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Remedial Action Report
Track 3 Impact Area MRA
Broadway Bypass
FORMER FORT ORD, CALIFORNIA

May 2019
DRAFT FINAL

Prepared For:

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Acronyms and Abbreviations

AGC	advanced geophysical classification
AGCMR-QAPP	Advanced Geophysical Classification for Munitions Response Quality Assurance Project Plan
ARARs	Applicable or Relevant and Appropriate Requirements
Army	U.S. Department of the Army
β	betas
bgs	below ground surface
BLM	Bureau of Land Management
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
cm	centimeter
CMC	central maritime chaparral
CQCSM	Contractor Quality Control System Manager
DGM	digital geophysical mapping
DTSC	Department of Toxic Substances Control
EMI	electromagnetic induction
EPA	Environmental Protection Agency
FFA	Federal Facility Agreement
FS	feasibility study
FWV	Field Work Variance
GPS	global positioning system
HE	high explosive
HMP	Habitat Management Plan
IMU	inertial management unit
ISO	industry standard object
ISO 80	schedule 80 small industry standard object
IVS	instrument verification strip
KEMRON	KEMRON Environmental Services, Inc.
LUCs	land use controls
MACTEC	MACTEC Engineering and Consulting, Inc.
MD	munitions debris
MEC	munitions and explosives of concern
mm	millimeter
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard

MQO	measurement quality objectives
MRA	Munitions Response Area
MRS	Munitions Response Site
mV	millivolt
NAEVA	NAEVA Geophysics, Inc.
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAO	remedial action objective
RAR	Remedial Action Report
RD/RA	Remedial Design/Remedial Action
RI	remedial investigation
ROD	Record of Decision
RRD	range-related debris
RTK	real-time kinematic
Shaw	Shaw Environmental, Inc.
SOP	standard operating procedure
SSWP	Site-Specific Work Plan
SUXOS	Senior Unexploded Ordnance Supervisor
TEMTADS	Time-domain Electro-Magnetic MTADS MP 2x2
TOI	target of interest
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
UXA	UX-Analyze Advanced
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
WP	white phosphorus

Executive Summary

The Broadway Bypass Remedial Action Report (RAR) was prepared for the United States Department of the Army (Army) to describe the remedial action conducted in the Broadway Bypass as part of the remedial action specified by the *Final Record of Decision Impact Area Munitions Response Area Track 3 Munitions Site Former Fort Ord, California* (Army, 2008) and *Final Work Plan Remedial Design (RD)/Remedial Action (RA) Track 3 Impact Area Munitions Response Area (MRA) Munitions and Explosives of Concern (MEC) Removal Former Fort Ord, California* (United States Army Corps of Engineers [USACE], 2009).

The Broadway Bypass fuel break is located in Munitions Response Site (MRS) Ranges 43-48 South in the Impact Area Munitions Response Area (MRA) and connects Broadway Avenue to Felix Road, providing an access route that bypasses the heavily eroded portion of Broadway Avenue west of the Orion Road intersection. It is approximately 2.1 acres in area and 2,000 feet in length. The fuel break consists of a 15-foot wide roadway surface with 15 feet of maintained shoulder on each side of the roadway, for a total width of 45 feet.

The overall scope of the munitions and explosives of concern (MEC) remedial action involved technology-aided surface MEC removal (completed previously), followed by digital geophysical mapping (DGM) and subsurface removal of DGM anomaly sources. As described in the *Final, Site-Specific Work Plan, Munitions and Explosives of Concern Remedial Action, Broadway Bypass, Former Fort Ord, California* (KEMRON Environmental Services, Inc. [KEMRON], 2017b), advanced geophysical classification (AGC) was chosen as the subsurface removal DGM method. The DGM process included a comprehensive dynamic DGM survey (Time-domain Electro-Magnetic MTADS MP 2x2 [TEMTADS] advanced electromagnetic induction [EMI] sensor) followed by a classification DGM survey (static TEMTADS classification).

A total of 5,021 anomalies were identified from the TEMTADS advanced EMI sensor survey that met the amplitude response characteristics of potential subsurface MEC items. Inversion modeling of the static survey data measured at the 5,021 detection flag locations resulted in the identification of 5,216 individual modeled anomaly source locations potentially related to targets of interest

(TOI). TOI include targets with features consistent with MEC and objects used for quality control (QC) and quality assurance (QA) verification and validation seeding. Static TEMTADS classification survey data analysis resulted in the identification of 2,175 targets classified as potential TOI, subject to subsurface investigation and removal. The remaining 3,041 anomaly source locations (over 60% of the detected anomalies) were classified as high-confidence non-TOI and therefore safe to leave in place without intrusive investigation.

During intrusive investigation of the 2,175 anomalies identified for subsurface removal, 50 TOI were recovered in addition to non-TOI munitions debris (MD) and other metal objects. The following TOI were recovered during the remedial action:

Item	Quantity Recovered	MEC	MD[1]
Rocket Motor	1	0	1
Signal, Illumination	1	0	1
Projectile, 57mm, HE, M306 series	12	3	9
Projectile, 60mm, mortar, HE, M49 series	4	3	1
Projectile, 81mm, mortar, model unknown	15	0	15
Projectile, 105mm, model unknown	2	0	2
Projectile, 155mm, model unknown	1	0	1
QC Seed	10	N/A	N/A
Validation Seed	4	N/A	N/A

[1] Specific model and filler designations are listed for MEC items only. Specific model and filler designations for recovered MD items, including the remains of projectiles that had functioned as designed or were partially disassembled on impact but were still identifiable as a specific size projectile, are unknown.

Of the 2,175 anomalies identified for subsurface removal, 371 were considered verification investigations functioning as QC inspections to verify the effectiveness of the classification process. An additional 104 validation investigations were selected by the USACE Quality Assurance Geophysicist from the non-TOI classification group to validate the classification process. No TOI were recovered from intrusive investigation of the validation anomalies. Based on the completion of the TEMTADS dynamic detection and static classification surveys, the associated subsurface removal of the identified TOI sources, and the demonstrated absence of remaining TOI, the subsurface MEC removal required for the remedial action has been successfully completed.

1.0 Introduction

This remedial action report (RAR) describes the munitions and explosives of concern (MEC) remedial action that was performed within the Broadway Bypass fuel break in Munitions Response Site (MRS) Ranges 43-48 South at the former Fort Ord, California (Figure 1). The general scope of the remedial action, as defined in the *Final Record of Decision Impact Area Munitions Response Area Track 3 Munitions Site Former Fort Ord, California* (Track 3 ROD; United States Department of the Army [Army], 2008), is to manage "the potential risk to future land users from MEC at the Impact Area Munitions Response Area (MRA)". Track 3 sites are areas at the former Fort Ord where MEC is known or suspected to be present, but MEC investigations have not yet been completed. Broadway Bypass is a portion of the network of fuel break roads within the Impact Area MRA where, under the Track 3 ROD (Army, 2008), subsurface removal will be conducted.

1.1 Approval Documents

The remedial action included subsurface MEC removal utilizing advanced geophysical classification (AGC) digital geophysical mapping (DGM) and was completed in accordance with:

- *Explosives Safety Submission Munitions and Explosives of Concern Remedial Action Impact Area Munitions Response Area: Broadway Bypass Fuel Break Former Fort Ord, Monterey County California* (KEMRON Environmental Services, Inc. [KEMRON], 2017a),

- *Final Quality Assurance Project Plan Superfund Response Actions Former Fort Ord, California Volume II Appendix A Munitions and Explosives of Concern Remedial Action* (QAPP; KEMRON, 2016a),

- *Final Quality Assurance Project Plan, Superfund Response Actions Former Fort Ord, California Volume II Munitions Response Appendix B Advanced Geophysical Classification for Munitions Response Quality Assurance Project Plan* (AGCMR-QAPP; KEMRON, 2016b),

- *Final Site-Specific Work Plan Munitions and Explosives of Concern Remedial Action Broadway Bypass Former Fort Ord, California* (Broadway Bypass SSWP; KEMRON, 2017b), and

- *Field Work Variance 009* (FWV 009; KEMRON, 2017c), which modified the AGCMR-QAPP (KEMRON, 2016b) for Time-domain Electro-Magnetic MTADS MP 2x2 (TEMTADS) DGM.

The remedial action was performed by KEMRON, with Gilbane and NAEVA Geophysics, Inc. (NAEVA) as subcontractors, for the United States Army Corps of Engineers (USACE) under the Worldwide Environmental Remediation Services (WERS) Contract # W912DY-10-D-0027, Task Order No. CM01.

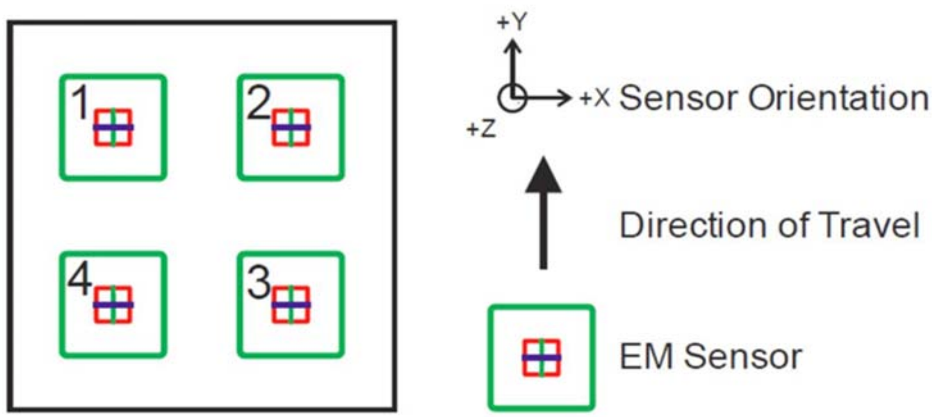
1.2 Remedial Action Objectives

The remedial action objective (RAO) for the Track 3 remedy is to protect human health and the environment in a manner that complies with the applicable or relevant and appropriate requirements (ARARs). The RAO is to be achieved by implementing the selected remedy of Technology-Aided Surface MEC Removal, with Subsurface MEC Remediation in Selected Areas and Land Use Controls (LUCs).

1.3 Remedial Action Approach

AGC DGM was chosen to complete the subsurface removal, as described in the Broadway Bypass SSWP (KEMRON, 2017b). AGC DGM involves a 2-phased DGM process composed of a detection DGM survey followed by a classification DGM survey. The dynamic detection DGM survey is conducted over the entire survey area to identify subsurface geophysical anomalies with characteristics consistent with potential MEC. The static classification survey follows the detection survey and consists of extended measurement recordings as the system remains stationary over each detected anomaly. The classification survey data is then analyzed to identify anomaly sources that can be confidently identified as non-MEC items and safely left in place. All other anomalies are classified as potential targets of interest (TOI) and resolved through intrusive investigation.

The Geometrics MetalMapper was identified in the SSWP for use during the remedial action but was replaced by an equivalent advanced electromagnetic induction (EMI) sensor, the U.S. Naval Research Laboratory TEMTADS MP 2x2, as described in FWV 009 (KEMRON, 2017c). The TEMTADS is a person-portable advanced EMI sensor designed for the detection and classification of buried metal objects. The TEMTADS is composed of four sensor elements arranged on 40-centimeter (cm) centers in a 2x2 array. Each sensor element consists of a 35-cm square transmit coil for target illumination with an 8-cm three-axis receive cube centered in the transmit coil. The transmitters are energized in sequence, and decay data are recorded with a 500 kHz sample rate after turn-off of the excitation pulse for up to 25 ms for each of the 12 (4 cubes with 3 axes each) receive channels. A schematic of the TEMTADS sensor coil configuration is shown below (U.S. Naval Research Laboratory, 2014).



Positioning of the TEMTADS is accomplished using real-time kinematic (RTK) global positioning system (GPS), and orientation is measured using a six-degree-of-freedom inertial measurement unit (IMU). TEMTADS data acquisition is controlled from a tablet computer wirelessly connected to the data acquisition computer, where measured data are logged.

1.4 Project Personnel and Subcontractors

TEMTADS data acquisition, analysis, and classification work was performed and supervised by geophysicists experienced in geophysical classification using advanced EMI sensors. Key personnel included the following:

- Project Geophysicist: Andy Gascho (Gilbane)
- Lead Data Processor: Alison Paski (NAEVA)
- Quality Control (QC) Geophysicist: Alex Kostera (NAEVA)
- Senior Unexploded Ordnance Supervisor (SUXOS): Brad Olson (KEMRON)
- UXO Quality Control Specialist (UXOQCS): Bruce McClain (KEMRON)
- UXO Safety Officer: Val Valdez (KEMRON)
- Contractor QC Systems Manager (CQCSM): Chuck Clyde (Gilbane)
- Project Manager: Steve Crane (KEMRON)
- Deputy Project Manager: Erin Caruso (Gilbane)

As a result of the modifications to the SSWP presented in FWV 009 (KEMRON 2017c), the roles of NAEVA personnel involved in the remedial action were changed from those presented in the SSWP. Alison Paski's role as QC Geophysicist was changed to Lead Data Processor, and Alex Kostera's role was changed from Field QC Geophysicist to QC Geophysicist. All QC activities were conducted in accordance with the SSWP.

1.5 Health and Safety

MEC remedial action work was conducted in accordance with the *Final, Basewide Accident Prevention Plan, Munitions and Explosives of Concern Removal and Soil Remediation, Former Fort Ord, California* (KEMRON, 2015).

1.6 Report Organization

This RAR details the work completed as part of the Broadway Bypass Remedial Action and is organized as follows:

- Introduction

- Site Background
- Remedial Action Activities
- Results
- QC
- Data Validation
- Conclusions

1.7 *Applicable or Relevant and Appropriate Requirements*

ARARs are outlined in the Track 3 ROD (Army, 2008). The performance of this remedial action was in compliance with the ARARs outlined in that document.

2.0 Site Background

2.1 Site Location

Fort Ord is a former military installation that comprises approximately 46 square miles in northwestern Monterey County, California and is located approximately 120 miles south of San Francisco. Monterey Bay forms the western boundary of the former Fort Ord, and the Santa Lucia Range bounds the former Fort Ord to the south. The cities of Marina and Seaside and the Salinas Valley are northwest, southwest, and east of the former Fort Ord, respectively. Figure 1 shows the location of the project area in the north-central portion of the Impact Area MRA.

The Broadway Bypass fuel break is located in MRS Ranges 43-48 South and connects Broadway Avenue to Felix Road, providing an access route that bypasses the heavily eroded portion of Broadway Avenue west of the Orion Road intersection. It is approximately 2.1 acres in area and 2,000 feet in length. The fuel break consists of a 15-foot wide roadway surface with 15 feet of maintained shoulder on each side of the roadway, for a total width of 45 feet. The work grids within the Broadway Bypass fuel break are shown on Figure 2.

2.2 Population, Proximity, and Access

The project area is within the Impact Area MRA, which is currently enclosed by a four-strand barbed wire fence with concertina wire along critical locations. Access is restricted to authorized personnel only. Potential exposure to MEC by unauthorized persons has occurred and could occur through intentional trespassing incidents. A security program to mitigate such incidents is currently being implemented by the Army (Army, 2016). The project area is located on land that is planned to be transferred to the Bureau of Land Management (BLM). Nearby BLM land is open to the public for hiking, biking, jogging, and horseback riding. Signs warning of the dangers associated with UXO are present throughout the former Fort Ord. The Impact Area MRA is in close proximity to a residential neighborhood on the former Fort Ord. Existing access deterrents, such as fencing posted with warning signs approximately every 500 feet along the fencing, discourage, but do not prevent, entry into the area. Personnel from the Fort Ord Base Realignment and Closure (BRAC) office and BLM routinely check the Impact Area MRA fences to ensure that they remain in good condition and to identify/complete needed repairs in a timely manner. The fences are maintained through a services support agreement with the BLM.

2.3 Reuse

The project area is currently designated for transfer to BLM as habitat reserve under the *Installation-Wide Multispecies Habitat Management Plan for Former Fort Ord, California* (HMP; USACE, 1997) which describes special land restrictions and habitat management requirements within habitat reserve areas. Habitat reserve areas support special-status plant and animal species that require implementation of mitigation measures during Army cleanup activities identified in the HMP to ensure compliance with the Endangered Species Act and to minimize potential adverse impacts to listed species. Based on information provided by BLM, the reuse of the area as a habitat reserve is anticipated to include a variety of activities including:

- Road and trail management and maintenance
- Habitat enhancement, including prescribed burning
- Fuel break construction and management
- Use of administrative areas
- Habitat monitoring and educational programs
- Species-specific monitoring and habitat enhancement
- Recreational access on established routes

2.3.1 Vegetation and Habitat

The topography of the Broadway Bypass area consists primarily of relatively flat ground and gently rolling hills, vegetated with maritime chaparral and grassland. Elevations range from approximately 500 feet to 540 feet above mean sea level. The surficial geology is primarily older stabilized dune and drift sand of the Aromas Sandstone and Paso Robles Formation with limited alluvial deposits to consolidated sands/sandstone.

