FINAL

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FORMER WITHLACOOCHEE CWS FIELD TRIALS & ATG BOMBING & GUNNERY RANGE

Sumter & Hernando Counties, Florida

prepared for

U.S. ARMY CORPS OF ENGINEERS, JACKSONVILLE DISTRICT
and
U.S. ARMY ENGINEERING AND SUPPORT CENTER HUNTSVILLE

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ACRONYMS AND ABBREVIATIONS

AAF	Army Airfield
AAFSAT	Army Air Forces School of Applied Tactics
AAFTAC	Army Air Forces Tactical Center
ABP	Agent Breakdown Product
ADD	Average daily dose
AHPA	Archaeology and Historical Preservation Act
ARAR	Applicable or Relevant Appropriate Requirements
AC	hydrogen cyanide
APPL	Agriculture and Priority Pollutants Laboratory, Inc.
ASR	Archives Search Report
ASTDR	Agency for Toxic Substances and Disease Registry
ATG	air-to-ground
ATGGR	Air-to-ground gunnery range
ATV	All-terrain vehicle
bgs	below ground surface
CA	Chemical Agent
CACM	Chemical agent contaminated material
CARA	Chemical, Biological, Radiological, Nuclear, and High-Yield Explosives Analytical and Remediation Activity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CC	cyanogen chloride
CG	phosgene
CK	cyanogen chloride
CNS	tearing agent (tear gas)
COC	Contaminant of concern
COPEC	Chemical of potential ecological concern
COPC	chemical of potential concern
CP	Command Post
CRZ	Contamination Reduction Zone
CSM	Conceptual Site Model
CTL	Cleanup Target Level
CUA1	Chemical Use Area #1 and Air-to-Ground Bombing and Gunnery Range
CUA2	Chemical Use Area #2
CUA3	Chemical Use Area #3
CWA	Clean Water Act
CWM	Chemical Warfare Materiel
CWS	Chemical Warfare Service
DAAMS	Depot Area Agent Monitoring System
DD	Decision Document
DERP	Defense Environmental Restoration Programs
DoD	Department of Defense
DPG	Dugway Proving Ground
DQO	Data Quality Objective

DVR	Data Validation Report
ECBC	Edgewood Chemical Biological Center
ECSM	Ecological Conceptual Site Model
EE/CA	Engineering Evaluation/Cost Analysis
EM	Engineering Manual
EMF	Exposure Modification Factor
EP	Engineering Pamphlet
EPC	Exposure Point Concentration
ER	Engineering Regulation
ERA	Ecological Risk Assessment
ESA	Endangered Species Act
ESE	Environmental Science & Engineering, Inc.
ESQD	Explosives safety quantity-distance
EZ	Exclusion Zone
FD	Field duplicate
FDEP	Florida Department of Environmental Protection
FFS	Florida Forestry Service
FGS	Florida Geological Survey
FIR	Food ingestion rate
FS	Feasibility Study
FUDS	Formerly Used Defense Sites
FWC	Florida Fish and Wildlife Conservation Commission
FTP	File transfer protocol
GPO	geophysical prove-out
GPS	Global Positioning System
H	mustard
HBESL	Health-Based Environmental Screening Level
HD	Distilled mustard
HDV	Thickened mustard
HHRA	Human Health Risk Assessment
HL	Mustard-lewisite mixture
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HN-1	nitrogen mustard
HN-3	Nitrogen mustard
HQ	Hazard quotient
HSDB	Hazardous Substances Data Bank
HT	Mixture of mustard and Agent T
HPA	historical photographic analysis
HV, HVV	Thickened mustard
IHF	Interim Holding Facility
INPR	Inventory Project Report
IRIS	Integrated Risk Information System
ISO	Industry standard object
L	Lewisite
LOAEL	Lowest-observed-adverse-effect level

LOD	Limit of detection
LOQ	Limit of quantitation
LUC	Land use control
LVV	Thickened Lewisite
MC	Munitions Constituents
MD	Munitions debris
MEC	Munitions and Explosives of Concern
MGFD	Munition with the Greatest Fragmentation Distance
MINICAMS	Miniature Chemical Agent Monitoring System
MMRP	Military Munitions Response Program
MPPEH	Munitions Potentially Presenting an Explosives Hazard
MRS	Munitions Response Site
MS	Methyl salicylate (oil of wintergreen)
MDS	Minimum Separation Distance
MRSPP	Munitions Response Site Prioritization Protocol
MQO	Measurement quality objective
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDRC	National Defense Research Council
NH3	Ammonia
NO2	Nitrous oxide
NOAEL	No-observed-adverse-effect level
NOSE	No Significant Effects
PA	Preliminary Assessment
PETN	Pentaerythritol Tetranitrate
PDS	Personnel decontamination station
PID	Photoionization Detector
PPE	Personal Protective Equipment
PSV	Preliminary Screening Values
PRG	Preliminary Remediation Goals
QA	Quality Assurance
QAPP	Quality Assurance Project Planning
QC	Quality Control
RA	Risk Assessment
RAC	Risk Assessment Code
RAGS	Risk Assessment Guidance for Superfund
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RSL	USEPA Regional Screening Level
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SCAR	Sub-caliber aircraft rocket

SCS	Soil Conservation Service
SCTL	Soil Cleanup Target Level
SUXOS	Senior Unexploded Ordnance Supervisor
TBC	To be considered
TEC	Topographic Engineering Center
Tetryl	Methyl-2,4,6-trinitrophenylnitramine
TGY	Toxic Gas Yard
TNT	2,4,6-trinitrotoluene
TO	Task Order
TPP	Technical Project Planning
TRV	Toxicity Reference Value
UPL	Upper prediction limit
USA	USA Environmental, Inc
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Engineering and Support Center Huntsville
USAPHC	U.S. Army Public Health Council
USC	United States Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
VOC	Volatile Organic Compounds
VSP	Visual Sample Plan
WMA	Wildlife Management Area
WP	Work Plan
WSF	Withlacoochee State Forest

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

A Remedial Investigation/Feasibility Study is used to determine the nature and extent of munitions-related materials in order to evaluate the need for remedial actions and to evaluate remedial alternatives. The Remedial Investigation Report explains how the investigation was conducted and what was found. The Feasibility Study Report recommends methods for addressing what was found.

ES.2 SITE HISTORY

ES.2.1 Between October 1943 and the fall of 1946, the military used approximately 18,240 acres to create the Withlacoochee Chemical Warfare Service Field Trials and Air-to-Ground Bombing and Gunnery Range (Withlacoochee Site). The site had two distinct purposes–as a practice range for conventional munitions and as a testing area for chemical agents and munitions. The Army Air Force constructed targets for strafing, dive and skip bombing and rockets. The Chemical Warfare Service conducted field trials to determine the effectiveness of chemical agents.

ES.2.2 The site, approximately 18 miles northeast of Zephyrhills, is now part of the Richloam Wildlife Management Area of the Withlacoochee State Forest. The Florida Division of Forestry manages the site for timber, and the public uses it for recreation. It also includes the Florida Bass Conservation Center offices and the Richloam State Fish Hatchery.

ES.3 PREVIOUS INVESTIGATIONS

In 1950 the U.S. Army Corps of Engineers investigated the site, removed munitions and recommended surface use only in some areas. Subsequently, the Corps completed a number of additional studies, which included historical records research and site visits. The site was divided into three areas and a Remedial Investigation/Feasibility Study was recommended. The Withlacoochee Site consists of one Munitions Response Site, the Chemical Use Area. For the convenience of conducting the Remedial Investigation, the Munitions Response Site was separated into three units: the Chemical Use Area 1 and Air-to-Ground Bombing and Gunnery Range (16,960 acres) and two geographically separate areas known as Chemical Use Area 2 (640 acres) and Chemical Use Area 3 (640 acres). These investigation areas are presented in Figure 1.1.

ES.4 REMEDIAL INVESTIGATION

ES.4.1 The Remedial Investigation/Feasibility Study was initiated in 2010, and fieldwork was conducted between February 2012 and February 2014. It included geophysical mapping of paths (known as transects) through the Munitions Response Site and grids (squares or rectangle of various sizes), digging selected metallic objects to identify what they were, and collecting soil samples to test for munitions constituents. Munitions constituents are materials that comprise munitions (metals, explosives and chemical warfare materiel). Geophysical mapping involves moving a digital metal detector across the ground surface; the digital signal changes according to how much metal is in an area. The digital data indicated to the team where they needed to place grids for further investigations and where they needed to dig.

ES.4.2 The teams searched along 332 miles of transects and in 98 grids and dug up 582 metallic objects to identify them. Two unexploded munitions were found, one of which contained mustard agent. That munition was packaged and safely transported by a special team to a research laboratory in another state. The second item did not contain any chemical warfare agent, and it was destroyed on site. Pieces from munitions (known as munitions debris) were identified in 117 locations within 12 grids.

ES.4.3 The team collected 166 soil samples throughout the three study areas. No chemical warfare agents or volatile organic compounds were detected in any sample. An explosives compound, 2,4,6-Trinitrotoluene (TNT), was detected in low amounts in two samples collected near where a chemical munition was found. Arsenic was detected above Florida Department of Environmental Protection's residential limit in nine soil samples. Arsenic occurs naturally in the environment and is prevalent throughout Florida; it is also associated with agricultural uses. Barium was detected in 6 samples above the Florida Department of Environmental Protection's residential limit but well below their commercial/industrial level. Copper was detected in one sample at a level above the Florida Department of Environmental Protection's residential limit but well below their commercial/industrial limit.

ES.5 SUMMARY AND CONCLUSION

ES.5.1 Based on the results of the munitions investigation, six areas were identified where munitions may still be present (five areas within Chemical Use Area 1 and one area within Chemical Use Area 2). The five areas within Chemical Use Area 1 consist of the Non-Persistent Forest (46 acres), A and B Forest (74 acres), D Meadow (14 acres), F Meadow (61 acres), and the Air-to-Ground Range (35 acres). One area is in Chemical Use Area 2: G Forest (19 acres). Together these areas identified during the RI were renamed as the "Test Areas MRS", and all areas outside of these delineated areas are referred to as "Remaining Lands MRS". Figure 4.9 presents the locations of these proposed MRSs. Recommendations for alternatives to remediate the areas with munitions hazards are evaluated in the Feasibility Study. No munitions hazards were identified in Chemical Use Area 3, so this area is not evaluated in the Feasibility Study.

ES.5.2 A detailed risk assessment was undertaken to determine the potential risk to people and the environment from the three metals and one explosives compound detected in the soil above the Florida Department of Environmental Protection's residential limit (see Chapter 6 for more information). This risk assessment indicates there is no unacceptable risk to people or the environment due to these compounds.

1.0 INTRODUCTION

1.1 INTRODUCTION

1.1.1 An RI at the former Withlacoochee Chemical Warfare Service (CWS) Field Trials and Air-to-Ground (ATG) Bombing and Gunnery Range (FUDS Project No. I04FL007801) was conducted under the DoD's Military Munitions Response Program (MMRP) (Contract No. W912DY-10-D-0026, Delivery Order 0004) to determine the nature and extent of MEC and MC and assess the related risk. By definition, MEC is understood to include chemical warfare materiel (CWM) and MC understood to include CA and ABPs. The DoD established the MMRP to address DoD sites suspected of containing MEC and MC. Under the MMRP, the USACE conducts environmental response activities at FUDS for the Army, the DoD's executive agent for the FUDS Program. The Withlacoochee Site is an eligible FUDS that falls within the DoD's MMRP.

1.1.2 The purpose of the RI documented in this report is to adequately characterize potential MEC and MC within the Withlacoochee Site. The RI Report is designed to present the results from the investigation and to assess any potential risks to human health, safety, and the environment. If a risk exists, data from this RI will be used to support the FS so that decisions on proposed remedies can be made.

1.1.3 This RI Report presents data gathered during the characterization of the Withlacoochee Site as prescribed in the approved Final Work Plan (WP) (USA, 2014). The overall goal of this TO is to obtain stakeholder concurrence on DDs that summarize the planned responses to address identified contamination.

1.1.4 The RI is a stand alone document and the FS is prepared as a separate document.

1.2 PROPERTY DESCRIPTION AND PROBLEM IDENTIFICATION

1.2.1 Project Location

This project addresses ONE munitions response area (MRA) comprising the Withlacoochee Site in Sumter and Hernando Counties, approximately 45 miles west of Orlando, Florida.

1.2.2 Site Description

1.2.2.1 The Withlacoochee Site is made up of one MRA which covers approximately 18,240 acres within the Richloam Tract of the Withlacoochee State Forest (Figure 1.1). The 49,201-acre Richloam Tract is one of seven tracts of the Withlacoochee State Forest covering a total of 157,091 acres. Hunting, fishing, wildlife viewing, camping, horseback riding, hiking and bicycling are popular recreational activities within the Richloam Tract. Several highways pass near the site and many secondary roads and trails run throughout the MRA. The MRA was divided into three geographically separate areas as described below.

1.2.2.2 The Chemical Use Area #1 and Air-to-Ground Range (CUA1) encompasses approximately 16,960 acres. The site was formerly used for chemical munitions and equipment tests; air-to-ground gunnery training (small arms ammunition), rocket firing, and possible practice bombing; and a decontamination center and Toxic Gas Yard (TGY) for bulk

CA storage and filling of munitions. The site is currently part of the Withlacoochee State Forest. The site also contains the Florida Bass Conservation Center (fish hatchery). State Highway 471 comprises the western border of CUA1.

1.2.2.3 The Chemical Use Area #2 (CUA2) encompasses approximately 640 acres. The site was formerly used for chemical munitions and equipment tests. The site is currently part of the Withlacoochee State Forest with the exception of the northwestern quarter-section of the site, which is privately owned. State Highway 50 runs through the southeastern corner of CUA2.

1.2.2.4 The Chemical Use Area #3 (CUA3) encompasses approximately 640 acres. The site was formerly used for chemical munitions and equipment tests. The site is currently part of the Withlacoochee State Forest. The Little Withlacoochee River flows westward in a bend through CUA3.

1.2.3 Known or Suspected MEC/CWM Hazards

CWM and MEC present safety hazards that constitute an imminent and substantial danger to the public, site personnel, and the environment. During World War II, a variety of chemical munitions were tested at the Withlacoochee Site. These munitions included chemical bombs; chemical rocket warheads; aircraft spray tanks, smoke pots and thermal generators with chemical fillers, and chemical mortars. In addition, conventional munitions that may have been used included small arms, practice bombs, and practice rockets. There is a potential for any of these munitions to remain at the Withlacoochee Site.

1.2.4 Topography

The land surface of the Withlacoochee Site is essentially flat with a gentle east to west slope. The highest land elevations (at approximately 100 feet above mean sea level [msl]) occur along the eastern site border and steadily drop to about 80 feet above msl along the western site border (Figure 1.2). The surrounding terrain is primarily cypress swamp and dense forests. The flat terrain is conducive to extensive wetland conditions, with water ranging in depth from shallow puddles to deeper swamps and ponds.

1.2.5 Climate

The Withlacoochee Site is situated in a subtropical climate characterized by mild, moderately dry winters and warm, humid summers. The mean annual temperature is approximately 71 degrees Fahrenheit (°F). The mean temperature in the winter is 60°F. August is the warmest month with an average high temperature of 92°F. Precipitation averages 54 inches per year with approximately 56% of the rainfall occurring June through September (City-Data.com, 2010).

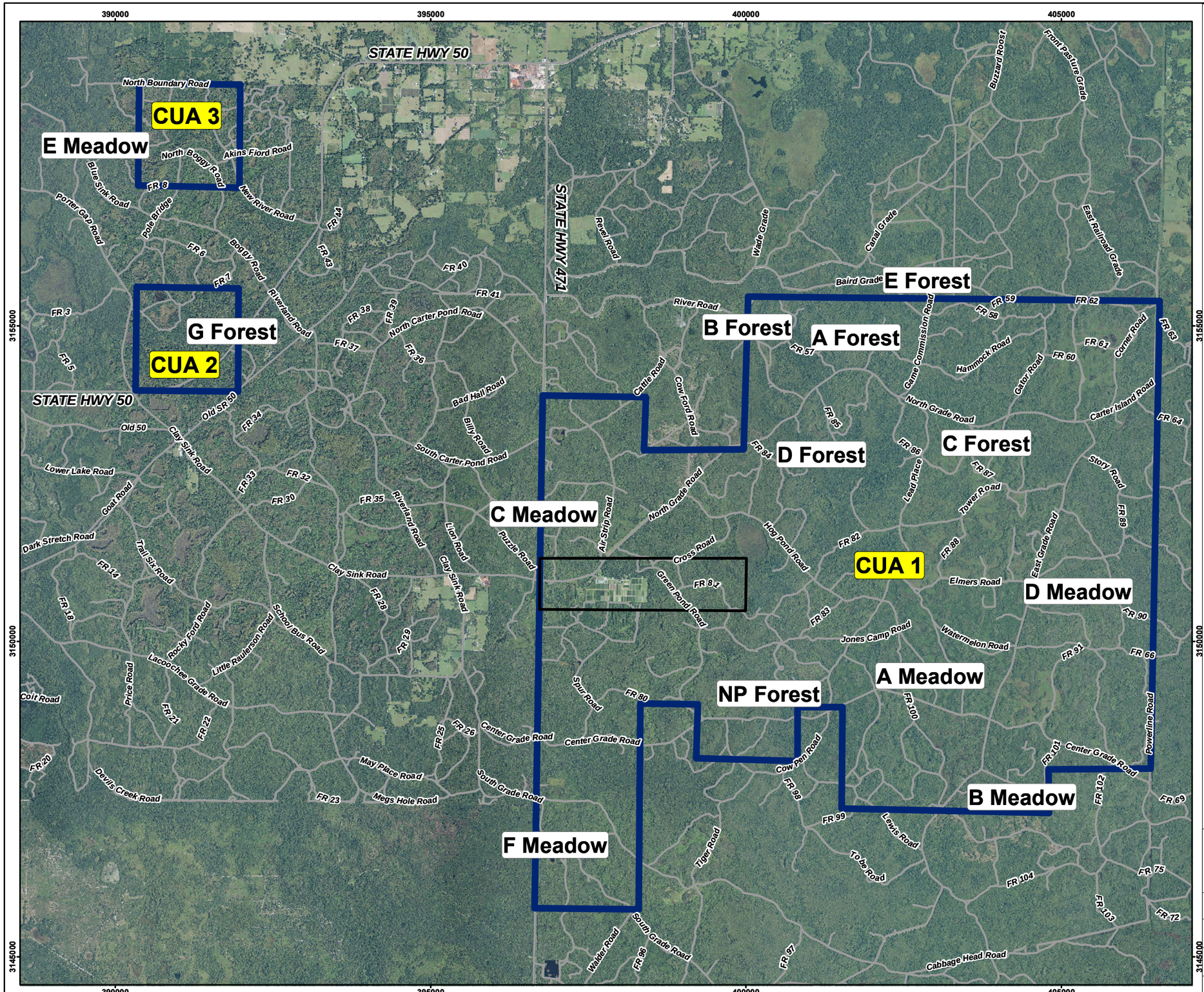
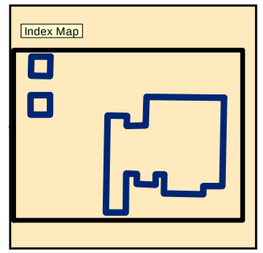


Figure 1.1

Overview Map
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend
- MRS Boundary
- Air-to-Ground Bombing and Gunnery Range



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DESIGNED BY: BT	Overview Map		
DRAWN BY: BT		SCALE: As Shown	PROJECT NUMBER: 747826.05000
CHECKED BY: IG		DATE: February 2015	PAGE NUMBER: 1-3
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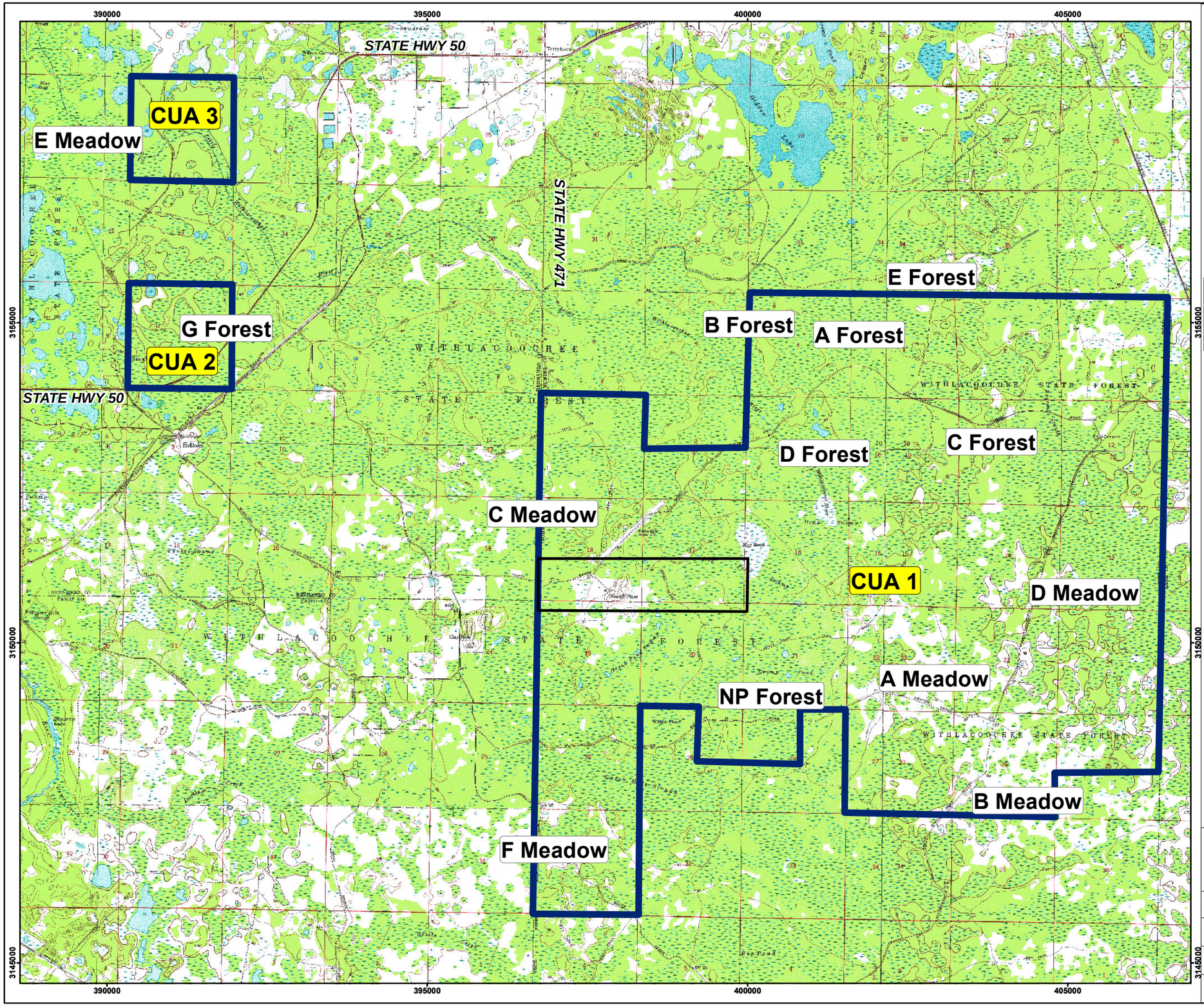
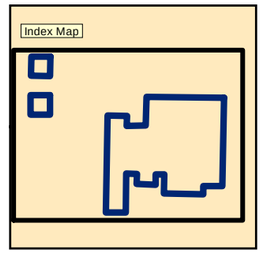


Figure 1.2

Topographic Map
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend
- MRS Boundary
- Air-to-Ground Bombing and Gunnery Range



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1.2.6 Vegetation

The Withlacoochee Site is approximately 40% wetland and predominately occupied by pine flatwoods and cypress ponds with several hardwood hammocks dispersed throughout the area. Predominant tree species within the flatwoods are the slash and longleaf pine, pond cypress and blackgum in the cypress ponds, and live oak, laurel oak, water oak, hickory, sweetgum, blue beech, and magnolia in the hardwood hammocks (Florida Division of Forestry, 2003).

1.2.7 Geology and Soil

1.2.7.1 The Withlacoochee Site is located in the Floridian Section of the Coastal Plain Physiographic Province. The topography of the region surrounding Sumter County is influenced by a series of marine terraces which were formed during the Pleistocene (approximately 10,000 to 1.8 million years ago) as part of a transgressional environment when sea levels were somewhat stationary and higher than present day sea level. When sea levels regressed, sediments were deposited during the period of transgression remained and are now observed to form the terraces. The terraces are divided into geomorphic subzones including the Northern Highlands, River Valley Lowlands and the Coastal Lowlands (Florida Geological Survey [FGS], 1964). The dominant topographic features near the Withlacoochee Site are the north to south trending Western Valley and the Brooksville Ridge. The Western Valley is a large irregularly shaped valley which is bounded to the west by the Brooksville Ridge. Elevations within the Western Valley range from approximately 40 to 100 feet above mean sea level (msl). Elevation of the ridge ranges from about 70 to 200 feet above msl. The Brooksville Ridge is comprised of a core of limestone which is overlain by clayey sands, sandy clays and clays which are in turn overlain by Pleistocene aged sands. Numerous sinkholes are found throughout Sumter County. Dissolution sinkholes are formed where the limestone is exposed at the ground surface or where overlying materials are permeable. The dissolution process is most active at the limestone surface and along rock fractures (FGS, 1989).

1.2.7.2 A series of carbonate (limestone, dolomite) rocks, clays, and marine sands underlie Sumter County. For the purpose of this document, the rocks and sediments that comprise the regional groundwater aquifers are discussed in the order from the oldest to the youngest.

1.2.7.3 The oldest formation described in this chapter is the Lake City Limestone of Eocene age. The formation is described as a hard to soft fossiliferous, brown limestone with dark brown beds of dolomitic limestone at irregular intervals. The thickness of the formation in the region is about 500 feet. The formation is highly permeable but because of its depth is seldom used as a source of groundwater (FGS, 1964). The Avon Park Limestone overlies the Lake City Limestone and is described as a dense tan to dark brown, porous dolomite, frequently interbedded with tan, gray or cream-colored limestones and dolomitic limestones. The formation is present throughout Sumter County but is not exposed. The Avon Park limestone ranges in thickness from 1,100 to about 1,400 feet in Sumter County with the thicker sequences found generally to

the southern end of the county. The Avon Park is unconformably overlain by the rocks of the Ocala Group (FGS, 1989).

1.2.7.4 The Ocala Group has been defined previously as being part of a single formation, the Ocala Limestone. More recently, the rocks have been further differentiated into three separate formations which include the Inglis, Williston, and Crystal River Formations with the Inglis Formation being the oldest member of the group. Near the Withlacoochee Site, the thickness of the Ocala Group is estimated to be over 120 feet. Rock layers within Ocala Group formations range in degree of hardness, fossil content and porosity. The top of the Ocala Group is between 20 and 80 feet above msl in Sumter County and estimated to occur between 60 and 80 feet above msl at the site (FGS, 1989).

1.2.7.5 Undifferentiated sediments primarily made up of sand, sandy clay and clay layers are found on top of the Ocala Group. These undifferentiated sediments make up a surficial aquifer across the site and are estimated to be about 20 feet thick across the Withlacoochee Site.

1.2.7.6 Soils within the Withlacoochee Site are comprised mainly of fine sands derived from sandy marine deposits that are formed mainly along depressions and ridges of marine terraces. These sands are poorly drained with a moderately high to high capacity (0.2 to 5.95 inches/hour) to transmit water. Depth to the water table ranges from about 0 to 18 inches (Web Soil Survey, 2010).

1.2.8 Hydrology

The Little Withlacoochee River, a tributary of the Withlacoochee River, originates in CUA1 flowing in a northwest course and crosses through CUA3. Almost the entire area surrounding the MRA drains into the Little Withlacoochee River. Discharge from the Little Withlacoochee River is into the Withlacoochee River which ultimately flows into the Gulf of Mexico some 53 miles northwest of the site (Google Earth, 2010). Surface water is present as scattered ponds and standing water in wetlands varying with precipitation rates.

1.2.9 Hydrogeology

1.2.9.1 The surficial aquifer is comprised mainly of undifferentiated surficial sand and clayey sands. The thickness of the surficial aquifer in Sumter County ranges from 0 to approximately 60 feet and is estimated to be approximately 20 feet in the vicinity of the site. The principal water-bearing aquifer in the west central Florida Peninsula is the Floridan aquifer system and is the primary source of potable water within the county. The upper portions of the Floridan aquifer system in the county is made up of rocks from the Ocala Group, Avon Park Limestone and the Lake City Limestone and is considered to be unconfined throughout most of Sumter County. Throughout the county recharge to this aquifer ranges from high to moderate. The top of the aquifer is generally less than 50 feet in most areas of the county and estimated to be between 60 and 80 feet above msl in the area of the Withlacoochee Site. The potentiometric surface within the Floridan aquifer generally dips to the northwest with the surface ranging from approximately 40 feet above msl along the Withlacoochee River Valley west of Lake Panasoffkee (northwest Sumter County) to between 90 and 100 feet above msl in the area of the Green Swamp surrounding the Withlacoochee Site.

1.2.9.2 Water leaves the Floridan aquifer system through natural movement down gradient (westward) and subsequent discharge via upward movement through springs, lakes, and wells (U.S. Geological Survey [USGS], 1990).

1.2.10 Threatened and Endangered Species

1.2.10.1 According to the U.S. Fish and Wildlife Service (USFWS) Threatened and Endangered Species Database, the State of Florida supports 114 federally listed threatened and endangered species consisting of 59 animals and 55 plants. Seventeen of these federally-listed species are known to exist in Sumter and Hernando Counties; these species are presented in Table 1-1. Florida also recognizes some species not on the federal list as being either endangered, threatened, or species of special concern; more information on these species and their occurrence within the Withlacoochee State Forest can be found in the Biological Monitoring Plan (Appendix M) of the Work Plan (USA, 2014).

1.2.10.2 The scientists of the Withlacoochee State Forest (WSF) have identified three "key" species known to be present in specific areas within the forest: the red-cockaded woodpecker, the gopher tortoise, and the Sherman's fox squirrel (WSF, 2003). The habitat within the Withlacoochee Site does not provide optimum habitat conditions for these three species, but no formal floral or faunal survey of the area has been undertaken to date. The high water table and periodic flooding make most of the area unsuitable for the gopher tortoise, although the tortoise has been observed in two locations. The lack of mature pines and the invasion of hardwood species due to fire suppression preclude the site from providing habitat for the red-cockaded woodpecker. The Sherman's fox squirrel is the only one of these "key" species that poses a real potential for being present within the Withlacoochee Site (WSF, 2003). One sighting has been documented in the western half of Section 14, Township 23 South, and Range 23 East. Sherman's fox squirrels are not solitary animals, so if one is present, there will be more in this location, at least. As stated previously, no formal surveys have been conducted within this area and it is highly probable that more Sherman's fox squirrels are found throughout (Morris, personal communication, 2011).

1.2.10.3 Other animal species known to occur within the WSF are the bald eagle, Florida gopher frog, short tailed snake, Florida pine snake, Eastern indigo snake, Eastern tiger salamander, striped newt, and Southern hognose snake. Bald eagles have been known to nest near the fish hatchery within the project area. Based on a 2013/2014 FWC survey, there are two active nests in the Richloam WMA, one near CUA3 and the other near the fish hatchery within the boundary of CUA1.

1.2.10.4 Plant species known to occur within the Withlacoochee watershed, but not yet known to occur on the project site include Cooley's water willow, eared spleenwort, low pepperomia, Brooksville bellflower, Tampa mock vervain, Florida pygmy pipes, pinkroot, swamp plume polypody, creeping fern, Florida filmy fern, giant orchid, and green ladies tresses (WSF, 2003). No formal surveys of the Richloam Unit have been conducted to determine if the listed plants are present. Given the overgrown character of the mesic flatwoods in the Richloam Unit, the historical usage, and the history of fire suppression, it is not likely that the species listed above are present on the site, with the exception of those plant species known to occur within hydric hammock plant communities (Werner, personal communication, 2011).

1.2.10.5 None of the species listed in Table 1-1 were observed during the fieldwork for this RI. As detailed in the Biological Monitoring Plan in Appendix M of the Work Plan (USA, 2014), all of the areas within the MRA have extremely similar terrain and environmental habitats. While some former test areas are named with "meadow", these areas are no longer meadows due to the natural progression of woody species. Any significantly different habitats would be infrequent and cover a small area.

1.2.10.6 All site personnel were briefed on identifying and avoiding these species and if any had been observed, care would have been taken to not disturb them or their immediate habitat. Species awareness training was included in the daily tailgate safety meetings.

1.2.11 Wetlands

1.2.11.1 The USFWS Wetlands Online Mapper, through the National Wetlands Inventory, was used to identify wetlands within the former Withlacoochee Site. Wetlands data for the entire site was available. Wetlands are found in all areas of the site. Some of the wetlands are seasonal and some are semi-permanently flooded. There are five main types of wetlands onsite. These wetlands are shown in Figure 1.3. The main wetland types are:

- PUBHx – Palustrine, unconsolidated bottom, permanently flooded, excavated.
- PAB3H – Palustrine, aquatic bed, permanently flooded.
- PFO2/6F – Palustrine, forested, semipermanently flooded.
- PEM1Cx – Palustrine, emergent, persistent, seasonally flooded, excavated.
- PSS1/6F – Palustrine, scrub shrub, semipermanently flooded.

Wetland area along North Grade Road, July 2013

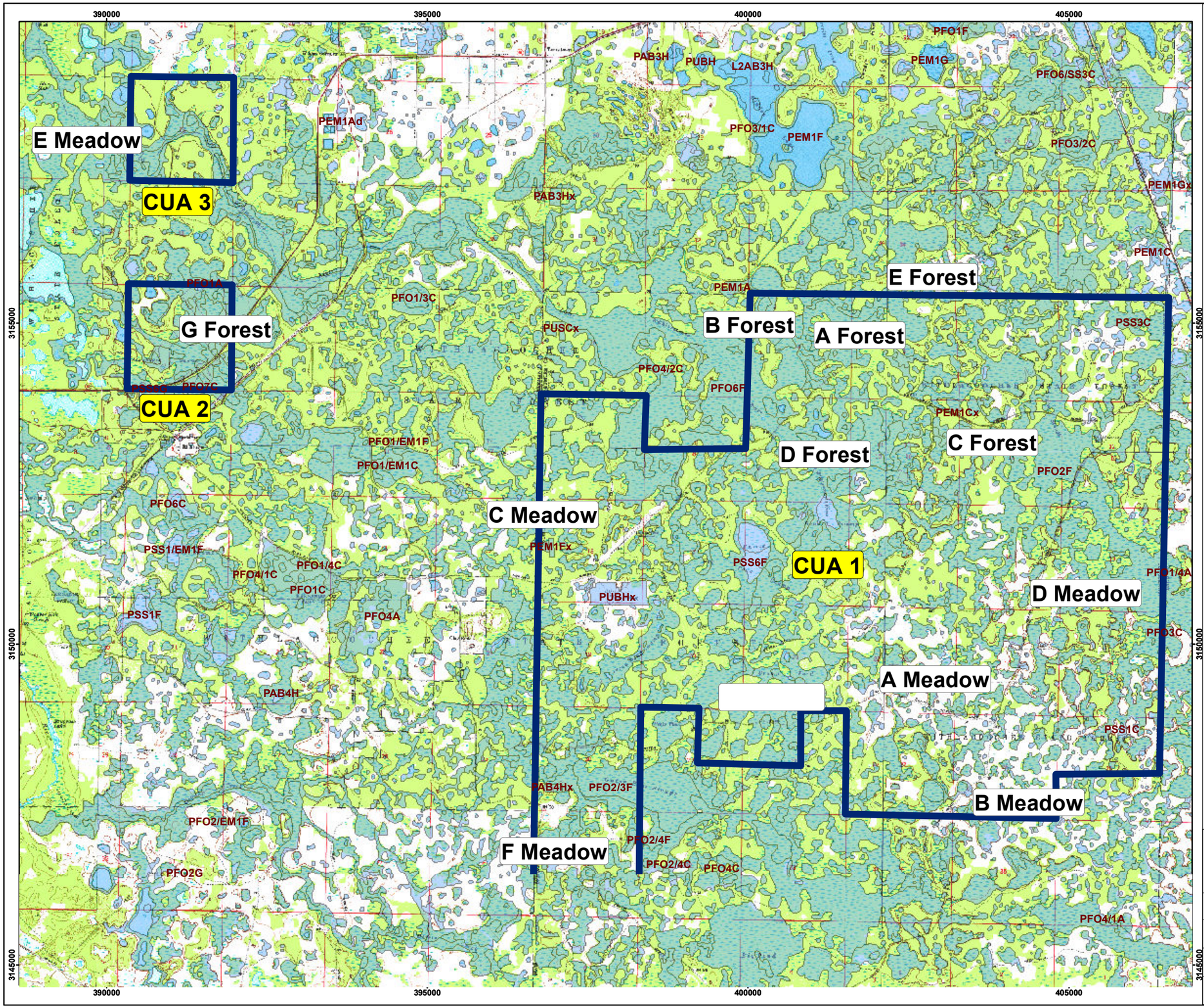

Figure 1.3

Wetland Map
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- MRS Boundary
- Wetland (Obtained from U.S. Fish & Wildlife Service)

Predominant Wetland Types:

PUBHx - Palustrine, unconsolidated bottom, permanently flooded, excavated.
PAB3H - Palustrine, aquatic bed, permanently flooded,
PFO2/6F - Palustrine, forested, semipermanently flooded,
PEM1Cx - Palustrine, emergent, persistent, seasonaly flooded.excavated.
PSS1/6F - Palustrine, scrub shrub, semipermanently flooded.

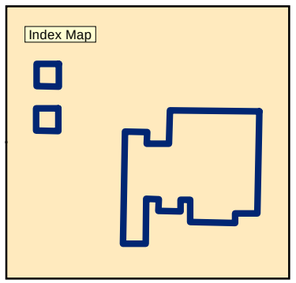

Image: USGS 7.5' Topo Quadrangles, Date Unknown.
Projection: UTM Zone 17 NAD83, Map Units in Meters

2,000 1,000 0 2,000 Meters

N

USA Environmental	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	Wetland Map		
DRAWN BY: BT			
CHECKED BY: IG	SCALE: As Shown	PROJECT NUMBER: 747826.05000	
SUBMITTED BY: JC	DATE: November 2014	PAGE NUMBER: 1-9	
	FILE: X:\CWM_GIS\GIS\MAPS\Withlacoochee_FL\RI-FS\RI_report		

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1.2.12 Cultural and Archaeological Resources

According to the Florida State Historical Preservation Office, National Registry of Historic Places, the National Historic Landmarks Program, the National Heritage Areas Program, there are no known significant cultural resources within the boundaries of the former Withlacoochee Site. During the RI/FS field effort, field teams monitored for archaeologically important areas as set out in Section 3.3 of the Archaeological Monitoring Plan (Appendix N) of the Work Plan (USA, 2014). No significant cultural resources were identified during the field effort. The only cultural debris noted during the intrusive work were some tin cans found in an excavation within CUA1 and many pieces of wire fencing found throughout the Withlacoochee Site.

1.2.13 Current and Projected Land Use

Currently, the Florida Forest Service (FFS) manages the Richloam Wildlife Management Area (WMA), which comprises most of CUA1 and CUA2, and all of CUA3. Timber harvesting has been in operation for 40 years with constant planting of pine trees in areas of cleared hardwoods. As part of its management of the WMA, the FFS maintains road access by cleaning drains along both sides of the sand and gravel roads, occasionally replacing culverts. Occasional sign posts and wire fences are maintained in a few areas. Timber management includes planting pine trees and conducting controlled burns of the understory vegetation to prevent buildup of combustable materials. In addition to timber management, the public uses the WMA for hiking and hunting – for which a number of primitive camping sites have been established. Since 1965, the Florida Fish and Wildlife Conservation Commission (FWC) has leased a portion of the WMA for the Richloam State Fish Hatchery. The hatchery covers 180 acres within CUA1 and includes 63 outdoor ponds, the Florida Bass Conservation Center offices, and a visitor's center that were constructed in 2007. In addition, there are two employee residences within CUA1 just north of the hatchery. The northwest quadrant of CUA2 (160 acres) is privately owned but remains undeveloped. A right-of-entry was not obtained for this property, but because the area is forested, not fenced, and contained within the WMA, property use is assumed to be the same as the rest of the WMA – timber harvesting, hiking, and hunting. Future use of the property in CUA1, CUA2, and CUA3 is expected to remain the same as current use.

1.3 HISTORICAL INFORMATION

Prior to government acquisition of the area that now includes the Withlacoochee Site, the land was either undeveloped or used for agriculture and livestock grazing. The U.S. Department of Agriculture (USDA) acquired the property in 1936 and managed it as the Withlacoochee Land Utilization Project under the Soil Conservation Service (SCS) in an effort to repurpose the land (ill-suited for crops) for forestry and grazing (USACE, 2011).

1.3.1 Air to Ground Gunnery Range – October 1943 to November 1946

1.3.1.1 In 1943, Zephyrhills Army Air Field (AAF) sought additional land to establish an Air-to-Ground Gunnery Range (ATGGR) for the Army Air Forces School of Applied Tactics (AAFSAT). The Withlacoochee Land Utilization Project site was a prime candidate, being a well-suited tract lying approximately 18 miles north-northeast of the Zeph-

yrhills AAF. In October 1943, the War Department issued a real estate acquisition directive to acquire 10,562 acres (as well as an existing truck trail) from the USDA through a temporary use permit. The Special Use Permit was granted to the Zephyrhills AAF on October 26, 1943. The War Department acquired additional land in Hernando County from the USDA, bringing the total acquisition to 18,240 acres. The AAFSAT cleared an area 4,000 by 2,500 feet and placed six strafing targets spaced approximately 600 feet apart. An emergency landing strip was also constructed on top of an existing service road (USACE, 2011).

Table 1-1: Federally Listed Threatened and Endangered Species in Sumter and Hernando Counties, Florida

Common Name	Scientific Name	Federal Status	County of Occur-rence
West Indian Manatee	*Trichechus manatus*	Endangered	Sumter, Hernando
Red Wolf	*Canis rufus*	Endangered	Hernando
Sherman's Fox Squirrel	*Sciurus niger shermani*	None / State Endangered	Sumter, Hernando
Red-Cockaded Woodpecker	*Picoides borealis*	None / State Species of Concern	Sumter, Hernando
Florida Scrub-Jay	*Aphelocoma coerulescens*	Threatened	Hernando
Brown Pelican	*Falco peregrinus tundrius*	Endangered	Sumter, Hernando
Wood Stork	*Mycteria americana*	Endangered	Sumter, Hernando
Eurasian Peregrine Falcon	*Falco peregrinus peregrinus*	Endangered	Sumter, Hernando
Gopher Tortoise	*Gopherus polyphemus*	None / State Threatened	Sumter, Hernando
Eastern Indigo Snake	*Dymarchon corais couperi*	Threatened	Hernando
Yellow Blossom (Pearlymussel)	*Epioblasma florentina florentina*	Endangered	Sumter
Alabama (=inflated) Heelsplitter	*Potamilus inflatus*	Threatened	Sumter
Stirrupshell	*Quadrula stapes*	Endangered	Sumter
Upland Combshell	*Epioblasma metastriata*	Endangered	Sumter
Ovate Clubshell	*Pleurobema perovatum*	Endangered	Sumter
Brooksville Bellflower	*Campanula robinsiae*	Endangered	Hernando
Cooley's Water-Willow	*Justicia cooleyi*	Endangered	Hernando

1.3.1.2 In October 1943, the AAFSAT was redesignated as the AAF Tactical Center (AAFTAC) tasked with organizing activities throughout the Orlando, Florida, area. In March 1944, the AAFTAC transferred authority for the ATGGR to the Third Air Force. In July 1944, the Assistant Secretary of Agriculture approved a modification to the Special Use Permit allowing use of the tract as a practice bombing range in addition to the gunnery range. The practice bombing range (now identified as the Lacoochee Bombing and Gunnery Range) was to be used by heavy bombardment groups from MacDill and Drew Fields. By May 1945, the Third Air Force reassigned the Bombing and Gunnery Range to Bartow AAF under the auspices of the Third Fighter Command. Bartow AAF constructed additional facilities by the end of the summer of 1945, which included:

- Complete ground gunnery range with a bank of six targets, including concrete target butts, foul lines, and range house;
- Moving the Diving Bomb Target approximately 1,500 feet south;
- Two 25-foot spotting towers;
- Low-level bombing target with a smaller spotting tower;
- Two huts for housing range personnel; and
- Water well, pump, and storage tank.

1.3.2 CWS Mobile Unit Field Trials – October 1943 to September 1945

1.3.2.1 In October 1943, the Dugway Proving Ground (DPG) commander requested and received permission from the SCS allowing use of the Raulerson Hammock Inviolate Area of the Withlacoochee Land Use Project site for the CWS tests. The U.S. Army CWS conducted field trials of persistent and non-persistent CA at the site beginning in November 1943. Personnel from the Army and the National Defense Research Committee (NDRC) cut an access road into the selected area and established a 400 x 400 yard sampler grid and a system of five simulated Japanese foxholes, bunkers, and dugouts. The test area was known as the "NP Forest." Non-persistent CA testing began on November 25, 1943 and ended on January 11, 1944 (USACE, 2011).

1.3.2.2 Personnel from DPG were mobilized in December 1943 to set up the site for persistent CA field testing. An office and laboratory were established in an unused store in the town of Bushnell with personnel housed either in town or in tents at the Bushnell AAF. Test support facilities, including a decontamination center and Toxic Gas Yard (TGY) for bulk CA storage and filling apparatus, were built at the area occupied by the East Richloam Fire Tower and Ranger Station. The organization conducting the field trials included more than 60 military personnel and civilians from a variety of organizations including DPG, Edgewood Arsenal, California Institute of Technology, Northwestern University, and a couple of Navy observers. Field testing of persistent CA began in January 1944 and included static firing and dropping of chemical bombs from aircraft, spray tanks, chemical munitions (e.g., mortars), thermal generators, and the testing of protective clothing. The personnel surveyed and staked out new test areas for the persistent testing including forest and meadow areas, which would eventually total sixteen areas. Table 1-2 provides a list of the test areas along with a history of the area, dates of testing, summary of the number of tests, number and type of munitions used, and chemicals involved in the tests (USACE, 2011).

1.3.2.3 Historical records indicate that 15 test areas were used for the non-persistent and persistent agent tests. These test areas were designated as forest or meadow areas. There were eight test areas with forest designations – NP Forest, and A Forest through G Forest. All of the forest test areas were within CUA1, except for G Forest, which is just east of CUA2. There were also seven test areas with meadow designations – Meadow A through Meadow G. All were located within CUA1, except E Meadow, which was located near the western edge of CUA3.

1.3.2.4 In August 1945, the base of operations was moved from Bushnell AAF to Brooksville AAF to allow the Bushnell AAF facility to be returned to its leaseholders. Following the move, the number of field tests being conducted at Withlacoochee was significantly reduced with the unit primarily focusing on completing reports for studies conducted previously. By February 1946, testing had ceased and by April operations were being shut down and equipment and munitions were dispersed from Brooksville AAF to various depots and facilities.

1.3.2.5 Among the items inventoried at Brooksville AAF in April 1946 were two 55-gal drums of Lewisite (L) and thickened Lewisite (LVV). The presence of these drums identifies the potential for L being used in the tests at Withlacoochee, which is supported by summary reports that showed testing of aircraft spray tanks with a mustard-Lewisite mixture (HL) was planned; however no records of the actual tests were found (USACE, 2011).

1.3.3 Range Use Following World War II – November 1945 to Present

1.3.3.1 By November 1945, the Lacoochee Bombing and Gunnery Range was no longer used for practice gunnery and bombing. The Third Air Force declared the area surplus in December 1945. Decontamination activities reportedly occurred in March and August 1946, although no dedudding or clearance certificates have been located. On 3 September 1946, the SCS Regional Office in Spartanburg, SC, requested termination of the Special Use Permit and transfer of all improvements, noting that the USDA will "…fully release the War Department from damages occasioned by fire or any other causes during the War Departments occupancy of the property." On 6 December 1946, the Savannah District transferred the property and improvements to the USDA (USACE, 2011).

1.3.3.2 In 1949, unexploded chemical mortars and bombs were found during a site inspection conducted by the USACE. As a result, the Corps conducted clearance operations covering 18,240 acres at the site from February through May 1950. A certificate of clearance was released on June 9, 1950 with the recommendation that specific large areas be restricted to surface use only. According to the 1950 clearance map provided in the HRR (USACE, 2011), all three CUAs were included in the clearance operations. Table 1-3 lists the items found during the 1950 clearance. All of the explosive munitions were detonated and all chemical munitions were burned and decontaminated with bleach powder and DANC (Decontaminating Agent, Non-Corrosive) (USACE, 2011).

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Table 1-2: Test Areas

Test Area	Test Description	Testing Dates	Chemical Use Area	Testing Methods	No. Tests/ Munitions[1]	Munitions Tested	Chemicals Used[2]
NP Forest	First test area established for the testing of munitions with non-persistent agents, persistent agents, and stimulants. Test grid approx. 500 yds by 500 yds.	25 November 1943 - 15 August 1944	CUA1	Bomb drops from 150 to 10,000 feet, static firing; firing of mortars	48 / 415[3]	British MK II Bomb, M47A2 Bomb, M70 Bomb, M74 Bomb, MK 42 Bomb, T-1 Bomb, T-2 Bomb, 4.2-inch Mortar	MS, MS thickened, H, water, NO2, CG, AC, NH3, CC
A Forest	Tests included the use of a 4.2-inch mortars and various bombs against a simulated Japanese defensive position constructed in the grid. Test grid approx. 360 yds by 360 yds.	31 January 1944 - 27 November 1944	CUA1	Bomb drops from 125 to 10,000 feet and static firing	29 / 103	4.2-inch Mortar, LC50 Bomb, M47A2 Bomb, M70 Bomb	H, MS, CNS
B Forest	Tests included the use of Comings Candles and F7-A thermal generators filled with H. A simulated Japanese defensive position was constructed in the grid. Test grid approx. 360 yds by 360 yds.	3 February 1944 - 31 January 1945	CUA1	Bomb drops from 100 to 10,000 feet and static firing	17 / 407	Comings Candle, F7-A Thermal Generator, LC50 Bomb, M47A2 Bomb, M70 Bomb, M74 Bomb, E27R1 Cluster Bomb	H, MS, water
C Forest	Two tests involved firing of a total of 214 4.2-inch mortars filled with H into the grid. Test grid approx. 350 yds by 400 yds.	20 April 1944 - 13 June 1945	CUA1	Bomb drops from 10,000 feet, firing mortars, and static firing	5 / 334	E61 Cluster Bomb (w E5 Bombs), LC50 Bomb, 4.2-inch Mortar	H
D Forest	Tests were conducted using bombs dropped from an altitude of 10,000 feet or statically fired on the ground.	15 June 1944 - 24 August 1944	CUA1	Bomb drops from 10,000 feet and static firing	7 / 19	M47A2 Bomb, M70 Bomb	HN3, H
E Forest	Tests were conducted using M70 bombs.	27 July 1944 - 12 August 1944.	CUA1	Bomb drops from 1,000 feet and static firing	3 / 15	M70 Bomb	H
F Forest	Only two tests were known to have been conducted at this test area.	27 November 1944 - 4 December 1944.	CUA1	Static firing	2 / 12	M47A2 Bomb	H
G Forest	Tests were conducted using rocket warheads, EK-4 bomblets, and M47A2 bombs. One test included dropping an E49 cluster.	28 December 1944 – 30 June 1945	CUA2	Bomb drops from 125 feet and static firing	16 / 76	7.2-inch Rocket Warhead, E49 Cluster Bomb, EK-4 Bomblet, M47A2 Bomb, M79 Bomb, M78 Bomb	H, AC
A Meadow	Tests of bombs with fillers that included: H, AC, white wash and MS. Two tests involved aerial spraying of thickened H (HV) using M10 aircraft spray tanks.	19 June 1944 - 25 January 1945	CUA1	Bomb drops, static firing and aerial spraying	16 / 46	M47A2 Bomb, M70 Bomb, M10 Spray Tank, LC50 Bomb	White wash, HV, MS, H, water
B Meadow	Tests conducted consisted of bombs air-dropped from altitudes of 125 to 10,000 feet or were statically fired on the ground. Chemical fillers consisted of AC, H, and MS.	28 June 1944 - 11 January 1945	CUA1	Air drops from 125-10,000 feet and static firing	20 / 35	M47A2 Bomb, Mk42 Bomb, M79 Bomb, M70 Bomb	MS, AC, H
C Meadow	The only tests conducted involved pouring agent (HN3) on the ground.	3 August 1944 - 21 August 1944.	CUA1	Pouring on the ground	3 / 0	Agent poured on ground	HN3
D Meadow	Tests conducted using M47A2 bombs (filled with HN1 and H). Three tests used HN1 or H poured directly on the ground. One test fired 200 4.2-inch mortars filled with HT into the test grid.	28 September 1944 - 22 January 1945	CUA1	Static firing (bombs), firing (mortars)	7 / 209	M47A2 Bomb, 4.2-inch Mortar, Agent poured on ground	H, HN1, HT

Table 1-2: Test Areas

Test Area	Test Description	Testing Dates	Chemical Use Area	Testing Methods	No. Tests/ Munitions[1]	Munitions Tested	Chemicals Used[2]
E Meadow	One static test was conducted firing a single M47A2 bomb filled with HN3.	6 September 1944	CUA3	Static firing	1 / 1	M47A2 Bomb	HN3
F Meadow	One of the most heavily used test areas. Tests included over 1,000 4.2-inch mortars being fired into the grid	10 September 1944 - 5 May 1945	CUA1	Bomb drops from 100 feet to 10,000 feet, firing of mortars, and static firing	71 / 1,257	4.2-inch Mortar, 7.2-inch Rocket Warhead, E49 Cluster Bomb, E5R8 Bomb, EK-4 Bomblet, M47A2 Bomb, E29 Thermal Generator, LC50 Bomb, M70 Bomb, Mk42 Bomb	H, HT, salt water, HN1, nitrobenzene, MS
G Meadow	Used for 2 tests using static firing of F7-A thermal generator filled with H and M47A2 filled with H	21 and 31 March 1945	CUA1	Static firing	2 / 2	F7-A Thermal Generator, M47A2 Bomb	H

[1]The number of tests listed and number of munitions are based on the records search conducted for the Preliminary Assessment (USACE, 2011). It is possible that not all tests have been identified.

[2]Chemicals Used:

AC – Hydrogen cyanide
CC – Cyanogen chloride
CG – Phosgene
CNS – Tearing agent
H – Mustard (inc. distilled Mustard (HD) and Levinstein Mustard)
HT – Mustard and Agent T mixture
HV – Mustard thickened with methyl methacrylate
HN1 – Nitrogen Mustard 1
HN3 – Nitrogen Mustard 3
MS – Methyl salicylate (oil of wintergreen) – chemical agent simulant
NH_3 – Ammonia – non-persistent agent simulant
NO_2 – Nitrous oxide – non-persistent agent simulant
water, salt water – chemical agent stimulants

[3]Includes one static test of a M47A2 bomb filled with H and one test of 150 4.2-inch mortars filled with H fired into the test grid from 1,000 yards. These tests were not tabulated in the PA Section 4 but documented in *Bi-Weekly Summary Report for Period Ending 26 March 1944*, 28 CWS R&D Program, DGP, Bushnell Field Installation, 28 March 1944.

1.3.3.3 The Florida Forest Service purchased the land from the Federal government between 1958 and 1983 as part of the Richloam Tract of the Withlacoochee State Forest. A fish hatchery, operated by the State of Florida, was constructed over the former target area of the air-to-ground range and began operation in April 1965. The hatchery was modernized and expanded in 2007 by the Florida Fish and Wildlife Conservation Commission with the renewed mission of raising several species of bass native to Florida (FWC Website, 2013).

1.4 PREVIOUS INVESTIGATIONS

Previous investigations concerning MEC and CWM conducted within the Withlacoochee Site include record searches, interviews, surface assessments, and geophysical surveys. These investigations are described in the following sections.

1.4.1 1993 Inventory Project Report

The Inventory Project Report (INPR), Withlacoochee Army Airfield, Site I04FL007800, was prepared by the USACE Jacksonville District. This INPR included performing a site visit, interviews, and historical background searches specific to the former airfield in order to determine if the site was eligible under the FUDS program. During the site visit, the INPR team discovered that an unexploded bomb had been found in a pond near the fish hatchery and that authorities were called and the bomb removed. The team visited areas of the Withlacoochee Site where the older trees showed bomb damage and saw the remains of a dugout used during the testing (likely in the A Forest test area). The INPR was approved recommending 18,240 acres as a FUDS. The site was assigned a Risk Assessment Code (RAC) of 2 recommending further action as a high priority (USACE, 1993b).

