Appendix M

Fort Ord Ordnance and Explosives Risk Assessment Protocol

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Acronyms and Abbreviations

Army	U.S. Department of the Army
BCT	Base Realignment and Closure Cleanup Team
BRA	Basewide Range Assessment
DQO d	ata quality objective
DTSC	Department of Toxic Substances Control
EPA	US Environmental Protection Agency
HMP	Habitat Management Plan
MEC	Munitions and Explosives of Concern
mm milli	meter
MRA	Munitions Response Area
MRS	Munitions Response Site
QA	quality assurance
QC qualit	y control
RA rem	edial action
RI/FS Remedial	Investigation/Feasibility Study
SL screening	levels
USACE	U.S. Army Corps of Engineers

1.0 Introduction

This appendix presents the results of the munitions and explosives of concern (MEC) risk assessment that addresses the explosive hazards associated with MEC in the Munitions Response Site (MRS)-16 site. The risks associated with chemical hazards are summarized based on work conducted as part of the Basewide Range Assessment (BRA), which is a component of the Hazardous Toxic Waste Remedial Investigation/Feasibility Study (RI/FS) program, separate from the Munitions Response RI/FS program.

This risk assessment focuses on the post-removal risks or risk associated with the current site conditions, with a short discussion of the pre-removal conditions and risk. This risk assessment presents a description of the process used for preparing MEC risk assessments, summarizes the data used, describes the receptors evaluated and the inputs used to determine the risk scores, presents the results of the risk assessment and provides an uncertainty analysis.

2.0 MEC Risk Assessment Process for Fort Ord

The MEC risk assessments for Fort Ord provide a qualitative description of the risks of a receptor encountering a MEC item. Because the nature of these types of risk assessments is largely qualitative, a specific protocol was developed to evaluate current and future MEC risks to humans at Fort Ord. The Fort Ord Ordnance and Explosives Risk Assessment Protocol (Protocol) (*Malcolm Pirnie, 2002*) was developed through the combined effort of the US Department of the Army (Army), California Department of Toxic Substances Control (DTSC), and U.S. Environmental Protection Agency (EPA), and allows for a comparative review of MEC risks at impacted sites. Unlike typical risk assessments that evaluate potential exposures to hazardous substances in environmental media, the Protocol does not calculate a numerical probability of adverse effects or a hazard index. Rather, it relies on an *a priori* assumption that any encounter with MEC will result in an adverse effect, and provides a qualitative description of the risk based on the likelihood of encountering a MEC item combined with the potential of the item to cause a serious injury if detonated. The Army is required to conduct a MEC risk assessment as part of the RI/FS study process for munitions response sites at Fort Ord. The Protocol is used to develop and allow for a comparative evaluation of various remedial alternatives in the FS.

The output of the risk assessment consists of an overall MEC Risk Score designated by the letters A through E, with A representing the lowest risk and E representing the highest risk. The scores are supported by a brief narrative describing the assumptions used in developing the input factors. A summary of the Protocol and the scoring tables is provided below.

2.1 Data Quality and Usability

The data quality assessment for MRS-16 is presented in the main text of the Remedial Action Report (RA Report). Usable data is defined as those data with sufficient quality for use in the decision-making process. In the case of MRS-16, the removal was conducted according to work plans approved by the Base Realignment and Closure Cleanup Team (BCT; consisting of the Army, EPA, and DTSC).

2.1.1 Selection of Data Set

All available data collected from MRS-16 as presented in the RA Report was used for performing the risk assessment.

As discussed in the RA report, subsurface MEC removal was not completed in a 5.4 acre area which includes 23 full and 2 partial grids areas. Only surface MEC removal was completed in this area. Data for these grids only represent data collected from the surface MEC removal.

2.1.2 Data Usability

The remedial action was conducted according to BCT approved work plan that identified quality control (QC) procedures and data collection and analysis objectives. The data collection and management processes were subject to both contractor QC and US Army Corps of Engineers (USACE) quality assurance (QA). The results of the USACE QA review are detailed in Section 7.2 of the RA Report.

2.2 Description of Proposed Reuse and Potential Receptors

2.2.1 Proposed Reuse

Munitions response site-16 is undeveloped land in the inland portion of the former Fort Ord separated from the Impact Area by Eucalyptus Road. MRS-16 is primarily left in its natural state; support facilities associated with training that occurred at the site (e.g. access roads, observation towers, targets, trenches, bunkers, etc.) have been removed.

