FORA ESCA REMEDIATION PROGRAM

FINAL

Interim Remedial Action Completion Report
Volume 1 – Interim Remedial Action Field Activities and Results

Interim Action Ranges
Munitions Response Area
Phase II

Former Fort Ord
Monterey County, California

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Phase II
Former Fort Ord
Monterey County, California

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ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
AOC	Administrative Order on Consent
Army	United States Department of the Army
BADT	Best Available and Appropriate Detection Technology
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
CTS	California Tiger Salamander
DGM	digital geophysical mapping
DGPS	differential global positioning system
DMM	discarded military munitions
DQO	data quality objective
DTSC	Department of Toxic Substances Control
EM	electromagnetic
EOD	Explosive Ordnance Disposal
EPA	United States Environmental Protection Agency
ERRG	Engineering/Remediation Resources Group, Inc.
ESCA	Environmental Services Cooperative Agreement
ESCA RP	Environmental Services Cooperative Agreement Remediation Program
FFE	free from explosives
FGCC	Federal Geodetic Control Committee
FORA	Fort Ord Reuse Authority
FS	Feasibility Study
ft	foot or feet
FVF	field variance form
GPS	Global Positioning System
GSV	geophysical system verification
HA	historical area
HE	high explosive
HEAT	high explosive anti-tank
HMP	Habitat Management Plan
HMX	cyclotetramethylene tetranitramine
HRP	Habitat Restoration Plan
IAR	Interim Action Ranges
IRACR	Interim Remedial Action Completion Report
ISO	industry standard objects
IVS	instrument verification strip

km	kilometers
lbs	pounds
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
mm	millimeter
MRA	Munitions Response Area
MRS	Munitions Response Site
mV	millivolt
NCA	Non-Completed Area
Pd	probability of detection
PDA	personal digital assistant
QA	quality assurance
QA/QC	quality assurance/quality control
QASP	Quality Assurance Surveillance Plan
QB	Qualified Biologist
QC	quality control
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
RPM	Remediation Project Manager
RTK	real-time kinematic
SAA	small arms ammunition
SCA	Special Case Area
SUXOS	Senior UXO Supervisor
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Specialist

GLOSSARY

Anomaly
Any item that is seen as a subsurface irregularity after geophysical investigation. This irregularity should deviate from the expected subsurface ferrous and nonferrous material at a site (i.e., pipes, power lines, etc.).

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980
CERCLA authorizes federal action to respond to the release or threatened release of hazardous substances into the environment or a release or threatened release of a pollutant or contaminant into the environment that may present an imminent or substantial danger to public health or welfare.

Construction Support
Assistance provided by United States Department of Defense (DOD) explosive ordnance disposal (EOD) or unexploded ordnance (UXO)-qualified personnel and/or by personnel trained and qualified for operations involving chemical agents (CA), regardless of configuration, during intrusive construction activities on property known or suspected to contain UXO, other munitions that may have experienced abnormal environments (e.g., DMM), munitions constituents in high enough concentrations to pose an explosive hazard, or CA, regardless of configuration, to ensure the safety of personnel or resources from any potential explosive or CA hazards.

Covenant Deferral Request (CDR)
A letter along with a supporting information package known as a Covenant Deferral Request (CDR) is assembled by the federal landholding to formally request deferral of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) covenant until all remediation has been accomplished prior to transfer. United States Environmental Protection Agency (EPA) requires that the information is: 1) of sufficient quality and quantity to support the request for deferral of the CERCLA Covenant; and 2) that it provides a basis for U.S. EPA to make its determination. This information is submitted to EPA in the form of a CDR.

Deferral period
The period of time that the CERCLA covenant warranting that all remedial action is complete before transfer, is deferred through the Early Transfer Authority.

Discarded Military Munitions (DMM)
Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include UXO, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations. (10 U.S.C. 2710[e][2])

Early Transfers
The transfer by deed of federal property by the DOD to a nonfederal entity before all remedial actions on the property have been taken. Section 120 (h)(3)(C) of the CERCLA allows Federal agencies to transfer property before all necessary cleanup actions have been taken. This provision, known as early transfer authority, authorizes the deferral of the CERCLA covenant when the findings required by the statute can be made and the response action assurances required by the statute are given. The Governor of the state where the property is located must concur with the deferral request for property not listed on the National Priorities List (NPL). For NPL property, the deferral must be provided by the U.S. EPA with the concurrence of the Governor. Upon approval to defer the covenant, DOD may proceed with the early transfer.

Environmental Services Cooperative Agreement Remediation Program (ESCA RP) Team
ARCADIS U.S., Inc., Weston Solutions, Inc., and Westcliffe Engineers, Inc.

Expended
The state of munitions debris (MD) in which the main charge has been expended leaving the inert carrier.

Explosive
A substance or a mixture of substances that is capable by chemical reaction of producing gas at such temperature, pressure, and speed as to cause damage to the surroundings. The term "explosive" includes all substances variously known as high explosives and propellants, together with igniters, primers, initiators, and pyrotechnics (e.g., illuminant, smoke, delay, decoy, flare, and incendiary compositions).

Explosive Hazard
A condition where danger exists because explosives are present that may react (e.g., detonate, deflagrate) in a mishap with potential unacceptable effects (e.g., death, injury, damage) to people, property, operational capacity, or the environment.

Explosive Ordnance Disposal (EOD)
The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of unexploded ordnance and of other munitions that have become an imposing danger, for example, by damage or deterioration.

Feasibility Study (FS)
A study conducted where the primary objective is "to ensure appropriate remedial alternatives are being developed and evaluated and an appropriate remedy selected" (NCP 40 CFR 300.430[e]).

Historical Impact Area
The historical impact area consists of approximately 8,000 acres in the southwestern portion of the former Fort Ord, bordered by Eucalyptus Road to the north, Barloy Canyon Road to the east, South Boundary Road to the south, and North-South Road General Jim Moore Blvd to the west.

Institutional Control (IC)
A legal or institutional mechanism that limits access to or use of property, or warns of a hazard. An IC can be imposed by the property owner, such as use restrictions contained in a deed, or by a government, such as a zoning restriction.

Intrusive Activity
An activity that involves or results in the penetration of the ground surface at an area known or suspected to contain MEC. Intrusive activities can be of an investigative or removal action nature.

Magnetometer
An instrument used to detect ferromagnetic (iron-containing) objects by measuring the distortion the object imposes on the ambient field. This distortion is known as an anomaly. Total field magnetometers measure the strength of the earth's natural magnetic field at the magnetic sensor location. Gradient magnetometers, sensitive to smaller near-surface metal objects, use two sensors to measure the difference in magnetic field strength between the two sensor locations. Vertical or horizontal gradients can be measured.

Material Potentially Presenting an Explosive Hazard (MPPEH)
Material that, prior to determination of its explosives safety status, potentially contains explosives or munitions (e.g., munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal; and range-related debris); or potentially contains a high enough concentration of explosives such that the material presents an explosive hazard (e.g., equipment, drainage systems, holding tanks, piping, or ventilation ducts that were associated with munitions production, demilitarization, or disposal operations). Excluded from MPPEH are munitions within DOD's established munitions management system and other hazardous items that may present explosion hazards (e.g., gasoline cans, compressed gas cylinders) that are not munitions and are not intended for use as munitions.

Memorandum of Agreement (MOA)
"Memorandum of Agreement Among the Fort Ord Reuse Authority, Monterey County and Cities of Seaside, Monterey, Del Rey Oaks and Marina, California State University Monterey Bay, University of California Santa Cruz, Monterey Peninsula College, and the Department of Toxic Substances Control Concerning Monitoring and Reporting of Environmental Restrictions on the Former Fort Ord, Monterey County, California"

Military Munitions
All ammunition products and components produced for or used by the armed forces for national defense and security, including ammunition products or components under the control of the DOD, the Coast Guard, the Department of Energy, and the National Guard. The term includes confined gaseous, liquid, and solid propellants, explosives, pyrotechnics, chemical and riot control agents, smokes, and incendiaries, including bulk explosives, and chemical warfare agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components thereof. The term does not include wholly inert items, improvised explosive

devices, and nuclear weapons, nuclear devices, and nuclear components, other than non-nuclear components of nuclear devices that are managed under the nuclear weapons program of the Department of Energy after all required sanitization operations under the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) have been completed. (10 U.S.C. 101[e][4][A through C]).

Munitions Response
Response actions, including investigation, removal actions, and remedial actions, to address the explosives safety, human health, or environmental risks presented by unexploded ordnance (UXO), discarded military munitions (DMM), or munitions constituents (MC), or to support a determination that no removal or remedial action is required.

Military Munitions Response Program (MMRP)
Department of Defense-established program that manages the environmental, health and safety issues presented by munitions of explosives concern.

Mortar
Mortars typically range from approximately 1 inch to 11 inches in diameter or larger, and can be filled with explosives, toxic chemicals, white phosphorus, or illumination flares. Mortars generally have thinner metal casing than projectiles but use the same types of fuzing and stabilization.

Munitions and Explosives of Concern (MEC)
This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks means: (A) UXO, as defined in 10 U.S.C. 101(e)(5)(A) through (C); (B) Discarded military munitions (DMM), as defined in 10 U.S.C. 2710(e)(2); or (C) Munitions constituents (e.g., trinitrotoluene, cyclotrimethylene trinitramine), as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.

Munitions Constituents (MC)
Any materials originating from UXO, discarded military munitions (DMM), or other military munitions, including explosive and nonexplosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions (10 U.S.C. 2710).

Munitions Debris (MD)
Remnants of munitions (e.g., fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal.

Munitions Response Area (MRA)
Any area on a defense site that is known or suspected to contain UXO, DMM, or MC. Examples include former ranges and munitions burial areas. A munitions response area is comprised of one or more munitions response sites.

Munitions Response Site (MRS)
A discrete location within an MRA that is known to require a munitions response.

Near-surface anomaly
A subsurface anomaly that is within 3 inches of the surface and can be excavated using hand tools, as described in Section 2.3.3 of the Final Phase II Interim Action Work Plan (ESCA RP Team 2011).

Ordnance and Explosives (OE)
See MEC.

Projectile
An object projected by an applied force and continuing in motion by its own inertia, as a bullet, bomb, shell, or rifle grenade. Also applied to rockets and guided missiles.

Quality Assurance (QA)
The management system implemented by a United States Army Corps of Engineers (USACE) Safety Specialist or a Third Party Safety Specialist to ensure Quality Control (QC) is functioning and that project quality objectives are being met. QC components include planning, implementation, assessment, reporting, and quality improvement.

Quality Control (QC)
The system of inspections, typically performed by the munitions contractor performing the work, of operational activities, work in progress, and work completed to assess the attributes and performance of a process against defined standards that are used to fulfill requirements for quality.

Range
A designated land or water area that is set aside, managed, and used for range activities of the Department of Defense. The term includes firing lines and positions, maneuver areas, firing lanes, test pads, detonation pads, impact areas, electronic scoring sites, buffer zones with restricted access, and exclusionary areas. The term also includes airspace areas designated for military use in accordance with regulations and procedures prescribed by the Administrator of the Federal Aviation Administration (10 U.S.C. 101(e)(1)(A) and (B)).

Range Activities
Research, development, testing, and evaluation of military munitions, other ordnance, and weapons systems; and the training of members of the armed forces in the use and handling of military munitions, other ordnance, and weapons systems (10 U.S.C. 101(e)(2)(A) and (B))

Range-Related Debris (RRD)
Debris, other than munitions debris, collected from operational ranges or from former ranges (e.g., target debris, military munitions packaging, and crating material).

Record of Decision (ROD)
A document used to record the remedial action decision made at a National Priorities List property. The ROD will be maintained in the project Administrative Record and project file.

Remedial Actions
Those actions consistent with a permanent remedy taken instead of or in addition to remedial actions in the event of a release or threatened release of a hazardous substance into the

environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health, welfare, or the environment. The term includes but is not limited to such actions at the location of the release as storage; confinement; perimeter protection using dikes, trenches, or ditches; clay cover; neutralization; cleanup of released hazardous substances and associated contaminated materials; recycling or reuse; diversion; destruction; segregation of reactive wastes; dredging or excavations; repair or replacement of leaking containers; collection of leachate and runoff; on-site treatment or incineration; provision of alternative water supplies; and any monitoring reasonably required to assure that such actions protect the public health, welfare, and the environment. The term includes the costs of permanent relocation of residents and businesses and community facilities where the President of the United States determines that, alone or in combination with other measures, such relocation is more cost-effective and environmentally preferable to the transportation, storage, treatment, destruction, or secure disposition off site of hazardous substances, or may otherwise be necessary to protect the public health or welfare. The term includes off-site transport and off-site storage, treatment, destruction, or secure disposition of hazardous substances and associated contaminated materials.

Remedial Investigation (RI)
An investigation intended to "adequately characterize the site for the purpose of developing and evaluating an effective remedial alternative" [NCP, 40 CFR 300.430(d)]. In addition, the RI provides information to assess the risks to human health, safety, and the environment that were identified during risk screening in the site investigation.

SiteStats/GridStats (SS/GS)
Programs developed by QuantiTech for the Huntsville Corps of Engineers to predict the density of ordnance on sites with spatially random dispersal of ordnance.

Small Arms Ammunition (SAA)
Ammunition, without projectiles that contain explosives (other than tracers), that is .50 caliber or smaller, or for shotguns.

Special Case Areas (SCAs)
SCAs were identified by the Army for a variety of reasons, such as dense metallic clutter that prevented digital detection or interference due to nearby metal structure or features. SCAs include historical and current fencing; asphalt/concrete range pads, roads, and walkways; areas under existing structures (i.e., field latrines and range-related structures); berms and culverts; and areas requiring excavation by heavy equipment (i.e., scrape areas).

Surface Removal
Removal of MEC from the ground surface by UXO teams using visual identification sometimes aided by magnetometers.

Time-Critical Removal Action (TCRA)
Removal actions where, based on the site evaluation, a determination is made that a removal is appropriate, and that less than six months exists before on-site removal activity must begin (40 CFR 300.5).

Unexploded Ordnance (UXO)
Military munitions that (A) have been primed, fuzed, armed, or otherwise prepared for action; (B) have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and (C) remain unexploded whether by malfunction, design, or any other cause (10 U.S.C. 101[e][5][A] through [C]).

Unimproved Road
A road that may or may not be graded and has a dirt or gravel surface of any width.

UXO-Qualified Personnel
Personnel who have performed successfully in military EOD positions, or are qualified to perform in the following Department of Labor, Service Contract Act, Directory of Occupations, contractor positions: UXO Technician II, UXO Technician III, UXO Safety Officer, UXO Quality Control Specialist, or Senior UXO Supervisor.

UXO Technicians
Personnel who are qualified for and filling Department of Labor, Service Contract Act, Directory of Occupations, contractor positions of UXO Technician I, UXO Technician II, and UXO Technician III.

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EXECUTIVE SUMMARY

Introduction and Purpose

This Interim Remedial Action Completion Report (IRACR) describes the operations and results of field activities conducted by the Fort Ord Reuse Authority (FORA) to complete the munitions and explosives of concern (MEC) Design Study and Phase II Interim Action in the Interim Action Ranges (IAR) Munitions Response Area (MRA) at the former Fort Ord in Monterey County, California. A site vicinity map is provided on Figure 1-1. This report has been prepared in accordance with the Administrative Order on Consent (AOC) Task 9. The field activities, operations, and results described in this report are limited to work conducted within the IAR MRA Phase II areas. The areas discussed in this IRACR are shown on Figure 1-2.

The United States Department of the Army (Army) previously conducted munitions response actions within Munitions Response Site (MRS) Ranges 43-48, which encompasses the IAR MRA (Parsons 2002b and Parsons 2007). The Army determined that the MRS Ranges 43-48 warranted an interim action due to the proximity and increased accessibility to the public, the threat of trespassing, and the MEC on or near the surface of the ranges. An Interim Action Record of Decision (ROD) was produced by the Army in August 2002 for Interim Action Sites at the former Fort Ord, which included MRS Ranges 43-48 (Army 2002). The interim remedial action selected for the Interim Action Sites included surface and subsurface MEC remediation. The interim action in MRS Ranges 43-48, which was referred to as the Phase I Interim Action by FORA, encompassed the IAR MRA and began in 2002 with site preparation followed by a prescribed burn. Interim remedial actions were conducted from November 2003 to December 2005 (Parsons 2007). The Army designated approximately 235 acres within MRS Ranges 43-48 where the interim remedial action was not completed as Special Case Areas (SCAs) or Non Completed Areas (NCAs). Subsurface removal was not completed within the SCAs due to high concentrations of metallic debris or high density of anomalies (Parsons 2007). Approximately 35 acres of SCAs and approximately 9 acres of NCAs within MRS Ranges 43-48 are located within the boundaries of the IAR MRA. Range 44 SCA (approximately 18.9 acres), Range 47 SCA (approximately 15.2 acres), and Central Area NCAs (approximately 9.2 acres) are the subject of this IRACR. Two additional SCAs (Range 45 Trench SCA [approximately 1.15 acres] and a small portion of the Fenceline SCA [one partial 100-ft by 100-ft grid]) are also located within the IAR MRA; however, these areas are not included in this IRACR. The data and recommendations for these areas will be included in the Feasibility Study (FS) for the IAR MRA to support a final remedial decision.

Investigation of the SCAs and NCAs comprise the Phase II activities for the IAR MRA. The Phase II activities and results reported in this IRACR complete the interim remedial action within the IAR MRA consistent with the objectives outlined in the Record of Decision (ROD), Interim Action for Ordnance and Explosives at Ranges 43-48, Range 30A, and Site OE-16, Former Fort Ord, California (“Interim Action ROD”; Army 2002) for the IAR MRA which includes a portion of the Army MRS for Ranges 43-48 (“MRS Range 43-48”).

As contractors to FORA under the Environmental Services Cooperative Agreement Remediation Program (ESCA RP), the work described in this report was conducted by

ARCADIS U.S., Inc., Weston Solutions, Inc., Westcliffe Engineers, Inc. (collectively, "the ESCA RP Team"), and their subcontractors.

The scope of work discussed in this IRACR generally included:

- Conducting digital geophysical mapping (DGM) surveys in selected areas, and investigation and removal of selected target anomalies to evaluate the presence of sensitively-fuzed MEC during the Design Study
- Conducting DGM surveys and investigation and removal of target anomalies that potentially represented MEC during the Phase II Interim Action
- Conducting analog geophysical surveys in areas that were not suitable for DGM surveys and investigation and removal of anomalies that potentially represented MEC during the Phase II Interim Action
- Conducting soil excavation, stockpiling and sifting operations in areas where site conditions (e.g., high concentration of metallic debris) interfered with digital detection instruments in establishing individual target anomalies
- Conducting habitat restoration activities, including monitoring, passive restoration (seeding), and active restoration (seeding and planting), in habitat parcels that were affected by the ESCA RP Team's activities

Report Organization

The IAR MRA IRACR is divided into two volumes. Volume 1 describes the MEC-related operations and presents results of field activities conducted by FORA to complete the Design Study and Phase II Interim Action. Volume 2 describes the habitat restoration field activities performed in the habitat parcels of the MRA and presents monitoring results.

Interim Remedial Action Field Activities and Results (Volume 1)

Volume 1 describes the technical approach employed to conduct MEC remedial action field activities associated with the Design Study and Phase II Interim Remedial Action in the IAR MRA and presents quality control (QC) and quality assurance (QA) activities, results, and conclusions.

The Design Study and Phase II Interim Remedial Action in the IAR MRA began in February 2011 and were completed in March 2013. In total, the Design Study and Phase II Interim Remedial Action conducted by FORA resulted in the recovery of the following:

- 3,655 MEC items
- Approximately 44,269 pounds (lbs) of munitions debris (MD)
- Approximately 11,144 lbs of other debris

The results of the Design Study and Phase II Interim Remedial Action activities presented in Volume 1as well as results from historical actions conducted by the Army will be incorporated into the FS for the IAR MRA to support a final remedial decision.