1.4.2 1993 Archives Search Report (ASR)

The USACE St. Louis District prepared an ASR for the Withlacoochee Site in July 1993. Preparation of the ASR included a site visit, research at various archives and records holding facilities, and interviews with individuals associated with the site or familiar with its operations. During a review of historical archives, a version of the 1950 range clearance map was discovered which aided in identifying the types of munitions discovered during the clearance and their locations. The site visit was conducted at the Withlacoochee Site on April 14, 1993 to evaluate current site conditions and to confirm the findings of the ASR related to CWM. A team visited six areas of interest associated with activities depicted in historic documents. Seven people (including several former military personnel) familiar with the former munitions testing operations and more recent site activities were interviewed for the ASR (USACE, 1993a).

Table 1-3: Munitions and Test Items found during 1950 Clearance

Quantity	Item	Filler	Area
177	M74 10-lb chemical bomblets (E5 series bomblets)	H	CUA1
20	M74 chemical bomblets (E5 series bomblets)	H	CUA2
9	M70 115-lb chemical bombs	H	CUA1
16	M69 bombs (actually EK-3 and EK-4 chemical bomblets)	H	CUA1
1	4.2-inch chemical mortar, fuzed	H	CUA1
3	M47A3 100-lb chemical bombs	H contaminated	CUA1
3	Test Bottle Kits	Empty	CUA1
1	Test Bottle	Empty	CUA1
3	Tail Assemblies with M145 fuze	n/a	CUA1
5	M5 Smoke Pots	Smoke (HC)	CUA1
2	Booster Adapters for M76, M78, and M79 chemical bombs with explosives	n/a	CUA1
9	AN Mk 4 Signal Flares	n/a	CUA1
15	Containers for smoke mixtures for M89, M90, and M99 250-lb Target Identification Bombs	H	CUA1
6	M10 bursters with AN M110A1 fuze	n/a	CUA1

Note that the item descriptions were from the clearance teams which may not discriminate between munitions that closely resemble each other.

1.4.3 1995 Site Characterization Report

The USAESCH contracted with Environmental Science & Engineering, Inc. (ESE) to conduct a site visit and, subsequently, a "limited" Engineering Evaluation/Cost Analysis (EE/CA) in 1993. The EE/CA included visual reconnaissance for surface MEC/CWM or MD and geophysical surveys, but did not include intrusive investigations of anomalies associated with the surveys. The visual reconnaissance covered approximately 80 acres at 19 areas. The geophysical surveys, which covered approximately 18 acres, were conducted within five areas, namely the Cow Camp, Flag Ford Camp, East Tower Camp, Raulerson House Camp, and South Loop Camp. The investigation team did not observe MEC/CWM or MD at these sites, but did detect multiple subsurface metallic anomalies (ESE, 1995).

1.4.4 2002-2007 CWM Scoping and Security Study

The USAESCH conducted a CWM Scoping and Security Study, which evaluated and prioritized 91 suspected CWM sites nationwide. The project began in Fall 2002 and was completed by December 2007. The former Withlacoochee Site was one of the sites eval-

uated. In January 2003, the project team conducted a site visit to evaluate current conditions and confirm previous findings. During the visit, the team toured the site and met with two people familiar with historic DoD operations. Both interviewees recounted hearing of former encounters with munitions (including chemical) or MD. The final report, issued in August 2007, recommended that a RI be conducted at the site (Parsons, 2007).

1.4.5 2004 ASR Supplement

The USACE St. Louis District prepared a Supplement to the ASR as part of a nationwide update with respect to the liability costs associated with UXO at all military ranges, generally referred to as the Advanced Range Survey. The ASR Supplement identified four areas for future investigation – three chemical use areas and an Air-to-Ground Range, which is contained within CUA1 (USACE, 2004; USACE, 2007a).

1.4.6 2005 Historical Photographic Analysis

The U.S. Army Engineer Research and Development Center, Topographic Engineering Center (TEC) conducted a historical photographic analysis (HPA) of aerial photographs taken in 1941, 1944 (partial coverage), 1951, 1952, and 1999. TEC evaluated these aerial photographs which ranged from before, during, and after the military use of the site and prepared a report titled "Special Assessment GIS-Based Historical Aerial Photographic Analysis," the final being prepared in July 2005. The HPA analyzed the aerial photographs in an attempt to discern areas of use (e.g., ground scars, potential burial sites, berms, craters) (U.S. Army Engineer Research and Development Center, Topographic Engineering Center, 2005). Features identified by the HPA were used for planning specific locations to be investigated for the RI.

1.4.7 2011 Preliminary Assessment

1.4.7.1 The USACE St. Louis District prepared a PA for the former Withlacoochee Site to update the ASR. The intent of this report was to compile the information obtained through historical research at various archives and records holding facilities. The PA has been instrumental in obtaining information regarding the property boundaries of the FUDS. The PA uncovered hundreds of reports and memos regarding the CWS field trials that were helpful in identifying potential MEC and CWM that might be encountered during the RI field activities (USACE, 2011).

1.4.7.2 Following the completion of the PA, one of the scientists (Harold Johnston) who worked at the site during the field trials found a copy of a 1945-era map that showed the locations of 15 test areas. Prior to this discovery, only the location of the NP Forest had been identified. A scanned copy of the map is contained in Appendix H.

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2.0 PROJECT REMEDIAL RESPONSE OBJECTIVES

The RI is being conducted in accordance with the objectives and goals presented and accepted by stakeholders during the TPP meetings and as summarized in the Final TPP Memorandum (USA, 2011). The primary purpose of the RI is to determine the nature and extent of the potential MEC and MC within the former Withlacoochee Site. The TPP team agreed that the RI data collection would focus on the geophysical surveys, intrusive investigation, and collection of environmental samples.

2.1 CONCEPTUAL SITE MODEL AND PROJECT APPROACH

2.1.1 Preliminary Conceptual Site Model

2.1.1.1 The conceptual site model (CSM) depicts and evaluates the potential interactions between human and ecological receptors and MEC and MC. The ways that MEC and MC can move in the environment and the means by which receptors may contact them are called migration and exposure pathways. The CSM identifies potential migration and exposure pathways and the possible human and ecological receptors for those pathways, based on site-specific conditions. It is necessary to evaluate site-specific conditions and land use to evaluate risks posed to potential receptors under current and future land use scenarios. Exposure pathways for relevant media are evaluated.

2.1.1.2 The CSM summarizes which potential receptor exposure pathways for MEC and MC are (or may be) complete and which are (and are likely to remain) incomplete. An exposure pathway is not considered complete unless all four of the following elements (in italics) are present (U.S. Environmental Protection Agency [USEPA] 1989). An example regarding a hypothetical surface water exposure pathway for MC is included.

- *A source of contamination* (for example, a site has known MEC from which MC have leached and contaminated surface soil).
- *An environmental transport and/or exposure medium* (in the example, the MC in soil are mobile and can migrate to surface water via storm water runoff).
- *A point of exposure at which the contaminant can interact with a receptor* (a swimming hole is located close to the site).
- *A receptor and a likely route of exposure at the exposure point* (a local resident uses the swimming hole for recreation).

2.1.1.3 In the hypothetical example, all four factors are present and, therefore, the surface water exposure pathway is complete. If any single factor was not present (e.g., MC were not present in soil, or there was no swimming hole located in the vicinity), the pathway would be incomplete. An incomplete exposure pathway indicates that there are no current means by which a receptor (human or ecological) can come into contact with either MEC or MC and, therefore, no hazards or risks from exposure to MEC or MC would be expected.

2.1.1.4 A CSM is dynamic and represents the current understanding of the site. The CSM is evaluated and revised each time new information is received. As part of the TPP

process for the RI at the Withlacoochee Site, preliminary CSMs were developed in accordance with Engineer Manual (EM) 200-1-12 (USACE, 2012). The preliminary CSMs are presented in tabular form (Table 2-1) and as flow charts (Figure 2.1, Figure 2.2, and Figure 2.3), and depict the possible contaminant migration and exposure pathways for the various receptors at the Withlacoochee Site based on information available prior to the RI. The known or suspected MEC and MC presented in these preliminary CSMs were developed based on the results of previous investigations conducted at the site (Subchapter 1.4) in conjunction with various available DoD data sources, and the rationale was concurred by the TPP Team and was presented in the final approved WP (USA, 2014).

2.1.1.5 The preliminary CSMs for CUA1, CUA2, and CUA3 showed that MC, MEC at the surface, and MEC in the subsurface were a potential concern based on historical evidence that suggested their presence. Receptors at this site may be exposed to surface soil through incidental ingestion, dermal contact, and inhalation of soil particles. Receptors may be exposed to surface water and sediment through incidental ingestion and dermal contact. Surface water from the site is not expected to be used as a source of drinking water for human receptors. Exposure to groundwater is possible via ingestion of drinking water, dermal contact, and inhalation of volatiles. In addition, residents are assumed to potentially be exposed to homegrown produce irrigated with contaminated groundwater. Potentially complete exposure pathways are present at the site that might result in residents, commercial/industrial workers (e.g., site workers), site visitors/recreational users, construction workers, and ecological receptors being exposed to MC if contamination is present, and MEC at the surface and subsurface.

2.1.1.6 The preliminary CSMs for the three CUAs have been updated based on the results of the RI. The updated CSMs are presented in Subchapter 4.3 of this report.

Table 2-1: Preliminary Conceptual Site Model and Remedial Investigation Technical Approach
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range, Sumter and Hernando Counties, Florida

Munitions Response Site Details	PRELIMINARY CONCEPTUAL SITE MODEL SUMMARY					REMEDIAL INVESTIGATION TECHNICAL APPROACH			
	Known or Suspected Contamination Source(s)	Potential/Suspected Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Potentially Complete Exposure Pathway	Investigation Method	Investigation Location(s)	Investigation Acreage/ Number of Samples	Decision Rule(s)
NAME: Chemical Use Area #1 and Air-to-Ground Range (CUA1) **Acreage:** 16,960 acres **Suspected Past DoD Activities (*release mechanisms*):** Chemical munitions and equipment tests; air-to-ground gunnery training (small arms ammunition) and possible practice bombing. **Current and Future Land Use:** State Forest	MEC/CWM: *Suspected:* Based on historical records: small arms (aircraft mounted .50-cal.), aircraft munitions, rockets, bombs, spray tanks, pyrotechnics, smoke pots	Chemical munitions and equipment tests at multiple unknown locations throughout CUA1 (test areas would have most likely been located in upland areas to accommodate placement of test equipment and monitoring of results); aircraft fired munitions (rockets, small arms ammunition and possibly bombs) used on air-to-ground range which occupies a large central portion of this CUA; CA filling and decontamination in the Toxic Gas Yard.	Surface soil and subsurface soil (in ATG Range only)	Commercial/industrial workers and recreational users/site visitors	Exposure to surface and subsurface MEC/CWM	DGM and intrusive investigation	DGM transects across ATG Range at approx. 83m spacing (sufficient to locate 180m diameter target area to a 90% conf. level) If potential 'target' areas detected, locate additional DGM transects and/or grids within area boundaries	DGM transects: ~4.5 acres based on the length of transects (3-ft width) needed to cover the ATG Range at 83m spacing (assuming all areas can be accessed). Up to 8 additional acres of transects for delineation (*total for CUA1*) Up to 8.5 acres of grids for site characterization (*total for CUA1*) Investigate at least 10 CWM or MEC-like anomalies per grid or all anomalies in grid if less than 10 (*intrusive investigation in grids only*)	If no high anomaly density areas (i.e., "target areas") are identified, then ATG Range will be considered uncontaminated by CWM/MEC If high anomaly density areas (i.e., "target areas") are identified and if further delineation is needed, then complete additional DGM transect investigation as necessary to better delineate the area and locate one or more DGM grids in area(s) of highest anomaly density If any grid anomalies in a target area are CWM or related items, then that whole target area will be considered potentially CWM-contaminated If any grid anomalies in a target area are MEC or related items, then that whole target area will be considered potentially MEC-contaminated If no grid anomalies in a target area are CWM/MEC or related items, then that whole target area will be considered uncontaminated by CWM/MEC
			Surface soil and subsurface soil (remaining areas of CUA1)	Commercial/industrial workers and recreational users/site visitors	Exposure to surface and subsurface MEC/CWM	DGM and intrusive investigation	DGM transects across CUA1 (outside ATG Range) at approx. 188m spacing (sufficient to locate 300m diameter target area to a 90% conf. level). Investigate along transects and connecting lines. If potential target areas detected, locate additional DGM transects and/or grids	DGM transects: ~81 acres acres based on the length of transects (3-ft width) needed to cover the remaining areas of CUA1 at 188m spacing (assuming all areas can be accessed). Up to 8 additional acres of transects for delineation (*total for CUA1*) Up to 8.5 acres of grids for site characterization (*total for CUA1*) Investigate at least 10 CWM or MEC-like anomalies per grid or all anomalies in grid	If no high anomaly density areas (i.e., "target areas") are identified, then CUA1 will be considered uncontaminated by CWM/MEC If high anomaly density areas (i.e., "target areas") are identified and if further delineation is needed, then complete additional DGM transect investigation as necessary to better delineate the area and locate one or more DGM grids in area(s) of highest anomaly density If any grid anomalies in a target area are CWM or related items, then that whole target area will be considered potentially CWM-contaminated If any grid anomalies in a target area are MEC or related items, then that whole target area will be considered potentially MEC-contaminated If no grid anomalies in a target area are CWM/MEC or related items, then that whole target area will be considered uncontaminated by CWM/MEC

Table 2-1: Preliminary Conceptual Site Model and Remedial Investigation Technical Approach
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range, Sumter and Hernando Counties, Florida

Munitions Response Site Details	PRELIMINARY CONCEPTUAL SITE MODEL SUMMARY					REMEDIAL INVESTIGATION TECHNICAL APPROACH			
	Known or Suspected Contamination Source(s)	Potential/Suspected Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Potentially Complete Exposure Pathway	Investigation Method	Investigation Location(s)	Investigation Acreage/ Number of Samples	Decision Rule(s)
							within area boundaries	if less than 10 (*intrusive investigation in grids only*)	
	Munitions Constituents/CA: CA/ABPs, explosives, metals, (VOCs in suspected Toxic Gas Yard area), perchlorate (in groundwater).	Associated with CWM, MEC, and/or MD; most likely concentrated at former test areas (targets) and/or ground scars	Surface soil and subsurface soil	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in soil (incidental ingestion, dermal contact, and inhalation of suspended particulates and volatiles)	Collect discrete soil samples and analyze for MC/CA; conduct both investigation of known features (e.g., former munitions finds, ground scars, suspected Toxic Gas Yard) and focused sampling at DGM grid locations where evidence of CWM/MEC use and/or testing is found	*Features Investigation*: Locations of former munitions finds, ground scars, and within the suspected Toxic Gas Yard *Grid-based Investigation*: Discrete locations at DGM grid locations where evidence of CWM/MEC use and/or testing is found	*Features Investigation*: 94 discrete soil samples (47 surface / 47 subsurface - collocated) *Grid-based Investigation*: Up to 166 discrete soil samples (83 surface / 83 subsurface - collocated) *Additional discrete samples as necessary to delineate extent*	If MC concentrations below Preliminary Screening Values, then soil not MC-contaminated and no further analysis required. If MC concentrations in soil exceed groundwater protection criteria (based on leachability), then collect groundwater samples at CUA1 (see groundwater pathway). If groundwater analysis indicates CUA1 is potential source of contamination, then collect additional samples to delineate extent of MC contamination source in soil. If MC concentrations exceed surface water protection criteria in vicinity of surface water features, then collect surface water samples at CUA1 (*see surface water pathway*). If MC concentrations exceed direct contact criteria, then collect additional samples to delineate extent of MC contamination in soil; once delineation is complete, conduct MC risk assessment for soil pathway.
		Various bodies of water (e.g., ponds, wetlands, creeks)	Surface water/ sediment	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in surface water/sediment (incidental ingestion or dermal contact)	Collect discrete surface water samples and analyze for MC/CA	Relevant water feature(s) – i.e. one pond and various wetlands across site.	Up to twenty discrete samples per medium	If MC concentrations less than Preliminary Screening Values, then surface water not MC-contaminated and no further analysis required. If MC analytes are detected in samples at concentrations above Preliminary Screening Values, then conduct MC risk assessment.

Table 2-1: Preliminary Conceptual Site Model and Remedial Investigation Technical Approach
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range, Sumter and Hernando Counties, Florida

Munitions Response Site Details	PRELIMINARY CONCEPTUAL SITE MODEL SUMMARY					REMEDIAL INVESTIGATION TECHNICAL APPROACH			
	Known or Suspected Contamination Source(s)	Potential/Suspected Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Potentially Complete Exposure Pathway	Investigation Method	Investigation Location(s)	Investigation Acreage/ Number of Samples	Decision Rule(s)
		Groundwater	Groundwater (via leaching from soil)	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in groundwater (incidental ingestion or dermal contact)	Collect discrete groundwater samples and analyze for MC/CA	Ten monitoring wells at locations of former munitions finds, ground scars, and within suspected Toxic Gas Yard area or where MC in soil exceeded FDEP Leachability to Groundwater criteria (precise locations TBD).	Up to ten discrete samples (one from each well)	If MC concentrations less than Preliminary Screening Values, then groundwater not MC-contaminated and no further analysis required. If further analysis required (i.e., concentrations exceed Preliminary Screening Values), then evaluate exceeding samples based on upgradient concentrations. If MC concentrations in exceeding samples are comparable to upgradient concentrations, then CUA was not source of contamination and no further analysis is required. If MC concentrations in exceeding samples are not comparable to upgradient concentrations, then CUA is potential source of contamination and MC risk assessment will be conducted for groundwater pathway.
NAME: Chemical Use Area #2 (CUA2) **Acreage:** 640 acres **Suspected Past DoD Activities (*release mechanisms*):** Chemical munitions and equipment tests **Current and Future Land Use:** State Forest	MEC/CWM: *Suspected:* Based on historical records: bombs, spray tanks, pyrotechnics, smoke pots	Chemical munitions and equipment tests at multiple unknown locations throughout CUA2 (test areas would have most likely been located in upland areas to accommodate placement of test equipment and monitoring of results)	Surface soil and subsurface soil	Commercial/industrial workers and recreational users/site visitors	Exposure to surface and subsurface MEC/CWM	DGM and intrusive investigation	DGM transects across CUA2 at approx. 188m spacing (sufficient to locate 300m diameter target area to a 90% conf. level) If potential target areas detected, locate additional DGM transects and/or grids within area boundaries	DGM transects: ~3.3 acres acres based on the length of transects (3-ft width) needed to cover the remaining areas of CUA2 at 188m spacing (assuming all areas can be accessed). Up to 1 additional acre of transects for delineation (*total for CUA2*) Up to 1.25 acres of grids for site characterization (*total for CUA2*) Investigate at least 10 CWM or MEC-like anomalies per grid or all anomalies in grid if less than 10 (*intrusive investigation in grids only*)	If no high anomaly density areas (i.e., “target areas”) are identified, then CUA2 will be considered uncontaminated by CWM/MEC If high anomaly density areas (i.e., “target areas”) are identified and if further delineation is needed, then complete additional DGM transect investigation as necessary to better delineate the area and locate one or more DGM grids in area(s) of highest anomaly density If any grid anomalies in a target area are CWM or related items, then that whole target area will be considered potentially CWM-contaminated If any grid anomalies in a target area are MEC or related items, then that whole target area will be considered potentially MEC-contaminated If no grid anomalies in a target area are CWM/MEC or related items, then that whole target area will be considered uncontaminated by CWM/MEC

Table 2-1: Preliminary Conceptual Site Model and Remedial Investigation Technical Approach
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range, Sumter and Hernando Counties, Florida

Munitions Response Site Details	PRELIMINARY CONCEPTUAL SITE MODEL SUMMARY					REMEDIAL INVESTIGATION TECHNICAL APPROACH			
	Known or Suspected Contamination Source(s)	Potential/Suspected Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Potentially Complete Exposure Pathway	Investigation Method	Investigation Location(s)	Investigation Acreage/ Number of Samples	Decision Rule(s)
	Munitions Constituents/CA: CA/ABPs, explosives, metals, perchlorate (in groundwater).	Associated with CWM, MEC, and/or MD; most likely concentrated at former test areas and/or ground scars	Surface soil and subsurface soil	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in soil (incidental ingestion, dermal contact, and inhalation of suspended particulates and volatiles)	Collect discrete soil samples and analyze for MC/CA; conduct both investigation of known features (e.g., former munitions finds, ground scars) and focused sampling at DGM grid locations where evidence of CWM/MEC use and/or testing is found	*Features Investigation*: Locations of former munitions finds and/or ground scars *Grid-based Investigation*: Discrete locations at DGM grid locations where evidence of CWM/MEC use and/or testing is found	*Features Investigation*: 14 discrete soil samples (7 surface / 7 subsurface - collocated) *Grid-based Investigation*: Up to 12 discrete soil samples (6 surface / 6 subsurface - collocated) *Additional discrete samples as necessary to delineate extent*	If MC concentrations below Preliminary Screening Values, then soil not MC-contaminated and no further analysis required. If MC concentrations in soil exceed groundwater protection criteria (based on leachability), then collect groundwater samples at CUA2 (see groundwater pathway). If groundwater analysis indicates CUA2 is potential source of contamination, then collect additional samples to delineate extent of MC contamination in soil. If MC concentrations exceed surface water protection criteria in vicinity of surface water features, then collect surface water samples at CUA2 (*see surface water pathway*). If MC concentrations exceed direct contact criteria, then collect additional samples to delineate extent of MC contamination in soil; once delineation is complete, conduct MC risk assessment for soil pathway.
	Various bodies of water (e.g., ponds, wetlands, creeks)	Surface water/ sediment	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in surface water/sediment (incidental ingestion or dermal contact)	Collect discrete surface water samples and analyze for MC/CA	Relevant water feature(s) – i.e. various wetlands across site.	Up to six discrete samples per medium	If MC concentrations less than Preliminary Screening Values, then surface water not MC-contaminated and no further analysis required. If MC analytes are detected in samples at concentrations above Preliminary Screening Values, then conduct MC risk assessment.	
	Groundwater	Groundwater (via leaching from soil)	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in groundwater (incidental ingestion or dermal contact)	Collect discrete groundwater samples and analyze for MC/CA	Three monitoring wells at locations of former munitions finds and/or ground scars, or where MC in soil exceeded FDEP Leachability to Groundwater criteria (precise locations TBD).	Up to three discrete samples (one from each well)	If MC concentrations less than Preliminary Screening Values, then groundwater not MC-contaminated and no further analysis required. If further analysis required (i.e., concentrations exceed Preliminary Screening Values), then evaluate exceeding samples based on upgradient concentrations. If MC concentrations in exceeding samples are comparable to upgradient concentrations, then CUA2 was not source of contamination and no further analysis is required. If MC concentrations in exceeding samples are not comparable to upgradient concentrations, then CUA2 is potential source of	

Table 2-1: Preliminary Conceptual Site Model and Remedial Investigation Technical Approach
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range, Sumter and Hernando Counties, Florida

Munitions Response Site Details	PRELIMINARY CONCEPTUAL SITE MODEL SUMMARY					REMEDIAL INVESTIGATION TECHNICAL APPROACH			
	Known or Suspected Contamination Source(s)	Potential/Suspected Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Potentially Complete Exposure Pathway	Investigation Method	Investigation Location(s)	Investigation Acreage/ Number of Samples	Decision Rule(s)
									contamination and MC risk assessment will be conducted for groundwater pathway.
NAME: Chemical Use Area #3 (CUA3) **Acreage:** 640 acres **Suspected Past DoD Activities (release mechanisms):** Chemical munitions and equipment tests **Current and Future Land Use:** State Forest	MEC/CWM: Suspected: Based on historical records: bombs, spray tanks, pyrotechnics, smoke pots	Chemical munitions and equipment tests at multiple unknown locations throughout CUA3 (test areas would have most likely been located in upland areas to accommodate placement of test equipment and monitoring of results)	Surface soil and subsurface soil	Commercial/industrial workers and recreational users/site visitors	Exposure to surface and subsurface MEC/CWM	DGM and intrusive investigation	DGM transects across CUA3 at approx. 188m spacing (sufficient to locate 300m diameter target area to a 90% conf. level) If potential target areas detected, locate additional DGM transects and/or grids within area boundaries	DGM transects: ~3.3 acres acres based on the length of transects (3-ft width) needed to cover the remaining areas of CUA1 at 188m spacing (assuming all areas can be accessed). Up to 1 additional acre of transects for delineation (*total for CUA3*) Up to 0.25 acres of grids for site characterization (*total for CUA3*) Investigate at least 10 CWM or MEC-like anomalies per grid or all anomalies in grid if less than 10 (*intrusive investigation in grids only*)	If no high anomaly density areas (i.e., "target areas") are identified, then CUA3 will be considered uncontaminated by CWM/MEC If high anomaly density areas (i.e., "target areas") are identified and if further delineation is needed, then complete additional DGM transect investigation as necessary to better delineate the area and locate one or more DGM grids in area(s) of highest anomaly density If any grid anomalies in a target area are CWM or related items, then that whole target area will be considered potentially CWM-contaminated If any grid anomalies in a target area are MEC or related items, then that whole target area will be considered potentially MEC-contaminated If no grid anomalies in a target area are CWM/MEC or related items, then that whole target area will be considered uncontaminated by CWM/MEC
	Munitions Constituents/CA: CA/ABPs, explosives, metals, VOCs.	Associated with CWM, MEC, and/or MD; most likely concentrated at former test areas and/or ground scars	Surface soil and subsurface soil	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in soil (incidental ingestion, dermal contact, and inhalation of suspended particulates and volatiles)	Collect discrete soil samples and analyze for MC/CA; conduct focused sampling at DGM grid locations where evidence of CWM/MEC use and/or testing is found	*Grid-based Investigation*: Discrete locations at DGM grid locations where evidence of CWM/MEC use and/or testing is found	*Grid-based Investigation*: Up to 12 discrete soil samples (6 surface / 6 subsurface - collocated) *Additional discrete samples as necessary to delineate extent*	If MC concentrations below Preliminary Screening Values, then soil not MC-contaminated and no further analysis required. If MC concentrations in soil exceed groundwater protection criteria (leachability), then collect groundwater samples at MRA (see groundwater pathway). If groundwater analysis indicates CUA3 is potential source of contamination, then collect additional samples to delineate extent of MC contamination source in soil. If MC concentrations exceed surface water protection criteria in vicinity of surface water features, then collect surface water samples at CUA3 (*see surface water pathway*). If MC concentrations exceed direct contact criteria, then collect additional samples to delineate extent of MC contamination in

Table 2-1: Preliminary Conceptual Site Model and Remedial Investigation Technical Approach
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range, Sumter and Hernando Counties, Florida

Munitions Response Site Details	PRELIMINARY CONCEPTUAL SITE MODEL SUMMARY					REMEDIAL INVESTIGATION TECHNICAL APPROACH			
	Known or Suspected Contamination Source(s)	Potential/Suspected Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Potentially Complete Exposure Pathway	Investigation Method	Investigation Location(s)	Investigation Acreage/ Number of Samples	Decision Rule(s)
									soil; once delineation is complete, conduct MC risk assessment for soil pathway.
		Various bodies of water (e.g., ponds, wetlands, creeks)	Surface water/ sediment	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in surface water/sediment (incidental ingestion or dermal contact)	Collect discrete surface water samples and analyze for MC/CA	Relevant water feature(s) – i.e. various wetlands across site.	Up to six discrete samples per medium	If MC concentrations less than Preliminary Screening Values, then surface water not MC-contaminated and no further analysis required. If MC analytes are detected in samples at concentrations above Preliminary Screening Values, then conduct MC risk assessment.
		Groundwater	Groundwater (via leaching from soil)	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in groundwater (incidental ingestion or dermal contact)	Collect discrete groundwater samples and analyze for MC/CA	Three monitoring wells at locations of former munitions finds, ground scars, or where MC in soil exceeded FDEP Leachability to Groundwater criteria (precise locations TBD).	Up to three discrete samples (one from each well)	If MC concentrations less than Preliminary Screening Values, then groundwater not MC-contaminated and no further analysis required. If further analysis required (i.e., concentrations exceed Preliminary Screening Values), then evaluate exceeding samples based on upstream concentrations. If MC concentrations in exceeding samples are comparable to upstream concentrations, then CUA3was not source of contamination and no further analysis is required. If MC concentrations in exceeding samples are not comparable to upstream concentrations, then CUA3 is potential source of contamination and MC risk assessment will be conducted for groundwater pathway.
ALL AREAS OF MRA	MC (post detonation): Explosives and MC metals	At MEC detonation locations, if any (conventional MEC).	Surface soil and subsurface soil	Commercial/industrial workers, intrusive workers, recreational users/site visitors, and ecological receptors	Exposure to MC in soil (incidental ingestion, dermal contact, or inhalation of suspended particulates)	Collect discrete soil samples and analyze for MC/CA	MEC detonation locations	One pre- and one post-detonation sample per location; additional discrete samples as necessary to delineate extent	If MC analytes are detected in post-detonation samples at concentrations above pre-detonation samples and Preliminary Screening Values, then collect additional samples to delineate extent of MC contamination; once delineation is complete, conduct MC risk assessment for soil pathway

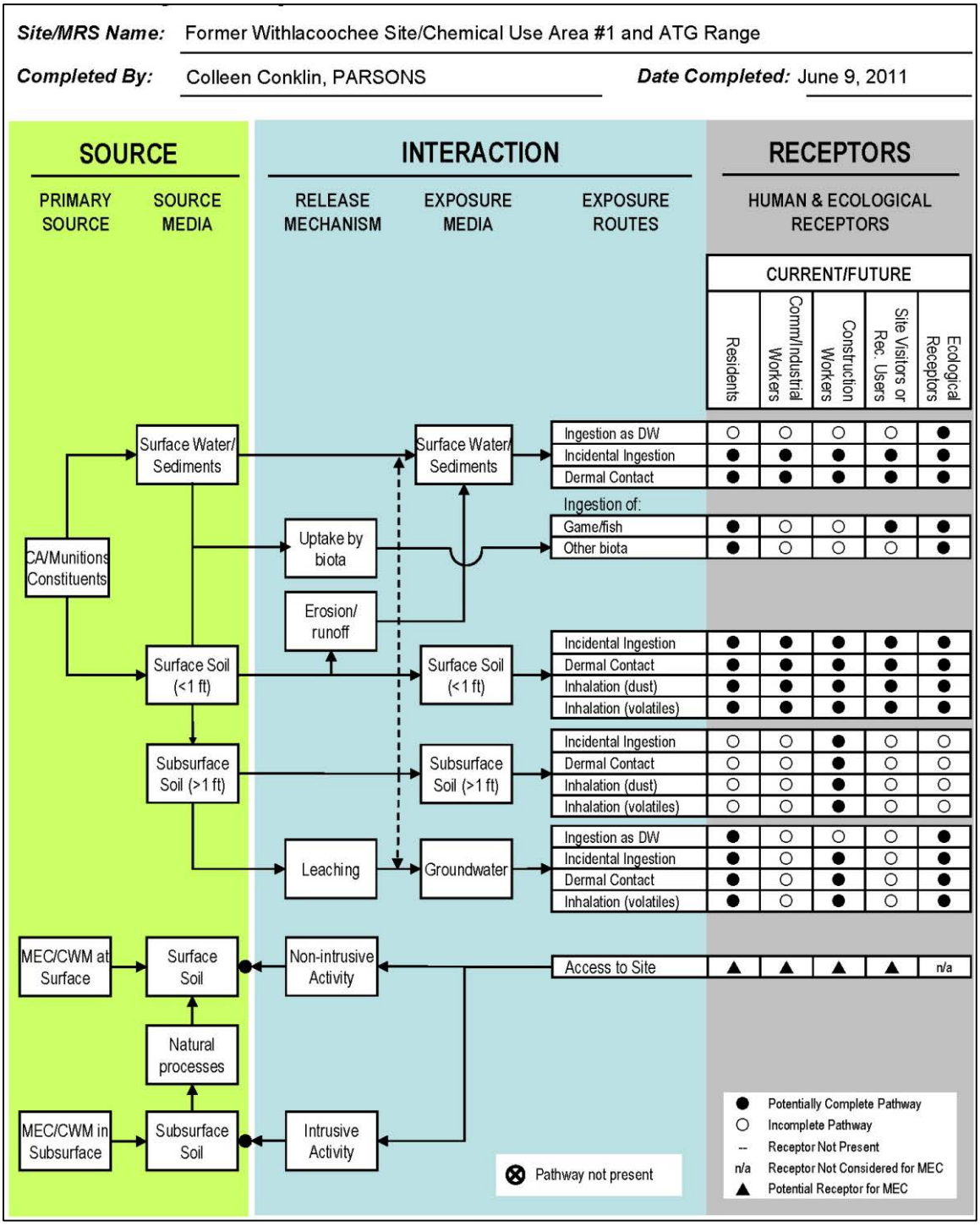

Figure 2.1: Preliminary Conceptual Site Model

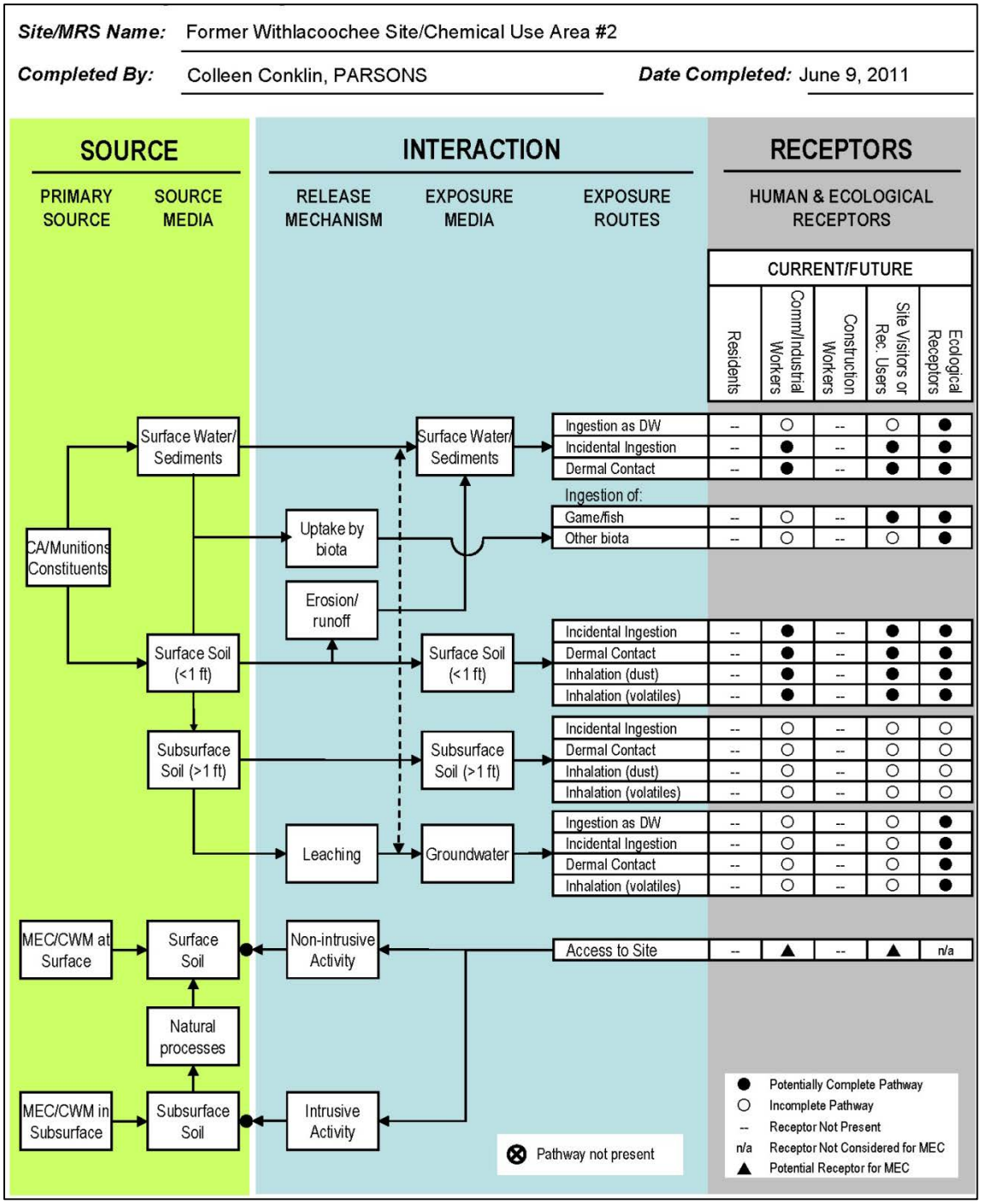

Figure 2.2: Prelliminary Conceptual Site Model

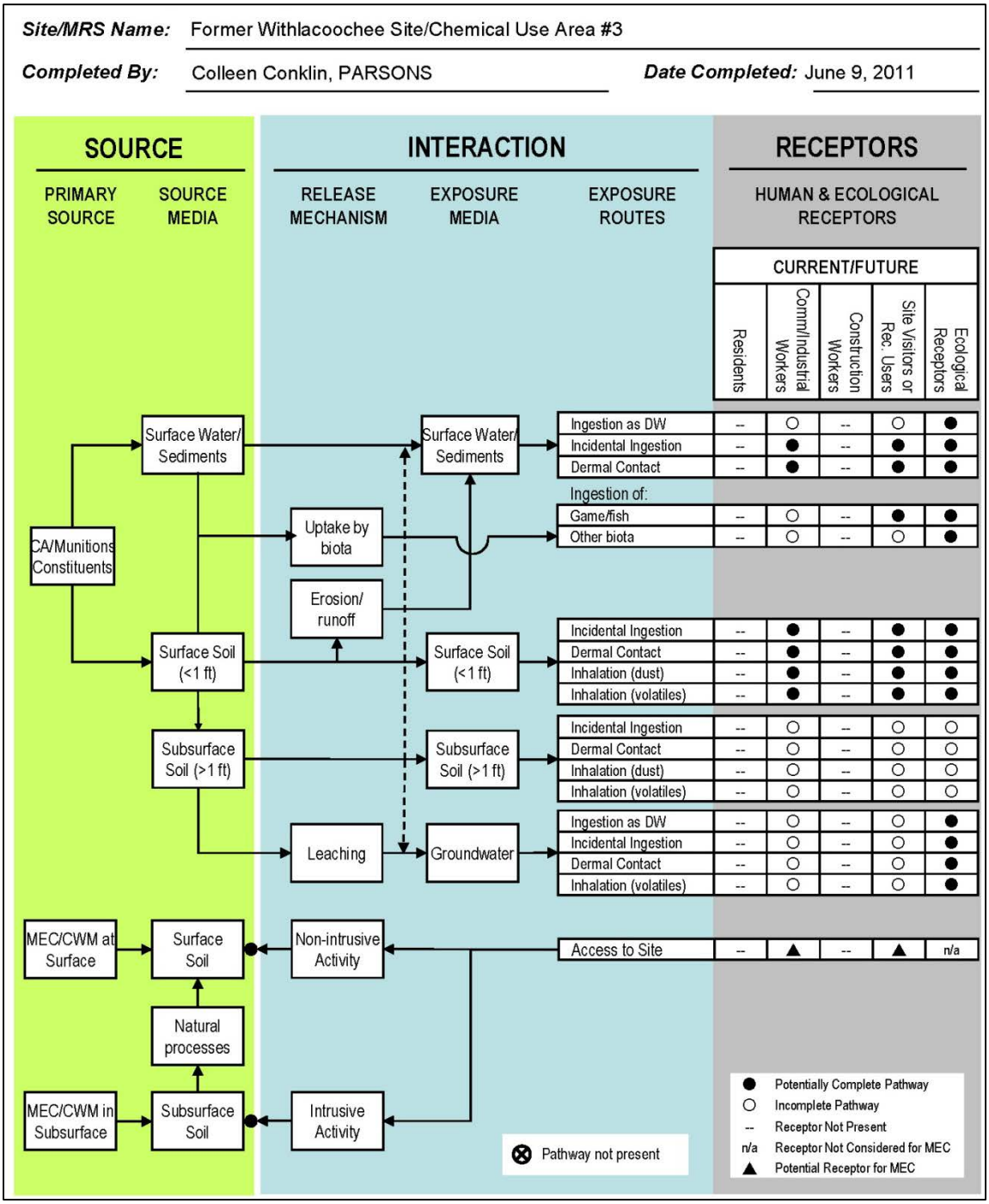

Figure 2.3: Preliminary Conceptual Site Model

2.1.2 Project Approach

2.1.2.1 The technical approach for this RI was developed based on the findings of previous record searches, interviews, and studies (see Subchapter 1.4); was designed to evaluate potentially complete MEC and MC exposure pathways as identified in the preliminary CSMs (Subchapter 2.1.1); and was planned to determine the potential presence or absence of MEC and MC. Furthermore, where MEC or MC is identified, the approach was planned to characterize the nature and extent of MEC and MC so that possible remedial alternatives could be developed and assessed. The general methods for this approach included DGM on transects, DGM on grids, intrusive investigation of identified geophysical anomalies, and media sampling and analysis for MC. Note that with the exception of the NP Forest, the locations of various test areas described in Table 1-2 were unknown as the field work was started; therefore, the technical approach presented in Table 2-1 was based on the assumption that the test areas could occur anywhere within the MRA boundary.

2.1.2.2 Based on information available (Subchapter 1.4), the munitions known or suspected to have been used at the Withlacoochee Site include small arms ammunition, practice rockets and bombs, various aerial chemical bombs, smoke pots, thermal generators, rocket warheads, aircraft spray tanks, and mortars, all from the World War II era. While most munitions were used in tests of munitions and equipment, some were configured as practice munitions, munitions with CA-simulants, munitions with smoke or other chemicals.

2.1.2.3 CWM was documented as having been used at the Withlacoochee Site and includes various munitions filled with persistent CA such as mustard (H), distilled mustard (HD), mustard-agent T mixture (HT), nitrogen mustard (HN-1, HN-3), thickened mustard (HV, HVV, or HDV), mustard/Lewisite mixture (HLV), and non-persistent chemicals such as hydrogen cyanide (AC), cyanogen chloride (CC or CK), phosgene (CG), ammonia (NH3), nitrogen dioxide (NO2), and chlorine. With the exception of those munitions removed during the 1950 clearance, no other encounters with CWM were documented since the halt of the field trials in 1946.

2.1.2.4 Currently, the Florida Forestry Service manages the Richloam Wildlife Management Area (WMA), which covers most of the site. In addition to timber management, the public uses the WMA for hunting, fishing, birding, and hiking for which a number of camping sites have been established. Since 1965, the Florida Fish and Wildlife Conservation Commission (FWC) has leased a portion of the WMA for the Richloam State Fish Hatchery. The hatchery covers 180 acres and includes 63 outdoor ponds and the Florida Bass Conservation Center offices and a visitors' center that were constructed in 2007. There are three employee residences located just north of the Florida Bass Conservation Center in CUA1 and one residence is located just outside the eastern boundary of CUA2. Potential human receptors at this site may include current and future residents, commercial/industrial workers (i.e., forestry and Bass Conservation Center workers), construction workers, and site visitors/recreational users (e.g., hunters, hikers, campers).

2.1.2.5 Although specific test areas and range areas were identified, the general investigation approach consisted of covering the MRA (all three CUAs and some adjacent areas) with transects spaced based on a typical projected test area of 500 yards across. Closer spacing was planned in areas within the former air-to-ground range based on the relatively

smaller fragmentation radius of typical bombs and rockets used on targets there. Because of the large portion of the site covered by wetlands, transects were expected to either deviate around the wetlands or terminate at the edge of a wetland and resume on the far side. Transects would be cleared using brush cutting equipment and would be geophysically mapped with a single pass with a G-858 magnetometer. The anomaly count along the transects would be used to select locations for grids, which would be geophysically mapped and would have anomalies intrusively investigated. Due to additional historical information coming available after the start of the project, the PDT decided to place additional transects outside the MRA boundary where test areas were reported near the edge of the MRA.

2.1.2.6 MC sampling was to be conducted in areas where MEC (including CWM) and MD with potential residual explosives were found. MC samples would also be collected at locations of former CWM finds from the 1950 clearance, at ground scars, and within the former Toxic Gas Yard (where samples would be collected on a grid pattern in an effort to determine whether CA residue remains due to decontamination or filling operations). In general, soil samples would be collected at the surface and in the subsurface. Surface water and sediment samples would be collected in areas adjacent to significant munitions finds and where leachable contamination was encountered in soil, if a suitable surface water source was nearby. Background samples were to be collected for surface and subsurface soil, surface water, and sediment. If initial sampling indicated a potential for groundwater contamination, monitoring wells would be installed adjacent to the suspected source areas and groundwater samples collected.

2.2 PRELIMINARY REMEDIATION GOALS

2.2.1 Preliminary remediation goals (PRGs) are both site- and contaminant-specific and define the conditions considered by stakeholders to be protective of human health and the environment. There may be PRGs for MEC and MC at each site evaluated during the RI. As with the CSM, PRGs may be reevaluated and refined throughout the RI/FS process as new information becomes available. The site closeout statement recommended for the CUA1, CUA2 and CUA3 is "To manage the MEC and MC hazards and risks through a combination of remedial action, administrative controls, and public education thereby rendering the site as safe as reasonably possible to humans and the environment, and conducive to the anticipated land use." The Remedial Action Objectives (RAOs) developed for the RI/FS are discussed in Chapter 2 of the FS Report.

2.2.2 The PRG for MEC is to limit interaction between any residual MEC and any receptors accessing the site. Based on the recommended site closeout statement for the Withlacoochee Site, the PRGs are either to remove any MEC present to a depth at which they no longer present a hazard to the anticipated human receptors, or to implement land use controls that will minimize the possibility of receptors coming into contact with MEC at the site.

2.2.3 The PRGs for MC at the MRA are the screening values that were agreed to by the TPP Team as being protective of the identified exposure pathways. The screening values and an evaluation of the analytical data are presented in Chapter 4. The PRG is to ensure that any identified MC contamination at the site determined to pose an unacceptable risk to human health or the environment is addressed.

2.3 PRELIMINARY IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND "TO BE CONSIDERED" INFORMATION

2.3.1 As amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), Section 121(d)(2) of CERCLA requires that on-site remedial actions attain (or waive) federal and more stringent state applicable or relevant and appropriate requirements (ARAR) of environmental laws upon completion of the remedial action. The revised NCP of 1990 requires compliance with ARARs during remedial actions as well as at completion.

2.3.2 The "Applicable" portion of the term is defined as:

- Cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

2.3.3 The "Relevant and Appropriate" portion of the ARAR term is defined as:

- Cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

2.3.4 Although compliance is not required, in order to incorporate guidance and other information into the alternatives developed, some remedial actions identify "to be considered criteria" defined as:

- Non-promulgated advisories, criteria, and guidance are not ARARs, but may sometimes be useful in developing a CERCLA remedy. When this is the case, at the discretion of the lead agency, they can be specified as "To-Be-Considered (TBC)" criteria. TBC criteria can be taken into consideration during evaluation of remedial alternatives, but unlike ARARs, identification of TBCs is not mandatory nor is compliance with TBCs a selection criterion for a remedial action.

2.3.5 Documents that are TBC are incorporated as appropriate into the RI report and not called out in a table to avoid confusion with the ARARs. Compliance with these documents is not required under CERCLA or the NCP; therefore, no tabulation is provided.

2.3.6 Any substantive environmental or facility siting requirement has the potential to be an ARAR. To assist in identification, ARARs are divided into three categories: chemical-specific ARARs, location-specific ARARs, and action-specific ARARs. These three categories are defined as follows:

- Chemical-specific ARARs are promulgated health-based or risk-based numerical values that establish the acceptable amount or concentration of a chemical that may

remain in, or be discharged to, the ambient environment. Where more than one requirement addressing a contaminant is determined to be an ARAR, the most stringent requirement should be used. Risk-based screening levels (for example, USEPA Regional Screening Levels) are not considered chemical-specific ARARs because they are not promulgated.

- Location-specific ARARs generally are restrictions placed on the concentration of a hazardous substance or the conduct of activities solely because they are in special locations. Requirements addressing cultural resources, historic places, floodplains, wetlands, or sensitive ecosystems and habitats, are potential location-specific ARARs.
- Action-specific ARARs are usually technology or activity-based requirements or limitations placed on actions taken with respect to remedial/removal actions, or requirements to conduct certain actions to address particular circumstances at a site. Regulations that dictate the design, construction, and operating characteristics of air stripping units, incinerators, landfills, or other waste management facilities are examples of action-specific ARARs. No action-specific ARARs were identified for this site.

2.3.7 ARARs are identified during the response process prior to issuance of the Record of Decision/Decision Document (ROD/DD), and they may continue to evolve over time. The NCP requires the lead agency to formally request ARARs from support agencies upon completion of the RI. For an alternative to pass into the detailed analysis stage of the FS and thus become eligible for selection it must comply with its ARARs or a waiver should be identified and the justification provided for invoking it. An alternative that cannot comply with ARARs, or for which a waiver cannot be justified, should be eliminated from consideration for further discussion as a potential alternative. Updates to ARARs are then requested as details of remedial alternatives become known. Thus, potential ARARs are initially identified on a fairly broad basis, are refined to specific requirements during the latter stages of the remedial action, and are finalized upon signature of the ROD/DD.

2.3.8 As the RI process continues, the list of ARARs will be updated, particularly as the response actions are selected and reviewed by state and federal agencies. ARARs will be used to establish the appropriate extent of site cleanup; to aid in scoping, formulating, and selecting proposed treatment technologies; and to govern implementation and operation of the selected remedial alternative. As the remedial action is developed, primary consideration should be given to remedial alternatives that attain or exceed the requirements of the identified ARARs. Throughout the RI, ARARs are identified and used by taking into account the following:

- Contaminants suspected or identified to be at the site;
- Chemical analysis performed or scheduled to be performed;
- Types of media (air, soil, groundwater, surface water, and sediment);
- Geology and other site-specific characteristics;
- Use of site resources and media;
- Potential contaminant transport mechanisms;
- Purpose and application of potential ARARs; and

- Remedial alternatives considered for site cleanup.

2.3.9 Potential ARARs identified for the RI at the former Withlacoochee Site are presented in Table 2-2. Compliance with RCRA 40 CFR 264 Subpart X that establishes rules for storage, management, and treatment of reactive hazardous wastes (explosives) via open burn/open detonation has been identified as a potential action-specific ARARs at sites involving these remedial actions. The Clean Water Act (CWA) [Section 404, 33 CFR 320.4(r)] has been identified as a potential location-specific ARAR. Note that activities undertaken entirely under CERCLA are not required to obtain permits under Section 404 of the CWA. When the habitats of potentially identified protected species may be affected during field work, the work will be adapted to meet the applicable requirements of the Endangered Species Act (USC Title 16 Chapter 35 §1538). Likewise, in order to comply with the referenced sections of the CWA, any future field work will also be conducted in a manner that protects wetlands and minimizes the effect on the wetlands. These regulations are potential ARARs only if a remedial action is conducted that might affect the specified species, habitats, or wetlands, or might require the management of wastes. As an example, a remedial action of instituting an education awareness program would not involve any impacts to the environment nor would it require the management of wastes and, therefore, none of the listed ARARs would be applicable to that remedial action.

Table 2-2: Potential Applicable or Relevant and Appropriate Requirements for the Withlacoochee Site

Requirement	Status / Synopsis of Requirement	Action to be Taken to Attain Requirement
RCRA, 40 CFR 264 Subpart X (Miscellaneous Units – OB/OD) §§264.601 (Environmental Performance Standards),	Relevant and Appropriate - Action-Specific / Establishes rules for identification, management, and treatment of hazardous wastes including open burn / open detonation and management.	Remedial actions must appropriately identify and manage investigative derived wastes and remedial wastes (that are hazardous wastes) stored on-site including pre- and post-demolition samples to document lack of, or measure the amount of, MC that is released.
CWA, Section 404, 33 CFR 320.4(r), 40 CFR 230	Relevant and Appropriate - Location-Specific / Establishes rules for the protection of wetlands and the environment.	Field work must be conducted in a manner that protects wetlands, and minimizes the effect on wetlands. The USACE and FDEP review and approval process is an important aspect of environmental protection relative to 40 CFR 230.

Table 2-2: Potential Applicable or Relevant and Appropriate Requirements for the Withlacoochee Site

Requirement	Status / Synopsis of Requirement	Action to be Taken to Attain Requirement
Endangered Species Act (ESA) (USC Title 16 chapter 35§1538) and Florida Admin. Code 68A-27, Rule 68A-27.003	Relevant and Appropriate - Location-Specific / The ESA protects federally listed species (fish, wildlife, and plants) which are either endangered or threatened and preserves critical habitat. The substantive requirement within the Act prohibits the "taking" of listed species (reference: 16 USC 1538) unless excepted (16 USC 1539)). Wildlife Rule 68A-27.003 of the Florida Administrative Code states that no person shall pursue, molest, harm, harass, capture, possess, or sell any endangered species or parts thereof or their nests or eggs except as authorized by specific permit. This rule also lists all the endangered species in the state.	When evaluating remedial alternatives, consideration must be given to avoiding impacts to endangered species and their habitats. A remedial alternative which "takes" an endangered species or destroys its habitat would not qualify for selection because the ESA ARAR would not be satisfied. Coordination with USFWS and Florida Fish and Wildlife Conservation Commission (FWC) is required. Either a different alternative which does not affect endangered species should be pursued or an exception allowing the taking of the species is needed, or a waiver of the ARAR is required.

2.3.10 TBC criteria that will be taken into consideration during evaluation of remedial alternatives and may be incorporated as appropriate into the RI report include:

- 42 United States Code (USC) Sect 6901-6987 Archeological and Historic Preservation Act (AHPA) (16 U.S.C. 469 et seq./36 CFR 65). The AHPA preserves cultural resources that may be damaged by federal or federally authorized construction activities. According to the Florida SHPO, NRHP, the NHL Program, and the NHA Program, there are no known significant cultural resources within the former Withlacoochee Site. The location of any archaeological or architectural resource observed during fieldwork will be recorded and reported to the Florida Forest Service.
- Florida Administrative Code 62-777 (Contaminant Cleanup Target Levels) establishes guidelines for determining cleanup target levels.

2.4 SUMMARY OF INSTITUTIONAL ANALYSIS

2.4.1 Institutional analyses are prepared to support the development of institutional control strategies and plans of action as a munitions response alternative. These strategies

rely on existing powers and authorities of government agencies to protect the public at large from MEC and MC hazards and risks.

2.4.2 A review of government institutions and private entities that exercise jurisdiction and ownership of the areas indicated that the property encompassing the former Withlacoochee Site was under varying levels of jurisdiction of several agencies including: Florida Department of Environmental Protection, Florida Forest Service, and Florida Fish and Wildlife Conservation Commission.

2.4.1 Florida Department of Environmental Protection (FDEP)

The FDEP is the lead agency in Florida state government for environmental management and stewardship and is one of the more diverse agencies in state government, protecting our air, water, and land. FDEP is divided into three primary areas: Regulatory Programs, Land and Recreation and Planning and Management. FDEP is responsible for enforcing compliance with Florida environmental regulations. Representatives from FDEP have participated in the TPP including attending meetings and reviewing and providing comments on project documents.

2.4.2 Florida Forest Service

The Florida Forest Service (FFS) is the property owner responsible for land management within the Withlacoochee State Forest including all three CUAs. Representatives from Florida Forest Service have participated as part of the TPP including attending meetings and reviewing and providing comments on project documents.

2.4.3 Florida Fish and Wildlife Conservation Commission

The Florida Fish and Wildlife Conservation Commission (FWC) is responsible for law enforcement, research, community outreach, and management aspects concerning fish and wildlife and waterways within the Withlacoochee State Forest. Representatives from the FWC participated as part of the TPP including attending meetings and reviewing and providing comments on project documents.

2.4.4 U. S Army Corps of Engineers (USACE)

The USACE is the lead agency for the Withlacoochee Site FUDS and executor for conducting CERCLA projects. The USACE is the implementing agency for this project, providing technical expertise for MEC and MC activities, and serving as the technical manager for conducting the RI/FS. USACE responsibilities include procurement and direction of the prime contractor (USA) and supporting agencies, and the coordination of document reviews and approvals. USACE also provide the on-site UXO-Qualified Safety Specialist for activities involving potential exposure to hazardous munitions and CA. USACE responsibilities include the review of project plans and documents, obtaining rights-of-entry to properties in the work area, working with the news media and the public, and coordinating with federal, state and local agencies on issues pertaining to implementation of this project and protection of ecological and cultural resources. Other responsibilities included providing proper notifications to FDEP, notifying the National Response Center and the state officials in the event of a release or spill, and signing the hazardous waste manifest as generator of any hazardous waste. The DERP is the primary funding source.

