FINAL
FEASIBILITY STUDY

MMRP MUNITIONS RESPONSE SERVICES
NATIONAL GUARD BUREAU

LEONA HEIGHTS RIFLE RANGE (CAHQ-013-R-01)
ALAMEDA COUNTY, CALIFORNIA

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LIST OF ACRONYMS

°F	degrees Fahrenheit
%	percent
ACSO	Alameda County Sheriff's Office
AEDB-R	Army Environmental Database – Restoration
AGC	advanced geophysical classification
ARAR	applicable or relevant and appropriate requirement
ARNG	Army National Guard
BEM	Buried Explosion Module
bgs	below ground surface
BIP	blow-in-place
BUD	Berkley UXO Discriminator
CAARNG	California Army National Guard
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDC	contained detonation chamber
CFR	Code of Federal Regulations
DD	Decision Document
DDESB	Department of Defense Explosives Safety Board
DGM	digital geophysical mapping
DGPS	Differential Global Positioning System
DMM	discarded military munitions
DoD	Department of Defense
DoDI	Department of Defense Instruction
EA	EA Engineering, Science, and Technology, Inc.
EBRPD	East Bay Regional Parks District
EM	Engineering Manual
EMI	electromagnetic induction
EMM	earth moving machinery
EOD	Explosive Ordnance Disposal
FDEMI	frequency domain electromagnetic induction
FS	Feasibility Study
GIS	Geographical Information System
GPS	Global Positioning System
GRA	general response action
HRR	Historical Records Review
IR	infrared

LIST OF ACRONYMS (CONT.)

ITRC	Interstate Technology & Regulatory Council
LTM	long-term management
LUC	land use control
MC	munitions constituents
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
MEC HA	munitions and explosives of concern hazard assessment
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard
MPV	Man-Portable Vector
MRA	Munitions Response Area
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
MSD	minimum separation distance
NA	not applicable
NAA	no action alternative
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDNODS	Non-Department of Defense, Non-Operational Defense Sites
NFA	no further action
NMD	non-munitions debris
O&M	operation and maintenance
PPE	personal protective equipment
PA	Preliminary Assessment
PP	Proposed Plan
QC	quality control
RAO	remedial action objective
RI	Remedial Investigation
ROSP	Regional Open Space Preserve
RTS	Robotic Total Station
SAA	small arms ammunition
SI	Site Inspection
SUXOS	Senior Unexploded Ordnance Supervisor
TBC	to-be-considered
TDEMI	time-domain electromagnetic induction

LIST OF ACRONYMS (CONT.)

U.S.	United States
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
WESTON	Weston Solutions, Inc.

1.0 INTRODUCTION

This report summarizes the work performed and results of the Feasibly Study (FS) conducted at the Non-Department of Defense (DoD), Non-Operational Defense Site (NDNODS) Leona Heights Rifle Range (Army Environmental Database-Restoration [AEDB-R] number CAHQ-013-R-01) Munitions Response Site (MRS), in Alameda County, California. The FS was completed by Weston Solutions, Inc. (WESTON®) in accordance with the United States (U.S.) Environmental Protection Agency (USEPA) October 1988 document *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988); the U.S. Army Military Munitions Response Program (MMRP) document, *Final Munitions Response Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009); and U.S. Army Corps of Engineers (USACE) *Engineer Pamphlet – 1110-1-18 Ordnance and Explosives Response* (USACE, 2000).

This FS was conducted in support of the MMRP at the request of the USACE. This is a firm-fixed price, performance-based acquisition issued as Delivery Order 0011 under the USACE Multiple Award Environmental Services Contract W912DR-09-D-0006 (USACE, 2013a and 2013b), and was performed in accordance with the 14 March 2013 Performance Work Statement.

The U.S. Congress established the MMRP to address former defense sites where unexploded ordnance (UXO), discarded military munitions (DMM), and munitions constituents (MC) may be present as a result of past training activities. NDNODS, defined as those defense sites that were exclusively used by the Army National Guard (ARNG) and were never owned, leased, or otherwise possessed or used by the U.S. Army or other DoD component, are a subcategory of MMRP. A MRS co-used by other DoD components or which fulfills other eligibility criteria may also be addressed under the ARNG MMRP RI/FS phase.

1.1 PURPOSE

The purpose of this FS is to determine the best approach to mitigate the explosive hazards from munitions and explosives of concern (MEC) that potentially remain at the Leona Heights Rifle Range MRS. Information was collected during the Site Inspection (SI) and Remedial Investigation (RI) relating to the nature and extent as well as the fate and transport of MEC. This information is used in the FS to identify and screen remedial technologies and process options, develop and screen alternatives, and perform a detailed comparative evaluation of those alternatives. MC (metals [antimony, copper, lead, and zinc] and explosives) were evaluated in the SI and RI as well (as described in Sections 3.1 and 3.2), but were determined to either not be present or not be present at levels that pose a risk to human and ecological receptors; therefore, MC is not evaluated in this FS.

The FS was developed with regard to specific criteria set forth by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The NCP was established by the Clean Water Act of 1972 and has been revised and broadened several times since then. The NCP is codified in 40 Code of Federal Regulations (CFR) Part 300. The purpose of the NCP is to provide the organizational structure and procedures for developing, evaluating, and implementing response actions at a site. The September 1994 revision is the latest version of the NCP. Paragraph

300.120(c) identifies the DoD as the removal response authority with respect to incidents involving DoD military weapons and munitions. The remedial alternatives proposed in this FS are protective of human health, the environment, and meet the requirements of all stakeholders.

The FS is the mechanism for the development, screening, and detailed evaluation of alternative remedial actions if such are determined to be required. In addition, a Proposed Plan (PP) describing the recommendations of the RI and FS will be completed for stakeholder and public concurrence. A Decision Document (DD) will be prepared following approval of the PP to identify the remedial alternative chosen from the FS.

1.2 REPORT FORMAT

The FS report format is as follows:

Section 1.0 – Introduction;

Section 2.0 – Installation Description;

Section 3.0 – Previous Investigations;

Section 4.0 – Applicable or Relevant and Appropriate Requirements (ARARs);

Section 5.0 – Identification and Screening of Technologies;

Section 6.0 – Development and Screening of Alternatives;

Section 7.0 – Detailed Analysis of Alternatives; and

Section 8.0 – References.

2.0 INSTALLATION DESCRIPTION

The Leona Heights Rifle Range MRS is located along Keller Avenue and Campus Drive in Sequoyah, approximately seven (7) miles southeast of Downtown Oakland, Alameda County, California (**Map A-1**, **Appendix A**). The MRS encompasses a portion (33.04 acres) of the public 290 acre East Bay Regional Parks District (EBRPD) Leona Canyon Regional Open Space Preserve (ROSP) and two (2) residential areas (48.29 acres) consisting of condominium and townhouse complexes and single family residences. The Leona Heights Rifle Range MRS (81.33 acres based on Geographical Information System [GIS] measurements) was used for artillery and mortar practice, and small arms training by multiple California Army National Guard (CAARNG) units from 1913 until the mid to late 1930s. Beginning in 1913, the range was first used for artillery practice, with the small arms range being constructed in 1920. The range consisted of as many as five (5) target berms at varying distances extending out to 1,000 yards. The following subsections describe the physical characteristics of Leona Heights Rifle Range MRS.

2.1 TOPOGRAPHY

The site topography is primarily rolling to flat in the western half of the MRS where the condominium and townhouse complex is located, while the eastern portion is very steep with sloping hillsides and heavily vegetated gullies. Portions of the hillside in the eastern half of the MRS are impassable due to very dense vegetation and/or steep terrain, especially on the upper slopes of the MRS. The western portion of the MRS consists mostly of a highly developed residential neighborhood; however, an oak-covered hillside is located in the southwest corner of the MRS.

2.2 CLIMATE

The warmest month of the year at Oakland International Airport, California is September with a maximum temperature of 73.4 degrees Fahrenheit (°F) and a minimum temperature of 41.9°F experienced in January, on average. In the summer, the temperatures tend to be in the lower to mid-70s, while in the winter months the temperatures are in the 40s. Annual average precipitation is 18.03 inches, where the wettest season is winter with 9.53 inches (Western Region Climate Center, 2015).

The average annual wind speed is 8.8 miles per hour and average prevailing wind direction (direction the wind blows from) is west at the Oakland International Airport (station ID: KOAK). Wind speed varies by season with average speeds between 6.8 to 8.5 miles per hour occurring from September through February. Average wind speeds between 9.0 – 10.4 miles per hour occur from March through August. Average wind direction is west February through November and from the southeast in December and January (Western Region Climate Center, 2017a and 2017b).

2.3 VEGETATION

Vegetation at Leona Heights Rifle Range MRS consists of barren to low grass, live oak, buckwheat, and blackberry brambles.

2.4 GEOLOGY

The MRS contains two (2) underlying geologic formations that divide the MRS to the east and west. The eastern half of the MRS contains cretaceous marine formation while the western half is a tertiary intrusive formation. The cretaceous marine formation contains undivided cretaceous sandstone, shale, and conglomerate; with minor non-marine rocks in Peninsular Ranges from the early to late Cretaceous age. The tertiary intrusive formation is mostly shallow plugs and dikes that include some Mesozoic rocks from the Jurassic age (WESTON, 2012).

2.5 HYDROLOGY AND HYDROGEOLOGY

The MRS is located in the California Coastal Basin national aquifer. A well is located 2.9 miles southwest of the MRS and in 1999 had a depth-to water of 40.8 feet below ground surface (bgs). Rifle Range Creek flows from north to south across the MRS and eventually drains to the west.

2.6 ECOLOGY

No federal or state threatened or endangered species are known to exist within the MRS (WESTON, 2012).

2.7 INSTALLATION HISTORY

According to the Preliminary Assessment (PA) (EA Engineering, Science, and Technology, Inc. [EA], 2009), Leona Heights Rifle Range MRS was used for artillery and mortar practice, and small arms training by multiple CAARNG units from 1913 until the mid to late 1930s. Beginning in 1913, the range was first used for artillery practice, with the small arms range being constructed in 1920. The range consisted of as many as five (5) target berms at varying distances extending out to approximately 1,000 yards (**Map A-2, Appendix A**).

Research conducted in support of the September 2011 California Final Historical Records Review (HRR)/SI Work Plan (WESTON, 2011) identified an excerpt from a letter dated October 22, 1917, from Brigadier General J.J. Borree that expresses appreciation to the California State Railroad Commission for assisting the National Guard in completing the Leona Heights Rifle Range in 1917. In addition, articles were located that indicated the range was used by high school cadets in 1920 and by the Rifle and Pistol Club of the California State Railroad Commission in 1922. Additionally, while the original MRS boundary depicted in the PA was not changed, GIS was used to recalculate the MRS acreage and the original 91.0-acre size of the MRS stated in the PA report was revised to 81.33 acres.

3.0 PREVIOUS INVESTIGATIONS

The following documents detail the investigations at the Leona Heights Rifle Range MRS as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and MMRP process to date:

- EA, 2009. *Final State/Territory Inventory Report, National Guard Bureau, Non-Department of Defense Owned Non-Operational Defense Sites Inventory, California*. May.
- WESTON, 2011. *Final Historical Records Review/Site Inspection Work Plan for California, Army National Guard, Munitions Response Sites, Site Inspection Phase.* September.
- WESTON, 2012. *Final Site Inspection Report, Army National Guard Munitions Response Sites, Site Inspection Phase, California.* August 2012.
- WESTON, 2016. *Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California.* May 2016.
- WESTON, 2017. *Final Remedial Investigation Report, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California.* May 2017.

3.1 SITE INSPECTION

The SI was conducted on 3 and 4 October 2011. During the SI, approximately 11 line miles of visual survey transects were conducted within the MRS aided by hand-held metal detectors (**Map A-2, Appendix A**). A small arms impact area was identified towards the top of the steep hillside adjacent to the northeastern most target area. The target area contained the remains of a pop-up targeting system located in a dugout trench with a protective berm area in front of the targets and a natural backstop hillside behind them. Small arms debris consisting of .30 caliber projectiles was identified on the surface of the earthen berm in front of and on the slope behind the target system. A 3-inch Stokes Mortar was discovered at the surface on the western side of the Leona Canyon ROSP at the south end of the center gully. The mortar was identified as MEC by the field team and was transported and disposed of by the Alameda County Sheriff's Office (ACSO) Explosive Ordnance Disposal (EOD) Squad. Although the field team identified the mortar as MEC, the responding ACSO EOD officer, following inspection, determined that it did not pose an explosive hazard. The mortar was taken to the ACSO EOD range for final disposition. Subsurface anomalies were detected a short distance below the mortar that were consistent with that type of munition (WESTON, 2012). Based on the SI, the MRS was recommended for further investigation for MEC.

Nine (9) surface soil samples and one (1) field duplicate were collected at various locations throughout the MRS. SI sampling rationale is presented in **Table 3-1** and the sampling locations are presented on **Map A-3** (**Appendix A**). The soil samples were analyzed for explosives via USEPA method 8330A and metals (antimony, copper, lead, and zinc) via USEPA method 6010C and were compared to the USEPA Regional Screening Levels and the California Human Health Screening Levels. All analytical results were below USEPA and California screening levels.

Therefore, the Leona Heights Rifle Range MRS was recommended for no further action (NFA) for MC.

Table 3-1
SI MC Sampling Rationale

Sample Designation	Sample Type	Rationale
CAHQ-013-SO-001	ITRC Grid Composite	Sample collected from location that appeared to be the highest impact area behind the target system.
CAHQ-013-SO-002	ITRC Grid Composite	Sample collected from location that appeared to be the highest impact area behind the target system.
CAHQ-013-SO-003	Spoke and Hub Composite	Taken from protective berm area below the target system Center location most likely to have MC.
CAHQ-013-SO-004	Spoke and Hub Composite	Collected as field duplicate sample of CAHQ-013-SO-003.
CAHQ-013-SO-005	Spoke and Hub Composite	Taken from hillside in front of the target system in location believed to most likely have MC and having metal detections.
CAHQ-013-SO-006	Discrete	Taken from accessible location in the dry drainage feature (ravine) which drains the middle portion of the steep hillside or target area.
CAHQ-013-SO-007	Discrete	Taken just down gradient and adjacent to 3-inch Stokes mortar.
CAHQ-013-SO-008	Discrete	Taken from low lying area in the drainage feature on the north end of the eastern portion of the MRS.
CAHQ-013-SO-009	Discrete	Taken from low lying area in the drainage feature on the south end of the eastern portion of the MRS.
CAHQ-013-SO-010	Discrete	Taken from low lying drainage feature at base of steep hillside on the southwest corner of the MRS.

Notes:
ITRC – Interstate Technology & Regulatory Council
MC – Munitions Constituent
MRS – Munitions Response Site
SI – Site Inspection

3.2 REMEDIAL INVESTIGATION

Based on results of the SI, further investigation was recommended for MEC at the Leona Heights Rifle Range MRS. The RI was conducted from 07 June 2016 to 15 June 2016 to determine the nature and extent of potential MEC, evaluate the hazards and risks to human health and the environment from potential MEC, and determine whether the Leona Heights Rifle Range MRS warrants further response action pursuant to CERCLA. This section contains a summary of the Final RI Report (WESTON, 2017).

3.2.1 Munitions and Explosives of Concern Investigation Coverage and Survey Design

The MEC characterization approach at the Leona Heights Rifle Range MRS included analog transect surveys (**Map A-4, Appendix A**) to detect potential MEC in the surface and subsurface within accessible areas followed by intrusive investigations along transects at anomaly locations to determine the nature, type, and distribution of MEC and munitions debris (MD).

Digital geophysical mapping (DGM) surveys were not planned to be performed as part of this RI due to the steep topography and dense vegetation. Analog handheld White's MXT all-metal detectors with an effective detection depth of 24-inches were used during the RI transect survey and subsequent intrusive investigation. Each anomaly detected was physically marked (flagged) in the field and the location recorded with Global Positioning System (GPS) for subsequent intrusive investigation. Anomaly locations, features and other points of interest were recorded with a Trimble Geo 7X GPS.

Using a Geo 7X, qualified UXO personnel navigated to the subsurface anomaly and MD locations identified during the SI to layout two (2) mini-grids (15-feet by ten [10]-feet) at the locations of subsurface anomalies and where MD, Practice 3-inch Stokes Mortars were found. The mini-grids were located in dense vegetation which dictated the layout. Additional transects and mini-grids were added after intrusive investigation along the proposed transects and mini-grids. In accordance with the approved RI Work Plan (WESTON, 2016), the additional transects and mini-grids were placed in accessible areas to delineate the MD. Transect and mini-grid locations and orientations are shown on **Map A-5**, (**Appendix A**).

3.2.1.1 Munitions and Explosives of Concern Results

The intrusive investigation began on 10 June 2016 and concluded on 15 June 2016. Qualified UXO personnel used hand tools to excavate and identify the 351 anomalies identified during the anomaly survey. Additionally, four (4) quality control (QC) items were identified. Anomalies were categorized as MD, material potentially presenting an explosive hazard (MPPEH), small arms ammunition (SAA), or non-munitions debris (NMD). Munitions-related anomalies included:

- MD – T02-023, 3-inch Stokes Mortar
- MPPEH – T03-016, T03-034, and T03-035, 3-inch Stokes Mortars

No munitions related “frag” (MD) was identified and the remaining anomalies were either SAA or NMD. The intrusive results summary is presented in **Table 3-2** and the anomaly types and locations are presented on **Map A-6** (**Appendix A**).

Table 3-2
Leona Heights RI Intrusive Summary

Item	Count	Percent (%)
MD	1	0.3%
MPPEH	3	0.9%
SAA	245	69.8%
NMD	102	29.1%
Total	**351**	**100.0%**

Notes:
MD – Munitions Debris
MPPEH – Material Potentially Presenting an Explosive Hazard
NMD – Non-Munitions Debris
SAA – Small-Arms Ammunition
RI – Remedial Investigation

3.2.2 Intentional Detonations

Intentional detonation of MPPEH was performed in accordance with the USACE approved Explosives Site Plan, the Explosives Management Plan and Demolition Operating Procedures (Section 3 and Appendix H of the RI Work Plan; WESTON, 2016). The intentional detonations followed the requirements of Engineering Manual (EM) 385-1-97 (USACE, 2013c), applicable Bureau of Alcohol, Tobacco, Firearms, and Explosives requirements, and applicable federal, state, and local regulations. The inspection/certification of MPPEH was conducted in accordance with DoD Instruction (DoDI) 4140.62 (DoD, 2015) and EM 200-1-15 (USACE, 2015).

The three (3) MPPEH 3-inch Stokes Mortars found in transect T03 were determined safe to move by the Senior Unexploded Ordnance Supervisor (SUXOS) and Unexploded Ordnance Safety Officer (UXOSO) and relocated to an area on the western end of transect T02. The MPPEH items were secured in a double locked job box by the SUXOS who controlled access. The items were guarded 24 hours a day (visual surveillance) from the time of discovery to intentional detonation.

WESTON coordinated demolition operations with the USACE Project Manager, USACE Ordnance and Explosives Safety Specialist, ARNG, EBRPD-Police and Fire, and condominium residents beginning on 15 June 2016. Intentional detonation of the three (3) MPPEH 3-inch Stokes Mortars, was performed on 17 June 2016 using the Buried Explosion Module (BEM) per DoD Explosives Safety Board (DDESB) Technical Paper 16 Revision 3 (DDESB, 2009). The MPPEH staging and demolitions areas are presented on **Map A-7**, **Appendix A**.

Each MPPEH item was prepped with two (2) perforators, and ten (10) feet of detonation cord. Per the BEM requirements, a hole was dug to approximately two (2) feet bgs, the prepped MPPEH item was placed in the hole, the hole was backfilled, and approximately two (2) feet of sandbags were placed on the hole. Each shot was dual primed with two (2) 40-millisecond delay detonators and two (2) lengths of lead line which ran to the firing point. The UXOSO and SUXOS ensured that the area was clear of unauthorized personnel prior to permitting attachment of the lead line to the detonators and prior to detonation. When the exclusion zone was secure, the lead line was initiated with a mushroom-style lead line initiator detonating the MPPEH item. After each detonation, the item was excavated and inspected by the SUXOS and verified by the UXO Quality Control Specialist (UXOQCS) to ensure that no explosive or fire hazards remained. Following

excavation and inspection, the process was repeated for the remaining MPPEH items. All three (3) items contained no high explosives with no high order detonation, and were therefore classified as vented MD and identified as MD on the dig list. The demolition area remained secured until the SUXOS, in conjunction with the UXOSO, gave the "all clear".

The MD was dual-inspected by the SUXOS and UXOQCS, certified as material documented as safe (MDAS) and locked in the job box for transportation and MDAS processing via smelting.

3.2.3 Munitions Constituent Assessment and Survey Design

At the completion of the SI, it was determined that the Leona Heights Rifle Range MRS did not require additional MC sampling and was recommended for NFA regarding MC. MC samples would have been be collected during the RI if an MC release was suspected due to field observations (e.g. burial sites, low-ordered or damaged MEC, or MC associated soil staining). MC samples were not collected during the RI based on field observations. However, biased discrete MC samples were collected prior to and following intentional detonation of MPPEH. These discrete samples were collected from locations most likely to be impacted by MC and used to confirm the presence of MC.

3.2.3.1 Munitions Constituent Investigation Results

During the RI fieldwork there was no evidence of damaged or leaking MEC or soil staining, criteria for additional MC sampling; therefore, additional MC samples were not collected. However, pre- and post-intentional detonation samples were collected on 17 June 2016 from the demolition area. Both the pre- and post-detonation samples were collected from the bottom of the BEM hole prior to and following detonation. The samples were collected, prepared, shipped and analyzed for explosives (nitroaromatics and nitroamines) via USEPA Method 8330B. Analytical results for the three (3) samples did not indicate concentrations above the laboratory detection limit (i.e. non-detect) for any of the analytes.

3.3 MUNITIONS RESPONSE SITE SUMMARY AND CONCLUSION

Analog survey and subsequent intrusive investigation around the subsurface SI anomalies and the expected migration paths (low spots) in the accessible areas within the Leona Canyon ROSP were completed as part of the RI. The RI identified 351 anomalies including; zero (0) MEC, four (4) MD, 245 SAA, and 102 NMD (additionally, four [4] QC items were identified). The four (4) MD items from the RI were located in the western portion of the Leona Canyon ROSP ranging in depth from two (2)-inches to 24-inches bgs (**Map A-6, Appendix A**). The single MD item identified during the SI was located on the surface on the western side of the Leona Canyon ROSP at the south end of the center gully (**Map A-2, Appendix A**). Although five (5) MD items (practice 3-inch Stokes Mortars) were identified during the SI and RI, no frag was encountered that would indicate the use of high explosive mortar training.

During the Technical Project Planning process, the substantial hardscape and extensive coverage of the SI in the developed areas was discussed along with the SI sampling locations, results and representativeness and data limitations. All stakeholders agreed that the developed areas and MC

were adequately characterized. Furthermore, observations during the RI fieldwork and the pre- and post-detonation sample results do not indicate MC poses a risk within the MRS. The characterization of MEC and MC at the Leona Heights Rifle Range MRS has been achieved through execution of the approved RI Work Plan which included incorporation of the SI data to meet the project data quality objectives.

A MEC hazard assessment (MEC HA) was completed using information gathered during the SI and RI to establish baseline conditions representing the current land-use activities resulting in a score of 870 (hazard level category of one [1]). Future land use is assumed to remain unchanged in the foreseeable future, so a separate score was not generated. A Munitions Response Site Prioritization Protocol (MRSPP) priority ranking was also calculated. The MRSPP priority for the MRS is six (6) (eight [8] being the lowest or least hazardous), based on the explosive hazard evaluation module.