Habitat Restoration Field Activities and Results (Volume 2)

Volume 2 summarizes the activities conducted by FORA during the implementation and monitoring of habitat restoration activities in the IAR MRA between October 16, 2012 and December 31, 2013. The habitat restoration implementation and monitoring activities conducted in the IAR MRA were performed in habitat parcels affected by the Design Study and Phase II Interim Action activities.

A Habitat Restoration Plan (HRP) for the IAR MRA was prepared to describe the activities to be undertaken to restore the natural resources in habitat parcels that were affected by the ESCA RP Team's MEC remedial activities. The HRP includes restoration requirements outlined in the Installation-Wide Multispecies Habitat Management Plan (HMP) for Former Fort Ord, California ("the HMP"; USACE 1997) and in Biological Opinions (BOs; USFWS 1999, 2002, 2005) issued to the Army.

The HRP identified the required restoration strategies to address the four types of vegetation disturbance activity that occurred in the habitat parcels. Restoration strategies including monitoring, passive restoration (seeding), and active restoration (seeding and planting), were implemented in the areas of vegetation disturbance. Implementation of the restoration strategies included site preparation (erosion control and installation of an animal deterrent system and an irrigation system), seeding of HMP annuals and seed bank, targeted seeding of common species, salvaging and transplanting of shaggy-barked manzanita, and installation of container plantings. Results of monitoring for plant survival, species richness, and percentage vegetation cover from October 2012 through December 2013 are reported in Volume 2.

Construction and implementation of the restoration areas has been completed and restoration systems are in place, operational and functioning. Operation and maintenance to support the long-term success of restoration at the site is being implemented through a post-installation adaptive management process to evaluate and manage the restoration areas as described in the HRP (ESCA RP Team 2013b). Results of the 2013 habitat monitoring data are consistent with current year performance targets for all activity types (ingress/egress corridors, vegetation cutting, small-scale excavation, and large-scale excavation). The initiated restoration activities are currently on track to achieve the prescribed performance criteria in the IAR MRA restoration areas.

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1.0 INTRODUCTION

This Interim Remedial Action Completion Report (IRACR) describes the operations and results of field activities conducted by the Fort Ord Reuse Authority (FORA) to complete the munitions and explosives of concern (MEC) Design Study and Phase II Interim Action in the Range 44 Special Case Area (SCA), Central Area Non-Completed Areas (NCAs), and Range 47 SCA of the Interim Action Ranges (IAR) Munitions Response Area (MRA) at the former Fort Ord in Monterey County, California. An IAR MRA location map is provided on Figure 1-1. The SCAs and NCAs are shown on Figure 1-2. The IRACR is presented in two volumes. Volume 1 focuses on the technical approach employed to conduct the Design Study and Phase II Interim Action and presents quality control (QC) and quality assurance (QA) activities, Design Study results, Phase II Interim Action results, and conclusions. Volume 2 focuses on the habitat restoration activities conducted between October 16, 2012 and December 31, 2013 in habitat parcels affected by the Design Study and Phase II Interim Action activities. Information included in this IRACR will be used to support a Feasibility Study (FS) and a final remedial action decision for the IAR MRA.

The objective of the Design Study and Phase II Interim Action was to complete the interim remedial action within the IAR MRA consistent with the objectives outlined in the Record of Decision (ROD), Interim Action for Ordnance and Explosives at Ranges 43-48, Range 30A, and Site OE-16, Former Fort Ord, California ("Interim Action ROD"; Army 2002) because the entire IAR MRA is located within a portion of the United States Department of the Army (Army) Munitions Response Site (MRS) for Ranges 43-48 ("MRS Range 43-48"). MRS Range 43-48 is shown on Figure 1-1. The interim remedial action objectives in the Interim Action ROD were to reduce risks to human health and the environment and comply with federal and state Applicable or Relevant and Appropriate Requirements (ARARs). The interim remedial action in the remaining portion of the IAR MRA, outside of the SCAs and NCAs, was completed by the Army in accordance with the objectives outlined in the Interim Action ROD and is referred to as the Phase I Interim Action by FORA (Figure 1-2). To meet the remedial action objectives and complete the selected remedy for the Interim Action ROD in the SCAs and NCAs, a design study was conducted followed by a remedial action in the Range 47 SCA. Two additional SCAs (Range 45 Trench SCA and a small portion of the Fenceline SCA) are also located within the IAR MRA; however, these areas are not included in this IRACR. Removal actions completed by the Army in these areas are discussed in the Final MRS-Ranges 43-48, Interim Action, Technical Information Paper (Parsons 2007). It was recommended in the technical information paper that construction support be required for any intrusive activities in the Range 45 Trench SCA if no further removal action is taken (Parson 2007). If no further removal action is taken in the Fenceline SCA, the technical information paper recommended limiting access to workers trained in MEC recognition or with a UXO escort (Parsons 2007). No further remedial actions were completed in the two SCAs. The data and recommendations for these areas will be included in the FS for the IAR MRA to support a final remedial decision.

The remaining portion of MRS Range 43-48 is being addressed by the Army under the Record of Decision, Impact Area MRA, Track 3 Munitions Response Site ("Track 3 ROD"; Army 2008), because this portion of MRS Range 43-48 is located within the boundary of the Impact Area MRA (Figure 1-1). The remedial action objectives in the Track 3 ROD are to

achieve the United States Environmental Protection Agency (EPA) threshold criteria of "Overall Protection of Human Health and the Environment" and "Compliance with ARARs", which are consistent with the Interim Action ROD. To meet the remedial action objectives, the selected remedy for the Impact Area MRA included vegetation clearance, technology-aided surface MEC remediation, with subsurface MEC remediation in selected areas, and land use controls.

1.1 Regulatory History

On March 31, 2007, the Army and FORA entered into an Environmental Services Cooperative Agreement (ESCA) governing the remaining MEC removal activities required for approximately 3,300 acres of the former Fort Ord property. In accordance with the ESCA and an Administrative Order on Consent (AOC), FORA is responsible for munitions response actions as defined in the ESCA and related documents, except for those retained by the Army, and demonstrating means of securing regulatory clearance for future uses on former military lands. The AOC was entered into voluntarily by FORA, the EPA Region 9, the California Department of Toxic Substances Control (DTSC), and the United States Department of Justice Environment and Natural Resources Division on December 20, 2006 (EPA Region 9 Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. R9-2007-03). The AOC was issued under the authority vested in the President of the United States by Sections 104, 106, and 122 of CERCLA, as amended, 42 United States Code §§ 9604, 9606, and 9622.

This IRACR was prepared in accordance with AOC Task 9. ARCADIS U.S., Inc. has prepared this document on behalf of FORA in accordance with industry standards and consistent with the requirements of the Remediation Services Agreement dated March 30, 2007 by and between ARCADIS U.S., Inc. and FORA including any applicable governing documents and applicable laws and regulations. As contractors to FORA under the Environmental Services Cooperative Agreement Remediation Program (ESCA RP), the field activities described in this IRACR were conducted by ARCADIS U.S., Inc., Weston Solutions, Inc., and Westcliffe Engineers, Inc. (collectively "the ESCA RP Team"), and their subcontractors.

1.2 Purpose and Scope

The purpose of Volume 1 of this IRACR is to document the Design Study and Phase II Interim Action activities conducted in the SCAs and NCAs of the IAR MRA. The results of the Design Study were evaluated to determine the areas where continuing the Phase II Interim Action was warranted and to refine the technical approach for the interim action within the SCAs and NCAs. The results of the Design Study and the decision regarding the extent and approach for completing the Phase II Interim Action were documented in field variance forms (FVFs). Decisions were made as the Design Study proceeded so that Phase II Interim Actions could immediately follow completion of the Design Study, if warranted.

To facilitate completion of the Design Study, the Range 44 SCA and Central Area NCAs were divided into northern and southern portions referred to in this IRACR as "Range 44 SCA (North)" and "Range 44 SCA (South) and Central Area NCAs" (Figure 1-2).

Additionally, one grid of the Central Area NCAs located adjacent to Range 47 SCA was combined with the Range 47 SCA (Figure 1-2). The activities conducted in the SCAs and NCAs are summarized below:

- Range 44 SCA (North)
  - Design Study transect based investigation
  - Design Study expansion grid based investigation
- Range 44 SCA (South) and Central Area NCAs
  - Design Study transect based investigation
- Range 47 SCA
  - Design Study transect based investigation
  - Design Study berm investigation
  - Completion of the interim remedial action (Phase II Interim Action)

The activities completed during the Design Study and Phase II Interim Action discussed in Volume 1 of this IRACR began in February 2011 and were completed in March 2013. Activities described in Volume 1 of this IRACR were conducted in accordance with the Final Phase II Interim Action Work Plan, IAR MRA ("Interim Action Work Plan"; ESCA RP Team 2011) and the approved FVFs associated with the Interim Action Work Plan, as presented in Section 3.2 of this IRACR.

1.3 Report Organization

Volume 1 of this IRACR is presented in numbered sections, tables, and figures and lettered appendices. Tables and figures are numbered to correspond with the section in which they are first referenced. Introductory information for the project is presented in Section 1.0. Site description and background information for the IAR MRA are presented in Section 2.0. Section 3.0 presents the technical operations employed to complete activities associated with the Design Study and Phase II Interim Action. QC and QA activities conducted throughout the course of the project are described in Section 4.0. The results of the Design Study are provided in Section 5.0. The results of the Phase II Interim Action are provided in Section 6.0. The conclusions are presented in Section 7.0. References are provided in Section 8.0.

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2.0 SITE DESCRIPTION AND BACKGROUND

The following sections discuss the background, history and previous munitions response actions conducted for the IAR MRA; however, field activities described in this IRACR were only required to be conducted in the SCAs and NCAs of the IAR MRA.

2.1 IAR MRA and Phase II Area Location

The IAR MRA is located in the north-central portion of the former Fort Ord, within the boundary of the historical impact area and is bordered by the Parker Flats MRA to the north, the Seaside MRA to the northwest, and the Impact Area MRA to the southeast, south, and southwest (Figure 1-1). The IAR MRA is contained within the jurisdictional boundaries of the City of Seaside and Monterey County (Figure 1-1).

The IAR MRA encompasses approximately 227 acres and contains five United States Army Corp of Engineer (USACE) property transfer parcels: E38, E39, E40, E41, and E42 (Figure 2-1). As described in Section 1.1, the IAR MRA Phase II areas consist of Range 44 SCA (North), Range 44 SCA (South) and Central Area NCAs, and Range 47 SCA (Figure 1-2).

The proposed future land use for the IAR MRA Phase II areas is habitat reserve (Figure 2-1). The proposed future land use presented in this report is primarily based upon the 1997 Fort Ord Base Reuse Plan (FORA 1997). Other sources of future land use information include public benefit conveyance, negotiated sale requests, transfer documents, the Installation-Wide Multispecies Habitat Management Plan (HMP; USACE 1997), and the Assessment East Garrison – Parker Flats Land Use Modifications (Zander 2002). The Fort Ord Base Reuse Plan identified approximately 20 land-use categories at the former Fort Ord (FORA 1997) including habitat management, open space/recreation, institutional/public facilities, commercial, industrial/business park, residential, tourism, mixed use, and others.

2.2 IAR MRA Physical Description

2.2.1 Topography and Geology

The terrain of the IAR MRA is relatively flat. The elevation ranges from approximately 370 to approximately 530 feet (ft) mean sea level with 2 to 15 percent slopes. The surface soils are characterized as eolian (sand dune) and terrace (river deposits), which consist of unconsolidated materials of the Aromas and Old Dune Sand formations. The primary soil type present in the IAR MRA area is Arnold-Santa Ynez Complex with Baywood Sand in the northwestern portion. Soil conditions at the MRA consist predominantly of weathered dune sand.

2.2.2 Vegetation

Vegetation in the IAR MRA consists primarily of maritime chaparral (USACE/Jones & Stokes 1992). Prior to 2003 much of the IAR MRA was inhabited by dense maritime chaparral with stands of varying maturity (or seral stage) ranging from very young to mature, the latter with shrub canopy up to 15 ft tall. The MRA was subjected to a prescribed burn in

2003. In early 2008, prior to initiation of ESCA RP vegetation monitoring activities in the MRA, the majority of vegetation was less than 4 ft tall and much less dense than it was prior to the 2003 prescribed burn. Patches of annual grassland habitats existed in 2008 along the western and southern boundaries of the MRA. Currently, there are areas within the MRA where poison oak occurs in dense stands.

2.2.3 Surface Water and Groundwater

Groundwater investigations associated with the Basewide Remedial Investigation/Feasibility Study (RI/FS) have resulted in the installation of a number of groundwater monitoring wells on former Fort Ord property near the IAR MRA. The IAR MRA overlies the Seaside groundwater basin, which is structurally complex and divided into several sub-basins. The depth to groundwater is estimated to be greater than 100 ft below ground surface (bgs). No wells are located within the IAR MRA. The occurrence of groundwater beneath the MRA was not expected to influence geophysical surveys conducted for the Design Study or Phase II Interim Action.

There are no surface-water features or delineated wetlands present on the IAR MRA; however, an aquatic feature is present approximately 4,500 ft to the east-southeast of the MRA.

2.2.4 Ecological Profile

In 2004, the California Tiger Salamander (CTS) was identified as a threatened species. CTS may be found as far as 2 kilometers (km) from aquatic breeding habitats. There is a possibility that CTS may be found in the IAR MRA as the MRA is within 2 km of aquatic features (i.e., vernal pools, ponds) that may provide habitat for the CTS (USFWS 2005).

As identified in the HMP, threatened and endangered species could be found on the IAR MRA (USACE 1997). Threatened or endangered plant species identified as having possible occurrence in the IAR MRA include Monterey gilia (endangered; formerly referred to as sand gilia) and Monterey spineflower (threatened). A portion of the IAR MRA has been designated as critical habitat for the Monterey spineflower by the United States Fish and Wildlife Service (USFWS; USFWS 2002).

2.3 Site History

The former Fort Ord was used to train Army infantry, cavalry, and field artillery units until official closure in 1994. In support of the training of soldiers, military munitions were used at the ranges throughout the former Fort Ord. As a result of the training activities, a wide variety of conventional MEC have been encountered in areas throughout the former Fort Ord. The MEC encountered at the former Fort Ord have been either unexploded ordnance (UXO) or discarded military munitions (DMM).

Initial use of the IAR MRA began in approximately 1917 when the United States government purchased more than 15,000 acres of land and designated it as an artillery range. Although no

training maps from this time period have been found, pre-World War II-era military munitions have been removed during previous Army response actions within the IAR MRA.

The IAR MRA contains the firing points and safety fans for Ranges 44, 45, 46, and 47 and a portion of the firing point and safety fans for Range 43 (Figure 2-2). The firing points for the ranges were located along the northern portion of the MRA. Historical range usage is summarized as follows:

- Range 43 - mortar training and subsequently as a platoon live fire course at the time of base closure
- Range 44 - antitank (AT) weapons range at the time of base closure
- Range 45 - grenade launcher range at the time of base closure
- Range 46 - small arms range from the late 1950s to the time of base closure
- Range 47 - 40 millimeter (mm) grenade range in the 1960s

2.4 Previous Munitions Response Actions

The following subsections describe the munitions response actions conducted by the Army within MRS Ranges 43-48, which encompasses the IAR MRA (Figure 2-2).

The historical information summarized in this IRACR is based on historical documents and previous munitions response actions in the IAR MRA. Table 2-1 lists the MEC that were encountered during the previous munitions response actions within the IAR MRA. Figures 2-3 and 2-4 show the locations where MEC and munitions debris (MD), respectively, were encountered and removed during the previous munitions response actions in the IAR MRA as described in the Sections 2.4.1, 2.4.2, and 2.4.3.

2.4.1 Actions Conducted Prior to Phase I Interim Action

The Army performed munitions response actions at MRS Ranges 43-48, which encompasses the IAR MRA. The following bullets describe the munitions response actions performed by the Army in MRS Ranges 43-48:

- Range 44: Site OE-15 Roads and Trails (April 1997) – removal to a 4-ft depth, and deeper following approval, on a 15-ft-wide, 600-foot long road identified as “Range 44 RD” (USA 2001a)
- Range 44 Grid Subsurface Removal (April 1997) – removal to a 4-ft depth on two 100-ft-by-100-ft grids (Parsons 2007)
- Range 44 Grid Sampling (August 1997) – grid sampling at one 100-ft-by-100-ft grid (Parsons 2007)
- Range 46: Site OE-15A Grid Sampling (October to November 1997) – grid sampling to a depth of 4 ft, and deeper following approval, at two 100-ft by 100-ft grids using Schonstedt magnetometers (USA 2000)

- Ranges 44, 45, and 46: OE-15 Fuel Break (May to July 1998) – a 4-ft removal using Schonstedt magnetometers for 284 30-ft-wide by 110-ft-long full and partial grids along a fuel break located on the interior boundary of the historical impact area (USA 2001c)
- Range 45 Surface Removal (April to October 1999) – a surface removal on an 11.5-acre portion of Range 45 as an immediate safety action in response to trespassing incidents (Parsons 2007)
- Ranges 43-48: Surface Removal (August to December 2001) – a visual surface removal in 555 acres of Ranges 43-48 to address an imminent and substantial danger. Vegetation was not cut; therefore, the removal action focused on open and accessible areas (Parsons 2002b).
- Range 46 Subsurface Removal (April to August 1999) – a 4-ft removal with Schonstedt magnetometers on nine grids within Range 46 to support efforts to remediate spent small arms ammunition (SAA) and lead-contaminated soil. Portions of these grids were located within the IAR MRA (USA 2001b).
- Ranges 44, 45, and 46: Site OE-15 Grid Sampling at MOCO.2 and Seaside 01 (March to August 1999) – grid sampling and 4-ft removal, and deeper following approval, at seven 100-ft by 100-ft grids using Schonstedt magnetometers (USA 2001c)
- MRS Ranges 43-48 Surface Removal Action (August to December 2001) – visual surface removal on trails, paths, and accessible areas of thirty-seven full and partial 1,000-ft by 1,000-ft grids (Parsons 2002b)

2.4.2 Army Phase I Interim Action

The Army determined that the MRS Ranges 43-48 warranted an interim action because of the proximity and increased accessibility to the public, the threat of trespassing, and the MEC on or near the surface of the ranges. An Interim Action ROD was produced by the Army in August 2002 for Interim Action Sites at the former Fort Ord, which included MRS Ranges 43-48 (Army 2002). The interim remedial action selected for the Interim Action Sites included surface and subsurface MEC remediation.

The interim action in MRS Ranges 43-48, which was referred to as the Phase I Interim Action by FORA, encompassed the IAR MRA and began in 2002 with site preparation followed by a prescribed burn in October 2003. Interim remedial actions were conducted from November 2003 to December 2005 and consisted of the following activities (Parsons 2007):

- Visual surface removal from November 2003 to February 2004
- Subsurface removal to depth at 1,251 100-ft-by-100-ft grids using Schonstedt magnetometers (approximately 272 acres) from December 2003 to July 2005 and at ten 100-ft-by-100-ft grids (approximately 2.3 acres) from May 2005 to October 2005
- Excavation and sifting, followed by analog subsurface removal and digital geophysical mapping (DGM)-based subsurface removal in a 14-acre area of Range 45 (May to October 2005) and deconstruction of the Range 45 pad (1.75 acres in 8

grids) followed by analog subsurface removal and DGM-based subsurface removal in the pad footprint (October and November 2005)

- DGM and subsurface removal in accessible areas, which included 1,249 100-ft-by-100-ft grids from April 2004 to November 2005

After completing the above activities, the Army designated approximately 235 acres within MRS Ranges 43-48 where the interim remedial action was not completed as SCAs or NCAs. Subsurface MEC remediation was not completed within the SCAs due to high concentrations of anomalies caused by metallic debris and various other reasons (Parsons 2007). Approximately 35 acres of the SCAs and approximately 9 acres of NCAs within MRS Ranges 43-48 are located within the boundaries of the IAR MRA. Range 44 SCA (approximately 18.9 acres), Range 47 SCA (approximately 15.2 acres), and Central Area NCAs (approximately 9.2 acres) are the subject of this IRACR (Figure 1-2). Two additional SCAs (Range 45 Trench SCA [approximately 1.15 acres] and a small portion of the Fenceline SCA [one partial 100-ft by 100-ft grid]) are also located within the IAR MRA; however, these areas are not included in this IRACR.

