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material -**applicable**	49 CFR 171.1(c)
Transportation of samples (i.e. contaminated soils)	Are not subject to any requirements of 40 CFR Parts 261 through 268 or 270 when : • The sample is being transported to a laboratory for the purpose of testing; or • The sample is being transported back to the sample collector after testing. • The sample is being stored by sampled collector before transport to a lab for testing	Samples of solid waste <u>or</u> a sample of water, soil for purpose of conducting testing to determine its characteristics or composition - **applicable**	40 CFR 261.4(d)(1)(i)-(iii) 15A NCAC 13A.0106
	In order to qualify for the exemption in paragraphs (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements • Assure that the information provided in (1) thru (5) of this section accompanies the sample. • Package the sample so that it does not leak, spill, or vaporize from its packaging.		40 CFR 261.4(d)(2)(i)(A) and (B) 15A NCAC 13A.0106

ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
CWA = Clean Water Act of 1972
DEACT = deactivation
DOT = U.S. Department of Transportation
EPA = U.S. Environmental Protection Agency
HMR = Hazardous Materials Regulations
HMTA = Materials Transportation Act
LDR = Land Disposal Restrictions
NPDES = National Pollutant Discharge Elimination System
POTW = Publically Owned Treatment Works
RCRA = Resource Conservation and Recovery Act of 1976
TCLP = Toxicity Characteristic Leaching Procedure
UTS = Universal Treatment Standard

TABLE B-2

Location-Specific Applicable or Relevant and Appropriate Requirements

Engineering Evaluation/Cost Assessment
D-9 Skeet Range
MCB CamLej, North Carolina

Location	Requirements	Prerequisite	Citation
Presence of an onsite wetland	No discharge of dredged or fill material into an aquatic ecosystem is permitted if there is a practicable alternative that would have less adverse impact.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands - **applicable**	Clean Water Act Regulations – Section 404(b) Guidelines 40 Part 230.10(a)
Within the Atlantic Migratory Flyway	Protects almost all species of native birds in the United States from unregulated taking.	Presence of migratory birds onsite - **applicable**	16 USC 703
Within the coastal zone	Federal activities must be consistent with, to the area that will affect maximum extent practicable, State coastal zone management programs. Federal agencies must supply the State with a consistency determination.	Wetland, flood plain, estuary, beach, dune, barrier island, coral reef, and fish and wildlife and their habitat, within the coastal zone - **applicable**	15 CFR 930.33(a)(1), (a)(2), (b); .35(a), (b); .36(a)

TABLE B-3
Chemical-Specific Applicable or Relevant and Appropriate Requirements
Engineering Evaluation/Cost Assessment
D-9 Skeet Range
MCB CamLej, North Carolina

Media	Requirements	Prerequisite	Citation
Soil	Chemical concentrations corresponding to fixed levels of human health risk (i.e., a hazard quotient of 1, or a lifetime cancer risk of $10^{-6,}$ whichever occurs at a lower concentration).	Assessment of potential human health risks -t**o be considered**	USEPA Tables only as they apply to lead (400 mg/kg), benzo(a)anthracene (0.15 mg/kg), benzo(a)pyrene (0.015 mg/kg), benzo(b)fluoranthene (0.15 mg/kg), dibenz(a,h)anthracene (0.015 mg/kg), and indeno (1,2,3-cd)pyrene (0.15 mg/kg).
Soil	Disposal of a RCRA hazardous-waste in a land-based unit if it meets the requirements in the table “Treatment Standards for Hazardous Waste” at 40 CFR 268.40 before land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted hazardous soils - **applicable**	40 CFR 268.40(a) as it applies to lead. The Universal Treatment Standard for lead is 0.75 mg/L by TCLP.
	All underlying hazardous constituents [as defined in 40 CFR 268.2(i)] must meet the Universal Treatment Standards, found in 40 CFR 268.48 Table UTS prior to land disposal	Land disposal of restricted RCRA characteristic wastes (D001-D043) that are not managed in a wastewater treatment system that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well - **applicable**	15A NCAC 13A.0112(c) only as it incorporates 40 CFR 268.40(e)