2.5 DATA NEEDS AND DATA QUALITY OBJECTIVES

2.5.1 Data Needs

2.5.1.1 Previous reports on the project site, including the 1993 INPR, 1993 ASR, 1995 Site Characterization Report, 2004 ASR Supplement, 2005 Historical Photographic Analysis, 2007 CWM Scoping and Security Study and 2011 PA, were reviewed. The 1993 ASR and 2004 ASR Supplement were used to document the use of the site for CWS field trials and air-to-ground bombing practice and to establish the MRA boundaries. The 2007 CWM Scoping and Security Study recommended that an RI/FS be conducted for the site.

2.5.1.2 The data needs for the RI (i.e., assessment of MEC and MC throughout the MRA) were reviewed by the TPP team. Data quality objectives (DQOs) associated with the data to be collected during the RI were developed by the TPP team, included in the approved WP (USA, 2014), and are presented in Table 3–3.

2.5.1.3 To accomplish the primary RI/FS project objective—acceptance of a DD—the TPP Team agreed that the RI data collection efforts would focus on a geophysical investigation on transects to develop anomaly density patterns, further definition of the dense areas (if needed), and the collection of geophysical data from grids placed strategically over the anomaly-dense areas. These procedures lead to the investigation of anomalies within the grids. Once MEC was identified within an area, soil (surface and subsurface) samples would be collected in an effort to define the nature and extent of MC contamination, if present. Additionally, groundwater wells would be installed within the areas where MC concentrations are greater than FDEP Leachability to Groundwater criteria in an effort to determine the MC impact within the groundwater at that location. All environmental samples collected during the RI would be analyzed for the appropriate chemical agents, agent breakdown products, explosives, and metals.

2.5.1.4 Procedural details of the field work were provided in the final approved WP. All findings of the RI are documented in this RI Report for the TPP Team and other stakeholders' review.

2.5.2 Data Quality Objectives

2.5.2.1 An evaluation of the existing data for the former Withlacoochee Site was conducted in conjunction with preparation of the RI/FS WP (USA, 2014). It was determined that there was a potential for MEC and MC contamination within the investigation area and additional data were needed to define the nature and extent of that contamination. DQOs, as presented in Table 2–3, were developed to make appropriate and supportable decisions and to define the parameters of the field investigation. DQOs are qualitative and quantitative criteria used to guide sample collection and analysis activities. The DQOs for this RI/FS project were developed as part of the TPP to ensure that the available data generated as part of previous investigations were of appropriate quality to support the anticipated end use of the data. DQOs seek to ensure that the right type, amount, and quality of data are collected to accomplish the objectives of the project. The DQOs as finalized in the work plan are provided below in Table 2-3 for the three CUAs within the Withlacoochee Site.

2.5.2.2 The DQOs for RI activities conducted at the former Withlacoochee Chemical Warfare Service Field Trials and Air-to-Ground Bombing and Gunnery Range were met. The methods and results of the MC sampling investigation are discussed in Chapter 3 and Chapter 4, respectively.

Table 2-3: Data Quality Objective Statements -- Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range RI/FS, Sumter and Hernando Counties, Florida

Munitions Response Site	INTENDED DATA USE(S)	DATA NEED REQUIREMENTS						APPROPRIATE SAMPLING AND ANALYSIS METHODS	
	Project Objective(s) Satisfied	Data User Perspective(s)	Contaminant or Characteristic of Interest Identified	Media of Interest Identified	Required Sampling Areas or Locations and Depths Identified	Amount of Sampling/ Number of Samples Required	Reference Concentration of Interest or Other Performance Criteria	Sampling Method Identified	Analytical Method Identified
Chemical Use Area #1 and Air-to-Ground Range (CUA1)	Characterize nature and extent of MEC contamination (in ATG Range only)	Risk (RI) and remedy (FS)	MEC/CWM and/or MD	Surface and subsurface soil	DGM transect surveys (spacing 83m) over approximately 7.6 acres throughout area; additional acreage of transects or grids as necessary to refine characterization; grids to be located in areas of higher and lower anomaly density; investigation to detection depth of instrument	DGM transect surveys over approximately 7.6 acres of the ATG Range; DGM transect surveys over approximately 87.6 acres of the remaining areas of CUA1; Additional transects or grids will be placed as necessary to refine characterization; approximately 7 acres of grids of 2,500 sqft and 10,000 sqft to be placed over CUA1 (ATG Range and remaining areas combined); the larger grids to be placed toward the edges of the high anomaly density areas and small grids near the centers of the high density areas. Investigate at least 10 CWM or MEC-like anomalies per grid or all anomalies in grid if less than 10 (*intrusive investigation in grids only*) Six background grids (10,000 sqft) will be placed in CUA1 away from military use areas to measure background anomaly density. Anomalies will not be investigated on these grids.	Areas where high anomaly density areas (i.e., “target areas”) are <u>not</u> CWM/MEC-related based on intrusive investigation of grids, will be considered uncontaminated by CWM/MEC; high anomaly density areas (i.e., “target areas”) that are related to CWM/MEC based on grid intrusive investigation results will be considered potentially contaminated by CWM/MEC. All geophysical investigations shall achieve applicable MQOs as stated in work plan and confirmed/modified by GPO, unless MQO failures can be adequately explained and/or justified.	DGM surveys and intrusive investigation	Not applicable
	Characterize nature and extent of MEC contamination (remaining areas of CUA1)	Risk (RI) and remedy (FS)	MEC/CWM and/or MD	Surface and subsurface soil	DGM transect surveys (spacing 188m) over approximately 87.6 acres throughout area; additional acreage of transects or grids as necessary to refine characterization; grids to be located in areas of higher and lower anomaly density; investigation to detection depth of instrument		Areas where high anomaly density areas (i.e., “target areas”) are <u>not</u> CWM/MEC-related based on intrusive investigation of grids, will be considered uncontaminated by CWM/MEC; high anomaly density areas (i.e., “target areas”) that are related to CWM/MEC based on grid intrusive investigation results will be considered potentially contaminated by CWM/MEC. All geophysical investigations shall achieve applicable MQOs as stated in work plan and confirmed/modified by GPO, unless MQO failures can be adequately explained and/or justified.	DGM surveys and intrusive investigation	Not applicable

Table 2-3: Data Quality Objective Statements -- Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range RI/FS, Sumter and Hernando Counties, Florida

Munitions Response Site	INTENDED DATA USE(S)	DATA NEED REQUIREMENTS						APPROPRIATE SAMPLING AND ANALYSIS METHODS	
	Project Objective(s) Satisfied	Data User Perspective(s)	Contaminant or Characteristic of Interest Identified	Media of Interest Identified	Required Sampling Areas or Locations and Depths Identified	Amount of Sampling/ Number of Samples Required	Reference Concentration of Interest or Other Performance Criteria	Sampling Method Identified	Analytical Method Identified
	Determine presence/absence of MC contamination	Risk (RI)	MC	Surface and subsurface soil	*Features Investigation*: Locations of former munitions finds, ground scars; samples collected at surface (0-2 inches) and subsurface (18-24 inches). Samples within the suspected Toxic Gas Yard will be collected subsurface (40-48 inches). *Grid-based Investigation*: Discrete locations at DGM grid locations where evidence of CWM/MEC use and/or testing is found; samples collected at ground surface and at the depth of MEC/MD.	*Features Investigation*: 94 discrete soil samples (47 surface / 47 subsurface – collocated) *Grid-based Investigation*: Up to 166 discrete soil samples (83 surface / 83 subsurface - collocated)	Preliminary Screening Values are presented in the UFP-QAPP, Appendix E. Areas where MC analytes are not detected or are detected at concentrations ≤ Preliminary Screening Values will be considered uncontaminated by MC; areas where MC analytes are detected at concentrations > Preliminary Screening Values will be considered contaminated by MC (i.e., those analytes are COPCs). All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified.	Collection of discrete soil samples	Analytical methods as described in the UFP-QAPP (Appendix E)
				Surface water/sediment	Relevant site water feature(s)	Up to 20 sample locations throughout MRA.	Preliminary Screening Values are presented in the UFP-QAPP, Appendix E. Criteria for contamination are identical to those for surface soil. All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete surface water/sediment samples (collocated)	Analytical methods as described in the UFP-QAPP (Appendix E)
				Groundwater	Ten monitoring wells at locations of former munitions finds, ground scars, and within suspected Toxic Gas Yard area or where MC in soil exceeded FDEP Leachability to Groundwater criteria (precise locations TBD).	Up to ten discrete samples (one from each well).	Preliminary Screening Values are presented in the UFP-QAPP, Appendix E Criteria for contamination are identical to those for surface soil. All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete groundwater samples	Analytical methods as described in the UFP-QAPP (Appendix E)

Table 2-3: Data Quality Objective Statements -- Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range RI/FS, Sumter and Hernando Counties, Florida

Munitions Response Site	INTENDED DATA USE(S)	DATA NEED REQUIREMENTS						APPROPRIATE SAMPLING AND ANALYSIS METHODS	
	Project Objective(s) Satisfied	Data User Perspective(s)	Contaminant or Characteristic of Interest Identified	Media of Interest Identified	Required Sampling Areas or Locations and Depths Identified	Amount of Sampling/ Number of Samples Required	Reference Concentration of Interest or Other Performance Criteria	Sampling Method Identified	Analytical Method Identified
	Characterize nature and extent of MC contamination (i.e., COPCs)	Risk (RI) and remedy (FS)	Any MC contaminants detected during Phase 1	Surface and/or subsurface soil; surface water; sediment; groundwater	*Features and Grid-based Investigations*: Discrete locations and depths as necessary to delineate extent of detected COPCs only	*Features and Grid-based Investigations*: Additional discrete samples, as necessary to delineate extent of any detected COPCs	Preliminary Screening Values will be reviewed and revised as necessary to support delineation. Delineation samples in which MC analytes are not detected or are detected at concentrations ≤ Preliminary Screening Values will be considered uncontaminated by MC and sufficient to be used for delineation of contamination; contamination in soil must be delineated laterally and vertically All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete samples	Analytical methods as described in the UFP-QAPP (Appendix E)
Chemical Use Area #2	Characterize nature and extent of MEC contamination	Risk (RI) and remedy (FS)	MEC/CWM and/or MD	Surface and subsurface soil	DGM transect surveys (spacing 188m) over approximately 5.3 acres throughout area; additional acreage of transects or grids as necessary to refine characterization; grids to be located in areas of higher and lower anomaly density; investigation to detection depth of instrument	DGM transect surveys over approximately 5.3 acres; additional transects or grids as necessary to refine characterization; approximately 1 acre of grids of 2,500 sqft and 10,000 sqft; the larger grids to be placed toward the edges of the high anomaly density areas and small grids near the centers of the high density areas. Investigate at least 10 CWM or MEC-like anomalies per grid or all anomalies in grid if less than 10 (*intrusive investigation in grids only*) One background grid (10,000 sqft) will be placed in CUA2 away from military use areas to measure background anomaly density. Anomalies will not be investigated on this grid.	Areas where high anomaly density areas (i.e., "target areas") are <u>not</u> CWM/MEC-related based on intrusive investigation of grids, will be considered uncontaminated by CWM/MEC; high anomaly density areas (i.e., "target areas") that are related to CWM/MEC based on grid intrusive investigation results will be considered potentially contaminated by CWM/MEC All geophysical investigations shall achieve applicable MQOs as stated in work plan and confirmed/modified by GPO, unless MQO failures can be adequately explained and/or justified	DGM surveys and intrusive investigation	Not applicable

Table 2-3: Data Quality Objective Statements -- Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range RI/FS, Sumter and Hernando Counties, Florida

Munitions Response Site	INTENDED DATA USE(S)	DATA NEED REQUIREMENTS						APPROPRIATE SAMPLING AND ANALYSIS METHODS	
	Project Objective(s) Satisfied	Data User Perspective(s)	Contaminant or Characteristic of Interest Identified	Media of Interest Identified	Required Sampling Areas or Locations and Depths Identified	Amount of Sampling/ Number of Samples Required	Reference Concentration of Interest or Other Performance Criteria	Sampling Method Identified	Analytical Method Identified
	Determine presence/absence of MC contamination	Risk (RI)	MC	Surface and subsurface soil	*Features Investigation*: Locations of former munitions finds and ground scars; samples collected at surface (0-2 inches) and subsurface (18-24 inches) *Grid-based Investigation*: Discrete locations at DGM grid locations where evidence of CWM/MEC use and/or testing is found; samples collected at ground surface and at the depth of MEC/MD.	*Features Investigation*: Up to 14 discrete soil samples (7 surface / 7 subsurface – collocated) *Grid-based Investigation*: Up to 12 discrete soil samples (6 surface / 6 subsurface – collocated)	Preliminary Screening Values are presented in the UFP-QAPP, Appendix E Areas where MC analytes are not detected or are detected at concentrations ≤ Preliminary Screening Values will be considered uncontaminated by MC; areas where MC analytes are detected at concentrations > Preliminary Screening Values will be considered contaminated by MC (i.e., those analytes are COPCs) All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete soil samples	Analytical methods as described in the UFP-QAPP (Appendix E)
				Surface water/sediment	Relevant site water feature(s)	Up to six discrete samples per media.	Preliminary Screening Values are presented in the UFP-QAPP, Appendix E Criteria for contamination are identical to those for surface soil. All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete surface water/sediment samples	Analytical methods as described in the UFP-QAPP (Appendix E)
				Groundwater	Three monitoring wells at locations of former munitions finds, ground scars, or where MC in soil exceeded FDEP Leachability to Groundwater criteria (precise locations TBD).	Up to three discrete samples (one from each well)	Preliminary Screening Values are presented in the UFP-QAPP, Appendix E Criteria for contamination are identical to those for surface soil. All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete groundwater samples	Analytical methods as described in the UFP-QAPP (Appendix E)

Table 2-3: Data Quality Objective Statements -- Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range RI/FS, Sumter and Hernando Counties, Florida

Munitions Response Site	INTENDED DATA USE(S)	DATA NEED REQUIREMENTS						APPROPRIATE SAMPLING AND ANALYSIS METHODS	
	Project Objective(s) Satisfied	Data User Perspective(s)	Contaminant or Characteristic of Interest Identified	Media of Interest Identified	Required Sampling Areas or Locations and Depths Identified	Amount of Sampling/ Number of Samples Required	Reference Concentration of Interest or Other Performance Criteria	Sampling Method Identified	Analytical Method Identified
	Characterize nature and extent of MC contamination (i.e., COPCs)	Risk (RI) and remedy (FS)	Any MC contaminants detected during Phase 1	Surface and/or subsurface soil; surface water; sediment; groundwater	*Features and Grid-based Investigations*: Discrete locations and depths as necessary to delineate extent of any detected COPCs	*Features and Grid-based Investigations*: Additional discrete samples, as necessary to delineate extent of any detected COPCs	Preliminary Screening Values will be reviewed and revised as necessary to support delineation. Delineation samples in which MC analytes are not detected or are detected at concentrations ≤ Preliminary Screening Values will be considered uncontaminated by MC and sufficient to be used for delineation of contamination; contamination in soil must be delineated laterally and vertically All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete samples	Analytical methods as described in the UFP-QAPP (Appendix E)
Chemical Use Area #3	Characterize nature and extent of MEC contamination	Risk (RI) and remedy (FS)	MEC/CWM and/or MD	Surface and subsurface soil	DGM transect surveys (spacing 188m) over approximately 4.7 acres throughout area; additional acreage of transects or grids as necessary to refine characterization; grids to be located in areas of higher and lower anomaly density; investigation to detection depth of instrument	DGM transect surveys over approximately 4.7 acres; additional transects or grids as necessary to refine characterization; Investigate at least 10 CWM or MEC-like anomalies per grid or all anomalies in grid if less than 10 (*intrusive investigation in grids only*) One background grid (10,000 sqft) will be placed in CUA3 away from military use areas to measure background anomaly density. Anomalies will not be investigated on this grid.	Areas where high anomaly density areas (i.e., "target areas") are <u>not</u> CWM/MEC-related based on intrusive investigation of grids, will be considered uncontaminated by CWM/MEC; high anomaly density areas (i.e., "target areas") that are related to CWM/MEC based on grid intrusive investigation results will be considered potentially contaminated by CWM/MEC. All geophysical investigations shall achieve applicable MQOs as stated in work plan and confirmed/modified by GPO, unless MQO failures can be adequately explained and/or justified	DGM surveys and intrusive investigation	Not applicable
	Determine presence/absence of MC contamination	Risk (RI)	MC	Surface and subsurface soil	*Grid-based Investigation*: Discrete locations at DGM grid locations where evidence of CWM/MEC use and/or testing is found; samples collected at ground surface and at the depth of MEC/MD.	*Grid-based Investigation*: Up to 12 discrete soil samples (6 surface / 6 subsurface – collocated)	Preliminary Screening Values are presented in the UFP-QAPP, Appendix E Areas where MC analytes are not detected or are detected at concentrations ≤ Preliminary Screening Values will be considered uncontaminated by MC; areas where MC analytes are detected at concentrations > Preliminary Screening Values will be considered contaminated by MC (i.e., those analytes are COPCs) All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete soil samples	Analytical methods as described in the UFP-QAPP (Appendix E)

Table 2-3: Data Quality Objective Statements -- Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range RI/FS, Sumter and Hernando Counties, Florida

Munitions Response Site	INTENDED DATA USE(S)	DATA NEED REQUIREMENTS						APPROPRIATE SAMPLING AND ANALYSIS METHODS	
	Project Objective(s) Satisfied	Data User Perspective(s)	Contaminant or Characteristic of Interest Identified	Media of Interest Identified	Required Sampling Areas or Locations and Depths Identified	Amount of Sampling/ Number of Samples Required	Reference Concentration of Interest or Other Performance Criteria	Sampling Method Identified	Analytical Method Identified
				Surface water/sediment	Relevant site water feature(s)	Up to six discrete samples per media.	Preliminary Screening Values are presented in the UFP-QAPP, Appendix E Criteria for contamination are identical to those for surface soil All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete surface water/sediment samples	Analytical methods as described in the UFP-QAPP (Appendix E)
				Groundwater	Three monitoring wells at locations of former munitions finds, ground scars, or where MC in soil exceeded FDEP Leachability to Groundwater criteria (precise locations TBD).	Up to three discrete samples (one from each well)	Preliminary Screening Values are presented in the UFP-QAPP, Appendix E Criteria for contamination are identical to those for surface soil All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete groundwater samples	Analytical methods as described in the UFP-QAPP (Appendix E)
	Characterize nature and extent of MC contamination (i.e., COPCs)	Risk (RI) and remedy (FS)	Any MC contaminants detected during Phase 1	Surface and/or subsurface soil; surface water; sediment; groundwater	*Grid-based Investigation*: Discrete locations and depths as necessary to delineate extent of any detected COPCs	*Grid-based Investigation*: Additional discrete samples, as necessary to delineate extent of any detected COPCs	Preliminary Screening Values will be reviewed and revised as necessary to support delineation. Delineation samples in which MC analytes are not detected or are detected at concentrations ≤ Preliminary Screening Values will be considered uncontaminated by MC and sufficient to be used for delineation of contamination; contamination in soil must be delineated laterally and vertically All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete samples	Analytical methods as described in the UFP-QAPP (Appendix E)

Table 2-3: Data Quality Objective Statements -- Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range RI/FS, Sumter and Hernando Counties, Florida

Munitions Response Site	INTENDED DATA USE(S)	DATA NEED REQUIREMENTS						APPROPRIATE SAMPLING AND ANALYSIS METHODS	
	Project Objective(s) Satisfied	Data User Perspective(s)	Contaminant or Characteristic of Interest Identified	Media of Interest Identified	Required Sampling Areas or Locations and Depths Identified	Amount of Sampling/ Number of Samples Required	Reference Concentration of Interest or Other Performance Criteria	Sampling Method Identified	Analytical Method Identified
ALL CUAs *MEC detonation locations*	Determine presence/absence of MC contamination at MEC detonation locations	Risk (RI)	MC	Surface and subsurface soil	MEC detonation locations; 0-2 inch sample depth	One pre- and one post-detonation sample per disposal location.	Areas where MC analytes are detected in post-detonation samples at concentrations above pre-detonation samples and Preliminary Screening Values will be considered contaminated by MC (i.e., those analytes are COPCs). All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified.	Collection of discrete soil samples	Analytical methods as described in the UFP-QAPP (Appendix E)
	Characterize nature and extent of MC contamination (i.e., COPCs) at MEC detonation locations	Risk (RI) and remedy (FS)	Any MC contaminants detected during Phase 1	Surface and/or subsurface soil; surface water; sediment; groundwater	Discrete locations and depths as necessary to delineate extent of any detected COPCs	Additional discrete samples, as necessary to delineate extent of any detected COPCs	Preliminary Screening Values will be reviewed and revised as necessary to support delineation. Delineation samples in which MC analytes are not detected or are detected at concentrations ≤ Preliminary Screening Values will be considered uncontaminated by MC and sufficient to be used for delineation of contamination; contamination in soil must be delineated laterally and vertically All sampling and analysis shall achieve applicable MQOs as stated in work plan, unless MQO failures can be adequately explained and/or justified	Collection of discrete soil samples	Analytical methods as described in the UFP-QAPP (Appendix E)

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3.0 CHARACTERIZATION OF MUNITIONS AND EXPLOSIVES OF CONCERN AND MUNITIONS CONSTITUENTS

3.1 INTRODUCTION

This chapter provides an overview of the approach, methods, and operational procedures used to complete the characterization of MEC/CWM and MC of the MRA at the former Withlacoochee Site. A detailed description of these methods is presented in the approved work plan (USA, 2014), which was reviewed and concurred with by the TPP Team. Departures from this work plan and other planning documents are discussed at the end of this chapter.

3.2 MEC CHARACTERIZATION

3.2.1 Identification of MEC Areas of Concern

The MEC/CWM areas of concern for the RI consisted of the CUA1, CUA2, and CUA3. The MEC or suspected CWM areas of concern and their history are described in detail in Chapter 2.

3.2.2 MEC Characterization Tasks

3.2.2.1 Vegetation Removal

3.2.2.1.1 A vegetation removal company was subcontracted to clear vegetation where needed for the geophysical surveys. To accommodate the passage of geophysical instruments, vegetation in transects was removed from a narrow path with branches removed up to six-feet from the ground surface. Transects and grids were cleared of vegetation prior to the collection of geophysical data. Each vegetation removal team was supported by a UXO Technician II escort. The cut vegetation was either chipped or placed in an adjacent area.

Brush Cutting at CUA1, July 2012

3.2.2.1.2 Because of the prevalence of invasive plant species on-site, the brush cutting team attended a training session with the Florida Forest Service. The training session included recognition of invasive plants and measures for minimizing the spread of those species. One of the measures taken was to wash the brush cutting equipment weekly. Another measure was to remove branches or vegetation caught in the equipment before transporting it from one area of the site to another.

3.2.2.2 Geophysical Prove Out (GPO)

3.2.2.2.1 The field team performed a GPO to demonstrate the capability and effectiveness of the Geometrics G-858 magnetometer in vertical gradiometer mode to locate buried practice and simulated unexploded ordnance items under anticipated conditions at the site and to confirm the measurement quality objectives (MQOs) and anomaly selection criteria for use in the field investigation.

Brush cut transects, June 2012

3.2.2.2.2 The GPO was located in a flat, open 31 m by 60 m portion of a field at the site office compound. The location was selected outside of the MRA and with close proximity to the site office trailer. Prior to burying 23 seed items which included practice and simulated ordnance items known to be used at the CUAs, a background survey was completed with the G-858 magnetometer. The selected locations of the seed items avoided all preexisting anomalies detected during the background survey.

3.2.2.2.3 Six test items were added to the GPO grid to be used for instrument standardization for DGM of grids. The test items selected were small Industry Standard Objects (ISO), which were placed on the ground surface in East-West and North-South orientations. The data collected over these items were later compared with the same test items seeded within the grids.

3.2.2.2.4 Parsons buried the seed items on April 25, 2012 with oversight from USA Environmental personnel. The details of the seed items and burial depths as well the GPO results are provided in the GPO report included in Appendix F.

GPO construction at the compound, April 2012

3.2.2.3 Geophysical Survey Equipment

3.2.2.3.1 The Geometrics G-858 magnetometer was operated as a vertical gradiometer with two sensors collecting magnetic field intensity data. The vertical separation distance of the sensors was 0.5 meters. The sensors on the G-858 are optically-pumped cesium vapor magnetometer sensors. The operating range of the instrument is between 17,000 nanotesla (nT) and 100,000 nT. The sensitivity of the instrument is 0.01 nT at a rate of one reading per second and 0.05 nT at a rate of 10 readings per second (the sample rate used during the survey). The difference between the two sensor's readings divided by the distance separating the sensors in meters was recorded as the magnetic gradient (nT/m) at

each measurement location. The magnetometer data were recorded on a portable electronic data recorder to be downloaded later for post-processing.

3.2.2.3.2 A Trimble R6 Real Time Kinematic (RTK) Global Positioning System (GPS) receiver was used to position the geophysical data during the GPO survey. The Trimble R6 RTK GPS system is an integrated parallel channel GPS receiver with a radio-modem communication system. A dedicated base station broadcasted base position information to the rover unit used by the field crew allowing for real-time positional corrections. Positional data were output to the logging computer at 1-second intervals using a serial cable. The GPS antenna was placed on a pole on the right side of the instrument backpack connected to the instrument console. The offset of the GPS antenna and the sensors was 1.1 meters.

3.2.2.3.3 A Garmin handheld GPS receiver was integrated with the G-858 magnetometer for positional data along transects. A RS232 cable was connected directly to the G-858 console, which feeds in the GPS data string at a 1-second interval. The handheld unit does not require a dedicated base station or clear view of the sky, which made is suitable for use on the transects.

3.2.2.4 Geophysical QC

3.2.2.4.1 The geophysical QC procedures included monitoring the DGM data based on the MQOs established in the WP and in the GPO report. The Site Geophysicist reviewed each dataset and documented MQOs (i.e. static and dynamic response and positioning repeatability, speed, etc.) in the Microsoft Access database format.

G-858 static test, June 2012

3.2.2.4.2 A static station area for the G-858 magnetometer was established at the site office compound using a special plastic mount on which the magnetometer was placed. The static station allowed repeatable orientations for the sensors to replicate static values established during the GPO. Static tests included a background survey, survey over a metal pipe, a cable shake survey, and an operator survey. Along with the static station area, a test strip was created using a portion of the GPO grid that included seeds placed in series along an east-west direction. The DGM teams surveyed the test strip daily to record dynamic values over the test items to compare against the values established during the GPO.

3.2.2.4.3 During DGM of grids, the UXO Quality Control Specialist (UXOQCS) placed test items (small metal pipes) on the surface in each grid prior to the arrival of the DGM team. The UXOQCS measured the local easting and northing from the SW corner of the grid to reference the test item location. The UXOQCS also measured the diagonals of each grid to verify proper grid dimensions prior to DGM. The test item response and local

offsets were reviewed for anomaly characteristics to confirm they were similar to the baseline characteristics determined during the GPO. The test item locations were also used to ensure that the grid data were collected properly in reference to the SW corner along with proper walking speeds and direction.

3.2.2.5 Density Mapping DGM

3.2.2.5.1 To identify high anomaly density target areas within the MRA, geophysical data were collected along transects to measure the anomaly density of the MRA. Areas with higher anomaly density were attributed to munitions target areas unless documented by the field teams as camp sites or areas with trash or other metallic surface debris not related to the training areas. VSP software was used to calculate the transect spacing required to find all target areas with 90% confidence. For those planning calculations, it was assumed that the target areas had an average anomaly density of 75 anomalies/acre. Over 3,800 anomalies were detected along the 332 miles of density transects surveyed in the MRA (Table 3-1).

1). Review of historical data and the results from the 1950 surface clearance revealed several clusters of munitions and related materials with the minimum cluster size of approximately 300m diameter. That target area size was used to design the transect approach to achieve 90% confidence of detecting a 300m target area for most of the MRA. A 180m target area assumption was used for the ATGGR based on the size of the target markings visible in the historical aerial photos. These assumptions resulted in a transect spacing of 188m in most of the site with an 83m spacing for a portion over the ATGGR. Transects were installed outside the northern, western, and southern boundaries of CUA1, east of CUA2, and west of CUA3 based on new historical information that identified test areas at those edges of the MRA.

3.2.2.5.2 DGM data were collected along transects using the spacing described above in order to identify target areas with high anomaly density. The G-858 magnetometer was linked with a Garmin Rhino global positioning system (GPS) receiver to collect data along transects that were previously brush cut. Brush cutting was performed along transects as required and permitted by the right of entry agreement. Some cleared firebreaks and dirt roads exist though the area, but these were avoided where possible because non-munitions debris along these paths could artificially increase the anomaly density values and make the data interpretation more difficult. Brush cutting attempted to follow transects as designed, but by necessity deviated around inaccessible swampy areas. As the work was being conducted, the brush cutting and DGM teams received maps daily showing the previous tracks covered to help plan each day's assignment and identify potential gaps to fill in. Through the Summer of 2012 and Winter of 2013, DGM teams collected approximately 125 acres of transect data covering the MRA. Table 3-1 presents the DGM density transects coverage for each area. Figure 3-1 and 3.2 display the DGM transect coverage for the CUAs. CUA1 and CUA2 were expanded based on historical information. Actual transect paths were deviated from the proposed paths due to the swampy conditions of the site. All accessible areas were investigated in order to meet the coverage needs of the site.

Table 3-1: Density Transect Coverage

Area	DGM Coverage		
	Proposed Density Transects (Acres)	Actual Density Transects (Acres)	Actual Density Transects (Miles)
CUA1	87.6	112.5	298
CUA2	5.3	6.25	17.2
CUA3	4.7	6.25	17.1
MRA Total	97.6	125.0	332.3

G-858 density transect data collection, July 2012

3.2.2.5.3 The DGM teams consisted of an instrument operator, UXO Technician II escort, and an all terrain vehicle (ATV) operator. The ATV carried a repeater for the radio communications system as well as supplies for the DGM team. Each morning, the DGM teams received their field assignments from the Site Geophysicist based on available brush-cut transects in the form of maps and preloaded transect data in the Garmin GPS receivers. Each morning prior to deployment to the field, the teams conducted a static test, test strip survey, and GPS test to ensure all instruments were working properly. Once the equipment checks were completed, the team leaders were briefed on their assignments by the Command Post (CP) and conducted radio checks. Following approval by the CP, the field teams loaded equipment onto their trucks and ATVs onto trailers and headed to their starting points. Once on the transect, the UXO Technician led the way following a map and Garmin GPS receiver for direction followed by the G-858 operator and the ATV operator. On average, the teams covered 3 to 4 miles per day following the cleared transects which had many deviations due to the swampy conditions of the site. Some portions of the site could not be traversed by foot due to flooding, submerged logs, and cypress trees and knees. Frequent communications between the field teams and the site office were maintained. Heavy rain events beginning with a tropical storm in August 2012 resulted in the long-term flooding of some areas that had been previously accessible with the result that DGM data were collected on some transects and grids that could not be accessed for later stages of the investigation.

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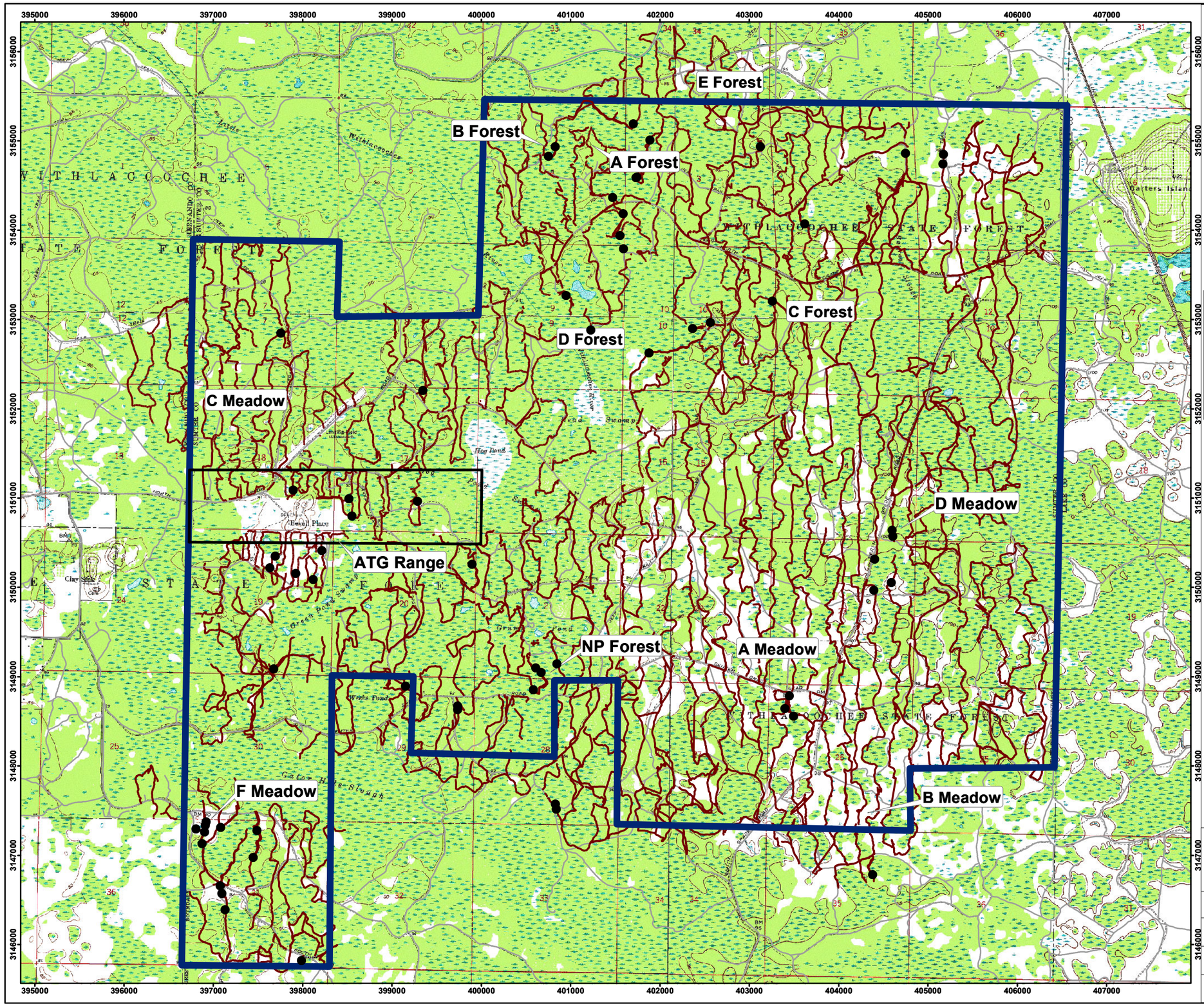

Figure 3.1

DGM Coverage for CUA 1
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend
- Grids
- DGM Transects
- Forest Roads
- MRS Boundary
- Air-to-Ground Bombing and Gunnery Range

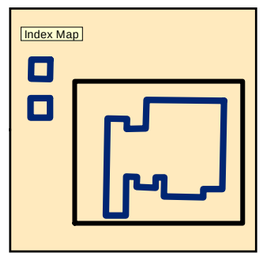

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Image: USGS 7.5' Topo Quadrangles, Date Unknown.
Projection: UTM Zone 17 NAD83, Map Units in Meters
1,000 500 0 1,000 Meters

USA Environmental	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	DGM Coverage for CUA 1		
DRAWN BY: BT			
CHECKED BY: IG	SCALE: As Shown	PROJECT NUMBER: 747826.05000	
SUBMITTED BY: JC	DATE: October 2014	PAGE NUMBER: 3-6	
	FILE: X:\CWM_GIS\GIS\MAPS\Withlacoochee_FL\RI-FS\RI_report		

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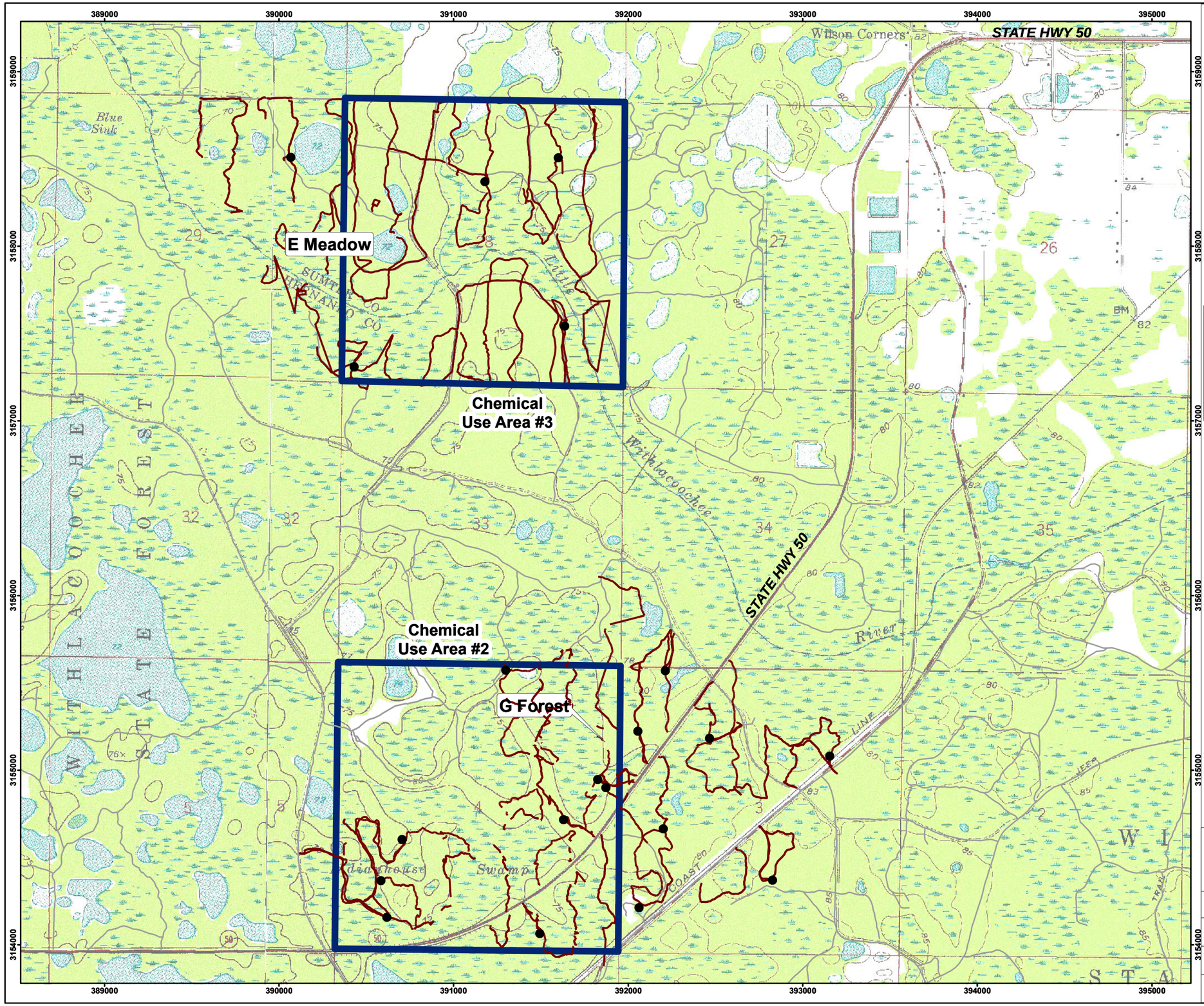

Figure 3.2

DGM Coverage for CUA 2 and CUA 3
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- Grids
- DGM Transects
- Forest Roads
- MRS Boundary

Index Map

Image: USGS 7.5' Topo Quadrangles, Date Unknown.
Projection: UTM Zone 17 NAD83, Map Units in Meters

500 250 0 500 Meters

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USA Environmental	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	CUA #2 and CUA #3		
DRAWN BY: BT			
CHECKED BY: IG	SCALE: As Shown	PROJECT NUMBER: 747826.05000	
SUBMITTED BY: JC	DATE: October 2014	PAGE NUMBER: 3-7	
	FILE: X:\CWM_GIS\GIS\MAPS\Withlacoochee_FL\RI-FS\RI_report		

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3.2.2.5.4 The Site Geophysicist analyzed the acquired data using industry standard software (Geosoft Oasis Montaj) and processing methods (leveling, latency correction). Advanced processing methods (e.g. modeling or size calculations) were not used for density mapping because the required data for those techniques was not available from a single transect. The Site Geophysicist imported the DGM transect paths and anomaly locations into VSP software to calculate anomaly densities and to identify high anomaly density areas which might indicate a target area. These calculations were prepared as the data collection was ongoing to monitor progress and allow adjustments to the process. The site geophysicist used VSP software to determine high anomaly density areas that might contain a 300-meter target area based on actual transect paths.

3.2.2.6 Characterization DGM Grids

3.2.2.6.1 Based on geostatistical analysis using VSP for transect data and review of historical information, grid locations were selected on the following basis:

- To coincide with areas of higher anomaly density so that MEC/MD characterization could be conducted,
- To provide MEC/MD characterization information at documented test area locations not otherwise associated with high anomaly density areas,
- To provide background information on anomaly density or, if needed, to be intrusively investigated to provide MEC/MD characterization data outside high anomaly density areas.

3.2.2.6.2 The number and placement of the grids were established based on parameters set in the work plan with the objective of identifying areas with concentrated MEC and MD and providing characterization data for those areas. Geophysicists from USA, Parsons, and the USACE proposed the grid locations to best delineate the historical training areas.

3.2.2.6.3 Prior to grid placement, reconnaissance was conducted on all the locations of proposed grids. A recon team using the Garmin Rhino GPS units located the proposed grids and determined their locations along the adjacent DGM transects. The recon team inspected the candidate grid area for surface debris, swampy conditions, and ability to clear access for supporting air monitoring equipment. The recon team documented the location and flagged the perimeters of the grid for the brush cutters.

3.2.2.6.4 The three brush cutting teams cut 98 grids at the three CUAs during Spring 2013. The grids were either 2,500 sqft or 10,000 sqft and included paths to enable access for the down range teams and air monitoring components. Ten of the 98 grids were background grids (10,000 sqft) and were located in areas outside the perimeters of high anomaly density areas. Originally, the background grids were intended to provide estimates of background anomaly density; however, the data provided by the transects proved sufficient for that purpose, so the background grids were placed closer to high density areas than planned and fewer were placed. Table 3–2 provides a summary of the number of grids and acreage by CUA. The locations of the grids are displayed in Figures 3.1 and 3.2. The final number of grids used to delineate potential former munitions test areas was supported by DGM transect data and VSP analysis and approved by the project team. The adjustment to the locations of the grids was a fluid process and discussed amongst the project team. Total

grid acreage was less than proposed due to fewer high density areas being identified and the use of fewer large (10,000 sqft) grids.

Table 3-2: Characterization Grid Coverage

Area	DGM Coverage			
	Proposed Grid Coverage (Acres)	Actual Grid Coverage (Acres)	Number of Grids	Number of Background Grids
CUA1	7	5.7	67	9
CUA2	1	0.86	15	0
CUA3	0.23	0.34	6	1

3.2.2.6.5 DGM data collected in these grids were positioned using line and fiducial methods to provide the positional accuracy necessary to reacquire detected anomalies. The grid corners were established using a handheld GPS to establish the location of the grid within approximately 30 feet or better. The DGM team used tape measures to ensure the grid dimensions were consistent with the data collection process. Nails were established in each corner with the SW corner consisting of slightly bigger nail.

3.2.2.6.6 The Site Geophysicist analyzed the GPO dataset to determine if additional anomaly characteristics (e.g. analytic signal value, footprint size) could be used to prioritize anomalies. Anomalies from the characterization grids with characteristics similar to GPO seed item anomalies were given a higher priority for investigation in grids with more than ten anomalies. All anomalies were investigated in each grid with ten or fewer anomalies. For grids containing more than ten anomalies, the Site Geophysicist selected ten for investigation including the five with anomaly characteristics most similar to the expected MEC. These intrusive results were used to characterize the nature of sources of anomalies and the numbers of anomalies in each grid were the most accurate measure of anomaly density.

Intrusive investigation at CUA1, January 2014

3.2.2.7 Intrusive Investigation

3.2.2.7.1 Prior to anomaly investigation, the locations of DGM anomalies selected for investigation were reacquired with survey tapes and verified using the G-858 magnetometer. Intrusive investigation of anomalies was conducted by alternating three-person downrange teams. Downrange teams were responsible for excavating anomalies and collecting samples within the EZ. Each downrange team consisted of a team leader (UXO Technician III) who was responsible for the overall direction of the team and for radio communications, and two workers (UXO Technician II or UXO Technician I). Each team took a turn either excavating anomalies downrange or resting.

Personnel from the Chemical, Biological, Radiological, Nuclear, and High-Yield Explosives (CBRNE) Analytical and Research Activity (CARA) staffed the personnel decontamination station (PDS) and two persons were on-standby as a rescue team. The Command Post (CP) Team was responsible for communications and directing field activities. The CP Team resided in the Support Zone. The CP Team consisted of the Senior UXO Supervisor (SUXOS), UXO Safety Officer (UXOSO), UXOQCS, Field Data Coordinator, and USACE Safety Specialist.

3.2.2.7.2 Initial excavation of anomalies began by hand with mechanical means available if needed. During excavation, the workspace was monitored using Miniature Chemical Agent Monitoring System (MINICAMS) for specific CA and industrial chemicals (H, HN1, HN3, L, CG, PS, CK). A MultiRAE instrument was used to monitor for AC, chloroform, and chlorine. To complement this task, the downrange teams also used a photoionization detector (PID) to monitor for volatile chemicals during anomaly investigation. These monitors were in place to detect harmful chemicals which might be present in the immediate vicinity of the workers. Depot Area Agent Monitoring System (DAAMS) was used for CA confirmation at the workspace and for perimeter monitoring for H, HN1, HN3 and L. When suspect CWM was encountered, the location was marked, and the downrange team withdrew to the PDS. CARA was notified and they sent a team downrange to conduct an assessment. If identified as suspected CWM, the munition was packaged, transported, and placed in the Interim Holding Facility (IHF).

PDS CUA1, January 2014

3.2.2.7.3 The starting personal protective equipment (PPE) for the intrusive investigations was Modified Level D (long sleeve shirts, rubber booties over footwear, nitrile gloves, and slung respirator). Hazard and risk assessment was a continuing process that was conducted throughout the duration of each investigation. PPE was modified or upgraded for specific tasks as needed during the investigation.

3.2.2.7.4 A PDS was established in the contamination reduction zone (CRZ) to facilitate decontamination in the event of encountered CA release and to prevent Exclusion Zone (EZ) personnel from transferring contamination to the support zone. The PDS was staffed by CARA personnel. The extent of decontamination depended on a number of factors, the most important being the type and concentration of the contaminant involved. A Rescue Team, consisting of two people, was available and was responsible for helping members of the Down Range Team that needed assistance in case of an accident. The rescue team was prepared to don Level B PPE for rescue use when CWM was suspected or air monitoring indicated a potential CA release. A medical monitoring tent was set up adjacent to the PDS and was available for the verification monitoring for decontaminated workers. An ambulance with paramedics was kept on standby during the intrusive work in the event that a chemical release would require evacuation of field personnel to the Level 1 Trauma Center at Tampa General Hospital.

3.2.2.7.5 During intrusive operations, an EZ was enforced to protect non-essential personnel from inadvertent chemical releases or detonations. The EZ was determined by the largest applicable protective distance of the No Significant Effects (NOSE) Distance (driven by potentially present CA filler) and minimum separation distance (MSD) – driven by the munition with the greatest fragmentation distance (MGFD). A weather station was used to monitor onsite conditions for the key parameters needed as input to the D2PC air dispersion computer model used in accordance with the Work Plan and CSP. A safety perimeter was established and, when necessary, non-essential personnel were asked to leave. Intrusive work would not resume until the EZ was clear.

3.2.2.7.6 Daily reports were prepared by the team, who also collected photographic evidence of the operations and progress. These reports were uploaded to a file transfer protocol (FTP) website or emailed to the Project Delivery Team to ensure real time evaluation of the progress and quality control of the activities. The team maintained a detailed accounting of MEC, investigative derived waste (IDW), and MD encountered during the RI, including the type, mark and mod number, condition, location, depth, orientation, and disposition. Photographs were taken of identifiable MEC. Material potentially presenting an explosive hazard (MPPEH) was inspected, certified, and disposed of in accordance with Chapter 14 of EM 1110-1-4009 (USACE, 2007b) and Errata Sheet No. 2.

3.2.3 Munitions Management

3.2.3.1 MEC Identification and Removal

Only two UXO items were encountered – one munition found in Grid CUA1-037, identified as an EK-4 10-lb chemical bomblet, was assessed to be potential CWM containing mustard (H) filler. This munition was packaged in a multiple round container and was placed in the IHF. The second UXO item, found in Grid CUA2-006, was an EK-4 bomblet with burster but the outer casing had been ruptured and there was no liquid fill. This munition was destroyed by detonation in CUA3. For each munition identified as possible MEC, the UXO Technician III evaluated the munition and reported its condition to the SUXOS and UXOSO. Suspect CWM was assessed by CARA with support from the UXOSO and USACE Safety Specialist.

3.2.3.2 MEC Storage

The UXO EK-4 10-lb chemical bomblet found at Grid CUA2-006 was determined to be acceptable to move and was temporarily stored in the explosives magazine (which had no other explosives) until demolition was arranged. The bomblet with filler found in Grid CUA1-037 was held in the IHF until June 11, 2014 when it was turned over to CARA and subsequently shipped to Aberdeen Proving Ground, Maryland. No other explosives were stored during the investigation. Donor explosives for the one demolition event were provided by an explosives supplier on an on-call basis and delivered directly to the demolition site.

3.2.3.3 MEC Disposal

MEC identified during fieldwork was destroyed in accordance with the approved work plan and standard operating procedures. USA sited an explosives magazine as part of the

initial mobilization and site set up. Demolition was conducted in CUA3 on August 15, 2013 for a ruptured EK-4 with potentially energetic fuze and burster assembly. The item was deemed safe to move and was relocated to a secure disposal location in grid CUA3-003. CUA3 was chosen as the location for the demolition because of its remote location. Demolition procedures were consistent with the procedures noted in TM 60A1-1-31 and USA's demolition SOP.

3.2.3.4 Inspection of MPPEH

Some MD recovered during the RI was temporarily considered MPPEH. All of these munitions were thoroughly inspected by the SUXOS and the USACE Safety Specialist. When the SUXOS and USACE agreed that the MD was free of explosives, both signed DD Form 1348-1A, which is presented in Appendix A. After inspection and certification, the recovered MD were drummed and sealed. MD recovered during the project was stored in separate containers until verified by the USACE Safety Specialist and certified by the SUXOS in accordance with EM 1110-1-4009 (USACE, 2007b). After inspection, MD was stored in a secured area within locked containers to prevent materials from being added that may not have been through the inspection process. The MD were crushed, shredded or smelted to render them unrecognizable as ordnance. Certificates of Destruction for the MD are included in Appendix A.

3.2.3.5 Intrusive Investigation Quality Control

Intrusive investigations were verified during intrusive operations by the downrange team and also during the independent verification by the UXOQCS and site geophysicist. All information from the downrange team was called into the CP to be verified by the UXOQCS and site geophysicist via radio communications. Findings were reviewed based on initial data and guidance from the UXOQCS was provided as needed. Once the intrusive investigations were completed for the grid, the excavations were left open for the UXOQCS and site geophysicist to verify. All air monitoring equipment remained operational during the QC process while the intrusive results were validated. Debris from the holes was checked along with the spoils and the excavated areas were documented with a post value with the G-858 magnetometer which was the same instrument used during the data collection and reacquisition phases. The results of the QC inspections which included all the excavated anomalies in the grid were recorded in the daily CP log (Appendix E). Readings from the G-858 magnetometer were recorded in the digsheets. The USACE Safety Specialist was present onsite to also monitor work quality and verify that safety procedures were being followed.

3.3 MC CHARACTERIZATION

3.3.1 Purpose of Munitions Constituents Sampling Activities

3.3.1.1 The objectives of the MC sampling program for this RI were:

- To determine if MC are present at locations where MEC, or select MD were encountered at the site during intrusive activities, at locations where MEC was found during the 1950s clearance, or at locations identified from aerial photographic analysis as ground scars and other areas of interest;

- To characterize the extent of MC contamination, if present; and
- To provide sufficient information to assess MC risk, if any, to human health and the environment.

3.3.1.2 To achieve the MC sampling program objectives, environmental samples were collected based on decisions made during the TPP meetings. Sampling was conducted where MEC and selected MD were found, where detonations were used to destroy munitions, at locations of former munitions finds, ground scars, and within the suspected Toxic Gas Yard. Background samples were collected throughout the site from locations determined to be outside of areas affected by former military activity. All samples were collected in accordance with the approved project SAP (USA, 2014).

3.3.1.3 The SAP was implemented for the collection of environmental data to assure that the quantity and quality of the data meets the needs of the end user. The sampling program satisfies the sampling and analysis requirements of the PWS, dated 15 Dec 2010.

3.3.2 Field Sampling Activities by Area

3.3.2.1 CUA1

3.3.2.1.1 The Withlacoochee Site RI/FS SAP and Work Plan (USA, 2014) prescribed samples for CUA1 as listed below in Table 3-3 and described as:

- Discrete surface (0 to 2 inches bgs), subsurface samples (18 to 24 inches bgs), subsurface samples in the Toxic Gas Yard (40 to 48 inches bgs) and associated QC samples to be collected where MEC or selected MD are found during the investigation of the anomalies at this area;
- Discrete surface and subsurface soil samples collected around locations of former munitions finds, ground scars, and within the suspected Toxic Gas Yard. Subsurface samples collected within the Toxic Gas Yard were collected at a depth of 48 inches;
- Discretionary samples, including follow-on samples;
- Locations where MEC are destroyed during the RI;
- Surface water and sediment samples, if appropriate, and a water source is available, and
- Groundwater samples collected from monitoring wells installed in locations where an analyte concentration exceeds the FDEP-LGW screening levels.

Collecting soil sample, September 2013

3.3.2.1.2 A total of 148 discrete surface and subsurface soil samples were collected throughout CUA1 (Figure 3.3), excluding field duplicate (FD) and quality assurance (QA) samples. A total of 18 FD and QA samples were collected as part of the QC process as described in Section 6.4.2 of the SAP (USA, 2014). In addition, 8 equipment blanks were collected during the decontamination of sample equipment at the Toxic Gas Yard. Soil

samples were collected and analyzed for CA/ABPs, explosives and selected metals to determine if widespread contamination due to past DoD use exists. The selected metals consisted of the following: antimony, arsenic, barium, copper, lead, manganese, nickel, and zinc. No surface water or sediment samples were collected during intrusive or historical sample collection due to lack of an available and appropriate nearby source where MEC and MD was found. No groundwater samples were collected or monitoring wells installed because no detected concentrations were found to exceed the FDEP Soil Cleanup Target Levels (SCTL), Leachability Based on Groundwater criteria, as prescribed in the Work Plan (USA, 2014).

3.3.2.1.3 To determine the potential presence of CA or decontamination agents within the Toxic Gas Yard, 52 samples were collected from a grid-based pattern within the suspected area (Figure 3.4). These samples consisted of surface (0 to 2 inches bgs) and subsurface (40 to 48 inches bgs) soil samples. The 52 soil samples were analyzed for metals, explosives, and volatile organic compounds (VOC) associated with suspected decontamination agents (trichloroethylene; 1,1,2,2-tetrachloroethane; 1,2-dichloroethene (cis); 1,2-dichloroethene (trans); and vinyl chloride). Based on the soil sample results, groundwater samples were not collected or monitoring wells installed because no detected concentrations were found to exceed the FDEP Soil Cleanup Target Levels (SCTL), Leachability Based on Groundwater criteria, as prescribed in the Work Plan (USA, 2014).

3.3.2.1.4 Six samples (3 surface and 3 subsurface) were collected as a result of munitions findings during the intrusive investigation.

- Two samples (WITH-CUA1-SS-002 and WITH-CUA1-SB-002) were collected from Grid CUA1-37, Anomaly 002, which was tentatively identified as an EK-4 10-lb chemical bomblet (CWM).
- Two samples (WITH-CUA1-SS-003 and WITH-CUA1-SB-003) were collected from Grid CUA1-75, between anomalies 003 and 004. The MD was identified as pieces of a M47A2 100-lb chemical bomb, not intact.
- Two samples (WITH-CUA1-SS-008 and WITH-CUA1-SB-008) were collected from grid CUA1-27, anomaly 003, where a bomb body (MD) was found.

The remaining samples collected in CUA1 during the initial round of sampling were collected from areas where MEC was historically found.