The land that includes MRS-16 is scheduled for transfer to Bureau of Land Management (USACE, 1995) and will be maintained as undeveloped habitat reserve under the *Installation-Wide Multispecies Habitat Management Plan* (HMP) *for former Fort Ord* (USACE, 1997), which describes special land restrictions and habitat management requirements within habitat reserve areas. MRS-16 is located in Transfer Parcel F1.3, which the HMP identifies as a habitat reserve area that will be maintained as open space and will not be developed. Habitat reserve areas support plant and animal species that require implementation of mitigation measures identified in the HMP to ensure compliance with the Endangered Species Act and to minimize potential adverse impacts to listed species.

For purposes of this risk assessment the following activities are considered applicable to MRS-16:

- Route, road, and trail management and maintenance;
- Habitat enhancement;
- Species specific monitoring and habitat enhancement; and
- Recreational access on established routes.

2.2.2 Potential Receptors

Based on the proposed reuses described above for MRS-16, the following receptors were identified for evaluation in the risk assessment in areas where surface and subsurface MEC removals were completed:

- Recreational User (using trails for hiking, bicycle riding, or horseback riding)
- Outdoor Maintenance/Fire Fighter/Prescribed Burn Workers (planting, habitat monitoring or maintenance, firefighting, vegetation clearance, preparation of fire breaks)
- Construction Worker (small construction job).

Table 2-1 presents a description of each receptor evaluated, associated activities, and exposure assumptions.

The following receptors were identified for evaluation in the risk assessment in areas where surface MEC removal was completed, but subsurface MEC removal was not completed (saturated area):

- Trespasser (entry into the fenced-off area).
- Outdoor Maintenance Worker (planting, habitat monitoring or maintenance, trail or fence maintenance).
- Construction Worker (small construction jobs, i.e. fence/gate post installation).

A two-strand barbed wire fence has been constructed around the saturated area and government property signs have been placed. The purpose of this fence is to delineate the area in which subsurface removal was not completed.

Table 2-2 presents a description of each receptor evaluated, associated activities, and exposure assumptions.

2.3 Discussion of MEC Risk Assessment Protocol

As discussed above, the Fort Ord MEC Risk Assessment Protocol is a qualitative risk assessment approach, with seven qualitative and quantitative input factors. Two matrices combine six of the input factors into scores for accessibility and exposure. A third matrix combines the scores for accessibility and exposure with overall hazard (the seventh input factor) into a qualitative score for estimating MEC risk. The seven input factors are shown in Figure 1-1.

For the post remedial action risks at MRS-16, two separate case/areas are considered:

1. Areas where surface and subsurface MEC removals were completed. This includes the entire 80-acre site excluding the 5.4-acre saturated area.

2. Areas where surface MEC removal was completed, but subsurface MEC removal was not completed. This includes the 23 full and 2 partial grids in the 5.4-acre saturated area.

2.3.1 Definition of Input Factors and Assumptions

The following sections discuss each of the input factors and matrices used to determine an overall MEC risk score, and are adapted from the Protocol (*Malcolm Pirnie, 2002*). The revised risk code classification presented in Revised Explosive Hazard Risk Code Classification Document (*USACE, 2005*) was used instead of the codes included in the Protocol.

2.3.1.1 Accessibility Factor

The accessibility factor reflects how likely the MEC would be accessible to receptors. Three factors are considered; (1) depth of MEC below ground surface (Table 2-3), (2) the level, or depth, of soil intrusion by the receptor (Table 2-4), and (3) the migration/erosion potential, which evaluates whether the apparent depth of MEC items will decrease over time as a consequence of soil erosion (Table 2-5).

A score is assigned for each of the three factors (discussed below) using the established criteria, and these input factors are combined to produce an overall score for the accessibility factor using the scoring matrix presented in Table 2-6. The accessibility factor score for the area where surface and subsurface MEC removals were completed is 1 for all receptors. The accessibility factor score for the area where surface MEC removal was completed but not subsurface MEC removal is 5 for all receptors.

2.3.1.2 MEC Depth below Ground Surface

For the areas where surface and subsurface MEC removals were completed a MEC Depth below Ground Surface Score of 1 was used for all receptors because 100 percent of the detected MEC was removed and the detection and removal procedures met the quality objectives (Section 2.1).