Although MEC was not encountered during the SI or RI; utilizing the most conservative assumptions, there is a potentially complete pathway for human receptors to come in contact with MEC via intrusive and non-intrusive activities within the southwest portion of the Leona Canyon ROSP, within the MRS. If MEC is present, migration to the toe of the slope may be possible through a significant erosional event. Analytical data collected during the SI and RI did not indicate MC poses a risk to human health or the environment within the MRS. Therefore, as presented in **Table 3-3**, a FS was recommended to address potential MEC within the 31.73-acre portion of the MRS comprised of the majority of the Leona Canyon ROSP that falls within the MRS (hereafter referred to as Leona Heights Rifle Range MRS – Leona Canyon ROSP) concentrating the removal efforts on a 100 foot buffer along the southwest boundary (3.13 acres). The remaining approximately 49.60 acres of the MRS was recommended for NFA, as there was no indication of a MEC or MC hazard. Map **A-8** (**Appendix A**) presents the RI recommendations.

The Leona Heights Rifle Range MRS will be converted into a Munitions Response Area (MRA) comprised of two (2) MRSs – the 31.73-acre Leona Heights Rifle Range MRS – Leona Canyon ROSP (AEDB-R number CAHQ-013-R-01) and the 49.60 acres Leona Heights Rifle Range MRS – Developed Areas (AEDB-R number CAHQ-013-R-02). The 49.60 acres recommended for NFA are not addressed nor discussed further in this FS. The name, split, and associated acreage for each phase of the CERCLA process for the MRS is located in **Table 3-4**.

Table 3-3
Leona Heights Rifle Range MRS Recommendation Table

	Leona Heights Rifle Range MRS – Developed Areas	**Leona Heights Rifle Range MRS – Leona Canyon ROSP**
Acreage	49.60	31.73
Recommended Action for MEC	NFA	Further Action
Recommended Action for MC	NFA	NFA

Notes:
MC – Munitions Constituents
MEC – Munitions and Explosives of Concern
MRS – Munitions Response Site
NFA – no further action

Table 3-4
Leona Heights Rifle Range Acreage Summary Table

Phase	**Name**	**Acreage**
PA	Leona Heights Rifle Range MRS	91.0
HRR/SI Work Plan	Leona Heights Rifle Range MRS	81.33
SI	Leona Heights Rifle Range MRS	81.33
RI	Leona Heights Rifle Range MRS	81.33
FS	Leona Heights Rifle Range MRA	81.33
	Leona Heights Rifle Range MRS – Leona Canyon ROSP	31.73
	Leona Heights Rifle Range MRS – Developed Areas	49.60

Notes:
FS – Feasibility Study
HRR – Historical Records Review
PA – Preliminary Assessment
SI – Site Inspection
RI – Remedial Investigation
ROSP – Regional Open Space Preserve

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4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Remedial Alternatives offered in this FS will be consistent with the guidance provided in CERCLA (42 U.S. Code § 9601-9675) and the NCP (40 CFR 300). CERCLA and the NCP require compliance with ARARs of promulgated laws.

Applicable Requirements means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable (40 CFR 300.5).

Relevant and Appropriate Requirements means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, addresses problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate (40 CFR 300.5).

Remedial Alternatives may incorporate environmental policies or proposals that are not applicable or relevant and appropriate, but do address site-specific concerns. Such to-be-considered (TBC) standards may be used in determining the cleanup levels necessary for protection of human health and the environment. TBCs are non-promulgated advisories or guidance issued by Federal or State government that are not legally binding and do not have the status of potential ARARs (USEPA, 1988). TBCs may be used where ARARs do not exist or apply, such as for certain chemicals, circumstances, federal advisories, or guidance documents, which help determine what is protective for a site.

According to the USEPA, ARARs fall into three (3) categories: chemical-specific, action-specific, and location-specific:

- Chemical-specific ARARs are typically health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment (USEPA, 1988). However since no MC were reported above USEPA and State screening levels during the SI and RI and NFA was recommended for MC, no chemical-specific ARARs apply during the FS process.
- Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to specific hazardous wastes (USEPA, 1988).

- Location-specific ARARs are restrictions on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations (USEPA, 1988). No location-specific ARARs were identified with regards to Leona Heights Rifle Range MRS – Leona Canyon ROSP.

TBC requirements are used when there are no ARARs, or when ARARs alone may not adequately protect human health and the environment. TBC requirements are meant to complement the use of ARARs, not to compete with or replace them. The ARARs and TBCs are summarized in **Table 4-1**.

Table 4-1
Identification of ARARs and TBCs

Requirement	Citation	Description	ARAR/TBC Determination	Comments
Chemical Specific				
None				
Location Specific				
None				
Action Specific				
Standards for owners and operators of hazardous waste treatment, storage, and disposal facilities; miscellaneous units	40 CFR 264 Subpart X	A miscellaneous unit must be located, designed, constructed, operated, maintained, and closed in a manner that will ensure protection of human health and the environment.	TBC	Applies to treatment (detonation) of MEC/MPPEH that requires technologies defined as "miscellaneous units" in Subpart X. Subpart X specifies an environmental performance standard that must be met through conformance with appropriate design, operating, and monitoring requirements.

Notes:
CFR – Code of Federal Regulations
MEC – Munitions and Explosives of Concern
MPPEH – Material Potentially Presenting and Explosive Hazard
TBC – to-be-considered

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5.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Alternatives for remediation are developed by assembling combinations of technologies, with respect to the media to which they would be applied, into alternatives that appropriately address contamination (in this case potential MEC) on a site wide basis. This process consists of six (6) general steps, which are listed below and described in the referenced sections (USEPA, 1988).

- Develop Remedial Action Objectives (RAOs) – **Section 5.1**
- Develop General Response Actions (GRAs) – **Section 5.2**
- Identify volumes or areas of media to which GRAs might be applied – **Section 5.3**
- Identify and screen potential technologies within relevant GRA categories – Section 5.3
- Evaluate and select representative process options for each technology– **Section 5.4**
- Assemble selected technologies into alternatives – **Section 6.0**

5.1 REMEDIAL ACTION OBJECTIVES

The first step in the development and screening of alternatives process is to define the RAOs. The remedial actions selected by this FS will be designed to achieve the RAOs. The RAO for the Leona Heights Rifle Range MRS – Leona Canyon ROSP is to:

- Minimize human exposure to potential surface and subsurface MEC to 24-inches bgs using geophysical methods while maintaining the current land use.

Human receptors at the MRS include site workers, land owners/residents (adult/child), and recreational users/site visitors/trespassers (adult/child).

5.2 GENERAL RESPONSE ACTIONS AND SCREENING OF TECHNOLOGIES

In general, MEC investigations are limited to topography with slopes of less than 30 degrees. Conducting routine MEC work in areas where the slope is greater than 30 degrees presents significant safety concerns. Major concerns include the inability to use MEC detection technologies (analog mag and dig and DGM) effectively, the ability to perform intentional detonations due to the condition (ability to move an item) and location (mitigation procedure implementability) for MEC, and slip, trips and fall incidents.

GRAs are selected to satisfy the RAOs for each medium of concern and relate to basic methods of protection such as land use controls (LUCs), treatment, removal, or containment. GRAs may be combined to form alternatives such as LUCs and removal. Location-specific and action-specific ARARs have the potential to place restrictive parameters on the design, construction, operation, monitoring, and maintenance of the GRAs. MEC is potentially present on the ground surface and in the subsurface at the MRS. The following GRAs will be considered at the Leona Heights Rifle Range MRS – Leona Canyon ROSP:

- **No Action** – No action means that no remedial action will be undertaken at the MRS and is evaluated to satisfy the NCP requirement of 40 CFR 300.430(e)(6), which requires

consideration of this alternative as a baseline for comparison against other remedial response actions.

- **Land Use Controls** – LUCs may include legal mechanisms, engineering controls, educational controls, and long-term management (LTM).
- **MEC Removal** – MEC can be detected and removed from the ground surface and/or below the ground surface. Alternatives for MEC removal will include technologies for MEC detection, positioning systems for the detection technologies, MEC removal, and MEC disposal. No method of MEC detection and removal has proven 100% effective; therefore, notifications of the possible presence of MEC must be made to property owners.

A list of potentially applicable MEC technologies and technology process options, corresponding to the GRAs, were examined and retained for further screening if they were technically implementable at the MRS. The three (3) general screening categories are effectiveness, implementability, and cost to ensure that they meet the minimum standards of the criteria within each category in the FS process (USEPA, 1989). The screening categories are described below:

- **Short- and long-term effectiveness and reductions achieved in toxicity, mobility, or volume** – The "short-term" is considered to be the remedial construction and implementation period while "long-term" begins once the remedial action is complete and RAOs have been met.
- **Implementability, including technical and administrative feasibility** – Technical feasibility includes the ability to construct, reliably operate and meet regulations, as well as the ability to meet the operations and maintenance, replacement, and monitoring requirements after completion of the remedial action. Administrative feasibility includes the ability to obtain approvals from other agencies; the availability of treatment storage, and disposal services; and the availability of equipment and technical expertise.
- **Grossly disproportionate cost** – The cost evaluation is to eliminate from further consideration those alternatives whose costs are grossly excessive for the effectiveness they provide.

5.3 EVALUATION AND SCREENING OF TECHNOLOGIES

5.3.1 Evaluation and Screening of Land Use Controls Technologies

Risks related to potential explosives hazards may be managed through LUCs. LUCs protect property owners and the public from potential hazards present at the MRS by warning of potential MEC hazard and/or limiting access to, or use of, the MRS. LUCs may include legal mechanisms, engineering controls, and educational controls. Existing and potential LUCs were evaluated as part of the Institutional Analysis Report (Appendix C of the Final RI Report; WESTON, 2017). Examples of LUCs evaluated for the MRS include the following:

- Legal Controls
  - Deed Restrictions
  - Environmental Covenants

  - Zoning
  - Dig Permit System
  - Contractor Control Policies
  - Construction Support
- Engineering Controls
  - Fencing
  - Warning Signs
  - Physical Barriers to Access
- Educational Controls
  - Public Notices
  - Management Plans
  - Community Awareness Meetings
  - Letter Notifications, Informational Pamphlets, and Fact Sheets
  - Formal Education Sessions
  - Website

The effectiveness of LUCs depends on the support, involvement, and willingness of local agencies and landowners to enforce and maintain LUCs. LUCs already in place or that have been used during the implementation of the RI at the MRS include:

- Educational Controls
  - Public Notices
  - Community Awareness Meetings
  - Letter Notifications, Informational Pamphlets, and Fact Sheets

No engineering controls currently exist over the Leona Heights Rifle Range MRS – Leona Canyon ROSP. There are no measures to notify future recreational users, nearby residents, or contractors/maintenance workers or the EBRPD of potential explosive hazards. Additionally, there are no existing measures to provide information on anomaly avoidance/encounter protocols.

Educational controls such as public notices, letters, and meetings were used during the RI. These controls informed the public of upcoming activities, created an open forum for public participation, and provided contact information.

5.3.1.1 Retained Land Use Controls

A summary of the LUCs retained for development of remedial action alternatives are:

- Engineering Controls
  - Warning Signs
  - Fencing

- Educational Controls
  - Public Notices
  - Community Awareness Meetings
  - Letter Notifications, Informational Pamphlets, and Fact Sheets
  - Website

Warning signs would serve as both engineering and educational controls for educating the public of the potential MEC hazards at the Leona Heights Rifle Range MRS – Leona Canyon ROSP. Other educational controls include maintaining a public website for distribution of project information. Informational pamphlets and fact sheets are recommended for distribution at key times during any MRS remediation activities. In addition, fact sheets and pamphlets are recommended for distribution to public officials, emergency management agencies, and the EBRPD office notifying recreational users of potential MEC.

5.3.1.2 Activities Affecting Land Use Controls

Construction Support. When activities are required that may affect the LUCs established for the MRS, UXO construction support activities would be necessary. UXO construction support would be used to ensure the safety of workers or the public in the event that MEC items were discovered at the MRS. In accordance with DoD 6055.09-M (DoD, 2012), the level of construction support changes in relation to the location and the probability for encountering potential MEC. Each activity occurrence would be reviewed with the ARNG/CAARNG to ensure the appropriate support is provided based upon the type of activity planned. In areas having a low probability of encountering MEC, UXO-qualified Technicians provide support either on an on-call basis to respond to MEC that was incidentally encountered, or on a standby basis to monitor construction activities. If the probability of encountering MEC is moderate to high, removal of MEC from the construction footprint is required.

CERCLA Five-Year Reviews. If the potential for MEC remains, CERCLA requires the review of remedial actions no less than every five (5) years to assure that human health and the environment are being protected. For LUC alternatives, Five-Year Reviews would be required including inspections to assess conditions of LUCs, erosion, and potential migration of MEC from the subsurface due to frost heave or by surface water overland during precipitation events to areas that have not been cleared.

Recurring reviews for MEC removal actions determine whether a remedial action continues to minimize explosives safety hazards and continues to be protective of human health, safety, and the environment, and provide an opportunity to assess the applicability of new technologies for addressing previous technical impracticability determinations. Recurring reviews will be completed by ARNG and will include the following general steps:

- Prepare Recurring Review Plan;
- Establish project delivery team and begin community involvement activities;
- Review existing documentation;
- Identify/review new information and current site conditions;
- Prepare preliminary Site Analysis and Work Plan;
- Conduct site visit; and
- Prepare Recurring Review Report.

5.3.2 Evaluation and Screening of Munitions and Explosives of Concern Technologies

MEC investigation/mitigation technologies consisting of detection, removal, and disposal were evaluated and screened. A description of the types of technologies used in each step is presented in the following subsections. Specific technologies are described and screened in **Tables 5-1** through **5-5**.

5.3.2.1 Munitions and Explosives of Concern Anomaly Detection

Detection methods for subsurface anomalies and potential MEC are selected based on the potential munitions properties such as the depth and size of the suspected items, physical characteristics of the MRS (i.e., soil type, topography, vegetation, and local geology), and previous experience. Technologies used at the MRS during the RI consisted of analog geophysical sensors followed by physical excavation and investigation of identified anomalies. These same technologies are also applicable as a component of a remedial action alternative at the MRS in addition to DGM technologies. Positioning technologies include various equipment and instruments that establish geo-referenced locations for detected subsurface anomalies that can later be investigated. Anomaly detection technologies and positioning technologies are described and screened in **Tables 5-1** and **5-2**.

5.3.2.2 Munitions and Explosives of Concern Anomaly Investigation

When subsurface anomalies are detected, investigation operations proceed based on the nature and extent of the explosive hazards. Identification of MEC during anomaly investigation may require excavation for removal and disposal. This aspect of technology evaluation is critical because excavation is considered the primary method for investigation of anomalies in the subsurface. The actual nature of buried anomalies cannot be determined without them being uncovered, unless advanced geophysical classification (AGC) methods are used. Non-essential personnel evacuations are necessary within a predetermined minimum separation distance (MSD) when anomaly investigations are being completed. The MSD is based on the munition with the greatest fragmentation distance that may be present within the MRS. All non-essential personnel and the general public must be evacuated from and maintain their distance beyond the MSD during any on-going intrusive operations.

Excavation of anomalies takes place with either hand tools or mechanical equipment, depending on the suspected depth of the object. In the case of the RI, hand tools were used. However, hand tools and/or mechanical equipment may be used for overburden removal to access the target of interest. Once an item has been exposed, it is then inspected, identified, collected (if possible), and transported to a designated area for cataloging and disposal. If it is determined during the inspection that the item is MEC and the risk of moving the item from the field is unacceptable, then it may be necessary to blow-in-place (BIP). For intentional detonations, all personnel must observe the applicable MSD. The MSD may also be reduced if engineering controls such as sand bagging are applied. Removal technologies for anomalies are described and screened in **Table 5-3**.

5.3.2.3 Munitions and Explosives of Concern Disposal Methods

Disposal of recovered MEC can take one of two (2) different forms: remote, on-site demolition and disposal; or in-place demolition and disposal. The decision regarding which of these techniques to use is based on the risk involved in employing the disposal option, as determined by the specific area's characteristics and the nature of the items recovered. If a MEC item is determined to be acceptable to move, the item can be moved to a remote part of the MRS where demolition and disposal can safely take place. For movable items, a countercharge can be used to destroy the item. Engineering controls, such as sandbag mitigation, are often used to reduce fragmentation distances when an item is destroyed in this manner.

Alternatively, MEC may be BIP. This method is typically employed when the risk of moving the item is unacceptable. When a BIP is required, procedures similar to those described above are used to detonate the MEC. Engineering controls are again used to minimize the fragmentation. Disposal technologies are described and screened in **Table 5-4**.

All disposal technologies generate a waste stream, which must be addressed when determining which technologies are most viable. The final waste streams generated by MEC disposal technologies include MDAS with no additional treatment necessary before recycling. Treatment technologies for the waste streams generated by disposal are described and screened in **Table 5-5**.

Table 5-1
MEC Detection Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Leona Heights Rifle Range MRS – Leona Canyon ROSP
Visual Searching	**Medium-High:** Effective for surface removals in open areas with little ground cover. Appropriate for subsurface removals when pits or excavations are opened to observe.	**Medium- High:** Easily implemented by trained UXO Technicians.	**Low:** Lower than other methods that require detection instrumentation and associated equipment.	Not applicable (NA)	Typically supported with analog or digital geophysical detection equipment to aid visual observation.	**Medium - High:** Items on or protruding from the soil surface can be identified.
Flux-Gate Magnetometers: Fluxgate magnetometers measure the vertical component of the geomagnetic field along the axis of the sensor and not the total intensity of the geomagnetic field.	**Medium:** Flux-gate magnetometers have been used as the primary detector in traditional mag and flag and mag and dig operations. There is a high industry familiarization. Detects ferrous objects only.	**High:** Light and compact. Can be used in any traversable terrain. Transportation and logistics requirements are equal to or less than other systems. Widely available from a variety of sources. Minimal to no impacts to cultural or natural resources.	**Low:** A number of flux-gate magnetometers have a low cost for purchase and operation compared to other detection systems. Lower than other methods on most terrains.	Schonstedt GA-52Cx Schonstedt GA-72Cd Foerster FEREX 4.032 Foerster FEREX 4.032 DLG Schonstedt 62-CX Ebinger MAGNEX 120 LW Vallon EL130D1 or 1303D Chicago Steel Tape (Magna-Trak 102)	Analog output not usually co-registered with navigational data – NA if screening excavated material.	**Medium:** This technology has been proven effective, but was not employed during the RI. Effectiveness limited if munitions with low ferrous content are present. Iron-bearing rocks and soils limit effectiveness.
Frequency Domain Electromagnetic Induction (FDEMI) Detectors: These systems are man portable and can detect all-metals. They operate in either time or frequency domain.	**Medium-High:** FDEMI metal detectors are the primary detection system in use when targets can potentially be either ferrous or non-ferrous metal. Discrimination capabilities make them particularly effective in ferrous rich soils. Systems are commonplace throughout the industry.	**High:** Light and compact. Can be used in any traversable terrain. Transportation and logistics requirements are equal to or less than other systems. Widely available from a variety of sources. Minimal to no impacts to cultural or natural resources. Classification possibilities exist among some multi-channel systems.	**Low:** Multiple electromagnetic induction (EMI) all-metals detectors have a low cost for purchase and operation compared to other detection systems, with the exception of the Geophex GEM3, which is average. Lower than other methods on most terrain.	Whites All-Metals Detector Minelabs Explorer II Fisher 1266X Foerster Minex Garrett Geophex GEM3	Analog output not usually co-registered with navigational data – NA if screening excavated material. Digital output should be co-registered with positional data	**High:** This technology has been proven effective during the RI. However, handheld EMI detectors have limited detection depth.
Optically Pumped Magnetometers: This technology is based on the theory of optical pumping and operates at the atomic level as opposed to the nuclear level (as in proton precession magnetometers).	**High:** This is the industry standard technology to detect MEC using magnetic data analysis. There is a high industry familiarization. Detects ferrous objects only. These systems can be used effectively for DGM.	**Medium - High:** Equipment is digital, ruggedized, and weather resistant. Common systems weigh more than most flux-gate systems and are affected by heading error. Can be used in most traversable terrain. Widely available from a variety of sources. Processing and interpretation requires trained specialists. Anomaly classification possibilities are limited to positional accuracy, magnetic susceptibility/ magnetic moment estimates, and depth estimates. Detection capabilities are negatively influenced by iron-bearing soils. Minor impacts to cultural or natural resources based on clearing areas for high quality data collection.	**Medium – High:** Has high purchase cost compared to other technologies. More dependent on terrain than flux-gate magnetometers. Lower costs can be realized when using arrays of multiple detector sensors.	Geometrics G-858 Geometrics G-822 GEM Systems GSMP-40 Scientrex Smart Mag	Digital signal should be co-registered with navigational data for best results.	**Low:** The technology is not effective at the Leona Heights Rifle Range MRS – Leona Canyon ROSP due to steep terrain.

Table 5-1
MEC Detection Technologies
(Continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Leona Heights Rifle Range MRS – Leona Canyon ROSP
Time-Domain Electromagnetic Induction (TDEMI) Metal Detectors: TDEMI is a technology used to induce a pulsed magnetic field beneath the Earth's surface with a transmitter coil, which in turn causes a secondary magnetic field to emanate from nearby objects that have conductive properties. This technology is the industry standard for detecting all-metals.	**High:** TDEMI technology is the industry standard for MEC detection using electromagnetic data analysis. There is a high industry familiarization. Detects both ferrous and non-ferrous metallic objects. Discrimination capabilities make them particularly effective in ferrous rich soils. Can be limited by terrain.	**High:** Sensors are typically larger than digital magnetometers. Can be used in most traversable terrain, common and widely available. Systems in many configurations; from single coil, multi-coil arrays, and three (3)-dimensional transmitter and receiver arrays. The arrays can be deployed using litter, wheeled cart, and towed sled. Processing and interpretation are relatively straightforward. Anomaly classification possibilities exist for multi-channel systems. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Medium:** Has high purchase cost compared to other technologies. Costs per acre are low for multi-coil arrays and increase if terrain dictates a single coil configuration.	Geonics EM61-MK1 Geonics EM61-MK2 Geonics EM61 MK2A Geonics EM61-MK2 HP Geonics EM61-HH Geonics EM63 Zonge Nanotem G-tek TM5-EMU Vallon VMH3 Schiebel AN PSS-12	The EM61 is the industry standard for MMRP DGM surveys. Digital signal should be co-registered with navigational data for best results. Detection depths are highly dependent on coil size (number of turns and wire resistance are important) and transmitter power.	**Low:** This technology has been proven effective; however, there are limitations in difficult and/or steep terrain (> 30 degree slope). Due to the steep terrain at this site, this technology is considered difficult to implement.
Advanced EMI Sensors (AGC): Emerging advanced sensors have the ability to precisely capture measurements from enough locations to sample all principal axis responses of an anomaly/item of interest. This provides the necessary information for analysis and classification of hazardous and nonhazardous items.	**High:** Some may be used in production mode to detect subsurface metallic objects, and all can collect static measurements over a target location to record entire EMI response pattern, Greatest ability of all sensors for the classification of anomalies as either a target of interest or a non-target of interest. Detects both ferrous and non-ferrous metallic objects.	**Low to Medium:** MetalMapper™, TEMTADS, and ALLTEM require the use of a vehicle to tow the sensors to the location of an anomaly. Other sensors are man portable. One (1)-meter-wide coil (or greater) limits accessibility in forested or steeply sloped areas; however, man portable systems have the same accessibility as production-level EMI sensors.	**Medium:** Use of the advanced systems often represents additional surveying and processing costs, which may be largely offset by the decrease in the intrusive investigation costs.	ALLTEM- Berkeley UXO Discriminator (BUD) Handheld BUD Geometrics MetalMapper™ Geometrics MetalMapper™ 2x2 Geonics EM63 TEMTADS TEMTADS MP 2x2 Cart Man-Portable Vector (MPV)	Sensors have greater industry availability and are becoming a more accepted technology for MEC detection and classification. Requires advanced training for operation, data processing, and analysis. Currently only the MetalMapper™ is commercially available. All other systems are in development and testing.	**Medium:** This technology has been demonstrated and validated by the DoD's Environmental Security Technology Certification Program. The technology would be generally difficult to implement in the areas of the MRS with > 30 degree slope.
Airborne Multi- or Hyper- Spectral Imagery: This airborne method uses unique spectral signatures produced by an item to determine the item composition and size. Multispectral techniques can be used because they provide more information than images from common broadband cameras.	**Low:** Detects both metallic and non-metallic objects. Only detects largest MEC or DMM. Requires line of sight. Low industry familiarization. Effectiveness increases when used for wide area assessment in conjunction with other airborne technologies.	**Low:** Requires aircraft and an experienced pilot. Substantial data processing and management requirements. Available from few sources. Minimal to no impacts to cultural or natural resources.	**High:** Aircraft and maintenance costs must be included. Processing costs are higher than other methods. Costs can be low-medium per acres when surveying large areas (>500 acres).	There are few multi/hyper spectral imagery providers.	Few have applied these technologies to detect MEC.	**Low:** Difficult to implement, high cost, only available from a few sources.
Airborne Laser and Infrared (IR) Sensors: IR and laser technologies can be used to identify objects by measuring their thermal energy signatures. MEC or DMM on or near the soil surface may possess different heat capacities or heat transfer properties than the surrounding soil, and this temperature difference theoretically can be detected and used to identify MEC.	**Low:** Detects both metallic and non-metallic objects. Low industry familiarization. Effectiveness increases when used for wide area assessment in conjunction with other airborne technologies.	**Low:** Requires aircraft and an experienced pilot. Poor implementability when vegetation obscures ground features and it cannot image the ground surface. Not used to locate individual targets of interest. Substantial data processing and management requirements. Available from few sources. Minimal to no impacts to cultural or natural resources.	**High:** Aircraft and maintenance costs must be included. Processing costs are higher than other methods. Costs can be low-medium per acres when surveying large areas (>500 acres).	There are few Airborne Laser and IR providers that have experience with MEC.	Few have applied these technologies to detect MEC.	**Low:** Difficult to implement, high cost, only available from a few sources.