The HMP (USACE, 1997) describes special land restrictions and habitat management requirements within habitat reserve areas. The habitat types that constitute the Broadway Bypass area contain special-status flora and fauna species that are identified in the HMP. Special-status species that can be encountered within the Broadway Bypass area are the California tiger salamander, Monterey spineflower, Seaside birds-beak, sand gilia, and HMP shrubs. The *Fort Ord Site Habitat Checklist, Broadway Bypass* (KEMRON, 2016c) outlines site-specific avoidance and minimization measures to reduce impacts to HMP species (Appendix G).

2.4 Regulatory Status

From 1917 to base closure in 1994, Fort Ord primarily served as a training and staging facility for infantry troops. From 1947 to 1974, Fort Ord was a basic training center. After 1974, the 7th Infantry Division was based at Fort Ord. Fort Ord was selected for closure in 1991. The majority of the soldiers were reassigned to other Army posts in 1993. There is no longer an active Army division stationed at the former Fort Ord.

Fort Ord was placed on the National Priorities List of Superfund sites by the Environmental Protection Agency (EPA) on February 21, 1990, due to evidence of contaminated soil and groundwater. A Federal Facility Agreement (FFA) was signed by the Army, EPA, Department of Toxic Substances Control (DTSC), and the Regional Water Quality Control Board, a part of the California EPA. The FFA established procedures and schedules for conducting remedial investigations (RI) and feasibility studies (FS) and requires remedial actions be completed as expeditiously as possible. The former Fort Ord was selected in 1991 for BRAC, and the base was officially closed in September 1994. The Army began investigating and removing MEC at the former Fort Ord after the BRAC listing, and a munitions response RI/FS began in 1998. In April 2000, an agreement was signed between the Army, EPA, and DTSC to evaluate MEC at the former Fort Ord subject to the provisions of the FFA. The April 2000 agreement also formalized the regulatory agencies' roles in the Military Munitions Response Program (MMRP) at former Fort Ord.

Following completion of the *Final Track 3 Impact Area Munitions Response Area Munitions Response Remedial Investigation/Feasibility Study Report Former Fort Ord, California* (Track 3

RI/FS; MACTEC Engineering and Consulting, Inc. [MACTEC], 2007), the Army prepared the Track 3 ROD (Army, 2008), which is the decision document presenting the selected remedial action for MEC in the Impact Area MRA. The remedy, which was selected following a 60-day public comment period, includes remedial action and is documented in the Track 3 ROD (Army, 2008). The remedy was selected in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and to the extent practicable, the *National Oil and Hazardous Substances Pollution Contingency Plan*.

The decision documented in the Track 3 ROD (Army, 2008) is undertaken pursuant to the President's authority under CERCLA Section 104, as delegated to the Army in accordance with Executive Order 12580, and in compliance with the process set out in CERCLA Section 120. The selection of the remedy is authorized pursuant to CERCLA Section 104, and the selected remedy is being carried out in accordance with CERCLA Section 121.

2.5 Site Features and History of Military Munitions Use

From 1917 to base closure in 1994, portions of former Fort Ord were used by cavalry, field artillery, and infantry units for maneuvers, target ranges, and other purposes. From 1947 to 1974, Fort Ord was a basic training center. After 1974, the 7th Infantry Division occupied Fort Ord. Military munitions were fired and used on the facility, including artillery and mortar projectiles, rockets and guided missiles, rifle and hand grenades, land mines, pyrotechnics, bombs, and demolition materials.

Fort Ord was selected in 1991 for decommissioning, but troop reallocation was not completed until 1993, and the base was not officially closed until September 1994. The property remaining in the Army’s possession was designated as the Presidio of Monterey Annex on October 1, 1994, and subsequently renamed the Ord Military Community. Although Army personnel still operate parts of the base, no active Army division is stationed at the former Fort Ord. Since the base was selected in 1991 for BRAC, site visits, historical and archival investigations, military munitions sampling, and removal actions have been performed and documented in preparation for transfer and reuse of the former Fort Ord property. The Army will continue to retain the Ord Military Community and the U.S. Army Reserve Center located at the former Fort Ord. The remainder of Fort Ord was identified for transfer to federal, state, and local government agencies and other organizations and, since base closure in September 1994, has been subjected to the reuse process.

The Impact Area MRA is a complex of numerous former military ranges with a variety of historical uses, designs, and characteristics. Over the years, various types of munitions have been used during training activities within the Impact Area MRA including artillery and mortar projectiles, rockets and guided missiles, rifle and hand grenades, land mines, pyrotechnics, bombs, and demolition materials. Select ranges were used for small arms training activities only, while other ranges are characterized as multi-use. In general, the firing points of the ranges were located near the perimeter of the MRA, and firing was directed toward the interior portion of the range complex. Training activities at the Impact Area MRA ceased after the closure of Fort Ord in 1994. The Impact Area MRA is fenced, warning signs are posted, and access is controlled by the Army. The perimeter of the historical Impact Area is patrolled to detect and prevent trespassing.

The Broadway Bypass remedial action area is located in the north-central portion of the Impact Area MRA and lies within MRS-Ranges 43-48 South. The historical ranges in MRS-Ranges 43-48 South are shown on Figure 3. As presented in *Final MRS-Ranges 43-48 Interim Action Technical Information Paper Volume 1 Former Fort Ord, Monterey, California Military Munitions Response Program* (Parsons, 2007) and the Track 3 RI/FS (MACTEC, 2007), MRS Ranges 43-48 contains all or most of Ranges 43, 44, 45, 46, 47, and 48 where training activities involving live ammunition and ordnance occurred from the mid-1940s through 1993. Table 1 lists the prior usage of these ranges, the majority of which directed fire in the direction of the Broadway Bypass area. Both penetrating and non-penetrating munitions were used in these ranges, including munitions with sensitive fuzes, and MEC is expected to lie in the shallow subsurface in addition to the MEC items recovered on the surface. Previously recovered MEC items are shown on Figure 4.

Table 1
Previous Range Use

Range	Range Use
43	Platoon live-fire course, mortar range
44	Antitank weapons (recoilless rifle rocket launcher, Dragon missile rocket launcher) range
45	SABOT/14.5 subcaliber training; grenade launcher range
46	Small arms range
47	40mm grenade range
48	Weapons familiarization; sniper, mortar, and machine gun range
Unknown	Range is visible on historical aerial imagery, but range usage is not documented

2.6 MEC-Related Activities and Data Collected Prior to the Remedial Action

MEC-related activities conducted in MRS Ranges 43-48 South prior to the subsurface MEC remedial action are detailed in the Broadway Bypass SSWP (KEMRON, 2017b).

An interim remedial action was conducted in MRS Ranges 43-48 between 2003 and 2005, and included vegetation removal by prescribed burning and visual surface MEC removal over the entire MRS, including the Broadway Bypass area. Two coincident MEC items were recovered during the surface MEC removal – one 57mm high explosive (HE) projectile and one point detonating (PD) fuze. This work is described in the *Final MRS-Ranges 43-48 Interim Action Technical Information Paper Volume 1 Former Fort Ord, Monterey, California Military Munitions Response Program* (Parsons, 2007).

Additional surface removal work was completed in approximately 55 acres of Range 48 to remove surface MEC and munitions debris (MD) resembling MEC after a 2009 wildfire burned approximately 7 acres of moderate-density vegetation approximately 250m northeast of the intersection of Evolution Road and Broadway Avenue inside the 2003 surface removal area of Range 48. The suspected cause was the unprovoked, spontaneous functioning of a Discarded Military Munitions (DMM) white phosphorus (WP) hand grenade. The magnetometer-assisted surface MEC removal was completed between March 22 and April 7, 2010, in accessible areas within Range 48 where WP grenades were previously located during the 2003 removal action, and included the central section of the Broadway Bypass area. No MEC items were recovered in the

Broadway Bypass footprint. This work is described in the *Technical Information Paper Surface Sweep Range 48* (Shaw Environmental, Inc. [Shaw], 2010a).

Shaw performed EM61 DGM along fuel breaks within the Impact Area MRA between August 2010 and February 2011, in accordance with the *Site-Specific Work Plan Munitions and Explosives of Concern Remedial Action Non-Burn Areas Former Fort Ord, California* (Non-Burn Areas SSWP; Shaw, 2010b). This work is described in *Technical Information Paper Digital Geophysical Mapping of the Permanent Fuel Breaks Former Fort Ord, California* (Shaw, 2011) and included the nominally 15-foot wide roadway of Broadway Bypass. Shaw conducted additional DGM along the outer portions of the Broadway Bypass fuel break (15 feet on each side of the roadway) in 2014. The DGM was preceded by surface MEC removal conducted by Gilbane, in accordance with the Non-Burn Areas SSWP (Shaw, 2010b).

MEC items and quantities recovered during activities prior to the MEC remedial action are presented in Table 2.

Table 2
MEC Items Recovered During Previous Investigations

Item Description	Quantity	Depth (inches)
Fuze, projectile, point detonating, M48 series	1	0
Projectile, 57mm, high explosive, M306 series	11	0
Projectile, 60mm, mortar, high explosive, M49 series	1	0
Projectile, 105mm, high explosive, M1	1	0
Projectile, 81mm, mortar, high explosive, M56	1	0
Projectile, 75mm, high explosive, M48	1	0

3.0 Remedial Action Activities

3.1 Site Layout

The Broadway Bypass remedial action activities utilized the existing Impact Area MRA fuel break grid system, which is composed of grids with nominal dimensions of 45-feet wide by 100-feet long. Site layout involved locating and staking the boundaries of the Broadway Bypass fuel break and was completed by a land survey team composed of two UXO Technicians.

3.2 Vegetation Clearance

Minimal vegetation clearance, in the form of mowing, was conducted by UXO Technicians to support the remedial action.

3.3 Quality Control Seeding

Prior to data acquisition activities, QC seed items were placed in the subsurface throughout the Broadway Bypass remedial action area. QC seed items provide verification of data acquisition, processing and analysis, classification, and intrusive investigation quality and consist of small schedule 80 industry standard objects (ISO-80). QC seed items were buried at depths between 4 and 6 inches below ground surface (bgs) by a UXO Technician II and the QC Geophysicist, utilizing anomaly avoidance techniques and RTK-GPS for location measurement and recording of burial information. Ten QC seed items were emplaced in the remedial action area in anticipation of encountering at least one seed item during each day of cued classification data acquisition and approximately 5 seed items during each day of dynamic data acquisition.

To maintain the integrity of the QC program, seed item burial information was not provided to personnel involved in data acquisition, processing, or intrusive investigation activities until those activities were completed, the initial classification results were submitted by the Project Geophysicist to the USACE Quality Assurance (QA) Geophysicist, and the successful identification of all QC seed items was confirmed by the QC Geophysicist and the QA Geophysicist. QC seeding results are reported in Section 5.1. A detailed discussion of the QC seeding program is provided in the Quality Control Seeding Report (Appendix B).

Additional validation seed items were emplaced by the USACE QA Geophysicist, details of which were unknown to the contractor team at the time of field work. Details of the validation seeding program are presented in Section 6.1.

3.4 Instrument Verification Strip Construction

An instrument verification strip (IVS) was constructed on April 11, 2017, in accordance with Appendix B (Standard Operating Procedure [SOP] AGCMR-02, Advanced EMI Sensor Instrument Verification Strip) of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c) to verify the performance of the TEMTADS advanced EMI system. The IVS was constructed along Felix Road just outside the northern terminus of Broadway Bypass. Prior to emplacement of IVS seed items, a background (DGM) survey of the IVS location was conducted with a person-portable EM61. The EM61 data were processed in accordance with GEO SOP 5 (Attachment B to the QAPP; KEMRON 2016a), and the IVS location was determined to be suitable for use. The IVS consisted of two ISO-80 seed items (one buried vertically 5.9 inches bgs; one buried horizontally, perpendicular to the survey path, 3.9 inches bgs), one blank location, and a background line. The IVS location is shown on Figure 5, and details of item placement are listed in Table 3. Initial IVS survey results are described in Section 5.3. A detailed discussion of the IVS construction and initial survey is provided in the Instrument Verification Strip Memorandum (Appendix C).

Table 3
Instrument Verification Strip Information

Point ID	Easting[1]	Northing[1]	Item	Depth (inches)[2]	Orientation
North End	5742210.316	2120548.564	N/A	N/A	N/A
Blank	5742222.550	2120539.925	N/A	N/A	N/A
AC-IVS-02	5742234.708	2120531.207	Small ISO-80	5.9	Vertical
AC-IVS-01	5742246.887	2120522.687	Small ISO-80	3.9	Horizontal
South End	5742259.185	2120514.030	N/A	N/A	N/A
BG North End	5742213.978	2120552.316	N/A	N/A	N/A
BG South End	5742262.712	2120517.543	N/A	N/A	N/A
GPS QC	5742359.377	2120410.242	N/A	N/A	N/A

[1] Coordinates reported in NAD83, California State Plane, Zone 4, US survey feet
[2] Depth reported to center of mass of item below ground surface

The SSWP stated that the IVS would also include two 37mm projectiles, buried at 16 inches bgs (one oriented horizontally, one vertically) to establish the baseline target detection threshold. To allow a more robust analysis and establishment of the target detection threshold, a deviation to the SSWP was implemented, and the baseline target detection threshold testing was conducted in a test pit, where measurements of inert 37mm and 40mm projectiles could be recorded at multiple depths and orientations. A discussion of the test pit measurements is included in Section 3.6.

3.5 Instrument Assembly and Verification

Prior to TEMTADS data acquisition, the correct assembly and operation of the geophysical sensor and navigation and orientation systems were verified through instrument function tests and an initial IVS survey.

3.5.1 Instrument Assembly

The TEMTADS system was assembled in accordance with SOP AGCMR-01 (AGCMR-QAPP, Appendix B; KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c), on April 12, 2017. Assembly of the system included attaching the wheels, handle, RTK-GPS antenna, and IMU to the coil assembly cart, and connecting and routing cables to the electronics backpack (which houses the data acquisition computer and batteries), RTK-GPS, and IMU. System assembly was followed by verification of the orientation of the IMU, operation of the RTK-GPS, and correct input of the data acquisition parameters, and a sensor function test was conducted in accordance with SOP AGCMR-01, with modification by FWV 009 (KEMRON, 2017c). System assembly and verification were completed by the data acquisition geophysicist and overseen by the QC Geophysicist.

3.5.2 Initial Instrument Tests

On April 12, 2017, initial dynamic and static IVS surveys were performed at the Broadway Bypass IVS, in accordance with SOP AGCMR-02 (AGCMR-QAPP, Appendix B; KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). The initial IVS survey is described in Section 5.3. A detailed discussion of the initial IVS survey is provided in the Instrument Verification Strip Memorandum (Appendix C).

3.6 Test Pit Measurements and Target Detection Threshold Establishment

In addition to the initial IVS surveys, a series of test pit measurements were conducted over an inert 40mm projectile and an inert 37mm projectile at various depths and orientations on April 19 and April 20, 2017, to verify TEMTADS detection depth performance and to determine data processing parameters to maximize the effective detection of the smallest TOI anticipated in the Broadway Bypass area. Test pit measurements were conducted by placing each item at precisely-measured depths and orientations in an excavated pit below the TEMTADS sensor and acquiring dynamic and static measurements as described in SOP AGCMR-07 (AGCMR-QAPP, Appendix B; KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). The test pit measurements were processed as described in SOP AGCMR-08 (AGCMR-QAPP, Appendix B; KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c).