For the area where subsurface MEC removal was not completed a MEC Depth below Ground Surface Score of 7 (Table 2-3) was used for all receptors corresponding to "no MEC on the surface and MEC below surface".

2.3.1.3 Level of Intrusion

The level of intrusion is dependent on the receptor. The recreational user and trespasser are expected to result in minor intrusion below the ground surface therefore a score of 2 was used for level of intrusion. The outdoor maintenance/ fire fighter/ prescribed burn worker is assumed to intrude up to 3 feet resulting in an intrusion score of 4 (Table 2-4). Intrusive activities could include planting, habitat monitoring or maintenance, firefighting, vegetation clearance, and preparation of fire breaks. The construction worker is assumed to intrude up to 5 feet resulting in an intrusion score of 5. Intrusive activities could include small construction jobs such as fence/gate post installation.

2.3.1.4 Migration/Erosion Potential

This potential is estimated using the Universal Soil Loss Equation, and is assumed to be less than 3/100 inches per year for MRS-16. This is consistent with that estimated for Parker Flats Munitions Response Area (MRA) (*Malcolm Pirnie, 2005*). This is a reasonable estimate for soil loss for areas of established vegetation even shortly after a burn; however, higher rates of erosion could be expected in disturbed areas such as roads and excavation areas. The migration/erosion potential score of 1 was therefore applied for all receptors (Table 2-5).

2.3.1.5 Exposure Factor

The exposure factor assesses the likelihood that some one will be exposed to the MEC when in the exposure area. Three input factors are evaluated: (1) MEC density (Tables 2-7 and 2-8), (2) intensity of contact with soil (Table 2-9); and (3) frequency of entry (Table 2-10).

Munitions and explosives of concern density, intensity of contact with soil, and frequency of entry (discussed below) are combined in an overall Exposure Factor Scoring Matrix (Table 2-11) to an overall score for the exposure factor. The exposure factor score for the area where surface and subsurface MEC removals were completed is 1 for all receptors.

The exposure factor score for the area where subsurface MEC removal was not completed is 3 for the trespasser and 5 for an outdoor maintenance/construction worker.

2.3.1.6 MEC Density

Munitions and explosives of concern density is based on the number of MEC items per acre, and is assessed to the level of intrusion for the specific receptor (Table 2-7).

Munitions and explosives of concern densities for the areas where surface and subsurface MEC removals were completed are assigned a score of 1 for all receptors because 100 percent of detected MEC was removed and the remedial action met the quality objectives as noted above in Section 2.1.

Table 2-8 presents the MEC densities obtained from subsurface MEC removals completed in grids adjacent to the saturated area where subsurface MEC removal was not completed (Section 10.0 of RA Report). A total of 9 MEC items were recovered during subsurface MEC removal in the 7.2-acre area adjacent to the saturated area. Figure 2-1 shows the location of the 9 MEC items. These items were used to evaluate MEC density in the saturated area. The MEC densities in Table 2-8 shows risk scores ranging from 1 through 3 for items with MEC hazards 1 and 3 recovered from 1-foot and 4-foot depths. A score of 3 was used for all receptors.

2.3.1.7 Intensity of Contact with Soil

The intensity of contact with soil (Table 2-9) represents an hours-per-day assessment of the receptor's contact with soil. The intensity of contact with soil is receptor dependent. The intensity of contact with soil in the areas where surface and subsurface MEC removals were completed was assumed to be less than 3 hours per day for a recreational user with a score of 2 and up to 8 hours per day for the outdoor maintenance/ fire fighter/ prescribed burn worker with a score of 4. The intensity of contact with soil in the areas where subsurface MEC removals was not completed was assumed to be less than 3 hours per day for a trespasser with a score of 2 and up to 8 hours per day for the outdoor maintenance and construction workers with a score of 4.

2.3.1.8 Frequency of Entry

The frequency of entry (Table 2-10) evaluates the number of entries per year, month, and week based on a person-days-per-year approach. Thus, the frequency of entry is the same if one person visits the site one day each month for a year or if 12 people visited the site for one day during the year. The exposure duration is fixed at one year for all receptors and the number of exposures during that year is evaluated. The frequency of entry for all receptors to the area where surface and subsurface removals were completed is expected to be once a week or more, resulting in a score of 4. Trespassers are expected to frequent the area less than once per month where subsurface removal was not completed, resulting in a score of 2 and the outdoor maintenance and construction workers are expected to frequent the area once a week or more, resulting in a score of 4.