Table 5-2
MEC Positioning Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Leona Heights Rifle Range MRS – Leona Canyon ROSP
Differential Global Positioning System (DGPS): GPS is a worldwide positioning and navigation system that uses a constellation of 29 satellites orbiting the Earth. GPS uses these satellites as reference points to calculate positions on the Earth's surface. Advanced forms of GPS, like DGPS, can provide locations to centimeter accuracy.	**Medium**: Very effective in open areas for both digital mapping and reacquiring anomalies. Very accurate when differentially corrected. Not effective in wooded areas or around large buildings. Commonly achieves accuracy to a few centimeters, but degrades when minimum satellites are available.	**High**: Easy to operate and set up. Available from a number of vendors. Better systems are typically ruggedized and very durable. Minor or no impacts to cultural or natural resources. DGPS was used effectively during the RI.	**Medium**: Requires rover and base station units. Survey control points required for high accuracy results.	Leica GPS 1200 Trimble Model 5800 Thales Ashtech Series 6500	Recommended in open areas.	**Medium-High:** This technology is effective at the Leona Heights Rifle Range MRS – Leona Canyon ROSP based upon experience using the equipment during the RI.
Robotic Total Station (RTS): RTS is a laser based survey station that derives its position from survey methodology and includes a servo operated mechanism that tracks a prism mounted on the geophysical sensor.	**Medium - High**: Effective in open areas for both digital mapping and reacquiring anomalies. Effective around buildings and sparse trees. Is being used in heavily wooded areas with moderate success. Commonly achieves accuracy to a few centimeters.	**Medium:** Relatively easy to operate with trained personnel. Requires existing control. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Low:** Operates as a standalone unit. Typically requires survey control points but can be used in a relative coordinate system.	Leica RTS 1100 Trimble Model 5600	Recommended in open areas and in moderately wooded areas. Typically used with TDEMI metal detectors (like Geonics EM61- MK2) and digital magnetometers (like Geometrics G-858).	**Medium – High:** This technology can be used for data positioning for digital detector systems in open to moderately wooded areas.
Fiducial Method: The fiducial method consists of digitally marking a data string with an indicator of a known position. Typically, markers are placed on the ground at known positions (e.g., 25-feet.).	**Medium - High**: Medium to high effectiveness when performed by experienced personnel. Low effectiveness when used by inexperienced personnel. Commonly achieved accuracy is 15-centimeters to 30-centimeters. The fiducial method can be used to establish physical reference points in combination with use of the Odometer Method.	**Medium**: Application requires a constant pace and detailed field notes. Can be used anywhere, with varying degrees of complexity in the operational setup. Minor impacts to cultural or natural resources.	**Low - Medium**: Minimal direct costs associated with this method; however, poor results may negatively impact costs associated with target resolution. Fiducial method requires more "backend" data processing than some other methods.	NA	Requires very capable operators. Useful method if digital positioning systems are unavailable. Primarily considered as a method to be used in combination with the Odometer Method to provide fixed reference points.	**High:** This technology can be used in combination with the Odometer Method to delineate areas for excavation.
Odometer Method: This method utilizes an odometer, which physically measures the distance traveled. Tape measures can also be substituted for vertical distance measurements in excavations.	**Medium**: Medium to high effectiveness when performed by experienced personnel. Low effectiveness when used by inexperienced personnel. Commonly achieved accuracy is 15-centimeters to 30-centimeters in line and 20-centimeters to 80-centimeters on laterals	**Low**: Setup and operation affected by terrain/environment. Requires detailed field notes and setup times can be lengthy. Can be used anywhere, with varying degrees of complexity in the operational setup. Minor or no impacts to cultural or natural resources.	**Low**: Minimal direct costs associated with this method; however, poor results may negatively impact costs associated with target resolution.	NA	Requires very capable operators. Useful method if digital positioning systems are unavailable.	**High:** Terrain will not significantly affect use.

Table 5-3
MEC Removal Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Leona Heights Rifle Range MRS – Leona Canyon ROSP
Hand Excavation: Technique includes digging individual anomalies using commonly available hand tools.	**Medium - High**: This is the industry standard for MEC removal. It can be very thorough and provides an excellent means of data collection.	**Low - Medium**: Hand excavation can be accomplished in almost any terrain and climate. Limited to a practical depth of two (2)-feet bgs or less and by the number of people available. Minimal to no impacts to cultural or natural resources.	**Medium**: It is the standard by which all others are measured.	Probe, trowel, shovel, pick axe	Locally available and easily replaced tools.	**High:** This technology can be used for removal, but limited from a practical standpoint to two (2)-feet bgs or less in depth. This technology was used during intrusive investigation of anomalies during the RI.
Mechanical Excavation of Individual Anomalies: This method uses commonly available mechanical excavating equipment to excavate items to within 12-inches with the remaining soil removal supported by hand excavations.	**Medium - High**: Used in conjunction with hand excavation when soil is too hard causing time delay during hand excavation. Method works well for the excavation of deep single anomalies or test pits to remove overburden.	**Low - High**: Equipment can be rented, is easy to operate, and allows excavation to within 12-inches of anomalies in hard soil. Access to site may be limited in certain areas by terrain (trees, boulders/rocks). Mechanical excavation is not appropriate for items located on or near the surface when hand excavation can be employed. Moderate impacts to cultural and natural resources.	**Low**: In hard soil, this method has a lower cost than that of having the single anomalies hand excavated.	Tracked mini-excavator, excavator, or wheeled backhoe. Multiple manufacturers.	Easy to rent and operate.	**High:** For deep subsurface anomalies not easily accessible by hand excavation. **Low:** For surface anomalies or shallow subsurface anomalies easily accessible by hand excavation.
Mass Excavation and Sifting: This method uses robotics earth moving machinery (EMM) to allow site workers to remain at a safe distance from excavation activities. Once soil has been excavated and transported to the processing area, it is then processed through a series of screening devices and conveyors to segregate MEC from soil.	**High:** Process works very well in heavily contaminated areas. Can separate several different sizes of material, allowing for large quantities of soil to be returned with minimal screening for MEC.	**Low:** Robotic EMM is not widely available. Equipment is harder to maintain and would require trained robotics EMM operators. Not feasible for large explosively-configured munitions. Not feasible for heavily wooded areas with numerous ecosystems that must be protected. Major impacts to cultural and natural resources because roadways, stockpiles, and material laydown areas would need to be established for both earth moving and sifting equipment.	**High:** Robotics EMM equipment is expensive to rent and insure and has the added expense of high maintenance costs. Robotics EMM would also require trained equipment operators.	**Earth Moving Equipment:** There is limited availability of trained operators in the country and providers for robotic EMM equipment, including excavators, off-road dump trucks, and front-end loaders. **Sifting Equipment:** Trommel, shaker, rotary screen from varying manufacturers.	Can be rented from specialty providers; however, the availability is limited. Significant maintenance costs.	**Low:** The availability of equipment and operators is limited and the high cost is prohibitive.
Magnetically Assisted Removal: Magnets are used to separate conductive material from soils.	**Low:** Primarily used in conjunction with mass excavation and sifting operations. Can help remove metal from separated soils, but does not work well enough to eliminate the need to inspect the smaller size soil spoils. Magnetic systems are also potentially useful to help with surface removal of MD and surface debris.	**High:** Magnetic rollers are easily obtained from the sifting equipment distributors and are designed to work with their equipment. Major impacts to cultural and natural resources because roadways, stockpiles and material laydown areas would need to be established for both earthmoving and sifting equipment which support magnetic operations.	**Low:** This method adds very little cost to the already expensive sifting operation.	Magnetic rollers or magnetic pick-ups are available from many manufacturers of the sifting equipment noted above.	Installed by sifting equipment owner.	**Low:** Primarily used in conjunction with mass excavation and sifting operations, which are not required or feasible for the Leona Heights Rifle Range - MRS – Leona Canyon ROSP.

Table 5-4
MEC Disposal Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Leona Heights Rifle Range MRS – Leona Canyon ROSP
BIP: BIP is the destruction of MEC for which the risk of movement beyond the immediate vicinity of discovery is not considered acceptable. Normally, this is accomplished by placing an explosive charge alongside the item.	**High:** Each MEC item is individually destroyed with subsequent results individually verified using quality assurance/QC. BIP yields unconfined releases of MC and MD, which can be restricted using engineering controls.	**Medium:** Field-proven techniques, transportable tools, and equipment; suited to most environments. Human exposure can limit viability of this option. Engineering controls can further improve implementation by limiting damages to natural and cultural resources and nearby structures.	**Medium:** Manpower intensive. Costs increase in areas of higher population densities or structures that may be damaged. Limited accessibility to construct engineering controls increases costs.	Electric or non-electric firing system.	Potential waste streams must be addressed in BIP operations planning.	**High:** Not implemented during the RI, but found effective on other sites.
Consolidated Shots: Consolidated detonations are the collection, configuration, and subsequent destruction by explosive detonation of MEC for which the risk of movement has been determined to be acceptable within a current working MRS.	**Medium - High:** Limited in use to MEC deemed acceptable to move. Detonation yields unconfined releases of MC and MD, which can be restricted using engineering controls.	**Medium – High:** Generally employs the same techniques, tools, and equipment as BIP procedures at a designated location or disposal area.	**Medium:** Manpower intensive, may require materials handling equipment for large-scale operations.	Electric or non-electric firing system.	Potential waste streams must be addressed.	**High:** Preferred over BIP because hazards are more easily controlled. Successfully implemented during the RI.
Contained Detonation Chambers (CDCs) – Stationary: CDCs involve destruction of certain types of munitions in a chamber, vessel, or facility designed and constructed specifically for the purpose of containing blast and fragments. CDCs can only be employed for munitions for which the risk of movement has been determined acceptable.	**Low – Medium:** CDCs successfully contain hazardous components. Current literature reviewed shows containment up to 40 pounds (assume net explosive weight). Commonly used for fuzes and smaller explosive components. Limited in use to munitions that are "acceptable to move." CDCs yield confined releases of MC and MD.	**Low:** Stationary facilities typically must meet regulatory and construction standards for permanent/semi-permanent waste disposal facilities. Such facilities are not commonly used in support of munitions responses. Produce additional hazardous waste streams. Major impacts to cultural and natural resources because roadways and staging areas would need to be established for equipment.	**High:** Siting and construction required. Low feed rates equal more hours on-site. Significant requirements for maintenance of system.	Typically designed on case-by case basis.	System cleaning and maintenance usually requires personal protective equipment (PPE) and worker training. Probable permitting issues with employment of technology. Not necessary at the MRS, common engineering controls are sufficient.	**Low:** Stationary CDCs are not available.
CDCs – Mobile: Same as above.	**Low – Medium:** CDCs successfully contain hazardous components. Commonly used for fuzes and smaller explosive components. May not be used for larger munitions items. Limited in use to MEC "acceptable to move." CDCs yield confined releases of MC and MDAS.	**Low:** Designed to be deployed at the project site. Greatly reduced footprint compared to stationary facilities. Requires substantial additional handling and transport of MEC. Requires items to be safe to move. Flashing furnaces have low feed rates because of safety concerns. Produces additional hazardous waste streams. Major logistical concerns if roadways and staging areas need to be established for equipment.	**Medium – High:** Possible construction required (e.g., berms and pads). Low feed rates equal more hours on site. Significant requirements for maintenance of system.	Donovan Blast Chamber, Kobe Blast Chamber.	System cleaning and maintenance usually requires PPE and worker training. Probable permitting issues with employment of technology. Not necessary at MRS, common engineering controls are sufficient.	**Low:** Mobile CDCs are not available.

Table 5-5
Waste Stream Treatment Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Leona Heights Rifle Range MRS – Leona Canyon ROSP
Chemical Decontamination: Uses chemical processes to eliminate all explosives residues from MEC.	**Low – Medium:** Great variety in chemicals required to decontaminate various MEC fillers (e.g., propellants, pyrotechnics, explosives). Difficult to test for effectiveness. May generate additional waste streams (some hazardous).	**Low:** Requires containment of multiple hazardous materials. May require emissions controls. Worker training and PPE typically required. No mobile systems deployable to MRS exist.	**High:** Specialized manpower, containment requirements, additional waste stream processing.	Supercritical water oxidation. Photocatalysis. Molten salt oxidation.	National Defense Center for Energy and Environment is working on a mobile system, but it treats only scrap metal, not MEC or DMM.	**Low:** No facilities of this type are available or preferred for the munitions types at Leona Heights Rifle Range MRS – Leona Canyon ROSP.
Shredders and Crushers: These technologies use large machines to deform metal components. This results in unusable remnants and overall reduced volume of scrap.	**Low:** Shredders are mainly used to render MDAS as unrecognizable from the shape of military munitions. Residue typically still requires additional treatment to achieve higher decontamination levels.	**Low - Medium:** Typically stationary facilities. Service life and very high maintenance are expected.	**Medium - High:** Specialized equipment and operators; high maintenance; additional waste stream processing.	Shred Tech ST-100H Roll-Off (vehicle mounted).	Disposition of resultant waste streams must be addressed.	**Low:** This process is used for the certified destruction of MDAS.
Thermal Treatment: Decontamination is achieved by exposing debris to high temperatures (between 600 ˚F and 1,400 ˚F) for specified periods of time.	**High:** Furnaces are designed to contain hazardous components. Methods are proven means of attaining high degrees (5X) of decontamination. Commonly used to destroy and decontaminate fuzes and smaller explosive components.	**Low:** Typically stationary facilities. Service life and maintenance are issues. Requires additional handling of MEC. Flashing furnaces have low feed rates because of safety concerns. Produces additional hazardous waste streams.	**High:** Possible construction required. Low feed rates equal more hours on-site. Maintenance of system.	Rotary kiln incinerator. Explosive waste incinerator. Transportable flashing furnace.	System cleaning and maintenance usually requires PPE and worker training. May require permit to deploy technology.	**Low:** No facilities of this type are available. Technology would not be applicable to munitions types at Leona Heights Rifle Range MRS – Leona Canyon ROSP.
Recycling: Required for MDAS and NMD items.	**High:** Very effective for MDAS and NMD.	**High:** Easily implemented if there is a local metal recycler.	**Low – Medium:** Scrap metal may be accepted without cost. Transportation costs will need to be included.	NA	MDAS must be transported and smelted and a certificate of destruction for the completion of the chain of custody of MDAS is required.	**High:** Technology was used for disposal of cultural debris, NMD items, and MDAS during the RI.

5.4 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

A summary of the technologies retained for remedial action alternative development is presented in **Table 5-6**. The general remedial action of MEC removal has been broken down into two (2) remedial alternatives for evaluation:

- Surface removal of MEC – Removal of MEC detected on the ground surface and breaching the ground surface; and
- Subsurface removal of MEC at depths up to 24-inches bgs – Removal of detectable MEC in focused areas or across the entire Leona Heights Rifle Range MRS – Leona Canyon ROSP. This includes surface removal. Depth of detection varies based on the depth, orientation, composition, mass and diameter of MEC, and the detection technology.

It has been determined, due to the steep terrain and thick vegetation at the Leona Heights Rifle Range MRS – Leona Canyon ROSP, that DGM and AGC methods are not applicable for this site and analog (mag and dig) methods have been retained. The detection depth of an all-metals detector (i.e. White's) is 18- 24-inches bgs (including for the practice Stokes mortar). All MEC removal alternatives will include a combination of disposal methods, recycling and LUCs.

Table 5-6
Retained MEC Technologies for the Leona Heights Rifle Range MRS –Leona Canyon ROSP

MEC Detection		MEC Removal	MEC Disposal	
Geophysical Sensors	**Positioning**		**Disposal**	**Waste Stream Treatment**
1. Analog (mag and dig or excavated soil screening), including all-metals (EMI) detectors. The instruments deemed viable are: ▪ Whites XLT ▪ Minelab Explorer II ▪ Vallon VMC1 ▪ Vallon VMH3	1. RTK GPS with fiducial and odometer/ tape measurements in specific areas.	1. Hand excavation of anomalies ≤two (2)–feet deep.	1. A combination of the following methods, based on MEC evaluation in the field by qualified UXO Technicians: ▪ BIP ▪ Consolidation	1. MDAS and NMD recovered from MEC removal and disposal will be sent to a certified recycler and MDAS will be smelted.

Notes:
BIP – blow-in-place
EMI – electromagnetic induction
MEC – munitions and explosives of concern
MDAS – material documented as safe
NMD – non-munitions debris
RTK GPS – real-time kinematic global positioning system
UXO – unexploded ordnance

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6.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Remedial alternatives are developed in this section by assembling the selected remedial technologies from **Section 5.0**. Remedial alternatives must meet the RAO in order to ensure that the selected remedy is protective of human health and the environment and complies with applicable regulations. This section provides a description of each remedial alternative and of how each remedial alternative meets the RAO for the Leona Heights Rifle Range MRS – Leona Canyon ROSP.

The following alternatives have been assembled: 1) a No Action Alternative (NAA); 2) alternatives that include LUCs, (engineering controls, educational controls, and LTM) and 3) MEC removal. Based on these requirements and the technology screening in **Section 5.0**, the following alternatives have been assembled:

- Alternative 1 – NAA;
- Alternative 2 – LUCs;
- Alternative 3 - LUCs and focused surface and subsurface (24-inches bgs) clearance;
- Alternative 4 - LUCs and complete surface and subsurface (24-inches bgs) clearance.

These remedial alternatives are described in the following subsections. CERCLA and the NCP [CERCLA 121(c) and NCP 300.430(f)(4)(ii)] require Five-Year Reviews where unlimited land use is not achieved (USEPA, 2001), which would apply to Alternatives 2 through 4. Recurring reviews determine if a remedial action continues to minimize the hazard and continues to be protective of human health and the environment and provides an opportunity to assess the applicability of new technologies for addressing previous impracticability determinations.

6.1 ALTERNATIVE 1 – NO ACTION ALTERNATIVE

The NAA is carried through the analysis to provide a baseline for comparison to the other alternatives. This alternative does not provide mitigation of hazards, contaminant reduction, monitoring, or LUCs and is the least preferred GRA category. This alternative does not meet the RAO but is required by the NCP. Site access is assumed to be unrestricted and there are no limitations on current or future site use or activities.

6.2 ALTERNATIVE 2 – LAND USE CONTROLS

Alternative 2 includes LUCs for the Leona Heights Rifle Range MRS – Leona Canyon ROSP. Alternative 2 is protective of human health and the environment and meets the RAO, ARARs, and NCP requirements. The remaining potential explosive hazards at the Leona Heights Rifle Range MRS – Leona Canyon ROSP would be mitigated by LUCs to prevent receptors from coming into contact with potential MEC. However, this alternative offers no physical reduction of MEC that potentially exists in the surface or subsurface.

The Alternative 2 LUCs would consist of various engineering and educational controls including:

- Engineering Controls:
    - Warning Signs - located at access points to the Leona Canyon ROSP and along the MRS boundaries at approximately 300 foot intervals totaling 20 signs (**Map A-9, Appendix A**). Sign installation would include a UXO Tech II accompanying site workers.
    - Fencing – located along the southwestern border between the Leona Canyon ROSP and adjacent residential areas.
- Educational Controls
    - Public Notice;
    - Community Awareness Meeting;
    - Letter Notification, Informational Pamphlet, and Fact Sheet; and
    - Website.

Education controls would be conducted once, by the contractor, with information pamphlets and fact sheets kept at strategic locations for public distribution (i.e., local library). Yearly inspections and replacement of signs (ten [10] per year), are included as part of LTM and would substantiate LUC restrictions. Annual inspections, sign replacement, and Five-Year Reviews would be conducted by a contractor, using five (5)-year contracts for a total of six (6) contracts over 30 years. A Five-Year Review is required for this remedy, as it results in hazards remaining at the MRS above levels that allow for unrestricted use (USEPA, 2001). **Map A-9** (**Appendix A**) presents the LUCs associated with Alternative 2.

6.3 ALTERNATIVE 3 – LAND USE CONTROLS AND FOCUSED SURFACE AND SUBSURFACE (24-INCHES BELOW GROUND SURFACE) CLEARANCE

Alternative 3 includes a removal action consisting of MEC detection, removal, and disposal technologies to mitigate the potential explosive hazards at the MRS by clearing a 100-foot buffer zone along the western boundary of the Leona Heights Rifle Range MRS – Leona Canyon ROSP as shown in **Map A-10** (**Appendix A**). The total area within the MRS requiring surface and subsurface MEC removal under this alternative is 3.13 acres. Additionally, LUCs would be implemented as presented in Alternative 2.

Prior to surface and subsurface clearance, vegetation thinning would be required across the 100-foot wide buffer zone. **Map A-11** (**Appendix A**) shows the location and types of vegetation at the MRS. Vegetation thinning would be required on the areas where trees and shrubs are present to allow qualified UXO personnel to access the ground surface. It is estimated that the clearance could be conducted in two (2) days. One (1) UXO Technician II would be required for oversight and MEC avoidance during vegetation thinning.

After vegetation thinning, a full coverage surface and subsurface clearance would be conducted across the 3.13 acres using analog geophysical methods to detect surface and subsurface MEC,

MD, and NMD and intrusive operations to remove buried MEC, MD and NMD. The subsurface clearance operation would be performed by one (1) UXO Team consisting of one (1) UXO Technician III, one (1) UXO Technician II, and one (1) UXO Technician I. Each UXO Technician would operate a handheld EMI all metals detector such as the White's MXT or equivalent to aid in locating surface and subsurface MEC, MD and NMD requiring removal and disposal. A SUXOS would provide overall management of the UXO Team and a UXOSO/UXOQCS would provide quality and safety oversight. UXO Team members would traverse the removal action area adjacent to each other while sweeping the handheld detectors. Munitions-related items and NMD identified in the surface and subsurface would be collected and documented. Subsurface anomalies identified with the handheld detectors would be excavated by qualified UXO personnel using hand tools. It is estimated that the surface and subsurface clearance could be conducted in four (4) days at ~0.75 acres per day.

Qualified UXO personnel would inspect each item to correctly classify as a potential explosive hazard requiring further treatment or MDAS. MD would be segregated from NMD and stored in lockable containers for ultimate transfer to a recycling facility for smelting. Recovered MEC would either be BIP or consolidated for detonation and disposal.