3.3.2.1.5 Analytical results indicated two samples, WITH-CUA1-HSS-0-2-11 and WITH-CUA1-HSB-20-24-11 (surface and subsurface from the same location), contained concentrations of barium higher than the FDEP FAC 62-777 Soil Cleanup Target Levels (SCTL) (FDEP, 2005), Direct Exposure Residential. These samples were collected on August 19, 2013, in an area just south of the Fish Hatchery and within the former ATG bombing and gunnery range. To delineate the extent, five additional soil samples were collected on February 5, 2014 (Figure 3.4). One sample was collected at 28" to determine vertical extent, and four soil samples were collected surrounding the central location at 22" to determine the horizontal extent. The four surrounding samples were collected two meters from the central location, in each cardinal direction. Of the follow-on samples, concentrations of barium in two samples, WITH-CUA1-HSB-28-30-11D and WITH-CUA1-HSB-20-24-11E, were higher than the FDEP SCTL, Direct Exposure Residential.

3.3.2.1.6 At this point, an additional discussion with the PDT was held regarding the path forward regarding the barium exceedances in the WITH-CUA1-HSS-0-2-11 area and it was determined that additional sampling at this location should be limited to one more set of step-out soil samples in the direction of the exceedances plus an additional contingency set of samples to be collected at twice the usual distance (4 m) to the northeast, east, and southeast. These additional contingency samples would be subjected to the usual process of monitoring the headspace of an initial split, if clear sending a second headspace sample to ECBC for low-level CA/ABP analysis, and if clear, the third split would be sent to the commercial lab, Agriculture and Priority Pollutants Laboratory, Inc. (APPL), but held rather than be analyzed immediately pending the commercial lab results of the earlier step-out. If additional exceedances were encountered in the step-out samples, then the appropriate contingency samples (in the appropriate direction) would be analyzed. The decision was made to curtail step-out sampling at the contingency stage due to cost of maintaining the staff and equipment onsite to conduct headspace monitoring and the fact that barium is not a CERCLA hazardous substance. Thus, thirteen more follow-on samples were collected on February 20, 2014. Six (3 surface and 3 subsurface) were collected two meters north, south, and east of sample WITH-CUA1-HSB-20-24-11E (Group #1), one was collected at 40" depth below sample WITH-CUA1-HSB-28-30-11D, and six (3 surface and 3 subsurface) were collected four meters north, south, and east of sample WITH-CUA1-HSB-20-24-11E (Group #2). The Group #2 samples were not analyzed immediately, but were held by APPL pending analysis of the Group #1 samples. Two of the samples from the Group #1 samples had concentrations higher than the FDEP SCTL, Direct Exposure Residential, samples WITH-CUA1-HSB-20-24-11E-East1 and WITH-CUA1-HSB-20-24-11D-40". Based on the eastward direction of the exceeding concentrations, two of the east samples from Group #2, WITH-CUA1-HSS-0-2-11E-East2 and WITH-CUA1-HSB-20-24-11E-East2, were released for analysis. The nine samples from Group #2 released for analysis are shown on Figure 3.4. One of these samples, WITH-CUA1-HSB-20-24-11E-East2, was found to have concentrations higher than the FDEP SCTL, Direct Exposure Residential. Due to time constraints and lack of onsite air monitoring personnel, no further follow-on samples were collected.

Sample WITH-CUA1-HSS-0-2-11/WITH-CUA1-HSB-20-24-11 Location, February 2014

Table 3-3: Sampling Strategy for CUA1

Medium	Work Plan Strategy		Work Completed	
	# of Samples*	Locations	# of Samples*	Location/Explanation
Surface Soil (0-2")	83	Collected from intrusively investigated grids	3	CWM and MD found in Grids CUA1-027, CUA1-037, and CUA1-075
	47	Locations of former munitions finds, ground scars, and within the suspected Toxic Gas Yard	59	Locations of former munitions finds, ground scars, and within the suspected Toxic Gas Yard
	30	Discretionary samples (including follow-on)	6	Follow-on samples for WITH-CUA1-HSS-0-2-11
	12	Pre/Post demolition samples	0	No demolition shots conducted in CUA1
Subsurface Soil (> 12")	83	Collected from grids proposed for intrusive investigations	3	CWM and MD found in Grids CUA1-027, CUA1-037, and CUA1-075
	47	Locations of former munitions finds, ground scars, and within Former Toxic Gas Yard	59	Locations of former munitions finds, ground scars, and within the suspected Toxic Gas Yard
	30	Discretionary samples (including follow-on)	18	Follow-on samples for WITH-CUA1-HSB-20-24-11
Surface Water	20	One pond and various wetlands throughout the site	0	No applicable water sources
Sediment	20	Co-located with surface water samples	0	No applicable water sources
Groundwater	8	Locations of former munitions finds, ground scars, and within suspected Toxic Gas Yard	0	No detected concentrations were found to exceed the FDEP Soil Cleanup Target Levels, Leachability Based on Groundwater criteria
	2	Areas where MC in soil exceeded FDEP Leachability to Groundwater criteria.	0	No detected concentrations were found to exceed the FDEP Soil Cleanup Target Levels, Leachability Based on Groundwater criteria

* Sample totals do not include QC samples.

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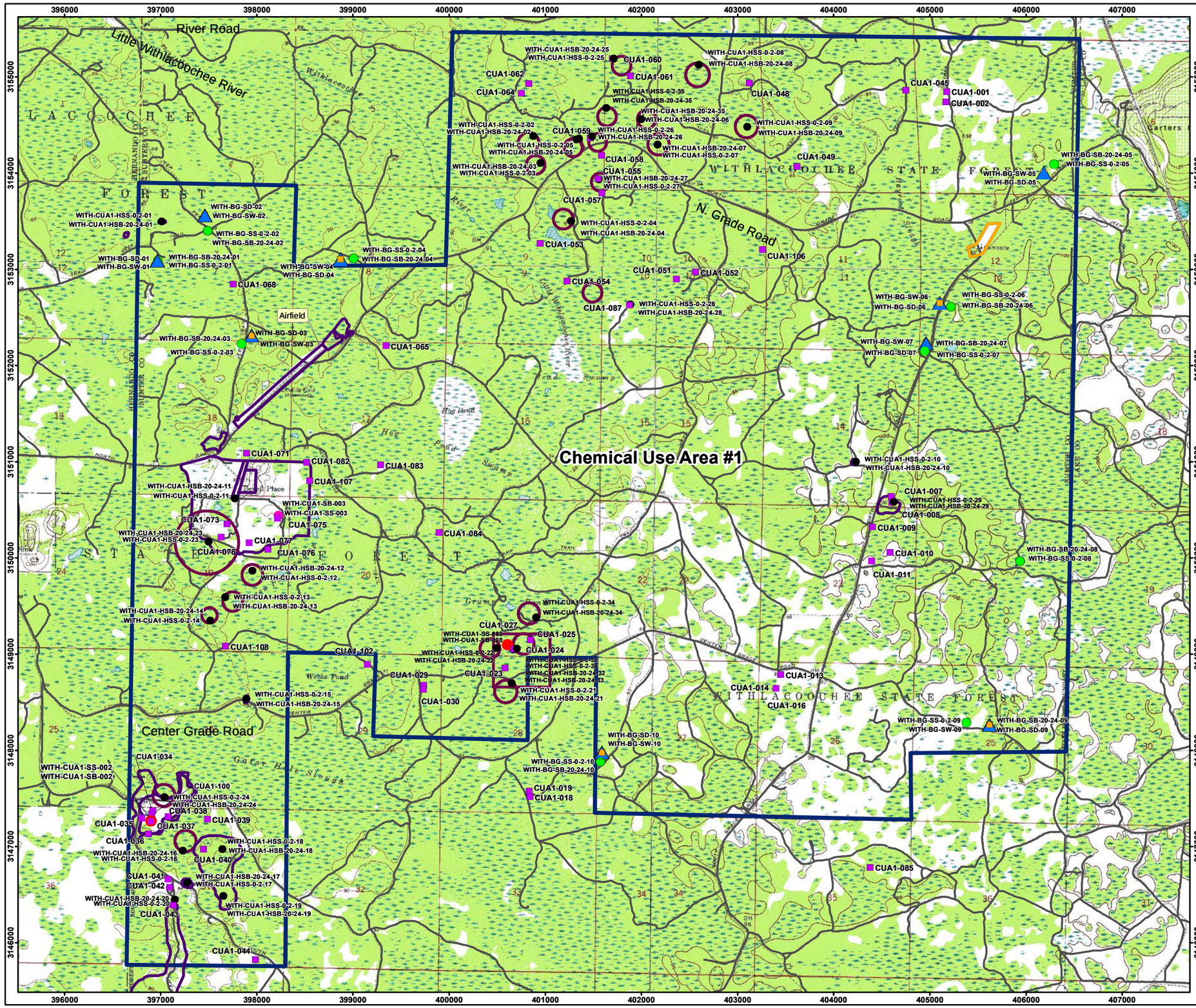

Figure 3.3

Sample Locations
Chemical Use Area #1
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range

Sumter and Hernando Counties, Florida

Legend

- Sediment - Background
- Soil - Background
- Soil - Historical Munitions Find Area
- Soil - Potential MEC/CWM Find
- Soil - Select MD
- Surface Water - Background
- Dig Grids
- Forest Roads
- MRS Boundary
- Investigation Area of Interest/Ground Scar
- Ordnance Area
- Former Toxic Gas Yard

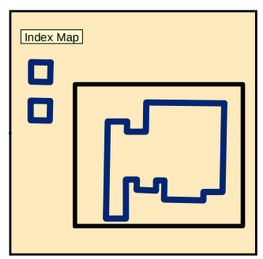

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Image: USGS 7.5' Topo Quadrangles, Date Unknown.
Projection: UTM Zone 17 NAD83, Map Units in Meters

1,000 500 0 1,000 Meters

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DESIGNED BY: BT	Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range		
DRAWN BY: BT			
CHECKED BY: KR	SCALE: As Shown	PROJECT NUMBER: 747826.05000	
SUBMITTED BY: JC	DATE: July 2014	PAGE NUMBER: 3-18	
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Figure 3.4

Toxic Gas Yard (CUA1) Samples
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range

Sumter and Hernando Counties, Florida

Legend

- Soil - Toxic Gas Yard
- Former Toxic Gas Yard

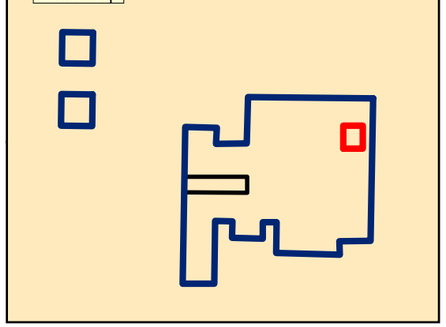

Image: 2010 Orthophoto
Projection: UTM Zone 17 NAD83, Map Units in Meters

150 75 0 150 Feet
50 25 0 50 Meters

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SUBMITTED BY: JC	DATE: October 2014 — PAGE NUMBER: 3-19
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WITH-CUA1-HSB-20-24-11N
(22", 46 mg/kg)

WITH-CUA1-HSS-0-2-11E-North1
(2", 49 mg/kg)
WITH-CUA1-HSB-20-24-11E-North1
(22", 110 mg/kg)

WITH-CUA1-HSB-20-24-11W
(22", 62 mg/kg)

WITH-CUA1-HSS-0-2-11
(2", 130 mg/kg)
WITH-CUA1-HSB-20-24-11
(22", 130 mg/kg)
WITH-CUA1-HSB-20-24-11D
(28", 180 mg/kg)
WITH-CUA1-HSB-20-24-11D-40
(40", 550 mg/kg)

WITH-CUA1-HSB-20-24-11E
(22", 140 mg/kg)

WITH-CUA1-HSS-0-2-11E-East1
(2", 88 mg/kg)
WITH-CUA1-HSB-20-24-11E-East1
(22", 120 mg/kg)

WITH-CUA1-HSS-0-2-11E-East2
(2", 93 mg/kg)
WITH-CUA1-HSB-20-24-11E-East2
(22", 220 mg/kg)

WITH-CUA1-HSB-20-24-11S
(22", 120 mg/kg)

WITH-CUA1-HSS-0-2-11E-South1
(2", 36 mg/kg)
WITH-CUA1-HSB-20-24-11E-South1
(22", 110 mg/kg)

Figure 3.5

Follow On Sample Locations
Chemical Use Area #1
WITH-CUA1-HSS-0-2-11 and
WITH-CUA1-HSB-20-24-11
Barium Exceedance
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- Original sample with exceedance
- Follow on samples with exceedance
- Follow on samples - no exceedance

Note:
Barium PSV = 120 mg/kg

Index Map

Projection: UTM Zone 17 NAD83, Map Units in Meters

0 1 2 Meters

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3.3.2.2 CUA2

3.3.2.2.1 The SAP and Work Plan (USA, 2014) prescribed samples for CUA2 as listed below in Table 3-4 and described as:

- Discrete surface (0 to 2 inches bgs), subsurface samples (18 to 24 inches bgs) and associated QC samples to be collected where MEC or selected MD are found during the investigation of the anomalies at this area;
- Discrete soil samples collected around locations of former munitions finds and ground scars;
- Discretionary samples, including follow-on samples;
- Locations where MEC are destroyed during the RI;
- Surface water and sediment samples, if appropriate and a water source is available, and
- Groundwater samples collected from monitoring wells installed in locations where an analyte concentration exceeds the FDEP-LGW screening levels.

3.3.2.2.2 A total of 11 discrete surface and subsurface soil samples were collected from CUA2 (Figure 3.6). No FD or QA samples were collected from CUA2. Samples were collected and analyzed for explosives and selected metals in an effort to determine if widespread contamination due to past military use exists. The selected metals consisted of the following: antimony, arsenic, barium, copper, lead, manganese, nickel, and zinc. No surface water or sediment samples were collected during intrusive or historical sample collection due to lack of an available and appropriate nearby source where MEC and MD was found. No groundwater samples have been collected or monitoring wells installed because no detected concentrations were found to exceed the FDEP Soil Cleanup Target Levels, Leachability Based on Groundwater criteria.

Sample WITH-CUA2-SS-007 Location, August 2013

3.3.2.2.3 Seven of the samples (4 surface and 3 subsurface) were collected as a result of findings during the intrusive investigation. Two samples (WITH-CUA2-SS-006 and WITH-CUA2-SB-006) were collected from Grid CUA2-006, Anomaly 010, which was tentatively identified as a portion of an EK-4 10-lb chemical bomblet. Two samples (WITH-CUA2-SS-004 and WITH-CUA2-SB-004) were collected from Grid CUA2-006, Anomaly 003, which was tentatively identified as a portion of an EK-4 10-lb chemical bomblet. Two samples (WITH-CUA2-SS-007 and WITH-CUA2-SB-007) were collected from Grid CUA2-006, Anomaly 015, which was tentatively identified as a portion of an EK-4 10-lb chemical bomblet. One sample (WITH-CUA2-SS-005) was collected from Grid CUA2-006, Anomaly 019, which was tentatively identified as a portion of an EK-4 10-lb chemical bomblet. A subsurface sample was not collected at this location due to the high water table. The remaining samples collected in CUA2 during the initial round

of sampling were collected from areas where MEC or suspected CWM were historically found.

3.3.2.2.4 When the analytical results from samples collected were received, it was noted that two samples, WITH-CUA2-SS-006 and WITH-CUA2-SS-007, had 2,4,6-trinitrotoluene (TNT) concentrations that exceeded the FDEP FAC 62-777 SCTL (FDEP, 2005), Leachability Based on Groundwater criteria. Sample WITH-CUA2-SS-006 was collected on August 6, 2013 from within Grid CUA2-006, at Anomaly 010, which was tentatively identified as a portion of an EK-4 10-lb chemical bomblet. Sample WITH-CUA2-SS-007 was collected on August 6, 2013 from within Grid CUA2-006, at Anomaly 015, which was also tentatively identified as a portion of an EK-4 10-lb chemical bomblet. Given the number of years since the testing of munitions at those locations and lack of association of TNT with the EK-4 bomblets, the detection of TNT was unexpected. Two follow-on soil samples adjacent to the initial surface samples were planned and collected on February 4, 2014 (Figure 3.7); however, the analysis of those samples did not detect TNT.

Collection of Follow on Sample WITH-CUA2-SS-007RE, February 2014

Table 3-4: Sampling Strategy for CUA2

Medium	Work Plan Strategy		Work Completed	
	# of Samples*	Locations	# of Samples*	Location/Explanation
Surface Soil (0-2")	6	Collected from grids proposed for intrusive investigations	4	UXO and MD found in Grid CUA2-006
	7	Locations of former munitions finds, ground scars	1	Location of former munitions finds and ground scars
	2	Discretionary samples (including follow on)	2	Follow-on samples for WITH-CUA2-SS-006 and WITH-CUA2-SS-007
	2	Pre/Post demolition samples	0	No demolition shots conducted in CUA2
Subsurface Soil (> 12")	6	Collected from grids proposed for intrusive investigations	3	UXO and MD found in Grid CUA2-006
	7	Locations of former munitions finds, ground scars	1	Location of former munitions finds and ground scars
	2	Discretionary samples (including follow on)	0	None needed
Surface Water	6	Various wetlands or ponds throughout the site	0	No applicable water sources
Sediment	6	Co-located with surface water samples	0	No applicable water sources
Groundwater	2	Locations of former munitions finds, ground scars	0	No detected concentrations were found to exceed the FDEP Soil Cleanup Target Levels, Leachability Based on Groundwater criteria
	1	Areas where MC in soil exceeded FDEP Leachability to Groundwater criteria	0	No detected concentrations were found to exceed the FDEP Soil Cleanup Target Levels, Leachability Based on Groundwater criteria

* Sample totals do not include QC samples.

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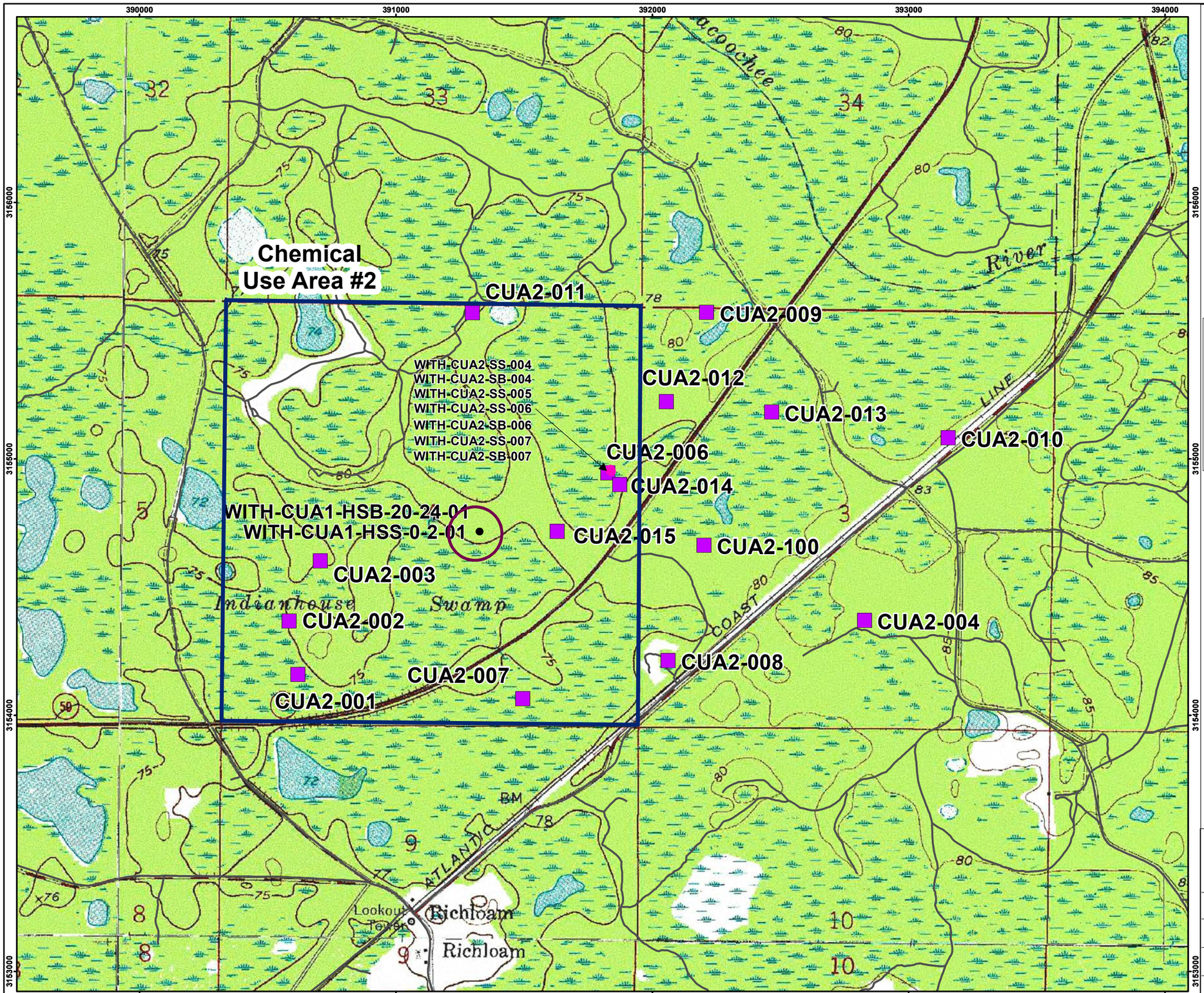


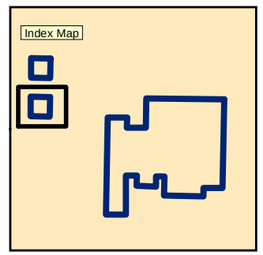
Figure 3.6

Sample Locations
Chemical Use Area #2
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range

Sumter and Hernando Counties, Florida

Legend

- Soil - Historical Munitions Find Area
- Soil - Select MD
- Dig Grids
- Forest Roads
- MRS Boundary
- Ordnance Area



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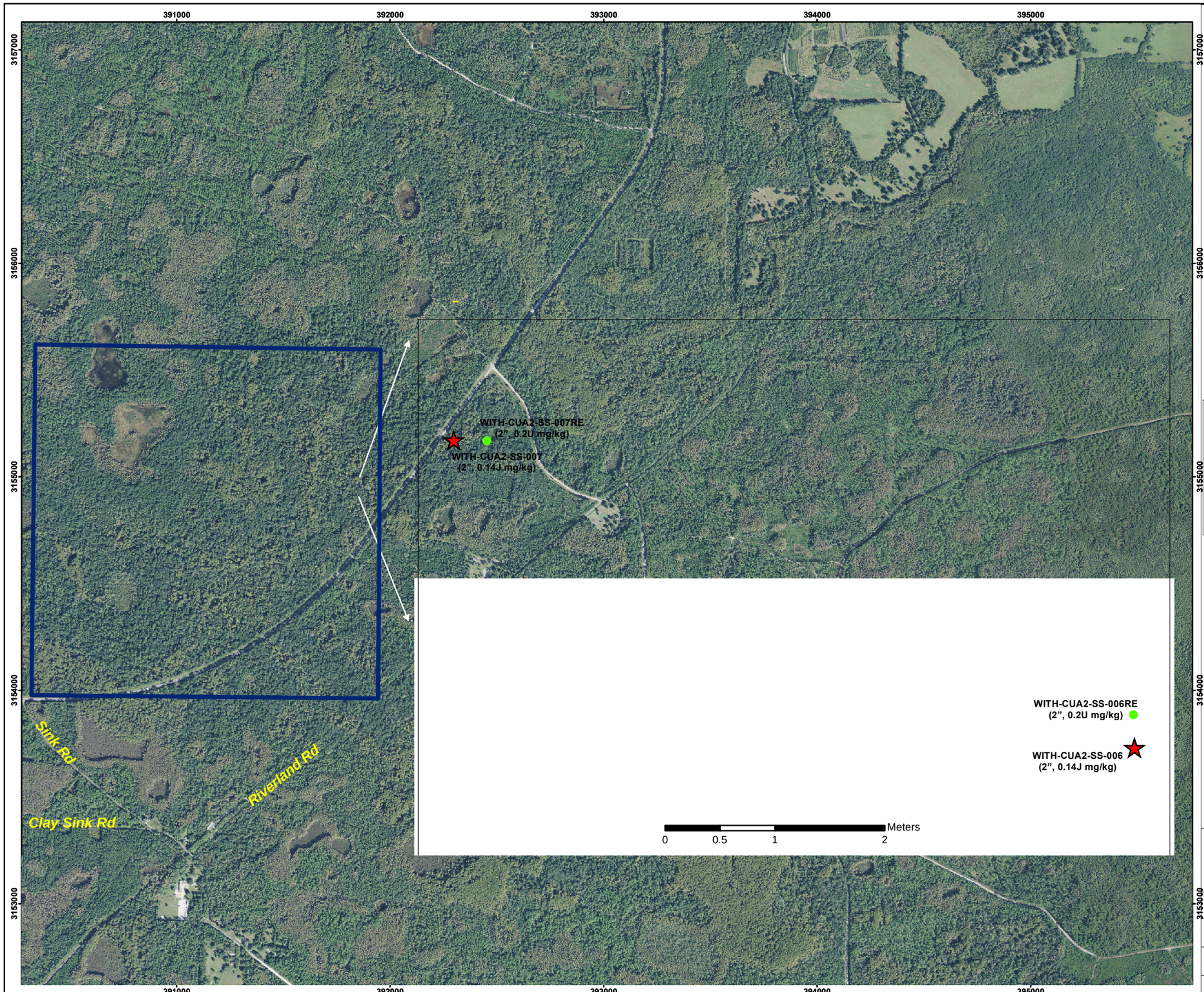


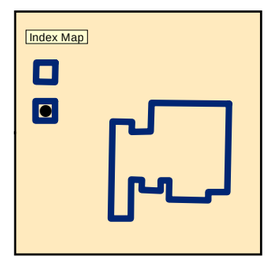
Figure 3.7

Follow On Sample Locations
Chemical Use Area #2
WITH-CUA2-SS-006 and
WITH-CUA2-SS-007
2,4,6-Trinitrotoluene Exceedances
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- Original sample with exceedance
- Follow on samples - no exceedance
- MRS Boundary

Note:
TNT PSV = 0.006 mg/kg



Projection: UTM Zone 17 NAD83, Map Units in Meters

0 500 1,000 Meters

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3.3.2.3 CUA3

3.3.2.3.1 The Withlacoochee Site RI/FS SAP and Work Plan (USA, 2014) prescribed samples for CUA3 as listed below in Table 3-5 and described as:

- Discrete surface (0 to 2 inches bgs), subsurface samples (18 to 24 inches bgs) and associated QC samples to be collected where MEC/CWM or selected MD are found during the investigation of the anomalies at this area;
- Discrete soil samples collected around locations of former munitions finds and ground scars;
- Discretionary samples, including follow-on samples;
- Locations where MEC are destroyed during the RI;
- Surface water and sediment samples, if appropriate and a water source is available, and
- Groundwater samples collected from monitoring wells installed in locations where an analyte concentration exceeds the FDEP-LGW screening levels.

3.3.2.3.2 A total of 7 discrete surface and subsurface soil samples were collected during 2013 and 2014 from CUA3 (Figure 3.8). No FD or QA samples were collected from CUA3. All 7 samples were collected as a result of demolition of a munition during the RI and were analyzed for explosives and selected metals in an effort to determine if contamination resulted from the explosion. The selected metals consisted of antimony, arsenic, barium, copper, lead, manganese, nickel, and zinc. No surface water or sediment samples were collected during intrusive or historical sample collection due to not finding MEC or MD in this area. No groundwater samples were collected or monitoring wells installed because no detected concentrations were found to exceed the FDEP Soil Cleanup Target Levels, Leachability Based on Groundwater criteria.

3.3.2.3.3 No samples were collected as a result of anomaly findings during the intrusive investigation in CUA3 as no MEC or MD was found. No samples were collected based on former munitions findings or ground scars because none of these areas were identified in CUA3.

Collection of Pre-Demolition Sample, August 2013

3.3.2.3.4 Because of its remote location and lack of munitions findings, CUA3 was chosen as the location for the demolition of the UXO found in Grid CUA2-003, Anomaly 019. The item was identified as a fuze and burster from an EK-4 10-lb chemical bomblet. Two samples were collected from the detonation location; one was collected before the demolition (WITH-DEMOPRE-SS-01) and one after (WITH-DEMOPOST-SB-01). The demolition was conducted on August 15, 2013.

3.3.2.3.5 When the analytical results from samples collected were received, it was noted that one sample, WITH-DEMOPOST-SB-01, had a copper concentration that exceeded the FDEP SCTL. Detection of copper is unsurprising since the jet perforators and other components used to set off the explosion contain copper. Five

follow-on samples were planned and collected on February 3, 2014 (Figure3.9). One sample was collected at 8" to determine vertical extent, and four soil samples were collected surrounding the central location at 2" to determine the horizontal extent. The four surrounding samples were collected two meters from the central location, in each cardinal direction. Results of these samples are discussed in Section 4.2.2.5.4.

Post-Demolition Location,

Collection of Post-Demolition Sample, August 2013

Table 3-5: Sampling Strategy for CUA3

Medium	Work Plan Strategy		Work Completed	
	# of Samples*	Locations	# of Samples*	Location/Explanation
Surface Soil (0-2”)	6	Collected from grids proposed for intrusive investigations	0	Samples not warranted
	9	Discretionary samples (including follow-on)	5	Follow-on samples for WITH-DEMO-POST-SB-01
	--	Pre/Post demolition samples	2	One demolition conducted in CUA3
Subsurface Soil (> 12”)	6	Collected from grids proposed for intrusive investigation	0	Samples not warranted
	9	Discretionary samples (including follow-on)	0	Samples not warranted
Surface Water	6	One pond and various wetlands throughout the site	0	Samples not warranted
Sediment	6	Collected with surface water samples	0	Samples not warranted
Groundwater	3	Areas where MC in soil exceeded FDEP Leachability to Groundwater criteria	0	No detected concentrations were found to exceed the FDEP Soil Cleanup Target Levels, Leachability Based on Groundwater criteria

* Sample totals do not include QC samples.

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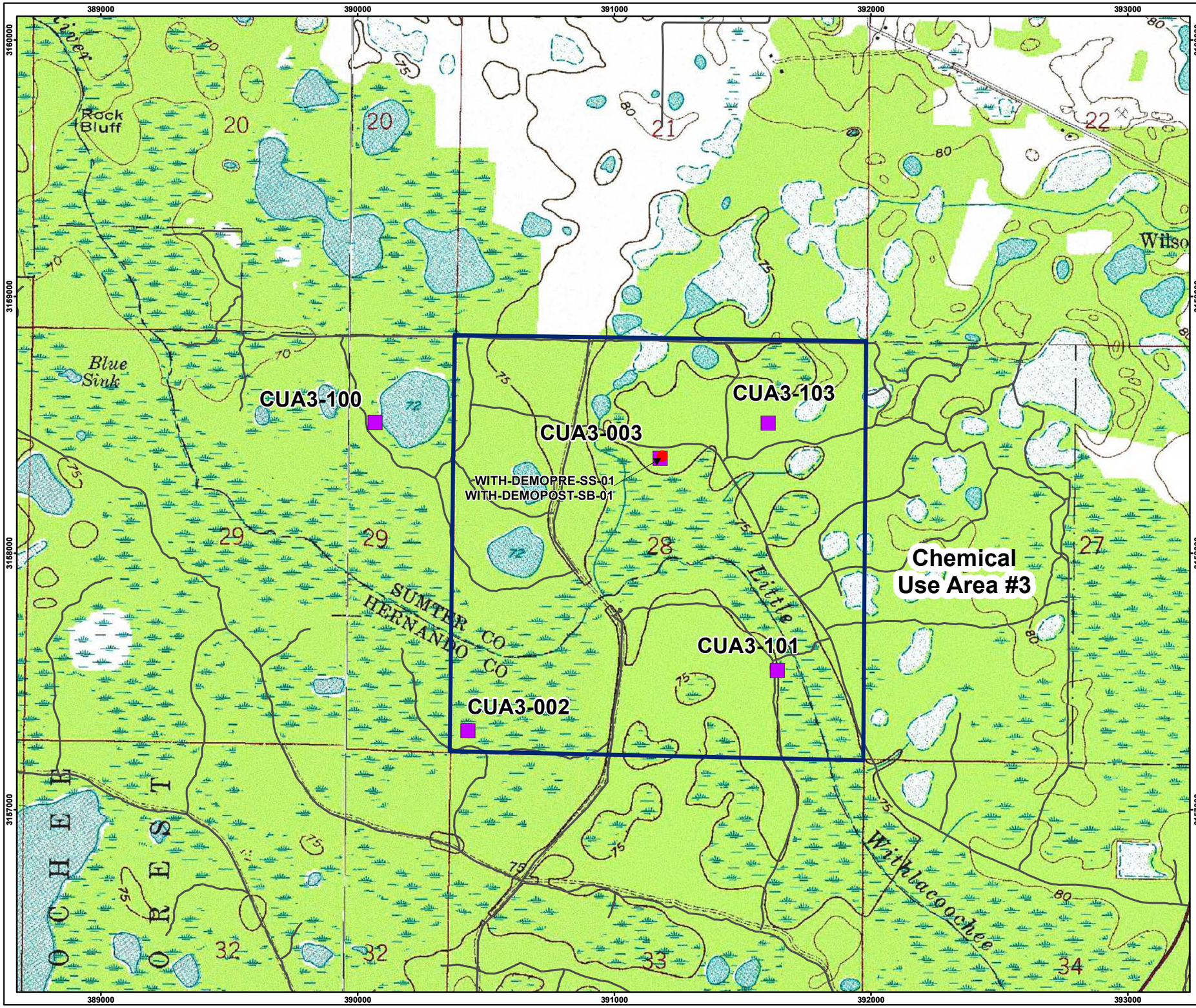
Figure 3.8

Sample Locations
Chemical Use Area #3
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range

Sumter and Hernando Counties, Florida



Legend

- Soil - Demolition Shot Samples
- Dig Grids
- Forest Roads
- MRS Boundary

Index Map

Image: USGS 7.5' Topo Quadrangles, Date Unknown.
Projection: UTM Zone 17 NAD83, Map Units in Meters

300 150 0 300 Meters

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DESIGNED BY: BT	Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range	
DRAWN BY: BT		
CHECKED BY: KR	SCALE: As Shown	PROJECT NUMBER: 747826.05000
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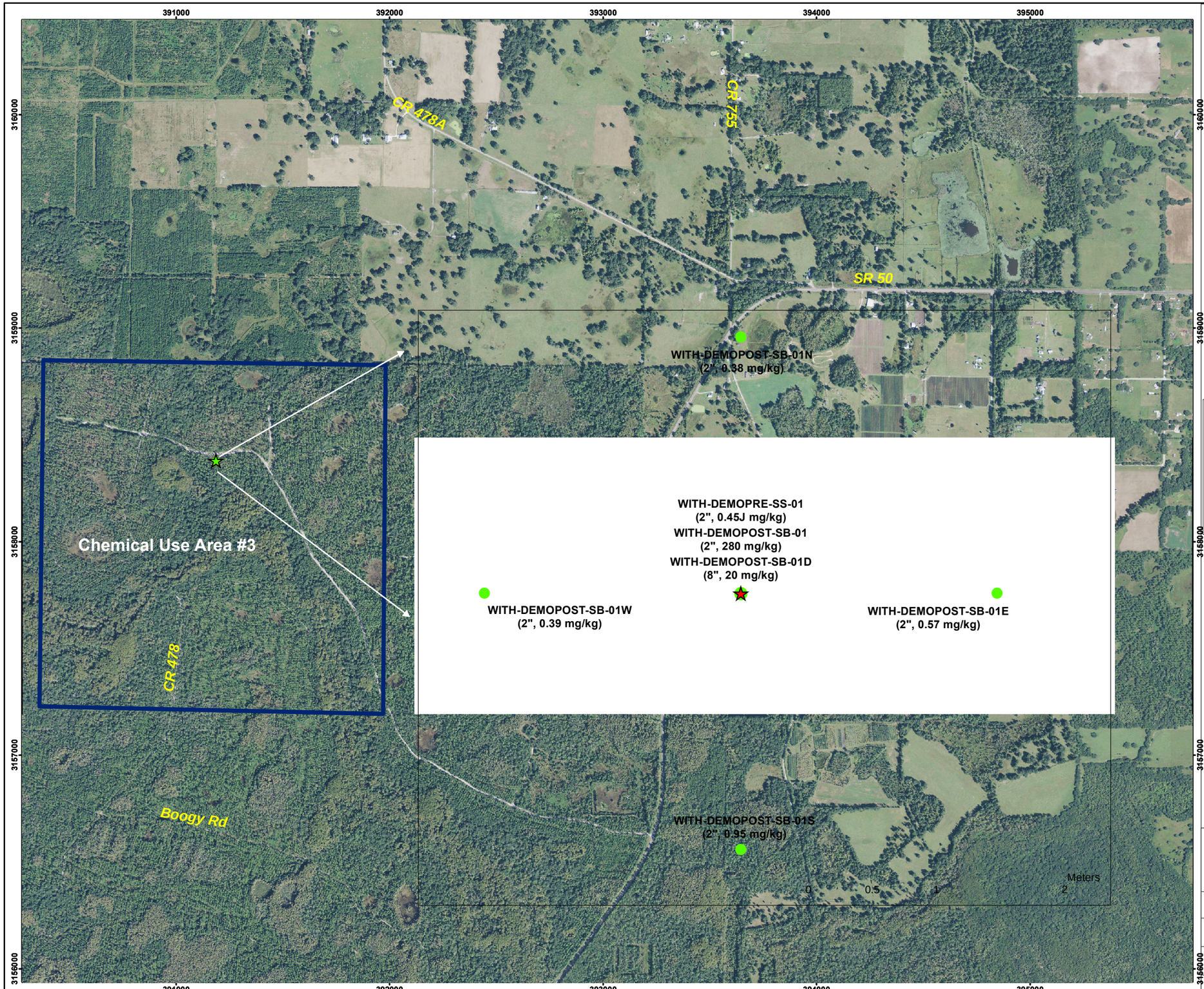


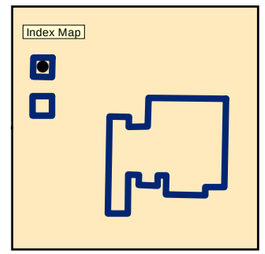
Figure 3.9

Follow On Sample Locations
Chemical Use Area #3
WITH-DEMOPOST-SB-01
Copper Exceedance
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- Original sample with exceedance
- Follow on samples - no exceedance
- MRS Boundary

Note:
Copper PSV = 150 mg/kg



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Projection: UTM Zone 17 NAD83, Map Units in Meters

0 500 1,000 Meters

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3.3.3 Background Samples

Twenty background soil samples (ten surface and ten subsurface) and ten each of background surface water and sediment samples were collected during June and July 2013 as part of the RI field effort in order to provide a representative background concentration of metals in the various media (Figure 3.3). The background samples were collected from media types similar to their corresponding biased sample locations. Due to the large size of CUA1 and in an effort to keep the background samples representative of the MRA, the background samples were placed within CUA1 but outside of areas potentially affected by former military activities. Analytical results for these samples can be found in Appendix B.

3.3.4 IDW Samples

Investigative Derived Waste (IDW) was handled in accordance with the work plan. IDW sampling was limited to waste water from the decontamination process as part of the sample collection at the Toxic Gas Yard. The waste water was stored in two 55 gallon drums. One combined water sample was collected from the two disposal drums on September 17, 2013 and sent to ECBC for CA analysis. Another combined water sample was collected from the two disposal drums on February 18, 2014 and sent to APPL for TCLP analysis. Based on the lack of detections in the analytical results for the waste water, this water was sent offsite for disposal as non-hazardous waste. Laboratory waste associated with air monitoring was removed from the site by CARA.

3.3.5 Analytical Laboratory and Analyses

3.3.5.1 All samples were collected, shipped, and analyzed according the SAP (USA, 2014). Headspace-screening analysis was performed by CARA on all soil and sediment samples, with the exception of background samples, before any further processing was conducted. Split samples were then shipped to ECBC for CA and ABP analysis. Remaining split samples were held on site until ECBC confirmed non-detect results for all samples. Once non-detect results were received from ECBC, corresponding split samples were shipped to APPL, in Clovis, California. Biased samples submitted to APPL were analyzed for explosives and metals, in accordance with the SAP. Samples collected from the Toxic Gas Yard were also analyzed for VOCs. Background samples were analyzed for metals. All analytical data were verified prior to being released by APPL. Verification included both editorial and technical reviews. Laboratory extraction, analysis methods, and target analytes were conducted in accordance with the RI/FS work plan (USA, 2014) and as shown below in Table 4-6. In accordance with the SAP, QA laboratory sample splits were sent to Katahdin Analytical Services in Maine. Analytical results from the QA lab were sent to the USAESCH chemist.

3.3.5.2 Once finalized by the laboratories, the Parsons Project Chemist, Ms. Tammy Chang and her staff, validated all the analytical data generated during the sampling effort in accordance with the requirements identified in the work plan SAP. The validation included requirements in Department of Defense (DoD) Quality System Manual (QSM) Version 4.2, USEPA SW 846 methods. Laboratory results were assessed for compliance with required precision, accuracy, completeness, and representativeness. Field QC results were also evaluated for compliance with required precision, accuracy, and representativeness.

Based on this review, all sample data were considered usable for project decision-making purposes. Data validation reports (DVR) were generated by the Project Chemist for all data packages and are provided in Appendix B. It is noted in the DVRs that all data are usable.

3.3.6 Summary

The sample locations and rationale are presented in Table 3-3, Table 3-4, and Table 3-5 and on Figures 3.3 through Figure 3.9. Sampling, sample handling, packaging, shipping, and analyses were conducted in strict accordance with the approved SAP. Sample locations were recorded using GPS survey technology.

3.4 DEVIATIONS FROM THE WORK PLAN

The MRA at the Withlacoochee Site was investigated in accordance with the final RI/FS work plan (USA, 2014) and approved errata packages with the following exceptions:

- The Work Plan (USA, 2014) stated that wet sediment would not undergo onsite headspace-screening analysis (Section. 6.4.2.2). At the direction of the onsite USACE Safety Specialist, sediment samples were strained of excess water at the collection site using a disposable plastic strainer to obtain a sample dry enough to allow for the onsite headspace-screening analysis. This procedure was done for each of the 10 sediment samples collected.

Draining Sediment Sample

- Due to the swampy nature of the Withlacoochee Site and high water levels, some of the soil samples contained excess water that made it difficult for CARA to perform the headspace-screening analysis. Based on agreement between the USACE Safety Specialist and the CARA supervisor, such soil samples were drained by CARA personnel prior to headspace-screening analysis by tipping the sample jar and allowing the excess water to run into a second sample jar. This second jar containing the excess water was disposed of in the same manner as the original sample jars, as prescribed in the Work Plan (USA, 2014).

Sample Location WITH-CUA1-HSB-20-24-06

- Some of the proposed sample locations as indicated in the Work Plan had to be moved due to standing water or other impassable conditions. New locations were chosen to be as close to the original location as possible and as close to the same media representation as possible. A Garmin GPS handheld unit was used to obtain the coordinates of the new sample location and the new coordinates were recorded in the sample log.

Impassable Road in CUA1, August 2013

Table 3-6: Laboratory Analysis Method and Analyte List by Area

Area	Media	Analyte Group	Laboratory Extraction/Analysis Method	Analytes *
CUA1 CUA2 CUA3	Soil (Surface/Subsurface)	CA/ABPs	IOP-MT-08 and IOP-MT-57	CA=Mustard (HD), nitrogen mustard (HN-1), nitrogen mustard (HN-3), lewisite ABPs=1,4-dithiane, 1,4-thioxane, n-ethyldiethanolamine, diethanolamine, triethanolamine
		Explosives	SW8330B	1,3,5-Trinitrobenzene, '1,3-Dinitrobenzene, 2,4,6-Trinitrotoluele (TNT), 2,4-Dinitrotoluene, 2,6-Dinitrotolunene, 2-Amino-4,6-dinitrotoluene, 2-Nitrotoluene, 3-Nitrotoluene, 4-Amino-2,6-dinitrotoluene, 4-Nitrotoluene, Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), Methyl-2,4,6-trinitrophenylnitramine (Tetryl), Nitrobenzene, Nitroglycerin, Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), Pentaerythritol Tetranitrate (PETN)
		Metals	SW6010B	Antimony, Arsenic, Barium, Copper, Lead, Manganese, Nickel, Zinc
CUA1 (Toxic Gas Yard Only)	Soil (Surface/Subsurface)	Volatile Organic Compounds	SW8260B	Trichloroethylene, 1,1,2,2-tetrachloroethane, 1,2-dichloroethene (cis), 1,2-dichloroethene (trans), and vinyl chloride
Background	Soil (Surface/Subsurface) Surface Water Sediment	CA/ABPs	IOP-MT-08 and IOP-MT-57	CA=Mustard (HD), nitrogen mustard (HN-1), nitrogen mustard (HN-3), lewisite ABPs=1,4-dithiane, 1,4-thioxane, n-ethyldiethanolamine, diethanolamine, triethanolamine
		Metals	SW6010B	Antimony, Arsenic, Barium, Copper, Lead, Manganese, Nickel, Zinc

*Not all analytes were analyzed in every sample. Follow on samples were only analyzed for the analyte with an exceedance.

4.0 REVISED CONCEPTUAL SITE MODEL AND REMEDIAL INVESTIGATION RESULTS

The field activities conducted during the RI are described in Chapter 3. The results of those activities are presented in this chapter. The results consist primarily of the intrusive investigation findings and laboratory analyses of environmental samples collected at the site. Based on these results, a revised CSM is presented.

4.1 MUNITIONS AND EXPLOSIVES OF CONCERN

4.1.1 Nature and Extent of MEC Found

4.1.1.1 From the historical information about the CWS Field Trials, we understand that weapons testing was conducted in specific test areas (see subchapter 1.3). Any remaining MEC is assumed to be associated with those test areas. The approach for determining the extent of MEC for this project was based on two main steps – first, installation of transects and, second, grids.

4.1.1.2 Transects. The first step was to cross the areas interest with transects and record the geophysical anomalies in order to prepare an anomaly density map. Once the nature of the anomalies in a particular area was confirmed to be MEC or MD, the extent of the MEC and MD would be interpreted to correspond with the higher anomaly density area. Locations of the transects and data collection along the transects is discussed in Chapter 3. Figure 4.1 shows the anomaly density map for CUA1. Figure 4.2 shows the anomaly density map for CUA2 and CUA3. These maps, which also show transect locations and features interpreted from historical aerial photographs, provide generalized color contours for different levels of anomaly density based on the transects.

4.1.1.3 Grids. The second step was to select locations for grids that would be cleared, mapped with a magnetometer, have anomalies selected and reacquired, and be intrusively investigated to identify MEC and MD. The locations of the grids were selected based on the anomaly density data and on interpretation of the available historical data. Investigation of the anomalies provided information on whether a high density area was attributable to munitions and on the nature and presence of MEC or MD, where present. Figures 4.1 and 4.2 show the locations of the grids and whether the grid had UXO/CWM, MD, non-munitions debris/hot rocks, no anomalies, or was inaccessible. The 'hot rocks' term is applied for anomalies which provided a measureable magnetic response that was solely attributable to soil or rocks at that location.

4.1.1.4 The descriptions below provide a summary of the grid investigation results by test area. Six areas described below had MD or MEC findings from the intrusive investigation of anomalies. Five of the areas are located in CUA1 and one area is located in CUA2. No MEC or MD was encountered in CUA3. No significant MEC hazards were identified in any other area of the MRA.

4.1.1.5 **NP Forest –** Three grids in this area contained MD findings (CUA1-023, CUA1-024, CUA1-027). Table 4-1 provides a summary of the MD findings including the depth ranges for each grid. The grid CUA1-025 could not be intrusively investigated due to long term flooding of the grid; however, the characteristics of the anomalies recorded in that grid were consistent with those in the other three grids in this former test area. Figure 4.3 shows the area around the former NP Forest test area. As shown on the map, approximately 46 acres are covered by a relatively well-defined high anomaly density area. Also shown is the location of the NP Forest Test Area based on the hand-drawn maps from the WWII-era test reports and aerial photographs.

MD found in grid CUA1-023, June 2013

Table 4-1: NP Forest Intrusive Investigation Results

Grid ID	Intrusive Results	Depth Range (inches)
CUA1-023	10 anomalies, all MD; 3 locations - large frag, fuze parts, fuze adapters, base plate from 4.2 inch mortars; 7 locations - frag.	2 to 20
CUA1-024	10 anomalies, all MD; 2 locations – EK-4 (M74?) bomb bodies; 8 locations – frag.	1 to 13
CUA1-025	Not investigated due to flooding	-
CUA1-027	3 anomalies, all MD; 1 location – empty 500-lb bomb body; 2 locations – frag (associated with the 500-lb bomb body).	1 to 8

4.1.1.6 The munitions identified from the intrusive investigation (500-lb bombs, 4.2-inch mortars) are consistent with the historical record of the tests conducted at the NP Forest. The EK-4 10-lb chemical bomblet was not documented as having been tested at the NP Forest; however, the M74 (E5) 10-lb chemical bomblet was tested at the NP Forest and is very similar to the EK-4 bomblet and the EK-4 could easily be mistaken for the M74.

4.1.1.7 **A and B Forest** – two grids contained MD findings (CUA1-062 and, CUA1-064). Table 4-2 provides a summary of the MD findings including the depth ranges for each grid. Figure 4.4 shows the A and B Forest test areas. Based on the historical Test Area location map provided by Harold Johnston and on maps provided in the PA (USACE, 2011; Figures 64 through 67), the specific location of the B Forest test area has been identified. The area of B Forest, shown on Figure 4.4 as a square, coincided with a high anomaly density area that has been confirmed to contain MD in Grids CUA1-062 and CUA1-064. The modern wetlands boundaries coincide with the wetland boundaries show on Figure 66 of the PA. The location of A Forest test area has not been as precisely located but has been inferred based on the presence of a high anomaly density area east of B Forest (roughly at the same distance from B Forest as indicated on the Harold Johnston map) and

also is the approximate location of former dugouts, reportedly located north of the Cow Camp campground on North Grade Road. A boundary has been drawn based on the high anomaly density area based on the historical information and data gathered during the RI. The area covers approximately 74 acres. The MD encountered during the intrusive investigation consisted of frag (munitions fragmentation) that could not be positively identified for type of munition.

MD found in grid CUA1-064, May 2013

Table 4-2: A and B Forests Intrusive Investigation Results

Grid ID	Intrusive Results	Depth Range (inches)
CUA1-062	10 anomalies, 4 MD; 4 locations - frag.	1 to 9
CUA1-064	10 anomalies, 9 MD; 9 locations - frag.	3 to 14

4.1.1.8 **D Meadow** - two grids contained MD findings (CUA1-007 and CUA1-008). Table 4-3 provides a summary of the MD findings including the depth ranges for each grid. Figure 4.5 shows the D Meadow test area. A boundary has been drawn around area of the grids and high anomaly density area, which totals 14 acres. The MD from 4.2-inch mortars found in this test area is consistent with the historical documentation which shows these mortars as the predominant munition tested there.

MD found in grid CUA1-007, July 2013

Table 4-3: D Meadow Intrusive Investigation Results

Grid ID	Intrusive Results	Depth Range (inches)
CUA1-007	3 anomalies, 1 MD; 1 location – frag.	5
CUA1-008	8 anomalies, all MD; 8 locations – 4.2-inch mortar base plate and frag.	4 to 13

4.1.1.9 **F Meadow** - six grids contained MD findings (CUA1-034, CUA1-035, CUA1-036, CUA1-037, CUA1-038, and CUA1-100). Table 4-4 provides a summary of the CWM and MD findings including the depth ranges for each grid. Figure 4.6 shows the F Meadow test area. A boundary has been drawn around area of the grids and a relatively well-defined high anomaly density area, which totals 61 acres. The munitions found in this area (EK-4

10-lb chemical bomblets, 4.2-inch mortars) are consistent with the historical tested reported for the area.

Table 4-4: F Meadow Intrusive Investigation Results

Grid ID	Intrusive Results	Depth Range (inches)
CUA1-034	10 anomalies, all MD; 10 locations – base plates, tail booms, fuze adapters and frag from 4.2-inch mortars	1 to 8
CUA1-035	10 anomalies, all MD; 10 locations – base plates, tail booms, fuze adapters, and frag from 4.2-inch mortars	1 to 16
CUA1-036	10 anomalies, 4 MD; 4 locations – fuze parts and frag from 4.2-inch mortars	4 to 12
CUA1-037	10 anomalies, 1 CWM, 7 MD; 1 location – unexploded liquid-filled EK-4 10-lb chemical bomblet (CWM); 7 locations – half shells, base plates, fuze adapters, and frag from 4.2-inch mortars	14 (CWM), 2 to 12 (MD)
CUA1-038	10 anomalies, all MD; 10 locations – base plates, fuze adapters, and frag from 4.2-inch mortars.	1 to 8
CUA1-100	10 anomalies, all MD; 10 locations – base plates, fuze adapters, fuze adapter rings, and frag from 4.2-inch mortars	2 to 12

4.1.1.10 **ATG Range** – one grid (CUA1-075) contained MD findings. This grid is located within a high anom-aly density area south of the Florida Bass Conservation Center. The area corre-sponds to the dive bombing and rocket firing target identified in the PA and in the 2005 HPA. Table 4-5 provides a summary of the MD findings including the depth ranges for the one grid. Figure 4.7 shows the ATG range area. A bound-ary has been drawn around area of the grid and high anomaly density area, which totals 35 acres. The only type of MD encountered was identified as from AN-M47 100-lb bombs.

MD found in Grid CUA1-075, June 2013

Table 4-5: ATG Range Intrusive Investigation Results

Grid ID	Intrusive Results	Depth Range (inches)
CUA1-075	5 anomalies, 2 MD; 2 locations – burster tube, nose fuze, and frag from AN-M47 100-lb bombs	36 to 40

4.1.1.11 **G Forest –** in CUA2, two grids (CUA2-006 and CUA2-014) contained MD find-ings. Table 4-6 provides a summary of the UXO and MD findings including the depth ranges for each grid. Grid CUA2-014 was the location where MD was found at the surface during the brush clearing of transects. Figure 4.8 shows the G Forest area. The area does not have a high anomaly density so a boundary has been drawn based on the typical test area size (19 acres). The identifiable MD was from EK-4 10-lb chemical bomblets, which were documented as having been statically fired at the test area.

UXO found in grid CUA2-006, August 2013

Table 4-6: G Forest Intrusive Investigation Results

Grid ID	Intrusive Results	Depth Range (inches)
CUA2-006	10 anomalies, 1 UXO, 9 MD; 1 location – EK4 bomb with burster, no liquid filler (UXO); 9 loca-tions – bomb bodies, brackets, dispensers from EK-4 bombs.	1 to 16
CUA2-014	7 anomalies, all MD; 7 locations – fuze, nose cap, banding strap, and frag from EK-4 bombs	1 to 10

4.1.1.12 The other test areas identified from historical maps did not have high anomaly densities and no significant MEC hazard was identified. Table 4–7 provides a summary of the investigation results for the other historical test areas.

Table 4-7: Historical Test Areas with No MEC Hazard Identified

Area	Historical Test Area	Historical Usage[1]	Results
CUA1	A Meadow	Tests – 16; Bomb drops, static firing, aerial spraying	Low anomaly density area; 1 grid - no anomalies
	B Meadow	Tests – 20; Bomb drops, static firing	Low anomaly density area; no grids
	C Meadow	Tests – 3; Pouring agent on ground	Low anomaly density area; no grids

Table 4-7: Historical Test Areas with No MEC Hazard Identified

Area	Historical Test Area	Historical Usage[1]	Results
	G Meadow	Tests – 2; Static firing only	Area not identified
	C Forest	Tests – 5; Bomb drops, static firing	Low anomaly density area, 1 grid – no anomalies
	D Forest	Tests – 7; Bomb drops, static firing	Low anomaly density area; 2 grids – no MD
	E Forest	Tests – 3; Bomb drops, static firing	Low anomaly density area; 2 grids – CUA1-061 – MD (frag in tree and piece of rust)
CUA3	E Meadow	Tests – 1; Static firing only	Low density area

[1]See Table 1-2 for more details of historical munitions testing.

4.1.1.13 The E Forest test area can potentially be associated with the MD found in CUA1-061, which consisted of a piece of fragmentation in a tree (near the ground) and a close-by piece of rust. Historical records for E Forest test area show that only three tests were conducted. One test was set up as a static firing of 13 M70 but only one bomb fired. The test was conducted again two days later with a new bomb added to replace the one that fired and this time all 13 bombs detonated. The third test consisted of dropping two M70 bombs from a height of 1,000 feet, for which the test reports indicate the bombs detonated. Thus, only a small number of bombs were tested in this area, which corresponds well with the relatively low anomaly density, and all of the bombs detonated for all of the known tests.