2.4.3 Army Activities after Phase I Interim Action

A removal action was performed at Range 44 SCA in March 2007 which included surface removal of any MEC, MD, or metallic debris greater than 2 inches in dimension (with the exception of non-MEC-like MD in a portion of the site). Results of the surface removal were presented in the Draft Final Technical Information Paper, Surface Removal Range 44 Special Case Area (Shaw 2007).

As stated in the Final Findings of Suitability for Early Transfer, further evaluation was recommended for historical areas (HAs) identified in Range 43 (HA-43) and Range 44 (HA-44) due to the presence of munitions constituents in soil samples (Army 2007). HA-43 is partially located within the southeastern boundary of the IAR MRA and HA-44 is entirely located in the central portion of the MRA (Figure 1-2). Ranges 43 and 44 are part of Installation Restoration Program Site 39 (Inter-Garrison Site) at the former Fort Ord.

In February to September 2010, Shaw Environmental, Inc. (on behalf of the Army) excavated approximately 150 cubic yards of soil from HA-43 and approximately 4,070 cubic yards of soil from HA-44 and disposed of the soil in the Operable Unit 2 landfills. The results of the soil removal activities were presented in the Final Technical Memorandum (Shaw 2011). As presented in the Final Basewide Range Assessment Report, Revision 2, no further action was recommended for HA-43 and HA-44 (Shaw 2012). As a follow-up to the 3rd Five-Year Review, an additional evaluation was conducted by the Army to determine the protectiveness for 17 lead-impacted sites, including Site 39 (Army 2012). Results of the evaluation are presented in the Draft Technical Memorandum Evaluation of Lead Concentrations at Selected Sites (ITSI Gilbane 2013). As presented in the Draft Final Remedial Action Completion Report, Site 39 Inland Ranges Habitat Reserve, results of the soil remedial action completed by the Army meet the remedial action objectives established for the Site 39 Inland Ranges for removal of soil contaminated with lead and/or explosives constituents (ITSI Gilbane 2014).

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3.0 TECHNICAL OPERATIONS

This section describes the technical approach employed to conduct activities associated with the Design Study and Phase II Interim Action in the IAR MRA. The Design Study and Phase II Interim Action in the IAR MRA began in February 2011 and were completed in March 2013.

3.1 General Approach

The SCAs and NCAs were evaluated through a Design Study to determine the portions of the SCAs and NCAs that required subsurface MEC remediation in accordance with the Army Interim Action ROD. The subsurface MEC remediation is referred to in this document as the Phase II Interim Action. The initial step in the general approach was to conduct a Design Study consisting of DGM surveys in transects in the Range 44 SCA (North and South) and Central Area NCAs, and soil excavation (scraping) and sifting followed by DGM survey in the Range 47 SCA transects. Best Available (and Appropriate) Detection Technology (BADT) was used during DGM surveys. Target investigation along transects was conducted to evaluate the potential types (i.e., sensitively-fuzed), depths, and densities of the munitions within the SCAs and NCAs. In Range 44 SCA (North and South) and Central Area NCAs, it was necessary in some cases to scrape and sift soil from the transects and/or expand the Design Study to a grid level in order to complete the evaluation. The next step in the general approach was to review the data with the regulatory agencies and the Army to determine where the Phase II Interim Action activities were needed to achieve the remedial action objectives. The final step of the general approach was to conduct the Phase II Interim Action, which consisted of soil excavation and sifting, DGM surveys using BADT, and target investigation. In some cases, the DGM surveys and target investigation needed to be repeated followed by verification DGM surveys in order to achieve the remedial action objectives. The specific activities associated with the Design Study and Phase II Interim Action are described in detail in Sections 3.1.1 and 3.1.2. The implemented procedures and methods for the Design Study and Phase II Interim Action are described in Sections 3.2 through 3.6 with QA/QC described in Section 4.0. Habitat mitigation measures were implemented to avoid and minimize impacts to rare, threatened, and endangered species and their habitats during the Design Study and Phase II Interim Action field activities as described in Section 3.6.

3.1.1 Design Study Activities

This section summarizes the activities performed to complete the Design Study in each of the Phase II work areas. Contractor and subcontractor daily field reports are provided in Appendix A.

3.1.1.1 Range 44 SCA (North)

The Design Study activities conducted in Range 44 SCA (North) are described below with technical procedures and methods provided in the following subsections as referenced adjacent to the bulleted activity. In Range 44 SCA (North), two parallel, 10-ft wide by 100-ft long transects (reported as 8.2-ft wide transects in FVF IAWP-004) were investigated in 28

grids (Figure 3-1). This covered approximately 20% of the area within each grid, but did not include the Army's HA-44 Remediation Area. The Design Study activities in the transects included:

- Site Preparation (Section 3.3) – activities included preparatory inspections, grid corner and transect marker installation, vegetation cutting, and surface debris removal.
- Analog-Assisted Near-Surface Investigation (Section 3.4.4) – activities included removal and disposal of recovered MEC, MD, and other debris to facilitate DGM surveys and target investigation.
- DGM Survey and Target Investigation (Section 3.4.5) – DGM survey activities included geophysical data collection, data processing, target selection, and target investigation. Target investigation activities included removal and disposal of recovered MEC, MD, and other debris.
- Soil Sifting Operations (Section 3.5) – soil in 14 selected transects was scraped and sifted to evaluate the high density of small metallic debris (Figure 3-1). Sifting operations included debris disposal, MEC demolition operations (if needed), and the replacement of the sifted soil to the location of origin at the conclusion of the work in the area.
- QA/QC Activities (Section 4.0) – activities included daily instrument checks, QC of DGM areas, QC of sifting operations, implementation of a seeding program, and Third Party QA review and reporting conducted by a FORA independent contractor (blind QA/QC seeding was not required).

The results of the transect investigation in Range 44 SCA (North) are presented in Section 5.1. The transect investigation indicated that further investigation was required to determine the extent of sensitively-fuzed munitions potentially present in Range 44 SCA (North).

The Design Study activities were expanded to a grid level and included approximately 8.3 acres (28 whole and 13 partial grids) of Range 44 SCA (North), referred to as the "Design Study Expansion" as documented in a FVF (Section 3.2), but did not include the Army's HA-44 Remediation Area (Figure 3-1). The following additional activities were performed in Range 44 SCA (North) to complete the Design Study Expansion:

- Site Preparation (Section 3.3) – activities included preparatory inspections, boundary marker installation, vegetation cutting, and surface debris removal.
- Analog-Assisted Near-Surface Investigation (Section 3.4.4) – activities included removal and disposal of recovered MEC, MD, and other debris to facilitate DGM surveys and target investigation.
- DGM Survey and Target Investigation (Section 3.4.5) – Two DGM surveys and a transect verification DGM survey were conducted and activities included geophysical data collection, data processing, target selection, and target investigation. Target investigation activities included removal and disposal of recovered MEC, MD, and other debris.

- Soil Sifting Operations (Section 3.5) – localized areas (referred to as "polygons") with a high density of small metallic debris were excavated and sifted (Figure 3-1). Sifting operations included debris disposal, MEC demolition operations, and the replacement of the sifted soil to the location of origin at the conclusion of the work in the area.
- QA/QC Activities (Section 4.0) – activities included daily instrument checks, QC of DGM areas, QC of sifting operations, implementation of a seeding program, and Third Party QA review and reporting conducted by a FORA independent contractor.
- Other Activities (Section 3.6) – activities included erosion control, environmental protection, weed abatement, habitat restoration (Volume 2), and CTS protection.

The results of the Design Study Expansion in Range 44 SCA (North) are presented in Section 5.2. Over the course of the Design Study Expansion, a second DGM survey and target investigation was conducted in the northernmost 33 whole and partial grids (excluding the southernmost eight grids) because of the high density of anomalies remaining and evidence of use of sensitively-fuzed munitions. The DGM survey and target investigation in the southernmost eight grids did not show evidence for sensitively-fuzed munitions. Following the second DGM survey and target investigation, a transect verification DGM survey and target investigation was performed over approximately 16% of the 41 whole and partial grids in Range 44 SCA (North) to determine if additional DGM surveys and target investigations were necessary. The survey was conducted using the same activities as outlined above for the DGM survey and target investigation. As a result of the transect verification DGM survey, a final verification DGM survey was conducted in a 1.5-acre portion of Range 44 SCA (North) where a single non-sensitively-fuzed MEC item was recovered during the transect verification DGM survey activities (Section 5.2). The final verification survey was conducted using the same activities as outlined above for the DGM survey and target investigation.

3.1.1.2 Range 44 SCA (South) and Central Area NCAs

The Design Study activities conducted in Range 44 SCA (South) and the Central Area NCAs are described below with technical procedures and methods provided in the following subsections as referenced adjacent to the bulleted activity. In Range 44 SCA (South) and the Central Area NCAs, two parallel, 10-ft-wide by 100-ft-long transects were investigated in 77 grids (Figure 3-1), which covered approximately 20% of the area within each grid. The Design Study activities in the transects included:

- Site Preparation (Section 3.3) – activities included preparatory inspections, grid corner and transect marker installation, vegetation cutting, and surface debris removal.
- Analog-Assisted Near-Surface Removal (Section 3.4.4) – activities included removal and disposal of recovered MEC, MD, and other debris to facilitate DGM surveys and target investigation.
- DGM Survey and Target Investigation (Section 3.4.5) – DGM survey activities included geophysical data collection, data processing, target selection, and target

investigation. Target investigation activities included removal and disposal of recovered MEC, MD, and other debris.

- Soil Sifting Operations (Section 3.5) – soil in selected transects (15 transect segments in Range 44 (South) and 11 transect segments in Central Area NCAs) was scraped and sifted to evaluate the high density of small metallic debris (Figure 3-1). Sifting operations included disposal of debris, MEC demolition operations (if needed), and the replacement of the sifted soil to the location of origin at the conclusion of the work in the area.
- QA/QC Activities (Section 4.0) – activities included daily instrument checks, QC of DGM areas, QC of sifting operations, implementation of a seeding program, and Third Party QA review and reporting conducted by a FORA independent contractor (blind QA/QC seeding was not required).
- Other Activities (Section 3.6) – activities included erosion control, environmental protection, weed abatement, habitat restoration (Volume 2), and CTS protection.

The results of the Design Study in Range 44 SCA (South) and the Central Area NCAs are presented in Section 5.1. Due to the lack of evidence for sensitively-fuzed items to remain in the Range 44 (South) SCA and Central Area NCAs, an interim remedial action was not warranted for these areas (Section 5.1).

3.1.1.3 Range 47 SCA

The Design Study activities conducted in Range 47 SCA are described below with technical procedures and methods provided in the following subsections as referenced adjacent to the bulleted activity. In Range 47 SCA, one approximately 10-ft-wide by 100-ft-long transect across 53 of the 67 grids within the SCA was investigated, which covered approximately 8% of the area (Figure 3-1). In addition, seven approximately 10-ft wide transects were used to investigate a berm that occupied portions of the remaining 14 grids of the SCA (Figure 3-1). It was determined that excavation and sifting of the berm was necessary to evaluate the presence of sensitively-fuzed munitions potentially remaining beneath the berm, as presented in a FVF (Section 3.2). Excavation and sifting of soil from the berm was performed as part of the Design Study. The Design Study activities in the transects included:

- Site Preparation (Section 3.3) – activities included preparatory inspections, grid corner and transect marker installation, vegetation cutting and removal, and surface debris removal.
- Soil Sifting Operations (Section 3.5) – soil in the transects was scraped and sifted to evaluate the high density of metallic debris. Some transects required removal of multiple 6-inch soil lifts to reduce the anomaly density. Following the removal of each soil lift, the anomaly density was verified by conducting a post-scrape DGM survey. The Interim Action Work Plan did not require investigation of all anomalies in all transect segments following the DGM surveys conducted to verify anomaly density. Sifting operations included disposal of debris, MEC demolition operations, and the replacement of the sifted soil to the location of origin at the conclusion of the work in the area.

- DGM Survey and Target Investigation (Section 3.4.5) – DGM survey activities included geophysical data collection along transects, data processing, target selection, and investigation of a portion of the selected targets. A post-scrape DGM survey was initially conducted to observe the density of anomalies and to determine if individual targets could be selected effectively or if additional soil excavation would be required to reduce anomaly densities. As part of the Design Study, the DGM survey and selected target investigation was conducted to determine the depth of soil to be excavated during Phase II Interim Action and did not require investigation of every anomaly in every transect segment. Approximately 18% of the post-scrape DGM target anomalies were investigated to determine appropriate soil lifts depths during the Phase II Interim Action. All of the investigated anomalies were located within one transect. Phase II Interim Action included excavation and sifting of the majority of the SCA followed by a post-scrape DGM survey and target investigation. Target investigation activities included removal and disposal of recovered MEC, MD, and other debris.
- Berm Removal and Soil Sifting Operations (Sections 3.2 and 3.5) – soil from the berm area was excavated and sifted. Sifting operations included disposal of debris and MEC demolition operations, and the replacement of the sifted soil to the location of origin at the conclusion of the work in the area.
- QA/QC Activities (Section 4.0) – activities included QC of DGM surveys and Third Party QA reporting conducted by a FORA independent contractor (blind QA/QC seeding was not required).
- Other Activities (Section 3.6) – activities included erosion control, environmental protection, weed abatement, and CTS protection.

The results of the Design Study in Range 47 SCA are presented in Section 5.3. Results of the data collected indicated that completion of the Phase II Interim Action was warranted in the Range 47 SCA (Section 5.3) due to the limited effectiveness of target investigation caused by high anomaly density and recovery of numerous sensitively-fuzed munitions as presented in a FVF (Section 3.2). The depth of soil excavation necessary to complete an effective target investigation during the Phase II Interim Action was determined to be between 6 to 24 inches bgs as presented in the FVF (Section 3.2). The Phase II Interim Action activities included excavation of 12.4 acres of the Range 47 SCA Design Study area, DGM survey and target investigation over the majority of the SCA, and analog survey and target investigation of the sloped escarpment. These activities are described in Section 3.1.2. Soil excavated from the Design Study transects was sifted and returned to the excavated area following completion of the Phase II Interim Action activities.

3.1.2 Phase II Interim Action Activities

This section summarizes the activities performed to complete the Phase II Interim Action in the Range 47 SCA. Contractor and subcontractor daily field reports are provided in Appendix A.

3.1.2.1 Range 47 SCA

The interim remedial activities conducted in Range 47 SCA are described below with technical procedures and methods provided in the following subsections as referenced adjacent to the bulleted activity. Phase II Interim Action included:

- Site Preparation (Section 3.3) – activities included vegetation removal and grinding to support soil excavation in the central portion (i.e., range fan portion) of the SCA and vegetation cutting, as needed, in the remainder of the SCA (i.e., northern and southern boundaries) (Figure 3-2).
- Soil Excavation and Sifting Operations (Section 3.5) – soil in the central portion (i.e., range fan portion) of the SCA was excavated and sifted to reduce anomaly density (Figure 3-2). High anomaly density was not a concern for the remaining portions of the SCA (i.e., northeastern and southwestern margins). Soil from the face of the sloped escarpment was excavated to depths of 2 to 4 ft bgs and sifted to reduce anomaly density. Activities included disposal of debris, MEC demolition operations, and the replacement of the sifted soil to the location of origin at the conclusion of the work in the area.
- DGM Survey and Target Investigation (Section 3.4.5) – DGM surveys were completed over the excavated areas and brush cutting areas (Figure 3-3). DGM survey activities included collection and processing of geophysical data, target selection and investigation, and removal and disposal of recovered MEC, MD, and other debris.
- Analog Survey and Target Investigation (Section 3.4.6) – activities were completed in the excavated face of the sloped escarpment including analog survey, target investigation, and removal and disposal of recovered MEC, MD, and other debris (Figure 3-3).
- QA/QC Activities (Section 4.0) – activities included QC of DGM and analog surveys, QC surveys in DGM investigated areas, and Third Party QA reporting conducted by a FORA independent contractor.
- Other Activities (Section 3.6) – activities included erosion control, environmental protection, weed abatement, habitat restoration (Volume 2), and CTS protection.

The results of the Phase II Interim Action in Range 47 SCA are presented in Section 6.0. A QC-2 DGM survey indicated that additional soil excavation and sifting was needed to address areas where large clusters of anomalies or high anomaly densities remained. These areas were identified as verification polygons (Figure 3-2) where additional soil excavation and sifting was conducted followed by DGM surveys and target investigation as described in the above bulleted activities. At the conclusion of the verification polygon activities, a verification DGM survey and target investigation was conducted over the Range 47 SCA to evaluate anomaly removal efficiency and completion of the Phase II Interim Action (Sections 6.5 and 6.8).

3.2 Project Field Variances

During the course of the field activities the project field team encountered situations requiring different methodologies from those described in the approved work plan (ESCA RP Team 2011). To address these issues the project team prepared four FVFs to document each issue and how the work performed in addressing the issue varied from the procedures outlined in the work plan. The FVFs are provided in Appendix C. The following bullets provide an overview of the FVFs:

- **Field Variance Form No. IARWP-001: Blow-in-Place Demolition Procedures for Interim Action Ranges MRA**

  FVF No. IARWP-001 indicated that site operations have been shut down for 2 to 3 hours a day depending on the number of non-movable MEC items found. This field variance recommended a change from destroying non-movable MEC items on a daily basis to a weekly basis, ensuring no recovered MEC remained at the site over the weekend.

- **Field Variance Form No. IARWP-002: Design Study Enhancement for Range 47 Special Case Area – Berm**

  FVF No. IARWP-002 indicated the berm and the area under the berm would be investigated and evaluated for the potential presence of sensitively-fuzed munitions. This field variance recommended the removal of the Range 47 SCA berm through excavation and soil sifting operations.

- **Field Variance Form No. IARWP-003: Interim Remedial Action Recommended for Range 47 Special Case Area**

  FVF No. IARWP-003 discussed the Range 47 Design Study findings and concluded the following: 1) soil excavation and sifting to a depth ranging from approximately 6 to 24 inches bgs followed by DGM survey and target investigation was an effective remedial action approach for the range fan area of the SCA (referred to as "Area A" in FVF No. IARWP-003; Appendix C); 2) DGM survey with target investigation was an effective and efficient remedial action approach for the former berm area and portions of the northern and southern boundary grids (referred to as "Areas B and C" in FVF No. IARWP-003; Appendix C); and 3) continuation of the interim remedial action was warranted for the Range 47 SCA.

- **Field Variance Form No. IARWP-004: Design Study Expansion Recommended for Northern Portion of Range 44 Special Case Area**

  FVF No. IARWP-004 discussed the findings of the Design Study and recommended the expansion of DGM survey and target investigation in Range 44 SCA (North) because of the potential for additional subsurface sensitively-fuzed munitions to remain.

3.3 Site Preparation Operations

Site preparation activities included preparatory inspections, grid corner and transect marker installation, vegetation cutting and in some cases vegetation removal, and surface debris removal. Preparatory inspections of the IAR MRA Phase II work areas were conducted prior to commencing operations. The purpose of the inspections was to determine the site preparatory measures and to identify environmentally sensitive areas, degree of vegetation present, and areas containing metallic debris, scrap metal, or other material that would interfere with geophysical survey operations. Site preparation activities started in February 2011 and were conducted with the escort of a qualified UXO Technician II.

3.3.1 Grid Corner and Transect Marker Installation

In April and May 2011, grid corner and transect markers were installed based on established monuments tied to the North American Datum 83 California State Plane Zone IV coordinate system. The control points used for base lines met the standards established by the Federal Geodetic Control Committee for Third Order, Class 1 survey as published in the "Classification, Standards of Accuracy and General Specifications of Geodetic Control Surveys" (FGCC 1984) and "Specifications to Support Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys" (FGCC 1980). Control points recovered and/or established at the site were plotted on planimetric drawings at the appropriate coordinate location and were identified by name or number. Design Study transects and grid corners are shown in Figure 3-1.