Appendix C
Cost Estimates for Removal Action Alternatives

Alternative 2: Excavation with Offsite Disposal

Site: D-9 Skeet Range
Location: MCB CamLej, North Carolina
Phase: EE/CA
Date: 7-Sep-11

Description: Excavation of impacted surface soil to a minimum of 1 ft, with offsite disposal as hazardous waste

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Construction Management Mob					
Trailers and Personnel	1	LS	$5,000	$5,000	Engineer's Estimate, based on recent procurement
Decon Pad	1	LS	$2,500	$2,500	
SUBTOTAL				**$7,500**	
Site Survey					
Survey of excavation boundary	3	Day	$1,750	$5,250	Engineer's Estimate, based on recent procurement
SUBTOTAL				**$5,250**	
Erosion and Sediment Controls					
Installation of Erosion and Sedient Controls	5,050	LF	$3.40	$17,170	Engineer's Estimate
SUBTOTAL				**$17,170**	
Vegetation Clearance					
Mobilization	1	EACH	$1,500	$1,500	Engineer's Estimate, based on recent procurement
Clearing, Grubbing	5.3	ACRE	$3,500	$18,550	Engineer's Estimate
Stump Grinding Mob	0.0	EACH	$10,000	$0	Engineer's Estimate
Stump Grinding	0.0	DAY	$5,000	$0	Engineer's Estimate
SUBTOTAL				**$20,050**	
Remove Contaminated Soil					
Excavate and stockpile/load material	25,835	CY	$6.50	$167,928	Engineer's Estimate, contractor quote
SUBTOTAL				**$167,928**	
Confirmation Sampling					
Laboratory Analysis (PAHs)	179	EACH	$165.90	$29,696	Engineer's Estimate, based on recent procurement
Laboratory Analysis (Metals - lead)	179	EACH	$16.64	$2,979	Engineer's Estimate, based on recent procurement
SUBTOTAL				**$32,675**	
Disposal Characterization					
TCLP, reactivity, ignitability and corrosivity analysis	78	EACH	$736.48	$57,080	1 per 500 tons
SUBTOTAL				**$57,080**	
Transportation and Disposal (Hazardous Waste)					
Transport and Disposal Haz Waste	38,752	Ton	$200	$7,750,400	Engineer's Estimate, contractor quote
SUBTOTAL				**$7,750,400**	
Site Restoration/Demobilization					
Backfill Placement	25,835	CY	$6.50	$167,928	Assumes Onsite Source
Seeding (upland)	16.0	ACRE	$2,178.00	$34,848	Engineer's Estimate
Replace Stone Roads	100	TONS	$20	$2,000	Engineer's Estimate
Decon/Demob Equipment	1	LS	$5,000	$5,000	
Remove/Dispose Pad	1	LS	$1,000	$1,000	
Remove Construction Mgmt Facilities	1	LS	$10,000	$10,000	Engineer's Estimate
SUBTOTAL				**$220,776**	
SUBTOTAL CAPITAL COSTS				**$8,278,828**	
PROFESSIONAL SERVICES					
Final Design, Plans, Submittals	1	LS	$100,000	$100,000	
Construction Management	55	Days	$2,250	$123,750	
Project Management	65	Days	$1,850	$120,250	
SUBTOTAL PROFESSIONAL SERVICES				**$344,000**	
SUBTOTAL				**$8,622,828**	
Contingency	15%			$1,293,424	
G&A & Fee	15%			$1,293,424	
SUBTOTAL FEES				**$2,586,848**	
TOTAL ALTERNATIVE COST				**$11,209,676**	

The costs estimates are provided to an accuracy of +50 percent and -30 percent.

Generated by: Monica Fulkerson/CLT Checked by: David Cole/CLE

Assumptions:

1) Clearing
   * All trees and shrubs within the excavation limits will be cleared
2) MEC Support
   * MEC support is not required
3) Erosion and Sediment Controls
   * Perimeter controls around the 5,050 foot perimeter are assumed.
4) Excavation
   * Depth of impacted surface soil is 1 ft
   * Excavated materials disposed at approved, permitted offsite landfill
   * 100% of waste is assumed to be hazardous
   * It is assumed that the density of site soil is 1.5 tons/cy
5) Confirmation Sampling
   * Collected and composited by grids in removal area (side wall and base)
   * Samples analyzed for lead and PAHs
6) Disposal Characterization
   * 1 sample per 500 tons of soil
   * Actual frequency of disposal characterization samples will be based on disposal facility
7) Site Restoration
   * Seed will be applied to the excavated area at a rate of 40 pounds per acre for erosion control.
   * Excavation will be backfilled using clean soil that has been stockpiled on site.
   * Assuming Stone on Parachute Tower Road to be replaced
8) The project is expected to require 10 weeks in the field.