The test pit measurements indicated that deep (16 inches bgs) 37mm projectiles have a low amplitude broad response similar to many of the smaller pieces of metal clutter throughout the Broadway Bypass area. The response from 37mm projectiles, however, was visible across all receivers of the TEMTADS, whereas the responses from smaller clutter items were not detected by all TEMTADS receivers due to their small size. Target selection was therefore based on a summation of the monostatic component of the four receivers rather than on individual receiver values. The sum of the receiver measurements amplifies TOI responses which are detected across all receivers compared to smaller non-TOI responses which are detected on only one or two receivers. This allows a target selection approach that maximizes detection of TOI to the required depth while minimizing false positive target selection. Based on the initial IVS survey and the test pit measurements, the target detection threshold was established at 2.5 millivolt (mV)/amp (utilizing the summed monostatic Z-component response) to maximize probability of target selection for 37mm projectiles to a depth of 16 inches bgs.

3.7 Dynamic Detection Survey

The TEMTADS dynamic detection survey included data acquisition and data processing and analysis tasks and culminated in the creation of a list of anomalies potentially representing subsurface TOI. Details of the detection survey data acquisition, processing, and analysis approaches are presented in Section 5 of the Broadway Bypass SSWP (KEMRON, 2017b) and in Appendix B (Advanced EMI Sensor SOPs) of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). Measurement quality objectives (MQO) associated with the TEMTADS detection survey are presented in Worksheet 22 of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c).

3.7.1 Dynamic Detection Data Acquisition

A comprehensive dynamic DGM detection survey utilizing the TEMTADS in person-portable mode was conducted in the Broadway Bypass fuel break area between April 13 and April 19, 2017. Data acquisition was completed in accordance with the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c), and the Broadway Bypass SSWP (KEMRON, 2017b), including verification of successful attainment of MQO. The data acquisition team consisted of a NAEVA geophysicist, an equipment operator, and a UXO Technician II as a MEC escort.

3.7.2 Dynamic Detection Data Processing and Analysis

Processing and analysis of the detection survey data, including target selection and verification of successful attainment of MQO, were accomplished by NAEVA data processors using Geosoft's Oasis Montaj UX-Analyze Advanced (UXA) software, in accordance with Section 2.5.3 of the Broadway Bypass SSWP (KEMRON, 2017b). The summed monostatic Z-component measurements in the detection survey data were processed and analyzed to identify anomalies meeting the minimum response amplitude criteria of potential TOI (2.5mV/amp), which were based on the initial IVS survey results and the test pit response of an inert 37mm projectile at 16 inches bgs, as described in Section 3.6.

The dynamic TEMTADS detection survey resulted in the identification of 5,021 anomalies as potential TOI, each of which was assigned a unique identification number. Detection survey results are discussed in Section 4.1. The dynamic detection data is presented on Figure 6, and the selected subsurface anomaly locations are displayed on Figure 7.

3.8 Static Classification Survey

The TEMTADS static classification survey followed the dynamic detection survey and included data acquisition and data processing, analysis, and classification tasks. The static classification survey utilized the potential TOI list developed from the detection survey and culminated in a ranked list of investigated targets, with those most likely to be TOI at the top of the list and those least likely to be TOI at the bottom. Details of the classification survey data acquisition, processing, and analysis approaches are presented in Section 6 of the Broadway Bypass SSWP (KEMRON, 2017b) and in Appendix B (Advanced EMI Sensor SOPs) of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). MQO associated with the TEMTADS classification survey are presented in Worksheet 22 of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c).

3.8.1 Static Classification Data Acquisition

Following processing of the dynamic TEMTADS DGM data and identification of subsurface anomalies potentially related to TOI, a static TEMTADS classification survey was conducted to classify each detected anomaly as a potential TOI or a high-confidence non-TOI. The potential-TOI classification includes high-confidence TOI (Category 1), inconclusive targets, or those for which a confident determination could not be made (Category 2), and those which could not be analyzed, that is the data did not allow accurate modeling of the anomaly source (Category 3). The static classification survey was conducted from April 24 through July 10, 2017, and included measurement of 5,021 targets. The static survey involved placing the TEMTADS over each detected anomaly location and acquiring an extended measurement while each TEMTADS transmitter was energized in sequence. Responses were recorded at every receiver coil. Data acquisition was completed in accordance with the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c), and the Broadway Bypass SSWP (KEMRON, 2017b), including verification of successful attainment of MQO.

Data acquisition procedures included the following steps, which are described in detail in SOP AGCMR-07 (AGCMR-QAPP, Appendix B; KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c):

1. **Background measurement acquisition.** Static TEMTADS data was acquired at previously-identified background locations, free of metallic interference. Background measurements recorded the non-target system response, including responses from the ambient environment, soil and geologic features, and the TEMTADS system itself. During data processing, the background signal was removed from target anomaly measurements, leaving only the response from the source of each anomaly. Background measurements

were collected at a minimum of once every 2 hours during data acquisition activities to provide background signatures representative of changing target locations and environmental conditions.

2. **Navigation to the anomaly location**. Anomaly locations were flagged utilizing RTK-GPS prior to data acquisition operations. The center of the sensor was precisely positioned (within 2 inches) over the flagged anomaly location for measurement recording.

3. **Static anomaly measurement acquisition**. The static measurement acquisition process was initiated, taking care that the sensor was isolated from external sources of electromagnetic signals and remained stationary during the measurement process. Metal associated with the sensor and deployment platform (e.g., console, support structures) that could not be reasonably distanced from the sensor was kept in the same physical location with respect to the sensor as during background measurements.

4. **Acquired data integrity and quality verification.** Immediately after data acquisition, the integrity and quality of the data were verified by the data acquisition geophysicist by inspection of the TEMTADS data acquisition display to verify the following:

   - The data acquisition cycle completed properly
   - The transmit current for each transmitter was within the acceptable range (≥ 5.5 amps)
   - The decay curves measured by each receiver coil appeared reasonable and were not flat-lined or over-saturated
   - GPS and IMU information were recorded

5. **Field inversion**. Prior to moving from the initial data acquisition location, an abbreviated in-field inversion of the acquired data was performed to verify that the estimated horizontal target location was within 12 inches of the center of the TEMTADS sensor array to allow the best opportunity for valid inversion results. Several factors can contribute to offsets

between the initial target horizontal position and the center of the sensor array, including the following:

- Positioning errors in the initial detection survey
- Imprecision in the derivation of the anomaly position from the detection survey data
- Imprecision in the reacquisition of the anomaly
- Imprecision in positioning the sensor
- The presence of multiple anomaly sources in relatively close proximity

If the anomaly source location estimated by the in-field inversion algorithm was greater than 12 inches from the center of the TEMTADS array, the sensor was re-positioned over the modeled target location provided by the in-field inversion, and a new measurement was acquired.

3.8.2 Classification Data Processing and Analysis

Processing and analysis of the classification survey data, including verification of successful attainment of MQO, were accomplished by NAEVA data processors using Geosoft's Oasis Montaj UXA software, in accordance with Section 2.5.3 of the Broadway Bypass SSWP (KEMRON, 2017b). Classification survey data from each measured anomaly were processed, modeled, and classified to determine if the item was safe to leave in place or was a potential TOI to be intrusively investigated and removed.

After applying background corrections, which were derived from the static background measurements acquired throughout the day, each static TEMTADS measurement was modeled to estimate the intrinsic and extrinsic features of the target anomaly source using the UXA process data interface. The modeled features for each anomaly include extrinsic parameters, such as location and orientation, as well as the intrinsic parameters related to the object size, shape and composition. The target feature estimation process was accomplished through inversion modeling of the static TEMTADS data. Inversion modeling involves proposing and testing multiple combinations of potential targets and locations to determine which combinations produce a result most-similar to the measured data for each anomaly. Both single-target and multi-target inversion routines were applied to determine the parameters of each target source (single-target inversion), or of each group of target sources (multi-target inversion), that would produce a response similar to each measured response. The modeled intrinsic parameters are visualized as three principal axis polarizabilities, also known as betas (β), which describe the EMI response of each target along the three principle axes of the item. The combination of principal axis polarizabilities is unique to a particular item, and is therefore used for classification by comparing the modeled polarizabilities to a library containing the measured polarizabilities of representative munitions items. Size and decay parameters of each anomaly at specific timegates were also calculated.

The single-target inversion solves for a single target as the anomaly source, while the multi-target inversion assumes that the measured response is the result of multiple sources. The multi-target solver not only presupposes multiple sources contributing to a measured anomaly response but also produces many potential combinations of targets. Each potential combination proposes a configuration of targets whose combined modeled response reasonably fits the measured data. For example, one potential combination may have three targets, while a second potential combination for the same measurement may have two or four targets. This process reflects the fact that, with an unknown number of potential anomaly sources of different sizes and shapes, a number of different models can closely match the measured data. A separate fit coherence value, which measures the degree of fit between the modeled and measured data, is derived for each potential multiple-target combination as well as for the single target model.

An example inversion fit summary, showing single-source and multiple-source modeled primary axis polarizabilities of the items contributing to an anomaly response, is shown on Figure 8. Inversion model results were only used for classification after verification that they met the MQO in Worksheet 22 of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c).

3.8.2.1 Daily IVS

At the beginning and at the end of each day of data acquisition, cued measurements were acquired at each IVS target location, as described in SOP AGCMR-02 (AGCMR-QAPP, Appendix B; KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). The IVS measurements were processed as described above, and the derived features were assessed against the MQO presented in Worksheet 22 of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). The results are documented and summarized in the Follow-on IVS Checklists included in Appendix A.

3.8.2.2 Data Verification

Data verification was conducted each day of data acquisition to demonstrate the achievement of project MQOs. Prior to importing TEMTADS data into UXA, the data processor specified general settings in UXA to define the data acquisition parameters for the survey, including settings such as survey mode (static or dynamic), database names, and distance units. After initial setup of the UXA project, the data processor imported data into the following four separate databases:

- Cued background measurement data
- Background features
- Cued anomaly measurement data
- Target features

The target features database initially contained the locations of each surveyed anomaly but was subsequently populated with summaries of the derived feature and classification information for each target. The background features database initially contained the locations of each background measurement but was subsequently populated with statistics and quality control check values.

After importing the static classification data, the data processor verified the quality of the measurements against the MQO provided in Worksheet 22 of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c), for the following characteristics:

- Transmit (Tx) current within limits
- GPS fix quality
- Valid IMU data

- EMI response signal not saturated
- Offset of acquisition location from flag/anomaly list location

A preliminary library match using the single source modeled parameters was performed as part of data verification to assist in determining the usability of the data and to verify that cued classification survey MQOs were satisfied.

Graphic decision plots displaying a summary of measured and modeled data associated with each cued measurement were evaluated along with the target features database for the following:

- Tx current
- Valid GPS fix
- Valid IMU reading (or correctable based on field notes)
- Offset from flag within MQO
- Acceptable fit error
- Fit coherence within MQO
- Reasonable size and decay
- Successful library match

If any readings failed to meet the MQOs, a request for re-collection was sent to the field crew along with the reason for re-collection, such as a request for the instrument to be located closer to the apparent source. Only measurements (including re-collections) that satisfied the MQO were used for classification analysis.

3.8.2.3 Classification Library Validation

The library of source item signatures used for classification was based on the standard UXA classification library. On-going validation of the classification library was conducted through analysis of the daily IVS survey measurements and, later, through analysis of QC seed item measurements and comparison of intrusive investigation results against the modeled classification results. The data validation process is described in the Geophysical Classification Validation Plan (Appendix E).

3.8.2.4 Initial Classification

Classification of targets was based upon objective, quantitative criteria. Using these criteria, a prioritized list was created with high-likelihood TOI placed at the top of the list and high likelihood non-TOI placed at the bottom of the list. Targets for which the measured data could not support classification modeling were labeled "cannot analyze". Because it was not possible to identify targets that could not be analyzed as non-TOI, they were placed above the high-likelihood TOI at the top of the prioritized list and excavated. The primary method for classification was library matching, supplemented by cluster analysis and feature space analysis.

Library Matching

Classification was based primarily on the fit metric (values from 0.0 to 1.0, with 1.0 representing a perfect match) generated by UXA during a comparison of the β values estimated for each surveyed target and the β values of the TOI items in the classification library. The comparison was performed via the library match utility in UXA. The fit metric is a measure of the fit correlation between a target and the library entry that best matches that target, with higher values indicating a better fit between the target and the corresponding item in the library. The library fit analysis matches the following four combinations of βs to those of the candidate library TOI:

- β1, β1/β2, β1/β3
- β1, β1/β2
- β1/β2, β1/β3
- β1

The confidence metrics for each potential fit combination were averaged to derive a decision statistic metric, which is the final measure of the library match comparison and the basis for classification decisions and ranking of the targets.

Both single-source and multiple-source models were used during the inversion process for each anomaly location. The results of all the models were compared against the library signatures, and the most conservative result, or the result most similar to a TOI, was selected. Once completed, the targets were ordered, or ranked, from TOI to non-TOI based on their decision statistic values. Decision statistic values below the project decision metric threshold, which is discussed in Section 3.8.2.5, were considered high-confidence non-TOI.

At the onset of classification data analysis, a small number of training digs were selected from the classified targets for intrusive investigation. The intrusive investigation results of the 61 training digs, as well as the decision metrics derived for other known TOI (IVS and QC seed items), were used to determine the final classification criteria and decision metric threshold.

Cluster Analysis and Feature Space Analysis

Cluster analyses were performed using the UXA scatter analysis utility to identify potential clusters of anomalies with similar β signatures not represented by an entry in the classification library and to demonstrate confidence in the classification process. The same library matching method described above was used, but rather than using the known TOI signature library, a "self-match" of each measured anomaly was performed. Cued measurements with high cluster threshold confidence metrics were identified and reviewed along with a size-decay feature space plot to determine if the similar source responses were related to a grouping of unique signatures representing a TOI not included in the initial classification library. For each identified cluster, the data processor selected a representative sample to be intrusively investigated. If the intrusive investigation identified a potentially hazardous item that should be on the TOI list, a representative signature would have been placed in the site-specific library, and the library matching process would have been repeated to ensure that all items with similar β signatures were classified as TOI. No additional TOI requiring placement in the munitions library were identified during the cluster analysis.

Individual items not matching any library items but having β signatures indicating large, axially-symmetric, thick-walled objects were also identified and investigated as part of the training data, and would have been added to the library if they were determined to be TOI. No additional TOI requiring placement in the munitions library were identified during the feature space analysis.

3.8.2.5 Classification Thresholds

Threshold selection values were established based on the initial IVS survey and test pit results and evaluated during preliminary library matching and cluster analysis. Intrusive investigation results were regularly analyzed to verify that the optimal classification expressions, which contained the logic for sorting the ranked target list, were being used. The classification expressions sorted each modeled anomaly source into one of the following categories:

- Category -1 (Training Digs)
- Category 0 (Cannot Analyze)
- Category 1 (High-Confidence TOI)
- Category 2 (Inconclusive)
- Category 3 (High-Confidence Non-TOI)

Category 0 (cannot analyze) anomalies included measurements where the inversion process failed, reliable polarizabilities could not be extracted from the data, modeled depths were unreasonable, or fit coherence was poor. Category -1 anomalies (training digs), as described in Section 3.8.2.4, were selected to refine the classification process and selection thresholds based on the results of the intrusive investigation of a small quantity of anomalies. Category 1 anomalies were those highly-likely to be TOI. Category 2 (inconclusive) anomalies consisted of measurements not obviously TOI but with enough TOI characteristics that they could not be classified as high-confidence non-TOI. Category 3 anomalies were those highly likely to be non-TOI. The following decision statistic metric thresholds were used for initial classification of the anomalies:

- Category 1 (High-Confidence TOI) > 0.955
- Category 2 (Inconclusive) > 0.9
- Category 2 (Inconclusive, Low Signal) > 0.75
- Category 0 (Cannot Analyze) – Signal amplitude must be > 2

- Poor Fit Coherence < 0.8
- Unreasonable Depth > 2 meters

The classification thresholds were selected to eliminate as many unnecessary digs as possible while maintaining high confidence that all TOI were identified and recovered. The thresholds were based on industry standard values adjusted (within an acceptable range of those values) to accommodate site conditions such as the signal to noise ratio of the collected data so that lower signal targets were classified more conservatively. The classification thresholds utilized were validated through verification and validation digs, as described in Section 6.2.

3.8.2.6 Final Classification

After all target measurements were acquired and analyzed, a preliminary ranked list containing all anomalies was delivered to the QC Geophysicist to determine if all relevant MQOs (including QC seed classification) were met, and a final review of the ranked list was performed to generate the prioritized target list, which is included in Appendix D. Final classification and ranking were based on the decision statistic values but were adjusted for individual anomalies according to specific target response characteristics as discussed in Section 3.8.2.4. The final ranked classification list included a stop-dig point at the lower limit of the Category 2 targets. All remaining Category 3 targets were classified as high-confidence non-TOI and identified as safe to leave in place. From the 5,021 detection flag locations, 5,216 individual anomaly source locations were modeled, 3,041 of which were classified as high-confidence non-TOI and determined to be safe to leave in place. The remaining 2,175 anomaly source locations were selected for intrusive investigation. Classification survey results are discussed in Section 4.2, and the intrusive investigation target locations are presented on Figure 9.