Map A-10 (**Appendix A**) presents the location of the surface and subsurface MEC removal area to 24-inches bgs for Alternative 3.

6.4 ALTERNATIVE 4 – LAND USE CONTROLS AND COMPLETE SURFACE AND SUBSURFACE (24-INCHES BELOW GROUND SURFACE) CLEARANCE

Alternative 4 includes MEC detection, removal, and disposal technologies to eliminate the potential explosive hazard across the entire Leona Heights Rifle Range MRS – Leona Canyon ROSP (31.73 acres) down to 24-inches bgs (**Map A-12, Appendix A**). LUCs would be included as presented in Alternative 2 with the exception of fencing. No fencing would be constructed for Alternative 4.

Prior to surface and subsurface clearance, vegetation thinning would be required across the Leona Heights Rifle Range MRS – Leona Canyon ROSP. **Map A-11** (**Appendix A**) shows the location and types of vegetation at the site. Vegetation thinning would be required on the areas where trees and shrubs are present to allow qualified UXO personnel to access the ground surface. It is estimated that vegetation thinning would take ten (10) days. An UXO Technician II would be required for oversight and MEC avoidance of the vegetation thinning crew.

After vegetation thinning, a full coverage surface and subsurface clearance would be conducted across the 31.73 acres using analog geophysical methods to detect surface and subsurface MEC, MD, and NMD and intrusive operations to remove buried MEC, MD, and NMD. The surface and subsurface clearance operation would be performed by one (1) UXO Team consisting of one (1) UXO Technician III, two (2) UXO Technician II, and five (5) UXO Technician I. Each UXO Technician would operate a handheld EMI all metals detector such as the White's MXT or equivalent to aid in locating subsurface MEC, MD, and NMD requiring removal and disposal. All surface and subsurface anomalies would be investigated. A SUXOS would provide overall

management of the UXO Team and a UXOSO/UXOQCS would provide quality and safety oversight. UXO Team members would traverse the removal action area adjacent to each other while sweeping the handheld detectors and visually inspecting the ground surface. Munitions-related items and NMD identified in the surface and subsurface would be collected and documented. Subsurface anomalies identified with the handheld detectors would be excavated by qualified UXO personnel using hand tools. It is estimated that subsurface clearance would be conducted over 22 work days equating to 1.5 acres per day.

Qualified UXO Technicians would inspect each item to correctly classify it as a potential explosive hazard requiring further treatment or MDAS. MD would be segregated from NMD and stored in lockable containers for ultimate transfer to a recycling facility for smelting. Recovered MEC would either be BIP or consolidated for detonation and disposal.

Map A-12 (**Appendix A**) presents the location of surface and subsurface MEC removal using analog survey methods to 24-inches bgs for Alternative 4.

7.0 DETAILED ANALYSIS OF ALTERNATIVES

The detailed analysis of remedial alternatives consists of the analysis and presentation of the relevant information needed to allow decision makers to select a site remedy, not the decision making process itself. **Section 7.1** describes the criteria by which individual alternatives are analyzed according to the NCP. The individual analysis is provided in **Section 7.**2. The results of the individual analyses are then comparatively evaluated in **Section 7.3** to aid in identifying and assessing relative strengths and weaknesses between the remedial alternatives. This approach to analyzing alternatives is designed to provide decision makers with sufficient information to adequately compare the alternatives, select an appropriate remedy for the site, and demonstrate compliance with the NCP and the CERCLA process.

7.1 DETAILED ANALYSIS CRITERIA

The alternatives are evaluated per the criteria in NCP §300.430(e)(9). The USEPA guidance for conducting RIs and FSs was used in this evaluation (USEPA, 1988). They are arranged into three (3) categories: threshold criteria, balancing criteria, and modifying criteria and are described in the following subsections.

7.1.1 Threshold Criteria

Assessments against the following two (2) criteria relate directly to statutory findings that must ultimately be made in the DD; therefore, these are categorized as "threshold" criteria since an alternative may not be implemented without meeting them. These two (2) criteria are listed below and described in the following subsections:

- Overall protectiveness of human health and the environment; and
- Compliance with ARARs.

7.1.1.1 Overall Protectiveness of Human Health and the Environment

This criterion assesses whether the alternatives can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the MRS by eliminating, reducing, or controlling exposure. Overall protection of human health and the environment draws on the attainment of RAOs and assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Additionally, a MEC HA was conducted for each alternative in the Final RI Report (WESTON, 2017). The MEC HA has been updated for this FS and is included in **Appendix C**. The scores are included in the analysis of each alternative.

7.1.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

This criterion assesses whether the alternatives attain Federal or state ARARs or provides grounds for invoking a waiver. Potential site-specific ARARs are presented in **Section 4.0**. Final ARARs and compliance determinations will be made in consultation with Stakeholders (USACE, ARNG, CAARNG, and California Department of Toxic Substance Control) in the DD.

7.1.2 Balancing Criteria

The following five (5) "balancing criteria" are grouped together because they represent the primary criteria upon which the individual and comparative analyses are based. The balancing criteria are listed below and described in the following subsections:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

7.1.2.1 Long-Term Effectiveness and Permanence

The assessment of alternatives against this criterion evaluates the long-term effectiveness of alternatives in maintaining protection of human health and the environment after response objectives have been met. The assessment includes the magnitude of residual risk from untreated waste or treatment residuals and the adequacy and reliability of controls used to manage untreated wastes or treatment residuals.

For MRSs with potential explosives hazards, the ability to maintain protection of human health and the environment over time will typically fall into categories associated with LUCs. The evaluation of long-term effectiveness and permanence of LUCs will take into account the administrative feasibility of maintaining the LUCs and the potential risk/hazard should they fail, as well as mechanisms like the CERCLA Five-Year Review process to evaluate on a periodic basis the long-term effectiveness and permanence, as well as protectiveness, of the alternative.

7.1.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion assesses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the MRS. Factors that will be considered, as appropriate, include the following:

- Treatment or recycling processes the alternatives employ and the materials they will treat;
- Amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;

- Degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reduction(s) are occurring;
- Degree to which the treatment is irreversible;
- Type and quantity of residuals that will remain following treatment; and
- Degree to which treatment reduces the inherent hazards posed by the principal threats at the MRS.

For MRSs where the treatment options are generally limited to certain disposal options (BIP, consolidated shot, containerized version of these), the destruction of the MEC will be considered as constituting treatment that reduces the amount of MEC recovered. This is analogous to reduction in volume. Mobility in the context of hazardous, toxic, and radioactive waste treatment, where a hazardous substance is immobilized, does not have a direct analogy for MEC. Mobility may be considered a function of the ease of moving MEC. Transport mechanisms include: 1) picking up or moving of potential MEC by a person(s); 2) disturbance of potential MEC during construction, excavation, or other soil moving activities; and 3) natural processes such as erosion/deposition, uptake or frost heave, gravity, hydrologic effects, or degradation. Each process may affect movement of MEC from its original depth or location. To the extent that MEC is detected, recovered, and disposed of, its ability to move is reduced. MEC remaining after a removal activity would maintain its ability to move, based on the physical processes described above, and should be accounted for.

7.1.2.3 Short-Term Effectiveness

This criterion assesses the short-term impacts of alternatives considering the following:

- Short-term risks that might be posed to the community during implementation of an alternative;
- Potential impacts on workers during remedial action and the effectiveness and reliability of mitigation measures during implementation;
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and
- Time until remedial protection is achieved.

In addition, for MEC, safety considerations will include an evaluation of what is available from an administrative standpoint (e.g., access) and what is available from a technical standpoint (e.g., setbacks; are buildings too close for demolition; what will it take to bring the correct resources to the MRS to mitigate hazards of a demolition operation).

7.1.2.4 Implementability

This criterion assesses the ease or difficulty of implementing the alternatives by considering the following types of factors as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.
- Administrative feasibility, including activities needed to coordinate with other offices and agencies, and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions).
- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

7.1.2.5 Cost

The NCP requires the assessment of the following cost categories:

- Capital costs, including both direct and indirect costs;
- Annual operation and maintenance (O&M) costs; and
- Net present value of capital and O&M costs.

Both capital and O&M costs will be considered, where appropriate. The evaluation will include those O&M costs that will be incurred for as long as necessary, even after the initial remedial action is complete. In addition, potential future remedial action costs will be considered during alternatives evaluation to the extent that can be defined.

Present value analyses will be used during alternatives evaluation to assess expenditures that occur over different time periods. By discounting all costs to a common base year, the costs for different technologies/alternatives can be compared based on a single figure for each alternative. Included in each cost calculation is an estimate as to the amount of time that will be necessary to complete the proposed alternative.

Present value cost is the total cost of an alternative over time in terms of today's dollar value. Costs have been rounded to the nearest thousand dollars and estimates are expected to be accurate within a range of +50% to -30%. **Appendix B** presents the basis of the cost estimates. The costs developed for each alternative are based on vendor quotes, literature values, professional experience, and engineering judgment. The level of detail utilized in these elements is considered appropriate for choosing between alternatives, but the estimates are not intended for use in detailed budget planning.

Final costs will depend on actual labor and material costs, actual MRS conditions, market conditions, final project scope, final project schedule, productivity, and other variable factors. As a result, the final costs will vary from the estimates presented in this FS; however, these factors should not affect the relative cost differences between the alternatives.

7.1.3 Modifying Criteria

The final two (2) criteria, the "modifying factors," will be evaluated following receipt of comments on the FS and the PP. These criteria are listed below and described in the following subsections:

- Regulatory acceptance; and
- Community acceptance.

7.1.3.1 Regulatory Acceptance

This assessment reflects the state's (or support agency's) apparent preferences among or concerns about alternatives.

7.1.3.2 Community Acceptance

This assessment reflects the community's apparent preferences among or concerns about alternatives. Prior to remedy selection, the community is provided with an opportunity to review the FS and subsequent PP during the public comment period. The public is also given the opportunity to express concerns and comments during a community meeting, which is usually held during the public comment period.

7.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

The individual analysis of each of the four (4) alternatives based on the criteria described above is provided in this section.

7.2.1 Alternative 1 – No Action Alternative

7.2.1.1 Overall Protectiveness of Human Health and the Environment

The NAA would not decrease the potential risks to human health or the environment and does not meet the RAO for the MRS. This alternative would leave potential MEC on the MRS and offer no controls to prevent exposure to explosive hazards.

The MEC HA conducted for the FS for the Leona Heights Rifle Range MRS – Leona Canyon ROSP (**Appendix C**), assuming no action, produced a score of 870 with a hazard level category of one (1) (highest hazard potential.

7.2.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

The identified ARARs and TBCs (**Table 4-1**) would only apply to alternatives that include active remediation. Therefore, since there are no actions under this alternative, Alternative 1 would not meet this criterion.

7.2.1.3 Long-Term Effectiveness and Permanence

This alternative would not provide long-term effectiveness or permanence. The RAO would not be met initially as potential MEC hazards would still be present on the MRS and nothing would be done to prevent direct contact with current and future receptors, and controls would not be implemented to maintain protection of human health or the environment.

7.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative would not reduce the source of risk, which is potential surface and subsurface MEC. Therefore, there would be no reduction of the number and density of MEC, and as a result Alternative 1 would not meet this criterion.

7.2.1.5 Short-Term Effectiveness

The short-term effectiveness of this alternative is high because no remedy would be implemented under the NAA. No site work would be conducted that would pose a hazard to human health or the environment, including workers and the community, during the construction and implementation of the remedy.

7.2.1.6 Implementability

No activities are proposed; therefore, the alternative would be technically and administratively implementable.

7.2.1.7 Cost

There are no costs associated with Alternative 1.

7.2.1.8 Regulatory Acceptance

This subsection is reserved for the inclusion of regulatory comments. Comments or approval will be incorporated into the final document.

7.2.1.9 Community Acceptance

This subsection is reserved for the inclusion of public participation or community stakeholder comments. Solicitation of community involvement in the decision making of a final remedy is sought with the PP.

7.2.2 Alternative 2 – Land Use Controls

7.2.2.1 Overall Protectiveness of Human Health and the Environment

This alternative is protective of human health through fencing and signage (**Map A-9, Appendix A**) identifying the potential MEC hazard area and minimizing interaction of all users with MEC, in addition to educational controls to raise public awareness resulting in increased protection for

human health. However, signage and fencing may not keep all trespassers out of the restricted area at all times. Through LTM, land use would be monitored and restricted, protecting human health and the environment. Together, these technologies would be sufficient to meet the RAO for the MRS. There would be minimal impacts to the environment during fencing and sign installation under Alternative 2.

Assuming LUCs, the MEC HA conducted for the FS for the Leona Heights Rifle Range MRS – Leona Canyon ROSP (**Appendix C**) produced a score of 830 with a hazard level category of two (2) (high hazard potential) with category one (1) (highest hazard potential) being the most severe.

7.2.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

The identified ARARs and TBCs (**Table 4-1**) would only apply to alternatives that include active remediation. Therefore, since ARARs do not apply to Alternative 2, they were not considered.

7.2.2.3 Long-Term Effectiveness and Permanence

Alternative 2 would not provide a permanent remedy. However, the RAO would be met under this alternative as site receptors would be informed of and protected from direct contact with potential surface and subsurface MEC. LUCs administered under Alternative 2 would meet long-term effectiveness but would be contingent on the cooperation and active participation of the existing powers and authorities of government agencies. The remedial design would specify steps and controls to be put in place that will ensure that the LUCs, including signs and fences, are maintained. Construction support required and CERCLA Five -Year Reviews would be conducted to assess the MRS condition and the degree of protectiveness to human health and the environment.

7.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

No treatment would be provided; therefore, there would be no reduction of the number and density of MEC potentially present at the Leona Heights Rifle Range MRS – Leona Canyon ROSP. Therefore, this alternative would not meet this criterion.

7.2.2.5 Short-Term Effectiveness

Land disturbance associated with installation of warning signs and fencing would be minimal and short-term (less than one [1] month). There may be a slight increase in risk to contractor personnel during physical installation, depending on where signs and fences are posted. Otherwise, there would be no additional risk to contractors because there are no other construction or operation activities associated with Alternative 2. In addition, there are no short-term risks to the community or workers associated with the development of educational materials. Therefore, this alternative would meet this criterion.

7.2.2.6 Implementability

Design and implementation of administrative LUCs and maintaining a public information program would require coordination between the USACE, ARNG, and CAARNG. However, there may be some administrative implementability concerns since the properties are not under the control of the DoD. Fencing, signs and educational materials and services are readily available. Therefore, LUCs would be technically and administratively feasible, thereby meeting this criterion. Additionally, annual site inspections would be conducted as part of the LTM during which the condition of the signage will be assessed. These tasks are realistically achievable.

7.2.2.7 Cost

The estimated cost for this alternative includes the capital cost associated with installing the fencing and signage and implementing educational controls, creating planning documents, and site closure (No Further Action Explosive Safety Submission). Periodic costs include those associated with annual site inspections and Five-Year Reviews required for CERCLA sites for years 5, 10, 15, 20, 25, and 30. A summary of costs is shown in **Table 7-1**. A detailed breakdown of costs is included in **Appendix B**.

Table 7-1
Alternative 2 Cost Summary

Cost Type	Total Cost
Capital Cost	$272,000
Annual O&M Cost	$306,000
Periodic Cost	$74,000
Total Present Value Cost	**$652,000**

Notes:
O&M – Operation and Maintenance

7.2.2.8 Regulatory Acceptance

This subsection is reserved for the inclusion of regulatory comments. Comments or approval will be incorporated into the final document.

7.2.2.9 Community Acceptance

This subsection is reserved for the inclusion of public participation or community stakeholder comments. Solicitation of community involvement in the decision making of a final remedy is sought with the PP.

7.2.3 Alternative 3 – Land Use Controls and Focused Surface and Subsurface (24-Inches below Ground Surface) Clearance

7.2.3.1 Overall Protectiveness of Human Health and the Environment

This alternative would protect human health and through fencing, signage, educational controls, and removing the potential surface and subsurface MEC hazard from a focused area (3.13 acres) within the Leona Heights Rifle Range MRS – Leona Canyon ROSP (**Map A-10, Appendix A**). The focused area is located in the area most likely to contain MEC and most likely to see human receptors. Therefore, this alternative would prevent direct contact with receptors in those areas and would meet the RAO for the MRS. However, the potential for MEC to remain outside the focused area would remain. Additionally, the environment would be affected by vegetation removal in the focused area to allow UXO Technicians to access the ground surface and subsurface during clearance.

The MEC HA conducted for the FS for the Leona Heights Rifle Range MRS – Leona Canyon ROSP (**Appendix C**) produced a score of 505 with a hazard level category of four (4) (low hazard potential) with category one (1) (highest hazard potential) being the most severe.

7.2.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

Surface and subsurface removal of potential MEC would be performed to comply with the ARARs in **Table 4-1**.

7.2.3.3 Long-Term Effectiveness and Permanence

Focused surface and subsurface removal (to 24-inches bgs) of MEC would provide long-term effectiveness by permanently removing potential remaining munitions on the ground surface or in the subsurface to 24-inches bgs in a focused area. However, potential MEC at the surface and in the subsurface could remain in other areas and potentially below 24-inches bgs. Therefore, Alternative 3 would not provide a permanent remedy. However, LUCs would provide additional long-term effectiveness; however, as noted in Alternative 2, effectiveness would be contingent on the cooperation and active participation of the existing powers and authorities of government agencies. Together, the LUCs and focused removal would meet the RAO of minimizing human exposure to potential MEC. Construction support and CERCLA Five-Year Reviews would be conducted to assess the MRS condition and the degree of protectiveness to human health and the environment.

7.2.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Focused surface and subsurface (to 24-inches bgs.) removal across Leona Heights Rifle Range MRS – Leona Canyon ROSP, followed by disposal and recycling of recovered MEC and MD, would reduce the number (or volume) of explosives hazards. The presence and mobility of potential surface and subsurface MEC items in remaining areas (areas not included in Alternative 3) would not be reduced. LUCs would not reduce the volume or mobility of MEC.

7.2.3.5 Short-Term Effectiveness

There would be an increased risk to workers while the removal action is conducted (estimated at one [1] month duration). The increased risk to the community during the removal action would be mitigated, where possible, by the use of engineering controls and/or evacuations and/or road closures to maintain MSDs. The risk to workers and the community associated with MEC that need to be BIP would be greater than the risk associated with consolidation because it is more difficult to control the area around an item. Items that are acceptable to move can be disposed of in a more controlled environment. LUCs would not increase risk to workers or the public.

7.2.3.6 Implementability

Surface and subsurface removal of MEC along investigative transects and grids was implemented effectively during the RI. As vegetation thinning would be required in some areas, vegetation thinning is implementable and equipment is readily available. However, it is unclear if stakeholders would agree to vegetation thinning. Regarding MEC disposal, BIP is more difficult to implement than consolidation because it is more difficult to control the area around an item. It may also be more difficult to transport engineering controls to the MEC for BIP demolition than to a consolidation area that may be more accessible. LUCs would be technically and administratively feasible as described in Alternative 2. Therefore, Alternative 3 would be technically and administratively feasible, thereby meeting this criterion.

7.2.3.7 Cost

The estimated cost for this alternative includes capital costs associated with LUCs, vegetation thinning, and the removal, detonation, and recycling of potential MEC which includes significant engineering controls and health and safety documents, reviews, and plans to implement work. Additionally, costs include site closure efforts (After Action Report and Removal Action Report). Periodic costs include those associated with annual site inspections and Five-Year Reviews required for CERCLA sites for years 5, 10, 15, 20, 25, and 30. A summary of costs is shown in **Table 7-2**. A detailed breakdown of costs is included in **Appendix B**.

Table 7-2
Alternative 3 Cost Summary

Cost Type	Total Cost
Capital Costs	$701,000
Annual O&M Costs	$306,000
Periodic Costs	$74,000
Total Present Value Cost	**$1,081,000**

Notes:
O&M – Operation and Maintenance

7.2.3.8 Regulatory Acceptance

This subsection is reserved for the inclusion of regulatory comments. Comments or approval will be incorporated into the final document.

7.2.3.9 Community Acceptance

This subsection is reserved for the inclusion of public participation or community stakeholder comments. Solicitation of community involvement in the decision making of a final remedy is sought with the PP.

7.2.4 Alternative 4 – Land Use Controls and Complete Surface and Subsurface (24-Inches below Ground Surface) Clearance

7.2.4.1 Overall Protectiveness of Human Health and the Environment

This alternative would protect human health by removing potential MEC hazards in the surface and subsurface (up to 24-inches bgs) across the entire Leona Heights Rifle Range MRS – Leona Canyon ROSP (**Map A-12, Appendix A**) and would meet the RAO for the MRS. The environment would be affected by vegetation thinning across the entire Leona Canyon ROSP in order to allow UXO Technicians to access the ground surface and subsurface during the clearance.

The MEC HA conducted for the FS for the Leona Heights Rifle Range MRS – Leona Canyon ROSP (**Appendix C**) produced a score of 475 with a hazard level category of four (4) (low hazard potential) with category one (1) (highest hazard potential) being the most severe.

7.2.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

Potential surface and subsurface MEC clearance would be performed to comply with the ARARs in **Table 4-1**.

7.2.4.3 Long-Term Effectiveness and Permanence

Alternative 4 would be the most effective of the four (4) alternatives over the long term because potential MEC would be removed from the surface and the subsurface (to 24-inches bgs) across the entire Leona Canyon ROSP. LUCs would provide additional long-term effectiveness; however, as noted in Alternative 2, effectiveness would be contingent on the cooperation and active participation of the existing powers and authorities of government agencies. Together, the LUCs and complete removal would meet the RAO of minimizing human exposure to potential MEC. Construction support and CERCLA Five-Year Reviews would be conducted to assess the MRS condition and the degree of protectiveness to human health and the environment.

7.2.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 would reduce the toxicity, mobility and volume of potential MEC across the entire MRS by removing the potential MEC hazards from the surface and subsurface (to 24-inches bgs). However, a low potential for MEC below 24-inches bgs would remain.

7.2.4.5 Short-Term Effectiveness

There would be an increase in risk to workers while the removal action is conducted (estimated at two [2] months). The increased risk to the community during the removal action would be mitigated, where possible, by the use of engineering controls and/or evacuations to maintain MSDs. The risk to workers and to the community associated with MEC that need to be BIP would be greater than the risk associated with consolidation because it is more difficult to control the area around an item. Items that are acceptable to move can be disposed of in a more controlled environment. The risk to the community during the disposal could be mitigated by the use of engineering controls and/or evacuations to maintain MSDs. LUCs would not increase risk to workers or the public.

7.2.4.6 Implementability

Surface and subsurface removals of MEC were implemented effectively during the RI. Clearance activities would be complicated on the steep slopes, which could cause safety hazards for the site workers, and would make the use of specialized equipment difficult. However, safety lines could be used to conduct visual sweeps for MEC in areas with steep slopes. As vegetation thinning would be required in some areas, vegetation thinning is implementable and equipment is readily available. However, it is unclear if local authorities would agree to vegetation thinning. Regarding MEC disposal, BIP is more difficult to implement than consolidation because it is more difficult to control the area around an item. It may also be more difficult to transport engineering controls to the MEC items for BIP demolition than to a consolidation area that may be more accessible. LUCs would be technically and administratively feasible as described in Alternative 2.

Therefore, Alternative 4 would be technically and administratively feasible, thereby meeting this criterion.

7.2.4.7 Cost

The estimated cost for this alternative includes capital costs associated with LUCs, vegetation thinning, and the removal, detonation, and recycling of potential MEC, including significant engineering controls and health and safety documents, reviews, and plans to implement work along steep slopes. Additionally, costs include site closure efforts (After Action Report and Removal Action Report). A summary of costs is shown in **Table 7-3**. A detailed breakdown of costs is included in **Appendix B**.

Table 7-3
Alternative 4 Cost Summary

Cost Type	Total Cost
Capital Costs	$1,488,000
Annual O&M Costs	$306,000
Periodic Costs	$74,000
Total Present Value Cost	**$1,868,000**

Notes:
O&M – Operation and Maintenance

7.2.4.8 Regulatory Acceptance

This subsection is reserved for the inclusion of regulatory comments. Comments or approval will be incorporated into the final document.