3.3.2 Vegetation Cutting and Removal

Brush cutting and vegetation removal activities within the IAR MRA Phase II work areas were conducted in coordination with an ESCA RP Biologist. Brush cut and vegetation removal areas are shown in Figure 3-2. Brush cutting began in May 2011 and concluded in October 2011. Vegetation cutting activities were performed by Woolery Timber Management (Appendix A). Vegetation cutting was performed in Design Study transects, the Design Study Expansion area of Range 44 SCA (North), and in portions of Range 47 SCA during the Phase II Interim Action (Figure 3-2).

Prior to brush cutting, a UXO Technician II performed a search for surface MEC in the brush cutting areas with the aid of a magnetometer. Surface MEC removal was logged electronically in the field utilizing the personal digital assistant (PDA)-based RespondFast UXO data logging system. Vegetation within the work areas was then cut to ground surface level, leaving vegetation roots intact.

Vegetation removal, which included vegetation roots, was performed in transects selected for soil scraping during the Design Study and in the majority of Range 47 SCA during the Phase II Interim Action (Figure 3-2). Vegetation removal began in June 2011 and concluded in August 2012. During vegetation removal, vegetation piles were removed from the work area to avoid interference with Design Study and Phase II Interim Action activities.

Vegetation consisting of shrubs, grass, and small trees (less than five inches in diameter) were cut to ground surface or removed to facilitate soil scraping, soil excavation, DGM surveys, and analog investigation activities. One larger tree (greater than five inches in diameter) was not removed in from the northwestern portion of the Range 47 SCA.

3.4 MEC Remedial Action with Geophysical Detection Equipment

The following subsections discuss the digital and analog geophysical detection equipment and procedures used during the Design Study and Phase II Interim Action in the IAR MRA Phase II work areas. The Design Study and Phase II Interim Action were completed using BADT in accordance with the Interim Action Work Plan and associated FVFs (ESCA RP Team 2011).

3.4.1 Digital Geophysical Equipment

The DGM survey activities were conducted using the Geonics EM61-MK2 time domain metal detector. A specially configured, multi-coil EM61-MK2 towed array platform ("the FORA ESCA Sled") was used within the IAR MRA Phase II work areas. The EM61-MK2 is battery-powered and operates at a maximum output of 10,000 milliVolts (mV). When conductive objects are present below the instrument, the amplitude and decay time of the induced eddy currents vary in response to the size, mass, and orientation of the objects.

The FORA ESCA Sled, was designed, tested, and used during MEC remedial action field activities on ESCA property and was capable of meeting the project scope and data quality objectives (DQOs) as discussed in the Interim Action Work Plan. A photograph of the FORA ESCA Sled is shown in Photograph 3-1. During Design Study and Phase II Interim Action activities, the FORA ESCA Sled was used with a multi-coil configuration.

Photograph 3-1 – The FORA ESCA Sled in Multi-coil Configuration

Features of the FORA ESCA Sled include the following:

- Coils mounted with the long axis along the direction of travel, thereby increasing the power density introduced to the ground for the same area of coverage
- Coils were configured to a (lower) height of approximately 7.9 inches (20 centimeters [cm]) above ground surface
- The platform was a heavy plastic sled made of high density polyethylene to minimize coil rocking due to surface irregularity (e.g., rough terrain)
- Sled had a hinge on the tow bar to reduce lifting of the EM61-MK2 sensors due to terrain differences between the sled and tow vehicle
- Coils were carried in a reconfigurable tray so total sensor width and height could be adjusted for terrain and the number of coils available; however, height remained consistent for the IAR MRA Phase II DGM surveys

QC function checks were performed following the instrument operating manuals and standard industry practices. The EM61-MK2 sensors on the FORA ESCA Sled were set to record and store data in a field laptop computer at 10 readings per second (10 Hertz). The system logging software cannot null the EM61-MK2 sensors; therefore, the values provided for the QC function checks are presented as raw data for the FORA ESCA Sled.

A Trimble Real-Time Kinematic (RTK) Differential Global Positioning System (DGPS) was utilized to position the data collected during the EM61-MK2 surveys to cm accuracy. The DGPS antenna was mounted over the center of the FORA ESCA Sled sensors and connected to the logging device. This receiver captures real-time differential corrections from a fixed local base station and output a National Marine Electronics Association global positioning system (GPS) Fixed Data message directly into the data logger at 1-second intervals.

3.4.2 Analog Detection Equipment

The analog instruments that were used included the Schonstedt® GA-52/Cx handheld magnetometer and the Whites XLT® E Series handheld all-metals detector. Prior to operating an analog instrument, the analog operator conducted and documented the analog checkout procedure. The handheld instruments were used to investigate digital geophysical targets and to investigate areas that were not accessible by digital geophysical systems.

3.4.2.1 Schonstedt® GA-52/Cx

The Schonstedt® GA-52/Cx handheld magnetometer has been approved for use at the former Fort Ord as documented in the Ordnance Detection and Discrimination Study (Parsons 2002a). Schonstedt® magnetometers are typically used to locate ferrous anomalies, and were used in conjunction with the Whites XLT® E Series all-metals detector to ensure that both ferrous and non-ferrous anomalies are capable of being detected.

Ferrous metal (iron) objects cause local variations in the Earth's magnetic field which can be detected by a magnetometer. The magnetometer is comprised of two fluxgate magnetometer sensors that measure the local magnetic field. The magnetometer sensors are aligned opposing so that the magnetic field measured by one sensor is the negative of the magnetic

field measured by the other. The locator then sums the output of the two sensors. By summing the two output signals, the detector cancels any field common to both sensors, such as the Earth's magnetic field, and showing only the local variations in the magnetic field caused by a ferrous object.

Schonstedt® magnetometer sweeps (i.e., "mag and dig") are particularly effective in areas where vegetation and terrain limit the use of larger digital systems.

3.4.2.2 Whites XLT® E Series

The Whites XLT® E Series handheld all-metals detector is also commonly used for geophysical investigations. Whites® all-metals detectors are typically used to locate anomalies associated with buried objects composed of various types of metal, and were used in conjunction with the Schonstedt® GA-52/Cx handheld magnetometer to ensure that both ferrous and non-ferrous anomalies are capable of being detected.

The Whites XLT® all metals detector is comprised of transmitting and receiving coils. Current moving through the transmitter coil creates an electromagnetic field that is transmitted into the ground. As the magnetic field pulses back and forth into the ground, it interacts with any conductive objects (e.g., metal) it encounters, causing the objects to generate weak magnetic fields of their own.

The receiver coil is completely shielded from the magnetic field generated by the transmitter coil. However, it is not shielded from magnetic fields coming from objects in the ground. When the receiver coil passes over a conductive object, it detects the magnetic field created by the object as a result of the signal from the transmitter coil. The receiving coil amplifies the field and sends it to sensors in the control box of the metal detector.

3.4.2.3 EM61-MK2 Hand Held

The EM61HH-MK2 is a "hand-held" complement to the EM61-MK2, providing greater sensitivity to smaller targets at shallow depths. Data is collected from a single receiver at four time gates after transmitter turn-off. Information from four gates provides for the discrimination of targets based on the response decay rate; the early-time data will detect both small and large targets with short and long decay rates respectively, while the late-time data will detect only larger targets with relatively long response decay.

The EM61HH-MK2 can be operated either with or without wheels. In either configuration, the smaller, more portable design offers improved access to areas of difficult terrain and dense vegetation.

3.4.3 Geophysical System Verification

A physics-based geophysical system verification (GSV) approach was implemented for DGM surveys conducted in the IAR MRA Phase II work areas. The GSV approach capitalized on the known performance of geophysical sensors used under the Interim Action Work Plan and

established metrics that monitored the entire mapping effort rather than depending only on sensor evaluations made during initial geophysical prove out procedures.

As part of this GSV approach, two Instrument Verification Strips (IVSs) were constructed. At the time of the writing of this IRACR, the IVSs remain at the site. The IVS was seeded with target MEC-sized items in order to validate that the instrumentation was achieving detection performance metrics as established in the work plan. The IVS data was collected daily during pre- and post-production in conjunction with standard QC tests.

Items in the test strips were seeded linearly over a distance of approximately 100 ft. Five 1-inch diameter by 4-inch long small industry standard objects (ISOs) and three inert 37mm projectiles were emplaced in IVS No. 1. Four 1-inch diameter by 4-inch long small ISOs and two inert 37mm projectiles were emplaced in IVS No. 2. The items were placed at a depth of 12 inches bgs in a least favorable orientation (horizontal).

IVS No. 1 was designed to accommodate geophysical sensors in three- or four-coil towed array configurations. IVS No. 2 was designed to accommodate geophysical sensors in a four-coil towed array configuration. The design details of the IVS and approximate placement of each item is provided in the below illustrations. The IVS was designed so that the sled runners (three) drop into furrows that run the length of the strip. This design ensured that the passes were consistent from one run to the next.

To accommodate the three- or four-coil towed array configurations, four to five ISO items were placed along-track, staggered at a 10-ft interval to eliminate signal overlap between items. Two to three inert 37mm projectile items were placed to increase the sample size of the three- or four-coil towed array dataset.

Illustration 1 - IVS No. 1 Seed Locations for Three-Coil Towed Array

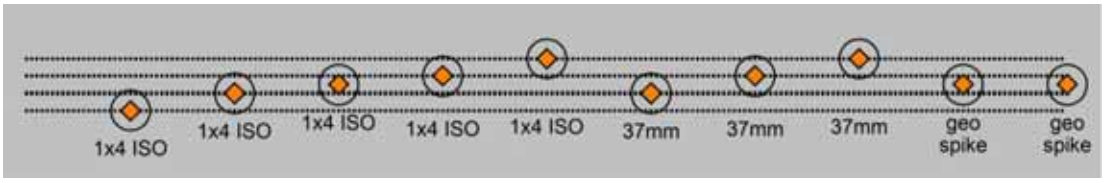

Illustration 2 - IVS No. 1 Seed Locations for Four-Coil Towed Array

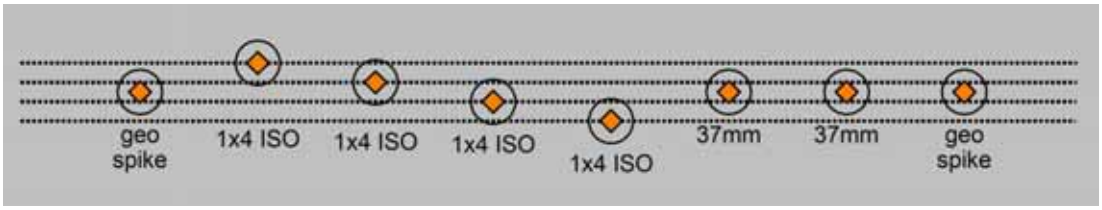

Illustration 3 - IVS No. 2 Seed Locations for Four-Coil Towed Array

The IVS test strips also contained two to three known seeds (i.e., geo spikes) used in the DGM survey areas to facilitate monitoring of the equipment performance (Section 4.1.4.1). Additionally, blind seeds located within the DGM survey area grids were placed at depths consistent with the IVS to assist in validating detection results within the production data (Section 4.1.4.2).

The IVS approach provided an ongoing, quantifiable verification of equipment performance throughout the duration of the production DGM survey. Results of the IVS and seeding program are located in Appendix B.

3.4.4 Analog Instrument-Aided Surface and Near-Surface Investigations

Analog instrument-aided surface and near-surface investigations were conducted in the Range 44 (North) SCA and Range 44 (South) SCA and Central Area NCAs by UXO Technicians prior to DGM surveys. When an anomaly response was located, the UXO Technician began excavation of the location using hand tools. Item(s) recovered were logged into a PDA. At the end of each day, all data was uploaded to the RespondFast UXO Investigation Database and Access database.

3.4.5 DGM Surveys and Target Investigations

DGM surveys were performed in the IAR MRA Phase II work areas between June 2011 and December 2012 (Figure 3-3). DGM surveys were performed during the following activities as discussed in Section 3.1:

- Design Study transects in Range 44 SCA (North), Range 44 SCA (South), Central Area NCAs, and Range 47 SCA (Sections 3.1.1.1, 3.1.1.2, and 3.1.1.3)
- Design Study Expansion grids in Range 44 SCA (North) (Section 3.1.1.1)
- Phase II Interim Action in Range 47 SCA (Section 3.1.2)

The sloped escarpment area of Range 47 SCA was not accessible by digital geophysical systems; therefore, an analog investigation was conducted in that area (Section 3.4.6). Procedures for the DGM surveys conducted during the Design Study and Phase II Interim Action activities are provided in the following subsections.

3.4.5.1 DGM Processing and Dig List Preparation

The data collected from the digital detection instruments were processed using the techniques described in this section. DGM processing and dig list preparation were performed for Design Study and Phase II Interim Action as described below:

- Design Study transects in Range 44 SCA (North), Range 44 SCA (South), and Central Area NCAs with a 50mV target selection threshold (sum channel)
- Design Study Expansion in Range 44 SCA (North) with a 300mV target selection threshold (sum channel)
- Phase II Interim Action in Range 47 SCA with a 50mV target selection threshold (sum channel)

The target selection threshold for DGM investigations during the Design Study and Phase II Interim Action was 50mV based on the Interim Action Work Plan objective of detecting a 37mm projectile at 12 inches bgs. The instrument response for a 37mm projectile at 12 inches bgs in least favorable orientation was 120mV. However, to allow for potential influences related to terrain and fluctuations in background interference, which may influence the peak response of buried conductive items, a conservative threshold of 50mV was used.

For the Range 44 (North) Design Study Expansion, a target selection threshold of 300mV sum channel response was used, based on the 66mm, high explosive anti-tank (HEAT), M72 series rocket in least favorable orientation at 12 inches bgs (Appendix C; FVF No. IARWP-004). This was a result of the initial findings of the Range 44 SCA (North) Design Study which indicated the potential for sensitively-fuzed 66mm, HEAT, M72 series rockets to be present.

The FORA ESCA Sled electromagnetic (EM) data were collected using MagLog software and pre-processed using MagMap 2000 software. MagLog is able to stream all four EM signals as well as the GPS signal into one set of files. These files contain a main project file with a GPS file and four EM sensor files, along with ancillary header files. Then using MagMap 2000 software, the MagLog survey project file is opened. Once the project file is open, the ancillary files open for display and verification. At this step, the GPS data is converted to Universal Transverse Mercator coordinates in meters. Next, the data is examined for completeness and errors in data collection. Once verified, the data is then exported into a Geosoft XYZ format which is composed of separate XYZ files; one for each EM sensor. Each coil contains accurate position information along with the EM61 signal information. Finally, the XYZ files are imported in Geosoft using a custom script which loads each file in succession. The data may then be corrected and gridded in Geosoft Oasis Montaj™ for viewing and target selection.

Raw Geosoft XYZ files were imported into Geosoft Oasis Montaj™ processing software and the data were checked for positioning accuracy, line distribution, and coverage. Latency values obtained during the pre- and post-survey QC tests and IVS were applied to the data, correcting for temporal lags in the data. A Geosoft script was run to automatically progress through the processing steps for each of the four individual data channels. The script was

used to drift-correct the data using a nonlinear median drift correction filter, which is a common filtering technique used to remove drift associated with each data channel occurring throughout the survey period. Velocity and sample separation were calculated for each dataset (Appendix B). After each of the four time-gate data channels was processed and evaluated, the channels were summed into a single "stack" channel.

Grid images for the EM61-MK2 data (stacked channels 1 through 4) were then generated using Geosoft Oasis Montaj™ contour plotting software. Contour plots were generated by gridding the stack data channel using a grid cell size of 0.25 ft, a search radius of 2 ft, and blanking distance of 1.5 ft (for the three or four coil configuration). EM61-MK2 data color plots were used to identify targets and locate anomalies requiring further investigation. The targets were selected for the gridded data by running the Blakely Peak algorithm in Geosoft. Target review consisted of manually evaluating selected targets, and merging multiple targets associated with large anomalies. Targets were also adjusted (where necessary) to the location of the peak response associated with a given anomaly. A target decay analysis was also run to remove targets that had an atypical decay between their four time-gate channels. An atypical decay occurs when an anomaly undergoes a decay that does not decrease through time, but instead shows an increase in subsequent time-gate channels. Atypical decay represents nonmetallic anomalies generated by ambient forces such as terrain-induced interference, magnetic rocks, and electrical interference. A maximum amplitude was also determined, by searching out from the target a radius of 3 ft for the maximum amplitude, and stored with the target information.

The data processing procedures were used to generate a target anomaly database (i.e., dig list). Coordinate positions for each of the DGM targets were compiled by grid into a dig list, which was then provided to the UXO Dig Teams for reacquisition and excavation. In addition, polygons were selected to define the boundaries of larger anomalies if necessary. The composite dig list includes the unique identification, position, anomaly characteristics, and dig information for each target selected. Positioning and target picking accuracy were checked by selecting a target over a known survey control (i.e., grid corner spike) and by measuring the anomaly target location to the actual geo-referenced location of the grid corner spike recorded during the grid survey. The measured offset was logged for each data set (Section 4.1.4.1).

3.4.5.2 Anomaly Reacquisition Procedures

UXO Dig Teams reacquired the target anomalies based on information provided on the dig sheets. Target anomaly reacquisition was performed utilizing the Trimble RTK DGPS for navigation to the precise coordinate location for each target anomaly and the location was flagged with a nonmetallic pin flag bearing the unique target identifier.

3.4.5.3 Excavation of DGM Anomaly Targets

Target intrusive investigations occurred in the IAR MRA Phase II work areas between June 2011 and February 2013. The flagged target anomaly locations were investigated by UXO Dig Teams using handheld analog instruments (Schonstedt® GA-52/Cx magnetometers and Whites XLT® E Series all-metals detectors) within a 3-ft radius around the flag. The UXO

Dig Teams noted any offset from the flag to the excavated anomaly source(s) and logged the information accordingly. Each 3-foot radius around the target anomaly was cleared to depth of detection using a Geonics EM61-MK2 Hand Held instrument.

UXO Dig Teams consisting of UXO Technicians and equipment operators performed excavations at the target anomaly locations identified by the DGM survey. The target anomaly excavations were generally performed with hand tools, such as shovels. Photograph 3-2 shows the hand excavation of target anomalies. Those items considered too large or deep to be excavated by hand tools were investigated using heavy equipment, such as a backhoe.

Photograph 3-2 – Hand Excavation of Anomalies

The UXO Dig Teams identified the source of the anomaly and utilized the PDA-based RespondFast UXO data logging system to electronically log the characteristics of each find real-time in the field. Logged target anomaly characteristics included, but were not limited to: item category (e.g., UXO, DMM, MD, other debris, QC item, no contact); item description (e.g., concrete, practice grenade); estimated weight of item; estimated depth of item; and confirmation of hole cleared. MEC items encountered were photographed for documentation purposes. At the end of each day, the data was uploaded from the PDAs to the RespondFast UXO database.

Target investigation varied during the Design Study depending on the area being evaluated and initial findings. A summary of the Design Study target investigation progression is provided below by area.

Range 44 SCA (North) Design Study Transect Target Investigation

During the Design Study transect target investigation in Range 44 (North) to evaluate the presence of sensitively-fuzed munitions; all of the targets at and above the 50mV target

selection threshold were investigated in three grids (Figure 3-4). Evidence of sensitively-fuzed munitions debris was encountered in the three grids; therefore, target investigation was reduced to 20% of the transect targets at and above the 50mV target selection threshold, which were randomly selected, in eight grids and 10% in the remaining 17 grids to evaluate the extent, type, and depth of the sensitively-fuzed munitions debris and where Design Study expansion was necessary, as discussed in Section 3.1.1.1.

Range 44 SCA (South) and Central NCAs Design Study Transect Target Investigation

During the Design Study transect target investigation in Range 44 (South) and the Central NCAs to evaluate the presence of sensitively-fuzed munitions, 10% of the transect targets at and above the 50mV target selection threshold were investigated (Figure 3-4). No evidence of sensitively-fuzed munitions or related debris were encountered in the transect targets; however, target investigation was increased to 50% of the transect targets (randomly selected) at and above the 50mV target selection threshold in 16 grids (Figure 3-4).