3.9 Intrusive Investigation and Subsurface Removal

As discussed in Section 3.8.2.6, 3,041 anomalies were classified as high-confidence non-TOI and determined to be safe to leave in place. The remaining 2,175 anomalies, including those identified for intrusive investigation as training digs (Category -1), those that could not be analyzed due to data quality (Category 0), those classified as high-confidence TOI (Category 1), and those for which a confident non-TOI classification could not be made (Category 2), were identified for intrusive investigation and removal. An additional set of 104 high-confidence non-TOI (Category

3) anomalies were also selected for intrusive investigation as part of the validation process, as discussed in Section 6.2.5.

3.9.1 Target Reacquisition

Reacquisition of the 2,175 targets identified for intrusive investigation was conducted by a reacquisition team composed of one NAEVA geophysicist and one UXO Technician II, in accordance with Appendix B (SOP AGCMR-09, Anomaly Reacquisition and Intrusive Investigation) of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). Anomalies were reacquired using an RTK-GPS and marked with a non-metallic survey flag at the modeled target location derived through the data processing and classification process. Each target location was reacquired with accuracy within 1 inch.

3.9.2 Intrusive Investigation and Removal of Anomaly Sources

Anomalies identified for subsurface removal from the TEMTADS classification survey were intrusively investigated to identify each anomaly source. Intrusive investigation and subsurface MEC removal were conducted by a UXO dig team consisting of one UXO Technician III, one UXO Technician II, and two UXO Technician Is. The initial 61 training digs were intrusively investigated July 17 through July 19, 2017, the remainder of the dig list targets were intrusively investigated between September 13, 2017 and February 21, 2018, and the 104 QA validation digs discussed in Section 6.2.5 were intrusively investigated May 14 and May 15, 2018.

The UXO dig team intrusively investigated each reacquired anomaly using the general safety and excavation procedures described in Attachment C (UXO SOP 4, Intrusive Investigation of DGM Targets) of the QAPP with modifications described in Appendix B (SOP AGCMR-09, Anomaly Reacquisition and Intrusive Investigation) of the AGCMR-QAPP (KEMRON, 2016b). Each excavation was conducted in the immediate vicinity of the reacquired target location, with an approximate search radius of 10 inches. The investigation proceeded until the predicted item (or a metallic item of comparable size and shape) was recovered or until the excavation depth reached 12 inches below the predicted depth (to the center of mass of the target item). Post-investigation anomaly resolution was verified by comparing the modeled classification predictions (predicted item, identity, and depth) to the actual intrusive investigation results.

If an investigated subsurface contact proved to be MD, range-related debris (RRD), or other debris, visible metal was removed, and the excavation was rechecked by the UXO dig team to verify that the area had been cleared. If MEC or material potentially presenting an explosive hazard (MPPEH) were identified during the investigation, the items were treated in accordance with procedures detailed in Attachment C (UXO SOP 6, MEC and MPPEH Management) of the QAPP (KEMRON, 2016a). Each MEC/MPPEH item identified by the UXO dig team was recorded and tracked by item type, description, weight, and recovery depth. The recovery location of each MEC/MPPEH item was recorded with RTK-GPS.

3.9.3 Disposition of Munitions and Explosives of Concern and Munitions Debris

During the course of the Broadway Bypass remedial action, 6 MEC items were destroyed by detonation. All procedures for demolition operations included in the QAPP (KEMRON, 2016a) and the Broadway Bypass SSWP (KEMRON, 2017b) were followed. All items were destroyed by detonation, and details, including the date and result of demolition operations, are included in the Fort Ord MMRP database. MD and material documented as safe were disposed of in accordance with the QAPP (KEMRON, 2016a).

3.10 Environmental Protection

The Broadway Bypass remedial action area is within the Natural Resource Management Area designated for transfer to BLM as undeveloped habitat reserve. Habitat reserve areas support plant and animal species protected under the Endangered Species Act and require implementation of mitigation measures identified in the HMP (USACE, 1997) and the *Programmatic Biological Opinion for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California* (United States Fish and Wildlife Service [USFWS], 2017) to minimize potential adverse impacts to listed species. The Broadway Bypass remedial action area consists primarily of central maritime chaparral (CMC) vegetation and contains numerous protected species listed in the HMP. The vegetation and HMP species present within the remedial action area are described in Section 2.3.1.

Remedial action activities conducted within Broadway Bypass included selective mowing of chaparral vegetation and vehicle use to support vegetation removal, DGM, subsurface MEC removal, and debris removal. Mitigation and environmental protection measures to reduce impacts to protected species during MEC remedial actions are described in the HMP (USACE, 1997) and the Programmatic Biological Opinion provided by the USFWS (USFWS, 2017). Prior to the remedial action, a Site Habitat Checklist outlining specific avoidance and minimization measures was prepared by the Project Biologist and reviewed with all personnel involved in remedial action activities (KEMRON, 2016c). Additionally, an Employee Education Program was conducted for all supervisors and field personnel by the Project Biologist prior to working on the site. Training included information on rare, threatened, and endangered species on the site, including a description of the species, their protected status, a list of measures to be implemented to avoid and reduce impacts to these species and their habitat, and contact information to report unintentional impacts to HMP species. Avoidance and minimization measures implemented during the project are summarized below:

- Minimize Disturbance Associated with Ordnance and Explosives Removal: Disturbances were limited to those required for the activities mentioned above. To minimize impacts to the habitat, the existing road surface was used for vehicular traffic with the exception of where it was necessary to traverse the approximately 15-foot wide off-road area on either side of the fuel break road in order to remove vegetation, conduct DGM, access excavation sites, and remove recovered debris. Staging areas and the IVS were sited to avoid impacts to HMP plant and wildlife species.

- Avoid Disturbance of Sand Gilia, Monterey Spineflower, Yadon’s piperia, and Seaside Bird’s-Beak Populations.

- Minimize Impacts to Black Legless Lizard: Supervisors and field personnel were trained during the Employee Education Program to identify black legless lizard and were informed of the potential for this species to occur within the Broadway Bypass remedial action area and of the established protocol if individuals were encountered. No black legless lizards were observed during remedial action activities.

- Minimize Impacts to California Tiger Salamander: Supervisors and field personnel were trained during the Employee Education Program to identify California tiger salamander and were informed of the potential for this species to occur within the Impact Area MRA and of the established protocol if individuals were encountered. No tiger salamanders were observed during remedial action activities.

- Invasive Weed Control: To reduce the spread of invasive weeds, all equipment coming from off-site was pressure-washed prior to entering habitat reserve areas.

- Erosion Control: To reduce the potential for increased erosion due to remedial action activities, normal vehicle access was restricted to the existing Broadway Bypass road except where necessary to remove vegetation, conduct DGM, access excavation sites, and remove recovered debris. DGM surveys were completed utilizing a person-portable DGM system to avoid unnecessary vehicular traffic in off-road portions of the remedial action area.

4.0 Results

4.1 Dynamic Survey Results

Based on the response amplitudes from the dynamic TEMTADS detection data, 5,021 subsurface anomalies were identified for further investigation. The detected anomalies are displayed on Figure 7.

4.2 Classification Results

Each of the 5,021 detected flag locations was investigated by TEMTADS classification survey and analysis. Inversion modeling of the static survey data measured at the 5,021 detection flag locations resulted in the identification of 5,216 individual modeled anomaly source locations. Classification analysis of the static survey data resulted in the identification of 2,175 targets for intrusive investigation and 3,041 anomaly source locations classified as high-confidence non-TOI and therefore safe to leave in place. A summary of the classification results is presented in Table 4.

Table 4
Classification Category Summary

Classification Category	Quantity	Dig/Do Not Dig
Category -1 (Training Digs)	61	Dig
Category 0 (Cannot Analyze)	12	Dig
Category 1 (High-Confidence TOI)	291	Dig
Category 2 (Inconclusive)	1,811	Dig
Category 3 (High-Confidence Non-TOI)	3,041	Do Not Dig
TOTAL	5,216	

4.3 Subsurface Removal Results and Summary of Recovered MEC

Intrusive investigation and subsurface removal results indicated that a majority of TOI recovered during intrusive investigation were Category 1 (high-confidence TOI), and the remainder were Category 2 (inconclusive), with 30 recovered TOI coming from Category 1 targets (1 of which was intrusively investigated as a training dig) and 20 recovered TOI coming from Category 2 targets. Correlation between predicted anomaly sources and intrusive investigation results was good in terms of general mass of recovered items, but the high density of subsurface metal, particularly 50cal small arms and assorted MD components resulted in only 2.3% of investigated anomalies with TOI sources. However, 47.7% of investigated anomalies resulted in the recovery of some form of MD, and 58.5% resulted in the recovery of 50cal small arms.

4.3.1 Recovered TOI

Intrusive investigation of the 2,175 training, Category 0, Category 1, and Category 2 targets resulted in the recovery of 50 TOI, including one rocket motor, one illumination signal, 12 57mm HE projectiles, four 60mm mortar HE projectiles, 15 81mm mortar HE projectiles, two 105mm projectiles, and one 155mm projectile. Six of the recovered TOI were UXO, while 30 were MD. MD items with the physical structure of a MEC item, including the remains of projectiles that had functioned as designed or were partially disassembled on impact but were still identifiable as a specific size projectile (even if the type and model could not be confidently determined), were considered TOI regardless of the presence or absence of explosive content. The remainder of the recovered TOI included 10 QC seed items (small ISO-80) and 4 validation seed items (inert 40mm projectiles). TOI subsurface removal results are summarized in Table 5, and the locations of the recovered TOI are displayed on Figure 10. Locations of recovered MEC items are shown on Figure 11.

Table 5

Recovered Target of Interest Summary

Item	Quantity Recovered	Successfully Identified for Intrusive Investigation	Category -1[1]	Category 1[2]	Category 2[3]	MEC	MD[4]
Rocket Motor	1	1	0	1	0	0	1
Signal, Illumination	1	1	0	1	0	0	1
Projectile, 57mm, HE, M306 series	12	12	0	4	8	3	9
Projectile, 60mm, mortar, HE, M49 series	4	4	0	3	1	3	1
Projectile, 81mm, mortar, model unknown	15	15	0	7	8	0	15
Projectile, 105mm, model unknown	2	2	0	2	0	0	2
Projectile, 155mm, model unknown	1	1	0	0	1	0	1
QC Seed	10	10	0	9	1	N/A	N/A
Validation Seed	4	4	1	2	1	N/A	N/A

[1] Category -1 = Training Dig

[2] Category 1 = High-Confidence TOI

[3] Category 2 = Inconclusive

[4] Specific model and filler designations are listed for MEC items only. Specific model and filler designations for recovered MD items, including the remains of projectiles that had functioned as designed or were partially disassembled on impact but were still identifiable as a specific size projectile, are unknown.

Information regarding the six recovered MEC items, all of which were identified as UXO, is summarized in Table 6. Five of the six recovered UXO items were positively classified as Category 1 (high-confidence TOI) in the classification analysis, while 1 was classified as a Category 2 (inconclusive) target. The Category 2 target, which resulted in the recovery of a 57mm HE projectile, M306 series, was ranked high on the Category 2 portion of the dig list (at overall rank 405), and likely was not included in Category 1 primarily due to a lower decision statistic confidence caused by a weaker signal associated with its depth of 12 inches bgs, which is relatively deep for a 57mm projectile.

Table 6
Recovered Munitions and Explosives of Concern Summary

Flag ID	Grid ID	Easting[1]	Northing[1]	Type	Model Description	Recovery Depth (inches)	Classification Category[2]
1005	BB001	5742139.649	2118594.433	UXO	Projectile, 57mm, HE, M306 series	3	1
4013	BB004	5742229.664	2118857.468	UXO	Projectile, 57mm, HE, M306 series	12	2
5005	BB005	5742186.228	2118924.833	UXO	Projectile, 57mm, HE, M306 series	7	1
7004	BB007	5742141.735	2119127.622	UXO	Projectile, 60mm, mortar, HE, M49 series	24	1
7045	BB007	5742152.031	2119135.108	UXO	Projectile, 60mm, mortar, HE, M49 series	7	1
8014	BB008	5742126.288	2119208.535	UXO	Projectile, 60mm, mortar, HE, M49 series	6	1

[1] Coordinates reported in NAD83, California State Plane, Zone 4, US survey feet

[2] Classification Category 1 = High-Confidence TOI; Classification Category 2 = Inconclusive

4.3.2 Non-TOI in Category 1

Of the 291 anomalies classified as Category 1 (high-confidence TOI), 30 resulted in the recovery of TOI, although 1 was investigated as a training dig. The remaining Category 1 targets had non-TOI sources, nearly all of which were reported as 50cal small arms, assorted MD components, or shared targets where the anomaly source was recovered midway between two flagged anomalies.

4.3.3 TOI in Category 2

The majority of Category 2 (inconclusive) anomalies resulted in the recovery of non-TOI, as expected, with only 20 of the 1,811 Category 2 anomalies resulting in the recovery of TOI. The lowest-ranked anomaly (flag ID 14012) that resulted in the recovery of a TOI was ranked 1,742 of the 2,175 intrusive investigation targets. The final recovered TOI was an 81mm mortar MD item, which was buried 3 inches bgs. The decision metric statistic for this item was 0.9189. The 360 targets ranked lower on the intrusive investigation list all resulted in the recovery of non-TOI. The verification and validation investigation results discussed in Section 6.2, in conjunction with the results of the Category 2 intrusive investigations, confirm that the classification thresholds were appropriately selected, with enough deliberate conservativeness to provide confidence in the results of the remedial action, as discussed in Section 6.2.

5.0 Quality Control

Quality control of TEMTADS data, processing and classification was conducted by NAEVA geophysicists experienced in geophysical classification work. Data that had undergone quality verification by the data processor was validated prior to data processing and classification. The QC Geophysicist validated the data quality by monitoring the data for agreement with the MQOs in Worksheet 22 of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c), and returned the data to the data processor for completion of data classification. The QC Geophysicist also validated the completeness and quality of the site-specific classification library. The data processing, classification, and ranking process was verified against the MQOs in Worksheet 22 by the QC Geophysicist prior to finalization of the ranked classification dig list.

5.1 Blind Seeding Program

As described in Section 3.3, ten small ISO-80s were placed at depths between 4 and 6 inches bgs as blind QC seed items. All QC seed items were identified for subsurface removal on the ranked classification dig list and recovered during subsurface removal operations in accordance with the seed item recovery MQO established in Worksheet 22 of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). Nine of the 10 QC seed items were classified as Category 1 (high-confidence TOI), while one (BB006G) was included in Category 2 with a decision metric statistic of 0.9516 and a rank of 379 of the 2,175 intrusive investigations. The QC seed item recovery information is summarized in Table 7, and the locations are displayed on Figure 12. QC seeding was planned in anticipation of encountering at least one seed item during each day of cued classification data acquisition and approximately 5 seed items during each day of dynamic data acquisition. Due to slower than anticipated data acquisition rates and more targets for static measurement than anticipated, however, the actual average QC seed item encounter rate was 2/day for the dynamic detection survey and 0.22/day for the static classification survey. A detailed discussion of the QC seeding program is provided in the Quality Control Seeding Report (Appendix B).

Table 7

Quality Control Seed Item Information

Seed ID	Target ID	Item	Burial Depth (inches)[1]	Orientation	Predicted Location Offset (inches)[2]
BB001G	2065	Small ISO-80	5.9	Vertical	2.82
BB002G	4068	Small ISO-80	3.9	Horizontal	1.76
BB003G	6108	Small ISO-80	5.1	45 Degrees	1.95
BB004G	8035	Small ISO-80	5.9	Vertical	2.54
BB005G	10015	Small ISO-80	4.3	Horizontal	1.27
BB006G	12040	Small ISO-80	5.5	45 Degrees	3.76
BB007G	14004	Small ISO-80	5.9	Vertical	1.03
BB008G	16016	Small ISO-80	3.9	Horizontal	1.08
BB009G	18021	Small ISO-80	5.1	45 Degrees	1.39
BB010G	20013	Small ISO-80	5.9	Vertical	0.43

[1] Burial depth information is reported to the center of mass of the item bgs.
[2] QC seed item recovery offsets are provided to demonstrate compliance with the MQO established in Worksheet 22 of the AGCMR-QAPP, with modification by FWV 009 (KEMRON, 2017c) (all predicted seed item locations within 10 inches of the known locations).