4.1.1.14 An overview of the six test sights mentioned in the preceeding paragraphs are presented in Figure 4-9. Together, these areas are simply referred to as the "Test Areas".

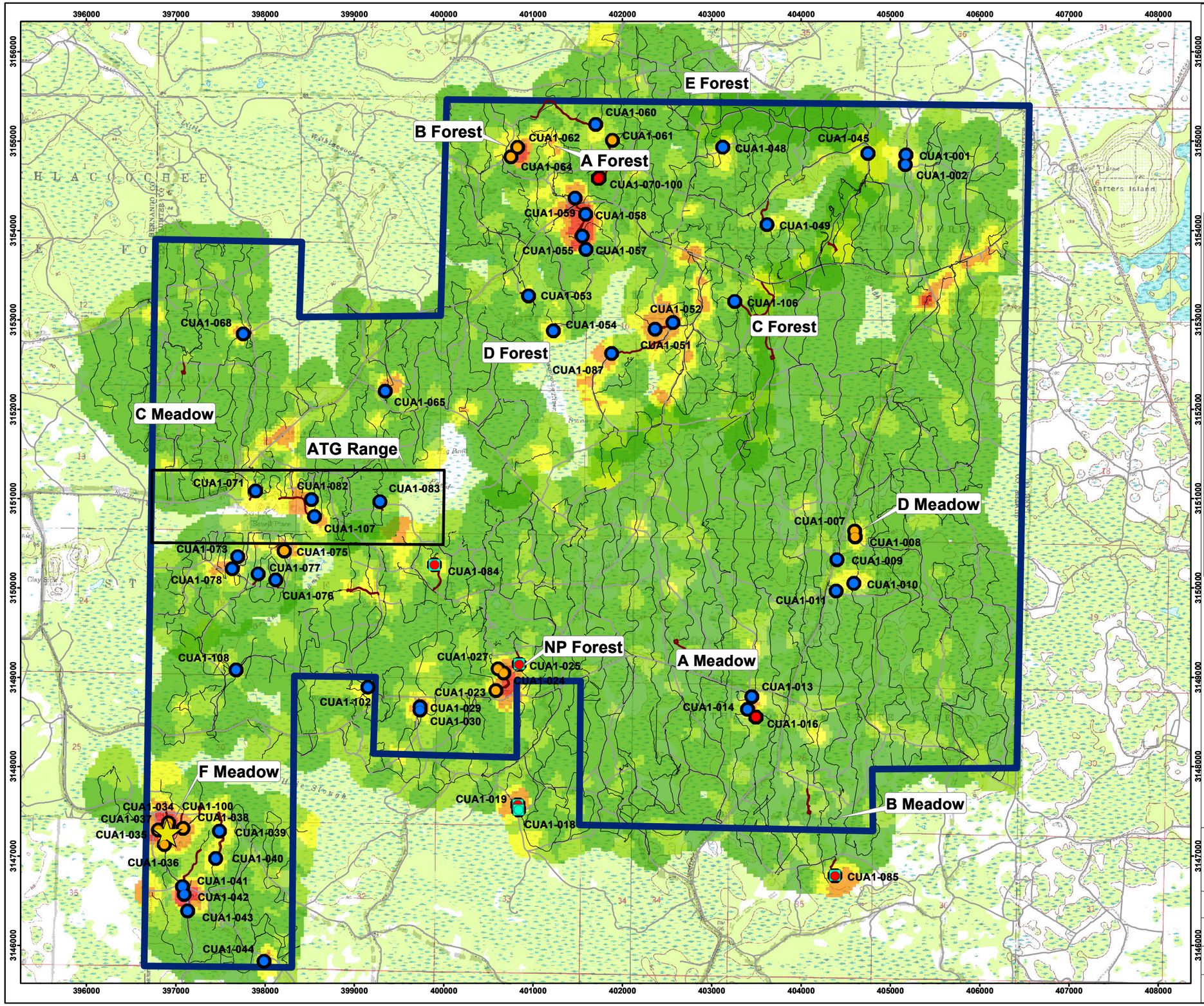

Figure 4.1

CUA #1
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- Grid - Digs Completed - CWM/MEC
- Grid - Digs Completed - MD
- Grid - Digs Completed - No Munitions
- Grid - Grid - Not Investigated
- Grid - Inaccessible due to Flooding
- DGM Transects
- Forest Roads
- MRS Boundary
- Air-to-Ground Bombing and Gunnery Range

Anomaly Density per Acre

- 1,000 - 2,500
- 550 - 1,000
- 255 - 550
- 70 - 255
- 0 - 70

Note: Color shading shows relative anomaly density.

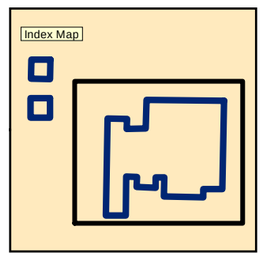

Image: USGS 7.5' Topo Quadrangles, Date Unknown.
Projection: UTM Zone 17 NAD83, Map Units in Meters

1,000 500 0 1,000 Meters

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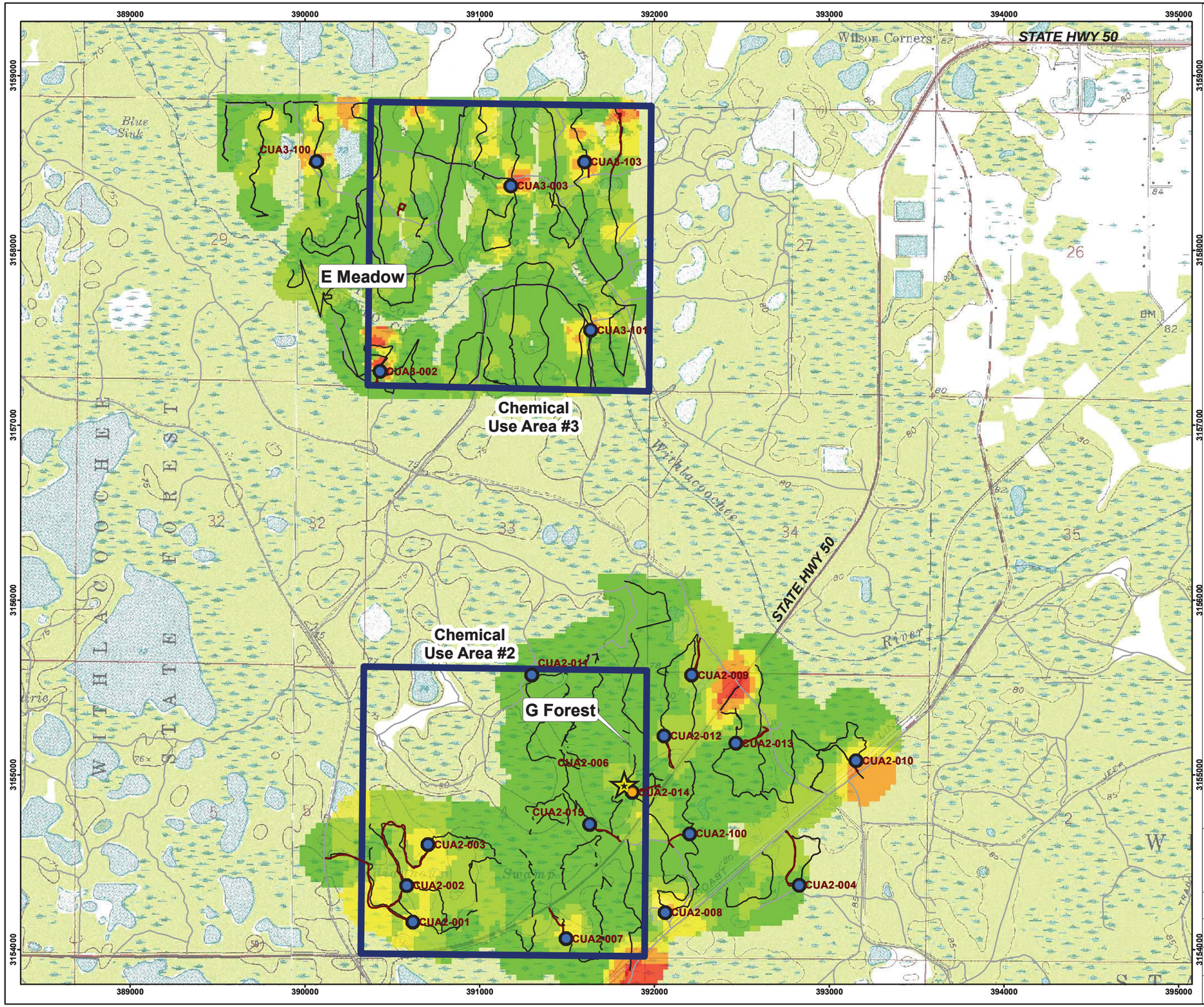

Figure 4.2

CUA #2 and CUA #3
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- Grid - Digs Completed - CWM/MEC
- Grid - Digs Completed - MD
- Grid - Digs Completed - No Munitions
- DGM Transects
- Forest Roads
- MRS Boundary

Anomaly Density per Acre

- 1,000 - 2,500
- 550 - 1,000
- 255 - 550
- 70 - 255
- 0 - 70

Note: Color shading shows relative anomaly density.

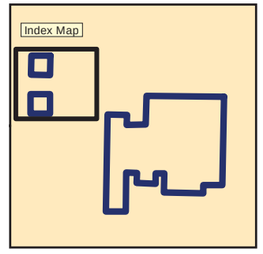

Image: USGS 7.5' Topo Quadrangles, Date Unknown.
Projection: UTM Zone 17 NAD83, Map Units in Meters

500 250 0 500 Meters

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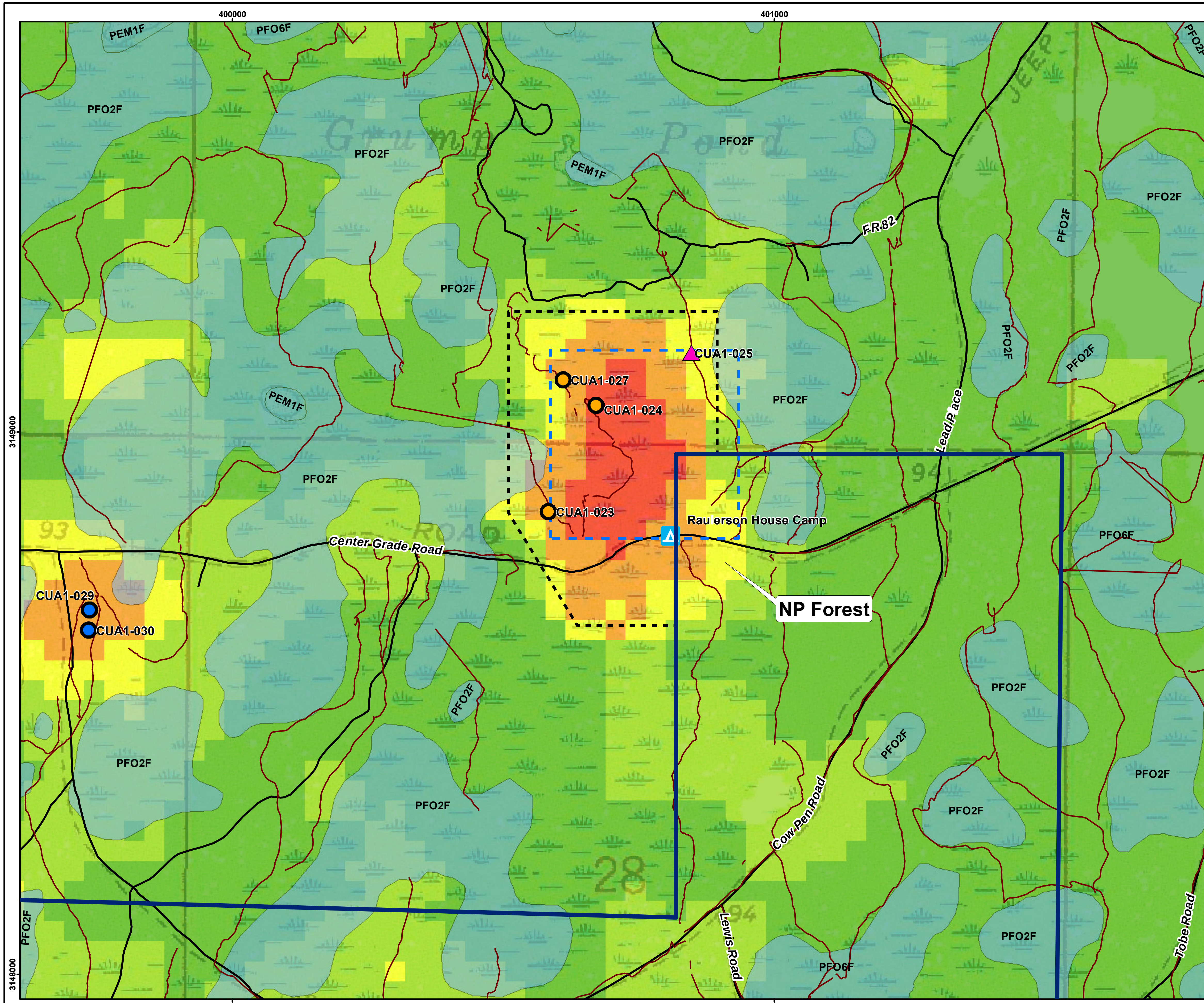


Figure 4.3
NP Forest
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- Grid - Digs Completed – MD
- Grid - Digs Completed – No Munitions
- Grid - Inaccessible Due to Flooding
- Hunt Camp
- DGM Transects
- Forest Roads
- Approximate Location of NP Forest Test Area Based on Aerial Photos
- Estimated Extent of MEC Contamination (46 Acres)
- MRS Boundary

Anomaly Density per Acre

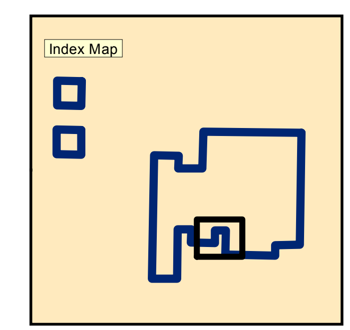
- 1,000 - 2,500
- 550 - 1,000
- 255 - 550
- 70 - 255
- 0 - 70

Note: Color shading shows relative anomaly density.

- Wetland (Obtained from U.S. Fish & Wildlife Service)

Predominant Wetland Type:

PUBH - Palustrine, unconsolidated bottom, permanently flooded,
PAB3H - Palustrine, aquatic bed, permanently flooded,
PFO2/6F - Palustrine, forested, semipermanently flooded
PEM1F - Palustrine, emergent, persistent, semipermanently flooded.
PSS1/6F - Palustrine, scrub shrub, semipermanently flooded.



Projection: UTM Zone 17 NAD83, Map Units in Meters

200 100 0 200 Meters

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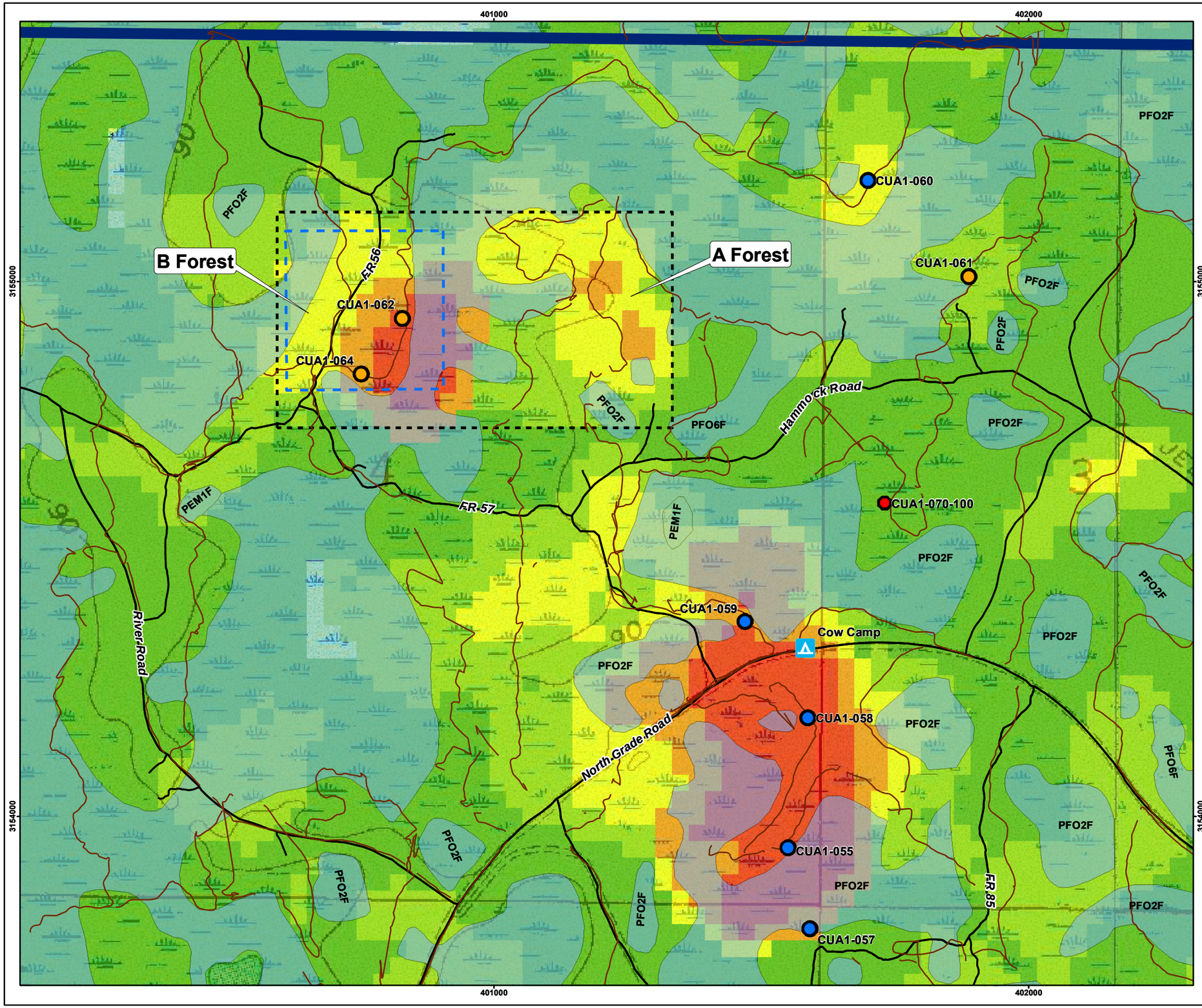
Figure 4.4

A and B Forests
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida



Legend

- Grid - Digs Completed – MD
- Grid - Digs Completed – No Munitions
- Grid - Digs Not Completed, No Anomalies
- Hunt Camp
- DGM Transects
- Forest Roads
- Approximate Location of B Forest based on Historical Maps
- Estimated Extent of MEC Contamination (74 Acres)
- MRS Boundary

Anomaly Density per Acre

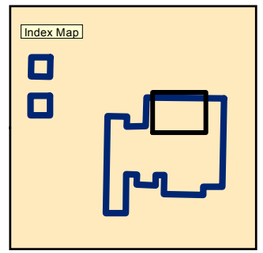
- 1,000 - 2,500
- 550 - 1,000
- 255 - 550
- 70 - 255
- 0 - 70

Note: Color shading shows relative anomaly density.

Wetland (Obtained from U.S. Fish & Wildlife Service)

Predominant Wetland Type:

PUBH - Palustrine, unconsolidated bottom, permanently flooded,
PAB3H - Palustrine, aquatic bed, permanently flooded,
PFO2/6F - Palustrine, forested, semipermanently flooded
PEM1F - Palustrine, emergent, persistent, semipermanently flooded.
PSS1/6F - Palustrine, scrub shrub, semipermanently flooded.



N

Projection: UTM Zone 17 NAD83, Map Units in Meters

200 100 0 200 Meters

USA Environmental	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	A and B Forests		
DRAWN BY: BT			
CHECKED BY: IG	SCALE: As Shown	PROJECT NUMBER: 747826.05000	
SUBMITTED BY: JC	DATE: October 2014	PAGE NUMBER: 4-10	
	FILE: X:\CWM_GIS\GIS\MAPS\Withlacoochee_FL\RI-FS\RI_Report		

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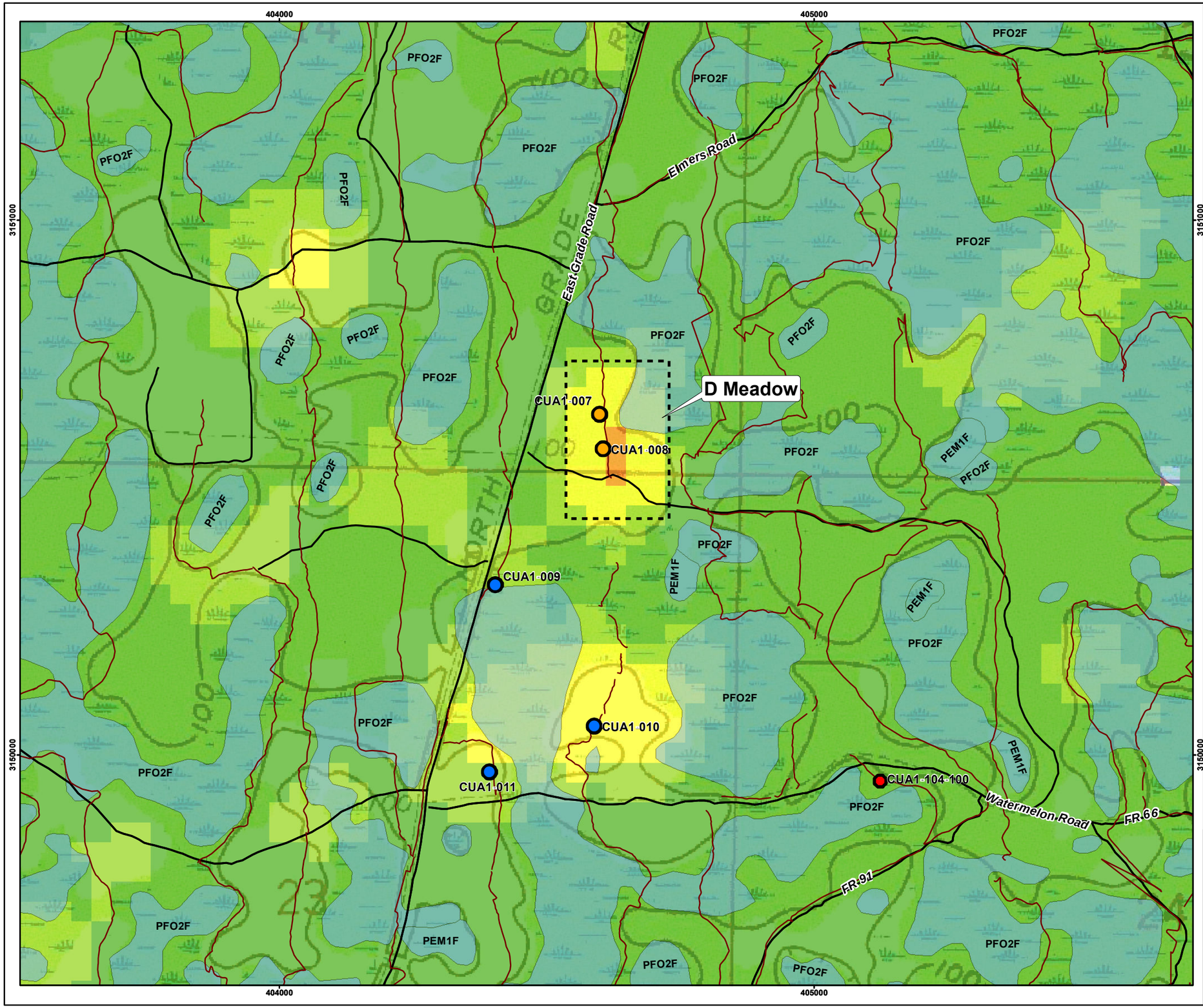


Figure 4.5

D Meadow
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- Grid - Digs Completed – MD
- Grid - Digs Completed – Cultural Debris / Hot Rocks
- Grid - Digs Not Completed, No Anomalies
- DGM Transects
- Forest Roads
- Estimated Extent of MEC Contamination (14 Acres)
- MRS Boundary

Anomaly Density per Acre

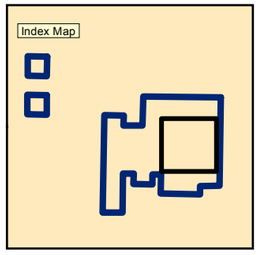
- 1,000 - 2,500
- 550 - 1,000
- 255 - 550
- 70 - 255
- 0 - 70

Note: Color shading shows relative anomaly density.

- Wetland (Obtained from U.S. Fish & Wildlife Service)

Predominant Wetland Type:

PUBH - Palustrine, unconsolidated bottom, permanently flooded,
PAB3H - Palustrine, aquatic bed, permanently flooded,
PFO2/6F - Palustrine, forested, semipermanently flooded
PEM1F - Palustrine, emergent, persistent, semipermanently flooded.
PSS1/6F - Palustrine, scrub shrub, semipermanently flooded.



N

Projection: UTM Zone 17 NAD83, Map Units in Meters

200 100 0 200 Meters

USA Environmental	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	D Meadow		
DRAWN BY: BT			
CHECKED BY: JC	SCALE: As Shown	PROJECT NUMBER: 747826.05000	
SUBMITTED BY: JC	DATE: October 2014	PAGE NUMBER: 4-11	
	FILE: X:\CWM_GIS\GIS\MAPS\Withlacoochee_FL\RI-FS\RI_Report		

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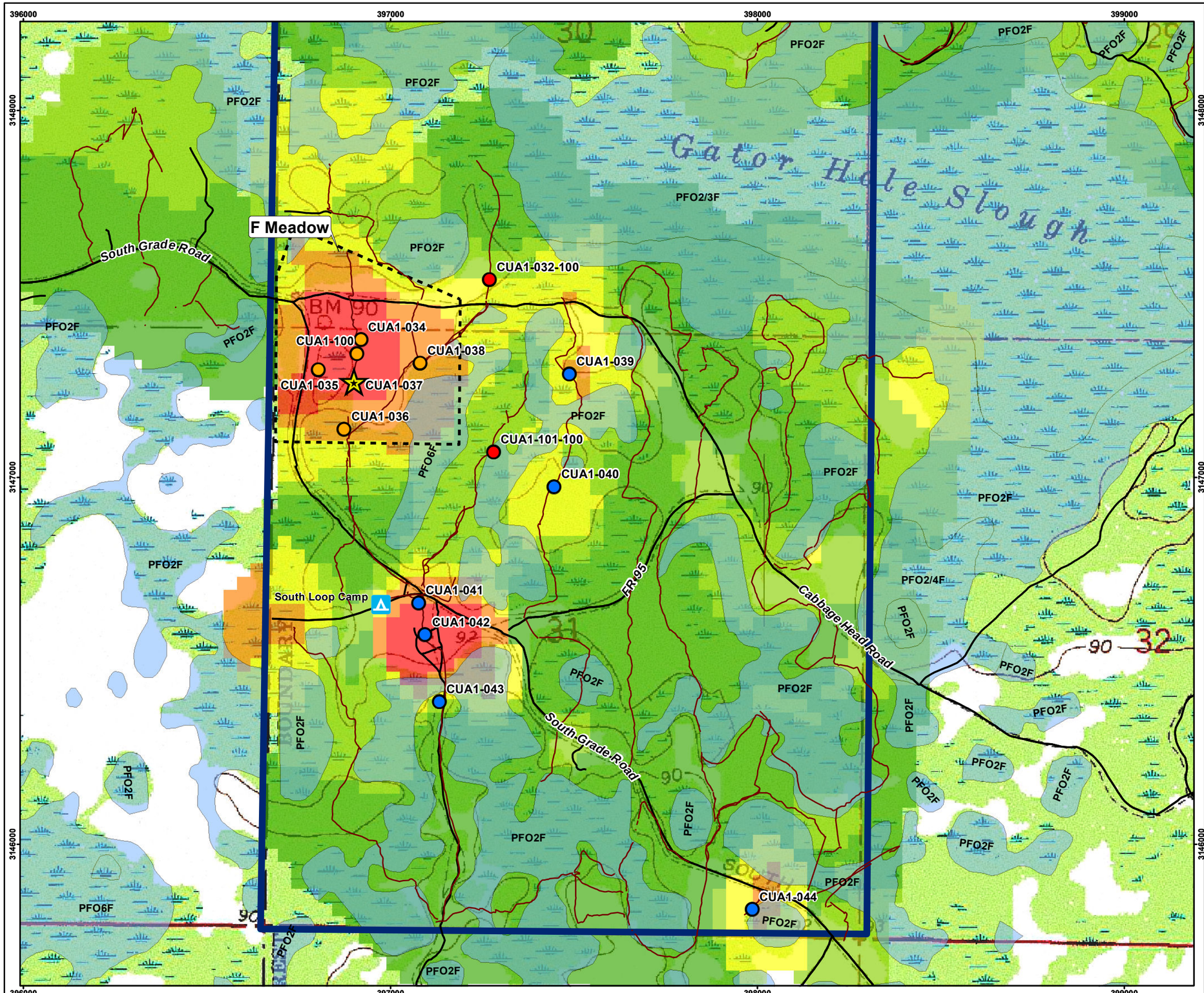
Figure 4.6
F Meadow
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida



Legend

- Grids - Digs Completed – CWM/MEC
- Grids - Digs Completed – MD
- Grids - Digs Completed – No Munitions
- Grids - Digs Not Completed - No Anomalies
- Hunt Camp
- DGM Transects
- Forest Roads
- MRS Boundary
- Estimated Extent of MEC Contamination (61 Acres)

Anomaly Density per Acre

- 1,000 - 2,500
- 550 - 1,000
- 255 - 550
- 70 - 255
- 0 - 70

Note: Color shading shows relative anomaly density.

Wetland (Obtained from U.S. Fish & Wildlife Service)

Predominant Wetland Type:

PUBH - Palustrine, unconsolidated bottom, permanently flooded,
PAB3H - Palustrine, aquatic bed, permanently flooded,
PFO2/6F - Palustrine, forested, semipermanently flooded
PEM1F - Palustrine, emergent, persistent, semipermanently flooded.
PSS1/6F - Palustrine, scrub shrub, semipermanently flooded.

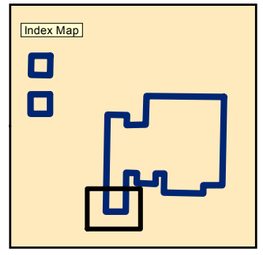


Image: USGS 7.5' Topo Quadrangles, Date Unknown.
Projection: UTM Zone 17 NAD83, Map Units in Meters

300 150 0 300 Meters

N

USA Environmental	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	F Meadow		
DRAWN BY: BT			
CHECKED BY: JY	SCALE: As Shown	PROJECT NUMBER: 747826.05000	
SUBMITTED BY: JC	DATE: October 2014	PAGE NUMBER: 4-12	
	FILE: X:\CWM_GIS\GIS\MAPS\Withlacoochee_FL\RI-FS\RI_Report		

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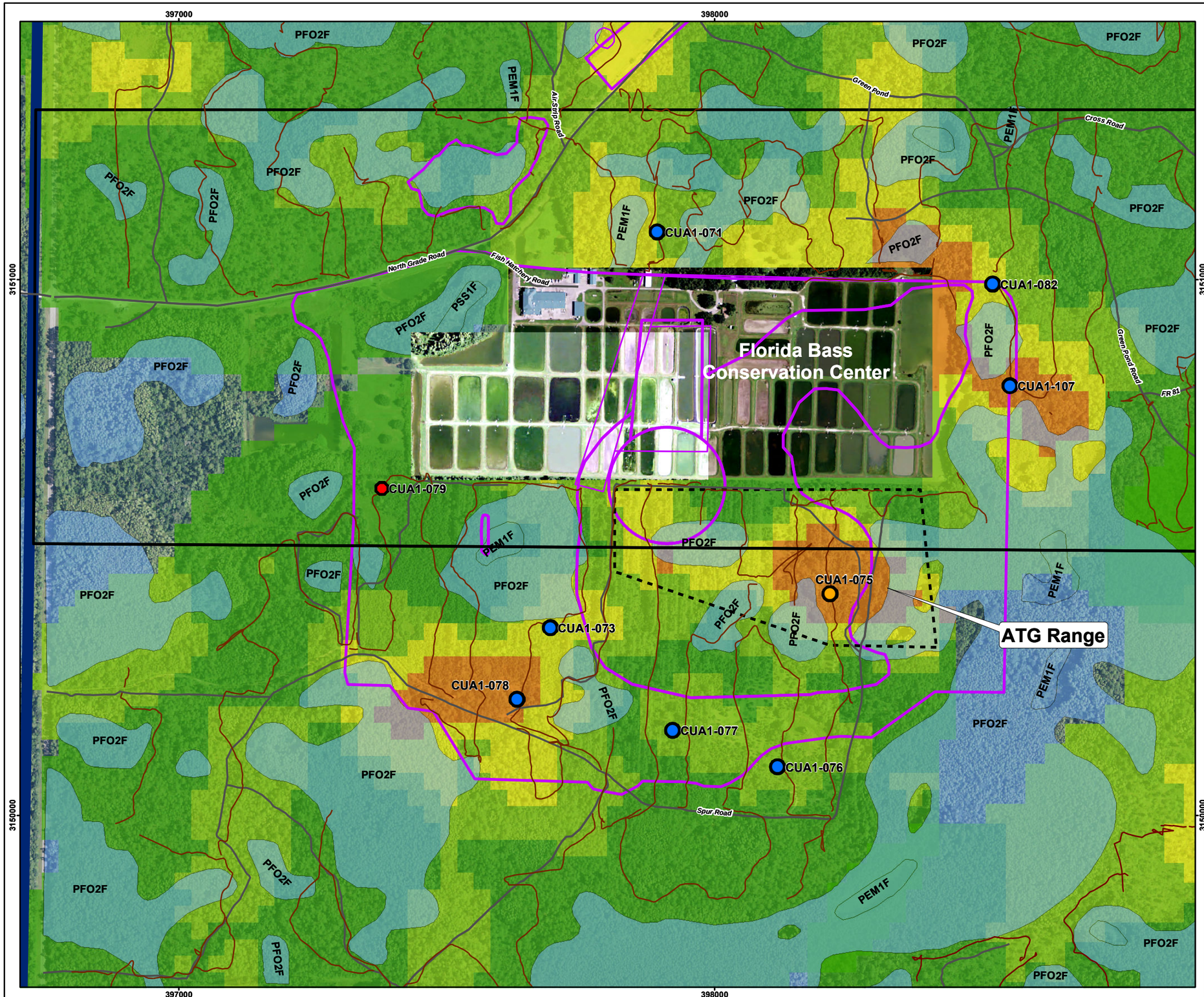
Figure 4.7
ATG Range
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida



Legend

- Grids - Digs Completed – MD
- Grids - Digs Completed – No Munitions
- Grids - Digs Not Completed, No Anomalies
- DGM Transects
- Forest Roads
- MRS Boundary
- Air-to-Ground Bombing and Gunnery Range
- TEC Features
- Estimated Extent of MEC Contamination (35 Acres)

Anomaly Density per Acre

- 1,000 - 2,500
- 550 - 1,000
- 255 - 550
- 70 - 255
- 0 - 70

Note: Color shading shows relative anomaly density.

- Wetland (Obtained from U.S. Fish & Wildlife Service)

Predominant Wetland Type:

PUBH - Palustrine, unconsolidated bottom, permanently flooded,
PAB3H - Palustrine, aquatic bed, permanently flooded,
PFO2/6F - Palustrine, forested, semipermanently flooded
PEM1F - Palustrine, emergent, persistent, semipermanently flooded.
PSS1/6F - Palustrine, scrub shrub, semipermanently flooded.

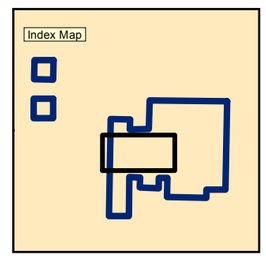


Image: 2013 Orthophoto
Projection: UTM Zone 17 NAD83, Map Units in Meters

200 100 0 200 Meters

N

USA Environmental	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	ATG Range		
DRAWN BY: BT			
CHECKED BY: JC	SCALE: As Shown	PROJECT NUMBER: 747826.05000	
SUBMITTED BY: JC	DATE: October 2014	PAGE NUMBER: 4-13	
	FILE: X:\CWM_GIS\GIS\MAPS\Withlacoochee_FL\RI-FS\RI_Report		

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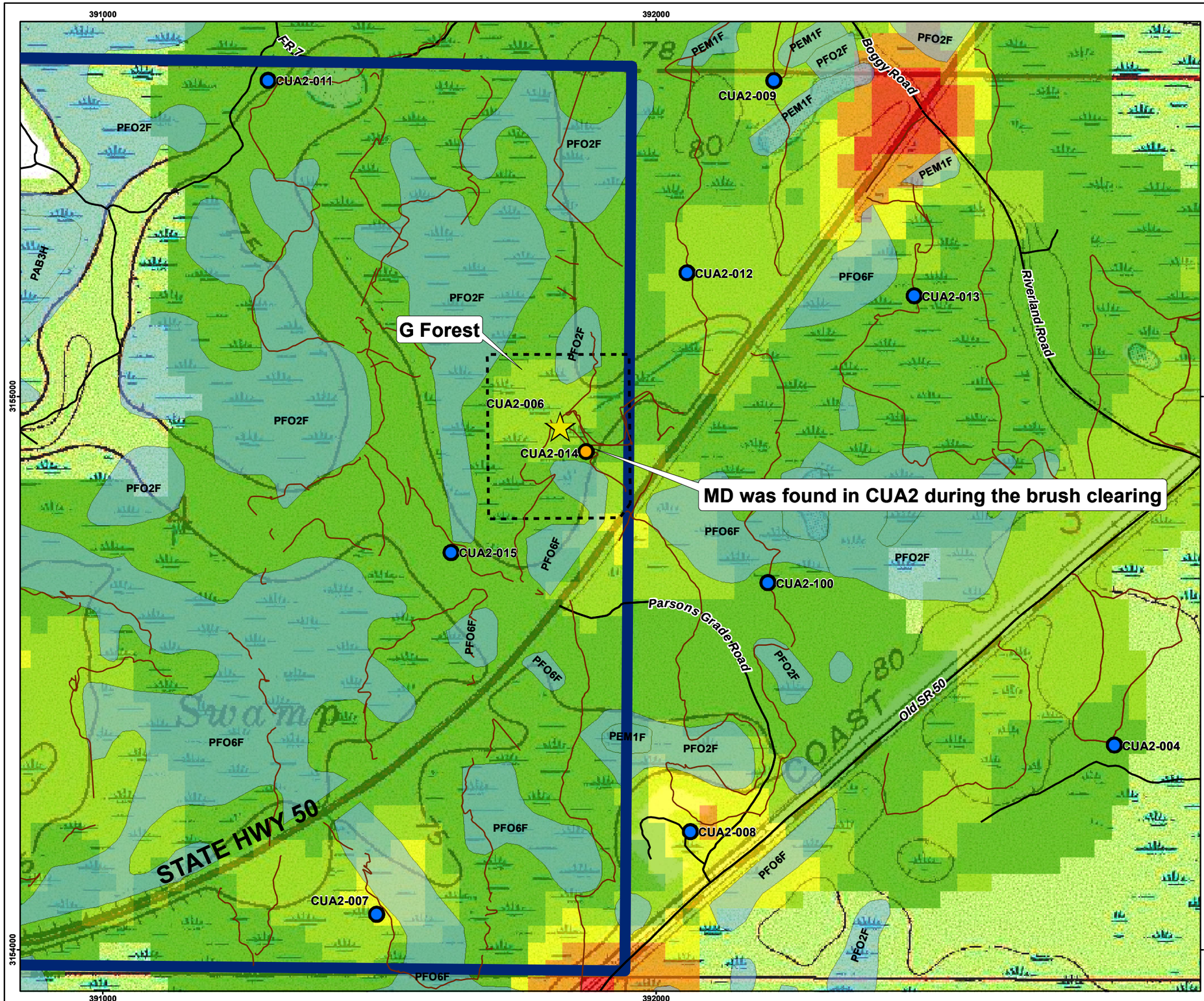


Figure 4.8
G Forest
Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend

- Grids - Digs Completed – CWM/MEC
- Grids - Digs Completed – MD
- Grids - Digs Completed –No Munitions
- DGM Transects
- Forest Roads
- Estimated Extent of MEC Contamination (19 Acres)
- MRS Boundary

Anomaly Density per Acre

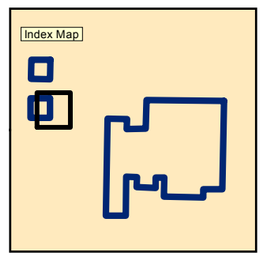
- 1,000 - 2,500
- 550 - 1,000
- 255 - 550
- 70 - 255
- 0 - 70

Note: Color shading shows relative anomaly density.

- Wetland (Obtained from U.S. Fish & Wildlife Service)

Predominant Wetland Type:

PUBH - Palustrine, unconsolidated bottom, permanently flooded,
PAB3H - Palustrine, aquatic bed, permanently flooded,
PFO2/6F - Palustrine, forested, semipermanently flooded
PEM1F - Palustrine, emergent, persistent, semipermanently flooded.
PSS1/6F - Palustrine, scrub shrub, semipermanently flooded.



N

Projection: UTM Zone 17 NAD83, Map Units in Meters

200 100 0 200 Meters

USA Environmental	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	G Forest		
DRAWN BY: BT			
CHECKED BY: KR	SCALE: As Shown	PROJECT NUMBER: 747826.05000	
SUBMITTED BY: JC	DATE: October 2014	PAGE NUMBER: 4-14	
	FILE: X:\CWM_GIS\GIS\MAPS\Withlacoochee_FL\RI-FS\RI_Report		

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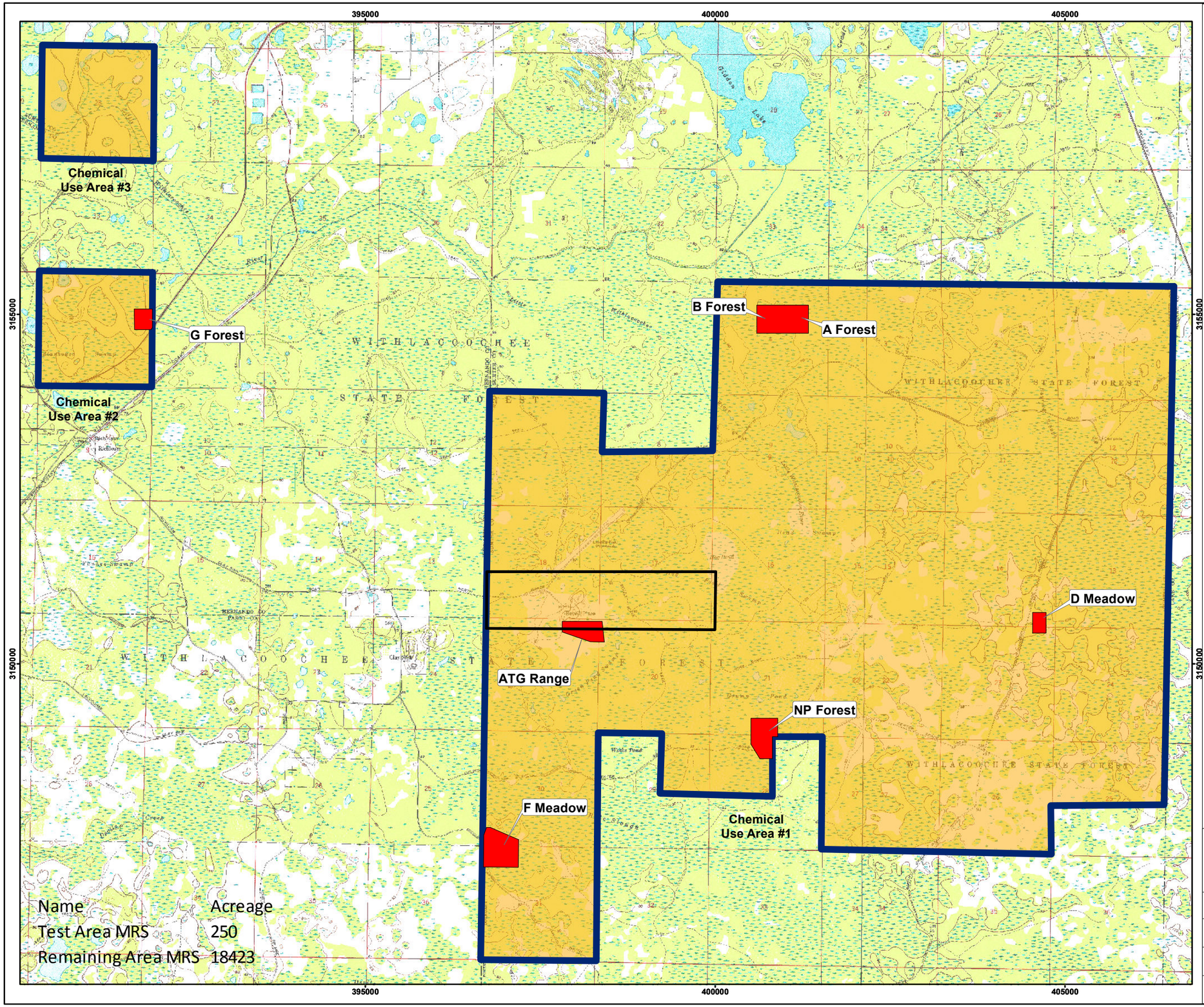

Figure 4.9

Remaining Lands MRS and
the Test Areas MRS
Withlacoochee CWS Field Trials and
ATG Bombing and Gunnery Range
Sumter and Hernando Counties, Florida

Legend
- Test Area MRS
- Remaining Area MRS
- Air-to-Ground Bombing and Gunnery Range
- MRA Boundary

Image: USGS 7.5' Topo Quadrangles, Date Unknown.
Projection: UTM Zone 17 NAD83, Map Units in Meters
1,000 500 0 1,000 Meters

N

USA Environmental	U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER

DESIGNED BY: BT	Withlacoochee CWS Field Trials and ATG Bombing and Gunnery Range	
DRAWN BY: BT		
CHECKED BY: DS	SCALE: As Shown	PROJECT NUMBER: 640138.0002.747826.06000.L&BOR
SUBMITTED BY: JC	DATE: March 2015	PAGE NUMBER:
	FILE: X:\CWM_GIS\GIS\MAPS\Withlacoochee_FL\RI-FS\RI_report	

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4.2 MUNITIONS CONSTITUENTS

4.2.1 Munitions Constituent Sampling Results

During the RI, a total of 165 biased soil samples were collected, excluding FD and QA samples, to verify the presence or absence and to determine the nature and extent of potential MC contamination (CA, ABPs, explosives, metals, and VOCs) at the Withlacoochee Site. The sampling strategy and methodology for the RI at the former Withlacoochee Site is presented in Subchapter 4.3. The rationale for the collection of the discrete (grab) soil samples, and the reason for their locations are summarized in Chapter 3, and sample locations are presented in Figures 3.3 through 3.9. The laboratory analytical results for the soil samples collected during the RI are presented in Appendix B.

4.2.2 Identification of Chemicals of Potential Concern

4.2.2.1 Overview

4.2.2.1.1 The primary objective of the RI with regard to MC was to first determine if there was evidence of a release of CA/ABPs, explosives, select metals, or VOCs in the Toxic Gas Yard to the environment (i.e., to identify Chemicals of Potential Concern [COPCs]) and then to characterize the nature and extent of any COPCs found to be present at the Withlacoochee Site resulting from past military use of the site. The data obtained during the RI were used in the risk assessment (see Chapter 6) to assess whether COPCs are present at sufficient concentrations to pose a risk to human health and the environment and, therefore, should be considered to be chemicals of concern (COCs) requiring remedial action. The intent of this characterization was to determine if there is a need for remedial response due to MC and, if so, to provide the required information for the development and evaluation of any necessary response alternatives. The MC sampling program achieved the sampling and analysis requirements of the WP (USA, 2014) for this project.

4.2.2.1.2 For an analyte to be considered as a possible human health concern related to a release from munitions activities, the following conditions must be true:

- The analyte is detected in the sample medium;
- The analyte is a potential constituent of the munitions formerly used at the MRA; and
- The analyte is present above the Preliminary Screening Value (PSV).

4.2.2.1.3 For purposes of this RI, those analytes detected at concentrations greater than the preliminary screening values (PSVs) and background values that have been selected will be considered COPCs. Background samples were analyzed for CA/ABPs and select MC metals. Explosives in soil are not naturally occurring and were not compared to a background value. The PSVs are described further in Subchapter 4.2.2.2.

4.2.2.2 Preliminary Screening Values (PSVs)

4.2.2.2.1 For this RI, PSVs based on selected human health screening values are used to evaluate the potential presence of CA/ABPs, explosives, metals, and VOCs in soil. Any

MC detected at concentrations above its respective PSV and background value was considered to be a COPC and was retained for further consideration in the risk assessment in Chapter 6.

4.2.2.2.2 In accordance with the Final TPP Memorandum and the Final Work Plan (USA, 2014), the human health soil screening levels used to determine PSVs are the FDEP FAC 62-777 Soil Cleanup Target Levels (FDEP, 2005), the lower of the direct exposure residential and leachability based on freshwater surface water criteria and leachability based on groundwater criteria. If no FDEP value was available, the USEPA Regional Screening Levels (RSLs) for Residential Soil were used, supplemented with the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) values. There are no FDEP published screening levels for CA/ABPs. PSVs for soil are presented in Table 4-8. The USEPA Regional Screening Levels were updated in November 2013 and Table 4-8 reflects the updated values.

4.2.2.2.3 Background values were calculated using analytical results from the background samples collected for surface and subsurface soil. One background field duplicate sample was collected. The maximum result of the field duplicate sample and the parent sample was used in calculating the background value. The background value for each metal was based on the 95% upper prediction limit (UPL), as calculated using ProUCL Version 5.0. ProUCL considers data distribution and the percentage of non-detects to determine the most appropriate method for calculating a UPL. Tables 4-9a and 4-9b present the calculated 95% UPLs, the data distribution (normal vs. not normal) and the ProUCL calculation method used to determine the UPL. The selected background value is the calculated UPL, unless there were not a sufficient number of detected samples to calculate a reliable UPL. In that case, the maximum detected value was used. If there were no detected concentrations, no background value is provided. Appendix I provides the ProUCL output files.

Table 4-8: Preliminary Screening Values for Soil Samples, Withlacoochee Site

Analyte	CAS #	Human Health Screening Values (mg/kg) [1]			
		Florida Administrative Code 62-777 [2]			
		Direct Exposure Residential	Leachability Based on Freshwater Surface Water Criteria	Leachability Based on Groundwater Criteria	USEPA RSLs for Residential Soil [3]
Total Metals – SW6010B/6020					
Antimony	7440-36-0	27	3,900	**5.4**	31
Arsenic	7440-38-2	**2.1**	--	--	0.61
Barium	7440-39-3	**120**	--	1,600	15,000
Copper	7440-50-8	**150**	--	--	3,100
Lead	7439-92-1	**400**	--	--	400
Manganese	7439-96-5	**3,500**	--	--	1,800
Nickel	7440-02-0	340	--	**130**	1,500
Zinc	7440-66-6	**26,000**	--	--	23,000
Explosives – SW8321A					
1,3,5-Trinitrobenzene	99-35-4	2000	**0.09**	1.0	2,200
1,3-Dinitrobenzene	99-65-0	5.8	0.4	**0.004**	6.1
2,4,6-Trinitrotoluene	118-96-7	28	0.3	**0.006**	19
2,4-Dinitrotoluene	121-14-2	1.2	0.070	**0.0004**	1.6
2,6-Dinitrotoluene	606-20-2	1.2	0.005	**0.0004**	61
2-Amino-4,6-dinitrotoluene	35572-78-2	--	--	--	**150**
2-Nitrotoluene (o-nitrotoluene)	88-72-2	400	7.3	**0.9**	2.9
3-Nitrotoluene (m-nitrotoluene)	99-08-1	640	3.6	**1.4**	6.1
4-Amino-2,6-dinitrotoluene	19406-51-0	--	--	--	**150**
4-Nitrotoluene (p-nitrotoluene)	99-99-0	750	7.3	**0.9**	30
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	7.7	1.3	**0.002**	5.5

Table 4-8: Preliminary Screening Values for Soil Samples, Withlacoochee Site

Analyte	CAS #	Human Health Screening Values (mg/kg) [1]			
		Florida Administrative Code 62-777 [2]			
		Direct Exposure Residential	Leachability Based on Freshwater Surface Water Criteria	Leachability Based on Groundwater Criteria	USEPA RSLs for Residential Soil [3]
Methyl-2,4,6-trinitrophenylnitramine	479-45-8	790	NA	**1.4**	240
Nitrobenzene	98-95-3	18	0.6	**0.02**	4.8
Nitroglycerin	55-63-0	27	NA	**0.03**	6.1
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazo-cine	2691-41-0	--	--	--	**3,800**
Pentaerythritol Tetranitrate	78-11-5	--	--	--	**120**
VOCs					
Trichloroethylene	79-01-6	6.4	0.9	**0.03**	2.8
1,1,2,2-tetrachloroethane	79-34-5	0.7	0.08	**0.001**	0.56
1,2-dichloroethene (cis)	156-59-2	33	--	**0.4**	160
1,2-dichloroethene (trans)	156-60-5	53	75	**0.7**	150
Vinyl Chloride	75-01-4	0.2	0.02	**0.007**	0.06
CA/ABPs					
Lewisite	541-25-3	--	--	--	**0.3** [4]
Mustard (HD)	505-60-2	--	--	--	**0.01** [4]
Nitrogen Mustard (HN-1 and HN-3)	538-07-8 (HN1) 51-75-2 (HN-2) 555-77-1 (HN-3)	--	--	--	**0.1** [5]
1,4-Dithiane	505-29-3	--	--	--	**610**

Table 4-8: Preliminary Screening Values for Soil Samples, Withlacoochee Site

Analyte	CAS #	Human Health Screening Values (mg/kg) [1]			
		Florida Administrative Code 62-777 [2]			
		Direct Exposure Residential	Leachability Based on Freshwater Surface Water Criteria	Leachability Based on Groundwater Criteria	USEPA RSLs for Residential Soil [3]
1,4-Thioxane	15980-15-1	--	--	--	**610** [6]
N-Ethyldiethanolamine	139.87-7	--	--	--	**0.13** [5]
Diethanolamine	111-42-2	--	--	--	**120**
Triethanolamine	7376-31-0	--	--	--	**0.13** [5]

Notes:
(1) **The selected comparison value is shown in Bold**. Used FDEP FAC 62-777 Soil Cleanup Target Levels (more stringent of the direct exposure residential and leachability based on freshwater surface water criteria and leachability based on groundwater criteria), February 2005. If FDEP SCTL values were not available, the USEPA RSLs for Chemical Contaminants at Superfund Sites for Residential Soil, Nov. 2013, was used.
(2) Florida Administrative Code 62-777. FDEP FAC 62-777 Soil Cleanup Target Levels, more stringent of the direct exposure residential and leachability based on freshwater surface water criteria and leachability based on groundwater criteria, February 2005 (http://www.dep.state.fl.us/waste/quick_topics/publications/wc/FinalGuidanceDocumentsFlowCharts_April2005/TechnicalReport2FinalFeb2005(Final3-28-05).pdf).
(3) USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites for Soil, Nov. 2013, (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/master_sl_table_run_NOV2013.pdf).
(4) No RSL available. Used U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) / Oak Ridge National Laboratory (ORNL) ORNL/TM-2001/00 Reevaluation of 1999 Health-Based Environmental Screening Levels (HBESLs) for Chemical Warfare Agents. May 2007. http://info.ornl.gov/sites/publications/files/Pub6607.pdf
(5) Analytes that have no screening levels, or whose screening levels are below laboratory MDLs or MQLs, will use the MQLs or MDLs (in that succession) for their screening levels.
(6) Although EPA Regional Screening Levels for 1,4-thioxane are not present, the chemical has been noted to be slightly less toxic than 1,4-dithiane (Munro et al., 1999), and thus the value for 1,4-dithiane will be used.
-- No published screening value available.
mg/kg - milligrams per kilogram

TABLE 4-9a
Surface Soil (0 -≤ 2 ft bgs) Summary Statistics for UPL Calculation
Background Samples
Former Withlacoochee Site

Variable	Number Samples Detected	Total Number Samples [1]	Percent Detected (%)	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Standard Deviation of Mean Concentration	Shapiro Wilk Test Statistic [2]	Shapiro Wilk Critical Value	Distribution [3]	UPL test	UPL [4] (mg/kg)	Selected Background Value [5] (mg/kg)
Antimony	1	10	10	0.34	0.34	0.34	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	0.34
Arsenic	0	10	0	--	--	--	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	--
Barium	10	10	100	0.35	16	4.4	4.8	0.808	0.842	Approx. Normal	95% UPL (t)	14	14
Copper	9	10	90	0.12	2.4	0.87	0.76	0.879	0.818	Normal	95% KM UPL (t)	2.1	2.1
Lead	10	10	100	0.37	8	4.2	2.7	0.941	0.842	Normal	95% UPL (t)	9.3	9.3
Manganese	10	10	100	0.21	1.8	0.86	0.52	0.92	0.842	Normal	95% UPL (t)	1.9	1.9
Nickel	8	10	80	0.30	0.95	0.62	0.24	0.923	0.803	Normal	95% KM UPL (t)	0.98	0.98
Zinc	5	10	50	1.8	3.1	2.4	0.58	0.945	0.748	Normal	95% KM UPL (t)	3.3	3.3

[1] Total number of samples does not include field duplicates. If a field duplicate was collected, the highest detected value between the duplicates was used to calculate the UCL.