Range 44 SCA (North) Design Study Expansion Target Investigation

All of the targets within the Design Study Expansion area at and above the 300mV target selection threshold were investigated; however, some grids contained a high density of metal objects, including other debris; therefore, targets could not be fully resolved within the 3-foot radius in areas during the first (of two) target investigation and QC activities (See Sections 4.2.1). A second DGM survey, transect verification DGM survey and final verification DGM survey were conducted, targets at and above the 300mV target selection threshold were investigated, and QC-1 was completed within a 3-foot radius of targets. Target investigation results were sufficient to determine that there was no evidence of sensitively-fuzed munitions within the southernmost eight grids (Section 5.0).

Range 47 SCA Design Study Transect Target Investigation

During the Design Study in Range 47 SCA, a portion of the post-scrape DGM target anomalies in sift transects were selected for target investigation to determine if individual targets could be selected effectively or if additional soil excavation would be required to reduce anomaly densities. Approximately 18% of the post-scrape DGM transect targets at and above the 50 mV target selection threshold were investigated. The investigated anomalies were located in one transect. Based on Design Study transect target investigation in the one transect and sift transect results, Phase II Interim Action was conducted (Sections 3.1.1.3 and 6.0).

3.4.6 Analog Magnetometer Investigations

Analog survey was conducted to investigate the sloped escarpment in the southern portion of Range 47 SCA that was not suitable for DGM survey equipment (Section 6.7; Figure 3-3). The handheld Schonstedt magnetometer and the Whites all-metals detectors were used to locate anomaly responses in this area utilizing 3-ft search lanes. When an anomaly was encountered, the UXO Technician investigated the anomaly to-depth. The to-depth investigation was conducted by excavating the anomaly location using either shovels and/or

an excavator depending on the depth of the anomaly. During the to-depth investigation, anomaly responses were investigated until resolved (i.e., until the metallic source of the anomaly was completely removed). Once the anomaly source was found and removed, the UXO Technicians rechecked a 3-ft-radius area around the source location to determine if other items remained buried.

The UXO Dig Teams identified the source of the analog detected anomalies and utilized the PDA-based RespondFast UXO data logging system to electronically log the analog detected anomaly characteristics real-time in the field. Target anomaly characteristics logged included, but were not limited to: item category (e.g., UXO, DMM, MD, other debris, QC item, no contact); item description (e.g., concrete, practice grenade); estimated weight of item; estimated depth of item; and confirmation of hole cleared. MEC items encountered were photographed for documentation purposes. At the end of each day, the data was uploaded from the PDAs to the RespondFast UXO database.

3.5 Soil Excavation and Sifting Operations

During the Design Study for Range 44 SCA and Range 47 SCA, areas were identified where soil excavation and sifting were necessary to provide a more complete characterization of munitions in subsurface soil (i.e., Range 44 SCA [North] polygons and Range 47 SCA berm and sift transects), as discussed in Sections 3.1.1 and 3.1.1.3. Soil scrapes and sifting operations were used in areas where the soil contained a high density of metallic debris that could not be feasibly identified or individually removed from the soil in a timely manner (i.e., transects in Range 44 SCA [North] and Range 44 [South] and Central Area NCAs), as discussed in Sections 3.1.1.1 and 3.1.1.2. During the Phase II Interim Action in Range 47 SCA, areas were identified where additional soil excavation and sifting was necessary following QC-2 activities (i.e., Range 47 SCA verification polygons), as discussed in Section 3.1.2. Figure 3-2 shows the areas where soil excavation and sifting were conducted in Range 44 SCA (North), Range 47 SCA, and Range 44 SCA (South) and Central Area NCAs. Figure 3-5 shows the approximate depths of soil excavations in Range 47 SCA.

Excavation and sifting operations were conducted in accordance with the Interim Action Work Plan and FVF Nos. IARWP-002 and IARWP-003 (Appendix C). Armored heavy equipment was used to excavate soil in lifts (approximately 6 inches in a single pass with excavation equipment). Excavated soil was stockpiled separately for each transect or polygon to allow the data from soil sifting to be recorded by area of origin. The soil was loaded into haul trucks and soil was transported to a central sifting area of the development portion of the IAR MRA in accordance with the following general procedures:

- Soil was loaded into trucks by excavator and tamped down;
- The load for each truck was reduced by 5 cubic yards, to insure that the level of soil was below the top of the truck sides; and
- Trucks were checked for debris before leaving the excavation area.

The transportation route was checked immediately following the passage of the truck to ensure that items or debris had not fallen from the vehicles.

Where multiple soil lifts were required, the soil excavated below approximately 6 inches was stockpiled and sifted separately from the top 6 inches to allow the seed bank contained in the top 6 inches to be subsequently replaced on top of the excavation areas once the deeper soil was replaced.

Excavated soil was introduced into the feed hopper/grizzly using an armored excavator. Material greater than 6 inches in size was discharged and re-introduced into the feed hopper/grizzly at least one more time to minimize volume of oversized material. Material that would not pass through the 6-inch screen was stockpiled and inspected for MEC by UXO Technicians.

Material less than 6 inches was diverted to a conveyor belt where it was exposed to a ferrous metal magnet. Ferrous items collected by the magnet were diverted to a scrap bin which was inspected for MEC by UXO Teams. The material not collected by the magnet continued on a heavy duty conveyor belt through dual-layered vibrating screens, 2-inch (top screen) and 3/4-inch (bottom screen). The material less than 3/4 inch continued on a heavy duty conveyor belt leading to the second magnet that collected ferrous metal which was inspected for MEC by UXO Teams.

MEC encountered during sifting were cataloged by UXO Teams. Information recorded included site name, grid number (when known), type of item (i.e., UXO, DMM), description, weight, and subsequent actions taken.

Material that did not pass through the screens, including vegetation, was inspected for MEC MD items by UXO Teams. This material was processed using size-reduction equipment to reduce the size of the material to 1 inch or smaller. Following size reduction, the material was transported and placed within the northwestern portion of the 100-foot borderland buffer in the development portion of the IAR MRA. UXO Technicians observed the material during transportation and placement activities.

Soil from the sifting operations was returned to the excavation area specified by a Qualified Biologist (QB) after QC and verification procedures were completed, except for the transect and polygon soil from Range 44 SCA (North) and the transect soil from Range 44 SCA (South) and Central NCAs transects. Soil from the Range 44 SCA (North) transects and polygons and soil from Range 44 SCA (South) and Central NCAs transects were used in the Range 47 SCA following completion of the Phase II Interim Action activities in that area.

Excavation and soil sifting activities performed for each of the Phase II work areas during the Design Study and Phase II Interim Action are summarized below.

Range 44 SCA (North) Design Study

Fourteen 10-ft by 100-ft transect segments were excavated to a depth of approximately 6 inches bgs and the soil was sifted (Section 5.1.3). In addition, eight polygons were excavated to varying depths and sifted in the Design Study Expansion area (Section 5.1.6).

Range 44 SCA (South) and Central Area NCAs Design Study

Fifteen 10-ft by 100-ft transect segments in Range 44 SCA (South) and eleven 10-ft by 100-ft transect segments in the Central Area NCAs were excavated to a depth of approximately 6 inches bgs and the soil was sifted (Section 5.2.3).

Range 47 SCA Design Study

Eight 10-ft wide transects in Range 47 SCA and seven 10-ft wide transects in the berm area of Range 47 SCA (Figure 3-1) were excavated to depths of approximately 6 to 24 inches bgs and the soil was sifted (Sections 5.2.1 and 5.2.3, respectively). A summary of the excavation activities is provided below:

- Excavation of transects in eleven southern grids of Range 47 SCA revealed the presence of lead bullets in the soil. The sifting of stockpiled soil from these grid transects was halted and the stockpiled soil was covered with plastic. The Army collected and analyzed representative soil samples from the grids and stockpiled soil. The Army subsequently reported that the analytical results were below action levels (Shaw 2012); therefore, the sifting of soil from the eleven grids continued in accordance with the Design Study.
- Transects in Range 47 SCA grids were excavated to 6 inches bgs and sifted. A post-excavation DGM survey was conducted in the excavated transects. Analysis of the DGM data determined that 31 grids in Range 47 SCA required excavation of an additional 6 to 12 inches bgs and four grids required additional excavation to 24 inches bgs to confirm the need to complete the Phase II Interim Action in Range 47 SCA and expected depth of soil excavation (Figure 1 of FVF No. IARWP-003; Appendix C).
- Soil excavated from the seven transects located in the berm area was sifted as a single unit. Visual reconnaissance and berm transect investigation results indicated that there was potential for sensitively-fuzed munitions to remain beneath the berm; therefore, the berm was removed through excavation and material sifted as part of the Design Study (FVF No. IARWP-002; Appendix C) in preparation of completing the Phase II Interim Action in Range 47 SCA (FVF No. IARWP-003; Appendix C).

The Design Study sifted soil was returned to Range 47 SCA after the completion of the Phase II Interim Action activities in that area.

Range 47 SCA Phase II Interim Action

Soil excavation in the Range 47 SCA occurred between October 25, 2011, and September 19, 2012. Excavations were conducted to various depths in an area totaling approximately 12.4 acres shown in Figure 3-2. Soil excavation was anticipated in the portion of the SCA referred to as “Area A” in FVF No. IARWP-003 (Appendix C); however, the area was expanded to include the area indicated in Figure 3-2. A summary of the excavation activities is provided below:

- Approximately 10,875 cubic yards of top soil (top 6 inches bgs) was excavated. The top soil excavation and sifting operations included soil that was removed from a 1.8-acre area (approximately 2,400 cubic yards of soil) and sifted separately because it was identified by a QB as an "area of low recruitment" for vegetation.
- Following top soil excavation, approximately 19,750 cubic yards of subsoil (below 6 inches bgs) was excavated in the Range 47 SCA, as shown on Figure 3-5, and sifted. Depths of subsoil removal varied from 6 to 36 inches bgs depending on the amount of metallic debris in the soil.
- A 0.5-acre area consisted of a sloped escarpment located in the southern portion of Range 47 SCA (shown in Photograph 3-3; Figure 3-3). The sloped escarpment was approximately 635 ft long and ranged from 15 to 20 ft in height. The slope angle was generally steep and there was slumping of soil at the toe of the slope. Parts of the slope were vegetated; however, there were several areas where no vegetation was present. A QB identified the soil as an area of low recruitment for vegetation. Due to the potential for the slope to contain sensitively-fuzed munitions (i.e., 40mm projectiles), excavation and sifting of soil from the sloped surface ranged from approximately 2 ft bgs at the bottom of the sloped escarpment to 4 ft bgs at the top of the escarpment, which was approximately 2,800 cubic yards of soil.

The sifted top soil (top 6 inches bgs) and subsoil (below 6 inches) were returned to the area of origin and depth from December 2012 to January 2013. The top soil from the 1.8-acre low recruitment area and the sloped escarpment soil, that were excavated and sifted, were used as subsoil (below 6 inches).

Photograph 3-3 – Range 47 SCA Sloped Escarpment

3.5.1 MEC Demolition Operations

Demolition operations and explosives storage were performed in accordance with the Interim Action Work Plan (ESCA RP Team 2011). MEC items that were determined to be unsafe for transport or storage were either blown in place or temporarily secured at an on-site demolition area and destroyed on a weekly basis in accordance with FVF No. IARWP-001 (Appendix C). There were nine blow-in-place demolition operations during the remedial activities in the IAR MRA Phase II work areas: four in Range 47 SCA and five in Range 44 (North) SCA. There were no blow-in-place operations in Range 44 (South) SCA. MEC items that were deemed safe for transport were temporarily stored in the Explosives Siting Location until scheduled for demolition.

3.5.2 Material Documented As Safe for Recycling

Following completion of Design Study and Phase II Interim Action, material documented as safe (MDAS; i.e., MD, other debris, metal scrap) was transported from the IAR MRA Phase II work areas and stored until disposal by a foundry or recycler, where it will be processed through a smelter, shredder, or furnace prior to resale or release. Recovered MDAS is secured in clearly marked lockable containers after discovery. Containers will remain locked until they are delivered to and signed for by a foundry and/or recycler. Prior to off-site shipment, the MDAS will be inspected by a Senior UXO Supervisor (SUXOS) and a UXO Quality Control Specialist (UXOQCS) to verify that it is free from explosives (FFE). Information will be tracked and Form 1348 will be provided showing that the material leaving the site is FFE. A complete summary of MDAS disposal and/or recycling efforts, to include certification of FFE will be included in the FS for the IAR MRA.

3.6 Other Related Operations

Additional activities conducted during the interim remedial activities included biological monitoring and implementation of habitat mitigation measures, such as storm water and erosion control measures, and dust monitoring to minimize fugitive dust from leaving the MRA during field activities.

3.6.1 Environmental Protection

Within the IAR MRA Phase II work areas, the biological monitoring activities were the responsibility of a QB. Efforts were made to the extent possible to preserve and protect environmental features within the IAR MRA Phase II work areas, including, but not limited to:

- Minimized vegetation removal and cutting where possible while ensuring that the required work could be completed in accordance with the Interim Action Work Plan
- Awareness training for the CTS and other sensitive animal and plant species was provided for field personnel by the QB
- Avoided vernal pools and ponds whenever possible

The biological monitoring activities, to include Natural Resource Impact Mitigation checklists, were conducted in the IAR MRA Phase II work areas and were documented in annual natural resources monitoring, mitigation, and management reports (ESCA RP Team 2012, 2013a, and 2014).

3.6.2 Habitat Reserve Controls

This section discusses the habitat reserve controls that were implemented in accordance to the USFWS Biological Opinion (USFWS 1999, 2002, and 2005) and the HMP (USACE 1997).

3.6.2.1 Erosion Control and Inspections

Erosion control measures were installed within the IAR MRA Phase II work areas to reduce erosion. Periodic erosion control inspections were conducted throughout the duration of the IAR MRA Phase II field activities (ESCA RP Team 2012, 2013a, and 2014). Erosion control activities and inspections were conducted in accordance with the Interim Action Work Plan (ESCA RP Team 2011).

3.6.2.2 Weed Inspections and Abatement

Weed monitoring was conducted to document preexisting weed populations and at locations where surface soil had been disturbed during Design Study and Phase II Interim Action. An active Pampas grass (invasive weed) population was observed along the slope escarpment and in the southern portion of the Range 47 SCA. The excavation completed on the sloped escarpment as part of the remedial action removed the Pampas grass population.

3.6.2.3 Habitat Restoration

In accordance with the Interim Action Work Plan and the HMP, a Habitat Restoration Plan (HRP) for the IAR MRA was prepared to describe the activities to be undertaken to restore the natural resources in habitat parcels that were affected by the Phase II interim remedial activities in the MRA (ESCA RP Team 2013b). The plan was reviewed and approved by the Army and USFWS and was provided as an addendum to the Interim Action Work Plan. The activities outlined in the HRP were designed to establish native vegetation at the site that is progressing on a trajectory toward a self-sustaining native plant community equitable with the species richness and relative cover of species included in the HMP that were present on the site prior to the FORA ESCA RP Team remedial efforts.

Work areas in the IAR MRA included Range 44 (North) SCA, Range 44 (South) SCA and Central Area NCAs, Range 47 SCA, and ingress/egress routes established during remedial activities. Restoration implementation commenced in October 2012 and included site preparation (erosion control and installation of an animal deterrent system and an irrigation system), seeding of HMP annuals and seed bank, targeted seeding of common species, manzanita salvaging and transplanting, and installation of container plantings. Restoration activities and monitoring results are described in detail in Volume 2 of this IRACR and are presented in Appendix A of the 2013 Annual Natural Resources Monitoring, Mitigation, and Management Report (ESCA RP Team 2014). The restoration area is subject to ongoing

extensive monitoring and sampling to ensure restoration is successful according to the performance targets established in the approved HRP.

3.6.2.4 California Tiger Salamander

Along with the general impact minimization practices such as employee training, limiting ingress and egress to a work area to established roads and paths, and limiting soil disturbances to work areas only, further CTS-specific mitigation measures were implemented by the ESCA RP Team. In early October, at the beginning of the nominal wet season, a QB performed training of field personnel regarding CTS awareness, requirements and mitigation measures. This training was not required but was performed as an additional protective measure in advance of the period when CTS are most likely to be encountered. Fieldwork supervisors also frequently coordinated with the QBs on the status of field operations so that the QBs were aware of where work was occurring, which enabled the QBs to notify the supervisors of any additional mitigation measures. Field personnel were requested to notify a QB if trapped CTS were encountered in an excavation. They were also instructed to cover the excavation to prevent desiccation of the animal and to call the designated project QB immediately. No such encounters occurred during IAR MRA Phase II work activities.

The Interim Action Work Plan, Section 12, and the USFWS CTS biological opinion (USFWS 2005) were implemented regarding the restoration requirements for CTS in the 0.5-km-radius buffer zone within the IAR MRA Phase II work area.

4.0 QUALITY CONTROL/QUALITY ASSURANCE

QC/QA activities, including QC and FORA independent QA, were conducted throughout the project. FORA independent QA activities were conducted by Third Party QA subcontractor Engineering/Remediation Resources Group, Inc. (ERRG) under the FORA Quality Assurance Surveillance Plan (QASP), as described in Section 4.6. The QC activities and results are discussed in the following sections.

4.1 Quality Control of Digital Geophysical Mapping

Geophysical survey QC is an appropriate evaluation performed to assure that DGM instruments fully meet the prescribed requirements. The QC Geophysicist is responsible for overseeing and documenting QC performed with respect to the DGM surveys. Instrument checks, data acquisition, positional accuracy, data processing and evaluation and seeding are described in detail in the following sections.

4.1.1 Digital Instrument Survey and Data Acquisition

Prior to target investigation, the following QC actions were performed to ensure that the field activities were meeting the DQOs for the project.

4.1.1.1 Daily DGM Instrument Function Testing

The quality of geophysical data sets is dependent on the operational capabilities of the equipment used. To ensure that equipment is fully capable and will perform in accordance with the project requirements, geophysical teams performed daily QC function tests. QC function checks were performed following the instrument operating manuals, standard industry practices, and the Interim Action Work Plan. Following these checks, any equipment that was found unsuitable was immediately removed from service.

QC data for the dates October 27 and 28, 2011, and November 1, 2011, did not meet project requirements due to failure to meet an established metric or because the QC data was not logged correctly. The DGM survey data collected during those dates were recollected with the exception of data collected on October 27, 2011. Data collected on October 27, 2011, was subjected to additional review consisting of IVS strip and known seed analysis in order to ensure that the data was acceptable for use. Subsequent QC data for re-collected data met established project requirements.

QC data for the dates January 17, 18, and 26, 2012, and February 1 and 2, 2012, did not meet project requirements due to equipment issues. After review of the QC data, the battery invertor was deemed faulty and replaced. The DGM survey data collected during those dates were recollected. Subsequent QC data met established project requirements

The EM61-MK2 sensors were set to record and store data in a field laptop computer at 10 Hertz. The system logging software could not null the EM61-MK2 sensors; therefore, the values provided for the QC function checks were presented as raw data, which are presented

in Appendix B. Calculated standard deviations for pre-and post-survey function tests were used to verify noise levels. The QC function checks and results are described below:

- Static Background - The static background tests consisted of collecting EM data at a relatively quiet area with normal background noise for a period of three minutes. The static test enabled the operator(s) to see if fluctuations in the data were occurring in real-time. The objective was for the standard deviation of the four EM61-MK2 data channels to be < 2 millivolts (mV). The standard deviation of static background met the established metric with exceptions as noted above and when ambient temperature changes cause minor drift during the period of the test (not considered a failure).
- Static Response - Static spike tests for the EM-61 were performed with spike objects (2-inch pipes) positioned next to the coils and data collected for a period of three minutes. The static response test enabled the operator(s) to monitor the instrument response to the spike objects and potential real-time fluctuations in the data. Responses between pre- and post-survey tests are not expected to vary more than 20%. The standard deviation of static background met the established metric with exceptions as noted above and when ambient temperature changes cause minor drift during the period of the test (not considered a failure).
- Cable Connection - The cable test was performed to measure the effect of moving the cables during data collection and to verify that the connections were in good condition and operating as designed. The cable test was conducted for no longer than 30 seconds. The objective was for standard deviation of the four EM61-MK2 data channels to be < 2 mV with no visible spikes observed in data. The standard deviation of static background met the established metric with exceptions as noted above and when ambient temperature changes cause minor drift during the period of the test (not considered a failure). Additionally, random spikes were observed during the cable connection tests but were not considered failures.