5.2 Measurement Quality Objectives

The MQO for dynamic and static TEMTADS data acquisition, processing and analysis are presented in Worksheet 22 of the AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c), (including MQO for daily IVS performance as well as for individual measurement metrics). Performance relative to the MQO was assessed during the processing and analysis of the data. TEMTADS data were not used for target detection or classification until compliance with the MQO was verified. Performance relative to key MQO is shown in Table 8.

Table 8
Measurement Quality Objective Performance

TEMTADS Sensor Function Test Measurement Quality Objective Performance				
Measurement Quality Objective	**DFW/SOP Reference[1]**	**Frequency**	**Acceptance Criteria**	**Performance**
Initial sensor function test (five measurements over an emplaced IVS item, 1 with item directly under center of array and 1 each with item centered under each diagonal quadrant of the array). Modeled locations are compared to the known locations of the ISO for each measurement. Note that the preferred sensor function test procedure described in SOP AGCMR-01 does not include acceptance criteria in AGCMR-QAPP WS #22. A successful test is documented by display of a green light on the data acquisition tablet.	Dynamic Detection Survey and Cued Classification Survey/ SOP AGCMR-01/ SOP AGCMR-08	Once following assembly	Modeled location of each measurement is under the correct quadrant of the TEMTADS sensor array	The preferred function test method described in SOP AGCMR-01 utilizing the ISO80 mounted on the sensor platform resulted in a successful test. The displayed green light on the data acquisition tablet verified that the test results agreed with the reference values.
Dynamic TEMTADS Detection Survey Measurement Quality Objective Performance				
Initial derived target position accuracy – dynamic IVS	Dynamic Detection Survey/ SOP AGCMR-02/ SOP AGCMR-05/ SOP AGCMR-06	Once during initial system IVS test	All IVS item fit locations within 10 inches of ground truth locations	IVS items ACIVS01 and ACIVS02 were located with offsets of 7.1 inches and 1.2 inches, respectively.
Initial detection response amplitudes – dynamic IVS	Dynamic Detection Survey/ SOP AGCMR-02/ SOP AGCMR-05/ SOP AGCMR-06	Once during initial system IVS test	Response amplitudes within 25% of predicted (or baseline) amplitudes	Baseline IVS item response amplitudes for ACIVS01 and ACIVS02 were established during the initial IVS survey at 30.95mV/amp and 27.75mV/amp, respectively.
Ongoing derived target position precision – dynamic IVS	Dynamic Detection Survey/ SOP AGCMR-02/ SOP AGCMR-05/ SOP AGCMR-06	Twice daily, at the beginning and end of data acquisition, as part of IVS testing	All IVS item fit locations within 10 inches of the average locations	All ongoing derived target positions for ACIVS01 and ACIVS02 were within 7.1 inches and 7.5 inches of the baseline location, respectively.

Ongoing detection response precision – dynamic IVS	Dynamic Detection Survey/ SOP AGCMR-02/ SOP AGCMR-05/ SOP AGCMR-06	Twice daily, at the beginning and end of data acquisition, as part of IVS testing	Response amplitudes within 25% of the predicted response amplitude	All ongoing response amplitudes for ACIVS01 and ACIVS02 were within 13.9% and 17.1% of the baseline response amplitude, respectively.
Down-line measurement spacing – dynamic	Dynamic Detection Survey/ SOP AGCMR-05	Verified for each survey unit using existing UX Detect tools based upon monostatic Z coil data positions	98% ≤ 8 inches between successive measurements	99.8% of downline measurement spacing was ≤ 8 inches.
Coverage	Dynamic Detection Survey/ SOP AGCMR-05	Verified for each survey unit using existing UX Detect tools based upon GPS antenna positions	95% (or greater) of the line spacing within 2 ft., and 100% of the line spacing within 2.6 ft., with no unexplained data gaps.	>95% of the line spacing was within 2 feet and 100% of the line spacing was within 2.6 feet, with no unexplained data gaps.
Transmit current levels – dynamic	Dynamic Detection Survey/ SOP AGCMR-05	Evaluated for each sensor measurement	Peak transmit current ≥ 5.5 amps	All transmit current levels were ≥ 5.5 amps.
Dynamic detection performance	Dynamic Detection Survey/ SOP AGCMR-05/ SOP AGCMR-06	Evaluated for each dataset	All blind seed items detected and positioned within 16-inch radius of ground truth location	All blind seed items were detected and positioned within 10.1 inches.
Position data are valid – dynamic (1 of 2)	Dynamic Detection Survey/ SOP AGCMR-05/ SOP AGCMR-06	Evaluated for each sensor measurement	GPS status flag indicates RTK fix	All sensor measurements used for target detection were acquired with RTK fix.
Position data are valid – dynamic (2 of 2)	Dynamic Detection Survey/ SOP AGCMR-05/ SOP AGCMR-06	Evaluated for each sensor measurement	Orientation data valid Data input string checksum passes	Orientation data was valid and the data input string checksum passed for all sensor measurements used for target detection.
Static TEMTADS Classification Survey Measurement Quality Objective Performance				
Initial IVS background measurement (five background measurements – 1 centered at the flag and 1 offset 15 inches in each cardinal direction)	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Once during initial system IVS test	Decay amplitudes are below the selected background threshold at each offset background location	Decay amplitudes at each offset IVS background location were below the project threshold.

Initial derived polarizabilities accuracy – static IVS	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Once during initial system IVS test	Library Match metric ≥ 0.9 for each set of inverted polarizabilities	The derived polarizabilities of IVS items ACIVS01 and ACIVS02 from the initial IVS survey matched the classification library item with decision statistics of 0.9980 and 0.9989, respectively.
Initial derived target position accuracy – static IVS	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Once during initial system IVS test	All IVS item fit locations within 5 inches of ground truth locations	The fit locations of IVS items ACIVS01 and ACIVS02 were within 0.54 and 0.63 inches inches of ground truth locations, respectively.
Ongoing IVS background measurements – static IVS	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Twice daily as part of IVS testing	All decay amplitudes lower than project threshold and qualitatively agree with initial measurement	All ongoing IVS background measurement decay amplitudes were lower than the project threshold and qualitatively agreed with initial measurement.
Ongoing derived polarizabilities precision – static IVS	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Twice daily as part of IVS testing	Library match to initial polarizabilities metric ≥ 0.9 for each set of three inverted polarizabilities	The derived polarizabilities of IVS items ACIVS01 and ACIVS02 from ongoing IVS surveys matched the classification library item with decision statistics of at least 0.9950 and 0.9925, respectively.
Ongoing derived target position precision – static IVS	Cued Classification Survey/ SOP AGCMR-02/ SOP AGCMR-07/ SOP AGCMR-08	Twice daily as part of IVS testing	All IVS item fit locations within 5 inches of average of derived fit locations	All ongoing derived target positions for ACIVS01 and ACIVS02 were within 1.5 inches and 0.9 inches of the baseline location, respectively.
Initial measurement of production area background locations	Cued Classification Survey/ SOP AGCMR-04/ SOP AGCMR-08	Once per background location	All decay amplitudes lower than project threshold	All decay amplitudes for initial production area background measurements were lower than the project threshold.
Ongoing production area background measurement frequency	Cued Classification Survey/ SOP AGCMR-04/ SOP AGCMR-07	Evaluated for each background measurement	Time separation between background measurement and anomaly measurement < 2 hour	All anomaly measurements were acquired within 2 hours of a valid background measurement.

Ongoing production area background measurement	Cued Classification Survey/ SOP AGCMR-04/ SOP AGCMR-07/ SOP AGCMR-08	Evaluated for each background measurement	All decay amplitudes lower than project threshold and qualitatively agree with initial measurement	All decay amplitudes for ongoing production area background measurements were lower than the project threshold.
Transmit current levels – static	Cued Classification Survey/ SOP AGCMR-07	Evaluated for each sensor measurement	Peak transmit current ≥ 5.5 amps	All transmit current levels were ≥ 5.5 amps.
Initial anomaly (flag) location interrogated	Cued Classification Survey/ SOP AGCMR-07/ SOP AGCMR-08	Evaluated for each flag position	For each anomaly, a measurement must be acquired with the center of the array within 12 inches of the flag location.	All sensor measurements used for classification were acquired with the center of the array within 12 inches of the flag location.
Position data are valid – static (1 of 2)	Cued Classification Survey/ SOP AGCMR-07	Evaluated for each sensor measurement	GPS status flag indicates RTK fix	All sensor measurements used for classification were acquired with RTK fix.
Position data are valid – static (2 of 2)	Cued Classification Survey/ SOP AGCMR-07/ SOP AGCMR-08	Evaluated for each sensor measurement	Orientation data valid Data input string checksum passes	Orientation data was valid and the data input string checksum passed for all sensor measurements used for classification.
Confirm inversion model supports classification (1 of 2)	Cued Classification Survey/ SOP AGCMR-08	Evaluated for all models derived from a measurement (i.e., single item and multi-item models)	Derived model response must fit the observed data with a fit coherence > 0.8	All anomaly measurement used for classification fit the observed data with fit coherences >0.8.
Confirm inversion model supports classification (2 of 2)	Cued Classification Survey/ SOP AGCMR-08	Evaluated for derived target	Fit location estimate of item ≤ 15 inches from center of sensor	The fit location estimate for each derived target was within 15 inches of the center of the sensor.
Confirm all anomalies classified	Cued Classification Survey/ SOP AGCMR-08	Evaluated for each anomaly (flag) location	100% of anomalies are classified as: TOI/ Non-TOI/Inconclusive	All anomalies were classified and are included in the ranked target list (Appendix D).
Confirm reacquisition GPS accuracy and precision	Intrusive Investigation/ SOP AGCMR-09	Daily	Benchmark positions repeatable to within 3 inches	Benchmark positions recorded daily with the reacquisition RTK-GPS receiver were within 1.7 inches of known location positions.
Confirm derived features match ground truth (1 of 2)	Intrusive Investigation/ SOP AGCMR-09	Evaluated for all recovered items	95% of recovered item positions < 10 inches from predicted position	Greater than 95% of recovered item positions were within 10 inches of the predicted position.

Confirm derived features match ground truth (2 of 2)	Intrusive Investigation/ SOP AGCMR-09	Evaluated for all recovered seed items	100% of predicted seed item positions < 10 inches from known position	All QC seed item positions were within 10.5 inches of the known positions.
Classification performance	Intrusive Investigation/ SOP AGCMR-09	For each delivered dig list	100% of seed items classified as TOI	All seed items were classified as TOI.
Classification validation	Intrusive Investigation/ SOP AGCMR-09	For each delivered dig list	100% of predicted intrusively investigated non-TOI are confirmed to be non-TOI	All predicted intrusively investigated non-TOI were confirmed to be non-TOI.

[1] All SOP references have been modified by FWV 009 (KEMRON, 2017c) for TEMTADS DGM.

5.3 *Instrument Verification*

Initial system operation was verified by conducting the built-in TEMTADS system function test utilizing a small ISO-80 mounted on top of the sensor platform, as described in SOP AGCMR-01 (AGCMR-QAPP, Appendix B; KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). Transmit current levels were monitored in addition to verification of agreement between the test results and the reference values (indicated by the display of a green light on the data acquisition tablet).

After completion of the instrument tests, initial dynamic and cued IVS surveys were performed as described in SOP AGCMR-02 (AGCMR-QAPP, Appendix B; KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). The IVS consisted of two ISO-80 seed items (one buried vertically 5.9 inches bgs; one buried horizontally, perpendicular to the survey path, 3.9 inches bgs), one blank location, and a background line. The IVS location is shown on Figure 5, and details of item placement are listed in Table 3. A detailed discussion of the IVS construction and initial survey is provided in the Instrument Verification Strip Memorandum (Appendix C).

The initial dynamic IVS survey resulted in baseline response amplitude measurements for the two IVS items (ACIVS01 and ACIVS02) of 30.95mV/amp and 27.75mV/amp, respectively. The locations of the peak response values were within 7.1 inches and 1.2 inches of the known locations, respectively. The derived polarizabilities of IVS items ACIVS01 and ACIVS02 from the initial cued IVS survey matched the classification library item with decision statistics of 0.9980 and 0.9989, respectively. The fit locations of the items were within 3 inches of the known item locations.

On-going verification of the TEMTADS system performance was conducted through daily IVS surveys prior to and after completion of data acquisition activities.

5.4 Unexploded Ordnance Operations Quality Control

The UXOQCS was responsible for visually observation of UXO teams and periodic QC inspections to verify that work was being conducted in accordance with the QAPP (KEMRON, 2016a) and AGCMR-QAPP (KEMRON, 2016b), with modification by FWV 009 (KEMRON, 2017c). The UXOQCS also reviewed intrusive investigation results received from field personnel prior to entry in the Fort Ord MMRP database. Each entry was reviewed for completion of field QC, MEC and MD nomenclature, completion of grids, and ultimate disposition of MEC items. Daily QC forms are included in Appendix A.

6.0 Data Validation

Data validation activities were conducted throughout the course of the data acquisition, processing and analysis, and intrusive investigation activities. Validation activities are summarized in the sections below. The Geophysical Classification Validation Plan (Appendix E) presents details of the validation process, including a detailed description of the verification and validation digs selected for intrusive investigations. Results of the verification and validation investigations are presented in Section 6.2.

6.1 Validation Seeding

The QA Geophysicist placed four blind subsurface validation seed items across the Broadway Bypass remedial action area prior to TEMTADS data acquisition. The integrity of the validation seeding program was maintained by keeping validation seed item information unknown to the data acquisition, processing and analysis, intrusive investigation, and QC personnel until the initial classification results were submitted and the successful identification of all validation seed items was confirmed by the QA Geophysicist. Validation seed items were emplaced by the USACE Ordnance and Explosives Safety Specialist and the QA Geophysicist.

Validation seed items consisted of inert 40mm projectiles, and were placed at depths to 5.5 inches bgs. The validation seed item recovery information is summarized in Table 9, and the locations are displayed on Figure 13.

Table 9
Validation Seed Item Information

Seed ID	Easting[1]	Northing[1]	Item	Depth (in.)	Orientation	Target ID
BB-01	5742139.009	2120142.910	40mm projectile	5.5	E-W	17033
BB-02	5742185.140	2119759.335	40mm projectile	3	E-W	13022
BB-03	5742182.441	2118987.743	40mm projectile	5.5	vertical	6070
BB-04	5742192.339	2118710.671	40mm projectile	3.5	vertical	3028

[1] Coordinates reported in NAD83, California State Plane, Zone 4, US survey feet

All validation seeds were detected, successfully classified as potential TOI, included on the intrusive investigation list, and recovered during subsurface removal operations in accordance with the seed item recovery MQO established in Worksheet 22 of the AGCMR-QAPP (KEMRON, 2016b). One validation seed item (BB-01) was initially classified as Category 1 (high-confidence TOI) but was selected and intrusively investigated as a training dig, two (BB-02 and BB-04) were classified as Category 1 (high-confidence TOI), and one (BB-03) was included in Category 2.

6.2 Verification and Validation Investigations

Included in the targets selected for intrusive investigation and subsurface removal on the ranked classification dig list were verification and validation investigations, as described in the Geophysical Classification Validation Plan (Appendix E). These verification and validation investigations included the following:

- 360 library match threshold verification investigations
- 11 cluster analysis verification investigations
- 104 QA validation investigations

6.2.1 Library Match Threshold Verification Investigations

Intrusive investigation of 50 anomalies ranked immediately below the lowest-ranked TOI recovered from the ranked classification dig list was required to verify that the library match threshold was appropriately selected to identify the remedial action TOI. Included in the dig list were 360 Category 2 anomalies ranked lower than the last recovered TOI, each of which were investigated as part of routine intrusive investigation activities. This satisfied the requirement for intrusive investigation of 50 anomalies ranked immediately below the lowest-ranked recovered TOI.

6.2.2 Cluster Analysis Verification Investigations

Intrusive investigation of 25 of anomalies selected from anomaly clusters with similar, MEC-like response characteristics was required to verify that TOI were correctly classified. Fourteen of the initial training digs were selected as cluster-analysis investigations, and 11 additional cluster-analysis verification investigations were selected from target clusters not classified as TOI and added to the dig list.