7.2.4.9 Community Acceptance

This subsection is reserved for the inclusion of public participation or community stakeholder comments. Solicitation of community involvement in the decision making of a final remedy is sought with the PP.

7.3 COMPARATIVE ANALYSIS OF ALTERNATIVES

The results of the alternatives analysis are compared to identify the key tradeoffs among them, and identify their strengths and weaknesses relative to one another. The alternatives are evaluated against each of the nine (9) criteria and the alternatives are then compared to one another to identify their relative performance against the nine (9) criteria. This approach to analyzing alternatives is designed:

- To provide decision makers with sufficient information to adequately compare the alternatives;
- To select an appropriate remedy for the MRS; and
- To demonstrate satisfaction of the CERCLA remedy selection requirements.

The comparative analysis of the alternatives is provided in **Table 7-4**. A numerical score is applied to each of the nine (9) categories, with zero (0) being the least preferred and three (3) being the most preferred. The cumulative scores are totaled for evaluation of overall evaluation criteria.

Table 7-4
Comparative Analysis of Alternatives

Detailed Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	NAA	**LUCS**	**LUCs and Focused Surface and Subsurface (24-inches bgs) Clearance**	**LUCs and Complete Surface and Subsurface (24-inches bgs) Clearance**
Description	Per the NCP, the NAA is included for baseline comparison	Protecting receptors by limiting access to MEC using LUCs	Protecting receptors by removing potential MEC in focused areas and using LUCs	Protecting receptors by removing the potential MEC hazard across the MRS to 24-inches and implementing LUCs
Overall Protectiveness of Human Health and the Environment	0	1	2	2
Compliance with ARARs	0	0	3	3
Long-Term Effectiveness and Permanence	0	1	2	3
Reduction of Toxicity, Mobility, or Volume through Treatment	0	0	2	3
Short-Term Effectiveness	3	2	1	0
Implementability	3	3	2	1
Cost (Total Present Value)	3 $0	2 $652,000	1 $1,081,000	0 $1,868,000
Total Score	**9**	**9**	**13**	**12**

Notes:
ARAR – applicable or relevant and appropriate requirement
LUC – land use control
MEC – munitions and explosives of concern
MRS – Munitions Response Site
NAA – no action alternative
NCP – National Oil and Hazardous Substances Contingency Plan

This FS presents four (4) possible remedial alternatives to address the potential MEC at the Leona Heights Rifle Range MRS – Leona Canyon ROSP. Each alternative has been evaluated for effectiveness, implementability, and cost relative to current comparable technologies. A detailed evaluation of each alternative was then performed per NCP §300.430(e)(9) and CERCLA criteria. The final step is for stakeholders and decision makers to review the comparative analysis (each criterion is assigned a numerical score) and select the most appropriate remedial alternative. The preferred remedy will be documented in the PP and the public will have a chance to review and comment on the proposed remedy. The selected remedy will be documented in the DD.

Table 7-5 summarizes the total scores received by each of the alternatives in the comparative analysis as presented in **Section 7.3**, and **Table 7-4.** Of the four (4) alternatives, Alternative 3 received the highest total score (most preferable alternative). This alternative is protective of human health and the environment through LUCs (fencing, signage identifying the MEC hazard area and educational controls), in addition to plans to manage the potential MEC through focused surface and subsurface clearance. Through LTM, land use would be monitored and restricted, protecting human health.

Table 7-5
Comparative Analysis Scoring Summary

Alternative	Comparative Analysis Score
Alternative 1 – NAA	9
Alternative 2 – LUCs	9
Alternative 3 – LUCs and Focused Surface and Subsurface (to 24-inches bgs) Clearance	13
Alternative 4 – LUCs and Complete Surface and Subsurface (24-inches bgs) Clearance	12

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8.0 REFERENCES

40 Code of Federal Regulations (CFR) 300.

42 United States Code 9601-9675. Comprehensive Environmental Response and Liability Act.

Department of the Army Pamphlet (AP), 2013. *Ammunition and Explosives Safety Standards*, 385-64, Rapid Action Revision (RAR), 10 October.

Department of Defense (DoD), 2005. *Explosives Safety Management and the DoD Explosives Safety Board*, DoD Directive (DoDD) 6055.9E, U.S. Department of Defense, Washington, D.C. 19 August.

DoD, 2015. *Material Potentially Presenting an Explosive Hazard*, DoD Instruction (DoDI) 4140.62, U.S. Department of Defense, Washington, D.C. 20 August.

DoD, 2012. DoD Manual 6055.09-M. *DoD Ammunition and Explosives Safety Standards: General Explosives Safety Information and Requirements.* 29 February 2008. Administratively Reissued 04 August 2010. Incorporating Change 1, 12 March 2012.

DoD, 2015. *DoD Instruction 4140.62, Material Potentially Presenting and Explosive Hazard (MPPEH).* August 20.

Department of Defense Explosives Safety Board (DDESB), 2009. *Technical Paper 16, Methodologies for Calculating Primary Fragment Characteristics*. Rev. 3, Alexandria Virginia.

EA Science, Engineering, and Technology, Inc. (EA), 2009. *Final State/Territory Inventory Report, National Guard Bureau, Non-Department of Defense Owned Non-Operational Defense Sites Inventory, California.* May.

United States Army, 2009. *Final Military Munitions Response Program, Munitions Response Remedial Investigation/Feasibility Study Guidance*. Final. Department of the Army Headquarters, Washington, D.C. November.

United States Army Corps of Engineers (USACE), 2000. April 24. *Engineer Pamphlet 1110-1-18 Engineering and Design Ordnance and Explosives Response*, Washington, DC.

USACE, 2011. Huntsville Center Technical Information HNC-ED-CS-S-98-7 (Amendment 1), *Use of Sandbags for Mitigation of Fragmentation and Blast Effects due to Intentional Detonation of Munitions*. February.

USACE, 2013a. Contract No. W912DR-09-D-0006, Delivery Order 0011, Multiple Award Environmental Services. September 23.

USACE, 2013b. Contract No. W912DR-09-D-0006, Delivery Order 0011, Mod. 01. Multiple Award Environmental Services. September 30.

USACE, 2013c. *Explosives Safety and Health Requirements Manual (EM 385-1-97).* 12 April.

USACE 2015. *Technical Guidance for Military Munitions Response Actions, Engineering Manual (EM) 200-1-15,* U.S. Army Corps of Engineers, Washington, D.C. 30 October.

United States Environmental Protection Agency (USEPA), 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*. EPA/540/G-89/004. October.

USEPA, 1989. *The Feasibility Study, Development and Screening of Remedial Action Alternatives.* Directive 9355.3-01FS3. November.

USEPA, 2001. *Comprehensive Five-Year Review Guidance.* United States Environmental Protection Agency. Office of Emergency Remedial Response. EPA 540-R-01-007. June.

Western Region Climate Center. wrcc.dri.edu. 'Oakland, CALIFORNIA - Climate Summary'. N.p., 2015. Web. 25 June 2015.

Western Region Climate Center, 2017a. California, Average Wind Speed, OAKLAND INTL AP ASOS [KOAK]. Accessed on 18 July 2017 from: https://wrcc.dri.edu/htmlfiles/westwind.final.html#CALIFORNIA

Western Region Climate Center, 2017b. California, Prevailing Wind Direction, OAKLAND INT'L AP, CA (KOAK). Accessed on 18 July 2017 from: https://wrcc.dri.edu/htmlfiles/westwinddir.html#CALIFORNIA

Weston Solutions, Inc. (WESTON), 2011. *Final Historical Records Review/Site Inspection Work Plan for California, Army National Guard Munitions Response Sites, Site Inspection Phase*. September.

WESTON, 2012. *Final Site Inspection Report, Army National Guard Munitions Response Sites, Site Inspection Phase, California*. August 2012.

WESTON, 2016. *Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Non-DOD Non-Operational Defense Sites, Remedial Investigation/Feasibility Study Program. Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California*. May 2016.

WESTON, 2017. *Final Remedial Investigation Report, MMRP Munitions Response Services, National Guard Bureau, Non-DoD Non-Operational Defense Sites, Remedial Investigation/Feasibility Study Program, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California.* May 2017.

APPENDIX A

SITE MAPS

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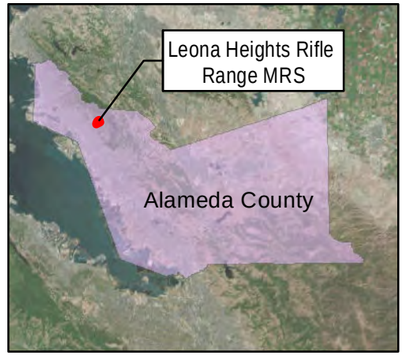

Legend

- Leona Heights Rifle Range MRS
- Road
- California State Boundary
- Alameda County

Acronyms:
MRS - Munitions Response Site

N
W E
S

0 1 2
Miles

1 inch = 2 miles

Leona Heights Rifle Range MRS Location

Leona Heights Rifle Range MRS Feasibility Study Report	Map A-1

WESTON SOLUTIONS
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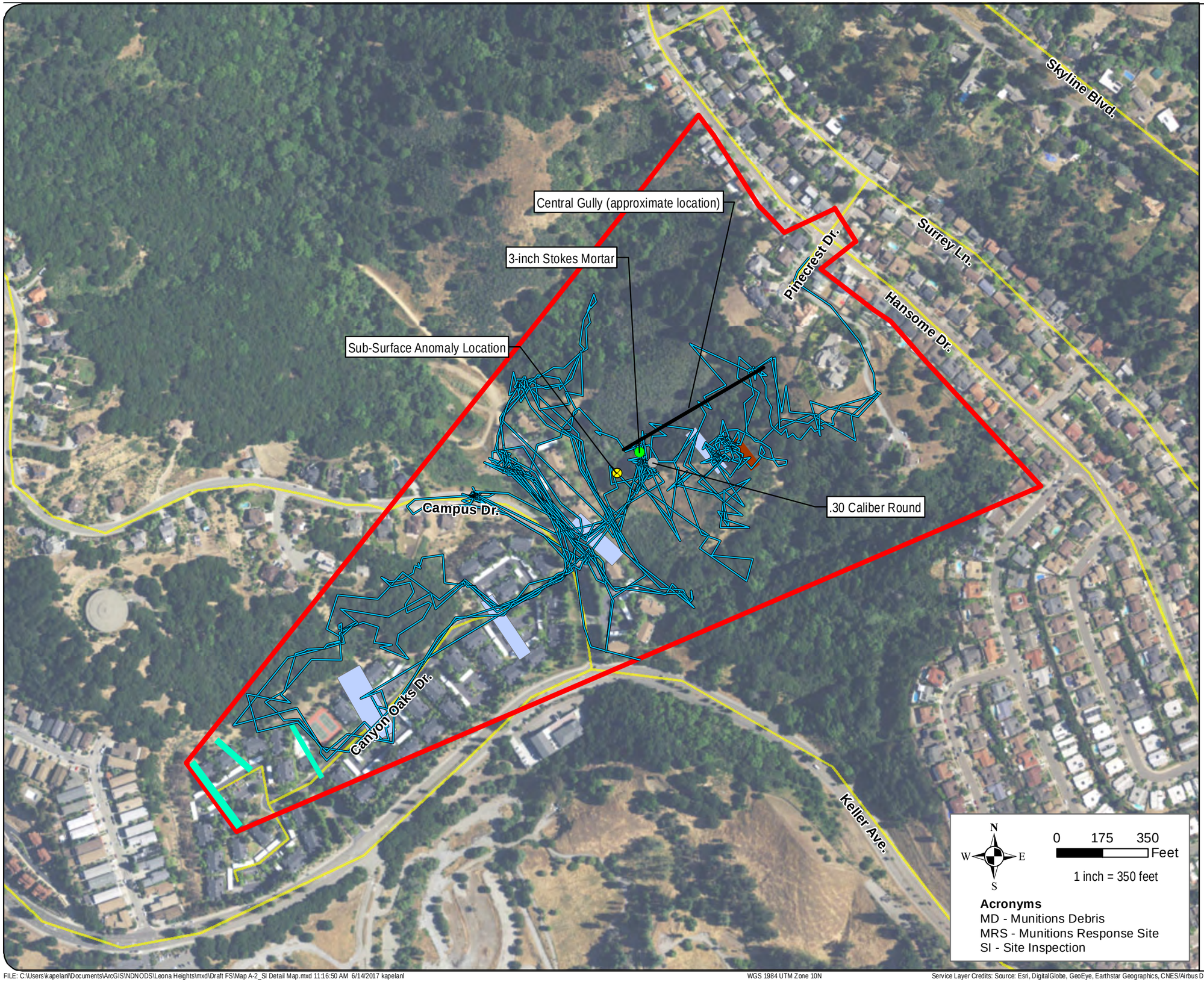

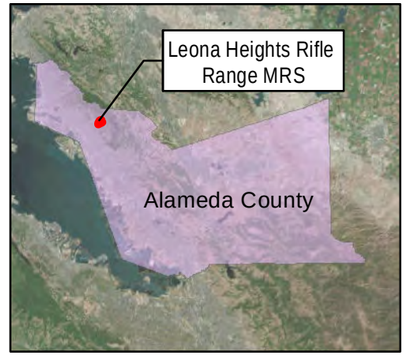

Legend

- MD - 3-inch Stokes Mortar
- .30 Caliber Round
- Sub-Surface Anomaly Location
- Road
- SI Visual Instrument Aided Survey Transects
- Firing Line
- Target Area
- Target System Trench
- Leona Heights Rifle Range MRS

N W E S

0 175 350 Feet

1 inch = 350 feet

Acronyms
MD - Munitions Debris
MRS - Munitions Response Site
SI - Site Inspection

SI Visual Instrument Aided Survey

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-2

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WGS 1984 UTM Zone 10N
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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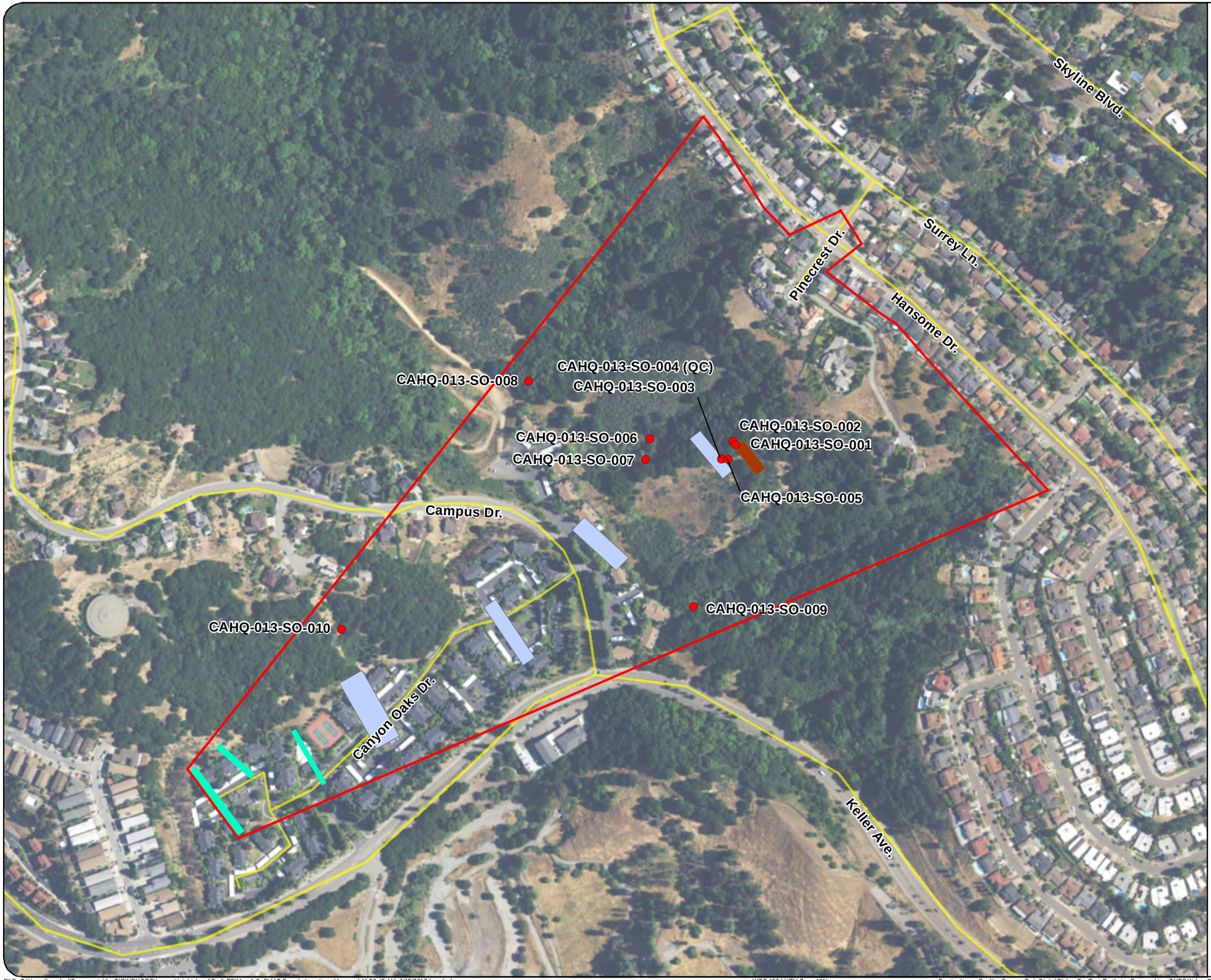

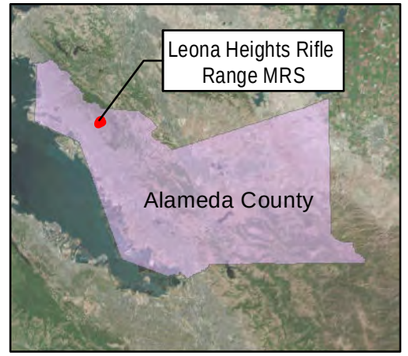

Legend

- Sample Location
- Road
- Firing Line
- Target Area
- Target System Trench
- Leona Heights Rifle Range MRS

Acronyms

MC - Munitions Constituents
MRS - Munitions Response Site
SI - Site Inspection

N
W E
S

0 175 350 Feet

1 inch = 350 feet

SI MC Sample Locations

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-3

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WGS 1984 UTM Zone 10N
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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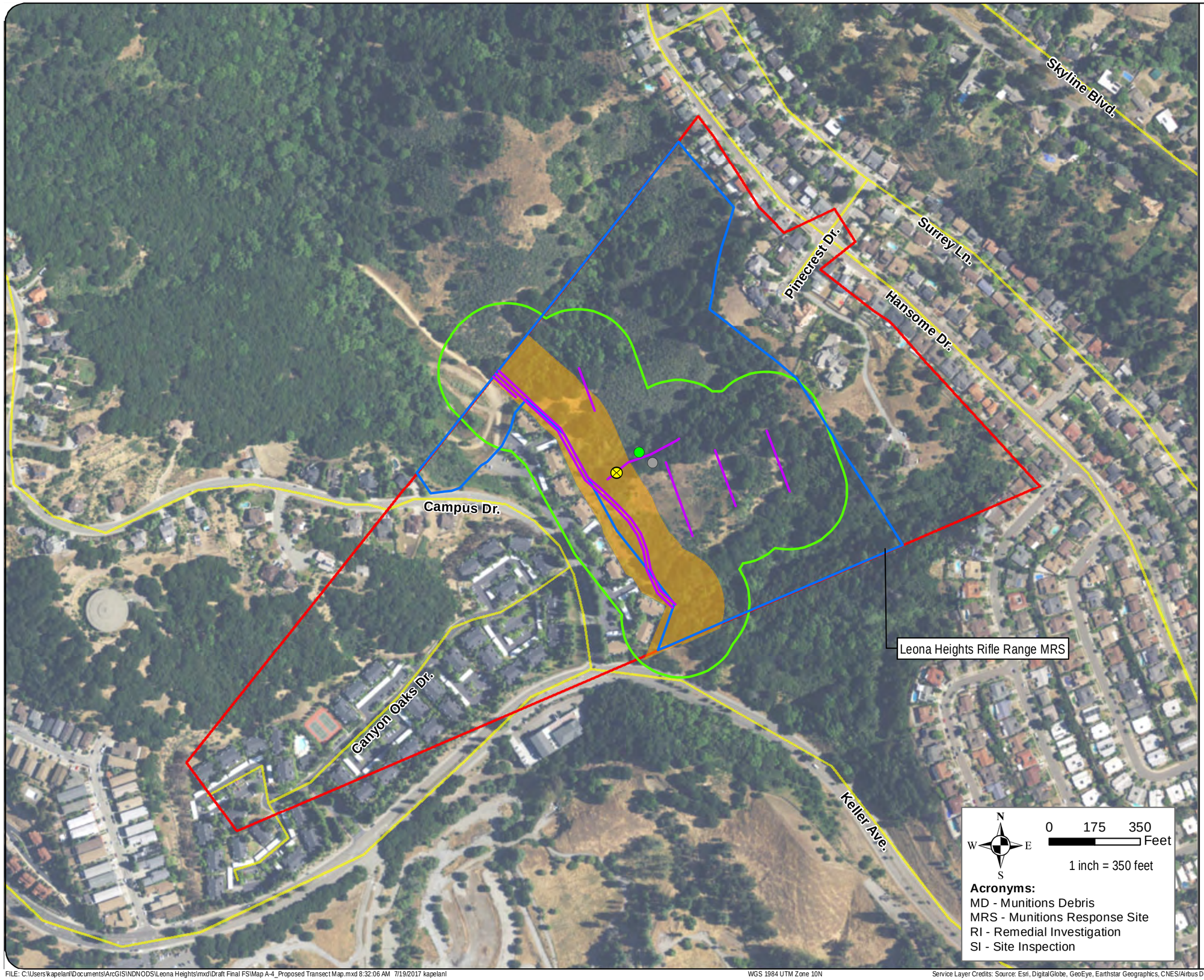

Legend

- MD - 3-Inch Stokes Mortar (SI)
- .30 Caliber Round (SI)
- Sub-Surface Anomaly Location (SI)
- Road
- Proposed Transect (3,971 feet)
- Hazardous Fragment Distance (225 feet)
- Leona Canyon Regional Open Space Preserve
- Leona Heights Rifle Range MRS
- Evacuation Work Area (225 feet)

N
W E
S

0 175 350 Feet

1 inch = 350 feet

Acronyms:
MD - Munitions Debris
MRS - Munitions Response Site
RI - Remedial Investigation
SI - Site Inspection