Evaluation of compliance with digital survey equipment verification DQOs was made in the field at the beginning of the day when the morning QC function tests were performed and both morning and evening QC function tests were later reviewed by a geophysicist. QC function test data plots are presented in Appendix B.

4.1.1.2 Instrument Verification Strip

The IVSs were performed by traversing the strips in a single pass. The IVSs contained seed test items (i.e., ISOs), inert munitions, and positioning “geo” spikes (Section 3.4.3). The test strips were built with furrows so that the sled runners dropped into the furrows and the sled coils were located in the same position with respect to the items for each run. The IVSs were run both morning and evening to monitor daily equipment function and response consistency and to accomplish the purpose of repeat lines. The values of the test items were compared each day with the standard run to ensure proper functioning of the coils (Appendix B).

4.1.2 Quality Control of Digital Survey Data Acquisition

Data acquisition QC was performed for each DGM data set to verify compliance with survey DQOs. The DQOs for data acquisition, such as along-track spacing and cross-track measurements, were evaluated by the data processing operator after the survey was completed. The results of the evaluation are described below:

- Mean Acquisition Speed – A mean speed of less than 3 miles per hour was maintained during data collection (Appendix B). The speed was evaluated based on sensor orientation and bounce in terms of the amount of noise introduced into the data and along line sample spacing.
- Along-Track Sampling – Along track measurements were reviewed to ensure adequate data density (sample separation) of less than 6 inches for 98% of the data collected and of less than 8 inches for 100% of the data collected (Appendix B). Sample separation is calculated through Oasis Montaj's Sample Separation Calculation tool. This tool creates a map and allows the processing geophysicist to examine if sample separation metrics are exceeded. Sample separation is reviewed by the QC Geophysicist for each complete set of data. Sample separation was within 0.5 ft for more than 98% of data collected. However, as shown in Appendix B, 1% or less of sample separation were found to exceed 8 inches for each complete set of data. The QC Geophysicist evaluated the data as it was collected and confirmed that the data was acceptable for use.
- Cross-Track Measurements – This metric is intended to control data gaps associated with inconsistent track plots that are not associated with trees or other obstructions. To achieve this measurement quality objective, the surveys were run to achieve a 2.5-ft spacing. Ninety-five percent (95%) of the data within a dataset must meet this metric. Up to 5% of the data is permitted between 2.5 ft and 3.0 ft to account for rough terrain. The across track line spacing did not exceed 3 ft, excluding data gaps due to trees or other obstacles that precluded the survey platform from providing complete coverage. These areas were unavoidable and well within the acceptance criteria identified in the Quality Assurance Project Plan included in the Interim Action Work Plan (ESCA RP Team 2011). These areas were investigated with analog instruments to obtain maximum coverage.

4.1.2.1 Positioning Accuracy

The RTK DGPS base station was set up over a previously established control point with the supplied X and Y coordinates to third-order accuracy. The base station then provided corrected data to the rover unit mounted above each geophysical sensor or array with cm accuracy. Geophysical data were collected over known locations (geospikes as galvanized nails and grid corners as galvanized nails) at the latency QC station during the surveys (pre- and post-daily) to validate positional precision and target selection. The positioning DQO for the project (2 ft) was achieved, as documented in Tables 4-1 and 4-2 with two exceptions. Those exceptions consist of two blind seed offsets that exceed the three standard deviations above the mean offset value. A root cause analysis is provided in Section 4.1.4.2. The 2 ft DQO relates strictly to the positioning system itself. It is independent of

additional/cumulative "offsets" that may propagate when the geophysical sensors and the processing/target picking are considered.

4.1.3 Quality Control of Digital Data Processing and Analysis

QC was performed during DGM data processing and target selection as described below:

- Processing Statement – Leveling and/or filtering routines that are applied to data sets were evaluated, on a data set by data set basis, to confirm that those routines did not alter the nature of the original measured response.
- Leveling/Drift Correction – For any given data set of electromagnetic data, low frequency, long wavelength noise were removed.
- Instrument Latency – Instrument latency effects were monitored as part of the IVS. Seeds were placed in the IVS track underneath each coil and offset along the direction of travel so as not to interfere with each other. Latency effects were then observed and corrected in the IVS data and these values were carried over into the production data for that day's surveys. Instrument latency documentation is provided in Appendix B.
- Target Anomaly Selection – Anomalies meeting the target selection criteria were selected. This was verified by the Project Geophysicist. The target selection process for each dataset was verified. Appendix F provides the DGM data plots with targets and Appendix G provides the list of targets selected.
- Geophysicist QC Checks – The Project Geophysicist examined each grid and the associated targets. The quality of the data was examined and additional targets were selected in the grid, to add anomalies that may have been missed or were marginal with respect to the project target selection threshold.

4.1.4 Quality Control of DGM Anomaly Reacquisition and Investigation

The following sections describe the QC checks performed during the field investigation of target DGM anomalies to ensure anomalies were fully resolved.

4.1.4.1 DGM Anomaly Reacquisition

The following QC was performed for the DGM target reacquisition and excavation data.

- Known Location QC Seeds – Grid Corner Spikes (i.e., known QC seeds) were established during site preparation activities at grid corner locations for use as known geospatial calibration points and known QC seeds (Table 4-2). Known QC seeds consisted of 6-inch galvanized nails driven vertically into the ground. The known QC seed locations were recorded using RTK DGPS. The digital anomaly response from each known QC seed was identified during data processing and analysis. Positional accuracy was determined by measuring the distance between (i.e., offset) the anomaly target location and the actual geo-referenced location of the known QC seed. In accordance with the positioning delta DQO, the offset of the anomaly target

location should not be greater than 2 ft from the recorded position. Known QC seeds were also used during QC-2 and verification surveys.

The detection results for each known QC seed items are detailed in Table 4-2. The minimum offset was 0.00 ft and the maximum offset was 1.73 ft. The average offset was 0.65 ft.

- Anomaly Reacquisition – Reacquisition was performed on DGM anomalies throughout the duration of the project. More than 95% of the locations of reacquired anomalies were within 1 meter of their original surface location as marked on the dig list.
- Reporting Checks - Recovered target anomaly characteristics were electronically logged into the handheld PDA data logger. Handheld PDA data logger information was uploaded and verified daily.
- Dig List Backcheck - The QC geophysicist examined each DGM anomaly and the excavation result. If the mV reading of the initial response did not correlate with the size, depth, and/or identity of the item recovered, the target anomaly was resubmitted to the dig team for reinvestigation. Documentation of dig list backcheck is provided in Appendix G (see "Geo QC by"). The dig list back check resulted in 35 targets (including No Contact targets) returned to the dig team for reinvestigation.
- False Positives - False positives (also known as No Contacts) were kept to a minimum. This was achieved by careful data collection activities (i.e., stable, fluid motion) and thorough data processing techniques. One hundred percent of false positives were reviewed by the geophysicist. If the geophysicist picked close to noise level, then the resolution was reclassified as noise. If it was a large anomaly, then the geophysicist submitted the anomaly to the dig team for reinvestigation. No contacts are reviewed and documented during the dig list backcheck as discussed in the previous bullet.

4.1.4.2 Blind Seed Investigation

Blind seed items were placed within the Design Study areas and Phase II Interim Action areas in accordance with the Interim Action Work Plan for both analog and DGM investigations. The blind seeds consisted of 1- by 4-inch hollow steel pipes painted blue and wrapped with silver duct tape with a specific QC seed number written on it. The seeds were used to simulate small MEC items such as 37mm projectiles. Additionally, in the Range 44 SCA and Central NCAs, 2- by 8-inch hollow steel pipes painted blue and wrapped with silver duct tape with a specific QC seed number written on it were used to simulate a medium-sized MEC item such as the 66mm, HEAT, M72 series rocket. The blind seeds were buried at a depth interval between 6 and 12 inches, which was within the geophysical limits of 100% probability of detection at a target selection threshold of 50mV or 300 mV. UXO Technicians were shown examples of the blind seed items so they could positively identify the item when found. The UXOQCS, in consultation with the Remediation Project Manager (RPM), determined the locations of the blind seed items. The locations of the blind seed items were not known to the survey, investigation, or data processing personnel for either the analog or the DGM operations. Blind seed items were used by QC personnel to ensure the investigation was meeting the DQOs and to measure instrument detection capability.

A total of 26 QC seeds were placed within the expected DGM survey boundaries by the UXOQCS. Placement and retrieval details for the QC seed items are provided in Figures 4-1, 4-2, and 4-3. The detection results and retrieval details for each QC seed item are detailed in Table 4-1.

After completion of the DGM survey, eight seeds were excluded from the DQO evaluation. Two of the eight seeds (QC Seeds 190 and 224) excluded from the DQO evaluation were located outside the expected DGM survey boundaries and were recovered by UXOQCS. Six blind seeds placed in Range 44 SCA (North) were not chosen as targets due to the increased target selection threshold of 300 mV. The six blind seeds not chosen as targets were 1-inch diameter by 4-inch long seeds buried before the increased target selection threshold of 300 mV. Due to the size, depth, and/ or orientation, the seeds were not suitable for target selection at the increased target selection threshold (FVF No. IARWP-004; Appendix C).

Of the remaining 18 seeds within the DGM survey boundaries, 16 were recovered within the DQO metric of 2 ft. The minimum offset was 0.37 ft and the maximum offset was 3.41 ft. The average offset was 1.33 ft. QC Seed 189 was not selected as a target; however, the blind seed was recovered while digging target 12042 at an offset of 2.3 ft. QC Seed 234 was recovered 3.41 ft from Target 3400. The response at this blind seed location was 45 mV, which is below the target selection threshold of 50mV for the Range 47 SCA.

One blind seed was placed within the analog survey boundaries by the UXOQCS. After completion of analog investigation, one seed was recovered.

4.2 QC Surveys in Analog and DGM Areas

4.2.1 QC-1

Following the excavation of the anomaly source by the UXO Dig Teams during analog and/or DGM surveys, the UXOQCS conducted a QC-1 investigation of each target location. The QC-1 investigation involved using a geophysical instrument (EM61-MK2 Handheld) to verify that the detectable MEC-like items within the search radius area around the target had been removed.

One QC-1 failure was reported during the Phase II field activities in Range 47 SCA. The UXOQCS identified the failure and reported it to the RPM. A copy of the non-conformance report is included in Appendix D. No other QC-1 failures were encountered during the Phase II field activities. QC-1 is documented as complete by the UXOQCS for each target as provided in Appendix G and H.

The Range 44 SCA (North) Design Study Expansion DGM survey and target investigation (Section 5.2.2) indicated that grids contained a high density of metal objects, including other debris; therefore, some targets could not be fully resolved within the 3-foot radius during target investigation and QC activities. For this reason, QC-1 was not conducted for the first (of two) DGM surveys conducted in the Range 44 SCA (North) Design Study Expansion area. In addition, a portable screen table, as shown in Photograph 3-2, was utilized prior to returning the soil to the excavations.

As discussed in Section 5.2, the first DGM survey indicated evidence of concern for 66mm, HEAT, M72 series rockets to potentially remain in Range 44 SCA (North), with the exception of the southernmost 8 grids. A second DGM survey and target investigation was conducted in the northernmost 33 whole and partial grids (excluding the southernmost eight grids) in Range 44 SCA (North) because of the high density of anomalies remaining and evidence of use of sensitively-fuzed munitions. Targets identified from the second DGM survey were resolved and QC-1 was completed. Results of the two DGM surveys and target investigations are presented in Section 5.2.2 and conclusions of the Design Study Expansion are presented in Section 5.2.6.

4.2.2 QC-2

Implementing the same procedures as the initial DGM survey operations, a minimum of 16% of the initial DGM survey area was subjected to a second survey known as QC-2. QC-2 target locations were identified by the project geophysicist for investigation. The selected target coordinates were imported into the target database for use by the UXO Technicians during QC-2 target reacquisition and investigation.

For Range 47 SCA, a QC-2 failure is constituted by 1) the discovery of MEC or similar item, 2) five re-acquirable anomalies as a result of the QC survey, or 3) the discovery of five non-selected anomalies (with dimensions similar to a 37mm projectile or greater) during the QC process that should have been selected during the initial DGM survey within a single 100-ft by 100-ft grid. For Range 47 SCA, QC-2 target locations were identified by the Project Geophysicist for investigation based on a 50mV target selection threshold (sum channel).

A QC-2 failure was reported during Phase II Interim Action at the Range 47 SCA due to large cluster type anomalies that should have been identified as investigation polygons instead of individual targets. The identification of the re-acquirable anomalies was determined to meet QC-2 failure criteria “2”, as described above. It was determined that two DGM surveys were necessary to complete the Phase II Interim Action. Therefore, a second DGM and target investigation was recommended for the entire Range 47 SCA. The second DGM survey, referred to as a “verification survey”, as discussed in Section 6.5, was conducted throughout the Range 47 SCA as a corrective action. The QC-2 target investigation findings are provided in Sections 5.0 and 6.0 and Appendix G.

The Design Study within Range 44 SCA (North) and Range 44 SCA (South) and Central Area NCAs was completed without finding evidence for sensitively-fuzed items to remain in these areas; therefore, QC-2 was not necessary in these areas.

4.3 Quality Control Analog Surveys and Excavations

Prior to operating an analog instrument, the analog operator completed the analog checkout procedure. The UXO Technicians conducted a daily instrument standardization check by placing the instrument over a standard item prior to commencing daily field activities.

The data acquisition parameters for analog operations included:

- Survey Speed and Lane Spacing: UXOQCS, SUXOS and Team Leaders observed operations and verified that operator instrument swing speed did not exceed best practices and that lane spacing was approximately 3 ft in width.

The analog investigation areas were checked by the UXOQCS after the initial investigation was completed. At least 10% of each grid was inspected by the UXOQCS and no QC issues were reported. QC of analog operations was documented in Appendices D and H.

4.4 Quality Control of Soil Sifting Operations

As part of the QC process, the UXOQCS or designated representative placed three seed items in the sifting plant twice daily (morning and afternoon) during the sifting operations.

The seeds consisted of the following items:

- inert 57mm projectile, painted blue
- 1 ½- by 5-inch galvanized pipe, painted orange (used to simulate 37mm and 40mm projectiles)
- ½- by 12-inch piece of rebar, painted blue (used to simulate 22mm subcaliber projectiles and 35mm subcaliber rocket)

These items were placed in the bucket of the heavy equipment loading the hopper of the sift plant.

The purpose of this QC task was to verify that the sifting operation removed detectable items from the excavated material. At the plant shutdowns, the UXOQC or designated representative inspected the various materials rejected to determine if the seed items were removed by the magnets and/or screens. There were no QC seed failures in the sift plant.

In addition to the twice-daily placement of seed items and QC checks of the sifted soil, the screens on the sifting plant were also inspected twice-daily for damage as a means to provide early detection of potential problems as noted on Construction Reports (Appendix A).

4.5 Seeding Program

Seed items were used to measure instrument detection capability. Known seed items were used as a positioning QC check during data processing. Blind seed items were used by QC and QA personnel to ensure the investigation met the DQOs and to measure instrument detection capability.

The Interim Action Work Plan identified three DQOs used to evaluate the effectiveness and thoroughness of the DGM investigation activities. The first of these metrics, the False Positive DQO, was addressed during the geophysical activities prior to QC-1 of the initial survey. The remaining two quality metrics were the Positioning Delta (Pd) 1st Level and 2nd Level DQOs.

The Pd 1st Level DQO required that 100% of the QC seeds within the established detection zone to be recovered during the DGM investigation. This metric was evaluated by the UXOQCS by checking 100% of the targets identified by the DGM survey after the excavation of that target was completed by the UXO Technicians. The UXOQCS evaluated the results of the blind seed program. The final metric used to evaluate the DGM investigation was the Pd 2nd Level DQO, which specified that 85% of the blind seed items placed within the final DGM survey area were required to be excavated within 2 ft of a selected investigation target with 90% confidence. The implementation and results of the seeding program at Interim Action MRA Phase II are discussed above in Sections 4.1.4.1, 4.1.4.2, and 4.4.

4.6 FORA Independent Quality Assurance

Third Party QA reports were submitted to FORA by ERRG and its subcontractor, InDepth. The Third Party QA work included periodic field observation, installation of blind seeds, and data review activities for both analog and DGM-related activities. ERRG and InDepth provided independent QA reports to FORA, which presented the results of their work. The reports are included in Appendix E (pending). The performance audits were accomplished through independent blind seeding and procedural audits were accomplished through periodic inspection of field operation against established policies and procedures in accordance with the FORA QASP. No deficiencies are anticipated to be identified during performance and procedural audits that were conducted for the Design Study and Phase II Interim Action.

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5.0 DESIGN STUDY RESULTS

The following sections discuss the results of the Design Study field activities for Range 44 SCA (North), Range 44 SCA (South) and Central Area NCAs, and Range 47 SCA. The technical aspects of the activities conducted during the Design Study were presented in Section 3.0 of this report.

The MEC and MD recovered during Design Study activities are provided in Table 5-1 and are summarized below.

Range 44 SCA (North)

- 3,128 UXO items
- 19,520 pounds (lbs) of MD
- 4 lbs of SAA

Range 44 SCA (South) and Central Area NCAs

- 27 UXO items
- 1,077 lbs of MD
- 0.1 lb of SAA

Range 47 SCA

- 131 UXO items
- 8,973 lbs of MD
- 85 lbs of SAA

Detailed findings for each Design Study activity are provided in the following sections.

5.1 Range 44 SCA (North and South) and Central Area NCAs Design Study Transect Investigation

This section presents the results of the transect investigation in Range 44 SCA (North) and Range 44 SCA (South) and Central Area NCAs, which included an analog-assisted near-surface investigation, DGM survey and target investigation, and soil sifting as presented in Section 3.0 of this report.

5.1.1 Transect Analog-Assisted Near-Surface Investigation Results

Analog-assisted near-surface investigation of transects in Range 44 SCA (North) and in Range 44 SCA (South) and Central Area NCAs was conducted from June 2 to 7, 2011, prior to conducting transect DGM surveys (Section 5.1.2). An overview of the findings during the analog-assisted near-surface investigation of transects in each area is presented below.

Range 44 SCA (North)

No sensitively-fuzed MEC were recovered during the analog-assisted near-surface investigation in Range 44 SCA (North). Nine MD items associated with the 66mm, HEAT, M72 series rocket were recovered during near-surface analog investigation in Range 44 SCA (North). The physical findings are summarized in the bullets below:

- 180 MEC items
- 630 lbs of MD
- 24 lbs of other debris items

Table 5-1 and Figures 5-1 through 5-2 provide an overview of MEC and MD found within Range 44 SCA (North). Figure 5-3 shows the location of 66mm, HEAT, M72 series rocket MD recovered in Range 44 SCA (North) during the Design Study. A detailed list of the analog findings is located in Appendix H.

Range 44 SCA (South) and Central Area NCAs

No sensitively-fuzed MEC were recovered during the analog-assisted near-surface investigation in Range 44 SCA (South) and Central Area NCAs. One MD item (tail boom) associated with the sensitively-fuzed 90mm HEAT projectile was found during near-surface analog investigation in Range 44 SCA (South) and Central Area NCAs. The physical findings are summarized in the bullets below:

- 196 lbs of MD
- 1 SAA item
- 15 lbs of other debris items

Table 5-1 and Figures 5-4 through 5-5 provide an overview of MEC and MD found within Range 44 SCA (South) and Central Area NCAs. A detailed list of the analog findings is located in Appendix H.