6.2.3 Feature Analysis Verification

Verification of the feature analysis was accomplished through the library match verification and cluster analysis verification processes described in Sections 6.2.1 and 6.2.2. The intrusive investigation of at least 50 targets ranked below the final recovered TOI verifies that targets with features consistent with MEC items have been identified and classified as TOI. The intrusive investigation of 25 targets not classified as TOI but displaying βs clustered in the high amplitude, slow decay area of the feature space plot verifies that targets with MEC-like characteristics have been identified as TOI on the ranked classification list.

6.2.4 Modeled Depth Verification

The classification process resulted in a modeled depth of each classified target. Verification of modeled TOI depths is built into the processing and classification scheme. Recovery depths of all recovered items were recorded by the intrusive investigation team and compared to the modeled depths from the classification results to successfully verify that recovered TOI depths matched the modeled depths.

6.2.5 Quality Assurance Validation Investigations

After intrusive investigation of the dig list targets, the USACE QA Geophysicist selected 104 QA validation investigations as overall validation of the classification process. The validation investigations were selected from the high-confidence non-TOI (Category 3) targets. Of the 104 targets provided, 100 were primary validation investigations, and four were alternates to be investigated if any of the primary 100 could not be investigated. Prior to intrusive investigation, the Lead Data Processor delivered written rationale to the QA Geophysicist for the decision to classify each of the 104 anomalies as high-confidence non-TOI, and the explanations were validated against the intrusive investigation results, which were completed on May 14 and May 15, 2018. All 104 validation digs, including the four alternates, were intrusively investigated. The rationale for the validation dig classification decisions is provided in Appendix F.

6.2.6 Verification and Validation Investigation Results

All verification and validation investigations required by the AGCMR-QAPP (KEMRON, 2016b) were completed. No TOI were recovered from the verification and validation investigations. The successful completion of the verification and validation investigations constituted the final classification process validation.

7.0 Conclusions

7.1 Remedial Action Results

A total of 5,021 anomalies were identified from the dynamic TEMTADS detection survey that met the amplitude response characteristics of potential subsurface MEC items within the Broadway Bypass remedial action area. The TEMTADS advanced EMI sensor was utilized to acquire static data measurements over each identified anomaly. The static TEMTADS classification data was inverted and analyzed to estimate the intrinsic physical features of each anomaly source, allowing a comparison of the measured data to a TOI signature library and classification of each anomaly as a TOI or a non-TOI.

Inversion modeling of the static survey data measured at the 5,021 detection flag locations resulted in the identification of 5,216 individual modeled anomaly source locations potentially related to TOI. Classification analysis of the static survey data resulted in the identification of 2,175 targets for intrusive investigation and 3,041 anomaly source locations (over 60% of the detected anomalies) determined to be high-confidence non-TOI and therefore safe to leave in place.

During intrusive investigation of the 2,175 anomalies identified for subsurface removal, 50 TOI were recovered, including one rocket motor, one illumination signal, 12 57mm HE projectiles, four 60mm mortar HE projectiles, 15 81mm mortar HE projectiles, two 105mm projectiles, and one 155mm projectile. Six of the recovered TOI were UXO, while 30 were MD. The remainder of the recovered TOI included 10 QC seed items (small ISO-80) and 4 validation seed items (40mm projectiles).

No TOI were recovered from intrusive investigation of the verification and validation anomalies, demonstrating the validity of the classification process. Final classification and subsurface removal results are illustrated in the receiver operating characteristic (ROC) curve shown on Figure 14 and the decision statistic plot shown on Figure 15.

7.2 Accomplishment of Remedial Action Objectives

Based on the completion of the TEMTADS dynamic detection and static classification surveys, the associated subsurface removal of the identified TOI sources, and the demonstrated absence of TOI remaining in the detected anomaly population, the subsurface MEC removal required for the

Broadway Bypass remedial action has been successfully completed. The advanced classification approach allowed the completion of the subsurface MEC removal with a reduction in the number of excavations by determining that over 60% of the detected anomalies were high-confidence non-TOI prior to intrusive investigation and subsurface removal.

7.3 Final Conceptual Site Model

The results of the remedial action, including the identities, locations, and depths of recovered munitions items support the existing conceptual site model for the Impact Area MRA in general and for historical usage of the Broadway Bypass area in MRS Ranges 43-48 South. Data derived from the remedial action has been added to the existing Fort Ord GIS and MMRP database.

7.4 Lessons Learned

Two primary lessons learned during the Broadway Bypass remedial action have been documented and will be applied to future geophysical classification work using advanced sensors at Fort Ord. These lessons learned are summarized below:

- To confidently meet the requirement of detecting 37mm projectiles to a depth of 16 inches bgs, detection of subsurface anomalies was based on the summed monostatic Z-component measurements in the detection survey data rather than on the individual monostatic Z-component measurements from each TEMTADS receiver, as described in Section 3.6. Test pit measurements indicated that deep (16 inches bgs) 37mm projectiles have a low amplitude broad response similar to many of the smaller pieces of metal clutter throughout the Broadway Bypass area. The response from 37mm projectiles, however, was visible across all receivers of the TEMTADS, whereas the responses from smaller clutter items were not detected by all TEMTADS receivers due to their small size. Target selection was therefore based on a summation of the monostatic Z-component of the four receivers rather than on individual receiver values. The sum of the receiver measurements amplifies TOI responses which are detected across all receivers compared to smaller non-TOI responses which are detected on only one or two receivers. This allows a target selection approach that maximizes detection of TOI to the required depth while minimizing false positive target selection.

- While the remedial action utilizing the AGC approach was successful, the density of subsurface metallic clutter of similar shape and size to small TOI items resulted in less benefit of the classification approach than could be expected in areas of lower subsurface anomaly density. Slightly more than 60% of the detected subsurface anomalies were determined to be safe to leave in the ground without intrusive investigation. This information will be considered in the determination of which future remedial actions at Fort Ord would benefit from utilizing AGC.

8.0 References

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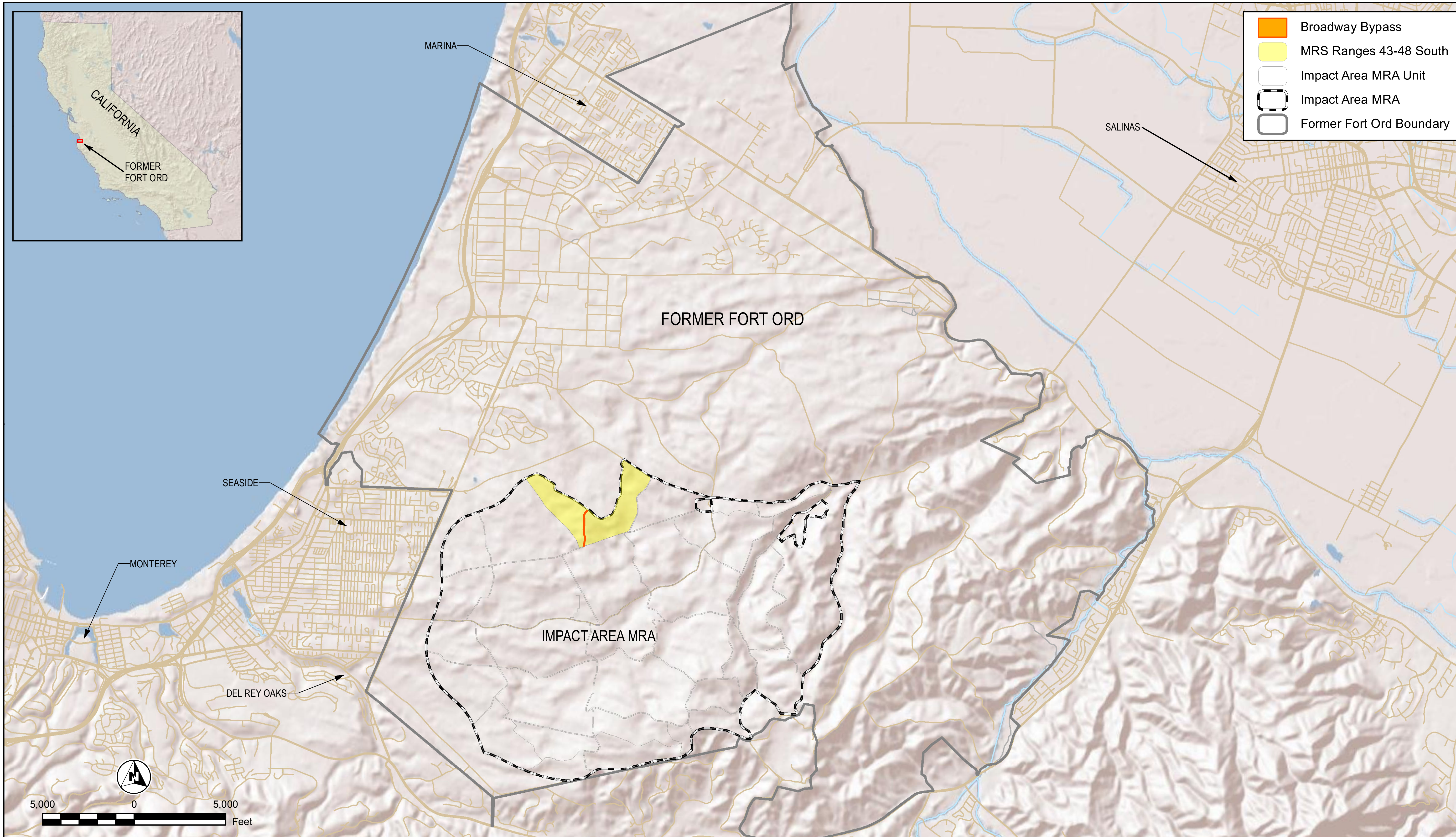
Figures



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Remedial Action Report
Track 3 Impact Area MRA, Broadway Bypass
Former Fort Ord, California

Figure 1
Regional Location Map

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Track 3 Impact Area MRA, Broadway Bypass
Former Fort Ord, California

Figure 2
Broadway Bypass Work Grids

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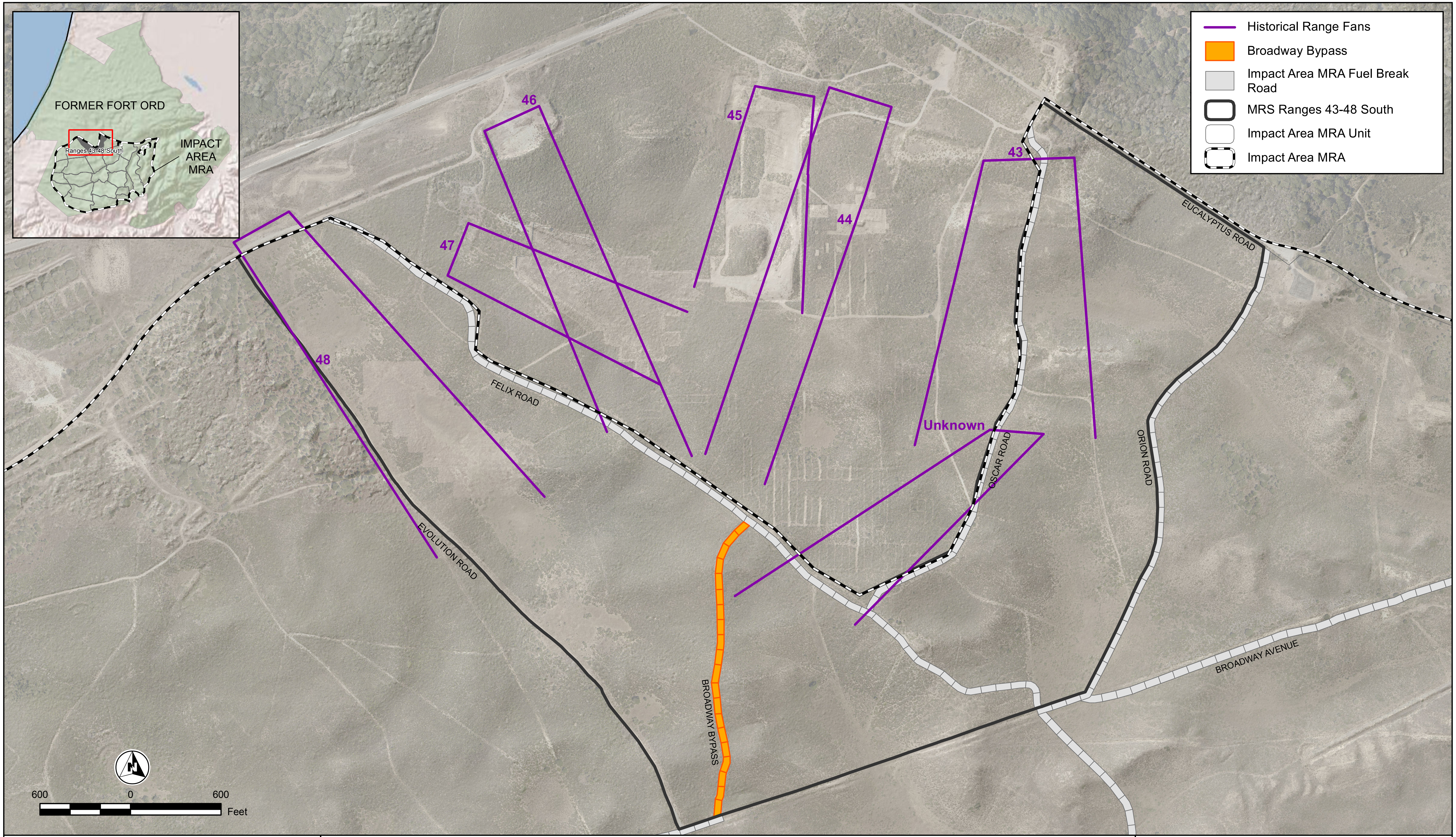

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Track 3 Impact Area MRA, Broadway Bypass
Former Fort Ord, California

Figure 3
MRS Ranges 43-48 South Historical Ranges

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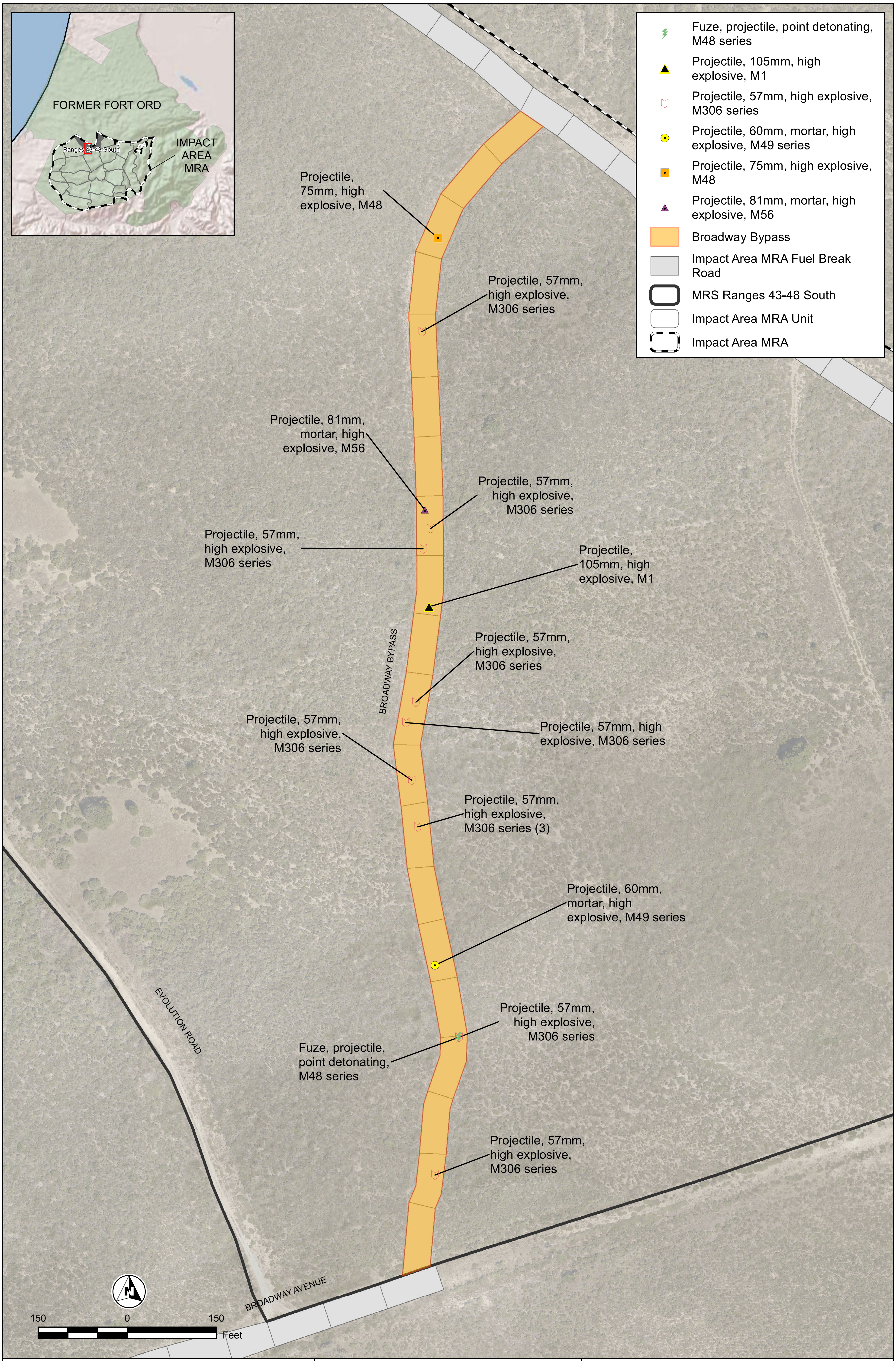