RI Exclusion Zone and Evacuation Work Area

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-4

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WGS 1984 UTM Zone 10N
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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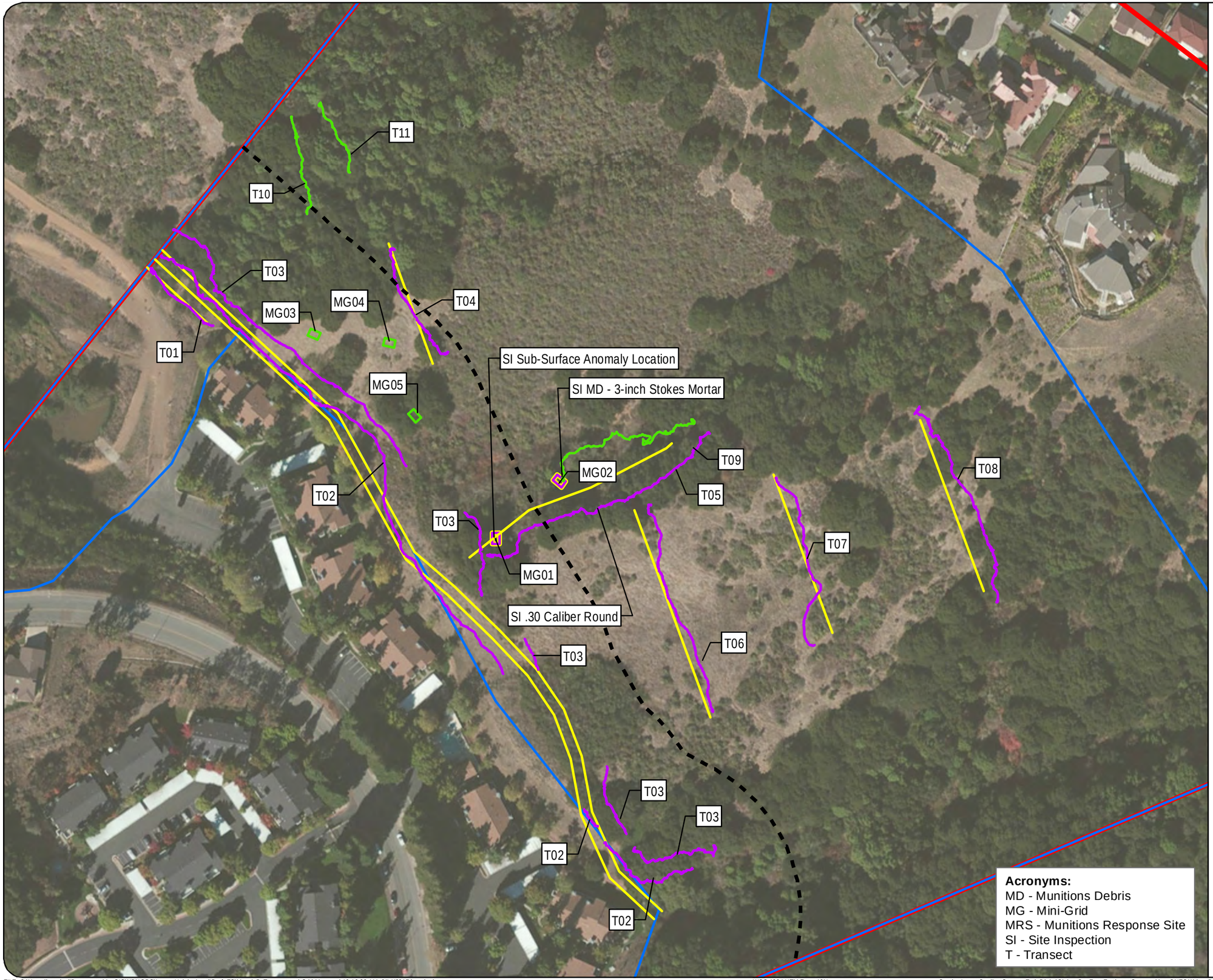

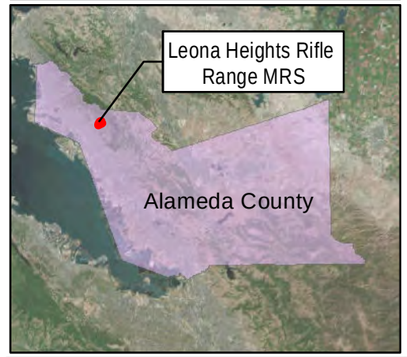

Legend

- Evacuation Work Area Boundary (225 feet)
- Actual Transects and Mini-Grids
- Additional Transects and Mini-Grids
- Proposed Transects and Mini-Grids
- Leona Heights Rifle Range MRS
- Leona Canyon Regional Open Space Preserve

N W E S

0 75 150 Feet

1 inch = 125 feet

Acronyms:
MD - Munitions Debris
MG - Mini-Grid
MRS - Munitions Response Site
SI - Site Inspection
T - Transect

Proposed and Actual Transects and Mini-Grids

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-5

WESTON SOLUTIONS
841 BISHOP STREET SUITE 2301 HONOLULU, HAWAII 96813 808.275.2000

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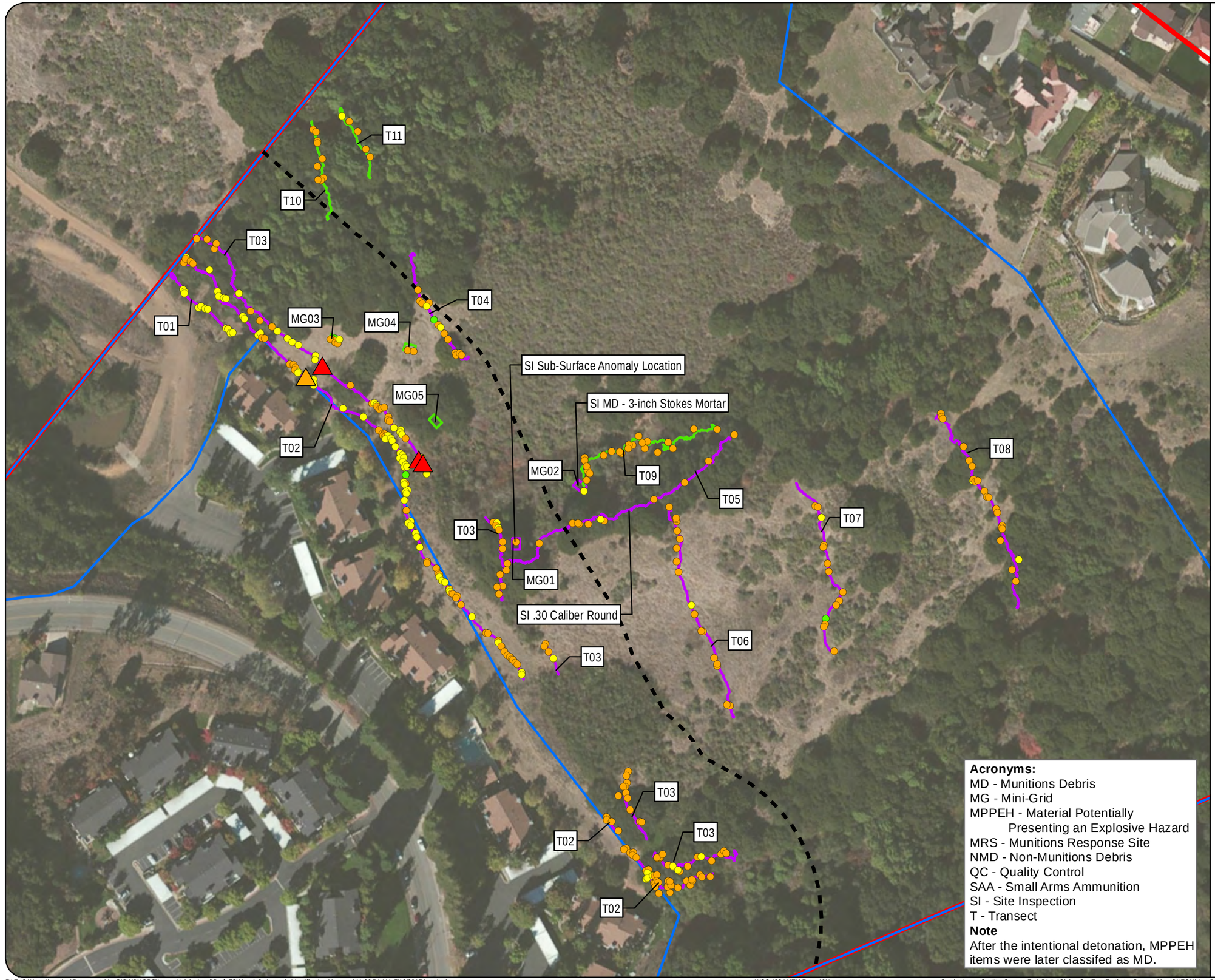

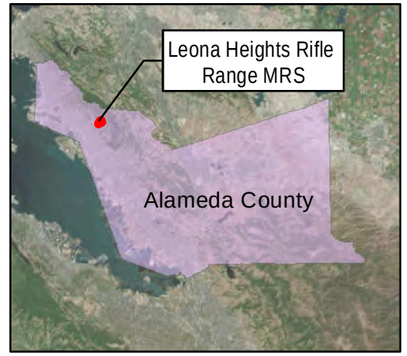

Legend

- MPPEH (n=3)
- MD (n=1)
- NMD (n=102)
- SAA (n=245)
- QC SEED (n=4)
- Evacuation Work Area Boundary (225 feet)
- Actual Transects and Mini-Grids
- Additional Transects and Mini-Grids
- Leona Heights Rifle Range MRS
- Leona Canyon Regional Open Space Preserve

N W E S

0 75 150 Feet

1 inch = 125 feet

Acronyms:
MD - Munitions Debris
MG - Mini-Grid
MPPEH - Material Potentially Presenting an Explosive Hazard
MRS - Munitions Response Site
NMD - Non-Munitions Debris
QC - Quality Control
SAA - Small Arms Ammunition
SI - Site Inspection
T - Transect

Note
After the intentional detonation, MPPEH items were later classifed as MD.

Anomaly Identification

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-6

WESTON SOLUTIONS
841 BISHOP STREET SUITE 2301 HONOLULU, HAWAII 96813 808.275.2900

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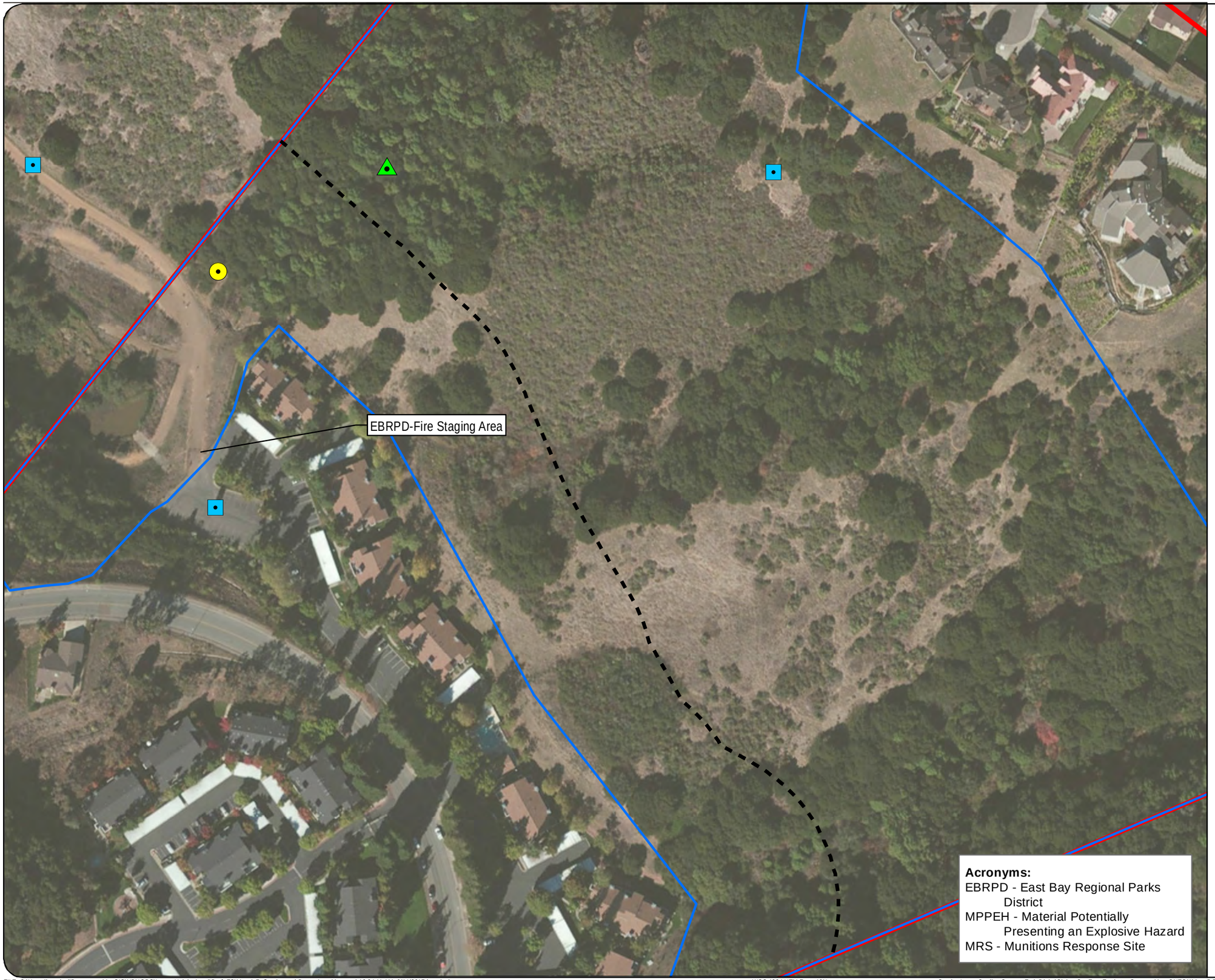

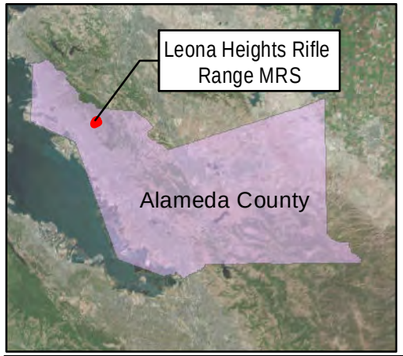

Legend

- Exclusion Zone Personnel
- Demolition Area
- MPPEH Staging Area
- Evacuation Work Area Boundary (225 feet)
- Leona Heights Rifle Range MRS
- Leona Canyon Regional Open Space Preserve

N
W E
S

0 75 150 Feet

1 inch = 125 feet

Acronyms:
EBRPD - East Bay Regional Parks District
MPPEH - Material Potentially Presenting an Explosive Hazard
MRS - Munitions Response Site

MPPEH Staging and Demolition Areas

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-7

WESTON SOLUTIONS
841 BISHOP STREET SUITE 2301 HONOLULU, HAWAII 96813 808.275.2900

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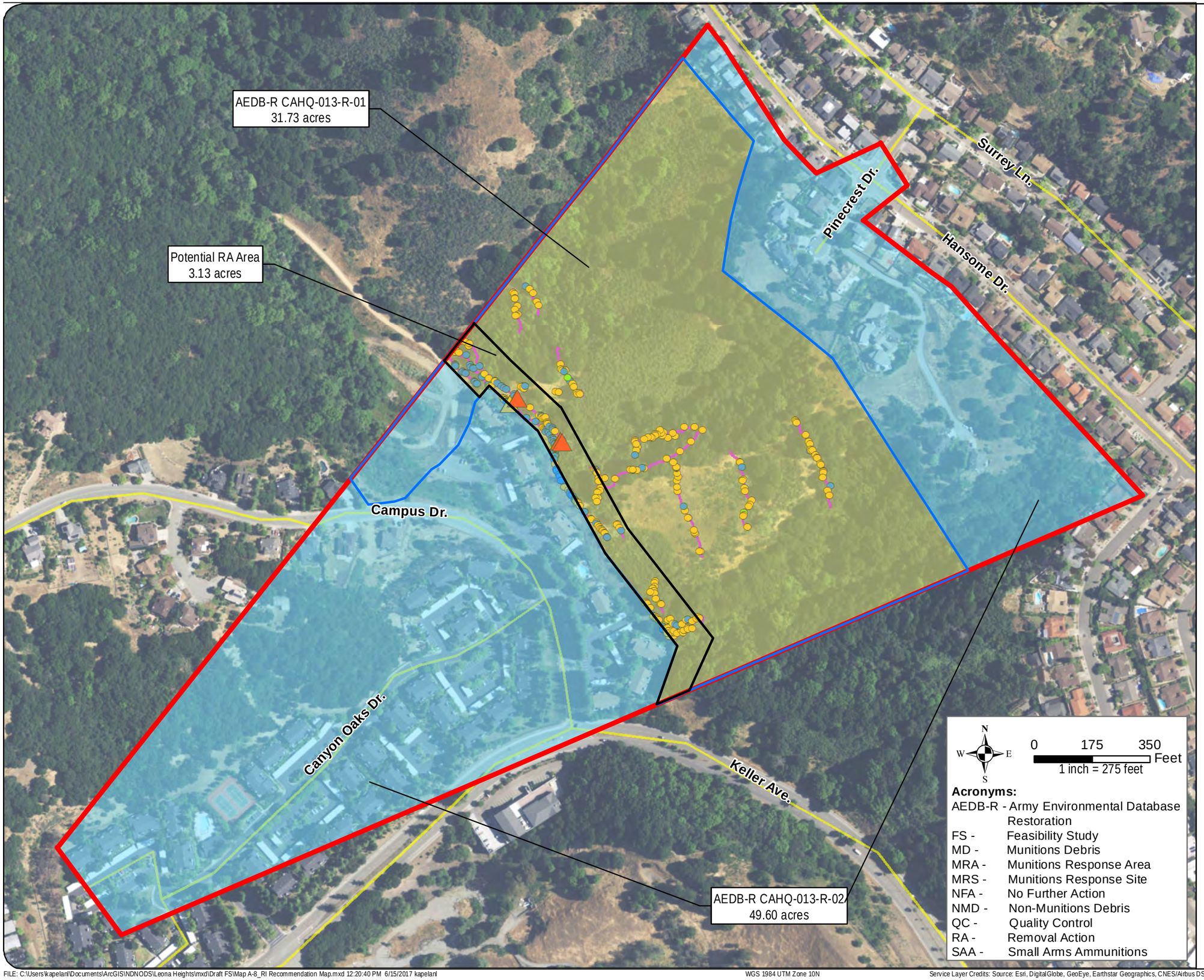

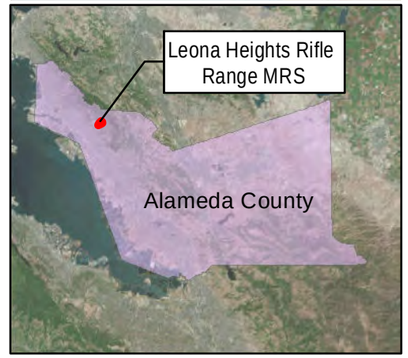

Legend

- Transect
- Road
- Evacuation Work Area Boundary (225 feet)
- Leona Heights Rifle Range MRS - Leona Caonyon ROSP (31.73 acres) AEDB-R CAHQ-013-R-01
- Leona Heights Rifle Range MRS - Developed Area (49.60 acres) AEDB-R CAHQ-013-R-02
- Potential RA Area (3.13 acres)
- Leona Heights Rifle Range MRA
- Leona Canyon Regional Open Space Preserve
- MD
- NMD
- SAA
- QC SEED

N W E S

0 175 350 Feet

1 inch = 275 feet

Acronyms:

AEDB-R - Army Environmental Database Restoration
FS - Feasibility Study
MD - Munitions Debris
MRA - Munitions Response Area
MRS - Munitions Response Site
NFA - No Further Action
NMD - Non-Munitions Debris
QC - Quality Control
RA - Removal Action
SAA - Small Arms Ammunitions

Remedial Investigation Recommendation

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-8

WESTON SOLUTIONS
841 BISHOP STREET SUITE 2301 HONOLULU, HAWAII 96813 808.275.2900

DRAWN	DATE	CONTRACT NO.
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Leona Heights Rifle Range MRS - Leona Canyon ROSP
AEDB-R CAHQ-013-R-01
31.73 acres

Educational Controls
Public Notice
Community Awareness Meeting
Letter Notification
Information Pamphlet
Fact Sheet
Website

Leona Heights Rifle Range MRS - Developed Areas
AEDB-R CAHQ-013-R-02
49.60 acres

Surrey Ln.
Pinecrest Dr.
Hansome Dr.
Campus Dr.
Canyon Oaks Dr.
Keller Ave.

Legend
- Warning Sign
- Fence (actual location may be limited by topography)
- Road
- Leona Heights Rifle Range MRS - Leona Canyon ROSP (31.73 acres) AEDB-R CAHQ-013-R-01
- Leona Heights Rifle Range MRS - Developed Area (NFA Area - 49.60 acres) AEDB-R CAHQ-013-R-02
- Leona Heights Rifle Range MRA
- Leona Canyon ROSP

N W E S
0 175 350 Feet
1 inch = 275 feet

Acronyms:
AEDB-R - Army Environmental Database Restoration
MRA - Munitions Response Area
MRS - Munitions Response Site
NFA - No Further Action
ROSP - Regional Open Space Preserve

Alternative 2
Land Use Controls

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-9

WESTON SOLUTIONS
841 BISHOP STREET SUITE 2301 HONOLULU, HAWAII 96813 808.275.2900

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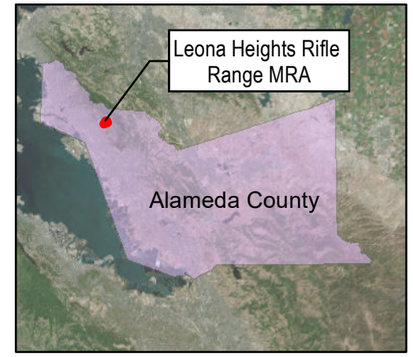
Leona Heights Rifle Range MRS - Leona Canyon ROSP
AEDB-R CAHQ-013-R-01
31.73 acres

Educational Controls
Public Notice
Community Awareness Meeting
Letter Notification
Information Pamphlet
Fact Sheet
Website

Focused Surface and Subsurface Clearance to 24-inches bgs (3.13 acres)

Leona Heights Rifle Range MRS - Developed Areas
AEDB-R CAHQ-013-R-02
49.60 acres

Pinecrest Dr.
Surrey Ln.
Hansome Dr.
Campus Dr.
Canyon Oaks Dr.
Keller Ave.