5.1.2 Transect DGM Survey and Target Investigation Results

DGM surveys and target investigation of transects were conducted in Range 44 SCA (North) and in Range 44 SCA (South) and Central Area NCAs from June 7 to 30, 2011 (Figures 5-6 and 5-7). An overview of the findings during the transect DGM survey and target investigation in each area is presented below.

Range 44 SCA (North)

A total of 1,337 target locations were identified by the Project Geophysicist for investigation. As discussed in Section 3.4.4, 10 to 100% of targets (19% of total targets) were investigated for a total of 252 targets investigated. Of the 252 targets investigated, one was determined to be “No Contact”, three were located outside of the work area and were therefore not investigated, and the remaining 248 targets investigated resulted in 426 physical items found.

Sixteen MD items (various) associated with a sensitively-fuzed 66mm, HEAT, M72 series rocket and one MD item (fin) associated with a sensitively-fuzed 90mm HEAT projectile were found during the transect DGM survey operations. The physical findings are summarized as follows:

- 37 MEC items
- 555 lbs of MD
- 11 lbs of other debris items
- 2 blind QC seeds

Table 5-1 and Figures 5-1 and 5-2 provide an overview of MEC and MD found within Range 44 SCA (North). Figure 5-3 shows the location of 66mm, HEAT, M72 series rocket MD recovered in Range 44 SCA (North) during the Design Study. DGM data plots with targets and a detailed list of the targets and findings are located in Appendices F and G, respectively.

Range 44 SCA (South) and Central Area NCAs

A total of 3,885 target locations were identified by the Project Geophysicist for investigation. As discussed in Section 3.4, 10 to 50% of targets (19% of total targets) identified were investigated in each grid, for a total of 746 targets investigated. Of the total 746 targets investigated, 17 were determined to be "No Contact", one was located outside of the work area and was therefore not investigated, and the remaining 728 targets resulted in 757 physical items found. One sensitively-fuzed MEC item (projectile, 40mm, practice, M407A1) and one MD item (a rocket motor) associated with a sensitively-fuzed 66mm, HEAT, M72 series rocket were found during the transect DGM survey operations. The physical findings are summarized as follows:

- 4 MEC items (2 practice 35 mm subcaliber rockets, 1 signal (illumination, ground: green star, parachute, M19 series), and 1 projectile, 40mm, practice, M407A1) in three locations
- 497 lbs of MD

Table 5-1 and Figures 5-4 through 5-5 provide an overview of MEC and MD found within Range 44 SCA (South) and Central Area NCAs. DGM data plots with targets and a detailed list of the targets and findings are located in Appendices F and G, respectively.

5.1.3 Transect Soil Sifting Results

Excavation (scraping) and soil sifting of transects was conducted between July 25 and 28, 2011. An overview of the findings during soil sifting operations for each area is provided below.

Range 44 SCA (North)

Fifteen MD from sensitively-fuzed 66mm, HEAT, M72 series rockets were found in 14 of the 28 grids containing transects. One sensitively-fuzed MEC 66mm, HEAT, M72 series rocket was found in one grid containing transects. The following bullets provide a summary of physical findings during the soil sifting of transects in Range 44 SCA (North):

- 219 MEC items
- 710 lbs of MD

Table 5-1 and Figures 5-1 through 5-2 provide an overview of MEC and MD found within Range 44 SCA (North). Figure 5-3 shows the location of the 66mm, HEAT, M72 series rocket MEC recovered in Range 44 SCA (North) during the Design Study. A detailed list of the soil sifting findings is located in Appendix I.

Range 44 SCA (South) and Central Area NCAs

No sensitively-fuzed MEC were recovered during Design Study activities in the Range 44 SCA (South) and Central Area NCAs. Two MD items (a projectile fin and tail boom) associated with the sensitively-fuzed 90mm HEAT projectile were found during soil sifting activities in the sifted transects. MD related to 40mm projectiles (model unknown) was found, but the majority of these items were related to 40mm practice projectiles. The following bullets provide a summary of physical findings during the soil sifting operations in the Range 44 SCA (South) and Central Area NCAs:

- 23 MEC items
- 384 lbs of MD
- 0.25 lb of other debris items

Table 5-1 and Figures 5-4 through 5-5 provide an overview of MEC and MD found within Range 44 SCA (South) and Central Area NCAs. A detailed list of the soil sifting findings is located in Appendix I.

5.1.4 Design Study Transect Investigation Conclusions

Design Study activities confirmed the presence of 66mm, HEAT, M72 series rocket MD and MEC within Range 44 SCA (North); however, the extent of the subsurface sensitively-fuzed munitions could not be determined without collection of additional data. Therefore, DGM survey activities in Range 44 SCA (North) were expanded to include the remainder of the Range 44 SCA (North) (referred to as the "Design Study Expansion") excluding the Army's HA-44 Remediation Area (Appendix C, FVF No. IARWP-004) (Section 5.2). The expanded scope of the Design Study fieldwork completed to evaluate the presence of sensitively-fuzed munitions in Range 44 SCA (North) included:

- Conducting an initial DGM survey and removal of target anomalies in 8.3 acres followed by a second DGM survey and removal of target anomalies in 6.5 acres of the 8.3 acre area

- Conducting excavation and sifting of high density anomaly polygons
- Conducting transect verification DGM survey and removal of target anomalies in 16% of the 8.3 acre area
- Conducting verification DGM survey and removal of target anomalies in 1.5 acres of the 8.3 acre area

Due to the lack of evidence for sensitively-fuzed items to remain in the Range 44 (South) SCA and Central Area NCAs, completion of the interim remedial action was not warranted for these areas.

5.2 Range 44 SCA (North) Design Study Expansion

This section presents the results of the Design Study Expansion in Range 44 SCA (North), which included an analog-assisted near-surface investigation, grid-based DGM survey and target investigation, soil sifting, and verification DGM surveys and target investigation as presented in Section 3.0 of this report.

Over the course of the Design Study Expansion, a DGM survey and target investigation was conducted in the 41 whole and partial grids of Range 44 SCA (North). A second DGM survey and target investigation was conducted in the northernmost 33 whole and partial grids (excluding the southernmost eight grids) because of the high density of anomalies remaining and evidence of use of sensitively-fuzed munitions. The DGM survey and target investigation in the southernmost eight grids did not show evidence for sensitively-fuzed munitions. The southernmost eight grids did contain a high density of metal objects, including other debris; therefore, targets could not be fully resolved within the 3-foot radius in areas (See Section 4.2.1). Based on professional judgment and data collected during the Design Study Expansion, target investigation results were sufficient to determine that there is no evidence of sensitively-fuzed munitions target areas within the southernmost eight grids.

Following the second DGM survey and target investigation, a transect verification DGM survey and target investigation was performed to determine if additional DGM surveys and target investigations were necessary. The survey was performed over approximately 16% of the 41 whole and partial grids in Range 44 SCA (North). The transect verification DGM survey and target investigation resulted in no evidence for sensitively-fuzed items to remain in Range 44 SCA (North) (Section 5.2.5); however, a single non-sensitively-fuzed MEC item was recovered in an area that had a high density of anomalies remaining following the two DGM surveys and target investigations. Therefore, a final verification DGM survey was conducted in a 1.5-acre portion of Range 44 SCA (North) where the single non-sensitively-fuzed MEC item was recovered during the transect verification DGM survey activities.

5.2.1 Analog-Assisted Near-Surface Investigation Results

Analog-assisted near-surface investigation was conducted from October 26 to 27, 2011, prior to conducting the Design Study Expansion DGM survey.

A total of 9 MD items related to the sensitively-fuzed 66mm, HEAT, M72 series rocket and one MD item (tail boom) potentially related to the sensitively-fuzed 90mm projectile were recovered in the northern portion of Range 44 SCA (North) during the analog-assisted near-surface investigation. The following bullets provide an overview of physical findings (excluding those found in the southernmost eight grids) during the analog-assisted near-surface investigation of the Design Study Expansion area:

- 53 MEC items
- 173 lbs of MD
- 44 lbs of other debris items

MEC or MD items associated with the sensitively-fuzed munitions were not found within the southernmost eight grids during the analog-assisted near-surface investigation. The following bullets provide specific findings for the southernmost eight grids:

- No MEC items
- 113 lbs of MD
- 10 lbs of other debris items

Table 5-1and Figures 5-1 and 5-2 provide an overview of MEC and MD found within Range 44 SCA (North). A detailed list of the analog findings is located in Appendix H.

5.2.2 DGM Survey Target Investigation Results

Two DGM surveys and target investigations were conducted in the Design Study Expansion area. The first DGM survey and target investigation of approximately 8.3 acres was performed in the Design Study Expansion area from October 26 to November 3, 2011 (Figures 5-8). A second DGM survey and target investigation of approximately 6.5 acres was performed in the Design Study Expansion area, excluding the southernmost eight grids, from March 27 to April 5, 2012 (Figure 5-9).

As a result of the first DGM survey, a total of 6,838 target locations were identified by the Project Geophysicist for investigation. Of the total 6,838 targets identified, 13 were determined to be “No Contact”, 28 were determined to be “Duplicate Targets”, and the remaining 6,797 target investigations resulted in 14,239 physical items found.

A total of 10 MEC associated with the sensitively-fuzed 66mm, HEAT, M72 series rocket (four rocket, 66mm M72 Series, HEAT items, five rocket, 66mm, M72 series, HEAT, components, and one fuze, point-initiating, base detonating, M412) were found during the first Design Study Expansion DGM target investigation. Two MEC items associated with the 40mm HE projectile were recovered. A total of 1,067 MD items associated with the sensitively-fuzed 66mm, HEAT, M72 series rocket, 18 MD items associated with the sensitively-fuzed 90mm projectile, two MD items associated with the sensitively-fuzed projectile, 40mm, practice, M407A1 item, and one MD item associated with the 40mm HE projectile were found. The following bullets provide an overview of physical findings,

excluding those found in the southernmost eight grids, during the first DGM survey target investigation in the Design Study Expansion area:

- 1,508 MEC items
- 7,262 lbs of MD
- 1 SAA item
- 4,273 lbs of other debris items
- QC/QA items (2 blind QC seeds and 2 QA seeds)

MEC or MD items associated with the sensitively-fuzed munitions were not found within the southernmost eight grids during the first DGM survey target investigation. The following bullets provide an overview of physical findings from the southernmost eight grids during the first DGM survey target investigation in the Design Study Expansion area:

- 17 MEC items
- 2,349 lbs of MD
- 66 lbs of other debris items
- 1 blind QC seed

As a result of the second DGM survey, which excluded the southernmost eight grids, a total of 4,484 target locations were identified by the Project Geophysicist for investigation. Of the total 4,484 targets identified, 10 were determined to be "Duplicate Targets," and the remaining 4,474 target investigations resulted 10,851 physical items found.

A total of eight MEC associated with the sensitively-fuzed 66mm, HEAT, M72 series rocket (three rocket, 66mm M72 Series, HEAT, components items, one rocket, 66mm, M72 series, HEAT, fuze, and four fuze, point-initiating, base detonating, M412) were found during the second Design Study Expansion DGM target investigation. A total of 4 MD items associated with the sensitively-fuzed 90mm projectile were found. The following bullets provide an overview of physical findings during the second DGM survey target investigation in the Design Study Expansion area:

- 749 MEC items
- 5,044 lbs of MD
- 528 lbs of other debris items
- QC/QA items (1 blind QC seed, 13 known QC seeds, and 1 QAs seeds)

Table 5-1, Figure 5-1, and Figure 5-2 provide an overview of MEC and MD found within Range 44 SCA (North). DGM data plots with targets and a detailed list of the targets and findings are located in Appendices F and G, respectively.

5.2.3 Soil Sifting Results

Following the initial DGM survey (Figure 5-6), areas where the soil contained a high density of small metallic debris that could not be feasibly identified or individually removed from the soil during target investigation were identified as sifting polygons. Eight polygons were excavated and sifted in the Design Study Expansion area (Figure 3-2) from December 6, 2011, to January 18, 2012. Eleven MEC (eight rocket, 66mm M72 series, HEAT, components items, and three fuze, point-initiating, base detonating, M412) and 12 MD recovered during soil sift operations in the Design Study Expansion area were related to the sensitively-fuzed 66mm, HEAT, M72 series rocket. One sensitively-fuzed MEC item (projectile, 40mm, practice, M407A1) was found. The following bullets provide an overview of physical findings during the soil sifting operation in the Range 44 SCA (North) Design Study Expansion area:

- 277 MEC items
- 724 lbs of MD
- 500 lbs of other debris items

Table 5-1, Figure 5-1, and Figure 5-2 provide an overview of MEC and MD found within Range 44 SCA (North). A detailed list of the sifting operations findings is located in Appendix I.

5.2.4 Transect Verification DGM Survey Target Investigation Results

During Design Study Expansion activities, a transect verification DGM survey and target investigation was performed in Range 44 SCA (North) to confirm the results of the Design Study Expansion and further support the decision that additional DGM survey and target investigation was not necessary. The transect verification DGM survey was performed over a minimum of 16% of Range 44 SCA (North) (Figure 5-10). Target locations were identified by the Project Geophysicist for investigation based on a 300 mV target selection threshold (sum channel). A total of 591 target locations were identified by the Project Geophysicist for investigation. Of the total 591 targets identified, 1 item was determined to be a “Duplicate Target”, and the remaining 590 target investigations resulted in 4,013 physical items found.

One MEC item (fuze, point-initiating, base detonating, M412) associated with a sensitively-fuzed 66mm, HEAT, M72 series rocket and one MD item (fragment) associated with a sensitively-fuzed 66mm, HEAT, M72 series rocket were recovered from the northern portion of the Range 44 SCA (North). The following bullets provide an overview of physical findings, excluding those found in the southernmost eight grids, during the transect verification DGM survey target investigation in Range 44 SCA (North):

- 29 MEC items
- 608 lbs of MD
- 8 lbs of other debris items

- 5 known QC seeds

One MEC associated with a sensitively-fuzed 40mm HE projectile (frag ball) was recovered from the southernmost eight grids in Range 44 SCA (North). The item was likely related to the 40mm HE training that occurred in Range 45 to the west. The following bullets provide an overview of physical findings from the southernmost eight grids during the transect verification DGM survey target investigation in Range 44 SCA (North):

- 8 MEC items
- 696 lbs of MD

The transect verification DGM survey and target investigation resulted in a lack of evidence for sensitively-fuzed items to remain in the entire Range 44 SCA (North); however, two MEC items associated with sensitively-fuzed MEC were recovered. Most of the grids received two DGM surveys and target investigations prior to the transect verification survey. Based on the recovery of the items associated with sensitively-fuzed MEC items, concern remained within the areas that had a high density of large anomalies remaining following the two DGM surveys. Therefore, a final DGM survey was conducted over areas with a high density of large anomalies remaining, a total of approximately 1.5 acres, in Range 44 SCA (North).

Table 5-1, Figure 5-1, and Figure 5-2 provide an overview of MEC and MD found within Range 44 SCA (North). DGM data plots with targets and a detailed list of the targets and findings are located in Appendices F and G, respectively.

5.2.5 Final Verification DGM Survey Target Investigation Results

The final verification DGM survey and target investigation was conducted over approximately 1.5 acres of Range 44 SCA (North) (Figure 5-11). A total of 474 target locations were identified by the Project Geophysicist for investigation. Of the total 474 targets identified, 1 target was determined to be “No Contact”, 8 were determined to be “Duplicate Targets”, and the remaining 465 target investigations resulted in 3,725 physical items found. One MD potentially related to the sensitively-fuzed 66mm, HEAT, M72 series rocket were recovered; however, no related MEC were found. One MD item related to the sensitively-fuzed 90mm projectile (fin) was recovered; however, no related MEC were found. One MEC from a 40mm, M406, HE, projectile (frag ball portion only) was recovered; however, this single MEC item did not indicate that the area was an impact area for 40mm projectiles. The recovery of the 40mm, M406, HE, projectile (frag ball portion only) likely related to the 40mm HE training that occurred in Range 45 to the west.

The following bullets provide an overview of physical findings during the verification DGM survey target investigation in Range 44 SCA (North):

- 51 MEC items
- 650 lbs of MD
- 4 SAA items

- 11 lbs of other debris items
- 12 QC items (4 blind QC seeds and 8 known QC seeds)

The extent of the final verification DGM survey and target investigation area included a small portion, along the northern border, of the southernmost eight grids. The final verification DGM resulted in 7 lbs of MD removed from the southernmost eight grids; none related to sensitively-fuzed munitions.

Table 5-1, Figure 5-1, and Figure 5-2 provide an overview of MEC and MD found within Range 44 SCA (North). DGM data plots with targets and a detailed list of the targets and findings are located in Appendices F and G, respectively.

5.2.6 Design Study Expansion Conclusions

The results of the DGM surveys, target investigation, soil sifting, and verification DGM survey investigation conducted during the Design Study Expansion activities indicated a lack of evidence for intact sensitively-fuzed MEC to remain in Range 44 SCA (North).

The following MEC and MD items related to sensitively-fuzed items were recovered in the northern 33 grids in Range 44 SCA (North) during the Design Study Expansion activities:

- 3 MEC items and 1 MD item associated with the sensitively-fuzed 40mm, M406, HE, projectile
- 1 MEC item and 2 MD items associated with the sensitively-fuzed projectile, 40mm, practice, M407A1
- 30 MEC items and 1,090 MD items associated with the sensitively-fuzed 66mm, HEAT, M72 series rocket
- 24 MD items associated with the sensitively-fuzed 90mm projectile

MEC and MD associated with sensitively-fuzed items were not found in the southernmost 8 grids of Range 44 SCA (North) during the Design Study Expansion activities with the exception of one 40mm, M406, HE, projectile. The recovery of the 40mm, M406, HE, projectile (frag ball portion only) likely related to the 40mm HE training that occurred in Range 45 to the west.

Based on the results of the Design Study and Design Study Expansion activities, an interim remedial action was not warranted within the SCA, as the potential for residual intact sensitively-fuzed MEC to remain in the Range 44 SCA (North) was not evident.

5.3 Range 47 SCA Design Study

This section presents the Design Study results for Range 47 SCA, which included soil sifting along transects, DGM survey and target investigation along transects, berm soil sifting along transects, and berm removal and soil sifting as presented in Section 3.0 of this report.

5.3.1 Transect Soil Sifting Results

Eight 10-ft wide transects were excavated to a depth of 6 to 24 inches bgs and soil was sifted from June 21 to July 21, 2011 (Figure 5-12). Sensitively-fuzed 40mm projectile (HE and practice) MEC were recovered from 13 grids. The following bullets provide an overview of physical findings during Range 47 SCA Design Study transect soil sifting investigation:

- 24 MEC items
- 2,755 lbs of MD
- 14 SAA items

Table 5-1 and Figure 5-13 provide an overview of MEC and MD found within Range 47 SCA during the Design Study activities. A detailed list of the soil sifting findings is located in Appendix I.

5.3.2 Transect DGM Survey Target Investigation Results

DGM survey and target investigation was performed in the Range 47 SCA transects during the Design Study to observe the density of anomalies in the area following a soil excavation to determine if additional soil excavation was necessary or if individual targets could be selected without removing additional soil. The DGM surveys indicated that remaining anomalies could be investigated as individual targets; therefore, a portion of the anomalies in the transects (18% of the selected anomalies) were investigated to confirm that remaining anomalies could be investigated as individual targets. It was determined that anomalies could be investigated as individual targets. A total of 26 lbs of MD were recovered during DGM survey target investigation in the Range 47 SCA prior to discontinuing the activity. As part of the Design Study, the DGM survey and target investigation was conducted to determine the depth of soil to be excavated during Phase II Interim Action and did not require investigation of every anomaly in every transect segment.

A high density of metallic debris was observed during the Range 47 SCA Design Study in the range fan portion of the SCA, which would limit the effectiveness of target investigation if soil was not removed prior to conducting DGM surveys. Because of the limited effectiveness of target investigation and the presence of sensitively-fuzed munitions during transect soil sifting, soil excavation was warranted in the area. Since the anomalies remaining after the Design Study would be resolved as part of Phase II Interim Action, the remaining targets were not investigated during the Design Study. Results of the DGM survey were assessed to determine excavation depths for completion of the Phase II Interim Action.