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Track 3 Impact Area MRA, Broadway Bypass
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Figure 4
Previously Recovered
Munitions and Explosives of Concern

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Figure 5
Instrument Verification Strip Location

G:\ArcGIS\USACE\Fort_Ord\PROJECTS\4_Field_Work_2018\Broadway_Bypass\Map_Docs\RAR\Fig_05_IVS_Location.mxd 10/4/2018 [08:59 AM] AGASCHO, Gilbane

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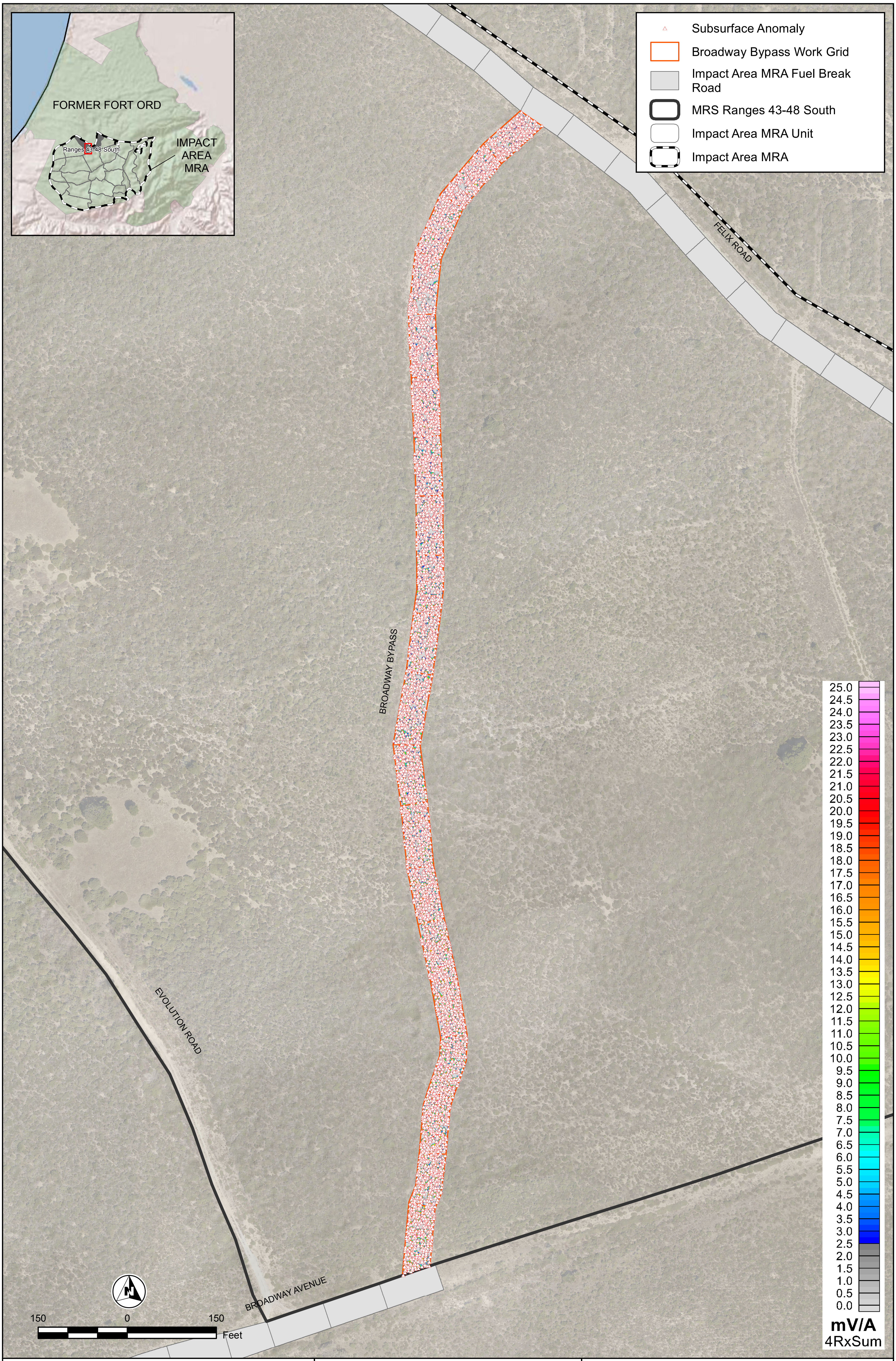
Track 3 Impact Area MRA, Broadway Bypass
Former Fort Ord, California

Figure 6
Dynamic Detection Data

G:\ArcGIS\USACE\Fort_Ord\PROJECTS\4_Field_Work_2018\Broadway_Bypass\Map_Docs\RAR\Fig_06_Dynamic_Detection_Data_rev1.mxd 4/17/2019 [13:29 PM] AGASCHO, Gilbane



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Track 3 Impact Area MRA, Broadway Bypass
Former Fort Ord, California

Figure 7
Detected Subsurface Anomaly Locations

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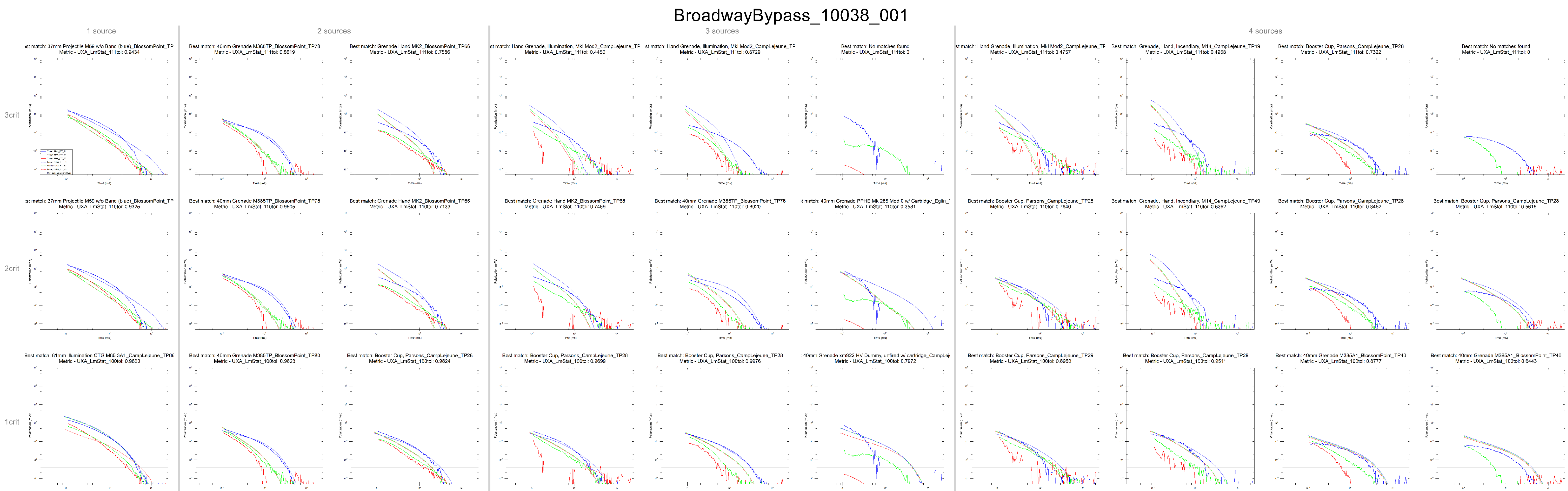

Remedial Action Report
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Figure 8
Example UX-Analyze Advanced Inversion Fit Summary

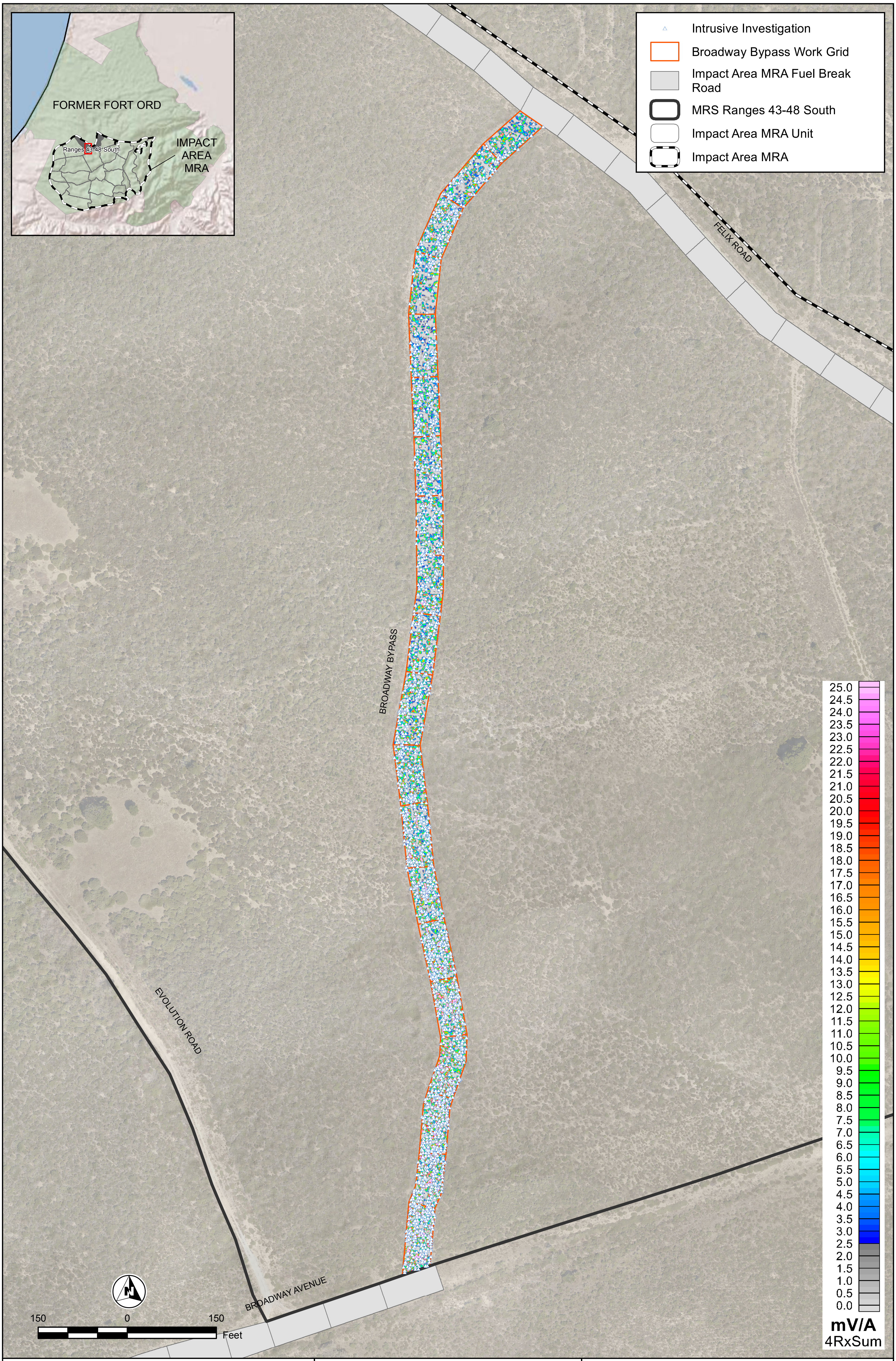

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Figure 9
Intrusive Investigation Target Locations

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Figure 10
Recovered Target of Interest Munitions

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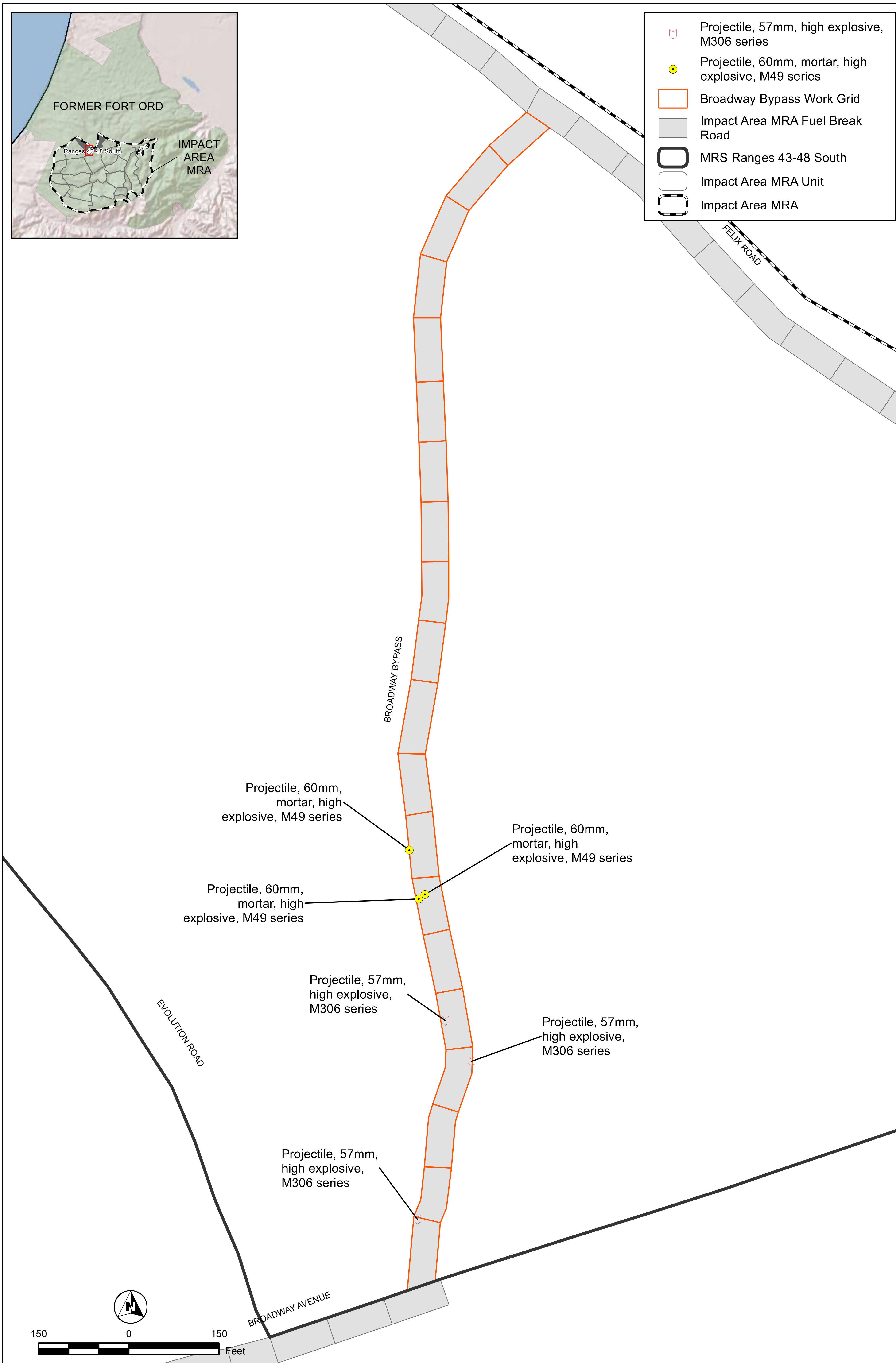