Legend
- Warning Sign
- Fence (actual location may be limited by topography)
- Road
- Surface and Subsurface Clearance to 24-inches bgs (3.13 acres)
- Leona Heights Rifle Range MRS - Leona Canyon ROSP (31.73 acres) AEDB-R CAHQ-013-R-01
- Leona Heights Rifle Range MRS - Developed Area (NFA Area - 49.60 acres) AEDB-R CAHQ-013-R-02
- Leona Heights Rifle Range MRA
- Leona Canyon ROSP

N W E S
0 175 350 Feet
1 inch = 275 feet

Acronyms:
AEDB-R - Army Environmental Database Restoration
bgs - below ground surface
LUC - land use control
MRA - Munitions Response Area
MRS - Munitions Response Site
NFA - No Further Action
ROSP - Regional Open Space Preserve

Alternative 3 - LUCs and Focused Surface and Subsurface Clearance to 24-Inches Below Ground Surface

Leona Heights Rifle Range MRS Feasibility Study Report

Map **A-10**

WESTON SOLUTIONS
841 BISHOP STREET SUITE 2301 HONOLULU, HAWAII 96813 808.275.2900

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MACMILS	9/25/2017	0011

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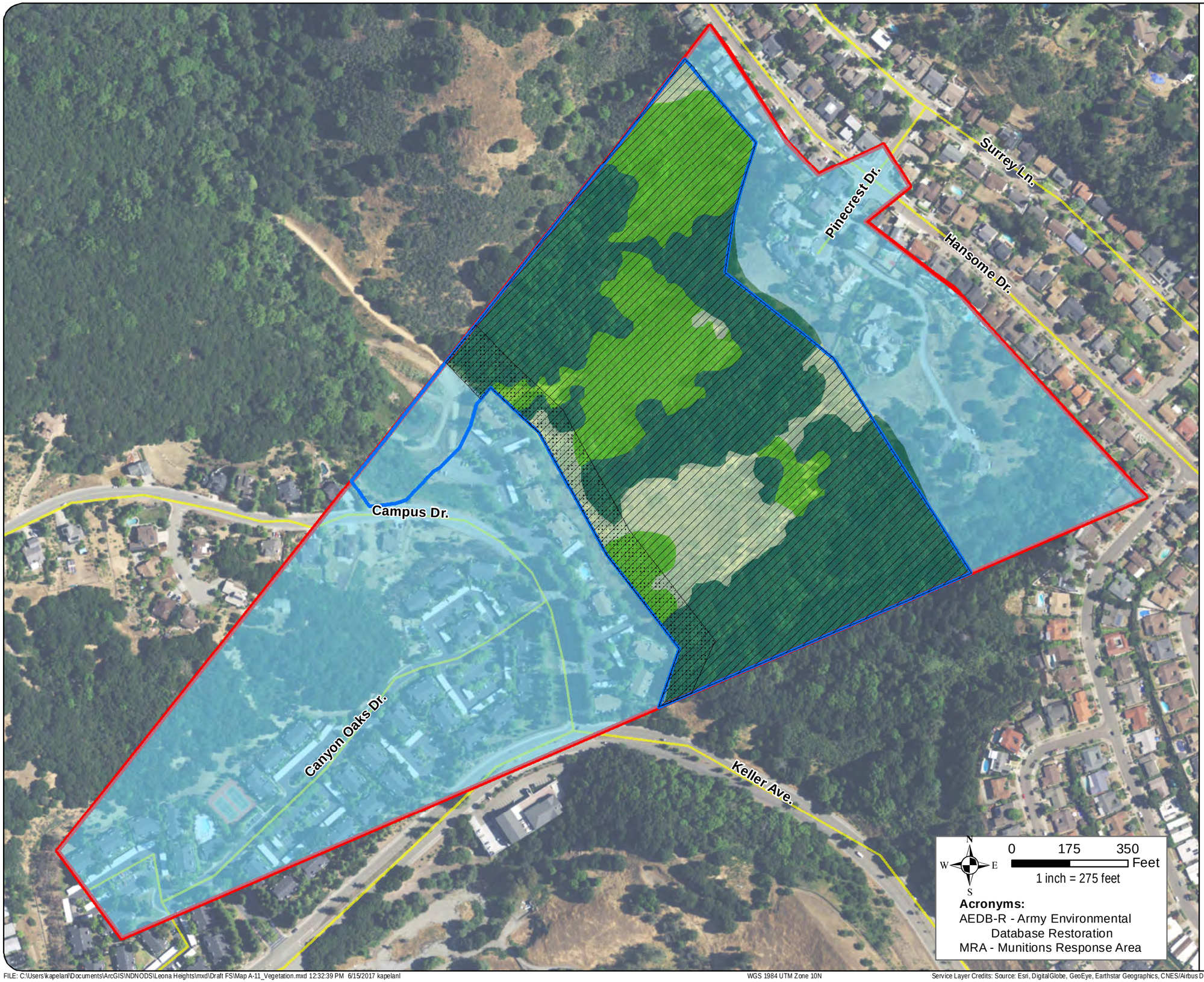

Legend

- Road
- Grass (slender oat,etc.)
- Shrubs (blackberry, buckwheat, etc.)
- Trees (live oak, etc.)
- Hardscape
- Alternative 3 Clearance Area
- Alternative 4 Clearance Area
- Leona Canyon Regional Open Space Preserve
- Leona Heights Rifle Range MRA

N
W E
S

0 175 350 Feet

1 inch = 275 feet

Acronyms:

AEDB-R - Army Environmental Database Restoration

MRA - Munitions Response Area

Vegetation Features

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-11

WESTON SOLUTIONS
841 BISHOP STREET SUITE 2301 HONOLULU, HAWAII 96813 808.275.2900

DRAWN	DATE	CONTRACT NO.
KAPELANL	6/15/2017	W912DR-09-D-0006
CHKD BY	CHKD DATE	DELIVERY ORDER NO.
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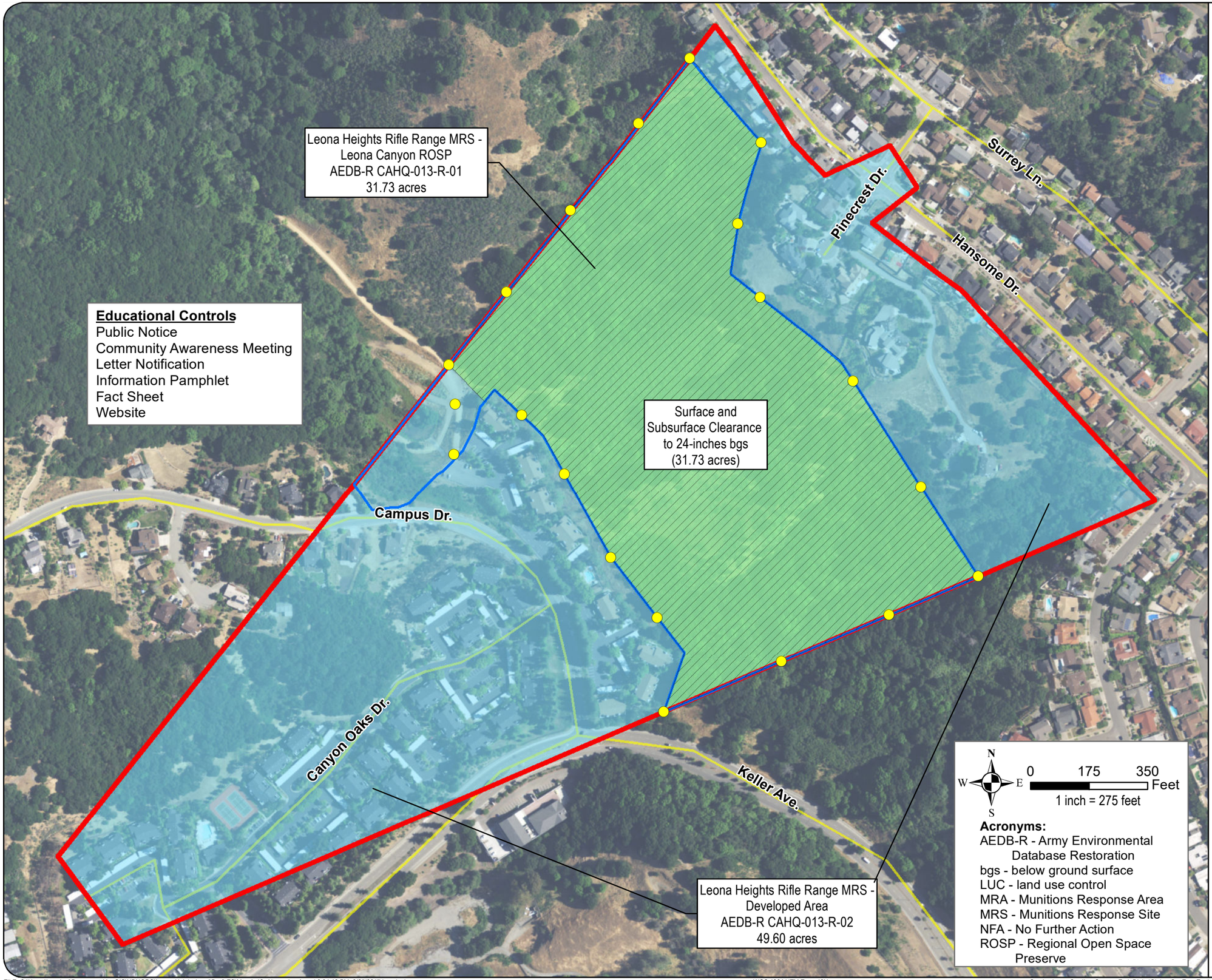

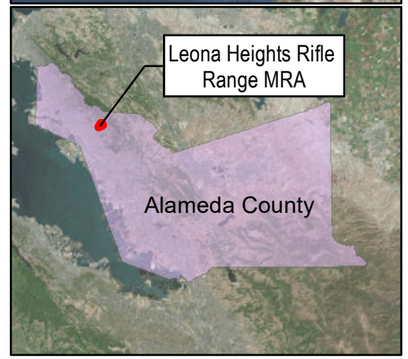

Legend

- Warning Sign
- Road
- Surface and Subsurface Clearance to 24-inches bgs (31.73 acres)
- Leona Heights Rifle Range MRS - Leona Canyon ROSP (31.73 acres) AEDB-R CAHQ-013-R-01
- Leona Heights Rifle Range MRS - Developed Area (NFA Area - 49.60 acres) AEDB-R CAHQ-013-R-02
- Leona Heights Rifle Range MRA
- Leona Canyon Regional Open Space Preserve

N, W, E, S

0 175 350 Feet

1 inch = 275 feet

Acronyms:

AEDB-R - Army Environmental Database Restoration
bgs - below ground surface
LUC - land use control
MRA - Munitions Response Area
MRS - Munitions Response Site
NFA - No Further Action
ROSP - Regional Open Space Preserve

Alternative 4 - LUCs and Surface and Subsurface Clearance to 24-inches Below Ground Surface

Leona Heights Rifle Range MRS Feasibility Study Report

Map A-12

WESTON SOLUTIONS
841 BISHOP STREET SUITE 2301 HONOLULU, HAWAII 96813 808.275.2900

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KAPELANL	9/25/2017	W912DR-09-D-0006
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APPENDIX B

COST ESTIMATION

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Leona Heights Rifle Range MRS - Leona Canyon ROSP — Cost Breakout

Site: Leona Heights Rifle Range MRS - Leona Canyon Regional Open Space Preserve
Location: Alameda County, California
Phase: Feasibility Study (-30% to +50%)
Base Year: 2017
Date: October 2017

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Remedial Design	**Cost**	**Cost**	**Cost**	**Cost**
Management Plan	$ -	$ 37,842	$ 107,540	$ 107,540
Removal Action	**Cost**	**Cost**	**Cost**	**Cost**
No Further Action Explosive Safety Submission	$ -	$ 10,000	$ -	$ -
LUC Implementation (Educational Controls - Facts Sheets, Public Meetings, etc.)	$ -	$ 92,027	$ 92,027	$ 92,027
LUC Implementation (Engineering Controls - Warning Signs)	$ -	$ 8,610	$ 8,610	$ 8,610
LUC Implementation (Engineering Controls - Fencing)	$ -	$ 50,615	$ 50,483	$ -
Explosive Safety Submission	$ -	$ -	$ 25,323	$ 25,323
Mobilization	$ -	$ -	$ 6,337	$ 11,885
Vegetation Thinning	$ -	$ -	$ 19,933	$ 370,565
Surface and Subsurface Munitions and Explosives of Concern Removal	$ -	$ -	$ 18,768	$ 192,929
Material Documented as Safe Removal	$ -	$ -	$ 2,473	$ 2,473
Demobilization	$ -	$ -	$ 6,337	$ 11,314
Site Management	$ -	$ -	$ 18,200	$ 96,730
After Action Report	$ -	$ -	$ 69,720	$ 71,760
Removal Action Report	$ -	$ -	$ 86,462	$ 96,115
Subtotal	**$ -**	**$ 199,095**	**$ 512,214**	**$ 1,087,272**
Contingency - 15%	$ -	$ 29,864	$ 76,832	$ 163,091
Subtotal	**$ -**	**$ 228,959**	**$ 589,047**	**$ 1,250,363**
Permitting - 1%	$ -	$ 2,290	$ 5,890	$ 12,504
Project Management - 8%	$ -	$ 18,317	$ 47,124	$ 100,029
Construction Management - 10%	$ -	$ 22,896	$ 58,905	$ 125,036
REMEDIAL DESIGN AND REMOVAL ACTION TOTAL	**$ -**	**$ 272,462**	**$ 700,965**	**$ 1,487,932**
Long Term Management	**Cost**	**Cost**	**Cost**	**Cost**
LUCs Maintenance	$ -	$ 305,300	$ 305,300	$ 305,300
Five-Year Review Report (for 30 years)	$ -	$ 74,204	$ 74,204	$ 74,204
LONG TERM MANAGEMENT TOTAL	$ -	$ 379,504	$ 379,504	$ 379,504
TOTAL	**$0**	**$652,000**	**$1,081,000**	**$1,868,000**

Alternative 1 - No Action Alternative — Cost Estimate Summary

Site: Leona Heights Rifle Range MRS - Leona Canyon Regional Open Space Preserve
Location: Alameda County, California
Phase: Feasibility Study (-30% to +50%)
Base Year: 2017
Date: October 2017

Description: The No Action Alternative implements no treatment, engineering controls, or institutional controls. It serves as a basis for comparison for all other alternatives. There are no capital costs, annual operations and maintenance

	Quantity	Unit	Unit Cost	Cost	Notes
Capital Costs					
Remedial Design				$ -	
Removal Action				$ -	
Sub-Total				$ -	
Contingency	15%			$ -	
Sub-Total				$ -	
Permitting	2%			$ -	
Project Management	5%			$ -	
Construction Management	6%			$ -	
TOTAL CAPITAL COSTS				**$ -**	
Annual Operation & Maintenance Costs					
Institutional Controls				$ -	
TOTAL ANNUAL OPERATION & MAINTENANCE COSTS				**$ -**	
Periodic Costs					
Five-Year Reviews				$ -	
TOTAL PERIODIC COSTS				**$ -**	

Present Value Analysis

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (0.75%)	Present Value	Notes
Capital Cost	0	$ -	$ -	1.000	$ -	
Annual Operation and Maintenance Cost	1-30	$ -	$ -	0.645	$ -	
Period Cost	5	$ -	$ -	0.935	$ -	
Period Cost	10	$ -	$ -	0.868	$ -	
Period Cost	15	$ -	$ -	0.806	$ -	
Period Cost	20	$ -	$ -	0.748	$ -	
Period Cost	25	$ -	$ -	0.694	$ -	
Period Cost	30	$ -	$ -	0.645	$ -	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$0.00**	

Notes: Discount Factor of 0.75% (OMB Circular No. A-94 revised November 2016)

Alternative 2 - Land Use Controls — Cost Estimate Summary

Site: Leona Heights Rifle Range MRS - Leona Canyon Regional Open Space Preserve
Location: Alameda County, California
Phase: Feasibility Study (-30% to +50%)
Base Year: 2017
Date: October 2017

Description: Alternative 2 includes land use controls (LUCs) consisting of educational controls (public notice, community awareness meeting, fact sheets, and website) and engineering controls (warning signs and fencing), management plans, annual operation and maintenance costs and long-term management. Periodic costs include 5-year review reports assumed to continue for 30 years.

	Quantity	Unit	Unit Cost	Cost	Notes
Capital Costs					
Remedial Design					
Management Plan	1	LS	$ 37,842	$ 37,842	
Removal Action					
LUC Implementation (Educational Controls - Facts Sheets, Public Meetings, etc.)	1	LS	$ 92,027	$ 92,027	
LUC Implementation (Engineering Controls - Warning Signs)	1	LS	$ 8,610	$ 8,610	
LUC Implementation (Engineering Controls - Fencing)	1	LS	$ 50,615	$ 50,615	
No Further Action Explosives Safety Submission	1	LS	$ 10,000	$ 10,000	
Sub-Total				$ 199,095	
Contingency	15%			$ 29,864	
Sub-Total				$ 228,959	
Permitting	1%			$ 2,290	
Project Management	8%			$ 18,317	
Construction Management	10%			$ 22,896	
TOTAL CAPITAL COSTS				**$ 272,462**	
Annual Operation & Maintenance Costs					
Annual Inspection and Warning Sign Replacement (Replace All Signs Every Year) for 30 Years Using 5-Year Contracts	1	LS	$ 15,789	$ 15,789.39	
TOTAL ANNUAL OPERATION & MAINTENANCE COSTS				**$ 15,789**	
Periodic Costs					
Five-Year Review Reports for 30 Years Using 5-Year Contracts	1	EA	$ 12,426	$ 12,426	
TOTAL PERIODIC COSTS				**$ 12,426**	

Present Value Analysis

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (0.75%)	Present Value	Notes
Capital Cost	0	$ 272,462	$ 272,462	1.000	$ 272,462	
Annual Operation & Maintenance Cost	1-30	$ 473,681.70	$ 15,789	0.645	$ 305,300	
Period Cost	5	$ 12,426	$ 12,426	0.935	$ 11,620	
Period Cost	10	$ 13,719	$ 13,719	0.868	$ 11,909	
Period Cost	15	$ 15,147	$ 15,147	0.806	$ 12,206	
Period Cost	20	$ 16,724	$ 16,724	0.748	$ 12,509	
Period Cost	25	$ 18,464	$ 18,464	0.694	$ 12,820	
Period Cost	30	$ 20,386	$ 20,386	0.645	$ 13,139	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$ 652,000**	

Notes: Discount Factor of 0.75% (OMB Circular No. A-94 revised November 2016)

Alternative 3 - Land Use Controls and Focused Surface and Subsurface Clearance Using Analog Geophysical Methods — Cost Estimate Summary

Site: Leona Heights Rifle Range MRS - Leona Canyon Regional Open Space Preserve
Location: Alameda County, California
Phase: Feasibility Study (-30% to +50%)
Base Year: 2017
Date: October 2017

Description: Alternative 3 uses analog geophysical surface and subsurface removal, detonation, and recycling of potential munitions and explosives of concern (MEC) to eliminate the explosive hazard at focused areas on the Leona Heights Rifle Range MRS - Leona Canyon ROSP to 24-inches below ground surface.

	Quantity	Unit	Unit Cost	Cost	Notes
Capital Costs					
Remedial Design					
Management Plans	1	LS	$ 107,540	$ 107,540	
Removal Action					
LUC Implementation (Educational Controls)	1	LS	$ 92,027	$ 92,027	
LUC Implementation (Engineering Controls - Warning Signs)	1	LS	$ 8,610	$ 8,610	
LUC Implementation (Engineering Controls - Fencing)	1	LS	$ 50,483	$ 50,483	
Mobilization	1	LS	$ 6,337	$ 6,337	
Vegetation Thinning	1	LS	$ 19,933	$ 19,933	
Surface and Subsurface MEC Removal	1	LS	$ 18,768	$ 18,768	
Material Documented as Safe Removal	1	LS	$ 2,473	$ 2,473	
Demobilization	1	LS	$ 6,337	$ 6,337	
Site Management	1	LS	$ 18,200	$ 18,200	
Explosive Safety Submission	1	LS	$ 25,323	$ 25,323	
After Action Report	1	LS	$ 69,720	$ 69,720	
Removal Action Report	1	LS	$ 86,462	$ 86,462	
Sub-Total				$ 512,214	
Contingency	15%			$ 76,832	
Sub-Total				$ 589,047	
Permitting	1%			$ 5,890	
Project Management	8%			$ 47,123.72	
Construction Management	10%			$ 58,904.65	
TOTAL CAPITAL COSTS				**$ 700,965**	
Annual Operation and Maintenance Costs					
Annual Inspection and Warning Sign Replacement (Replace All Signs Every Year) for 30 Years Using 5-Year Contracts	1	LS	$ 15,789	$ 15,789.39	
TOTAL ANNUAL OPERATION & MAINTENANCE COSTS				**$ 15,789**	
Periodic Costs					
Five-Year Review Report	1	EA	$ 12,426	$ 12,426	
TOTAL PERIODIC COSTS				**$ 12,426**	

Present Value Analysis

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (0.75%)	Present Value	Notes
Capital Cost	0	$ 700,965	$ 700,965	1.000	$ 700,965	
Annual Operation & Maintenance Cost	1-30	$473,681.70	$ 15,789	0.645	$ 305,300	
Period Cost	5	$ 12,426	$ 12,426	0.935	$ 11,620	
Period Cost	10	$ 13,719	$ 13,719	0.868	$ 11,909	
Period Cost	15	$ 15,147	$ 15,147	0.806	$ 12,206	
Period Cost	20	$ 16,724	$ 16,724	0.748	$ 12,509	
Period Cost	25	$ 18,464	$ 18,464	0.694	$ 12,820	
Period Cost	30	$ 20,386	$ 20,386	0.645	$ 13,139	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$ 1,081,000**	

Notes: Discount Factor of 0.75% (OMB Circular No. A-94 revised November 2016)

Alternative 4 - Land Use Controls and Complete Surface and Subsurface Clearance using Digital Geophysical Mapping

Cost Estimate Summary

Site: Leona Heights Rifle Range MRS - Leona Canyon Regional Open Space Preserve
Location: Alameda County, Arizona
Phase: Feasibility Study (-30% to +50%)
Base Year: 2017
Date: October 2017

Description: Alternative 4 uses 100% surface and subsurface removal of munitions and explosives of concern (MEC) to 24-inches below ground surface using analog geophysical methods, detonation, and recycling of potential MEC to eliminate the explosive hazard over the entire MRS.

	Quantity	Unit	Unit Cost	Cost	Notes
Capital Costs					
Remedial Design					
Management Plans	1	LS	$107,540	$ 107,540	
Removal Action					
LUCs (Educational Controls)	1	LS	$ 92,027	$ 92,027	
LUCs (Engineering Controls - Warning Signs)	1	LS	$ 8,610	$ 8,610	
Mobilization	1	LS	$ 11,885	$ 11,885	
Vegetation Thinning	1	LS	$370,565	$ 370,565	
Surface and Subsurface MEC Removal	1	LS	$192,929	$ 192,929	
Material Documented as Safe Removal	1	LS	$ 2,473	$ 2,473	
Demobilization	1	LS	$ 11,314	$ 11,314	
Site Management	1	LS	$ 96,730	$ 96,730	
Explosive Safety Submission	1	LS	$ 25,323	$ 25,323	
After Action Report	1	LS	$ 71,760	$ 71,760	
Removal Action Report	1	LS	$ 96,115	$ 96,115	
Sub-Total				$ 1,087,272	
Contingency	15%			$ 163,090.82	
Sub-Total				$ 1,250,363	
Permitting	1%			$ 12,503.63	
Project Management	8%			$ 100,029.04	
Construction Management	10%			$ 125,036.30	
TOTAL CAPITAL COSTS				**$ 1,487,932**	
Annual Operation & Maintenance Costs					
Annual Inspection and Warning Sign Replacement (Replace All Signs Every Year) for 30 Years Using 5-Year Contracts	1	LS	$ 15,789	$ 15,789	
TOTAL ANNUAL OPERATION AND MAINTENCE COSTS				**$ 15,789**	
Periodic Costs					
Five-Year Review Report	1	EA	$ 12,426	$ 12,426	
TOTAL PERIODIC COSTS				**$ 12,426**	

Present Value Analysis

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (0.75%)	Present Value	Notes
Capital Cost	0	$ 1,487,932	$ 1,487,932	1.000	$ 1,487,932	
Annual Operation & Maintenance Cost	1-30	$ 473,682	$ 15,789	0.645	$ 305,300	
Period Cost	5	$ 12,426	$ 12,426	0.935	$ 11,620	
Period Cost	10	$ 13,719	$ 13,719	0.868	$ 11,909	
Period Cost	15	$ 15,147	$ 15,147	0.806	$ 12,206	
Period Cost	20	$ 16,724	$ 16,724	0.748	$ 12,509	
Period Cost	25	$ 18,464	$ 18,464	0.694	$ 12,820	
Period Cost	30	$ 20,386	$ 20,386	0.645	$ 13,139	
TOTAL PRESENT VALUE OF ALTERNATIVE					**$ 1,868,000**	

Notes: Discount Factor of 0.75% (OMB Circular No. A-94 revised November 2016)

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APPENDIX C

MUNITIONS AND EXPLOSIVES OF CONCERN HAZARD ASSESSMENT

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MEC HA Workbook v1.02

December-07

Overview

This workbook is a tool for project teams to assess explosive hazards to human receptors at munitions response sites (MRSs) following the Munitions and Explosives of Concern Hazard Assessment (MEC HA) methodology. The MEC HA allows a project team to evaluate potential explosive hazard associated with a site, given current site conditions, under various cleanup, land use activities, and land use control alternatives. A complete description of the methodology can be found in the MEC HA Guidance (Public Review Draft, November 2006). Please reference this guidance when completing the worksheets.

Instructions

1. Open this file. Enable macros if prompted to do so. This spreadsheet will not work if your security setting is set to 'high' or 'very high'. To change your security level, go to the menu bar and select Tools/Macro/Security. Then close and reopen this spreadsheet.