Table 5-1 and Figure 5-13 provide an overview of MEC and MD found within Range 47 SCA during the Design Study activities. DGM data plots with targets and a detailed list of the targets and findings are located in Appendices F and G, respectively.

5.3.3 Berm Transect and Berm Removal Soil Sifting Results

Seven 10-ft wide transects within the berm area were excavated to a depth of 12 inches bgs and soil was sifted on July 20, 2011. Visual reconnaissance and berm transect investigation results indicated that there was potential for sensitively-fuzed munitions to remain within and beneath the berm. Therefore excavation and sifting of the berm area was recommended as part of the Design Study (Appendix C, FVF No. IARWP-002).

Excavation and sifting of the entire berm was conducted from August 16 to September 12, 2011. Sensitively-fuzed 40mm projectile MEC and 66mm, HEAT, M72 series rocket MD were recovered during excavation and soil sifting operations. The following bullets provide an overview of physical findings during Range 47 SCA Design Study berm soil sifting activities:

- 107 MEC items
- 6,193 lbs of MD
- 3,160 lbs of other debris items

Table 5-1 and Figure 5-13 provide an overview of MEC and MD found within Range 47 SCA during the Design Study activities. A detailed list of the sifting operations findings is located in Appendix I.

Following excavation and soil sifting of the berm, a DGM survey was conducted in the berm removal area to evaluate the presence of subsurface anomalies (Figure 3-3). Results of the DGM survey indicated that subsurface anomalies existed in the area that required further action (Section 5.3.4).

5.3.4 Range 47 SCA Design Study Conclusions

Based on the results of the transect soil sifting and DGM survey in the range fan portion of the Range 47 SCA, it was determined that Phase II Interim Action including excavation and sifting to a depth of 6 to 24 inches bgs followed by DGM survey and target investigation and removal would be an effective remedial action approach (Appendix C, FVF No. IARWP-003).

Results of the DGM survey in the berm removal area indicated that the anomalies remaining in the area could be remediated through target investigation and removal as part of an interim remedial action (Appendix C, FVF No. IARWP-003). Target investigation and removal was performed as part of the Phase II Interim Action at Range 47 SCA (Section 6.0).

Design Study results also indicated that there was potential for sensitively-fuzed munitions to remain in portions of the grids along the northern and southern boundaries of the SCA. Phase II Interim Action including DGM survey with target investigation and removal was recommended for these grids (Appendix C, FVF No. IARWP-003).

5.4 Design Study Area Habitat Restoration

This section presents a summary of the habitat restoration activities implemented following completion of the Design Study.

5.4.1 Range 44 SCA (North and South) and Central Area NCAs Habitat Restoration

Habitat restoration activities were conducted in the Range 44 SCA (North and South) and Central Area NCAs in accordance with the HRP (ESCA RP Team 2013b). Restoration implementation commenced in December 2012 and included the following activities:

- placement of excavated soil in excavated areas of Range 47 SCA following completion of the Phase II Interim Action activities
- seeding of native plant species in excavated transects
- erosion control as needed

The restoration areas are subject to ongoing monitoring and sampling to ensure restoration is successful according to the performance targets established in the approved HRP (ESCA RP Team 2013b). The habitat restoration efforts are presented in Volume 2 of this IRACR.

5.4.2 Range 47 SCA Habitat Restoration

Habitat restoration activities were not conducted in the Range 47 SCA following the Design Study because an interim remedial action was recommended and conducted as described in Section 6.0.

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6.0 RANGE 47 SCA INTERIM ACTION RESULTS

The following sections discuss the results of the Phase II Interim Action implemented at Range 47 SCA. The technical aspects of the activities completed during the Phase II Interim Action are presented in Section 3.0 of this report. A sloped escarpment was not accessible for DGM survey; therefore, excavation, soil sifting, and a post-excavation analog survey and target investigation were performed on the sloped escarpment (Section 6.6).

The MEC and MD recovered during Phase II Interim Action activities are provided in Table 6-1 and are summarized below.

- 234 UXO items
- 6,121 lbs of MD
- 72 lbs of SAA

Detailed findings for each Phase II Interim Action activity are provided in the following sections.

6.1 Soil Excavation and Sifting Results

Excavation and soil sifting was performed during Phase II Interim Action in Range 47 SCA. Phase II Interim Action was conducted from October 25, 2011, to September 19, 2012. Soil was excavated from Range 47 SCA in the soil removal area shown on Figure 3-2 to a depth of 6 to 36 inches bgs, depending on the amount of metallic debris in the soil, totaling approximately 37,000 cubic yards of soil. This soil volume included 2 to 4 ft of soil excavated from a sloped escarpment in the southern portion of the SCA. Sensitively-fuzed munitions consisting of 78 40mm projectile, HE, M406 MEC and 7 lbs of 66mm, HEAT, M72 series rocket MD were recovered during soil sifting operations. The following bullets provide an overview of physical findings during the Phase II Interim Action soil excavation and sifting activities in Range 47 SCA soil scrape areas. Results for the sifting of soil excavated from the sloped escarpment are presented in Section 6.6.

- 162 MEC items
- 2,751 lbs of MD
- 305 lbs of other debris items

Table 6-1, Figure 6-1, and Figure 6-2 provide an overview of MEC and MD found within Range 47 SCA during Phase II Interim Action. A detailed list of the sifting operations findings is located in Appendix I.

6.2 DGM Survey Target Investigation Results

DGM surveys were conducted over approximately 15.4 acres comprised of post-excavation areas, including the berm area excavated during Design Study activities (Section 5.3.3), and areas where only the brush needed to be cut (soil excavation was not required) (Figures 3-3

and 6-3). DGM surveys resulted in a total of 4,983 target locations identified by the Project Geophysicist for investigation. Of the total 4,983 targets identified, 136 were determined to be "No Contact", 164 were determined to be "Duplicate Targets", and the remaining 4,683 target investigations resulted in 6,614 physical items found. The following bullets provide an overview of physical findings during the Range 47 SCA Phase II Interim Action target investigation:

- 55 MEC items
- 2,942 lbs of MD
- 259 SAA items
- 347 lbs of other debris items
- 19 QC/QA items (8 blind QC seeds, 1 known QC seed, and 10 QA seeds)

During target investigation, a Livens Projectile was encountered at a depth of 4 ft bgs in Grid B2J7F2 on March 28, 2012 in an Explosive Ordnance Disposal (EOD) trash pit (Photograph 12; Appendix J). FORA, the Army, and regulatory agencies were notified. The Army dispatched the Army Tech Escort team from the 759th EOD Company of the National Training Center in Fort Irwin, California. The Livens Projectile was X-rayed, then blown-in-place on March 30, 2012. The results of the X-ray and the demolition indicated that the projectile was inert.

Table 6-1, Figure 6-1, and Figure 6-2 provide an overview of MEC and MD found within Range 47 SCA during Phase II Interim Action. DGM data plots with targets and a detailed list of the targets and findings are located in Appendices F and G, respectively.

6.3 QC-2 DGM Survey Target Investigation Results

A total of 781 target locations were identified by the Project Geophysicist for investigation from the QC-2 DGM survey results shown in Figure 6-4. Of the total 781 targets identified, 54 were determined to be "No Contact", 6 were determined to be "Duplicate Targets", and the remaining 721 target investigations resulted in 1,055 physical items found. The following bullets provide an overview of physical findings during QC-2 investigation:

- 1 MEC item
- 190 lbs of MD
- 144 SAA items
- 20 lbs of other debris items
- 7 QC/QA items (7 known QC seeds)

A QC-2 failure was reported due to large cluster type anomalies that should have been identified as investigation polygons instead of individual targets. The post-excavation DGM survey data (Figure 6-3) was reviewed and seven polygons were identified to be verified as a corrective action by excavating soil to a minimum depth of 6 inches bgs and sifting the soil

from the polygons (Section 6.4). In addition, a second DGM survey was recommended, as a "verification survey", to be conducted over the Range 47 SCA where DGM was previously conducted to confirm completion of the Phase II Interim Action (Section 6.5).

Table 6-1, Figure 6-1, and Figure 6-2 provide an overview of MEC and MD found within Range 47 SCA during Phase II Interim Action. DGM data plots with targets and a detailed list of the targets and findings are located in Appendices F and G, respectively.

6.4 Verification Polygons Soil Sifting Investigation Results

As part of the QC-2 corrective action performed in Range 47 SCA, soil excavation and soil sifting was performed in seven verification polygons as shown in Figure 6-4. A total of 21 lbs of MD and no MEC were recovered during soil sifting in the verification polygons.

Table 6-1, Figure 6-1, and Figure 6-2 provide an overview of MEC and MD found within Range 47 SCA during Phase II Interim Action. A detailed list of the sifting operations findings is located in Appendix I.

6.5 Verification DGM Survey and Target Investigation Results

Following soil excavation and sifting of the verification survey polygons, a verification DGM survey and target investigation was performed over the Range 47 SCA, with the exception of the sloped escarpment, to complete the corrective action and the Phase II Interim Action (Figure 6-5). A total of 870 target locations were identified by the Project Geophysicist for investigation. Of the total 870 targets identified, 31 were determined to be "No Contact", 23 were determined to be "Duplicate Targets", and the remaining 816 target investigations resulted in 1,079 physical items found. Two components of sensitively-fuzed 40mm projectile, HE, M406 MEC were recovered during target investigation. The following bullets provide an overview of physical findings during the Range 47 SCA verification DGM survey target investigation:

- 3 MEC items
- 137 lbs of MD
- 45 SAA items
- 18 lbs of other debris items
- 5 known QC seeds

Table 6-1, Figure 6-1, and Figure 6-2 provide an overview of MEC and MD found within Range 47 SCA during Phase II Interim Action. DGM data plots with targets and a detailed list of the targets and findings are located in Appendices F and G, respectively.

6.6 Sloped Escarpment Soil Sifting Investigation Results

To address the potential for 40mm projectiles to remain in the sloped escarpment located in the southern portion of the SCA, 2 to 4 ft of soil was excavated from the face of the slope and

the soil was sifted. A total of 69 lbs of MD and 13 MEC, including 2 lbs of MD and one MEC associated with sensitively-fuzed 66mm, HEAT, M72 series, rocket were recovered during sifting operations on the sloped escarpment.

Table 6-1, Figure 6-1, and Figure 6-2 provide an overview of MEC and MD items found within Range 47 SCA during Phase II Interim Action. A detailed list of the sifting operations findings is located in Appendix I.

6.7 Sloped Escarpment Post-Excavation Analog Survey and Target Investigation Results

Following excavation and sifting of the top 2 to 4 ft of soil, a post-excavation analog survey was conducted on the sloped escarpment in the southern portion of the SCA to complete the Phase II Interim Action in the area. A total of 6 lbs of 40mm projectile (model unknown) MD potentially related to sensitively-fuzed munitions was recovered during the target investigation. No MEC was found during analog operations. The following bullets provide an overview of physical findings during analog Phase II Interim Action on the slope in Range 47 SCA:

- 11 lbs of MD
- 1 blind QC seed

Table 6-1, Figure 6-1, and Figure 6-2 provide an overview of MEC and MD found within Range 47 SCA during Phase II Interim Action. A detailed list of the analog findings is located in Appendix H.

6.8 Range 47 SCA Conclusions

The results of the soil sifting, DGM surveys and target investigation, and verification DGM survey and target investigation indicated a lack of evidence for intact sensitively-fuzed MEC to remain in the Range 47 SCA DGM survey areas. Therefore, the Phase II Interim Action was considered complete and no further fieldwork was warranted in these areas.

The results of the soil sifting and analog survey and target investigation indicated a lack of evidence for intact sensitively-fuzed MEC to remain in the sloped escarpment of Range 47 SCA. Therefore, the Phase II Interim Action was considered complete and no further fieldwork was warranted in the area.

6.9 Range 47 SCA Habitat Restoration

Habitat restoration activities were conducted in the Range 47 SCA in accordance with the HRP (ESCA RP Team 2013b). Restoration implementation commenced in December 2012 and included the following activities:

- replacement of subsoil in excavated areas

- re-contouring of subsoil in excavated areas to match the original contouring of the SCA
- replacement of topsoil in excavated areas following subsoil re-countoring
- installation of erosion control best management practices
- installation of an animal deterrent system and an irrigation system
- seeding of native plant species
- transplanting of salvaged manzanita
- installation of container plants

The restoration area is subject to ongoing monitoring and sampling to ensure restoration is successful according to the performance targets established in the approved HRP (ESCA RP Team 2013b). The habitat restoration efforts are presented in Volume 2 of this IRACR.

6.10 Material Size Reduction Operations Results

From February 14 to March 22, 2013, size reduction was performed on approximately 1,300 cubic yards of material removed from Range 44 SCA (North and South), Central Area NCAs, and Range 47 SCA. The material consisted of vegetation, other comingled debris, and clumped soil that could not pass through the screens on the sift plant during implementation of the Design Study and Phase II Interim Action. During size reduction, the following items were removed:

- 135 MEC items
- 8,578 lbs of MD
- 1,805 lbs of other debris items

Because the material was comingled from the four work areas, the recovered items could not be tied to a specific work activity or a specific SCA or NCA; however, based on the extent of work conducted, it is expected that most of the material originated from Range 47 SCA. A detailed list of MEC and MD found during the material size reduction operations is provided in Table 6-2.

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7.0 CONCLUSIONS

The Design Study and Phase II Interim Action in the IAR MRA have been successfully implemented using BADT in accordance with the Interim Action Work Plan and associated FVFs. The BADT included both analog and digital instruments, which were used to detect subsurface anomalies in the work areas. Subsurface anomalies that potentially represented sensitively-fuzed MEC were intrusively investigated and removed from the work areas.

During the Design Study and Phase II Interim Action, required QC and QA inspections were successfully completed in accordance with the Interim Action Work Plan and associated FVFs. In addition, the activities were overseen by an independent QA professional on behalf of FORA.

Volume 1 of this IRACR presented the results of the Design Study and Phase II Interim Action activities. Volume 2 of this IRACR presents the habitat restoration efforts following completion of the Design Study and Phase II Interim Action activities. This information will be incorporated into the IAR MRA FS report to support a final remedial decision.

The following sections provide the summary and conclusions by work area resulting from the Design Study and Phase II Interim Action activities.

7.1 Range 44 SCA (North)

The scope of the Design Study fieldwork completed to evaluate the presence of sensitively-fuzed munitions in Range 44 SCA (North) under Volume 1 of this IRACR included:

- Conducting analog-assisted near-surface investigation in transects and Design Study Expansion area and removal of target anomalies
- Conducting DGM surveys of approximately 20% of the areas and investigation and removal of 19% of target anomalies
- Conducting excavation (scraping) and sifting in transects

The Design Study transect investigation activities indicated a potential for additional subsurface sensitively-fuzed munitions to remain in Range 44 SCA (North). Therefore, the scope of the Design Study was expanded. The expanded scope of the Design Study fieldwork completed to evaluate the presence of sensitively-fuzed munitions in Range 44 SCA (North) under Volume 1 of this IRACR included:

- Conducting an initial DGM survey and removal of target anomalies in 8.3 acres followed by a second DGM survey and removal of target anomalies in 6.5 acres of the 8.3 acre area
- Conducting excavation and sifting of high density anomaly polygons
- Conducting transect verification DGM survey and removal of target anomalies in 16% of the 8.3 acre area

- Conducting verification DGM survey and removal of target anomalies in 1.5 acres of the 8.3 acre area
- Implementing habitat restoration activities as stated in the HRP (ESCA RP Team 2013b) as documented in Volume 2 of this IRACR

Design Study Expansion activities confirmed that there is a lack of evidence for sensitively-fuzed items to remain in the Range 44 (North). Table 5-1, Figure 5-1, and Figure 5-2 provide an overview of MEC and MD items found within Range 44 SCA (North) during Design Study activities. Detailed lists of targets and findings are located in Appendices G, H, and I of this report.

The Design Study operations have been successfully completed. The Design Study results indicated that further interim remedial action was not warranted within the SCA. Based upon the results of the Design Study, the potential for residual sensitively-fuzed MEC risks to remain in the Range 44 SCA (North) has been reduced and no further remedial action is warranted.

7.2 Range 44 SCA (South) and Central Area NCAs

The scope of the Design Study fieldwork completed to evaluate the presence of sensitively-fuzed munitions in Range 44 SCA (South) and Central Area NCAs under this IRACR included:

- Conducting analog-assisted near-surface investigation and removal of target anomalies in Design Study transects
- Conducting DGM surveys of approximately 15% of the areas and investigation and removal of 19% of target anomalies
- Conducting excavation (scraping) and sifting in selected transects
- Implementing habitat restoration activities as stated in the HRP (ESCA RP Team 2013b) as documented in Volume 2 of this IRACR

During the Design Study activities, no sensitively-fuzed MEC items were recovered. A total of 4 MD items associated with the sensitively-fuzed 66mm, HEAT, M72 series rocket and the 90mm HEAT projectile were found. MD related to 40mm projectiles (model unknown) was also found; however, the majority of these recovered MD items were confirmed to be related to 40mm practice projectiles.

Design Study activities confirmed that there is a lack of evidence for sensitively-fuzed items to remain in the Range 44 (South) SCA and Central Area NCAs. Table 5-1, Figure 5-4, and Figure 5-5 provide an overview of the MEC and MD items found within Range 44 SCA (South) and Central Area NCAs during Design Study activities. Detailed lists of the targets and findings are located in Appendices G, H, and I of this report.

The Design Study operations have been successfully completed. The Design Study results indicated that completion of an interim remedial action was not warranted within these areas.

Based on the results of the Design Study, the potential for residual sensitively-fuzed MEC risks to remain in the Range 44 SCA (South) and Central Area NCAs has been reduced and no further remedial action is warranted.

7.3 Range 47 SCA

The scope of the Design Study fieldwork completed in Range 47 SCA to evaluate the presence of sensitively-fuzed munitions under this IRACR included:

- Conducting excavation (scraping) and sifting of transects
- Conducting DGM survey and target investigation of transects and subsequently using the data to determine soil excavation depth as part of the Phase II Interim Action
- Excavation and sifting of berm area

Based on the Design Study results, the following conclusions were made for the Range 47 SCA:

- There was a high potential of finding additional subsurface sensitively-fuzed munitions within the range fan portion of the SCA and the existing high density of metallic debris limited the effective use of target investigation without soil excavation
- There was a potential of finding additional sensitively-fuzed munitions under the former berm and in portions of the grids along the northern and southern boundaries of the SCA; however, there was a low potential of finding a high density of metallic debris in these areas

These concerns were addressed by completing the Phase II Interim Action in the Range 47 SCA. The scope of the Phase II Interim Action included soil excavation and sifting to a depth ranging from approximately 6 to 36 inches bgs followed by DGM survey and target investigation and removal in approximately 12.4 acres of the SCA and DGM survey with target investigation and removal in the remainder of the SCA (Figure 3-2). Habitat restoration activities as stated in the HRP (ESCA RP Team 2013b) were also implemented as documented in Volume 2 of this IRACR.

During the Design Study and Phase II Interim Action in Range 47 SCA, the sensitively-fuzed munitions recovered including the following:

- 97 40mm projectile, HE, M406 MEC
- 75 lbs of 66mm, HEAT, M72 series rocket MD
- 85 40mm projectile, HE, M406 MEC
- 6 lbs of 40mm projectile, HE, M406 MD
- 6 lbs of 40mm projectile (model unknown) MD

Table 5-1 and Figure 5-6 provide an overview of MEC and MD items found within Range 47 SCA during Design Study activities. Table 6-1, Figure 6-1, and Figure 6-2 provide an overview of MEC and MD items found within Range 47 SCA during Phase II Interim Action. Detailed lists of targets and findings are located in Appendices G, H, and I of this report.

Phase II Interim Action operations have been successfully completed in Range 47 SCA in accordance with the Interim Action ROD. Based upon the results of the Design Study and Phase II Interim Action, the potential for residual MEC risks to remain in the Range 47 SCA has been reduced and no further remedial action is warranted.

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APPENDIX A

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APPENDIX L

(Please see the enclosed CD)