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Track 3 Impact Area MRA, Broadway Bypass
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Figure 11
Recovered Munitions and Explosives of Concern

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Figure 12
Recovered Quality Control Seed Items

G:\ArcGIS\USACE\Fort_Ord\PROJECTS\4_Field_Work_2018\Broadway_Bypass\Map_Docs\RAR\Fig_12_Recovered_QC_Seeds.mxd 10/4/2018 [09:43 AM] AGASCHO, Gilbane

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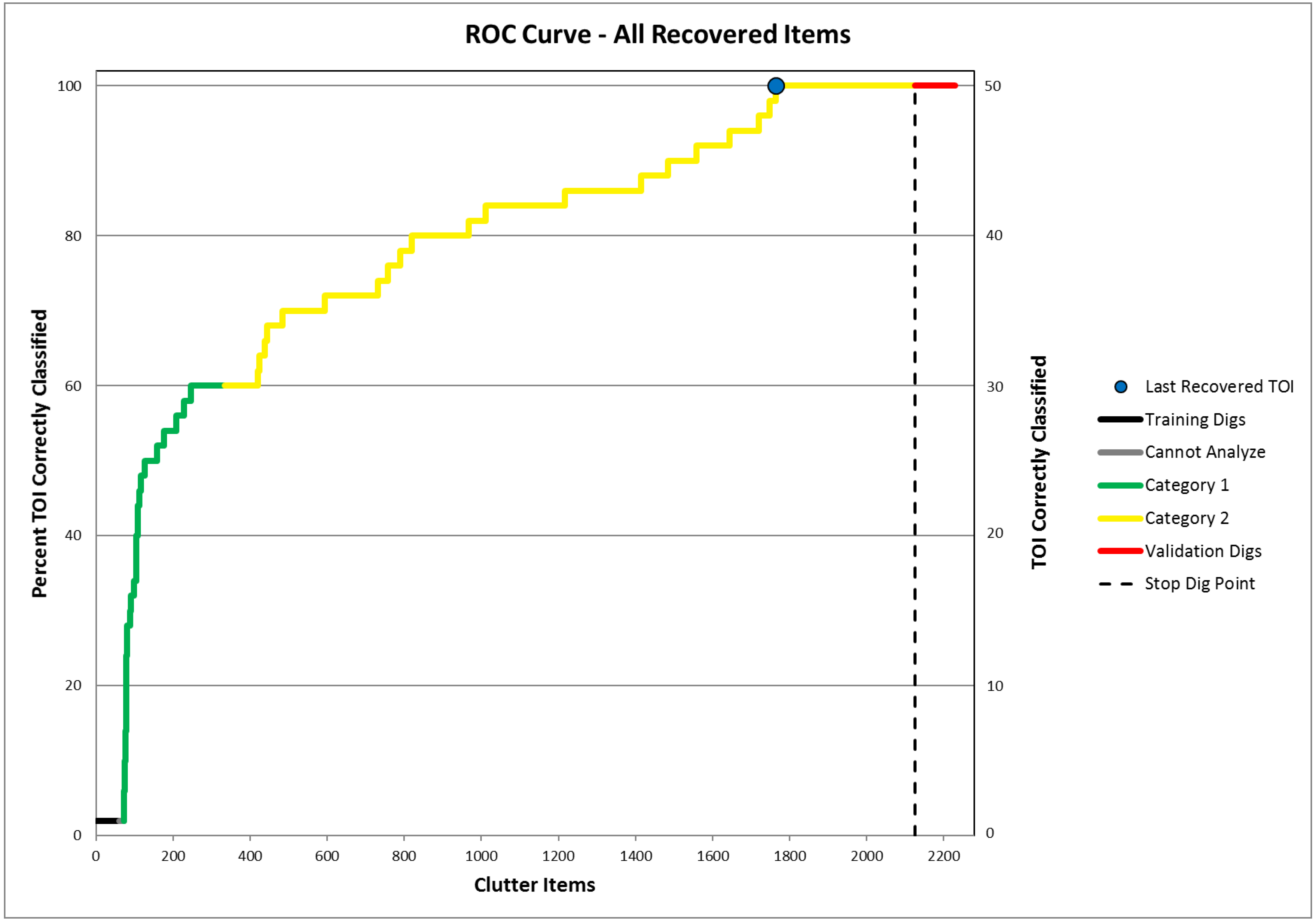
Figure 13
Recovered Validation Seed Items

G:\ArcGIS\USACE\Fort_Ord\PROJECTS\4_Field_Work_2018\Broadway_Bypass\Map_Docs\RAR\Fig_13_Recovered_QA_Seeds.mxd 10/4/2018 [09:44 AM] AGASCHO, Gilbane



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Track 3 Impact Area MRA, Broadway Bypass
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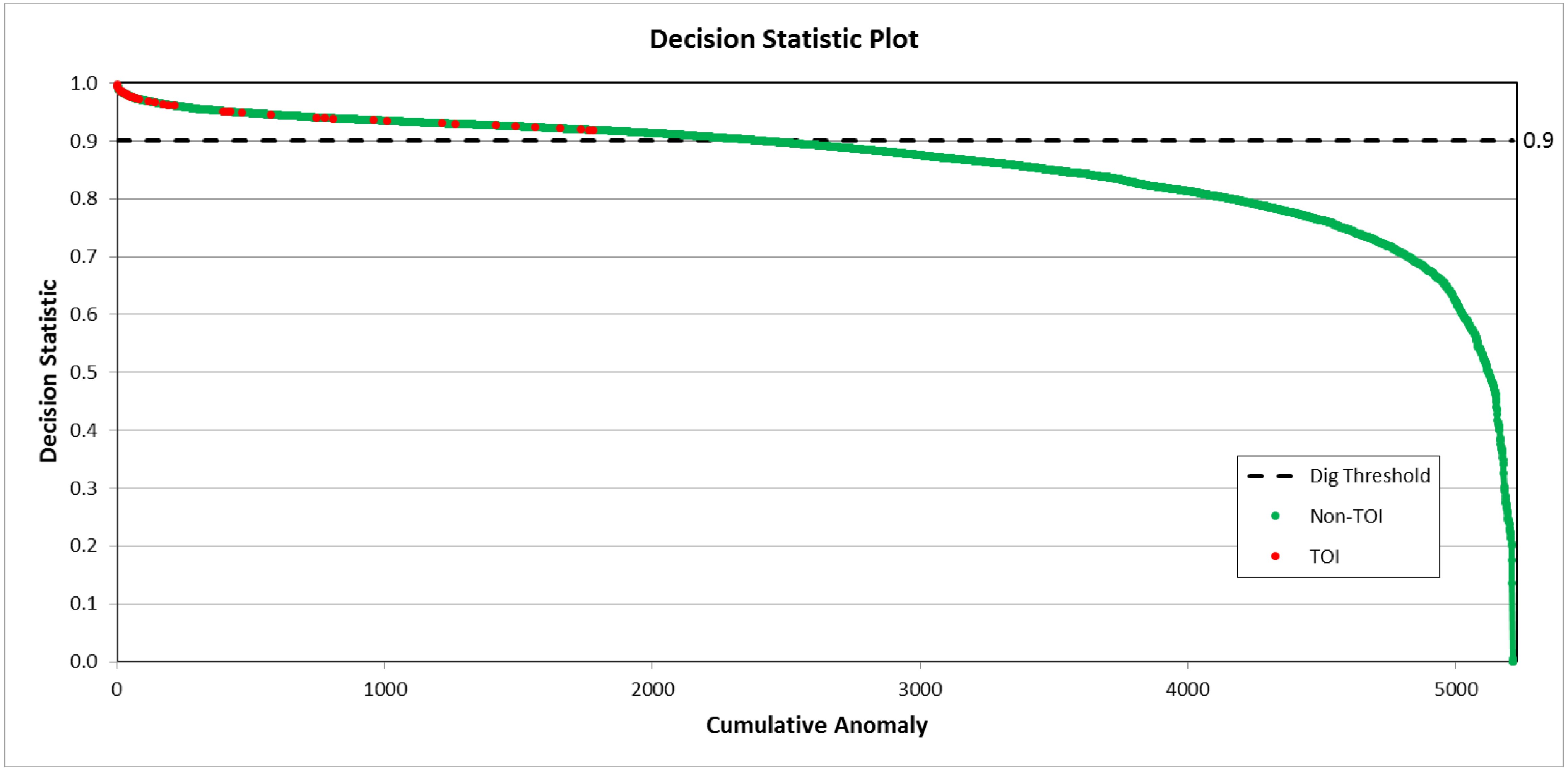
Figure 14
Receiver Operating Characteristic Curve



Remedial Action Report
Track 3 Impact Area MRA, Broadway Bypass
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Figure 15
Decision Statistic Plot

Appendices

Appendix A - G
(please see disc attached)

Appendix H

Digital Data DVDs

(please see discs attached)

Appendix I
Responses to Comments

RESPONSES TO COMMENTS

Document: Remedial Action Report, Track 3 Impact Area MRA, Broadway Bypass, Former Fort Ord, California, Draft

Commenting Organization: California Department of Toxic Substances Control (DTSC)
Name: Vlado Arsov
Date of Comments: March 13, 2019

Comment 1

Page 54/Section 6.1., Paragraph 3

"All validation seeds were detected, successfully classified as potential TOI, included on the intrusive investigation list, and recovered during subsurface removal operations in accordance with the seed item recovery MQO established in Worksheet 22 of the **AGCMR-QAPP** (KEMRON, 2016b)."

Please clarify that components of this QAPP are consistent with the current Uniform Federal Policy for Quality Assurance Project Plans, Advanced Geophysical Classification for Munitions Response.

Response to Comment 1

The Advanced Geophysical Classification for Munitions Response Quality Assurance Project Plan (AGCMR-QAPP) was prepared in 2016 in accordance with a draft version of the Uniform Federal Policy for Quality Assurance Project Plans, Advanced Geophysical Classification for Munitions Response template. The following text is included in the AGCMR-QAPP (Administrative Record number: OE-0868B): "This AGCMR-QAPP addresses the quality assurance (QA) and quality control (QC) elements of the American National Standard, ANSI/ASQ E4-2004 and meets the requirements of EPA/QA G-5. Modifications have been made to the standard worksheets based on the munitions response (MR) advanced geophysical classification format designed specifically for advanced EMI [electromagnetic induction] MR classification projects, as described *Uniform Federal Policy for Quality Assurance Project Plans Template: Geophysical Classification for Munitions Response, Revised Beta Draft* (IDQTF, 2015)." The measurement quality objectives in Worksheet 22 are consistent with the current QAPP guidance. No changes have been made to the text.

Comment 2

Page 68/Figure 3

Unknown Munitions Response Area

Is the Unknown MRA an actual range and is it a part of the Range 43? Does this range appear in other documents?

Response to Comment 2

The "Unknown" range shown on Figure 3 can be seen on historical aerial imagery and is included in the Fort Ord Geographic Information System (GIS), but the training activities and types of munitions used on the range are not well-documented. Table 1 (Section 2.5) has been revised as described in the response to U.S. Environmental Protection Agency (EPA) Specific Comment 2 (below) to include this range.

Comment 3

Page 71/Figure 6

Values in the legend spanning from -10 - 20 mV.

After several discussions with the Army, DTSC feels that DGM data should not have a negative response value calculated using minimum curvature grid surface approximation. This approximation appears to create false negatives. DTSC feels that removing or replacing all negative values with 0, and replacing blues with greens would be more valuable.

Response to Comment 3

A standard color scheme for the display of advanced EMI dynamic detection data has not previously been established for Fort Ord documents. Based on discussions with the U.S. Army Corps of Engineers (USACE) Quality Assurance Geophysicist, a new color scheme will be used for the display of dynamic advanced sensor data that displays all response values below the target detection threshold as shades of gray. For dynamic Time-domain Electro-Magnetic MTADS MP 2x2 (TEMTADS) data, the color scheme consists of a standard color ramp beginning with blue at 2.5 mV/amp and continuing through shades of green, yellow, orange, red, and pink to 25 mV/amp. The new color scheme has been added to Figures 6, 7, and 9 in this document.

Comment 4

Page 72/Figure 7

Items in the legend

Please expand the legend and include all colors of triangles seen on the drawing.

Response to Comment 4

Only one type of triangle symbol appears on Figure 7 (white triangles with a red border) representing subsurface anomalies detected in the digital geophysical mapping (DGM) detection data. This symbol is already included in the legend. Other colors visible between the symbols are the DGM data displayed in the background. Figure 7 has, however, been revised to display the dynamic DGM data using a different color scheme in response to DTSC comment 3.

Comment 5

Page 74/Figure 9

Items in the legend

Please expand the legend and include all colors of triangles seen on the drawing.

Response to Comment 5

Only one type of triangle symbol appears on Figure 9 (white triangles with a blue border) representing intrusive investigation locations. This symbol is already included in the legend. Other colors visible between the symbols are the DGM data displayed in the background. Figure 9 has, however, been revised to display the dynamic DGM data using a different color scheme in response to DTSC comment 3.

RESPONSES TO COMMENTS

Document: Remedial Action Report, Track 3 Impact Area MRA, Broadway Bypass, Former Fort Ord, California, Draft

Commenting Organization: United States Environmental Protection Agency, Region IX
Name: Maeve Clancy
Date of Comments: March 15, 2019

General Comment 1

The Draft Remedial Action Report, Track 3 Impact Area MRA Broadway Bypass, Former Fort Od, Monterey County, California, dated January 2019 (hereinafter referred to as the D RAR T3 IA MRA BB), contains references to projectiles that are identified as munitions debris (MD), but are not identified by type and/or model. These include Projectile, 81mm mortar, Projectile, 105mm, and Projectile 155mm. It is unclear as to how these projectiles were identified as MD without the projectile type also being identified. If they are complete projectiles that were fired (i.e., they have impacted without functioning as designed or being disassembled by the impact) they would likely be munitions and explosives of concern (MEC). If they are high explosive (HE) projectiles, have functioned and/or a low order detonation has occurred, they would very likely not be a complete projectile and should not be described as such. If they are base or nose ejection projectiles (i.e., smoke or illumination types), they would constitute an empty projectile (MD) and should be described by their type (e.g., projectile, 155mm, illumination; projectile, 105mm, base ejection smoke) as well as being designated MD. As these illumination and smoke projectiles are often fired into areas where their high explosive counterparts are not fired, this information is of value in analyzing the use of the areas involved.

Please revise all listings of recovered projectiles that are described as MD, that do not have the type of munition noted, to include this information. If model numbers (i.e., M or Mk) are available, please include them in the revision. If they are not available, the projectile type will suffice.

Response to General Comment 1

Footnotes in Table 5 (Section 4.3.1) and in the abbreviated version of the table that is included in the Executive Summary state, “Specific model and filler designations are listed for MEC items only. Specific model and filler designations for recovered MD items are unknown.” The referenced MD items were the partial remains of projectiles that had functioned as designed or were disassembled on impact but were still identifiable as a specific size projectile, although the type and model could not be confidently determined. The first paragraph of Section 4.3.1 states, “MD items with the physical structure of a MEC item were considered TOI [target of interest] regardless of the presence or absence of explosive content."

Additional text has been added to the table listings and to the text in Section 4.3.1 to clarify that the listed MD items were partial projectile remains rather than fully intact projectiles.

Specific Comment 1

Section 2.5, Site Features and History of Military Munitions Use, Page 10
The second paragraph on page 10 contains a sentence that states, "The former ranges within the MRA contain a concentration of similar expended munitions and MEC." It is unclear as to the intent of this sentence. The distribution of "expended munitions and MEC" by type and quantity varies significantly in the Fort Ord Impact Area MRA under investigation. It is generally dependent upon the range type and the munitions employed thereon. Please delete this sentence or revise it and/or the section listed to reflect this variance.

Response to Specific Comment 1

The sentence has been deleted.

Specific Comment 2

This table differs somewhat from Figure 3, MRS Ranges 43-48 South Historical Ranges. Differences include:

- Table 1 lists 2 ranges (44A and 45A) that are not shown on Figure 3.
- Figure 3 shows a range fan labeled "Unknown" that is not listed in Table 1, nor is it described in the verbiage preceding Table 1.

Please review the cited inconsistencies and correct them.

Response to Specific Comment 2

The following revisions have been made to Table 1 to match the ranges displayed on Figure 3:

- Ranges 44 and 44A have been combined
- Ranges 45 and 45A have been combined
- The "Unknown" range has been added