[2] The null hypothesis is that the data are normally distributed. The test statistic is compared to the Shapiro-Wilk Critical value, which is based on the number of samples. If Shaprio-Willk test statistic is greater than the critical value, do not reject the null hypothesis.

[3] The distribution of the data is estimated using the Shapiro-Wilk Test.

[4] The Upper Prediction Limit (UPL) is the 95% UPL using the distribution of the data. All data distributions and UPLs calculated in ProUCL (v. 5.0.00) (EPA 2013).

[5] The selected background value is the calculated UPL, unless there were not a sufficient number of detected samples to calculate a reliable UPL. In that case, the maximum detected value was used. If there were no detected concentrations no background value is provided.

[6]N/A - Not available, not enough detected samples in dataset.

TABLE 4-9b
Subsurface Soil (> 2 ft bgs) Summary Statistics for UPL Calculation
Background Samples
Former Withlacoochee Site

Variable	Number Samples Detected	Total Number Samples [1]	Percent Detected (%)	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Standard Deviation of Mean Concentration	Shapiro Wilk Test Statistic [2]	Shapiro Wilk Critical Value	Distribution [3]	UPL test	UPL [4] (mg/kg)	Selected Background Value [5] (mg/kg)
Antimony	0	10	0	--	--	--	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	--
Arsenic	0	10	0	--	--	--	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	--
Barium	9	10	90	0.15	8.1	1.5	2.5	0.594	0.829	Lognormal	95% KM UPL (lognormal)	6.2	6.2
Copper	2	10	20	0.13	0.52	0.33	0.28	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	0.52
Lead	6	10	60	0.19	2.7	1.1	1.1	0.774	0.788	Approx. Normal	95% KM UPL (t)	2.4	2.4
Manganese	9	10	90	0.17	0.95	0.39	0.24	0.811	0.829	Approx. Normal	95% KM UPL (t)	0.80	0.80
Nickel	6	10	60	0.11	1.2	0.43	0.40	0.797	0.788	Normal	95% KM UPL (t)	0.95	0.95
Zinc	3	10	30	1.9	8.2	5.1	3.2	N/A[6]	N/A[6]	N/A[6]	N/A[6]	N/A[6]	8.2

[1] Total number of samples does not include field duplicates. If a field duplicate was collected, the highest detected value between the duplicates was used to calculate the UCL.

[2] The null hypothesis is that the data are normally distributed. The test statistic is compared to the Shapiro-Wilk Critical value, which is based on the number of samples. If Shaprio-Willk test statistic is greater than the critical value, do not reject the null hypothesis.

[3] The distribution of the data is estimated using the Shapiro-Wilk Test.

[4] The Upper Prediction Limit (UPL) is the 95% UPL using the distribution of the data. All data distributions and UPLs calculated in ProUCL (v. 5.0.00) (EPA 2013).

[5] The selected background value is the calculated UPL, unless there were not a sufficient number of detected samples to calculate a reliable UPL. In that case, the maximum detected value was used. If there were no detected concentrations no background value is provided.

[6] N/A - Not available, not enough detected samples in dataset.

4.2.2.3 MC Results – CUA1

4.2.2.3.1 For purposes of the RI, 148 soil samples (68 surface and 80 subsurface), 9 FD, and 9 QA samples were collected at depths ranging from 2 to 48 inches bgs in CUA1. These samples were collected throughout CUA1 with locations based on intrusive findings, on former munitions find areas, or placed in the Toxic Gas Yard (Figure 3-3).

Using power auger for subsurface sample in Toxic Gas Yard, September

4.2.2.3.2 Soil samples collected for the RI were analyzed for CA/ABPs, explosives, select metals, and, in the Toxic Gas Yard only, VOCs. The analytical results for these samples are presented in Appendix B. It should be noted that not all samples were analyzed for all analytes.

4.2.2.3.3 As shown in Tables 4-10 and 4-11, CA/ABPs, explosives, and VOCs were not detected in any of the soil samples collected within CUA1; therefore, CA/ABPs, explosives, and VOCs will not be retained as COPCs for further consideration in the risk assessment in Chapter 6. All eight of the metals were detected and two of those, arsenic and barium, have maximum detections that exceeded the PSV and the background value and will be included in the risk assessment in Chapter 6 (Tables 4-11a and 4-11b).

4.2.2.3.4 Arsenic. Arsenic was detected in 18 samples in the surface soil with a maximum detected concentration of 2.4 mg/kg and one of those concentrations exceeded the PSV of 2.1 mg/kg. Arsenic was also detected in 35 subsurface samples with a maximum detected concentration of 13 mg/kg and 6 of those concentrations exceeded the PSV. Arsenic is a naturally occurring element which is very prevalent in Florida and—in relation to MMRP sites—occurs as a breakdown product of Lewisite. Arsenic was included in the metals list due to the fact that the PA reported that two drums of Lewisite were stored at the former Brooksville AAF, however no documentation exists showing that it was used at Withlacoochee. The Withlacoochee Site was formerly an agricultural area used for cattle grazing, and from historical literature we have learned that "cattle dipping" in arsenic baths was prevalent throughout the area. Arsenic will be evaluated in the risk assessment in Chapter 6.

4.2.2.3.5 Barium. In total, barium was detected in 42 surface soil samples and 75 subsurface samples. Two samples collected during the field event in 2013 were found to have detections of barium that exceeded the PSV. WITH-CUA1-HSS-0-2-11 and WITH-CUA1-HSB-20-24-11 are surface and subsurface soil samples from the same location. Both had concentrations of 130 mg/kg which exceed the PSV of 120 mg/kg. This sample was collected on August 19, 2013, in an area located just south of the Fish Hatchery property and within the former ATG Bombing and Gunnery Range. To delineate the extent, five additional soil samples were collected as detailed in Subchapter 3.3.2.1.4 and displayed in Figure 3.5.

4.2.2.3.6 When the results of the follow-on samples were obtained, two of the subsurface soil samples, WITH-CUA1-HSB-28-30-11D (28" deep with 180 mg/kg) and WITH-

CUA1-HSB-20-24-11E (22” deep with 140 mg/kg), had concentrations higher than the PSV (120 mg/kg). Thirteen more follow-on samples, designated as Group #1 or Group #2, were collected as detailed in Subchapter 3.3.2.1.5 and displayed in Figure 3.5. One of the subsurface samples from Group #1 had concentrations higher than the PSV, sample WITH-CUA1-HSB-20-24-11D-40" (40” deep with 550 mg/kg). One of the subsurface samples from Group #2, WITH-CUA1-HSB-20-24-11E-East2 (22” deep with 220 mg/kg), was also found to have a concentration higher than the PSV. There were no other barium exceedances identified on the Withlacoochee Site; therefore, the potential barium contamination appears to be confined to this area on the south side of the former ATG Bombing and Gunnery Range. However, an eastern boundary of contamination has not been established. Barium is a component of several munitions historically used on site: 4.2 mortar (primer), SCAR (motor), M38a2 (spotting charge), M70 (fuze primer), T3 (fuze primer), M89 (candles), M90 (candles), M98 (candles), M78 (fuze primer), and M79 (fuze primer). Barium will be evaluated in the risk assessment in Chapter 6.

Table 4-10a
Summary Statistics Table for Surface Soil Samples
Withlacoochee Site - CUA1

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)[1]	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
CA/ABPs							
Lewisite	0	67	0	--	--	0.3	0
Mustard (HD)	0	67	0	--	--	0.01	0
Nitrogen Mustard (HN-1 and HN-3)	0	67	0	--	--	0.1	0
1,4-Dithiane	0	67	0	--	--	610	0
1,4-Thioxane	0	67	0	--	--	610	0
N-Ethyldiethanolamine	0	67	0	--	--	0.13	0
Diethanolamine	0	67	0	--	--	120	0
Triethanolamine	0	67	0	--	--	0.13	0
Explosives							
1,3,5-Trinitrobenzene	0	67	0	--	--	0.090	0
1,3-Dinitrobenzene	0	67	0	--	--	0.0040	0
2,4,6-Trinitrotoluene (TNT)	0	67	0	--	--	0.0060	0
2,4-Dinitrotoluene	0	67	0	--	--	0.0060	0
2,6-Dinitrotoluene	0	67	0	--	--	0.00040	0
2-Amino-4,6-dinitrotoluene	0	67	0	--	--	0.00040	0
2-Nitrotoluene	0	67	0	--	--	0.90	0
3-Nitrotoluene	0	67	0	--	--	1.4	0
4-Amino-2,6-dinitrotoluene	0	67	0	--	--	150	0
4-Nitrotoluene	0	67	0	--	--	0.90	0

Table 4-10a (continued)
Summary Statistics Table for Surface Soil Samples
Withlacoochee Site - CUA1

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)[1]	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0	67	0	--	--	0.0020	0
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0	67	0	--	--	1.4	0
Nitrobenzene	0	67	0	--	--	0.020	0
Nitroglycerin	0	67	0	--	--	0.030	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0	67	0	--	--	3,800	0
Pentaerythritol Tetranitrate (PETN)	0	67	0	--	--	120	0
Metals							
Antimony	7	67	10	0.28J	0.94J	5.4	0
Arsenic	**18**	**67**	**27**	**0.34J**	**2.4**	**2.1**	**1**
Barium	**42**	**71**	**59**	**0.40J**	**130**	**120**	**1**
Copper	34	67	51	0.17J	7.4	150	0
Lead	38	67	57	0.57J	47	400	0
Manganese	38	67	57	0.27J	210	3,500	0
Nickel	37	67	55	0.087J	3.6	130	0
Zinc	32	67	48	1.6J	34	26,000	0
Volatile Organic Compounds							
Trichloroethylene	0	29	0	--	--	0.03	0
1,1,2,2-tetrachloroethane	0	29	0	--	--	0.001	0
1,2-dichloroethene (cis)	0	29	0	--	--	0.4	0
1,2-dichloroethene (trans)	0	29	0	--	--	0.7	0
Vinyl Chloride	0	29	0	--	--	0.007	0

N/A - Not applicable. J - Analyte detected, estimated concentration.
-- Not detected.
1) Preliminary Screening Values as shown in Table 4.8.

Table 4-10b
Summary Statistics Table for Subsurface Soil Samples
Withlacoochee Site - CUA1

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)[1]	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
CA/ABPs							
Lewisite	0	65	0	--	--	0.3	0
Mustard (HD)	0	65	0	--	--	0.01	0
Nitrogen Mustard (HN-1 and HN-3)	0	65	0	--	--	0.1	0
1,4-Dithiane	0	65	0	--	--	610	0
1,4-Thioxane	0	65	0	--	--	610	0
N-Ethyldiethanolamine	0	65	0	--	--	0.13	0
Diethanolamine	0	65	0	--	--	120	0
Triethanolamine	0	65	0	--	--	0.13	0
Explosives							
1,3,5-Trinitrobenzene	0	65	0	--	--	0.090	0
1,3-Dinitrobenzene	0	65	0	--	--	0.0040	0
2,4,6-Trinitrotoluene (TNT)	0	65	0	--	--	0.0060	0
2,4-Dinitrotoluene	0	65	0	--	--	0.0060	0
2,6-Dinitrotoluene	0	65	0	--	--	0.00040	0
2-Amino-4,6-dinitrotoluene	0	65	0	--	--	0.00040	0
2-Nitrotoluene	0	65	0	--	--	0.90	0
3-Nitrotoluene	0	65	0	--	--	1.4	0
4-Amino-2,6-dinitrotoluene	0	65	0	--	--	150	0
4-Nitrotoluene	0	65	0	--	--	0.90	0

Table 4-10b (continued)
Summary Statistics Table for Subsurface Soil Samples
Withlacoochee Site - CUA1

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)(1)	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0	65	0	--	--	0.0020	0
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0	65	0	--	--	1.4	0
Nitrobenzene	0	65	0	--	--	0.020	0
Nitroglycerin	0	65	0	--	--	0.030	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0	65	0	--	--	3,800	0
Pentaerythritol Tetranitrate (PETN)	0	65	0	--	--	120	0
Metals							
Antimony	7	65	11	0.23J	0.59	5.4	0
Arsenic	**35**	**65**	**54**	**0.31J**	**13**	**2.1**	**6**
Barium	**75**	**75**	**100**	**0.15J**	**550**	**120**	**5**
Copper	40	65	65	0.11J	10	150	0
Lead	57	65	88	0.39J	13	400	0
Manganese	65	65	100	0.19J	41	3,500	0
Nickel	58	65	89	0.098J	6.4	130	0
Zinc	36	65	55	1.5J	50	26,000	0
Volatile Organic Compounds							
Trichloroethylene	0	26	0	--	--	0.03	0
1,1,2,2-tetrachloroethane	0	26	0	--	--	0.001	0
1,2-dichloroethene (cis)	0	26	0	--	--	0.4	0
1,2-dichloroethene (trans)	0	26	0	--	--	0.7	0
Vinyl Chloride	0	26	0	--	--	0.007	0

N/A - Not applicable. J - Analyte detected, estimated concentration.
-- Not detected.
1) Preliminary Screening Values as shown in Table 5-8.

Table 4-11a
Surface Soil COPC Evaluation for Munitions Constituents Sampling Results
Withlacoochee Site – CUA1

Analyte	Maximum Detected Concentration[1] (mg/kg)	Preliminary Screening Value [2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
CA/ABPs							
Lewisite	ND	0.3	No	--	No	Not detected at site	None
Mustard (HD)	ND	0.01	No	--	No	Not detected at site	None
Nitrogen Mustard (HN-1 and HN-3)	ND	0.1	No	--	No	Not detected at site	None
1,4-Dithiane	ND	610	No	--	No	Not detected at site	None
1,4-Thioxane	ND	610	No	--	No	Not detected at site	None
N-Ethyldiethanolamine	ND	0.13	No	--	No	Not detected at site	None
Diethanolamine	ND	120	No	--	No	Not detected at site	None
Triethanolamine	ND	0.13	No	--	No	Not detected at site	None
Explosives							
1,3,5-Trinitrobenzene	0.20 U	0.090	No	N/A	No	Not detected at site	None
1,3-Dinitrobenzene	0.20 U	0.0040	No	N/A	No	Not detected at site	None
2,4,6-Trinitrotoluene (TNT)	0.20 U	0.0060	No	N/A	No	Not detected at site	None
2,4-Dinitrotoluene	0.20 U	0.0060	No	N/A	No	Not detected at site	None
2,6-Dinitrotoluene	0.20 U	0.00040	No	N/A	No	Not detected at site	None
2-Amino-4,6-dinitrotoluene	0.20 U	150	No	N/A	No	Not detected at site	None
2-Nitrotoluene	0.20 U	0.90	No	N/A	No	Not detected at site	None
3-Nitrotoluene	0.20 U	1.4	No	N/A	No	Not detected at site	None
4-Amino-2,6-dinitrotoluene	0.20 U	150	No	N/A	No	Not detected at site	None
4-Nitrotoluene	0.20 U	0.90	No	N/A	No	Not detected at site	None
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.20 U	0.0020	No	N/A	No	Not detected at site	None
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0.20 U	1.4	No	N/A	No	Not detected at site	None
Nitrobenzene	0.20 U	0.020	No	N/A	No	Not detected at site	None
Nitroglycerin	0.20 U	0.030	No	N/A	No	Not detected at site	None

Analyte	Maximum Detected Concentration[1] (mg/kg)	Preliminary Screening Value [2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.20 U	3,800	No	N/A	No	Not detected at site	None
Pentaerythritol Tetranitrate (PETN)	1.0 U	120	No	N/A	No	Not detected at site	None
Metals							
Antimony	0.94 J	5.4	No	0.34	No	Not detected above PSV	None
Arsenic	**2.4**	**2.1**	**Yes**	**--**	**Yes**	**Detected above PSV**	**WITH-CUA1-HSS-0-2-32**
Barium	**130**	**120**	**Yes**	**14**	**Yes**	**Detected above PSV and background**	**WITH-CUA1-HSS-0-2-11**
Copper	7.4	150	No	2.1	No	Not detected above PSV	None
Lead	47	400	No	9.3	No	Not detected above PSV	None
Manganese	210	3500	No	1.9	No	Not detected above PSV	None
Nickel	3.6	130	No	0.98	No	Not detected above PSV	None
Zinc	34	26,000	No	3.3	No	Not detected above PSV	None
Volatile Organic Compounds							
1,1,2,2-tetrachloroethane	0.0067 UJ	0.001	No	N/A	No	Not detected at site	None
1,2-dichloroethene (cis)	0.0067 UJ	0.4	No	N/A	No	Not detected at site	None
1,2-dichloroethene (trans)	0.0067 UJ	0.7	No	N/A	No	Not detected at site	None
Trichloroethylene	0.0067 UJ	0.03	No	N/A	No	Not detected at site	None
Vinyl Chloride	0.0067 UJ	0.007	No	N/A	No	Not detected at site	None

1) Maximum Detected Concentration unless no detections were found.
2) Preliminary Screening Values as shown in Table 5-8.
3) Background values are defined as detailed in Subchapter 5.2.2.2.3.

U - Analyte was analyzed for but not detected above the sample specific detection limit.
J - Analyte detected, estimated concentration.

Analyte	Maximum Detected Concentration[1] (mg/kg)	Preliminary Screening Value [2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name

-- - Not detected in any background sample.

Table 4-11b
Subsurface Soil COPC Evaluation for Munitions Constituents Sampling Results
Withlacoochee Site – CUA1

Analyte	Maximum Detected Concentration[1] (mg/kg)		Preliminary Screening Value[2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
CA/ABPs								
Lewisite	ND		0.3	No	--	No	Not detected at site	None
Mustard (HD)	ND		0.01	No	--	No	Not detected at site	None
Nitrogen Mustard (HN-1 and HN-3)	ND		0.1	No	--	No	Not detected at site	None
1,4-Dithiane	ND		610	No	--	No	Not detected at site	None
1,4-Thioxane	ND		610	No	--	No	Not detected at site	None
N-Ethyldiethanolamine	ND		0.13	No	--	No	Not detected at site	None
Diethanolamine	ND		120	No	--	No	Not detected at site	None
Triethanolamine	ND		0.13	No	--	No	Not detected at site	None
Explosives								
1,3,5-Trinitrobenzene	0.20	U	0.090	No	N/A	No	Not detected at site	None
1,3-Dinitrobenzene	0.20	U	0.0040	No	N/A	No	Not detected at site	None
2,4,6-Trinitrotoluene (TNT)	0.20	U	0.0060	No	N/A	No	Not detected at site	None
2,4-Dinitrotoluene	0.20	U	0.0060	No	N/A	No	Not detected at site	None
2,6-Dinitrotoluene	0.20	U	0.00040	No	N/A	No	Not detected at site	None
2-Amino-4,6-dinitrotoluene	0.20	U	150	No	N/A	No	Not detected at site	None
2-Nitrotoluene	0.20	U	0.90	No	N/A	No	Not detected at site	None
3-Nitrotoluene	0.20	U	1.4	No	N/A	No	Not detected at site	None
4-Amino-2,6-dinitrotoluene	0.20	U	150	No	N/A	No	Not detected at site	None

Analyte	Maximum Detected Concentration[1] (mg/kg)	Preliminary Screening Value[2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
4-Nitrotoluene	0.20 U	0.90	No	N/A	No	Not detected at site	None
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.20 U	0.0020	No	N/A	No	Not detected at site	None
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0.20 U	1.4	No	N/A	No	Not detected at site	None
Nitrobenzene	0.20 U	0.020	No	N/A	No	Not detected at site	None
Nitroglycerin	0.20 U	0.030	No	N/A	No	Not detected at site	None
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.20 U	3,800	No	N/A	No	Not detected at site	None
Pentaerythritol Tetranitrate (PETN)	1.0 U	120	No	N/A	No	Not detected at site	None
Metals							
Antimony	0.59	5.4	No	--	No	Not detected above PSV	None
Arsenic	**13**	**2.1**	**Yes**	**--**	**Yes**	**Detected above PSV**	**6 samples above PSV**
Barium	**550**	**120**	**Yes**	**6.2**	**Yes**	**Detected above PSV and background**	**5 samples above PSV**
Copper	10	150	No	0.52	No	Not detected above PSV	None
Lead	13	400	No	2.4	No	Not detected above PSV	None
Manganese	41	3500	No	0.80	No	Not detected above PSV	None
Nickel	6.4	130	No	0.95	No	Not detected above PSV	None
Zinc	50	26,000	No	8.2	No	Not detected above PSV	None
Volatile Organic Compounds							
1,1,2,2-tetrachloroethane	0.0026 U	0.001	No	N/A	No	Not detected at site	None
1,2-dichloroethene (cis)	0.0026 U	0.4	No	N/A	No	Not detected at site	None
1,2-dichloroethene (trans)	0.0026 U	0.7	No	N/A	No	Not detected at site	None
Trichloroethylene	0.0026 U	0.03	No	N/A	No	Not detected at site	None
Vinyl Chloride	0.0026 U	0.007	No	N/A	No	Not detected at site	None

Analyte	Maximum Detected Concentration[1] (mg/kg)	Preliminary Screening Value[2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name

1) Maximum Detected Concentration unless no detections were found.
2) Preliminary Screening Values as shown in Table 5-8.
3) Background values are defined as detailed in Subchapter 5.2.2.2.3.

U - Analyte was analyzed for but not detected above the sample specific detection limit.
J - Analyte detected, estimated concentration.
-- - Not detected in any background sample.

4.2.2.4 MC Results – CUA2

4.2.2.4.1 For purposes of the RI, 11 soil samples (7 surface and 4 subsurface) were collected at depths ranging from 2 to 24 inches bgs in CUA2. Two samples were collected from a former ordnance find near the center of CUA2. The remaining samples were collected from grid CUA2-006 on the east side of CUA2 with locations based on intrusive MD findings.

4.2.2.4.2 Soil samples collected for the RI were analyzed for CA/ABPs, explosives, and select metals. The analytical results for these samples are presented in Appendix B. It should be noted that not all samples were analyzed for all analytes.

4.2.2.4.3 As shown in Tables 4-12 and 4-13, CA/ABPs were not detected in any of the soil samples collected within CUA2; therefore, CA/ABPs will not be retained as COPCs for further consideration in the risk assessment in Chapter 6. One metal was detected (arsenic) in both surface and subsurface soil, and one explosive (TNT) was detected in surface soil which exceeded the PSV and will be included in the risk assessment in Chapter 6 (Tables 4-13a and 4-13b).

4.2.2.4.4 Arsenic. Arsenic was detected in four surface soil samples and four subsurface soil samples and two of those concentrations exceeded the PSV of 2.1 mg/kg. The maximum detected concentration and only exceedance in surface soil was 3.0 mg/kg from sample WITH-CUA2-SS-005 and the maximum detected concentration and only exceedance in subsurface soil was 3.9 mg/kg from sample WITH-CUA2-SB-007. Arsenic is a naturally occurring element which is very prevalent in Florida and—in relation to MMRP sites—occurs as a breakdown product of Lewisite. Arsenic was included in the metals list due to the fact that the PA reported that two drums of Lewisite were stored at the former Brooksville AAF, however no documentation exists showing that it was used at Withlacoochee. The Withlacoochee Site was formerly an agricultural area used for cattle grazing, and from historical literature we have learned that "cattle dipping" in arsenic baths was prevalent throughout the area. Arsenic will be evaluated in the risk assessment in Chapter 7.

4.2.2.4.5 TNT. As detailed in Subchapter 3.3.2.2.4, the TNT detections were found in two surface soil samples, WITH-CUA2-SS-006 (0.14J mg/kg) and WITH-CUA2-SS-007 (0.14J mg/kg), both located in grid CUA2-006 where pieces of an EK-4 10-lb chemical bomblet were found during intrusive activities. Both sample results were flagged by the lab with a "J" code meaning the analyte was detected, but with an estimated concentration. The PSV for TNT is the FDEP SCTL, leachability based on groundwater criteria, of 0.006 mg/kg. For this particular analyte, the FDEP-LGW criteria falls well below the laboratory's limit of detection (LOD) of 0.17 mg/kg and limit of quantitation (LOQ) of 0.50 mg/kg.

4.2.2.4.6 Two follow-on samples, WITH-CUA2-SS-006RE and WITH-CUA2-SS-007RE, were collected from the original locations to confirm these detections. The samples were collected approximately 10 inches from the original locations to avoid the previously disturbed and mixed area of soil. Both of the follow-on samples were non-detect for

TNT. Based on the data collected as part of this RI, the extent of potential TNT contamination in soil at CUA2 is limited to the vicinity of two soil samples, WITH-CUA2-SS-006 and WITH-CUA2-SS-007, both located in grid CUA2-006 approximately 7 meters apart.

Table 4-12a
Summary Statistics Table for Surface Soil Samples
Withlacoochee Site – CUA2

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)[1]	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
CA/ABPs							
Lewisite	0	5	0	--	--	0.3	0
Mustard (HD)	0	5	0	--	--	0.01	0
Nitrogen Mustard (HN-1 and HN-3)	0	5	0	--	--	0.1	0
1,4-Dithiane	0	5	0	--	--	610	0
1,4-Thioxane	0	5	0	--	--	610	0
N-Ethyldiethanolamine	0	5	0	--	--	0.13	0
Diethanolamine	0	5	0	--	--	120	0
Triethanolamine	0	5	0	--	--	0.13	0
Explosives							
1,3,5-Trinitrobenzene	0	5	0	--	--	0.09	0
1,3-Dinitrobenzene	0	5	0	--	--	0.004	0
2,4,6-Trinitrotoluene (TNT)	**2**	**7**	**29**	**0.14 J**	**0.14 J**	**0.006**	**2**
2,4-Dinitrotoluene	0	5	0	--	--	0.006	0
2,6-Dinitrotoluene	0	5	0	--	--	0.0004	0
2-Amino-4,6-dinitrotoluene	0	5	0	--	--	0.0004	0
2-Nitrotoluene	0	5	0	--	--	0.9	0
3-Nitrotoluene	0	5	0	--	--	1.4	0
4-Amino-2,6-dinitrotoluene	0	5	0	--	--	150	0
4-Nitrotoluene	0	5	0	--	--	0.9	0

Table 4-12a (continued)
Summary Statistics Table for Surface Soil Samples
Withlacoochee Site – CUA2

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)(1)	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0	5	0	--	--	0.0020	0
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0	5	0	--	--	1.4	0
Nitrobenzene	0	5	0	--	--	0.020	0
Nitroglycerin	0	5	0	--	--	0.030	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0	5	0	--	--	3,800	0
Pentaerythritol Tetranitrate (PETN)	0	5	0	--	--	120	0
Metals							
Antimony	2	5	40	0.23J	0.47J	5.4	0
Arsenic	**4**	**5**	**80**	**1.4**	**3.0**	**2.1**	**1**
Barium	5	5	100	15	27	120	0
Copper	5	5	100	0.52J	6.7	150	0
Lead	5	5	100	4.9	17	400	0
Manganese	5	5	100	36	420	3,500	0
Nickel	5	5	100	1.3	4.9	130	0
Zinc	4	5	80	31	180	26,000	0

N/A - Not applicable. J - Analyte detected, estimated concentration.

-- Not detected.

1) Preliminary Screening Values as shown in Table 5-8.

Table 4-12b
Summary Statistics Table for Subsurface Soil Samples
Withlacoochee Site – CUA2

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)[1]	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
CA/ABPs							
Lewisite	0	4	0	--	--	0.3	0
Mustard (HD)	0	4	0	--	--	0.01	0
Nitrogen Mustard (HN-1 and HN-3)	0	4	0	--	--	0.1	0
1,4-Dithiane	0	4	0	--	--	610	0
1,4-Thioxane	0	4	0	--	--	610	0
N-Ethyldiethanolamine	0	4	0	--	--	0.13	0
Diethanolamine	0	4	0	--	--	120	0
Triethanolamine	0	4	0	--	--	0.13	0
Explosives							
1,3,5-Trinitrobenzene	0	4	0	--	--	0.090	0
1,3-Dinitrobenzene	0	4	0	--	--	0.0040	0
2,4,6-Trinitrotoluene (TNT)	0	4	0	--	--	0.0060	0
2,4-Dinitrotoluene	0	4	0	--	--	0.0060	0
2,6-Dinitrotoluene	0	4	0	--	--	0.00040	0
2-Amino-4,6-dinitrotoluene	0	4	0	--	--	0.00040	0
2-Nitrotoluene	0	4	0	--	--	0.90	0
3-Nitrotoluene	0	4	0	--	--	1.4	0
4-Amino-2,6-dinitrotoluene	0	4	0	--	--	150	0
4-Nitrotoluene	0	4	0	--	--	0.90	0

Table 4-12b (continued)
Summary Statistics Table for Subsurface Soil Samples
Withlacoochee Site – CUA2

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)(1)	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0	4	0	--	--	0.0020	0
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0	4	0	--	--	1.4	0
Nitrobenzene	0	4	0	--	--	0.020	0
Nitroglycerin	0	4	0	--	--	0.030	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0	4	0	--	--	3,800	0
Pentaerythritol Tetranitrate (PETN)	0	4	0	--	--	120	0
Metals							
Antimony	2	4	50	0.24J	0.24J	5.4	0
Arsenic	**4**	**4**	**100**	**1.1**	**3.9**	**2.1**	**1**
Barium	4	4	100	7.2	21	120	0
Copper	3	4	75	0.35J	2.4	150	0
Lead	4	4	100	3.6	8.4	400	0
Manganese	4	4	100	14	210	3,500	0
Nickel	4	4	100	2.1	3.0	130	0
Zinc	4	4	100	2.3J	590	26,000	0

N/A - Not applicable. J - Analyte detected, estimated concentration.
-- Not detected.
1) Preliminary Screening Values as shown in Table 5-8.

Table 4-13a
Surface Soil COPC Evaluation for Munitions Constituents Sampling Results
Withlacoochee Site – CUA2

Analyte	Maximum Detected Concentration[1] (mg/kg)		Preliminary Screening Value [2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
CA/ABPs								
Lewisite	ND		0.3	No	--	No	Not detected at site	None
Mustard (HD)	ND		0.01	No	--	No	Not detected at site	None
Nitrogen Mustard (HN-1 and HN-3)	ND		0.1	No	--	No	Not detected at site	None
1,4-Dithiane	ND		610	No	--	No	Not detected at site	None
1,4-Thioxane	ND		610	No	--	No	Not detected at site	None
N-Ethyldiethanolamine	ND		0.13	No	--	No	Not detected at site	None
Diethanolamine	ND		120	No	--	No	Not detected at site	None
Triethanolamine	ND		0.13	No	--	No	Not detected at site	None
Explosives								
1,3,5-Trinitrobenzene	0.20	U	0.090	No	N/A	No	Not detected at site	None
1,3-Dinitrobenzene	0.20	U	0.0040	No	N/A	No	Not detected at site	None
2,4,6-Trinitrotoluene (TNT)	**0.14**	**J**	**0.0060**	**Yes**	**N/A**	**Yes**	**Detected above PSV**	**WITH-CUA2-SS-006 & WITH-CUA2-SS-007**
2,4-Dinitrotoluene	0.20	U	0.0060	No	N/A	No	Not detected at site	None
2,6-Dinitrotoluene	0.20	U	0.00040	No	N/A	No	Not detected at site	None
2-Amino-4,6-dinitrotoluene	0.20	U	150	No	N/A	No	Not detected at site	None
2-Nitrotoluene	0.20	U	0.90	No	N/A	No	Not detected at site	None
3-Nitrotoluene	0.20	U	1.4	No	N/A	No	Not detected at site	None
4-Amino-2,6-dinitrotoluene	0.20	U	150	No	N/A	No	Not detected at site	None
4-Nitrotoluene	0.20	U	0.90	No	N/A	No	Not detected at site	None
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.20	U	0.0020	No	N/A	No	Not detected at site	None

Analyte	Maximum Detected Concentration[1] (mg/kg)		Preliminary Screening Value [2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0.20	U	1.4	No	N/A	No	Not detected at site	None
Nitrobenzene	0.20	U	0.020	No	N/A	No	Not detected at site	None
Nitroglycerin	0.20	U	0.030	No	N/A	No	Not detected at site	None
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.20	U	3,800	No	N/A	No	Not detected at site	None
Pentaerythritol Tetranitrate (PETN)	1.0	U	120	No	N/A	No	Not detected at site	None
Metals								
Antimony	0.47	J	5.4	No	0.34	No	Not detected above PSV	None
Arsenic	**3.0**		**2.1**	**Yes**	**--**	**Yes**	**Detected above PSV**	**WITH-CUA2-SS-005**
Barium	27		120	No	**14**	No	Not detected above PSV	None
Copper	6.7		150	No	2.1	No	Not detected above PSV	None
Lead	17		400	No	9.3	No	Not detected above PSV	None
Manganese	420		3500	No	1.9	No	Not detected above PSV	None
Nickel	4.9		130	No	0.98	No	Not detected above PSV	None
Zinc	180		26,000	No	3.3	No	Not detected above PSV	None

1) Maximum Detected Concentration unless no detections were found.
2) Preliminary Screening Values as shown in Table 5-8.
3) Background values are defined as detailed in Subchapter 5.2.2.2.3.

U - Analyte was analyzed for but not detected above the sample specific detection limit.
J - Analyte detected, estimated concentration.
-- - Not detected in any background sample.

Table 4-13b
Subsurface Soil COPC Evaluation for Munitions Constituents Sampling Results
Withlacoochee Site – CUA2

Analyte	Maximum Detected Concentration[1] (mg/kg)		Preliminary Screening Value [2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
CA/ABPs								
Lewisite	ND		0.3	No	--	No	Not detected at site	None
Mustard (HD)	ND		0.01	No	--	No	Not detected at site	None
Nitrogen Mustard (HN-1 and HN-3)	ND		0.1	No	--	No	Not detected at site	None
1,4-Dithiane	ND		610	No	--	No	Not detected at site	None
1,4-Thioxane	ND		610	No	--	No	Not detected at site	None
N-Ethyldiethanolamine	ND		0.13	No	--	No	Not detected at site	None
Diethanolamine	ND		120	No	--	No	Not detected at site	None
Triethanolamine	ND		0.13	No	--	No	Not detected at site	None
Explosives								
1,3,5-Trinitrobenzene	0.20	U	0.090	No	N/A	No	Not detected at site	None
1,3-Dinitrobenzene	0.20	U	0.0040	No	N/A	No	Not detected at site	None
2,4,6-Trinitrotoluene (TNT)	0.20	U	0.0060	No	N/A	No	Not detected at site	None
2,4-Dinitrotoluene	0.20	U	0.0060	No	N/A	No	Not detected at site	None
2,6-Dinitrotoluene	0.20	U	0.00040	No	N/A	No	Not detected at site	None
2-Amino-4,6-dinitrotoluene	0.20	U	150	No	N/A	No	Not detected at site	None
2-Nitrotoluene	0.20	U	0.90	No	N/A	No	Not detected at site	None
3-Nitrotoluene	0.20	U	1.4	No	N/A	No	Not detected at site	None
4-Amino-2,6-dinitrotoluene	0.20	U	150	No	N/A	No	Not detected at site	None
4-Nitrotoluene	0.20	U	0.90	No	N/A	No	Not detected at site	None
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.20	U	0.0020	No	N/A	No	Not detected at site	None
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0.20	U	1.4	No	N/A	No	Not detected at site	None

Analyte	Maximum Detected Concentration[1] (mg/kg)	Preliminary Screening Value [2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
Nitrobenzene	0.20 U	0.020	No	N/A	No	Not detected at site	None
Nitroglycerin	0.20 U	0.030	No	N/A	No	Not detected at site	None
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.20 U	3,800	No	N/A	No	Not detected at site	None
Pentaerythritol Tetranitrate (PETN)	1.0 U	120	No	N/A	No	Not detected at site	None
Metals							
Antimony	0.24 J	5.4	No	--	No	Not detected above PSV	None
Arsenic	**3.9**	**2.1**	**Yes**	**--**	**Yes**	**Detected above PSV**	**WITH-CUA2-SB-007**
Barium	21	120	No	**6.2**	No	Not detected above PSV	None
Copper	2.4	150	No	0.52	No	Not detected above PSV	None
Lead	8.4	400	No	2.4	No	Not detected above PSV	None
Manganese	210	3500	No	0.80	No	Not detected above PSV	None
Nickel	3.0	130	No	0.95	No	Not detected above PSV	None
Zinc	590	26,000	No	8.2	No	Not detected above PSV	None

1) Maximum Detected Concentration unless no detections were found.
2) Preliminary Screening Values as shown in Table 5-8.
3) Background values are defined as detailed in Subchapter 5.2.2.2.3.

U - Analyte was analyzed for but not detected above the sample specific detection limit.
J - Analyte detected, estimated concentration.
-- - Not detected in any background sample.

4.2.2.5 MC Results – CUA3

4.2.2.5.1 For purposes of the RI, 7 surface soil samples were collected at depths ranging from 0 - 2 inches bgs in CUA3. No subsurface soil samples were collected. All 7 samples were collected as a result of a demolition activity. No samples were collected in CUA3 due to intrusive activities or former ordnance areas.

4.2.2.5.2 Soil samples collected for the RI were analyzed for CA/ABPs, explosives, and select metals. The analytical results for these samples are presented in Appendix B. It should be noted that not all samples were analyzed for all analytes.

4.2.2.5.3 As shown in Tables 4-14 and 4-15, CA/ABPs and explosives were not detected in any of the soil samples collected within CUA3; therefore, CA/ABPs and explosives were not retained as COPCs for further consideration in the risk assessment in Chapter 7. One metal was detected which exceeded the PSV and background value, copper, and will be included in the risk assessment in Chapter 6 (Table 4-15).

4.2.2.5.4 Copper. Copper was detected in seven samples, but concentrations of copper that exceeded the PSV were found in only one surface soil sample, the one collected after the demolition activity, WITH-DEMOPOST-SB-01. This sample had a concentration of 280 mg/kg which exceeds the PSV of 150 mg/kg. The pre-demolition surface soil sample, WITH-DEMOPRE-SS-01, had an estimated concentration of 0.45J mg/kg, far below the PSV. As detailed in Paragraph 3.3.2.3.5, five follow-on samples were collected and analyzed for copper. All five samples had detections of copper which ranged from 0.38J mg/kg to 20.5 mg/kg; however, all are well below the PSV and much lower than the post-demolition concentration.

4.2.2.5.5 No other samples collected from the Withlacoochee Site had copper concentrations that exceeded the PSV; therefore, the area of potential contamination is limited to the location of sample WITH-DEMOPOST-SB-01. Copper is not a component of the EK-4 10-lb chemical bomblet pieces which were destroyed, but is a component of the perforator used to destroy the munitions, so it is highly likely that the copper concentration in soil at this location is due to the demolition activity itself.

Table 4-14
Summary Statistics Table for Surface Soil Samples
Withlacoochee Site – CUA3

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)[1]	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
CA/ABPs							
Lewisite	0	2	0	--	--	0.3	0
Mustard (HD)	0	2	0	--	--	0.01	0
Nitrogen Mustard (HN-1 and HN-3)	0	2	0	--	--	0.1	0
1,4-Dithiane	0	2	0	--	--	610	0
1,4-Thioxane	0	2	0	--	--	610	0
N-Ethyldiethanolamine	0	2	0	--	--	0.13	0
Diethanolamine	0	2	0	--	--	120	0
Triethanolamine	0	2	0	--	--	0.13	0
Explosives							
1,3,5-Trinitrobenzene	0	2	0	--	--	0.090	0
1,3-Dinitrobenzene	0	2	0	--	--	0.0040	0
2,4,6-Trinitrotoluene (TNT)	0	2	0	--	--	0.0060	0
2,4-Dinitrotoluene	0	2	0	--	--	0.0060	0
2,6-Dinitrotoluene	0	2	0	--	--	0.00040	0
2-Amino-4,6-dinitrotoluene	0	2	0	--	--	0.00040	0
2-Nitrotoluene	0	2	0	--	--	0.90	0
3-Nitrotoluene	0	2	0	--	--	1.4	0
4-Amino-2,6-dinitrotoluene	0	2	0	--	--	150	0
4-Nitrotoluene	0	2	0	--	--	0.90	0

Table 4-14 (continued)
Summary Statistics Table for Surface Soil Samples
Withlacoochee Site – CUA3

Analyte	Number of Samples with Analyte Detected	Total Number of Samples	Percent Detected (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (mg/kg)[1]	Number of Samples with Detected Concentrations Greater than PSV (mg/kg)
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0	2	0	--	--	0.0020	0
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0	2	0	--	--	1.4	0
Nitrobenzene	0	2	0	--	--	0.020	0
Nitroglycerin	0	2	0	--	--	0.030	0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0	2	0	--	--	3,800	0
Pentaerythritol Tetranitrate (PETN)	0	2	0	--	--	120	0
Metals							
Antimony	0	2	0	--	--	5.4	0
Arsenic	1	2	50	0.39J	0.39J	0.61	0
Barium	2	2	100	2.5	4.1	120	0
Copper	**7**	**7**	**100**	**0.38J**	**280**	**150**	**1**
Lead	2	2	100	2.6	79	400	0
Manganese	2	2	100	1.6	16	3,500	0
Nickel	1	2	50	1.6	1.6	130	0
Zinc	1	2	50	49	49	26,000	0

N/A - Not applicable. J - Analyte detected, estimated concentration.
-- Not detected.
1) Preliminary Screening Values as shown in Table 5-8.

Table 4-15
Surface Soil COPC Evaluation for Munitions Constituents Sampling Results
Withlacoochee Site – CUA3

Analyte	Maximum Detected Concentration[1] (mg/kg)		Preliminary Screening Value [2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
CA/ABPs								
Lewisite	ND		0.3	No	--	No	Not detected at site	None
Mustard (HD)	ND		0.01	No	--	No	Not detected at site	None
Nitrogen Mustard (HN-1 and HN-3)	ND		0.1	No	--	No	Not detected at site	None
1,4-Dithiane	ND		610	No	--	No	Not detected at site	None
1,4-Thioxane	ND		610	No	--	No	Not detected at site	None
N-Ethyldiethanolamine	ND		0.13	No	--	No	Not detected at site	None
Diethanolamine	ND		120	No	--	No	Not detected at site	None
Triethanolamine	ND		0.13	No	--	No	Not detected at site	None
Explosives								
1,3,5-Trinitrobenzene	0.20	U	0.090	No	N/A	No	Not detected at site	None
1,3-Dinitrobenzene	0.20	U	0.0040	No	N/A	No	Not detected at site	None
2,4,6-Trinitrotoluene (TNT)	0.20	U	0.0060	No	N/A	No	Not detected at site	None
2,4-Dinitrotoluene	0.20	U	0.0060	No	N/A	No	Not detected at site	None
2,6-Dinitrotoluene	0.20	U	0.00040	No	N/A	No	Not detected at site	None
2-Amino-4,6-dinitrotoluene	0.20	U	150	No	N/A	No	Not detected at site	None
2-Nitrotoluene	0.20	U	0.90	No	N/A	No	Not detected at site	None
3-Nitrotoluene	0.20	U	1.4	No	N/A	No	Not detected at site	None
4-Amino-2,6-dinitrotoluene	0.20	U	150	No	N/A	No	Not detected at site	None
4-Nitrotoluene	0.20	U	0.90	No	N/A	No	Not detected at site	None
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.20	U	0.0020	No	N/A	No	Not detected at site	None
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0.20	U	1.4	No	N/A	No	Not detected at site	None
Nitrobenzene	0.20	U	0.020	No	N/A	No	Not detected at site	None

Analyte	Maximum Detected Concentration[1] (mg/kg)	Preliminary Screening Value [2] (mg/kg)	Exceeds Preliminary Screening Value?	Background Value [3] (mg/kg)	Further Evaluation Required?	Determination of COPC/COPEC or Primary reason for exclusion from Further Evaluation	Associated Sample Name
Nitroglycerin	0.20 U	0.030	No	N/A	No	Not detected at site	None
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.20 U	3,800	No	N/A	No	Not detected at site	None
Pentaerythritol Tetranitrate (PETN)	1.0 U	120	No	N/A	No	Not detected at site	None
Metals							
Antimony	0.47 U	5.4	No	0.34	No	Not detected at site	None
Arsenic	0.39 J	2.1	No	--	No	Not detected above PSV	None
Barium	4.1	120	No	**14**	No	Not detected above PSV	None
Copper	**280**	**150**	**Yes**	2.1	**Yes**	**Detected above PSV and background value**	**WITH-DEMO-POST-SB-01**
Lead	79	400	No	9.3	No	Not detected above PSV	None
Manganese	16	3500	No	1.9	No	Not detected above PSV	None
Nickel	1.6	130	No	0.98	No	Not detected above PSV	None
Zinc	49	26,000	No	3.3	No	Not detected above PSV	None

1) Maximum Detected Concentration unless no detections were found.
2) Preliminary Screening Values as shown in Table 5-8.
3) Background values are defined as detailed in Subchapter 5.2.2.2.3.

U - Analyte was analyzed for but not detected above the sample specific detection limit.

J - Analyte detected, estimated concentration.

-- - Not detected in any background sample.

4.2.3 Analytical Data Validation

Data validation reviews for laboratory data were performed by the Parsons' Project Chemist for all sample results in accordance with the requirements contained in the Quality Assurance Project Plan (QAPP) and DoD QSM Version 4.2. Laboratory results were assessed for compliance with required precision, accuracy, completeness, and representativeness. Field QC results were evaluated for compliance with required precision, accuracy, and representativeness. Based on this review, all sample data were considered usable for project decision-making. A summary of the analytical data and copies of the data validation reports are included as Appendix B.

4.3 REVISED CONCEPTUAL SITE MODEL

As part of the TPP process, the TPP team developed a CSM that included the three areas based on information available at the time. The CSM developed in support of the TPP process is presented in Chapter 2 (Table 2-1). A CSM is a dynamic document that is to be evaluated and revised each time new information is received. Table 4-16 presents the Post-RI CSM that is based on the RI and prior studies. The revised CSM and ECSM diagrams (Figures 4.9 through 4.14) summarize the most current information for the MRA. The MEC and MC exposure pathways shown on these revised CSM and ECSM are discussed further in the following subsections.

4.3.1 Munitions and Explosives of Concern Exposure Pathways

4.3.1.1 A potentially complete MEC exposure pathway is present any time a receptor can come near or into contact with a source of MEC and interact with it in a manner that might result in its detonation. As discussed in Subchapter 2.1.1, complete exposure pathways commonly require the presence of four critical elements (USEPA, 1989); however, for MEC exposure pathways, these are simplified to three critical elements: a source of MEC (i.e., an explosively hazardous munition); a receptor (i.e., a person); and the potential for interaction between the MEC source and the receptor (i.e., the possibility that the munition might be touched, moved, or otherwise disturbed by the receptor). All these elements must be present for a potentially complete MEC exposure pathway to exist; the MEC exposure pathway is incomplete if any one of these three elements is absent. The following paragraphs discuss the anticipated exposure pathways for MEC at the Withlacoochee Site based on the results of this RI, previous investigations, and historical information. Exposure pathways are discussed relative to the proposed assessment areas.

4.3.1.2 Based on the geophysical surveys and intrusive investigation of geophysical anomalies, six areas potentially containing MEC were identified. Although only two of the areas were confirmed to have UXO (1 conventional, 1 CWM), all six areas are interpreted to contain MEC based on the limited number of anomalies investigated. These areas were discussed in Subchapter 4.1.1 and are shown in Figures 4.3 through 4.8. MEC exposure pathways are considered complete for all six areas. Table 4-16 presents the exposure pathway information.

Table 4-16
Details and Results of Remedial Investigation and Overview of Revised Conceptual Site Model
Former Withlacoochee Site, Hernando and Sumter Counties, Florida

Investigation Area Details	Details and Results of Remedial Investigation				Conceptual Site Model Summary				
	Investigation Methods	Investigation Locations	Investigation Acreage/ Number of Samples	Investigation Results	Confirmed Contamination Sources	Confirmed Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Complete Exposure Pathways
NAME: Chemical Use Area #1 and ATG (CUA1) **Acreage:** 16,960 acres **Suspected Past DoD Activities (release mechanisms):** During World War II, a variety of chemical munitions were tested at the Withlacoochee Site. These munitions included chemical bombs; chemical rocket warheads; aircraft spray tanks, smoke pots and thermal generators with chemical fillers, and chemical mortars. In addition, conventional munitions that may have been used included small arms, practice bombs, and practice rockets. **Current and Future Land Use:** Withlacoochee State Forest and Richloam State Fish Hatchery. The hatchery covers 180 acres and includes the Florida Bass Conservation Center offices, and a visitor's center.	DGM and analog surveys, and intrusive investigation	DGM or analog surveys in identified areas; intrusive investigation in higher and lower anomaly density areas (higher and lower anomaly density areas delineated by Parsons Project Geophysicist using Geosoft, VSP, and/or other appropriate analytical tool; delineations reviewed and concurred by USACE Project Geophysicist). **Total acres investigated: 112.5** **Grids: 67**	NP Forest: 46 acres, 23 anomalies investigated	MD: large frag, fuze parts, fuze adapters, base plate from 4.2 inch mortars; EK-4 (M74?) bomb bodies; empty 500-lb bomb body and frag; 23 locations.	MD from 4.2-inch chemical mortars; EK-4 10-lb chemical bomblets; Mk II 500-lb chemical bomb	Estimated area of concentrated MD is approximately 46 acres	Soil, surface to 20 inches below the ground surface	Construction Workers, Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 36 inches.
			A and B Forests: 74 acres, 20 anomalies investigated	MD: frag; 13 locations	MD from chemical munitions tests.	Estimated area of concentrated MD is approximately 74 acres	Soil, surface to 14 inches below the ground surface	Construction Workers, Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 36 inches.
			D Meadow: 14 acres, 11 anomalies investigated	MD: 4.2-inch mortar base plate and frag; 9 locations	MD from 4.2-inch chemical mortars	Estimated area of concentrated MD is approximately 14 acres	Soil, surface to 13 inches below the ground surface	Construction Workers, Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 36 inches.
			F Meadow: 61 acres; 60 anomalies investigated	CWM: Unexploded liquid-filled EK-4 10-lb chemical bomblet; 1 location. MD: base plates, tail booms, fuze adapters and frag from 4.2-inch mortars; 51 locations	CWM - EK-4 100-lb chemical bomblet; MD from 4.2-inch chemical mortars	Estimated area of concentrated MD is approximately 61 acres	Soil, surface to 16 inches below the ground surface	Construction Workers, Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 36 inches.
			ATG Range: 35 acres, 5 anomalies investigated	MD: Burster tube, nose fuze, and frag from AN-M47 100-lb bombs; 2 locations	MD from M47 100-lb bombs	Estimated area of concentrated MD is approximately 35 acres	Soil, surface to 40 inches below the ground surface	Construction Workers, Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 36 inches.
	Collect discrete soil samples and analyze for MC	Where MEC and selected MD were found, at locations of former munitions finds, ground scars, and within the suspected Toxic Gas Yard.	68 discrete surface soil samples and 80 subsurface samples collected, 24 of the samples were focused around an area with high level of contaminant (barium).	No CA/ABPs, explosives, or VOCs identified. Arsenic and barium exceeded PSV in both surface and subsurface soil	Munitions Constituents: Surface Soil - Arsenic, Barium Subsurface Soil - Arsenic, Barium	Barium exceedance located at south end of former ATG range. 5 arsenic exceedances located just south of the A&B Forest test area, 1 located in the NP Forest test area.	Soil, surface (0-2") and subsurface (2-24")	Construction Workers, Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 36 inches.
NAME: Chemical Use Area #2 (CUA2) **Acreage:** 640 acres **Suspected Past DoD Activities (release mechanisms):** Chemical munitions and equipment tests **Current and Future Land Use:** Withlacoochee State Forest	DGM and analog surveys, and intrusive investigation	DGM or analog surveys in identified areas; intrusive investigation in higher and lower anomaly density areas (higher and lower anomaly density areas delineated by Parsons Project Geophysicist using Geosoft, VSP, and/or other appropriate analytical tool; delineations reviewed and concurred by USACE Project Geophysicist). **Total acres investigated: 6.25** **Grids: 15**	G Forest: 19 acres; 17 anomalies investigated	MEC: 1 EK-4 10-lb chemical bomb, no filler (UXO); 1 location in Grid CUA2-006. MD: EK-4 10-lb chemical bomb pieces; 16 locations.	UXO EK-4 10-lb chemical bomblet. MD from EK-4 10-lb chemical bomblets.	Estimated area of concentrated MEC/MD is approximately 19 acres	Soil, surface to 16 inches below the ground surface	Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 24 inches.

Investigation Area Details	Details and Results of Remedial Investigation				Conceptual Site Model Summary				
	Investigation Methods	Investigation Locations	Investigation Acreage/ Number of Samples	Investigation Results	Confirmed Contamination Sources	Confirmed Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Complete Exposure Pathways
	Collect discrete soil samples and analyze for MC	Where MEC and selected MD were found, at locations of former munitions finds, ground scars.	7 discrete surface soil samples and 4 subsurface samples collected. 2 of the samples were focused around an area with high level of contaminant (TNT).	No CA/ABPs, or VOCs identified. Arsenic and TNT exceeded PSV in both surface and subsurface soil	Munitions Constituents: Surface Soil - Arsenic, TNT Subsurface Soil - Arsenic	TNT and arsenic exceedances found in Grid CUA2-006 (location of MEC find).	Soil, surface (0-2") and subsurface (2-24")	Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 24 inches.
NAME: Chemical Use Area #3 (CUA3) **Acreage:** 640 acres **Suspected Past DoD Activities (release mechanisms):** Chemical munitions and equipment tests; static firing only **Current and Future Land Use:** Withlacoochee State Forest	DGM and analog surveys, and intrusive investigation	DGM or analog surveys in identified areas; intrusive investigation in higher and lower anomaly density areas (higher and lower anomaly density areas delineated by Parsons Project Geophysicist using Geosoft, VSP, and/or other appropriate analytical tool; delineations reviewed and concurred by USACE Project Geophysicist). **Total acres investigated: 6.25** **Grids: 6**	6 grids; 27 anomalies investigated	MEC/MD: None present	None	Not present	Not applicable	Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 24 inches.
	Collect discrete soil samples and analyze for MC	Where detonations were used to destroy munitions. Demo conducted in grid CUA3-003.	7 discrete surface soil samples collected, 5 of the samples were focused around an area with high level of contaminant (copper).	No CA/ABPs, explosives, or VOCs identified. Copper exceeded PSV in post-demolition surface soil sample.	Munitions Constituents: Copper	Copper exceedance only found in post-demo sample. Follow on samples had no exceedances.	Soil, surface (0-2")	Commercial/ Industrial Workers, Site Visitors, Ecological	Receptor activities at the soil surface and to a depth of 24 inches.

4.3.2 Munitions Constituents Exposure Pathways

An exposure assessment includes identification of potential exposure pathways, receptors, and exposure scenarios, as well as quantification of exposure. Characterization of the exposure setting and identification of all potentially exposed receptors and exposure pathways are discussed in this subchapter. Based on results of the MEC and MC characterizations conducted as presented above, the preliminary CSMs for each area described in Subchapter 3.1.1 were reviewed and updated to reflect any new applicable information. The revised CSMs (Figures 4.9, 4.10, and 4.11) and ECSMs (Figures 4.12, 4.13, and 4.14) summarize the most current information for the areas. The MEC and MC exposure pathways shown on these revised CSMs are discussed further in the following subsections. USEPA (1989) defines an exposure pathway as:

> *"The course a chemical or physical agent takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., air) or media (in cases of intermedia transfer) is also included."*

4.3.2.1 Known Contamination Areas and Source Media

4.3.2.1.1 As previously described, MEC hazards have been identified for five areas in CUA1 (NP Forest, A and B Forests, D Meadow, F Meadow, and ATG Range) and one area of CUA2 (G Forest). The basis for this conclusion is summarized below.