Notes:

cu yd = cubic yard
cu ft = cubic feet
ft = foot, feet
LF = linear foot
mobe/demobe = mobilization/demobilization
sq ft = square feet
MEC = munitions and explosives of concern

Alternative 3: Excavation with Particle Separation

Site: D-9 Skeet Range
Location: MCB CamLej, North Carolina
Phase: EE/CA
Date: 7-Sep-11

Description: Excavation of impacted surface soil to a minimum of 1 ft, with particle separation of excavated material, then backfill using treated material

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Construction Management Mob					
Trailers and Personnel	1	LS	$5,000	$5,000	Engineer's Estimate, based on recent procurement
Decon Pad	1	LS	$2,500	$2,500	Engineer's Estimate
SUBTOTAL				**$7,500**	
Site Survey					
Survey of excavation boundary	3	Day	$1,750	$5,250	Engineer's Estimate, based on recent procurement
Perform Treatability Testing	1	LS	$75,000	$75,000	Engineer's Estimate
SUBTOTAL				**$80,250**	
Erosion and Sediment Controls					
Installation of Erosion and Sedient Controls	5,050	LF	$3.40	$17,170	Engineer's Estimate
SUBTOTAL				**$17,170**	
Vegetation Clearance					
Mobilization	1	EACH	$1,500	$1,500	Engineer's Estimate, based on recent procurement
Clearing, Grubbing	5.3	ACRE	$3,500	$18,550	Engineer's Estimate
Stump Grinding Mob	0.0	EACH	$10,000	$0	Engineer's Estimate
Stump Grinding	0.0	DAY	$5,000	$0	Engineer's Estimate
SUBTOTAL				**$20,050**	
Remove Contaminated Soil					
Excavate, stockpile material @ Process Site	25,835	CY	$6.50	$167,928	Engineer's Estimate, contractor quote
SUBTOTAL				**$167,928**	
Confirmation Sampling					
Laboratory Analysis (PAHs)	179	EACH	$165.90	$29,696	Engineer's Estimate, based on recent procurement
Laboratory Analysis (Metals - lead)	179	EACH	$16.64	$2,979	Engineer's Estimate, based on recent procurement
SUBTOTAL				**$32,675**	
Particle Separation					
Soil Washing	38,752	TON	$50	$1,937,600	Engineer's Estimate, contractor quote
SUBTOTAL				**$1,937,600**	
Transportation and Disposal					
Transport and Disposal of Non-Haz Process Water	126,000	GAL	$1.07	$134,820	Engineer's Estimate, based on recent procurement
Transport and Disposal of Non-Haz Solid Waste (filter cakes)	5,060	TON	$55	$278,300	Engineer's Estimate, based on recent procurement
SUBTOTAL				**$413,120**	
Backfill Characterization					
Laboratory Analysis (PAHs)	78	EACH	$165.90	$12,858	Engineer's Estimate, based on recent procurement
Laboratory Analysis (Metals - lead)	78	EACH	$16.64	$1,290	Engineer's Estimate, based on recent procurement
SUBTOTAL				**$14,148**	
Site Restoration/Demobilization					
Backfill Placement	38,752	Ton	$3	$116,256	Assumes backfill with treated soil and onsite source
Seeding (upland)	16.0	ACRE	$2,178	$34,848	Engineer's Estimate
Replace Stone Roads	100	TONS	$20	$2,000	Engineer's Estimate
Decon/Demob Soil Washing	1	LS	$125,000	$125,000	
Remove/Dispose Pad	1	LS	$30,000	$30,000	
Remove Construction Mgmt Facilities	1	LS	$10,000	$10,000	Engineer's Estimate
SUBTOTAL				**$318,104**	
SUBTOTAL CAPITAL COSTS				**$3,008,544**	
PROFESSIONAL SERVICES					
Final Design, Plans, Submittals	1	LS	$175,000	$175,000	
Construction Management	130	Days	$3,000	$390,000	
Project Management	140	Days	$2,250	$315,000	
SUBTOTAL PROFESSIONAL SERVICES				**$880,000**	
SUBTOTAL				**$3,888,544**	
Contingency	25%			$972,136	
G&A & Fee	15%			$583,282	
SUBTOTAL FEES				**$1,555,417**	
TOTAL ALTERNATIVE COST				**$5,443,961**	