2.3.2 Overall Hazard Factor - MEC Hazard Classification

The overall hazard factor is an assessment of the inherent hazard of the specific MEC item, and must be determined by unexploded ordnance-trained personnel. The overall hazard factor relates to the MEC Hazard Classification score that considers the energetic material present in the MEC item and functioning of the item, and assumes that all items are fuzed and portable. The scoring is based on both the likelihood of the MEC to cause an injury, and the severity of the injury. Based on the factors identified above, four possible scores for the MEC Hazard factor are possible and are presented in Table 2-12. The scores range from 0 to 3, with 0 assigned to inert items and 3 representing the highest hazard. In August 2005, the

explosive hazard risk code classifi cations were updated (*USACE, 2005*). This updated inf ormation was used in sele cting the hazar d factors use d in this risk asse ssment. Type 3 MEC ite ms recovered from the 7.2 acre ar ea adjacent to the satur ated area include a 37 millimeter (mm) projectile, an anti-tank rifle grenade, and 2.36- inch a ntitank rocke ts. Som e T ype 1 item s recovered include a m issile sti mulant, 35mm subcaliber practice rocket, s moke rifle grenade, and surface trip flares. All ite ms at Fort Ord are assumed to be fuzed (if not inert) and portable.

Based on the type of items found, the overall MEC hazard classification score used for MRS-16 is 3.

2.3.3 Overall MEC Risk

The overall MEC risk is determined by combining the accessibility, exposure, and overall hazard factors in a matrix to yield (Table 2-13) an o verall risk score designated b y t he letters A through E, where A represents the lowest risk, and E represents the highest ris k. In addition to the letter score , accompanying narrative will explain the assu mptions used in calculating the risk score. It shoul d be noted that the risk score represents th e highest risk level for the receptors and does not neces sarily represent the expected risk.

	A	B	C	D	E
Overall MEC Risk Score	Lowest Low		Medium	High	Highest

2.4 MEC Risk Assessment Results

This section describes the results of the current (post-removal) risk for each identified receptor, considered separately for areas where subsurface MEC removal was or was not completed.

2.4.1 Areas where Surface and Subsurface MEC Removals were Completed

A summary of the input factors and post-rem oval MEC risks for each receptor is presented in Table 2-14. The highest MEC Ha zard Classifi cation of 3 was us ed as the ove rall score for each re ceptor. The post-removal MEC risk assess ment results for each rece ptor are presented in Tables 2-15 through 2-18. The tables present the results and a brief description of t he inputs used to generate the resultant score. T he post-removal results for all receptors is an A or lowest risk.

Although the risk is scored as an A for all receptors b ased on the risk Protocol, it should be noted that the detection efficiency of the geophy sical equipment is not assumed to be 100 percent and that while not expected, based on the uncertainty analysis pres ented in Section 2.5, it is possib le that MEC may remain below the surface at the site.

2.4.2 Area where Subsurface MEC Removals were not Completed

A summary of the input factors and post-rem oval MEC risks for each receptor is presented in Table 2-19. The highest MEC Ha zard Classifi cation of 3 was us ed as the ove rall score for each re ceptor. The post-removal MEC risk assess ment results for each rece ptor are presented in Tables 2-20 through 2-21. The tables present the results and a brief description of t he inputs used to generate the resultant score. T he post-removal results for all receptors is E which is the highest score.

It should be noted that the risk score represents the highest risk level possible for the receptors and does not necessarily represent the expected or actual risk.

2.5 Uncertainty

This section addresses the uncertainties in the risk assessment related to data used in the risk assessment, input scores, and assumptions about the uses of the land by future receptors.

2.5.1 Data

The data used in performance of the risk assessment went through a thorough QC/QA process as outlined in Section 7.0 of the RA Report and the remedial action was conducted according to BCT approved work plan that identified QC procedures and data collection and analysis objectives with the exception of the 23 full and 2 partial grid area. Except for the 23 full and 2 partial grid area, the objectives of the work plan were met, and all detected MEC was removed, and the data were considered usable for performing the risk assessment. If concerns are brought up about the data quality in the future, the results of the risk assessment would need to be re-evaluated and higher risk scores could occur.