- NP Forest – 23 anomalies investigated to identify large pieces of frag, fuze parts, fuze adapters, a base plate from a 4.2-inch mortar, EK-4 bomblet bodies, and an empty 500-lb bomb body.
- A & B Forests – 20 anomalies investigated to identify MD and frag.
- D Meadow – 11 anomalies investigated to find MD, a 4.2-inch mortar base plate, and frag.
- F Meadow – 60 anomalies investigated to find one unexploded mustard-filled EK-4 chemical bomblet (CWM) and base plates, half shells, tail booms, fuze adapters, and frag from 4.2-inch mortars.
- ATG Range – 5 anomalies investigated to find a burster tube, nose fuze, and frag from a AN-M47 100-lb bombs.
- G Forest – 17 anomalies investigated to find one EK-4 bomblet with burster but no liquid filler (UXO) and MD in the form of bomb bodies, brackets, fuze, nose cap, banding strap, frag, and dispensers from EK-4 bomblets.

The remaining areas of CUA1 and CUA2 and all of CUA3 do not have MEC hazards identified.

4.3.2.1.2 As described in Subchapter 5.2.2, COPCs arsenic and barium were identified in surface and subsurface soil in CUA1. In CUA2, TNT was identified as a COPC in

surface soil and arsenic was identified as a COPC in surface and subsurface soil. In CUA3, copper was identified as a COPC in surface soil. No biased samples were collected from surface water or sediment and no groundwater samples were collected. No other contamination or source media were identified during this RI.

4.3.2.2 Potential Receptors

4.3.2.2.1 Potential human receptors are defined as individuals who may be exposed to site-related contaminants in environmental media. Consistent with USEPA (1989) guidance, current and reasonably anticipated land uses were considered in the receptor selection process. Current land use on the site includes state forest, wildlife management area, and Florida Bass Conservation Center (fish hatchery and visitors' center). There are three residences located near the Florida Bass Conservation Center in the CUA1; however, these residences are located on property owned by the State and used only by State employees and their families. Because these residences are not located in areas of concern and they are not open to the public for residential purposes, residents are not considered receptors for this site. Future land use is anticipated to be similar to current uses. Potential human receptors at this site may include commercial/industrial workers (i.e., forestry and Florida Bass Conservation Center workers), construction workers, and site visitors/recreational users (e.g., hunters, campers).

4.3.2.2.2 As discussed in Subchapter 2.1.1, the primary receptors at CUA1 include commercial/industrial workers (i.e., forestry and Florida Bass Conservation Center workers), construction workers, and site visitors/recreational users (e.g., hunters, campers), and ecological receptors. The activities performed by the commercial/industrial workers and site visitors are anticipated to be largely non-intrusive, resulting in potential exposure to surface soil, surface water, sediment, and groundwater (human receptors only). Construction workers may be exposed to both surface and subsurface soil during earth moving activities and therefore, mixed soil is a potential exposure media for those receptors. There are no residences located within CUA2 or CUA3, so residents are not considered potential receptors for those areas. With no development planned now or in the foreseeable future, construction workers are not considered potential receptors for CUA2 or CUA3.

4.3.2.2.3 Exposure of human receptors due to intrusive activities will vary depending on the activity. Forestry workers may be involved in felling trees and cutting firebreaks. These activities may reach depths of one to two feet (12 to 24 inches). Recreational users will be expected to interact with the upper one foot (12 inches) of the subsurface. Utility workers installing or removing underground water lines, telephone cables, and power cables would only do such work in developed areas (such as near the fish hatchery in CUA1) but may reach as deep as one to three feet (12 to 36 inches). Road maintenance in all areas of the MRA will consist of grading, cleaning and excavating drainage ditches, and installing and removing culverts, which will typically be expected to reach depths of one to two feet (12 to 24 inches).

4.3.2.2.4 As detailed in the Biological Monitoring Plan in Appendix M of the Work Plan (USA, 2014), all of the areas within the MRA have extremely similar terrain and environmental habitats. While some former test areas are named with "meadow", these areas are no longer meadows due to the natural progression of woody species. Any significantly

different habitats would be infrequent and cover a small area. All of the investigated areas have similar habitat and therefore similar ecological receptors.

4.3.2.3 Surface and Subsurface Soil Exposure Pathways

4.3.2.3.1 Potential exposure of human receptors to COPCs in surface soil could occur via incidental ingestion, dermal contact, and inhalation of re-suspended particulates. In CUA1, potential human receptors that could be exposed to COPCs through these pathways include commercial/industrial workers (i.e., forestry and Florida Bass Conservation Center workers), construction workers, and site visitors/recreational users (e.g., hunters, campers). These receptors could come into contact with MC in surface soil. In addition, exposure to MC in surface soil could occur through ingestion of game that has been exposed to MC. Mixed surface and subsurface soil is a complete exposure pathway only for construction workers who could be exposed during earth moving activities via incidental ingestion, dermal contact, and inhalation of re-suspended particulates. In CUA2 and CUA3, potential human receptors that could be exposed to COPCs through these pathways include commercial/industrial workers (i.e., forestry workers) and site visitors/recreational users (e.g., hunters, campers). These receptors could come into contact with MC in surface soil with additional exposure possible through ingestion of game that has been exposed to MC. Revised CSMs are shown in Figures 4.10, 4.11, and 4.12.

4.3.2.3.2 Potential exposure of ecological receptors to COPCs in surface soil could occur via incidental ingestion and root/dermal contact, and inhalation of re-suspended particulates. Additionally, exposure to MC in surface soil could occur through ingestion of other biota that have been exposed to MC. Subsurface soil is not a complete exposure pathway for ecological receptors. Revised ECSMs are shown in Figures 4.13, 4.14, and 4.15.

4.3.2.4 Incomplete Exposure Pathways

As shown in the CSM and ECSM exposure pathway flow diagrams (Figures 4.10 – 4.15), the following exposure pathways were evaluated and considered incomplete for human and ecological receptors at the Withlacoochee Site:

- *Surface Soil:*
  - *Inhalation of volatiles:*
    - CUA1: The potential receptors for this area are commercial/industrial workers (i.e., forestry and Florida Bass Conservation Center workers), construction workers, and site visitors/recreational users (e.g., hunters, campers), and ecological receptors. Volatiles are not an expected component of the munitions used at this site; however, select volatiles are a potential component used at the Toxic Gas Yard. Samples collected from the Toxic Gas Yard were analyzed for select volatiles, but no evidence of potential volatile contamination was identified. Therefore, this exposure pathway is incomplete.
    - CUA2: The potential receptors for this area are commercial/industrial workers (i.e., forestry workers), and site visitors/recreational users (e.g., hunters, campers), and ecological receptors. Volatiles are not an expected component of the munitions used at this site and during the RI no evidence was

seen of potential volatile contamination. Therefore, this exposure pathway is incomplete.

- CUA3: The potential receptors for this area are commercial/industrial workers (i.e., forestry workers), and site visitors/recreational users (e.g., hunters, campers), and ecological receptors. Volatiles are not an expected component of the munitions used at this site and during the RI no evidence was seen of potential volatile contamination. Therefore, this exposure pathway is incomplete.

- *Subsurface Soil:*
  - CUA2 and CUA3: The potential receptors for these areas are commercial/industrial workers (i.e., forestry workers), and site visitors/recreational users (e.g., hunters, campers), and ecological receptors. In general, none of these receptors have access to subsurface soil and no evidence was seen of potential subsurface soil contamination, so the subsurface soil exposure pathways are incomplete for CUA2 and CUA3.
- *Surface Water/Sediment:*
  - All Areas: There was no evidence of release to surface water or sediment at any of the areas; therefore, all of the surface water and sediment exposure pathways for all receptors are incomplete.
- *Groundwater:*
  - CUA2: There are no known wells located within this area and due to the current and future land use as a state forest, there are unlikely to be any in the future. Therefore, all of the exposure pathways for all receptors for groundwater in CUA2 are incomplete.
  - CUA3: There are no known wells located within this area and due to the current and future land use as a state forest, there are unlikely to be any in the future. Therefore, all of the exposure pathways for all receptors for groundwater in CUA3 are incomplete.

Figure 4.10
Conceptual Site Model

Site/MRS Name: Former Withlacoochee Site/Chemical Use Area #1 and ATG Range

Completed By: Kathy Rowland, PARSONS *Date Completed:* October 28, 2014

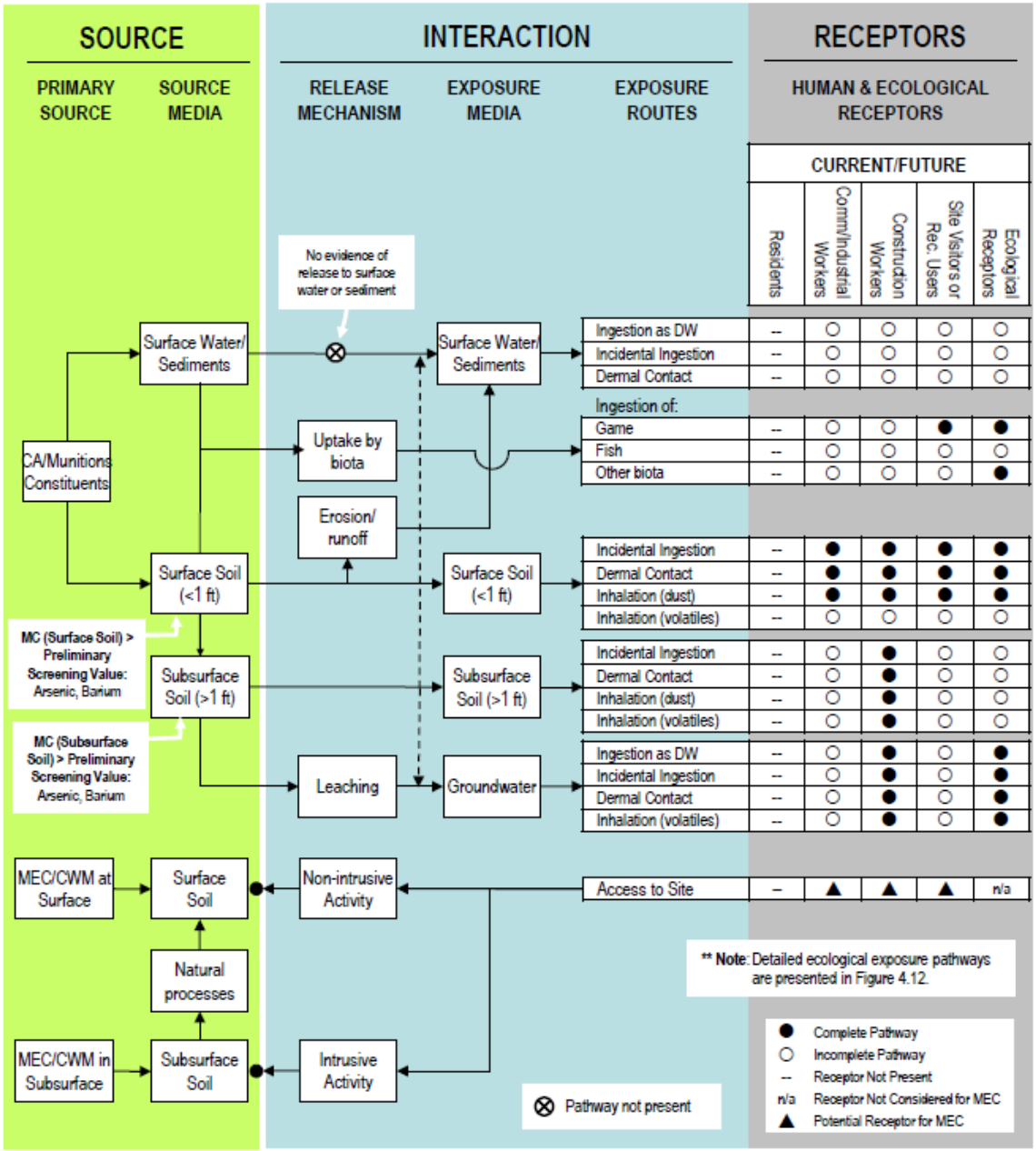


Figure 4.11
Conceptual Site Model

Site/MRS Name: Former Withlacoochee Site/Chemical Use Area #2

Completed By: Kathy Rowland, PARSONS *Date Completed:* October 28, 2014

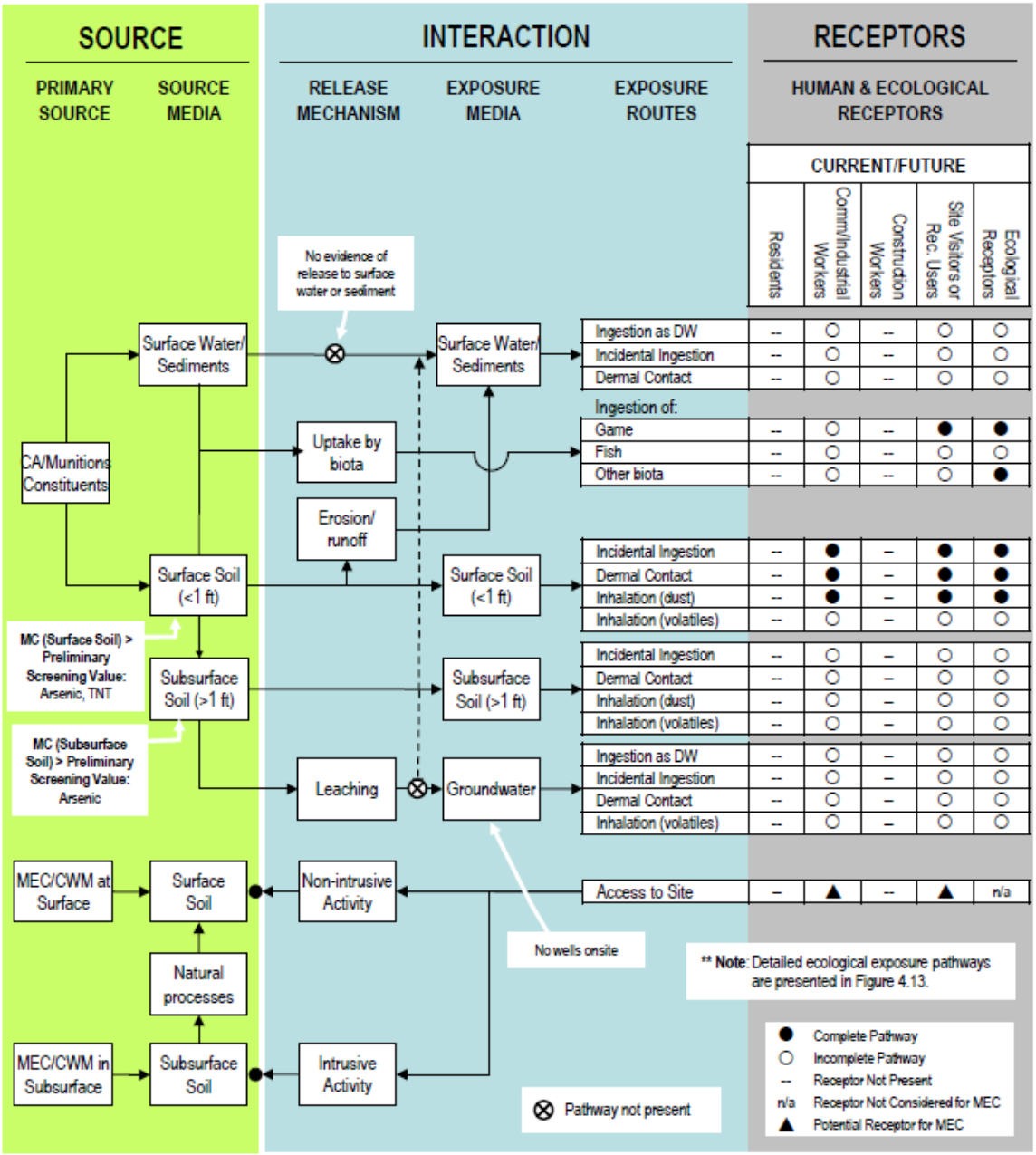


Figure 4.12
Conceptual Site Model

Site/MRS Name: Former Withlacoochee Site/Chemical Use Area #3

Completed By: Kathy Rowland, PARSONS *Date Completed:* October 28, 2014

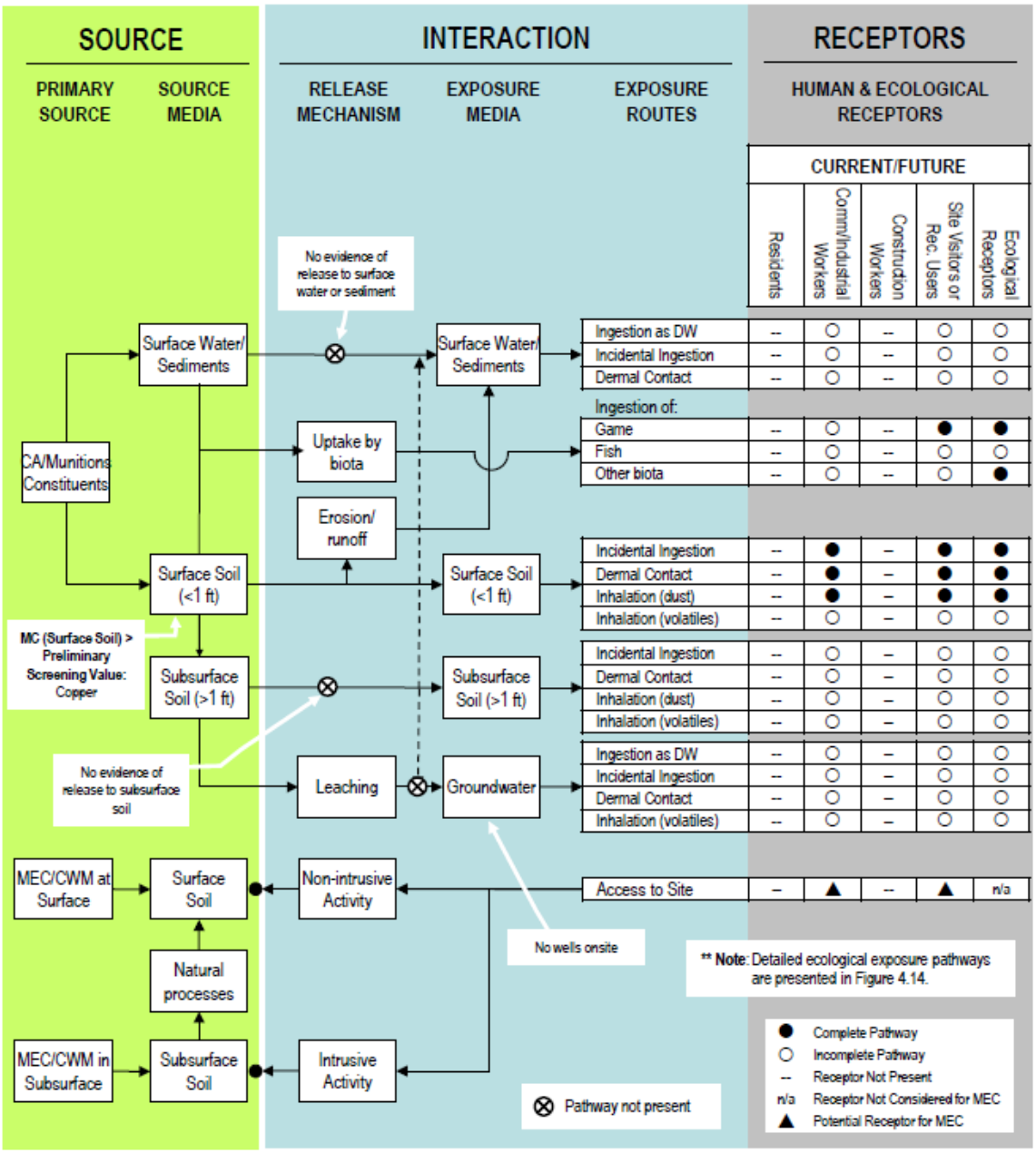


Figure 4.13
Ecological Conceptual Site Model

Site/MRS Name: Former Withlacoochee Site/Chemical Use Area #1 and ATG Range

Completed By: Kathy Rowland, PARSONS *Date Completed:* October 28, 2014

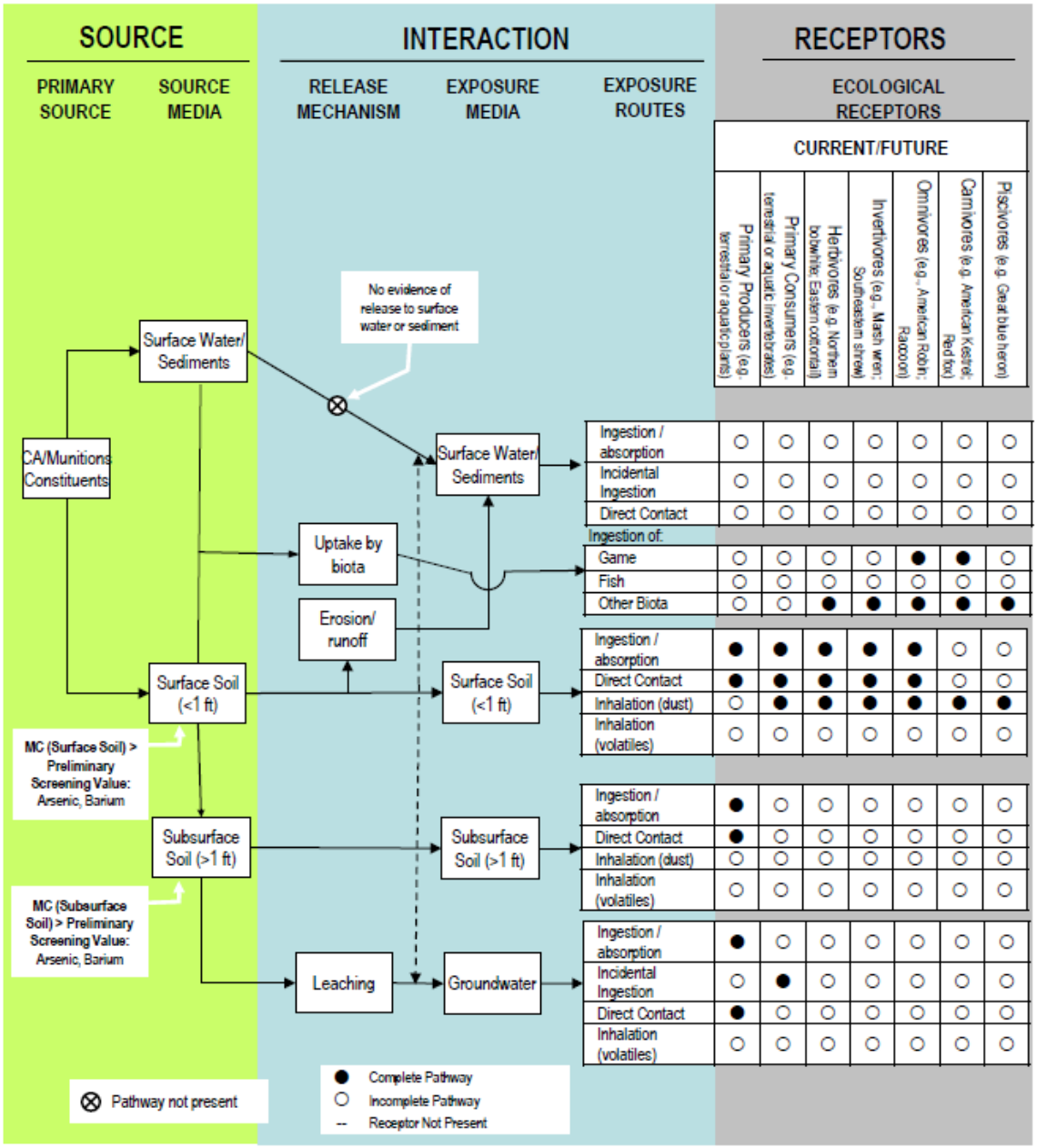


Figure 4.14
Ecological Conceptual Site Model

Site/MRS Name: Former Withlacoochee Site/Chemical Use Area #2

Completed By: Kathy Rowland, PARSONS *Date Completed:* October 28, 2014

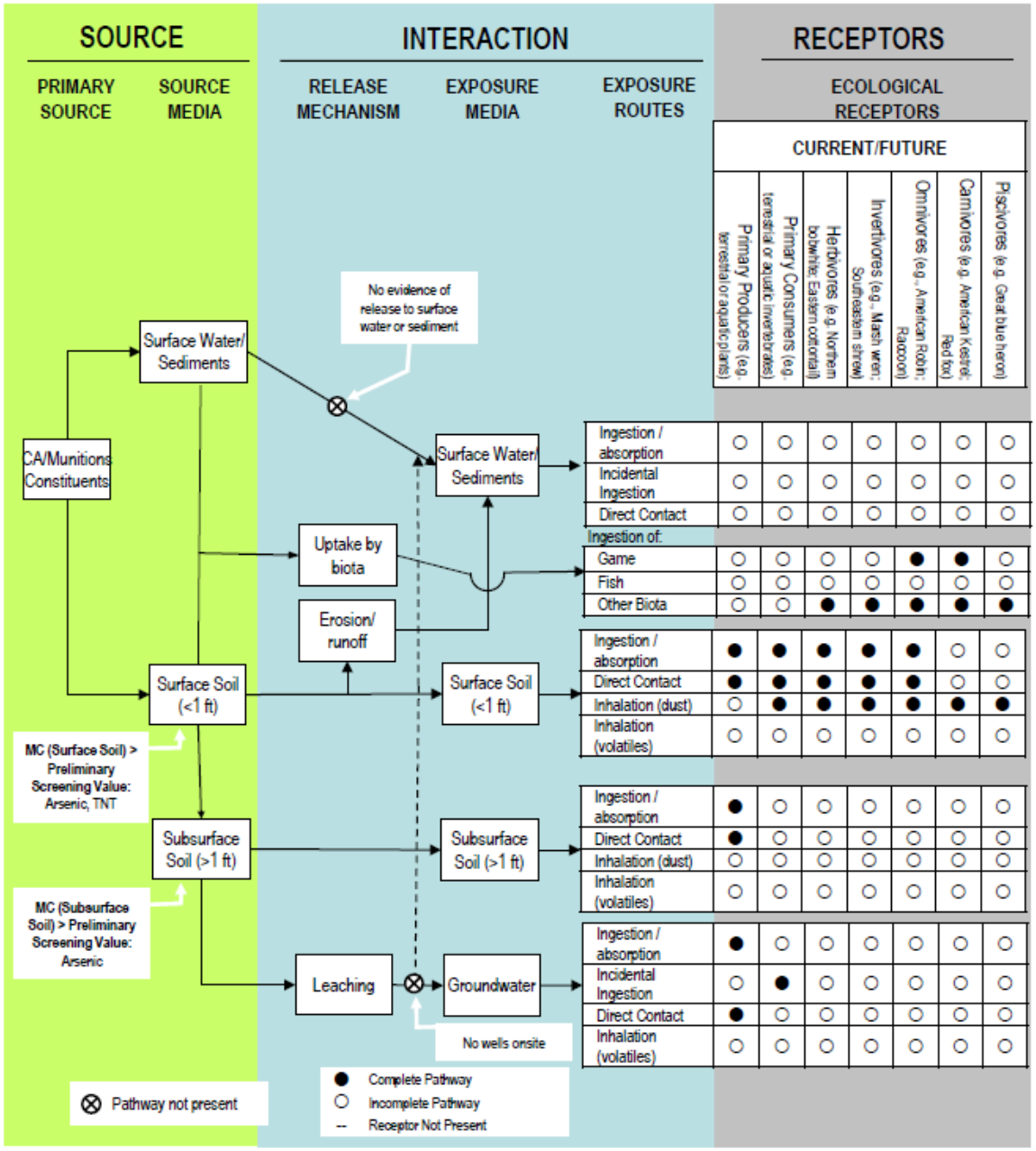
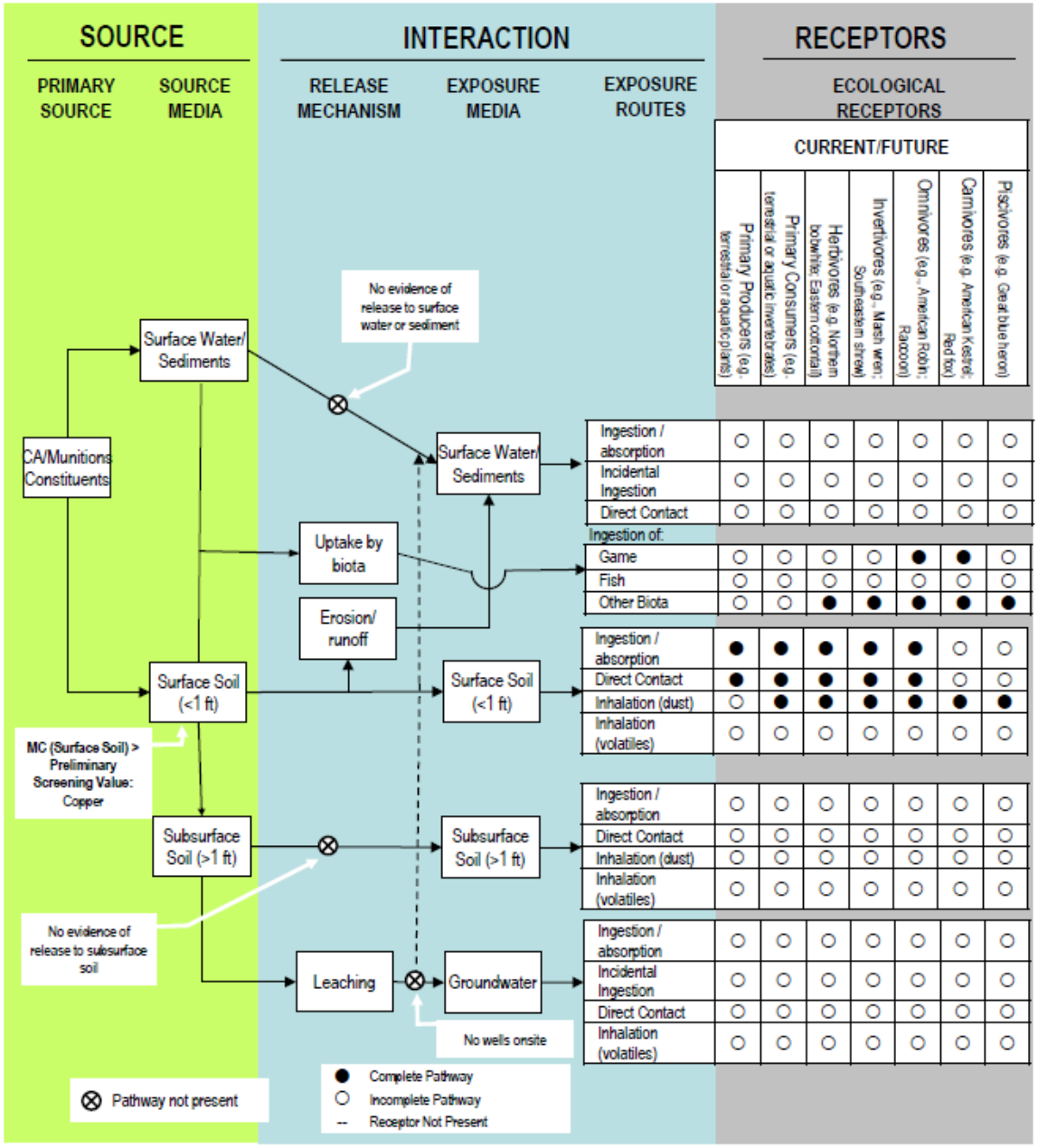


Figure 4.15
Ecological Conceptual Site Model

Site/MRS Name: Former Withlacoochee Site/Chemical Use Area #3

Completed By: Kathy Rowland, PARSONS *Date Completed:* October 28, 2014



5.0 CONTAMINANT FATE AND TRANSPORT FOR MC

MC may remain inside intact munitions or residual chemicals from munitions may be released to the environment during military activities. An understanding of the fate of the constituents released to the environment is important to determining the risk posed by those chemicals to human health and the environment. The following paragraphs discuss the potential routes of migration, the persistence of the various constituents, and the contaminant migration. The primary risk posed by MC at this site is through exposure to contaminated media and from the migration of chemicals through environmental media. For the purposes of this RI, a general discussion of MC fate and transport follows. Three metals, arsenic, barium, copper, and one explosive, TNT, which were detected at concentrations greater than PSVs (see Chapter 4), are evaluated in this chapter.

5.1 FATE AND TRANSPORT PROCESSES

Many different environmental processes act upon MC which may influence or alter its availability to interact with receptors. These processes are fully reliant on the media in which the source (MEC or MD) exists and the exposure of MC to the processes. These processes work through the different media: air, soil, surface water, groundwater, or biota. The following are short descriptions of these processes as described in Hewitt, *et al*. (2003):

- *Advection* – the passive movement of a solute with flowing water.
- *Dispersion* – the general term applied to the observed spreading of a solute plume and generally attributed to hydrodynamic dispersion and molecular diffusion.
- *Adsorption/desorption* – the process by which dissolved, chemical species accumulate (adsorption) at an interface or are released from the interface (desorption) into solution.
- *Diffusion* – the migration of solute molecules from regions of higher concentration to regions of lower concentration.
- *Biotic transformation* – the modification of a chemical substance in the environment by a biological mechanism.
- *Oxidation/reduction* – reactions in which electron(s) are transferred between reactants.
- *Covalent binding* – the formation of chemical bonds with specific functional groups in soil organic solids
- *Polymerization* – the process by which the molecules of a discrete compound combine to form larger molecules with a molecular weight greater than that of the original compound, resulting in a molecule with repeated structural units.
- *Photolysis* – the chemical alteration of a compound due to the direct or indirect effects of light energy.
- *Infiltration* – the process by which water enters the soil at the ground surface and moves into deeper horizons.
- *Evapotranspiration* – the collective processes of evaporation of water from water bodies, soil and plant surfaces, and the transport of water through plants to the atmosphere.

- *Plant root uptake* – the transport of chemicals into plants through the roots.
- *Sedimentation* – The removal from the water column of suspended particles by gravitational settling.

5.2 CONTAMINANT PERSISTENCE

5.2.1 Metals

Metals, although naturally occurring, can be a concern when casings, projectiles, or other components of military munitions corrode in the environment. Arsenic, barium, and copper were detected at concentrations above their PSV during the RI at the Withlacoochee Site.

5.2.2 Arsenic

5.2.2.1 Arsenic is an element widely distributed throughout the earth's crust usually combined in compounds of oxygen, chlorine, and sulfur (inorganic arsenic compounds) or with carbon or hydrogen (organic arsenic compounds). The inorganic arsenic compounds are naturally found in soils and rocks, especially where minerals or ores contain copper or lead.

5.2.2.2 Arsenic is not found as a constituent of any munition used at the Withlacoochee site. Arsenic was included in the metals list due to the fact that the PA reported that two drums of Lewisite were stored at the former Brooksville AAF; however no documentation exists showing that it was actually used at the Withlacoochee Site.

5.2.2.3 Arsenic cannot be destroyed in the environment, but can only change in form (through reaction with oxygen or microbe degradation) or become attached or separated from certain other elements. Many arsenic compounds are water soluble, so they may be readily transported to groundwater aquifers or surface water bodies. Most arsenic that bioaccumulates in fish or shellfish is in an organic form (arsenobetaine) that is much less harmful to humans than other arsenic compounds.

5.2.2.4 The general population may be exposed to arsenic via inhalation of ambient air, ingestion of food, and in some cases where children ingest soil. Arsenic in soil typically ranges from 1 to 40 ppm with a U.S. average of 3-4 ppm. Arsenic soil levels may be higher in industrial areas or those which have been historically treated with arsenic pesticides. From the 1910's to the 1950's, both Hernando and Sumter counties housed a number of arsenic vats used to treat livestock. By state law, all cattle, horses, mules, goats and other susceptible animals were required to be dipped in an arsenic-based solution every 14 days. The vats were filled with an arsenic solution for the control and eradication of the cattle fever tick.

5.2.2.5 Under some circumstances, the arsenic remaining at the site may present an environmental or public health hazard. Food is the highest form of typical arsenic intake in the general population. Arsenic is predominately found in seafood; however, as mentioned above, tends to be in a less harmful form. Children tend to ingest small amounts of dust or soil each day as they play, and in doing so, are exposed to arsenic compounds in soil.

5.2.3 Barium

5.2.3.1 Barium occurs naturally in the earth's crust and is present largely as compounds with other elements. Barium sulfate and barium carbonate are two compounds that are commonly found as underground ore deposits. Barium compounds are found naturally in food and drinking water. The types of barium compounds found in drinking water vary, as some compounds are not easily soluble in water. Those compounds which may be found in water are usually of the type which are not commonly found in nature and are most likely present due to localized anthropogenic sources.

5.2.3.2 Barium is documented as a constituent of some munitions including munitions used at the Withlacoochee Site. In particular, some primers and fuze primers contained barium nitrate, while rocket motors contained barium peroxide. The compositions of the various munitions are as follows.

- Barium nitrate is a constituent of the M2/M2A1 4.2-inch Gas Shell (in the primer).
- Mk1 through Mk4 and Mk6 2.25-inch Sub-Caliber Aircraft Rockets (SCAR) contained barium peroxide in the rocket motor.
- M38A2 100-lb Practice Bombs contained barium nitrate in the spotting charge.
- The M70 115-lb Chemical Bomb contained barium nitrate in the fuze primer.
- The T3 125-lb gas bomb contained barium nitrate in the fuze primer.
- The M89, M90, and M98 250-lb target identification bombs contained barium nitrate in the non-delay candles.
- The M78 500-lb chemical bomb and the M79 1,000-lb chemical bomb contained barium nitrate in the fuze primers.

The use and degradation of these munitions could result in the release of barium to the environment at the Withlacoochee Site.

5.2.3.3 Barium's persistence is determined by the form (compound) in which it is released. Non-soluble forms of barium (e.g. barium sulfate) have the potential to persist in the environment for a significant length of time, and those compounds which have greater water solubility tend to have a shorter life, but can eventually combine with sulfate or carbonate to form a more persistent compound. The sulfate and carbonate compounds have a higher partition to organic (soil) matter (Agency for Toxic Substances and Disease Registry [ASTDR], 2009).

5.2.3.4 The general population is exposed to barium through ambient air, especially in areas near industrial sources. Barium is not readily absorbed through the skin in the cases of direct contact with contaminated soil. The highest sources of barium intake are from food and water. Most public water supplies and surface waters have an average of 0.030 ppm barium or less, but have the potential of averaging as high as 0.3 ppm in some regions of the U.S. Water sources from underground wells can average slightly higher than the 2.0 ppm limit set by the USEPA. The amount of barium found in soil ranges from 15 to 3,000 ppm (mg/kg). Certain foods, such as nuts, fish, and certain plants have been found to contain high amounts of barium (ASTDR, 2009).

5.2.3.5 The amount of barium absorbed into the body depends on the type of barium compounds present. Those compounds which are soluble with water will enter the bloodstream more efficiently than those which are less soluble. Compounds which are readily absorbed into the bloodstream are filtered by the liver or kidneys and are excreted through the urine or feces within one to two weeks. Some barium which is not filtered may be incorporated into the teeth or bones (ASTDR, 2009).

5.2.4 Copper

5.2.4.1 Copper occurs in numerous minerals such as cuprite, tenorite, malachite, and azurite. It is an essential nutrient for humans, with dietary ingestion providing the primary source of the necessary copper (Hazardous Substances Data Bank [HSDB], 2012). Hydrolysis and precipitation reactions dominate the chemistry of copper compounds in most natural aqueous systems. Soluble copper compounds sorb strongly to suspended particles. The presence of complexing organic ligands can stabilize dissolved copper compounds in fresh water systems and prevent copper sorption onto solids. Most insoluble and soluble copper compounds are associated with solids, have low mobility in soil, and are not expected to volatilize from water or moist soil surfaces. There is no evidence that supports the existence of biotransformation processes for copper compounds which would have a significant bearing on the fate of copper in aquatic environments.

5.2.4.2 Copper is a component of military munitions, some of which have been documented as being used at the Withlacoochee Site, frequently as brass, bronze, or copper alloys.

- Copper is a constituent of the small arms (brass casings).
- The M2/M2A1 4.2-inch Gas Shell contains copper in the primer, the projectile rotating disc, and the fuze primer).
- The M74 10-lb bomb contains copper in the fuze primer and tail fuze.
- The M70 115-lb gas bomb contains copper in the nose fuze.
- The T3 125-lb gas bomb contains copper in the nose fuze and fuze primer.
- The M78 500-lb chemical bomb and M79 1,000-lb chemical bomb contain copper in the nose fuze and fuze primer.

The use and degradation of these munitions could result in the release of copper to the environment. Copper is also a constituent of the jet perforators frequently used for demolition of munitions during remedial actions.

5.2.4.3 The general population is exposed to copper primarily through the ingestion of water that has been transferred through copper pipes. This is especially significant in areas with corrosive water and copper piping. Occupational exposure can also be significant (HSDB, 2012). Occupational exposure to elevated levels of copper compounds may occur through inhalation and dermal contact in the workplace where copper compounds are produced or used.

5.2.5 Explosives

Explosive compounds can be found in the environment as a result of these constituents leaching from munitions, from heavy munition use, or from demolition activities performed to decommission a UXO. To determine the potential existence of these MC within the sites investigated, environmental samples were collected and analyzed during the RI field effort. TNT was detected in these samples above screening levels at the Withlacoochee site. Explosives are classified as "primary" or "secondary." Secondary explosives are used in much greater quantities in munitions than primary explosives, and are known to be more prevalent at military installations (USEPA, 2006).

5.2.6 Trinitrotoluene (TNT)

5.2.6.1 2,4,6-Trinitrotoluene (TNT) constitutes one of the largest quantities of secondary explosives used in military applications because it is a major ingredient in nearly every munitions formulation.

5.2.6.2 At the Withlacoochee Site, TNT is a constituent of several munitions.

- The Mk42 100-lb Chemical Bomb (Navy) contains TNT in the burster.
- M70 115-lb Chemical Bomb contains TNT in the fuze primer.
- T3 125-lb Persistent Gas Bomb contains TNT in the fuze primer.
- AN-M78 500-lb Chemical Bomb contains TNT in the burster and fuze primer.
- AN-M79 1,000-lb Chemical Bomb contains TNT in the burster and fuze primer.

The use and degradation of these munitions could result in the release of TNT to the environment.

5.2.6.3 TNT in the atmosphere can take two forms; vapor phase TNT is typically reduced through photodegredation (half-life estimated at 120 days) while particulate phase TNT is typically removed from the atmosphere through wet or dry deposition. TNT has a very low mobility within soil, however varies pending the organic content of the soil. Biodegradation of TNT appears to occur more in anaerobic communities. TNT in water tends to adhere quickly to suspended particles and sediment. Volatilization from moist soil or surface water is not an important fate process (HSDB, 2007).

5.2.6.4 Studies demonstrated that explosives are more likely to be found at active installations where active or recent use of munitions has been documented. Published information regarding the fate and transport of 2-amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene is documented only in relation to TNT rather than as specific compounds. If released into water, TNT is expected to adsorb to suspended solids and sediment. Microbial transformation of TNT leads to a variety of reduction products, including 2-amino and 4-amino dinitrotoluene and azoxydimers. (HSDB, 2008).

5.3 SUMMARY

Three naturally occurring metals and one explosives analyte were detected at concentrations above screening levels and background levels at the Withlacoochee site. These constituents could be associated with munitions which were used in the area during operations. Constituents leaching from MEC or MD present the possibility of a contaminant release

into the environment, which could potentially affect humans or ecological receptors coming into contact with the contaminant. Risks associated with these MC and the pathways present will be further evaluated in Chapter 6.

6.0 BASELINE RISK ASSESSMENT FOR MC AND HAZARD ASSESSMENT FOR MEC

6.1 INTRODUCTION

6.1.1 The need for remedial actions to reduce risks to human health or the environment must be demonstrated through the use of either quantitative or qualitative risk assessment (RA). A baseline RA evaluates potential current and future adverse health effects caused by hazards (MEC) or hazardous substances (MC) released at a site in the absence of any actions to control or mitigate these releases. In addition, the baseline RA evaluates the magnitude of the risk at the site and the primary causes of that risk. Results of the baseline RA aid in the development, evaluation, and selection of appropriate response alternatives.

6.1.2 Baseline RAs are site-specific evaluations and may vary in both detail and extent to which qualitative and quantitative inputs are used. Generally, baseline RAs follow a phased approach, starting with generic assumptions and moving toward a more complex site-specific evaluation as necessary. Characteristics of the baseline RA depend on the complexity and particular circumstances of the site as well as the availability of ARARs and other guidance. The baseline RAs also consider the potential risks associated with current land use and activities, as well as reasonably anticipated future land use.

6.2 HUMAN HEALTH RISK ASSESSMENT FOR MUNITIONS CONSTITUENTS

6.2.1 General Human Health Risk Assessment Approach and Guidance Documents

6.2.1.1 Risk assessment techniques and methods developed or recognized by the USACE and the USEPA were used for this Human Health Risk Assessment (HHRA). The HHRA is intended to satisfy USACE requirements for a baseline risk assessment in support of the RI. As recommended by USACE, the quantitative HHRA uses a phased approach to quantify potential risk. FDEP SCTLS, USEPA RSLs and other screening values were used for the risk analyses.

6.2.1.2 The primary resources for conducting this HHRA are listed and described below:

- FDEP Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, Florida Administrative Code, Final February 2005.
- USEPA *Regional Screening Levels* (USEPA, 2013). These medium-specific RSLs are available for soil.
- The USEPA provides the basic background and approach for performing HHRAs (*e.g.*, data evaluation, exposure assessments, *etc*.). General procedures identified in the USEPA's *Risk Assessment Guidance for Superfund* (RAGS) series (USEPA,

1989), were followed for this HHRA in terms of data evaluation, exposure assessment, toxicity assessment, and risk characterization. Supplemental USEPA guidance was also used in conjunction with RAGS.

- *Risk Assessment Handbook, Volume I -- Human Health Evaluation*, Final, EM 200-1-4 (USACE, 1999).

6.2.2 Organization of this Human Health Risk Assessment

The overall HHRA process consists of four key steps: data evaluation, exposure assessment, toxicity assessment, and risk characterization. These four steps provide the general outline for a baseline risk assessment report. This HHRA is consistent with USEPA guidance as presented in RAGS and supporting supplemental guidance including the USACE's *Risk Assessment Handbook, Volume I -- Human Health Evaluation*. This HHRA is organized into seven subchapters, as outlined below:

- Subsection 6.2.3: Data Evaluation and Hazard Identification,
- Subsection 6.2.4: Exposure Assessment,
- Subsection 6.2.5: Toxicity Assessment,
- Subsection 6.2.6: CUA1 - Risk Characterization and Conclusions,
- Subsection 6.2.7: CUA2 – Risk Characterization and Conclusions,
- Subsection 6.2.8: CUA3 – Risk Characterization and Conclusions, and
- Subsection 6.2.9: Analysis of Uncertainties.

6.2.3 Data Evaluation and Hazard Identification

6.2.3.1 The comparison of detected concentrations to the selected human health screening criteria provides a conservative estimate of potential risk to human receptors. Detected concentrations less than the residential human health screening values are not expected to pose an unacceptable risk to residential receptors. However, because screening values are based on conservative exposure assumptions, even if a detected chemical is found at concentrations greater than the selected human health screening value, it does not necessarily indicate that an unacceptable risk is present. All chemicals that were retained after the comparison to the preliminary screening criteria were considered COPCs. Table 6-1 summarizes the COPCs retained for this risk assessment.

6.2.3.2 During the 2012-2014 RI field work, sampling and analysis for MC was performed. Samples were collected from locations based on MEC previously found during a clearance effort conducted in the 1950s, and CWM/MEC and select MD found during the RI field work. See Figures 3.3 through 3.9 for sample locations. No CA/ABPs were detected.

Table 6-1: Summary of COPCs, Withlacoochee Site

Analyte	Maximum Detected Concentration (mg/kg)	Preliminary Screening Value (1) (mg/kg)	Background Value (2) (mg/kg)	Reason for COPC Selection
CUA1				
Surface Soil				
Arsenic	2.4	2.1	--	Exceeds PSV
Barium	130	120	8.1	Exceeds PSV and background
Subsurface Soil				
Arsenic	13	2.1	--	Exceeds PSV
Barium	550	120	8.1	Exceeds PSV and background
CUA2				
Surface Soil				
2,4,6-Trinitrotoluene (TNT)	0.14J	0.0060	n/a	Exceeds PSV
Arsenic	3.0	2.1	--	Exceeds PSV
Subsurface Soil				
Arsenic	3.9	2.1	--	Exceeds PSV
CUA3				
Surface Soil				
Copper	280	150	2.4	Exceeds PSV and background

1) Preliminary Screening Values as shown in Table 5-8.
2) Background values are defined as detailed in Subchapter 5.2.2.2.3.
J - Analyte detected, estimated concentration.
-- - Not detected in any background sample.
n/a – Not applicable. Explosives are not naturally occurring. Therefore, no background values are established.

6.2.3.3 Surface and subsurface soil samples were collected during the RI. Sampling results for the chemicals detected in each environmental medium are summarized in Tables 4-10, 4-12, and 4-14. COPCs are summarized in Tables 4-11, 4-13, and 4-15. The CSMs in Figures 4.9, 4.10, and 4.11 identify the anticipated current and future human receptors as construction workers, commercial/industrial workers (site workers), and site visitors/recreational users for the CUA1 and commercial/industrial workers (site workers) and site visitors/recreational users for the CUA2 and CUA3.

6.2.4 Exposure Assessment

6.2.4.1 Objective

6.2.4.1.1 The objective of the exposure assessment is to estimate the nature, extent, and magnitude of potential exposures of human receptors to COPCs considering the current and reasonably anticipated future uses of the site. The exposure assessment includes identification of potential exposure pathways, receptors, and exposure scenarios, as well as

quantification of exposure, if needed. Characterization of the exposure setting and identification of all potentially exposed receptors and exposure pathways are discussed in this subchapter. CSM flow diagrams presenting results of the exposure assessment for each CUA are shown on Figures 4.9, 4.10, and 4.11. Quantification of exposure involves quantifying the magnitude, frequency, and duration of exposure for the receptors and exposure pathways of concern. The exposure assessment consists of three main steps:

- Evaluation of exposure pathways and identification of receptors (subsection 6.2.4.2);
- Estimation of exposure-point concentrations (subsection 6.2.4.3); and
- Estimation of human intake (subsection 6.2.4.5).

6.2.4.1.2 This risk assessment evaluates the reasonable maximum exposure (RME) risk estimate, as defined by USEPA (1993a). The RME is designed to be a measure of "high-end" exposure. The most sensitive exposure parameters are identified and the maximum of several of these are used along with average values for the remaining parameters. This approach is intended to account for both uncertainty in the contaminant concentration and variability in the exposure parameters (such as exposure frequency or averaging time).

6.2.4.1.3 Surface and mixed surface and subsurface soil are evaluated as the environmental medium of concern at CUA1. Surface soil is evaluated as the environmental medium of concern at CUA2 and CUA3. The exposure pathways relevant to the site are described in this exposure assessment and shown in the CSMs.

6.2.4.2 Potential Receptors and Exposure Pathways

6.2.4.2.1 Potential human receptors are defined as individuals who may be exposed to site-related contaminants in environmental media. Consistent with USEPA (1989) guidance, current and reasonably anticipated land uses were considered in the receptor selection process.

6.2.4.2.2 USEPA (1989) defines an exposure pathway as: "The course a chemical or physical agent takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., air) or media (in cases of intermedia transfer) is also included."

6.2.4.2.3 A review of potential exposure pathways links the sources, locations, and types of environmental releases with receptor locations and activity patterns to determine the significant pathways of concern.

6.2.4.2.4 Based on the previous investigations, the observations and reasonable assumptions for the potential human receptors and the exposure pathways for each CUA are listed below:

CUA1

- **Current Receptors** – The vast majority of the land area is currently undeveloped and part of the Withlacoochee State Forest. A small portion of land is used by Florida Bass Conservation Center (fish hatchery). Hunting, fishing, wildlife viewing, camping, horseback riding, hiking and bicycling are popular recreational activities within CUA1. There are no changes in land use planned for the area. The current receptors at CUA1 include state employees and fish hatchery employees who are evaluated as commercial/industrial workers (e.g., site workers), and hunters/campers/hikers evaluated as site visitors/recreational users. Construction workers are also potential receptors for CUA1. Incidental ingestion, dermal contact, inhalation of re-suspended particulates, and ingestion of game that has been exposed to MC are potential exposure pathways for surface soil at CUA1. Construction workers are potentially exposed to mixed surface and subsurface soil via incidental ingestion, dermal contact, inhalation of re-suspended particulates. Exposure of human receptors to COPCs in groundwater could occur via incidental ingestion and dermal contact. There are no complete exposure pathways to surface water or sediment. Thus, surface water and sediment are not evaluated further in this risk assessment.
- **Future Receptors** – Future land use is reasonably expected to remain undeveloped. Thus, future receptors and exposure pathways are expected to be the same as current receptors.

CUA2

- **Current Receptors** – CUA2 is currently part of the Withlacoochee State Forest with the exception of the northwestern quarter-section of the site, which is privately owned but undeveloped. Hunting, fishing, wildlife viewing, camping, horseback riding, hiking and bicycling are popular recreational activities within this CUA. There are no changes in land use planned for the area. The current receptors at CUA2 include state employees who are evaluated as commercial/industrial workers (e.g., site workers), and hunters/campers/hikers evaluated as site visitors/recreational users. Incidental ingestion, dermal contact, inhalation of re-suspended particulates, and ingestion of game that has been exposed to MC are potential exposure pathways for surface soil at CUA2. There are no complete exposure pathways to subsurface soil, surface water, sediment, or groundwater. Thus, subsurface soil, surface water, sediment, and groundwater are not evaluated further in this risk assessment.
- **Future Receptors** – Future land use is reasonably expected to remain undeveloped. Thus, future receptors and exposure pathways are expected to be the same as current receptors.

CUA3

- **Current Receptors** –CUA3 is currently part of the Withlacoochee State Forest. Hunting, fishing, wildlife viewing, camping, horseback riding, hiking and bicycling are popular recreational activities within this CUA. There are no changes in land

use planned for the area. The current receptors at CUA3 include state employees who are evaluated as commercial/industrial workers (e.g., site workers), and hunters/campers/hikers evaluated as site visitors/recreational users. Incidental ingestion, dermal contact, inhalation of re-suspended particulates, and ingestion of game that has been exposed to MC are potential exposure pathways for surface soil at CUA3. There are no complete exposure pathways to subsurface soil, surface water, sediment, or groundwater. Thus, subsurface soil, surface water, sediment, and groundwater are not evaluated further in this risk assessment.

- **Future Receptors** – Future land use is reasonably expected to remain undeveloped. Thus, future receptors and exposure pathways are expected to be the same as current receptors.

6.2.4.3 Exposure Point Concentrations

Exposure Point Concentrations (EPC) are the concentrations of chemicals in a given medium to which a receptor may be exposed at a specific location or area known as the "exposure point". As a conservative measure, the exposure point is represented by the maximum detected concentration (MDC) of the COPC in the selected medium. Due to the small number of samples collected for each area, a representative 95% UCL could not be calculated. Because the MDC is a higher value than the 95% UCL, using the MDC in the risk assessment results in the most conservative, or highest, risk values possible for the site. No risk to human health or ecological receptors was identified using the MDC; therefore, using the 95% UCL, if it was available, would result in even lower risk estimations. For mixed surface and subsurface soil evaluation, the highest of the maximum detected concentration between the two media was used, in this case, from the subsurface soil.

6.2.4.4 Exposure Areas

6.2.4.4.1 CUA1 encompasses approximately 16,960 acres. The site was formerly used for chemical munitions and equipment tests; air-to-ground gunnery training (small arms ammunition), rocket firing, and possible practice bombing. The site is currently part of the Withlacoochee State Forest and also contains the fish hatchery. State Highway 471 comprises the western border of CUA1. EPCs and estimations of risk will be calculated for each COPC selected for this exposure area.

6.2.4.4.2 CUA2 encompasses approximately 640 acres. The site was formerly used for chemical munitions and equipment tests. The site is currently part of the Withlacoochee State Forest with the exception of the northwestern quarter-section of the site, which is privately owned. State Highway 50 runs through the southeastern corner of CUA2. EPCs and estimations of risk will be calculated for each COPC selected for this exposure area.