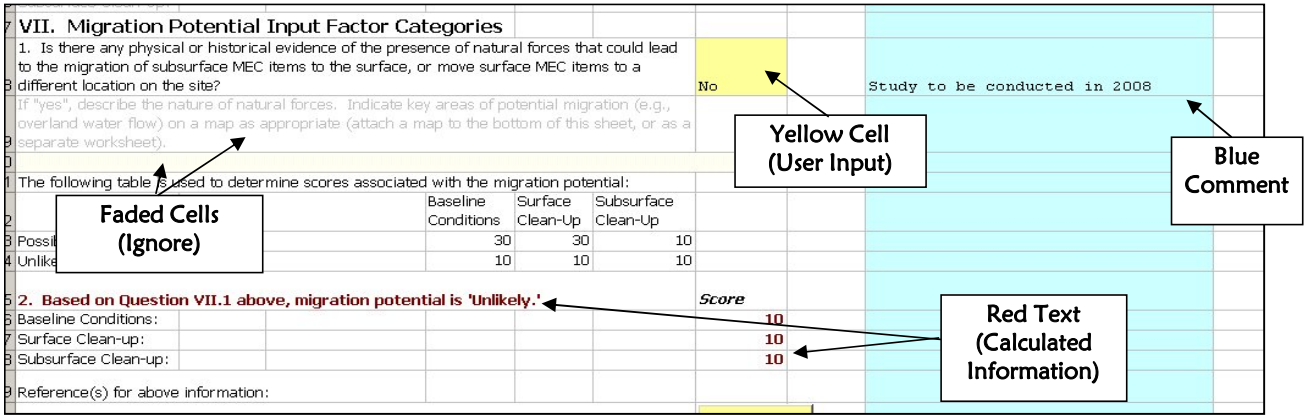
2. This MS Excel workbook contains 9 worksheets, designed to be used in order. After the '***Instructions***' sheet, the first 5 sheets ask for information about the following topics:

Summary Info - General information regarding the site.
Munitions/Explosive Info - MECs and bulk explosives present at the site.
Current and Future Activities - Current land use activites as well as planned future activities, if any.
Remedial-Removal Action - General information regarding remediation/removal alternatives being considered for the site.
Post-Response Land Use - Land use activities associated with the alternatives listed in the 'Remedial-Removal Action' sheet.

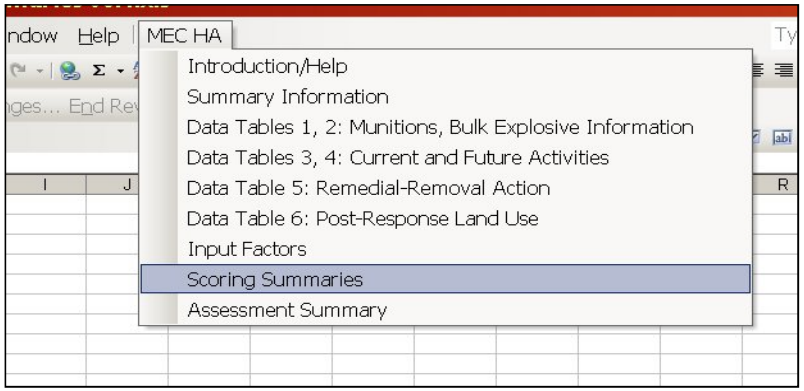
The remaining 3 sheets calculate and summarize the scores. The ***Input Factors*** sheet performs the Input Factor Score calculations, which are summarized in the ***Scoring Summaries*** sheet. The ***Hazard Level*** sheet presents the Hazard Level Category for current use activities, future use activities, and each response alternative based on the respective scores.

3. Starting with the ***Summary Info*** sheet, fill in any yellow cells. Some cells have drop-down lists from which you can select an answer. Select the cell. A down arrow to the right indicates that a drop-down list is available. Yellow buttons can be used to enter reference information. Blue cells can be used for any general comments you wish to make. Any faded cells can be ignored--these are questions that the spreadsheet has determined are not relevant for your situation.

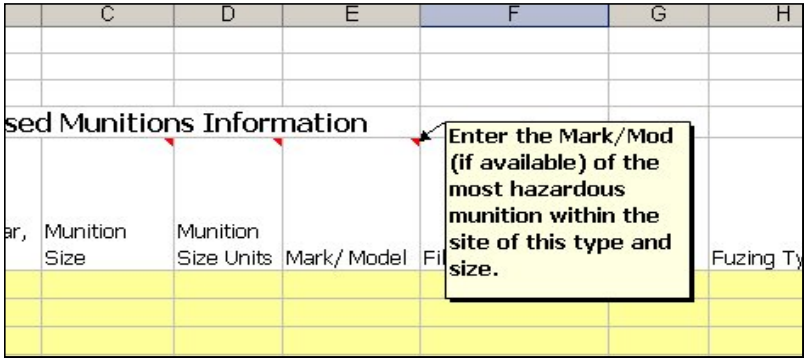
The computer will calculate information based on your inputs. Calculated information will appear as red text.



4. The MEC HA menu bar can be used to navigate to different worksheets.



5. Small red triangles in the upper-right corners indicate that help text is available by putting the mouse cursor on that cell.



MEC HA Summary Information

		Comments
Site ID:	Leona Heights Rifle Range - Leona Canyon ROSP (CAHQ-013-R-01)	
Date:	5/19/2017	

Please identify the single specific area to be assessed in this hazard assessment. From this point forward, all references to "site" or "MRS" refer to the specific area that you have defined.

A. Enter a unique identifier for the site:

CAHQ-013-R-01

Provide a list of information sources used for this hazard assessment. As you are completing the worksheets, use the "Select Ref(s)" buttons at the ends of each subsection to select the applicable information sources from the list below.

Ref. No.	Title (include version, publication date)
1	Weston Solutions, Inc. (WESTON), Final Site Inspection Report, Army National Guard Munitions Response Sites Site Inspection Phase California. August 2012.
2	Weston Solutions, Inc. (WESTON). 2016. Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California. May 2016.
3	Weston Solutions, Inc. (WESTON), Final Remedial Investigation Report, MMRP Munitions Reponse Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California. May 2017.
4	
5	
6	
7	
8	
9	
10	
11	
12	

B. Briefly describe the site:

1. Area (include units): 31.73 acres
2. Past munitions-related use:

Target Area

3. Current land-use activities (list all that occur):

Residential and recreational

4. Are changes to the future land-use planned? No
5. What is the basis for the site boundaries?

Based on historical use of Leona Heights Rifle Range MRS; range was originally identified as a 91.0 acre transferred range, but later determined to be 81.33 acres based on geographic information systems (GIS) measurements.

6. How certain are the site boundaries?

Limitations to the RI investigation include the defined acreage of the Leona Heights Rifle Range, which totals 81.33 acres according to the Site Investigation (SI) Historical Records Review (HRR). The site boundary is not shared with parcel boundaries therefore certainty is limited to the established MRS as determined by the SI.

Reference(s) for Part B:

Weston Solutions, Inc. (WESTON). 2016. Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California. May 2016.

C. Historical Clearances

1. Have there been any historical clearances at the site?	No, none	
2. If a clearance occurred:		

a. What year was the clearance performed?

Site ID: **Leona Heights Rifle Range - Leona Canyon ROSP (CAHQ-013-R-01)**
Date: **5/19/2017**

Cased Munitions Information

Item No.	Munition Type (e.g., mortar, projectile, etc.)	Munition Size	Munition Size Units	Mark/ Model	Energetic Material Type	Is Munition Fuzed?	Fuzing Type	Fuze Condition	Minimum Depth for Munition (ft)	Location of Munitions	Comments (include rationale for munitions that are "subsurface only")
1	Mortars	3	inches		Low Explosive Filler in a fragmenting round	No	UNK	UNK	0	Surface and Subsurface	No MEC was identified during the SI or RI. A total of 4 MD items (practice 3-inch Stokes Mortars) were identifided.
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
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17											
18											
19											
20											
21											
22											
23											
24											
25											

Reference(s) for table above:
Weston Solutions, Inc. (WESTON). 2016. Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California. May 2016.

Bulk Explosive Information

Item No.	Explosive Type	Comments
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Reference(s) for table above:

Weston Solutions, Inc. (WESTON), Final Site Inspection Report, Army National Guard Munitions Response Sites Site Inspection Phase California. August 2012.

Site ID: **Leona Heights Rifle Range - Leona Canyon ROSP (CAHQ-013-R-01)**
Date: **5/19/2017**

Activities Currently Occurring at the Site

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Trespassing	12	2	**24**	0	Estimate only. Surface activity with limited potential intrusive activities (e.g., footprint while walking). Limited based upon steep topography.
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr): **24**
Maximum intrusive depth at site (ft): **0**

Reference(s) for table above:
Weston Solutions, Inc. (WESTON). 2016. Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California. May 2016.

Activities Planned for the Future at the Site (If any are planned: see 'Summary Info' Worksheet, Question 4)

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Trespassing	12	2	24	0	Estimate only. Surface activity with limited potential intrusive activities (e.g., footprint while walking). Limited based upon steep topography.
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
	Total Potential Contact Time (receptor hrs/yr):			24		
	Maximum intrusive depth at site (ft):				0	

Reference(s) for table above:

Weston Solutions, Inc. (WESTON). 2016. Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California. May 2016.

Site ID: **Leona Heights Rifle Range - Leona Canyon ROSP (CAHQ-013-R-01)**
Date: **5/19/2017**

Planned Remedial or Removal Actions

Response Action No.	Response Action Description	Expected Resulting Minimum MEC Depth (ft)	Expected Resulting Site Accessibility	Will land use activities change if this response action is implemented?	What is the expected scope of cleanup?	Comments
1	No Action	0	Moderate Accessibility	No	No MEC cleanup	Current Site Use
2	LUCs	0	Limited Accessibility	No	No MEC cleanup	Signs, fencing, educational controls.
3	Focused Surface and Subsurface Clearance	0	Limited Accessibility	No	cleanup of MECs located both on the surface and subsurface	Focused Surface and Subsurface Clearance to 2 ft on 3.13 of the 31.73 acres. LUCs used.
4	Full Surface and Subsurface Clearance	2	Moderate Accessibility	No	cleanup of MECs located both on the surface and subsurface	Surface and Subsurface clearance of entire 31.73 acres to 2 feet. LUCs used (no fencing).

According to the 'Summary Info' worksheet, no future land uses are planned. For those alternatives where you answered 'No' in Column E, the land use activities will be assessed against current land uses.

Reference(s) for table above:
Weston Solutions, Inc. (WESTON). 2016. Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California. May 2016.

Site ID: **Leona Heights Rifle Range - Leona Canyon ROSP (CAHQ-013-R-01)**
Date: **5/19/2017**

This worksheet needs to be completed for each remedial/removal action alternative listed in the 'Remedial-Removal Action' worksheet that will cause a change in land use.

Land Use Activities Planned After Response Alternative #1: No Action

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):
Maximum intrusive depth at site (ft):

Reference(s) for table above:

Land Use Activities Planned After Response Alternative #2: LUCs

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):
Maximum intrusive depth at site (ft):

Reference(s) for table above:

[redacted]

Land Use Activities Planned After Response Alternative #3: Focused Surface and Subsurface Clearance

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

[redacted]

Land Use Activities Planned After Response Alternative #4: Full Surface and Subsurface Clearance

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

[redacted]

Site ID: **Leona Heights Rifle Range - Leona Canyon ROSP (CAHQ-013-R-01)**

Date: **5/19/2017**

Energetic Material Type Input Factor Categories

The following table is used to determine scores associated with the energetic materials. Materials are listed in order from most hazardous to least hazardous.

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
High Explosive and Low Explosive Filler in Fragmenting Rounds	100	100	100
White Phosphorus	70	70	70
Pyrotechnic	60	60	60
Propellant	50	50	50
Spotting Charge	40	40	40
Incendiary	30	30	30

The most hazardous type of energetic material listed in the 'Munitions, Bulk Explosive Info' Worksheet falls under the category 'High Explosive and Low Explosive Filler in Fragmenting Rounds'.

	Score
Baseline Conditions:	**100**
Surface Cleanup:	**100**
Subsurface Cleanup:	**100**

Location of Additional Human Receptors Input Factor Categories

1. What is the Explosive Safety Quantity Distance (ESQD) from the Explosive Siting Plan or the Explosive Safety Submission for the MRS? 1379 feet
2. Are there currently any features or facilities where people may congregate within the MRS, or within the ESQD arc? Yes
3. Please describe the facility or feature.

Residential Development

MEC Item(s) used to calculate the ESQD for current use activities

[redacted]

Item #1. Mortars

The following table is used to determine scores associated with the location of additional human receptors (current use activities):

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Inside the MRS or inside the ESQD arc	30	30	30
Outside of the ESQD arc	0	0	0

4. Current use activities are 'Inside the MRS or inside the ESQD arc', based on Question 2.'

	Score
Baseline Conditions:	**30**
Surface Cleanup:	**30**
Subsurface Cleanup:	**30**

5. Are there future plans to locate or construct features or facilities where people may congregate within the MRS, or within the ESQD arc? Yes
6. Please describe the facility or feature.

Residential Development

MEC Item(s) used to calculate the ESQD for future use activities

[redacted]

Item #1. Mortars (3inches, Low Explosive Filler in a fragmenting round)

The following table is used to determine scores associated with the location of additional human receptors (future use activities):

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Inside the MRS or inside the ESQD arc	30	30	30
Outside of the ESQD arc	0	0	0

Comments

MEC HA assigns the lowest score because there were no MEC items found at the MRS during the SI or RI.

Maximum Fragment Distance-Horizontal w/o Engineering Controls from ESP, based on 3 in Stokes HE mortar.

See figure below illustrating the ESQD arc buffer (red boundary).

There are no future plans to develop the MRS due to the steep topography of the site. However, development may occur within the ESQD arc buffer (red boundary).

MEC HA assigns the lowest score because there were no MEC items found at the MRS during the SI or RI.

7. Future use activities are 'Inside the MRS or inside the ESQD arc', based on Question 5.' ***Score***

Baseline Conditions: **30**
Surface Cleanup: **30**
Subsurface Cleanup: **30**

Site Accessibility Input Factor Categories

The following table is used to determine scores associated with site accessibility:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Full Accessibility	No barriers to entry, including signage but no fencing	80	80	80
Moderate Accessibility	Some barriers to entry, such as barbed wire fencing or rough terrain	55	55	55
Limited Accessibility	Significant barriers to entry, such as unguarded chain link fence or requirements for special transportation to reach the site	15	15	15
Very Limited Accessibility	A site with guarded chain link fence or terrain that requires special equipment and skills (e.g., rock climbing) to access	5	5	5

Current Use Activities ***Score***

Select the category that best describes the site accessibility under the current use scenario:

Moderate Accessibility

There are residential homes to the north and south of the MRS and there is no fencing. However, the steep topography and dense vegetation limit accessibility.

Baseline Conditions: **55**
Surface Cleanup: **55**
Subsurface Cleanup: **55**

Future Use Activities

Select the category that best describes the site accessibility under the future use scenario:

Moderate Accessibility

There are residential homes to the north and south of the MRS and there is no fencing. However, the steep topography and dense vegetation limit accessibility.

Baseline Conditions: **55**
Surface Cleanup: **55**
Subsurface Cleanup: **55**

Reference(s) for above information:
Weston Solutions, Inc. (WESTON). 2016. Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California. May 2016.

Potential Contact Hours Input Factor Categories

The following table is used to determine scores associated with the total potential contact time:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Many Hours	≥1,000,000 receptor-hrs/yr	120	90	30
Some Hours	100,000 to 999,999 receptor hrs/yr	70	50	20
Few Hours	10,000 to 99,999 receptor-hrs/yr	40	20	10
Very Few Hours	<10,000 receptor-hrs/yr	15	10	5

Current Use Activities :

Input factors are only determined for baseline conditions for current use activities. Based on the 'Current and Future Activities' Worksheet, the Total Potential Contact Time is: **24** hrs/yr
Based on the table above, this corresponds to a input factor score for baseline conditions of: **15** Score

receptor

Contact hours are unconfirmed estimates based upon best professional judgments and additional input is required to finalize.

Future Use Activities :

Input factors are only determined for baseline conditions for future use activities. Based on the 'Current and Future Activities' Worksheet, the Total Potential Contact Time is: **24** hrs/yr
Based on the table above, this corresponds to a input factor score of: **15** Score

receptor

Contact hours are unconfirmed estimates based upon best professional judgments and additional input is required to finalize.

Amount of MEC Input Factor Categories

The following table is used to determine scores associated with the Amount of MEC:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Target Area	Areas at which munitions fire was directed	180	120	30
OB/OD Area	Sites where munitions were disposed of by open burn or open detonation methods. This category refers to the core activity area of an OB/OD area. See the "Safety Buffer Areas" category for safety fans and kick-outs.	180	110	30
Function Test Range	Areas where the serviceability of stored munitions or weapons systems are tested. Testing may include components, partial functioning or complete functioning of stockpile or developmental items.	165	90	25
Burial Pit	The location of a burial of large quantities of MEC items.	140	140	10
Maneuver Areas	Areas used for conducting military exercises in a simulated conflict area or war zone	115	15	5
Firing Points	The location from which a projectile, grenade, ground signal, rocket, guided missile, or other device is to be ignited, propelled, or released.	75	10	5
Safety Buffer Areas	Areas outside of target areas, test ranges, or OB/OD areas that were designed to act as a safety zone to contain munitions that do not hit targets or to contain kick-outs from OB/OD areas.	30	10	5
Storage	Any facility used for the storage of military munitions, such as earth-covered magazines, above-ground magazines, and open-air storage areas.	25	10	5
Explosive-Related Industrial Facility	Former munitions manufacturing or demilitarization sites and TNT production plants	20	10	5

Select the category that best describes the ***most hazardous*** amount of MEC: ***Score***

Target Area

The MRS is identified as a target area as based on the historical use of artillery and mortar practice, and small arms training by multiple National Guard units from 1913 to the mid to late 1930s. There have been no MEC items found at the site as based on the SI and RI.

Baseline Conditions: **180**
Surface Cleanup: **120**
Subsurface Cleanup: **30**

Minimum MEC Depth Relative to the Maximum Intrusive Depth Input Factor Categories

Current Use Activities

The shallowest minimum MEC depth, based on the 'Cased Munitions Information' Worksheet: **0** ft
The deepest intrusive depth: **0** ft
The table below is used to determine scores associated with the minimum MEC depth relative to the maximum intrusive depth:

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240	150	95
Baseline Condition: MEC located surface and subsurface, After Cleanup: Intrusive depth does not overlap with subsurface MEC.	240	50	25
Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.	150	N/A	95

Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth does not overlap with minimum MEC depth.	50	N/A	25

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth will overlap after cleanup. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.' For 'Current Use Activities', only Baseline Conditions are considered. **240** ***Score***

Future Use Activities

Deepest intrusive depth: **0** ft

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.'. For 'Future Use Activities', only Baseline Conditions are considered. **240** ***Score***

Migration Potential Input Factor Categories

Is there any physical or historical evidence that indicates it is possible for natural physical forces in the area (e.g., frost heave, erosion) to expose subsurface MEC items, or move surface or subsurface MEC items? Yes

If "yes", describe the nature of natural forces. Indicate key areas of potential migration (e.g., overland water flow) on a map as appropriate (attach a map to the bottom of this sheet, or as a separate worksheet).

Erosion due to heavy rain events and steep topography.

The following table is used to determine scores associated with the migration potential:

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Possible	30	30	10
Unlikely	10	10	10

Based on the question above, migration potential is 'Possible.' ***Score***

Baseline Conditions: **30**
Surface Cleanup: **30**
Subsurface Cleanup: **10**

Reference(s) for above information:
Weston Solutions, Inc. (WESTON). 2016. Final Remedial Investigation Work Plan, MMRP Munitions Response Services, National Guard Bureau, Leona Heights Rifle Range (CAHQ-013-R-01), Alameda County, California. May 2016.

MEC Classification Input Factor Categories

Cased munitions information has been inputed into the 'Munitions, Bulk Explosive Info' Worksheet; therefore, bulk explosives do not comprise all MECs for this MRS.
The 'Amount of MEC' category is 'Target Area'. It cannot be automatically assumed that the MEC

Has a technical assessment shown that MEC in the OB/OD Area is DMM?

Are any of the munitions listed in the 'Munitions, Bulk Explosive Info' Worksheet: Yes

- Submunitions
- Rifle-propelled 40mm projectiles (often called 40mm grenades)
- Munitions with white phosphorus filler
- High explosive anti-tank (HEAT) rounds
- Hand grenades
- Fuzes
- Mortars

None of the items listed in the 'Munitions, Bulk Explosive Info' Worksheet were identified as 'fuzed'.

The following table is used to determine scores associated with MEC classification categories:

UXO Special Case	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
UXO Special Case	180	180	180
UXO	110	110	110
Fuzed DMM Special Case	105	105	105
Fuzed DMM	55	55	55
Unfuzed DMM	45	45	45
Bulk Explosives	45	45	45

Based on your answers above, the MEC classification is 'UXO Special Case'. ***Score***

Baseline Conditions: **180**
Surface Cleanup: **180**
Subsurface Cleanup: **180**

MEC Size Input Factor Categories

The following table is used to determine scores associated with MEC Size:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Small	Any munitions (from the 'Munitions, Bulk Explosive Info' Worksheet) weigh less than 90 lbs; small enough for a receptor to be able to move and initiate a detonation	40	40	40
Large	All munitions weigh more than 90 lbs; too large to move without equipment	0	0	0

Based on the definitions above and the types of munitions at the site (see 'Munitions, Bulk Explosive Info' Worksheet), the MEC Size Input Factor is: Small

Score

Baseline Conditions: **40**
Surface Cleanup: **40**
Subsurface Cleanup: **40**

Scoring Summary

Site ID:	Leona Heights Rifle Range - Leona Ca	a. Scoring Summary for Current Use Activities	
Date:	5/19/2017	Response Action Cleanup:	No Response Action
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Moderate Accessibility	55
IV. Potential Contact Hours		<10,000 receptor-hrs/yr	15
V. Amount of MEC		Target Area	180
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO Special Case	180
IX. MEC Size		Small	40
		Total Score	**870**
		Hazard Level Category	**1**

Site ID:	Leona Heights Rifle Range - Leona Ca	a. Scoring Summary for Future Use Activities	
Date:	5/19/2017	Response Action Cleanup:	No Response Action
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Moderate Accessibility	55
IV. Potential Contact Hours		<10,000 receptor-hrs/yr	15
V. Amount of MEC		Target Area	180
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO Special Case	180
IX. MEC Size		Small	40
		Total Score	**870**
		Hazard Level Category	**1**

MEC HA Hazard Level Determination		
Site ID: Leona Heights Rifle Range - Leona Canyon ROSP (CAHQ-013-R-01)		
Date: 5/19/2017		
	Hazard Level Category	**Score**
a. Current Use Activities	**1**	**870**
b. Future Use Activities	**1**	**870**
c. Response Alternative 1: No Action	**1**	**870**
d. Response Alternative 2: LUCs	**2**	**830**
e. Response Alternative 3: Focused Surface and Subsurface Clearance	**4**	**505**
f. Response Alternative 4: Full Surface and Subsurface Clearance	**4**	**475**
g. Response Alternative 5:		

Characteristics of the MRS	
Is critical infrastructure located within the MRS or within the ESQD arc?	Yes
Are cultural resources located within the MRS or within the ESQD arc?	No
Are significant ecological resources located within the MRS or within the ESQD arc?	No

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APPENDIX D

STAKEHOLDER COMMENTS

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Comments for the
Stakeholder Draft Feasibility Study
MMRP Munitions Response Services
Army National Guard Bureau
Maroon Crater Artillery Range (AZHQ-009-R-01), Arizona
Contract No.: W912DR-09-D-0006
Delivery Order No. 0011

Comment Number	Commenter	Page(s)	Section	Line(s)	Comment	Response Code	Response
TECHNICAL COMMENTS							
1	RR				None - The DTSC Regulator (Roman Racca) was involved and consulted for the Feasiblity Study; however, no written comments were received.		
EDITORIAL COMMENTS							
1	RR				None		
COMMENTS PROVIDED BY							
Initials	Name	Department/Organization			Email Address		Phone
RR	Roman Racca	DTSC			Roman.Racca@dtsc.ca.gov		916-255-6407

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