2.5.2 Input Scores

The following section addresses uncertainties related to some of the input scores including the Migration/Erosion Potential, the Level of Intrusion, the Frequency of Entry, and the Intensity of Contact with Soil. Most of the uncertainties are similar to those identified in the Parker Flats MRA Risk Assessment (*Malcolm Pirnie, 2005*).

2.5.2.1 MEC Depth below Ground Surface

For the areas where surface and subsurface MEC removals were completed, scores of "1" for all receptors were used in performing the post-remediation risk assessment as specified in the Protocol that states that the score of 1 is technically appropriate where "100 percent of detected MEC was removed considering the data quality for the site." Data quality is further defined as having detection and removal procedures meeting the data quality objectives (DQOs) for the site based on clearly identified investigational objectives. The remedial action within MRS-16 did meet the investigational objectives as described in Section 2.1. However, meeting the investigational objectives does not eliminate the possibility that MEC could still be present below the surface because the removal efficiencies have not been shown to be 100 percent.

The potential for MEC to remain below ground surface even though a score of "1" is used results in uncertainty in the "A" score.

For the area where subsurface MEC removal was not completed a MEC Depth below Ground Surface Score of 7 was used for all receptors. This is the most conservative score that can be assigned in the Protocol corresponding to "no MEC on the surface and MEC below surface". MEC is assumed to be present in the subsurface because subsurface MEC was found in adjacent grids. However, no MEC was found in exploration trenches (RA Report, Section 5.4).

2.5.2.2 Migration/Erosion Potential

The same Erosion Potential Score was used for this risk assessment as was used for the Parker Flats MRA Risk Assessment (*Malcolm Pirnie, 2005*) based on similar soil, vegetation cover, and topographic conditions through most of the site. Erosion could be higher in areas where soil is disturbed such as excavation areas and along roads and trails. Erosion is expected to be low in well vegetated areas. Based on review of topographical data a score of "1" for erosion potential best represents the site conditions. Most of MRS-16 will be allowed to revegetate. Surface and subsurface removals have been completed along and adjacent to trails within the site.

2.5.2.3 Level of Intrusion

The level of intrusion score is based on an assumed depth of soil intrusion by the receptor based on expected behavior. If a receptor intrudes to less than the assumed depth, the risk would be overestimated, and if a receptor intruded greater than the assumed depth, the risk would be underestimated. At MRS-16, it is expected that intrusive activities will be limited to planting and placing fence posts. Large scale construction excavations are not anticipated.

2.5.2.4 MEC Density

For the areas where surface and subsurface MEC removals were completed MEC density scores of "1" were used for all receptors as specified in the Protocol that states that the score of 1 is technically appropriate where "100 percent of detected MEC was removed considering the data quality for the site". Data quality is further defined as having detection and removal procedures meeting the DQOs for the site based on clearly identified investigational objectives including reuse and the detection of designated MEC. The subsurface removal actions within MRS-16 did meet the investigational objectives as described in Section 2.1; however, meeting the investigational objectives does not eliminate the possibility that MEC could still be present below the surface because the removal efficiencies have not been shown to be 100 percent. The potential for MEC to remain below ground surface even though a score of "1" is used results in uncertainty in the "A" score.

For the area where subsurface MEC removal was not completed, MEC densities were obtained from the subsurface removals conducted in adjacent grids. This is considered to be a reliable and likely conservative approach. The saturated area where subsurface work was not completed appears to be a disturbed area near the former targets; it is more likely that MEC items were removed in this area during training than in the "overshoot" areas behind the targets. Typical range maintenance activity would include training stoppage, location and detonation of any item that did not function as designed. No MEC was found in exploration trenches within the saturated zone (RA Report, Section 5.4).

2.5.2.5 Frequency of Entry and Contact with Soil

The frequency of entry factor depends on assumptions about the behavior of receptors that access the site. The frequency of entry factor is a measure of the number of times per year that a receptor (one or more persons) will be in the area. If people were to visit the site more times per year than assumed in the risk assessment, then the overall risk for that receptor would underestimate the actual risk. The opposite is also true, that if people were to visit the site fewer times than assumed in the risk assessment, then the

overall risk would be ove restimated. This asse ssment conservatively assumed frequent use of the site b y the recreatio nal user and outd oor m aintenance/construction worker. However, in the fe nced-off area where subsur face MEC re moval was n ot com pleted, it is projecte d that infrequent entry by trespass ers will occur.