The costs estimates are provided to an accuracy of +50 percent and -30 percent.

Generated by: Monica Fulkerson/CLT Checked by: David Cole/CLE

Assumptions:

1) Clearing
   * All trees and shrubs within the excavation limits will be cleared
2) MEC Support
   * MEC support is not required
3) Erosion and Sediment Controls
   * Perimeter controls around the 5,050 foot perimeter are assumed.
4) Excavation
   * Depth of impacted surface soil is 1 ft
   * It is assumed that the density of site soil is 1.5 tons/cy
5) Mechanical screening of excavated material
   * All excavated material will require mechanical screening prior to disposal
   * Excavation rate will be limited by screening; screening will be at a rate of 400 cu yd per day
6) Particle Separation
   * Physical treatment will result in soil concentrations below Action Limits
   * Soil washing is expected to conducted at a rate of 40 tons/hour, 10 hours/day, 5 days/week
   * Treated soil will be used to backfill the removal area
   * Process water will be non-hazardous
7) Confirmation Sampling
   * Collected and composited by grids in removal area (side wall and base)
   * Samples analyzed for lead and PAHs
8) Backfill Characterization
   * 1 sample per 500 tons of soil
9) Site Restoration
   * Seed will be applied to the excavated area at a rate of 40 pounds per acre for erosion control.
   * Excavation will be backfilled using clean soil that has been stockpiled on site.
10) The project is expected to require 26 weeks in the field.

Notes:

cu yd = cubic yard
cu ft = cubic feet
ft = foot, feet
LF = linear foot
mobe/demobe = mobilization/demobilization
sq ft = square feet
MEC = munitions and explosives of concern

Alternative 4: Excavation with Stabilization

Site: D-9 Skeet Range
Location: MCB CamLej, North Carolina
Phase: EE/CA
Date: 7-Sep-11

Description: In situ stabilization of impacted soils, followed by excavation for offsite disposal as non-hazardous waste