6.2.4.4.3 CUA3 encompasses approximately 640 acres. The site was formerly used for chemical munitions and equipment tests. The site is currently part of the Withlacoochee State Forest. The Little Withlacoochee River flows westward in a bend through the CUA3. EPCs and estimations of risk will be calculated for each COPC selected for this exposure area.

6.2.4.5 Estimation of Human Intake

6.2.4.5.1 RME exposure estimates were used in this RA. The RME is designed to be a measure of "high-end" exposure and is the maximum exposure reasonably expected to occur in a population. The most sensitive exposure parameters were identified and the 90th percentile of several of these parameters was used, along with average values for the remaining parameters. This approach is intended to account for both uncertainty in the contaminant concentration and variability in the exposure parameters (such as exposure frequency or averaging time).

6.2.4.5.2 To evaluate human intake of COPCs, assumptions regarding exposure parameters were made. Human intake, expressed as milligrams of chemical per kilogram of body weight per day (mg/kg-day), was obtained by multiplying the EPC by the exposure factors specific to an exposure scenario. The resultant intake was combined with a carcinogenic slope factor, or compared to a non-carcinogenic reference dose, to derive the carcinogenic and non-carcinogenic risk estimates associated with potential exposures from the site.

6.2.4.5.3 The following general equation is used to quantify exposure to potential receptors:

$$\text{Intake} = \frac{(C)(CR)(EF)(ED)}{(BW)(AT)}$$

Where:

C	=	Chemical concentration in medium
CR	=	Contact rate (amount/unit time)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kilograms [kg])
AT	=	Averaging time (days: equal to ED for non-carcinogens and 70 years for carcinogens x 365 days/year)

6.2.4.5.4 In accordance with USEPA guidance (1989), human intake for carcinogens is calculated differently from those for non-carcinogens. For carcinogens, human intake is averaged over an assumed lifetime of 70 years. This is appropriate because cancer is considered to be a non-threshold phenomenon, and multiple individual chemical exposures which could result in the development of cancer are accrued over a lifetime. The probability of developing cancer is believed to be proportional to the duration and intensity of exposure. That is to say, the probability of developing cancer is proportional to the dose of chemical absorbed into the body, the frequency of exposure, and the duration of exposure.

6.2.4.5.5 For non-carcinogens, the intake is averaged only over the duration of exposure. This reflects the assumption that non-carcinogenic effects have a toxicity threshold. Adverse health effects would result if the toxicity threshold were exceeded for a period of time corresponding to the exposure duration. Conversely, intake of a chemical below the toxicity threshold for a period of time corresponding to the exposure duration would not be expected to result in adverse health effects in the receptor.

6.2.4.5.6 All values used to calculate intake are presented herein. Where appropriate, site-specific information is used to develop reasonable, yet conservative, exposure factors.

When neither site-specific information nor default values are available, best professional judgment was used to develop exposure parameters.

6.2.4.5.7 **Soil intake factors**, in kg soil/kg-day, are estimated as follows:

Ingestion of soil, in mg/kg-day, was estimated as follows:

$$Ingestion = \frac{C_S \times IRS \times EF \times ED \times CF_S \times CF \times SFo \times ET}{AT \times BW}$$

Where:

Cs = Contaminant concentration in soil (mg/kg)
IRS = Ingestion rate soil (mg soil/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF_s = Conversion factor for soil (10^{-6} kg/mg)
CF = Conversion factor (0.04 day/hour)
SFo = Oral Slope Factor
ET = Exposure Time (hour)
AT = Averaging time (days: equal to ED for noncarcinogens x 365 days/year)
BW = Body weight (kg)

The **inhalation exposure concentration**, in µg/m^3, was estimated as follows:

$$Inhalation = \frac{C_a \times ET \times EF \times ED \times IUR}{AT \times 365\ days/year}$$

Where the **contaminant concentration in air**, in µ/m^3, was estimated as follows:

$$C_a = \frac{C_S \times 1000\ \mu g/mg}{PEF}$$

Where:
C_a = Contamination concentration in air (µg/m^3)
C_S = Chemical concentration in soil (mg/kg)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
IUR = Inhalation Unit Risk
AT = Averaging time (hours: equal to ED for noncarcinogens x 365 days/year x 24 hours/day)
PEF = Particulate emission factor (m^3/kg)

6.2.4.5.8 Table 6-2, Table 6-3, and Table 6-4 provide the exposure parameters, justification for the parameter value, and source of the value for these soil exposure pathways.

Table 6-2: Exposure Parameters for Soil Pathways: Ingestion, Dermal Absorption, and Inhalation, Current/Future On-Site Commercial/Industrial Worker

Exposure Variable	Reasonable Maximum Exposure (RME)	Rationale	Reference
IRS = Ingestion Rate, soil (mg/day)	100	USEPA recommended value for outdoor industrial worker. Exhibit 1-2.	USEPA 2002a
FC = Fraction Contacted	1	Assumes entire exposure time spent at one exposure area.	
AF = Dermal Adherence Factor, soil (mg/cm^2)	0.2	USEPA recommended value for outdoor industrial worker Exhibit 3-3. FDEP 2005 defers to RAGS Part E for worker.	USEPA 2002a
ABS_d = Dermal Absorption Fraction (unitless)	Chemical-specific	None available for copper or iron.	
SA = Skin Surface Area (cm^2)	3,300	Exposed Surface Areas for Worker.	USEPA 2002a
ET = Exposure Time (hours/day)	8	USEPA standard default value for workers.	USEPA 2002a
EF = Exposure Frequency (days/year)	250	USEPA recommended value for industrial worker. Site-specific value of 250 days per year for one year.	USEPA 2002a
ED = Exposure Duration (years)	25	USEPA standard default value for industrial worker.	USEPA 2002a
CF_s = Conversion Factor, soil (kg/mg)	1E-06		
BW = Body Weight (kg)	70	Default values derived from the Third National Health and Nutritional Examination Survey (NHANES III).	USEPA 2002a
AT = Averaging Time (days)	9,125 noncarcinogenic	Noncarcinogens ED expressed in days (equal to ED for noncarcinogens x 365 days/year)	
AT = Averaging Time (days)	25,550 carcinogenic	Carcinogens 70-year lifetime expressed in days.	
PEF= Particulate Emission Factor (m^3/kg)	1.32E+09	USEPA default value PEF used for non-volatile compounds.	USEPA 1996

Table 6-3: Exposure Parameters for Soil Pathways: Ingestion, Dermal Absorption, and Inhalation, Current/Future Construction Worker

Exposure Variable	Reasonable Maximum Exposure (RME)	Rationale	Reference
IRS = Ingestion Rate, soil (mg/day)	330	USEPA recommended value for outdoor worker and construction worker.	USEPA 2002a
FC = Fraction Contacted	1	Assumes entire exposure time spent at one exposure area.	
AF = Dermal Adherence Factor, soil (mg/cm^2)	0.3	USEPA standard default value for construction worker (Exhibit 5-1).	USEPA 2002a
AB = Dermal Absorption Fraction (unitless)	Chemical-specific	Chemical-specific dermal absorption fraction obtained from Exhibit C-6.	USEPA 2002a
SA = Skin Surface Area (cm^2)	3,300	USEPA default value for outdoor construction worker dermal contact (assumes face, forearms, and hands exposed) Exhibit 1-2.	USEPA 2002a
ET = Exposure Time (hours/day)	8	USEPA standard default value for workers.	USEPA 2002a
EF = Exposure Frequency (days/year)	30	USEPA recommended value for outdoor construction worker is 60 days per year. Anticipate periodic underground construction work for laying utilities at Withlacoochee, approximately 30 days per year.	USEPA 2002a
ED = Exposure Duration (years)	1	Site specific.	USEPA 2002a
CF_w = Conversion Factor, soil (kg/mg)	1E-06		
BW = Body Weight (kg)	70	Average adult body weight.	USEPA 2002a
AT = Averaging Time (days)	365 non-carcinogenic	Non-carcinogens ED expressed in days.	
AT = Averaging Time (days)	25,550 carcinogenic	Carcinogens 70-year lifetime expressed in days.	
PEF = Particulate Emission Factor (m^3/kg)	1.32E+09	USEPA default value PEF used for non-volatile compounds.	USEPA 1996

Table 6-4: Exposure Parameters for Soil Pathways: Ingestion, Dermal Absorption, and Inhalation, Current/Future Site Visitor/Recreational User

Exposure Variable	Reasonable Maximum Exposure (RME)	Rationale	Reference
IRS = Ingestion Rate, soil (mg/day)	100	Same value as USEPA recommended value for outdoor industrial worker. Exhibit 1-2.	USEPA 2002a
FC = Fraction Contacted	1	Assumes entire exposure time spent at one exposure area.	
AF = Dermal Adherence Factor, soil (mg/cm^2)	0.2	Same value as USEPA recommended value for outdoor industrial worker Exhibit 3-3.	USEPA 2002a
ABS_d = Dermal Absorption Fraction (unitless)	Chemical-specific	None available for copper or iron.	
SA = Skin Surface Area (cm^2)	3,300	Exposed Surface Areas for Adult (default adult is Worker).	USEPA 2002a
ET = Exposure Time (hours/day)	8	Site-specific value based on assumption of hunting 8 hours per day, 2 days per week, for 9 months of the year.	
EF = Exposure Frequency (days/year)	72	Site-specific value based on assumption of hunting 8 hours per day, 2 days per week, for 9 months of the year.	
ED = Exposure Duration (years)	25	Site-specific value.	
CF_s = Conversion Factor, soil (kg/mg)	1E-06		
BW = Body Weight (kg)	76	Default values derived from the Third National Health and Nutritional Examination Survey (NHANES III).	FDEP 2005
AT = Averaging Time (days)	1,800 noncarcinogenic	Noncarcinogen ED expressed in days (equal to ED for noncarcinogens x 72 days/year).	
AT = Averaging Time (days)	25,550 carcinogenic	Carcinogens 70-year lifetime expressed in days.	
PEF = Particulate Emission Factor (m^3/kg)	1.32E+09	USEPA default value PEF used for non-volatile compounds.	USEPA 1996

6.2.5 Toxicity Assessment

6.2.5.1 The purpose of the toxicity assessment is to identify the toxicity values for the COPC identified in the hazard identification that will be used to estimate site risk. It also provides a description of the terms that are used to estimate toxic effects (i.e., cancer and non-cancer effects) along with the relevant data sources. This includes the most recent Integrated Risk Information System (IRIS) updates.

6.2.5.2 Toxicity values provided by USEPA reflect administered-dose values, that is, they represent concentrations that will be protective following ingestion or inhalation. The dermal route of exposure, however, evaluates the toxicity of concentrations of chemicals in the blood (absorbed). Therefore, the absorbed-dose concentrations identified for dermal exposure must be compared to absorbed-dose toxicity values. The absorbed-dose toxicity values are derived by applying oral absorption factors to administered-dose toxicity values. The oral absorption factors used in the human health risk assessment were obtained from USEPA RSLs for Chemical Contaminants at Superfund Sites for Residential Soil, November 2013. Table 6-5 lists all toxicity values used to quantify risk for this human health risk assessment.

Table 6-5: Human Health Risk Assessment Toxicity Values, Withlacoochee Site

	CAS #	ABSd (1) (unitless)	Ingestion				OAF (2) (unitless)	Dermal Contact		Inhalation			
			RfD_o (mg/kg-day)		SF_o (mg/kg-day)$^{-1}$			RfD_d [3] (mg/kg-day)	SF_d [4] (mg/kg-day)$^{-1}$	RfC (mg/m^3)		IUR (mg/m^3)$^{-1}$	
Explosives													
2,4,6-Trinitrotoluene	118-96-7	3.20E-02	5.0E-04	I	3.0E-02	I	1	5.0E-04	3.00E-02	--		--	
Metals													
Arsenic	7440-38-2	3.00E-02	3.0E-04	I	1.5E+00	I	1	3.0E-04	1.50E+00	1.5E-05	C	4.3E-03	I
Barium	7440-39-3	--	2.0E-01	I	--		0.07	1.4E-02	--	5.0E-04	H	--	
Copper	7440-50-8	--	4.0E-02	H	--		1	4.0E-02	--	--		--	

[1] ABS_d is the recommended dermal absorption fraction of contaminants in soil. ABS_d values are obtained from USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites for Residential Soil, November 2013 (http://www.epa.gov/reg3hwmd/risk/human//rb-concentration_table/Generic_Tables/docs/master_sl_table_run_NOV2013.pdf).

[2] OAF is the oral absorption factor of analytes that are absorbed in the intestinal tract. If the OAF is greater than 0.5, use 1.0 as a value, indicating that organic chemicals are generally well absorbed across the gastrointestinal tract. OAF values obtained from USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites for Residential Soil, November 2013 (http://www.epa.gov/reg3hwmd/risk/human//rb-concentration_table/Generic_Tables/docs/master_sl_table_run_NOV2013.pdf).

[3] RfD_d is the dermal reference dose and is based on the absorbed dose. The RFD_d is calculated as RfD_o*OAF.

[4] SF_d is the dermal slope factor and is based on absorbed dose. The SF_d is calculated as SF_o / OAF.

-- = toxicity data not available.

Sources:
C = California EPA
I = IRIS, USEPA 2002b, Integrated Risk Information System
H = HEAST. USEPA 1997b. U.S. EPA. Health Effects Assessment Summary Tables (HEAST). U.S. Environmental Protection Agency, Washington, D.C., 1997.

6.2.6 CUA1 - Risk Characterization and Conclusions

6.2.6.1 The primary objective of this HHRA was to quantitatively characterize the human health risk associated with current and reasonably expected future exposure to contaminated media at the CUA1. All potentially complete exposure pathways for the site were evaluated or were assumed to be evaluated based on more protective exposure scenarios. The exposure pathways were outlined in subsection 6.2.4 and were also shown on the CSM (Figure 4.9). Site-specific cancer risks and non-carcinogenic hazards were estimated for receptors, exposure pathways, and COPCs per the methods described previously in this report.

6.2.6.2 To determine the risk/hazard associated with exposure to contaminants in media at the CUA1, samples collected from the site were evaluated. As described in subsection 6.2.3 and shown in Table 6-1, arsenic and barium were identified as human health COPCs in surface and subsurface soil.

6.2.6.3 For each COPC having available toxicity values, a cancer risk and a hazard quotient (HQ) (for non-carcinogenic risk) were calculated. The carcinogenic and non-carcinogenic risk estimates by pathway and receptor for current and future receptors exposed to surface and subsurface soil are presented in and Table 6-7. The detailed risk estimation tables are included in Appendix I.

6.2.6.4 The pathway specific and cumulative risks for surface soil are summarized in. The cancer risks for the commercial/industrial worker for surface soil are estimated to be $2 \times 10\text{-}6$. The cancer risks for the site visitor/recreational user for surface soil are estimated to be $4 \times 10\text{-}7$. All estimates of cancer risk for surface soil for onsite current and future receptors are within or below the cancer risk cumulative risk goal of $1 \times 10\text{-}6$ to $1 \times 10\text{-}4$ and are based on detected concentrations of arsenic. Therefore, unacceptable cancer risks due to exposure to COPCs in surface soil are not expected. The other COPC identified in surface soil, barium, is non-carcinogenic with a hazard index less than one.

6.2.6.5 The pathway specific and cumulative risks for mixed surface and subsurface soil are summarized in Table 6-7. The cancer risks for the construction worker, the only receptor exposed to mixed surface and subsurface soil, are estimated to be $1 \times 10\text{-}7$ which is below the cancer risk cumulative risk goal of $1 \times 10\text{-}6$ to $1 \times 10\text{-}4$ and is based on detected concentrations of arsenic. Therefore, unacceptable cancer risks due to exposure to arsenic in mixed soil are not expected. The other COPC identified in subsurface soil, barium, is non-carcinogenic with a hazard index less than one.

6.2.6.6 The cumulative non-carcinogenic hazard indices for each receptor are less than one for each medium (and Table 6-7). Because the hazard indices are not greater than one, hazards due to exposure to arsenic and barium are not expected for commercial/industrial workers, construction workers, or site visitors/recreational users in any of the evaluated media. See detailed calculation tables in Appendix I.

Table 6-6: Human Health Quantitative Risk Summary for Surface Soil - CUA1

Exposure Route	Hazard Index [a/] (RME [b/])	Cancer Risk (RME)
Receptor: Commercial/Industrial Worker (Surface Soil)		
Ingestion of Surface Soil	0.008	1E-06
Inhalation of Fugitive Dust from Surface Soil	0.00007	6E-10
Dermal Contact with Surface Soil	0.002	2E-07
Sum of Exposure Routes	**0.01**	**2E-06**
Receptor: Site Visitor/Recreational User (Surface Soil)		
Ingestion of Surface Soil	0.002	3E-07
Inhalation of Fugitive Dust from Surface Soil	0.00002	2E-10
Dermal Contact with Surface Soil	0.0004	7E-08
Sum of Exposure Routes	**0.003**	**4E-07**

[a/] HIs were calculated by summing across exposure routes for each receptor.
[b/] RME = reasonable maximum exposure.

Table 6-7: Human Health Quantitative Risk Summary for Mixed Surface and Subsurface Soil - CUA1

Exposure Route	Hazard Index [a/] (RME [b/])	Cancer Risk (RME)
Receptor: Construction Worker (Mixed Soil)		
Ingestion of Mixed Soil	0.02	1E-07
Inhalation of Fugitive Dust from Mixed Soil	0.00004	2E-11
Dermal Contact with Mixed Soil	0.002	1E-08
Sum of Exposure Routes	**0.02**	**1E-07**

[a/] HIs were calculated by summing across exposure routes for each receptor.
[b/] RME = reasonable maximum exposure.

6.2.7 CUA2 - Risk Characterization and Conclusions

6.2.7.1 The primary objective of this HHRA was to quantitatively characterize the human health risk associated with current and reasonably expected future exposure to contaminated media at the CUA2. All potentially complete exposure pathways for the site were evaluated or were assumed to be evaluated based on more protective exposure scenarios. The exposure pathways were outlined in subsection 6.2.4 and were also shown on the CSM (Figure 4.10). Site-specific cancer risks and non-carcinogenic hazards were estimated for receptors, exposure pathways, and COPCs per the methods described previously in this report.

6.2.7.2 To determine the risk/hazard associated with exposure to contaminants in media at the CUA2, samples collected from the site were evaluated. As described in subsection 6.2.3 and shown in Table 6-1, TNT and arsenic were identified as human health COPCs in surface soil.

6.2.7.3 For each COPC having available toxicity values, cancer risk and HQ (for non-carcinogenic risk) were calculated. The carcinogenic and non-carcinogenic risk estimates by pathway and receptor for current and future receptors exposed to surface soil are presented in **Table 6-8**. Subsurface soil is not a complete exposure pathway for CUA2 and is not evaluated. The detailed risk estimation tables are included in Appendix I.

6.2.7.4 The pathway specific and cumulative risks for surface soil are summarized in Table 6-4. The cancer risks for the commercial/industrial worker for surface soil are estimated to be 2×10^{-6}. The cancer risks for the site visitor/recreational user for surface soil are estimated to be 5×10^{-7}. All estimates of cancer risk for surface soil for onsite current and future receptors are within or below the cancer risk cumulative risk goal of 1×10^{-6} to 1×10^{-4} and are based on detected concentrations of TNT and arsenic. Therefore, unacceptable cancer risks due to exposure to TNT and arsenic in surface soil are not expected.

6.2.7.5 The cumulative non-carcinogenic hazard indices for each receptor are less than one for each medium (**Table 6-8**). Because the hazard indices are not greater than one, hazards due to exposure to TNT and arsenic are not expected for commercial/industrial workers or site visitors/recreational users in the evaluated media. See detailed calculation tables in Appendix I.

Table 6-8: Human Health Quantitative Risk Summary for Surface Soil - CUA2

Exposure Route	Hazard Index [a/] (RME [b/])	Cancer Risk (RME)
Receptor: Commercial/Industrial Worker (Surface Soil)		
Ingestion of Surface Soil	0.01	2E-06
Inhalation of Fugitive Dust from Surface Soil	0.00003	8E-10
Dermal Contact with Surface Soil	0.002	3E-07
Sum of Exposure Routes	**0.01**	**2E-06**
Receptor: Site Visitor/Recreational User (Surface Soil)		
Ingestion of Surface Soil	0.003	4E-07
Inhalation of Fugitive Dust from Surface Soil	0.00001	2E-10
Dermal Contact with Surface Soil	0.0005	8E-08
Sum of Exposure Routes	**0.003**	**5E-07**

[a/] HIs were calculated by summing across exposure routes for each receptor.

[b/] RME = reasonable maximum exposure.

6.2.8 CUA3 - Risk Characterization and Conclusions

6.2.8.1 The primary objective of this HHRA was to quantitatively characterize the human health risk associated with current and reasonably expected future exposure to contaminated media at the CUA3. All potentially complete exposure pathways for the site

were evaluated or were assumed to be evaluated based on more protective exposure scenarios. The exposure pathways were outlined in subsection 6.2.4 and were also shown on the CSM (Figure 4.11). Site-specific cancer risks and non-carcinogenic hazards were estimated for receptors, exposure pathways, and COPCs per the methods described previously in this report.

6.2.8.2 To determine the risk/hazard associated with exposure to contaminants in media at the CUA3, samples were collected from the site in two phases and evaluated. As described in subsection 6.2.3 and shown in Table 6-1, copper was the only analyte identified as a human health COPC in surface soil.

6.2.8.3 For each COPC having available toxicity values, a cancer risk and HQ estimate (for non-carcinogenic risk) were calculated. The carcinogenic and non-carcinogenic results and risk summaries by pathway and receptor for current and future receptors exposed to surface soil are presented in Table 6-9. Subsurface soil is not a complete exposure pathway for CUA3 and is not evaluated. The detailed risk estimation tables are included in Appendix I.

6.2.8.4 The pathway specific and cumulative risks for surface soil are summarized in Table 6-9. The only COPC identified in surface soil, copper, is non-carcinogenic with a hazard index less than one. Therefore, hazards due to exposure to surface soil are not expected.

6.2.8.5 The cumulative non-carcinogenic hazard indices for each receptor are less than one for surface soil (Table 6-9). Because the hazard indices are not greater than one, hazards due to exposure to copper are not expected for commercial/industrial workers or site visitors/recreational users in the evaluated media.

6.2.8.6 In addition, only one sample (WITH-DEMOPOST-SB-01) had a copper concentration above the human health screening criteria. This sample was collected after the demolition of an UXO item. Detection of copper is not surprising in this circumstance since the jet perforators and other components used to set off the detonation contain copper. The sample collected from the same location prior to the demolition contained copper at an estimated concentration much less than the human health screening criterion. All five follow on samples collected around WITH-DEMOPOST-SB-01 had detections far below the human health screening criteria (Figure 3.8). The MDC was used as the exposure point concentration because not enough samples were collected to calculate a representative 95% UCL. See detailed calculation tables in Appendix I which include the copper results.

Table 6-9: Human Health Quantitative Risk Summary for Surface Soil CUA3

Exposure Route	Hazard Index [a/] (RME [b/])	Cancer Risk (RME)
Receptor: Commercial/Industrial Worker (Surface Soil)		
Ingestion of Surface Soil	0.007	--
Inhalation of Fugitive Dust from Surface Soil	--	--
Dermal Contact with Surface Soil	--	--
Sum of Exposure Routes	0.007	--
Receptor: Site Visitor/Recreational User (Surface Soil)		
Ingestion of Surface Soil	0.002	--
Inhalation of Fugitive Dust from Surface Soil	--	--
Dermal Contact with Surface Soil	--	--
Sum of Exposure Routes	0.002	--

[a/] HIs were calculated by summing across exposure routes for each receptor.

[b/] RME = reasonable maximum exposure.

6.2.9 Analysis of Uncertainties

6.2.9.1 Introduction

All RAs involve the use of assumptions, judgments, and imperfect data to varying degrees resulting in uncertainties in the final estimates of risk. These uncertainties are generally associated with the multitude of conditions that characterize each step of the RA process (data evaluation and identification of COPCs, exposure assessment, toxicity assessment, and risk characterization). These conditions are characteristically conservative and tend to overestimate potential site-related risks. This subchapter qualitatively describes the inherent and site-specific uncertainties of the HHRA process.

6.2.9.2 Uncertainty in Data Collection and Evaluation

6.2.9.2.1 The analysis of uncertainties focuses on determining whether the available data are representative of contaminant concentrations and site conditions, and whether features of sampling, analyses, or statistical treatment of the data result in an over- or underestimation of potential risk.

6.2.9.2.2 Chemicals that were never detected in any samples were eliminated from the RA. It is possible that some chemicals may have been present in samples below the reporting limit and not retained in the RA. However, since samples were collected from areas where concentrations were expected to be high and because maximum detected concentrations were used in the RA comparisons, it is unlikely that any chemicals were present at health-significant levels and not detected in at least one sample.

6.2.9.2.3 As a conservative measure, the exposure point is represented by the MDC of the COPC in the selected medium. Due to the small number of samples collected for each area, a representative 95% UCL could not be calculated. Because the MDC is a higher value than the 95% UCL, using the MDC in the risk assessment results in the most conservative, or highest, risk values possible for the site. No risk to human health or ecological receptors was identified using the MDC; therefore, it is unlikely that any detected chemicals were present at health-significant levels.

6.2.9.2.4 Chemicals that were detected at concentrations less than the selected preliminary screening values were eliminated from the RA. It is possible that some chemicals may have been present in areas not sampled, however samples were collected from areas where concentrations were expected to be high and because maximum detected concentrations were used in the preliminary screening, it is unlikely that any chemicals were present at health-significant levels and not detected.

6.2.9.2.5 Steady-state conditions were assumed for evaluation of potential future exposures. The assumption of steady-state conditions may tend to overestimate long-term exposure and health risk since contaminant concentrations are expected to decline over time due to natural dissipation processes (e.g., biological and chemical degradation). It is noted though that in some cases, depending on the contaminant and/or the release mechanisms involved, steady-state assumptions could potentially underestimate risk (e.g., breakdown products that are more toxic than the parent compound or a continuous source contributing to contamination in another media).

6.2.9.3 Uncertainty in Exposure Assessment

6.2.9.3.1 The HHRA estimates are conditional on actual and potential exposure pathways identified at the site. If exposure does not occur, no risks are present. Furthermore, the HHRA process does not factor in the probability of exposure occurring.

6.2.9.3.2 Current land uses and characterization of the site's current physical setting provided the basis for predicting future land use at and in the vicinity of the site. The assumption of steady-state conditions was also used in predicting future contaminant concentrations. As mentioned above, this assumption would tend to overestimate potential future exposure levels since concentrations of chemicals generally decline with time due to natural degradation processes.

6.2.9.3.3 There is also some concern as to how well an exposure scenario approximates the actual conditions that a receptor may be exposed to at a given site. Potential human exposures could deviate from those used in the HHRA through differences in exposure frequency, contact rates, exposure durations, body weight, and life span. Each of these factors has a degree of uncertainty associated with it that could over- or underestimate risk.

6.2.9.3.4 There is a high degree of variability in soil adherence and duration of soil contact with the skin (USEPA, 2004). The adherence factor introduces uncertainty in the estimate of soil exposures (USEPA, 2004). Increasing moisture content increases the ability of soils to adhere to the skin. The increased moisture content may also affect the relative percentage absorbed.

6.2.9.3.5 The amount of chemical absorbed from soil or water is dependent on a number of chemical, physical, and biological factors. The relative importance of some of these factors on absorption may differ between soils and water. Per USEPA guidance (2004), the same dermal absorption factor for soils is used for sediments, until addition information becomes available. If a dermal absorption factor is not available (as provided in the USEPA RSL supporting documentation), then dermal risk was not calculated. This may underestimate the risk associated with exposure to some analytes that may pass through the skin, but do not have a published dermal absorption factor.

6.2.9.4 Uncertainty in Toxicity Assessment

6.2.9.4.1 Some uncertainty is also inherent in the toxicity values used in the HHRA. Carcinogenic slope factors and route-specific values are derived only for compounds that have been shown to cause an increased incidence of tumors in either human or animal studies. This dose-response curve is then assumed to be linear at low doses (e.g., those found in situations of environmental contamination) and is used to predict tumor incidence at low exposure levels. When an animal study is used, the final SF is adjusted to account for extrapolation of animal data to humans. If the studies used to derive the SF were conducted for less than the life span of the test organism, the final SF had also been adjusted to reflect risk associated with lifetime exposure.

6.2.9.4.2 The carcinogenic slope factors are generally an upper 95th percentile confidence limit of the probability of a response based on experimental animal data in the multistage model. This means that the site-specific chemical risk is not likely to exceed the risk estimate derived through the model and is likely to be less than the predicted risk.

6.2.9.4.3 The chronic reference dose (RfD) for a compound is based on studies where either human or animal populations were exposed to a given compound by a given route of exposure for the major portion of the life span (as an USEPA guideline, 7 years to a lifetime) (USEPA, 1989). RfDs are derived by determining dose-specific effect levels from all the available quantitative studies and applying uncertainty factors to the most appropriate effect level to determine an RfD for humans. Uncertainty factors are generally applied as multiples of 10 to represent specific areas of uncertainty in the data. Typically, an uncertainty factor of 100 to 1,000 is used in the professional judgment of uncertainties. General uncertainties in the derivation of RfDs may be associated with factors such as: (1) variations in the general population (to protect sensitive receptors); (2) extrapolation of animal data to humans; (3) use of a subchronic study versus a chronic study to determine the no-observed-adverse-effect level (NOAEL); or (4) use of a lowest-observed-adverse-effect level (LOAEL) versus a NOAEL. Both the uncertainty and modifying factors are conservative in nature and tend to overestimate risk.

6.2.9.5 Uncertainty in Estimating Chemical Risk

6.2.9.5.1 The expression of the potential risk associated with contaminants detected at the site is a result of the combined steps of data evaluation, exposure assessment, and toxicity assessment. This combination provides the potential to magnify the uncertainties present in these steps of the HHRA process.

6.2.9.5.2 Screening criteria are developed using very conservative (health-protective) exposure and intake assumptions. The HHRA comparisons also use conservative concentrations of the chemicals detected at the site. Additionally, screening criteria used in the HHRA are considered health-protective for carcinogenic and non-carcinogenic chemical mixtures. Carcinogenic chemicals correspond to the conservative 1×10^{-6} (one in a million) excess cancer risk level, providing a very protective screening value. Non-carcinogens use a target HQ of 1.

6.2.9.6 Uncertainty in Evaluating the Groundwater Exposure Pathway

No groundwater samples were collected during the RI, so groundwater was not quantitatively addressed at the Withlacoochee Site. No wells were identified and are unlikely to be located in CUA2 and CUA3. No wells were identified in CUA1; however, due to the existence of the fish hatchery and the employee residences onsite, it is possible that wells are located within CUA1. Based on the results of this RI, arsenic and barium were identified as COPCs for CUA1. The maximum detected concentration of barium (120 mg/kg) is far below the FDEP leachability based on groundwater criteria of 1,600 mg/kg, so barium is not expected to pose an unacceptable hazard or cancer risk in groundwater. Arsenic does not have a FDEP leachability value, but based on the SPLP analysis, arsenic is not expected to leach to groundwater; therefore, arsenic is not expected to pose an unacceptable hazard or cancer risk in groundwater.

6.2.9.7 Uncertainty in Evaluating the Surface Water and Sediment Exposure Pathways

No biased surface water or sediment samples were collected during the RI, as there was no evidence of release to surface water or sediment at any of the areas investigated. The Withlacoochee site is very swampy and many areas are covered by water that were not investigated; therefore, it is possible that contamination exists in areas that were not investigated. However, based on the soil investigation which resulted in no risk to human health or ecological receptors being identified, it is unlikely that an unacceptable hazard or cancer risk exists in surface water or sediment.

6.3 ECOLOGICAL RISK ASSESSMENT

6.3.1 Ecological Risk Assessment Approach

6.3.1.1 This ecological risk assessment (ERA) provides an evaluation of the potential risks to ecological receptors from exposure to MC in surface soil at each CUA at the Withlacoochee Site. The primary references used in the ERA include:

- Guidelines for Ecological Risk Assessment, EPA/630/R-95/002F (USEPA, 1998);
- Wildlife Exposure Factors Handbook (USEPA, 1993b);
- Risk Assessment Handbook: Volume II: Environmental Evaluation (USACE, 2010);
- Ecological Risk Assessment and Risk Management Principles for Superfund Sites (USEPA, 1999);

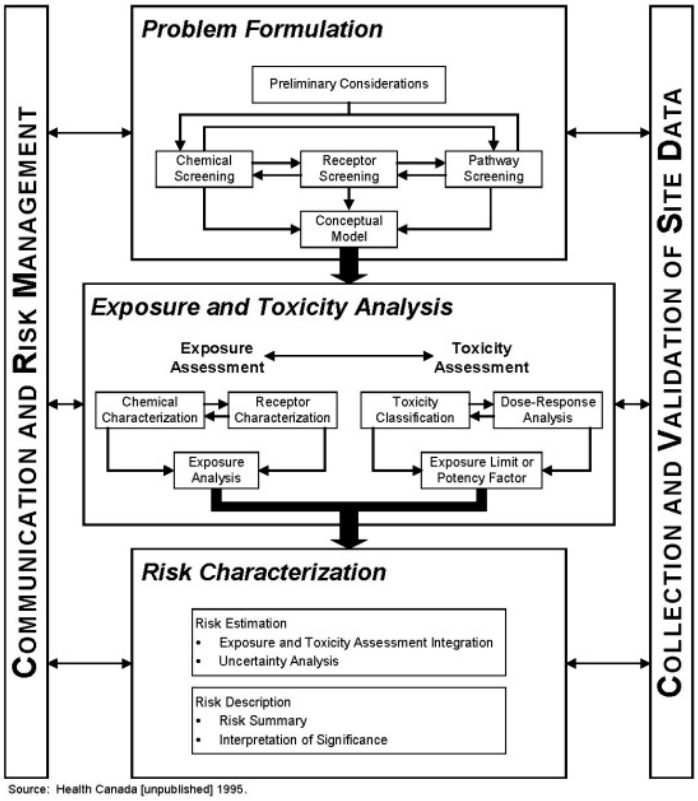
- Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (USEPA, 2002a);
- Guidance for Developing Ecological Soil Screening Levels (USEPA, 2003); and
- Withlacoochee Risk Assessment Work Plan (USA, 2014).

6.3.1.2 As presented in USEPA and USACE guidance documents, the ERA is a three-step evaluation process that encompasses the following:

- Problem formulation, including development of a conceptual site model to describe how a given stressor might affect the ecological components in the environment;
- Analysis phase, which is composed of two major elements,
  - Characterization of exposure;
  - Characterization of ecological effects, including the hazard identification and dose-response assessment; and
- Risk characterization.

6.3.1.3 Each of these steps is discussed in detail in the following subsections. A diagram of the ecological risk assessment process is presented in **Figure 6.1.**

Figure 6.1: Ecological Risk Assessment Flowchart



Source: Health Canada [unpublished] 1995.

6.3.2 Problem Formulation

An ERA evaluates the effects of stressors in the environment, including the effects of COPCs on particular environmental receptors. In addition, an ERA evaluates how environmental receptors may come into contact with stressors, and how these receptors potentially interact with one another. The determination of stressor characteristics begins with the identification of potential chemical stressors, followed by a description of the ecosystems in which the effects of the stressors may occur. The problem formulation step of an ERA includes selection of ecologically based endpoints that are relevant to decisions made about protecting the ecosystem. Ecologically based endpoints may be divided into two types: assessment endpoints are explicit expressions of the environmental value that is to be protected, and measurement endpoints are measurable responses to a stressor that are related to the characteristics selected as assessment endpoints. The final part of the problem formulation is to develop a conceptual site model.

6.3.2.1 Anticipated Land Use and Potential Exposure

6.3.2.1.1 The land surface of the Withlacoochee Site is essentially flat with a gentle east to west slope. The highest land elevations (at approximately 100 feet above mean sea level [msl]) occur along the eastern site border and steadily drop to about 80 feet above msl along the western site border. The surrounding terrain is primarily cypress swamp and dense forests. The terrain is flat and wet with water ranging in depth from shallow puddles of water to deeper swamps and ponds.

6.3.2.1.2 The Withlacoochee Site is approximately 40% wetland and predominately occupied by pine flatwoods and cypress ponds with several hardwood hammocks dispersed throughout the area. Predominant tree species within the flatwoods are the slash and longleaf pine, pond cypress and blackgum in the cypress ponds, and live oak, laurel oak, water oak, hickory, sweetgum, blue beech, and magnolia in the hardwood hammocks (Florida Division of Forestry, 2003). The potential environmental receptors are species or groups of species that may occur in the area, and receptors where life-history information is known and potential effects of stressors can be inferred. Samples were collected from surface soil as part of the remedial investigation to address the potential effects of stressors on environmental receptors. Surface water and sediment are considered incomplete exposure pathways and are not evaluated in this ERA. In general, ecological receptors are not exposed to groundwater, so that is an incomplete exposure pathway also.

6.3.2.2 Ecological Conceptual Site Models

6.3.2.2.1 Ecological conceptual site models (ECSMs) identify potential pathways for exposure of ecological receptors to COPECs at the site. An exposure pathway evaluation describes how a receptor could be exposed to COPECs at, or migrating from, the site. A potentially complete exposure pathway requires four necessary elements:

- A source and mechanism of chemical release;
- An environmental transport medium;
- A point of potential contact with a receptor; and
- A feasible route of exposure.

6.3.2.2.2 ECSMs illustrate onsite release points, affected physical media, types of COPEC transport mechanisms, groups of potentially exposed populations or ecological receptors, and how each receptor group may contact site-related contamination. In addition to potentially affected communities, ECSMs also identify major feeding guilds (e.g., omnivorous mammals, predators), and representative species or group of organisms for each complete, or reasonably anticipated to be complete, exposure pathway. The ECSMs for the Former Withlacoochee Site are presented in Figures 4.12 (CUA1), 4.13 (CUA2), and 4.14 (CUA3).

6.3.3 Ecological Characterization of Exposure

The exposure characterization, the first component of the ERA Analysis Phase, evaluates the interaction of the stressor with the ecological components under consideration. The stressor characterization involves determining the stressor's distribution and pattern of change, based largely on the ECSM. The ecological characterization is analyzed to determine the ecological attributes that influence the distribution and nature of the stressor. Characteristics of ecosystems that may influence exposure to the stressor may include such factors as habitat needs, food preferences, reproductive cycles, and seasonal activities.

6.3.3.1 Estimation of Exposure

Ecological receptors may be at-risk from exposures to COPCs if there is a complete exposure pathway between the COPC source and the receptor. Surface soil is the medium that was evaluated in the ERA. Subsurface soil, surface water, sediment, and groundwater are not complete exposure pathways and are not evaluated in the ERA.

6.3.3.2 Selection of Ecological Receptors

Ecological receptors provide measurement endpoints where the effects of chemical stressors can be quantified. For ecological receptors, the risk evaluation approach for direct exposure pathways was based on organism communities. These species were selected due to their presence or potential habitat within the site or its vicinity. Selected receptors include three mammal species and five bird species that are representative of the herbivore, insectivore, omnivore, and carnivore trophic levels. During the TPP process, it was determined that an avian piscivore should be included because there is a fish hatchery within the site, and several species of wading birds have been observed fishing from the ponds at the fish hatchery. The selected species that were evaluated are listed in Table 6-10.

Table 6-10: Ecological Receptors Selected for the Baseline ERA Evaluation

Ecological Receptor	Trophic Level	Dietary Source
MAMMALS		
Eastern cottontail (*Sylvilagus floridanus*)	Herbivore	100% plant material
Raccoon (*Procyon lotor*)	Omnivore	50% plant material 50% invertebrates
Red fox (*Vulpes vulpes*)	Carnivore	90% small prey 10% plant material
BIRD SPECIES		
Northern Bobwhite (*Colinus virginianus*)	Herbivore	100% plant material
Marsh wren (*Cictothorus palustris*)	Insectivore	25% plant material 75% invertebrates
American robin (*Turdus migratorius*)	Omnivore	60% plant material 40% invertebrates
American Kestrel (*Falco sparverius*)	Carnivore	100% small prey
Great Blue Heron (*Ardea herodias*)	Piscivore	100% fish

6.3.3.3 Direct Exposure

Terrestrial vegetation is exposed to contaminants in surface soil by direct contact, while soil-associated organisms are exposed by both dermal contact and ingestion.

6.3.3.4 Exposure by Food/Prey Ingestion

Terrestrial wildlife may be exposed directly to contaminants in soil by incidental soil ingestion, by dermal contact, or by the inhalation of wind-borne particles. Terrestrial wildlife could also be exposed to contaminants through food web transfer of chemicals from lower trophic levels (for example, plants to herbivores, plants and prey animals to omnivores).

6.3.4 Selection of COPECs

6.3.4.1 Sample data were evaluated to determine if a release has likely occurred and to identify COPCs. The data analysis and preliminary screening were previously presented in Section 4.2.2. For those COPCs retained from the preliminary screening, a second screening was conducted based on ecological screening criteria as detailed in the RAWP (USA, 2014). Any COPC that exceeded the ecological screening criteria is considered a

Chemical of Potential Ecological Concern (COPEC) and would be evaluated in the screening-level ERA that was conducted following the Guidelines for Ecological Risk Assessment outlined in USEPA guidance (USEPA, 1998).

6.3.4.2 Surface soil was analyzed for CA/ABPs, explosives and metals. VOCs were also analyzed for samples collected from the Toxic Gas Yard only. The preliminary evaluation of surface soil samples identified arsenic and barium at the CUA1, TNT and arsenic at the CUA2, and copper at the CUA3 as COPCs (Table 6-1). No CA/ABPs or VOCs were found at concentrations exceeding preliminary screening values.

6.3.4.3 None of the surface soil COPCs in CUA1 or CUA2 exceeded the ecological screening criteria (Table 6-11). Only copper was present at concentrations in CUA3 that exceed the selected criterion and is identified as a COPEC. Copper is discussed in further detail below.

Table 6-11: Summary of COPECs, Withlacoochee Site

COPC	Maximum Detected Concentration (mg/kg)	Ecological Screening Value (1) (mg/kg)	COPEC?
CUA1			
Surface Soil			
Arsenic	2.4	10	No
Barium	130	170	No
CUA2			
Surface Soil			
2,4,6-Trinitrotoluene (TNT)	0.14J	6.4 (2)	No
Arsenic	3.0	10	No
CUA3			
Surface Soil			
Copper	**280**	**40**	**Yes**

1) USEPA Region 4 Ecological Screening Values, updated November 30, 2001 (http://www.epa.gov/region04/waste/ots/epatab4.pdf).

2) No ESV available from the primary source. Used Los Alamos National Laboratory (LANL), Ecorisk Database (Release 2.5) October 2010 (http://www.lanl.gov/environment/cleanup/ecorisk.shtml).
J - Analyte detected, estimated concentration.

6.3.4.4 Only one sample (WITH-DEMOPOST-SB-01) had a copper concentration above the ecological screening criteria (see Subchapter 5.2.2.5.4 for more details). This sample was collected after the demolition of an MEC item. The copper concentration in a sample collected from the same location prior to the demolition was far less than the ecological screening criteria, indicating that copper was released during the detonation process. Copper is not a component of the EK-4 10-lb chemical bomblet pieces which were destroyed; however, detection of copper is not unexpected in this circumstance since the jet perforators and other components used to set off the explosion contain copper. All five follow on samples collected around and below WITH-DEMOPOST-SB-01 had detections far below the ecological screening criteria (Figure 4.9); therefore, the area of potential contamination is limited to the location of sample WITH-DEMOPOST-SB-01.

6.3.4.5 The potentially affected area is very small, approximately 4m x 4m, and only within 1-2 inches of the surface. This would represent an insignificant portion of habitat for the ecological receptors identified for evaluation and would not be expected to pose an ecological risk. Hundreds of acres of similar, unimpacted habitat surround the copper-contaminated area, thus there is no reason to expect that the detonation area would represent preferential habitat. When copper is released to soil, as in the case of the detonation activity, it becomes strongly attached to the organic matter and other materials in soil and does not migrate very far from the point of release. Additionally, based on the relatively small amount of copper released (jet perforators associated with the detonation), there is no reason to suspect the COPEC will migrate such that the contaminated area will become larger.

6.3.4.6 Because none of the surface soil COPCs in CUA1 or CUA2 exceeded the ecological screening criteria and copper is not expected to pose an ecological risk in CUA3, no further ecological risk evaluation was conducted on the Withlacoochee Site.

6.4 MUNITIONS AND EXPLOSIVES OF CONCERN HAZARD ASSESSMENT

Generally, a qualitative hazard assessment is conducted to assess potential explosive hazards to human receptors associated with potentially complete MEC exposure pathways within a site. The purpose of this hazard assessment would be to qualitatively evaluate the potential hazards from MEC and the primary causes of those potential hazards within the MRA. As described in Chapter 4, MEC hazards are limited to six areas within the MRA. However, the MEC associated with the Withlacoochee Site are CWM. Per the Munitions and Explosives of Concern Hazard Assessment Methodology, EPA: 505B08001, page xii, "*It does not address locations where military munitions are known or suspected to be present underwater, nor does it address chemical warfare materiel (CWM)*" (USEPA, 2008). Additional information from the MEC HA Methodology is also found in Section 1.3, page 3:

> *"The MEC HA assesses the acute hazard presented by the explosive component(s) of military munitions. Although military munitions include chemical weapons materiel (CWM), and thus CWM is MEC, the chemical agent component of the CWM presents a greater hazard to human health than the explosive components of CWM. Additionally, the toxic chemical hazard presented by the CWM can be calculated by current commonly acceptable methods. This does not dismiss the potential explosive hazard associated with many CWM but rather reflects the recognition that the greatest risk to human health from CWM is the chemical agent, not the explosive."*

Based on this guidance, a MEC HA will not be conducted for the Withlacoochee site.

6.5 CONCLUSIONS OF THE RISK ASSESSMENT

6.5.1 MEC Risk Assessment Conclusions

Based on USEPA MEC HA methodology (USEPA, 2008), a MEC HA was not conducted for the Withlacoochee site (see Section 6.4). Based on the results of the RI investigation, no complete MEC exposure pathways are present outside the six areas recommended for the Test Area MRA.

6.5.2 MC Risk Assessment Conclusions

6.5.2.1 Human Health Risk Assessment Conclusions

6.5.2.1.1 CUA1: To determine the risk/hazard associated with exposure to contaminants in surface and subsurface soil at CUA1, samples collected in 2013 and 2014 were evaluated. Two MC metals (arsenic and barium) were identified as COPCs in the surface and mixed surface and subsurface soil. All estimates of cancer risk for onsite current and future receptors at CUA1 are within or below the cancer risk cumulative risk goal of 1×10^{-6} to 1×10^{-4}, and therefore, cancer risks due to exposure to surface or mixed soil in CUA1 are not expected. The cumulative non-carcinogenic hazard indices for each receptor are less than 1 for surface and subsurface soil. Because the hazard indices are not greater than 1, hazards due to exposure to surface or mixed soil at CUA1 are not expected for commercial/industrial workers, construction workers, or site visitors/recreational users.

6.5.2.1.2 CUA2: To determine the risk/hazard associated with exposure to contaminants in surface soil at CUA2, samples collected within the MRA in 2013 and 2014 were evaluated. One explosive (TNT) and one MC metal (arsenic) were identified as COPCs in the surface soil. All estimates of cancer risk for onsite current and future receptors at CUA2 are within or below the cancer risk cumulative risk goal of 1×10^{-6} to 1×10^{-4}, and therefore, cancer risks due to exposure to surface soil in CUA2 are not expected. The cumulative non-carcinogenic hazard indices for each receptor are less than 1 for surface soil. Because the hazard indices are not greater than 1, hazards due to exposure to surface soil at CUA2 are not expected for commercial/industrial workers, or site visitors/recreational users.

6.5.2.1.3 CUA3: To determine the risk/hazard associated with exposure to contaminants in surface soil at CUA3, samples collected in 2013 and 2014 were evaluated. One MC metal (copper) was identified as a COPC in the surface soil. Copper is non-carcinogenic with a hazard index less than one. Therefore, hazards due to exposure to surface soil are not expected. The cumulative non-carcinogenic hazard indices for each receptor are less than 1 for surface soil. Because the hazard indices are not greater than 1, hazards due to exposure to surface soil at CUA3 are not expected for commercial/industrial workers, or site visitors/recreational users.

6.5.2.2 Ecological Risk Assessment Conclusions

6.5.2.2.1 Of the COPCs indentified in Table 6-1, only one (copper) in CUA3 exceeded the ecological screening value indicative of a potential risk for adverse effects on wildlife receptors. Copper was detected in one sample at a concentration that exceeded the ecological screening value. However, this sample was a post-detonation sample and it is highly

likely that the copper detection is from the detonation activity itself and is restricted to the immediate area of the sample. No unacceptable risks are expected within any area of the MRA (CUA1, CUA2, or CUA3) for ecological receptors.

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7.0 SUMMARY OF RESULTS

7.1 REMEDIAL INVESTIGATION

7.1.1 Objectives

The RI is intended to adequately characterize the MRA (determine the nature and extent of contamination) for the purpose of developing and evaluating effective remedial alternatives. The objective of the RI is considered complete when an investigation of MEC and MC sufficient to characterize the site, identify and quantify any associated risk, and support a feasibility study for remedial action has been safely conducted. The DQOs for the MEC investigation and MC sampling activities conducted at the Withlacoochee Site were met.

7.2 ACTIVITIES AND RESULTS

7.2.1 MEC Investigation

7.2.1.1 In support of these investigation goals, a combined 3,800 anomalies were identified at the Withlacoochee MRA along density transects during the RI through geophysical mapping within the three CUAs. Based on the anomaly density data and historical information, 108 grids were installed (including background grids) and geophysically mapped. Up to 10 anomalies per grid were intrusively investigated to determine the metallic sources of the anomalies. The intrusive investigation resulted in the identification of six areas that contained UXO and/or MD.

7.2.1.2 In CUA1, which had 298 miles of transects and 76 grids, intrusive investigation of anomalies identified five areas with UXO and MD. The five areas were as follows:

- NP Forest – 46 acres with subsurface MD from 4.2-inch mortars, an EK-4 (or M74) 10-lb chemical bomblet, and a 500-lb chemical bomb.
- A and B Forests – 74 acres with unidentifiable subsurface MD.
- D Meadow – 14 acres with subsurface MD from 4.2-inch mortars
- F Meadow – 61 acres with an unexploded subsurface (CWM) EK-4 10-lb chemical bomblet and subsurface MD from 4.2-inch mortars and EK-4 10-lb chemical bomblets.
- ATG Range – 35 acres within the former ATG Range that included subsurface MD from a M47A2 100-lb chemical bomb.

7.2.1.3 In CUA2, which had 17.2 miles of transects and 15 grids, intrusive investigation of anomalies identified one area with UXO and MD. The one area is identified as the G Forest, which has 19 acres and contained an unexploded EK-4 10-lb chemical bomblet with no filler and surface and subsurface MD from several other EK-4 bomblets.

7.2.1.4 In CUA3, which had 17.1 miles of transects and 7 grids, intrusive investigation of anomalies did not identify any areas with MEC or MD.

7.2.2 MEC Hazard Assessment

Based on USEPA MEC HA methodology (USEPA, 2008), a MEC HA was not conducted for the Withlacoochee site (see Section 6.4). Based on the results of the RI investigation, no complete MEC exposure pathways are present outside the six identified areas.

7.2.3 MC Sampling

For each of the CUAs, environmental samples were collected in surface and subsurface soil. Soil samples were collected at locations associated with UXO and MD found during the intrusive investigation and at locations of UXO/MD finds from the 1950s clearance activities to identify any residual contamination, and at other locations to further refine the extent of potential contamination as identified in samples from the RI. The soil samples were analyzed for CA, ABPs, explosives, and metals. Samples from the Toxic Gas Yard were additionally analyzed for VOCs. Samples were originally planned for surface water, sediment, and groundwater, but no samples were collected since no evidence was found of potential contamination in these media or the exposure pathways were incomplete based on criteria set forth in the work plan (USA, 2014).

7.2.4 MC Risk Assessment

7.2.4.1 The baseline MC risk assessment followed a phased approach starting with a simple screening level risk assessment (SLRA) and moving toward a more complex, site-specific risk assessment. In addition, the baseline risk assessment evaluated the magnitude of the risk at the site and the primary causes of that risk.

7.2.4.2 CUA1: Samples collected within CUA1 in 2013 and 2014 were evaluated to determine the risks and hazards associated with exposure to contaminants in surface and subsurface soil at CUA1. Two MC metals (arsenic and barium) were identified as COPCs in the surface and subsurface soil. All estimates of cancer risk for onsite current and future receptors at CUA1 are within or below the cancer risk cumulative risk goal of 1×10^{-6} to 1×10^{-4}, and therefore, cancer risks due to exposure to surface or subsurface soil at CUA1 are not expected. The cumulative non-carcinogenic hazard indices for each receptor are less than 1 for surface and subsurface soil. Because the hazard indices are not greater than 1, hazards due to exposure to surface or subsurface soil at CUA1 are not expected for commercial/industrial workers, construction workers, or site visitors/recreational users. None of the identified COPCs exceeded the ecological screening values; therefore, no unacceptable risks are expected from soil within CUA1 for ecological receptors.

7.2.4.3 CUA2: Samples collected within CUA2 in 2013 and 2014 were evaluated to determine the risks and hazards associated with exposure to contaminants in surface and subsurface soil at CUA2. One explosive (TNT) and one MC metal (arsenic) were identified as COPCs in the surface soil. All estimates of cancer risk for onsite current and future receptors at CUA2 are within or below the cancer risk cumulative risk goal of 1×10^{-6} to 1×10^{-4}, and therefore, cancer risks due to exposure to surface soil at CUA2 are not expected. The cumulative non-carcinogenic hazard indices for each receptor are less than 1 for surface soil. Because the hazard indices are not greater than 1, hazards due to exposure to surface soil at CUA2 are not expected for commercial/industrial workers, or site visitors/recreational users. None of the identified COPCs exceeded the ecological screening

values; therefore, no unacceptable risks are expected from exposure to soil within CUA2 for ecological receptors.

7.2.4.4 CUA3: Samples collected within CUA3 in 2013 and 2014 were evaluated to determine the risks and hazards associated with exposure to contaminants in surface soil at CUA3. One MC metal (copper) was identified as a COPC in the surface soil. Copper is non-carcinogenic with a hazard index less than one. Therefore, unacceptable cancer risks due to exposure to surface soil are not expected. The cumulative non-carcinogenic hazard indices for each receptor are less than 1 for surface soil. Because the hazard indices are not greater than 1, hazards due to exposure to surface soil at CUA3 are not expected for commercial/industrial workers, or site visitors/recreational users. Copper was detected in one sample at a concentration that exceeded the ecological screening value. However, this sample was a post-detonation sample and it is highly likely that the copper detection is from the detonation activity itself and is restricted to the immediate area of the sample. No unacceptable risks are expected within CUA3 for ecological receptors.

7.2.4.5 Based on the results of this risk assessment and a review of the MC risk assessment objectives, unacceptable human health and ecological risks are not expected to occur at any of the CUAs at the Withlacoochee Site.

7.3 CONCLUSIONS

7.3.1 The data collected during the RI were sufficient to characterize the MRA (comprised of CUA1, CUA2, and CUA3) so that an evaluation during the FS can be completed regarding the next action to be taken. The data collected were used to support a MC risk assessment approach as agreed to by the TPP team. The results of the RI indicate that there is a potential for human receptors to come into contact with CWM at CUA1 and CUA2. There is no MEC/CWM exposure pathway at CUA3. The MC risk assessment indicated that unacceptable human health and ecological risks are not expected to occur in any area of the MRA summarizes the recommendations of the RI.

7.3.2 Based on the conclusions regarding residual CWM hazards, an FS is recommended to assess response action alternatives for reducing and managing the hazards and risk present at six test areas (Test Areas MRS) totaling approximately 249 acres.

7.3.3 Based on the data collected during previous investigations and the RI, the areas outside the six test areas (Remaining Lands MRS) do not have a significant MEC or MC hazard or risk present and therefore, because a source is not present, the exposure pathways are considered incomplete. The Remaining Lands, comprising 17,990 acres, will not require evaluation of remedial alternatives in the FS.

Table 7-1: Summary of RI Findings

MRS Area	Area Acreage	MEC Hazards Identified	MC Hazards Identified	Next Actions
Test Areas	249	Yes	None	FS, Proposed Plan, and Decision Document
- NP Forest	46	Yes	None	
- A and B Forests	74	Yes	None	
- D Meadow	14	Yes	None	
- F Meadow	61	Yes	None	
- ATG Range	35	Yes	None	
- G Forest	19	Yes	None	
Remaining Lands	17,990	No	None	Proposed Plan and Decision Document
MRA Total	18,240	Yes	None	FS, Proposed Plan, and Decision Document

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