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Construction Management Mob					
Trailers and Personnel	1	LS	$5,000	$5,000	Engineer's Estimate, based on recent procurement
Decon Pad	1	LS	$2,500	$2,500	Engineer's Estimate
SUBTOTAL				**$7,500**	
Site Preparation					
Survey of excavation boundary	3	Day	$1,750	$5,250	Engineer's Estimate, based on recent procurement
Perform Treatability Testing	1	LS	$50,000	$50,000	Includes sampling and lab work
SUBTOTAL				**$55,250**	
Erosion and Sediment Controls					
Installation of Erosion and Sedient Controls	5,050	LF	$3.40	$17,170	Engineer's Estimate
SUBTOTAL				**$17,170**	
Vegetation Clearance					
Mobilization	1	EACH	$1,500	$1,500	Engineer's Estimate, based on recent procurement
Clearing, Grubbing	5.3	ACRE	$3,500	$18,550	Engineer's Estimate
Stump Grinding Mob	0.0	EACH	$10,000	$0	Engineer's Estimate
Stump Grinding	0.0	DAY	$5,000	$0	Engineer's Estimate
SUBTOTAL				**$20,050**	
Soil Stabilization					
EnviroBlend	1,550	TON	$600	$930,048	Engineer's Estimate, contractor quote
Application and Mixing of Amendment into Soil	16.0	ACRE	$5,200	$83,200	Engineer's Estimate, contractor quote
SUBTOTAL				**$1,013,248**	
Remove Contaminated Soil					
Excavate and stockpile/load material	26,868	CY	$6.50	$174,645	Engineer's Estimate, contractor quote
SUBTOTAL				**$174,645**	
Confirmation Sampling					
Laboratory Analysis (PAHs)	179	EACH	$165.90	$29,696	Engineer's Estimate, based on recent procurement
Laboratory Analysis (Metals - lead)	179	EACH	$16.64	$2,979	Engineer's Estimate, based on recent procurement
SUBTOTAL				**$32,675**	
Disposal Characterization					
TCLP, reactivity, ignitability and corrosivity analysis	78	EACH	$736.48	$57,080	1 per 500 tons
SUBTOTAL				**$57,080**	
Transportation and Disposal (Nonhazardous Waste)					
Transportation and disposal (non-hazardous)	41,853	Ton	$55.00	$2,216,642	Engineer's Estimate, based on recent procurement
SUBTOTAL				**$2,216,642**	
Site Restoration/Demobilization					
Backfill Placement	26,868	CY	$6.50	$174,645	24,768 cy
Seeding (upland)	16.0	ACRE	$2,178	$34,848	Engineer's Estimate
Replace Stone Roads	100	TONS	$20	$2,000	Engineer's Estimate
Decon/Demob Rapidmix	1	LS	$25,000	$25,000	
Remove/Dispose Pad	1	LS	$5,000	$5,000	
Remove Construction Mgmt Facilities	1	LS	$10,000	$10,000	Engineer's Estimate
SUBTOTAL				**$251,493**	
SUBTOTAL CAPITAL COSTS				**$3,845,752**	
PROFESSIONAL SERVICES					
Final Design, Plans, Submittals	1	LS	$125,000	$125,000	
Construction Management	50	Days	$2,250	$112,500	
Project Management	60	Days	$1,850	$111,000	
SUBTOTAL PROFESSIONAL SERVICES				**$348,500**	
SUBTOTAL				**$4,194,252**	
Contingency	10%			$419,425	
G&A & Fee	15%			$629,138	
SUBTOTAL FEES				**$1,048,563**	
TOTAL ALTERNATIVE ROM COST				**$5,242,815**	

The costs estimates are provided to an accuracy of +50 percent and -30 percent.

Generated by: Monica Fulkerson/CLT Checked by: David Cole/CLE

Assumptions:

1) Clearing
* All trees and shrubs within the excavation limits will be cleared
2) MEC Support
* MEC support is not required
3) Erosion and Sediment Controls
* Perimeter controls around the 5,050 foot perimeter are assumed.
4) Excavation
* Depth of impacted surface soil is 1 ft
* Following treatment, all waste will be characterized as non-hazardous soil for offsite disposal at a Subtitle D landfill
* It is assumed that the density of site soil is 1.5 tons/cy
5) Stabilization
* All excavated material will require mechanical screening prior to disposal
* Excavation rate will be limited by screening; screening will be at a rate of 400 cu yd per day
* Stabilization amendment is assumed to be EnviroBlend, which will be mixed into the soil prior to excavation.
* 4% of EnviroBlend by weight will be added.
6) Confirmation Sampling
* Collected and composited by grids in removal area (side wall and base)
* Samples analyzed for lead and PAHs
7) Disposal Characterization
* 1 sample per 500 tons of soil
* Actual frequency of disposal characterization samples will be based on disposal facility
8) Site Restoration
* Seed will be applied to the excavated area at a rate of 40 pounds per acre for erosion control.
* Excavation will be backfilled using clean soil that has been stockpiled on site.
9) The project is expected to require 10 weeks in the field

Notes:

cu yd = cubic yard
cu ft = cubic feet
ft = foot, feet
LF = linear foot
mobe/demobe = mobilization/demobilization
sq ft = square feet
MEC = munitions and explosives of concern

Alternative 5: In Situ Stabilization

Description: In situ mixing of a stabilization amendment

Site: D-9 Skeet Range
Location: MCB CamLej, North Carolina
Phase: EE/CA
Date: 7-Sep-11

CAPITAL COSTS

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Construction Management Mob					
Trailers and Personnel	1	LS	$5,000	$5,000	Engineer's Estimate, based on recent procurement
Decon Pad	1	LS	$2,500	$2,500	Engineer's Estimate
SUBTOTAL				**$7,500**	
Site Preparation					
Survey of excavation boundary	3	Day	$1,750	$5,250	Engineer's Estimate, based on recent procurement
Perform Treatability Testing	1	LS	$50,000	$50,000	Includes sampling and lab work
SUBTOTAL				**$55,250**	
Erosion and Sediment Controls					
Installation of Erosion and Sedient Controls	5,050	LF	$3.40	$17,170	Engineer's Estimate
SUBTOTAL				**$17,170**	
Vegetation Clearance					
Mobilization	1	Ea	$1,500	$1,500	Engineer's Estimate, based on recent procurement
Clearing, Grubbing	5.3	ACRE	$3,500	$18,550	Engineer's Estimate
Stump Grinding Mob	0.0	Ea	$10,000	$0	Engineer's Estimate
Stump Grinding	0.0	Day	$5,000	$0	Engineer's Estimate
SUBTOTAL				**$20,050**	
Soil Stabilization					
EnviroBlend	1,550	Ton	$600	$930,048	Assume 4%
Application and Mixing of Amendment into Soil	16.0	ACRE	$5,200	$83,200	Engineer's Estimate, contractor quote
SUBTOTAL				**$1,013,248**	
Remove Contaminated Soil					
Excavate and stockpile/load material	4,195	CY	$6.50	$27,268	Engineer's Estimate, contractor quote
SUBTOTAL				**$27,268**	
Disposal Characterization					
TCLP, reactivity, ignitability and corrosivity analysis	13	EACH	$736.48	$9,574	1 per 500 tons
SUBTOTAL				**$9,574**	
Transportation and Disposal (Nonhazardous Waste)					
Transportation and disposal (non-hazardous)	6,544	Ton	$55.00	$359,931	Engineer's Estimate, based on recent procurement
SUBTOTAL				**$359,931**	
Site Restoration/Demobilization					
Seeding (upland)	16.0	ACRE	$2,178	$34,848	Engineer's Estimate
Replace Stone Roads	100	TONS	$20	$2,000	Engineer's Estimate
Decon/Demob Equipment	1	LS	$7,500	$7,500	Engineer's Estimate
Remove Construction Mgmt Facilities	1	LS	$10,000	$10,000	Engineer's Estimate
SUBTOTAL				**$54,348**	
SUBTOTAL CAPITAL COSTS				**$1,564,339**	
PROFESSIONAL SERVICES					
Final Design, Plans, Submittals	1	LS	$115,000	$115,000	
Construction Management	30	Days	$2,250	$67,500	
Project Management	40	Days	$1,850	$74,000	
SUBTOTAL PROFESSIONAL SERVICES				**$256,500**	
SUBTOTAL				**$1,820,839**	
Contingency	10%			$182,084	
G&A & Fee	15%			$273,126	
SUBTOTAL FEES				**$455,210**	
TOTAL ALTERNATIVE ROM COST				**$2,276,048**	

The costs estimates are provided to an accuracy of +50 percent and -30 percent.

Generated by: Monica Fulkerson/CLT Checked by: David Cole/CLE

Assumptions:

1) Clearing
   * All trees and shrubs within the excavation limits will be cleared
2) MEC Support
   * MEC support is not required
3) Erosion and Sediment Controls
   * Perimeter controls @ $3.40 per foot around the 5,050 foot perimeter are assumed.
4) Stabilization
   * Stabilization amendment is assumed to be EnviroBlend 90/10, which will be mixed into the soil in
   * 4% of EnviroBlend by weight will be added
5) Excavation
   * PAH impacted soil will be excavated for offsite disposal
   * Depth of impacted surface soil is 1 ft
   * Excavated materials disposed at approved, permitted offsite landfill
   * It is assumed that the density of site soil is 1.5 tons/cy
6) Characterization of Excavated Material
   * 1 sample per 500 tons of soil
7) Site Restoration
   * Seed will be applied to the treated area at a rate of 40 pounds per acre for erosion control.
8) The project is expected to require 6 weeks in the field

Notes:

cu yd = cubic yard
cu ft = cubic feet
ft = foot, feet
LF = linear foot
mobe/demobe = mobilization/demobilization
sq ft = square feet