2.5.2.6 Intensity of Contact with Soil

The intensity of contact with soil factor is a measure of the length of ti me the r eceptor will have contact with the exposure medium (in this case, soil). It is difficult to evaluate the activities that will occur in the future, and what the intensity of contact with th e soil will b e. As with the Frequency of Entr y uncertainties, if the receptor spends m ore time in co ntact with the soil than assumed, the overall risk fo r the receptor would be underesti mated, and if the receptor were to spend less ti me in contact with the soil, the overall risk score could be overestimated.

2.5.3 Removal Uncertainties

The majority of the Ty pe 3 hazard 2.36-inch antita nk rockets w ere rem oved from within the 2.36-inch rocket range fan. A few were rem oved outside th e 2.36-i nch r ocket range fan. In addi tion, 37mm projectiles, 75mm projectiles, 35 mm rocket, and antitank rifle grenades were also found sporadically within MRS-16. MEC was recover ed between 0 inches and 48 inches below g round surface. These Type 3 hazard ite ms, including 2.36-inch antitank rockets, are more likely to be encountered in the subsurface. The re medial action within MRS-16 did m eet the investigational objectives as described in Section 2.1. However, meeting the investigational objectives does not eliminate the possibility that MEC could still be present below the surface because the re moval ef ficiencies ha ve not been shown to be 100 percent. Despite removal efficiencies not having been shown to be 100 per cent, detailed Data Quality Objectives and QC/QA processe s we re developed for the work at MRS-16 to m aximize detection and rem oval efficiencies.

3.0 Risk Assessment for Chemical Hazards

Potential ecological risks associated with metals and explosives compounds were evaluated in the *Ecological Risk Assessment for Small Arms Ranges, Habitat Areas, Impact Area* (ERA) (Shaw/Mactec/BBL, 2007). Screening levels (SLs) based on the assessment of habitat quality and distribution of chemicals of concern within the ranges were developed during the ERA to guide risk management and remedial decision-making for these ranges. The ERA SLs are lower than the regional SL for residential soil presented in *Regional Screening Levels for Chemical Contaminants at Superfund Sites* (Regional SLs) (EPA, 2008) and are protective of human health.

Section 3.3 of the main RA report presents the discussion on the soil sampling activities conducted as part of the BRA to evaluate possible presence of chemicals of concern in soil related to military munitions training (IT/Harding ESE, 2001). A separate technical memorandum will be prepared documenting the data and decisions reached by the BCT.

4.0 Conclusions

The following conclusions can be made based on the results of the risk assessment.

- For the areas where surface and subsurface MEC removals were completed, the post-removal risks (current) for all receptors are at the lowest risk (A).
- For the area where subsurface MEC removal was not completed, MEC may remain below the surface and it is possible that a receptor could encounter a MEC item. To reduce the possibility of an encounter, land use controls should be evaluated to restrict entry and intrusive work in this area. These controls could include a fence to delineate the area and warning signs. The post-removal results for all receptors is E which is the highest score.
- In all areas, it should be noted that the instrument detection efficiencies are not expected to be 100 percent; therefore, it is possible that MEC may remain at the site. Construction support is recommended for any intrusive work within the MRS-16 saturated area.

5.0 References

IT Corporation/Harding ESE (IT, Harding), 2001, *Basewide Range Assessment Work Plan and Contractor Quality Control Plan, Small Arms and Multi-Use Ranges, Fort Ord, California*

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USACE, 2005. *Revised Explosive Hazard Risk Code Classification Document. Memorandum for U. S. Army Presidio of Monterey, Environmental and Natural Resources. August.*

U.S. Environmental Protection Agency (EPA), 2008, *Regional Screening Levels for Chemical Contaminants at Superfund Sites*

Tables

Table 2-1 Description of Receptors Evaluated Areas where Surface and Subsurface MEC Removal were completed				
Receptor	Description	Level of Intrusion	Frequency of Entry	Intensity of Contact with Soil
Recreational User	Expected recreational uses of the property include walking on established trails, horse back riding, and bicycling on established trails and roads.	A recreational user is not expected to intrude below the surface.	A recreational receptor is expected to frequently enter the area.	A recreational user is expected to spend up to six hours in contact with the soil.
Outdoor Maintenance/ Fire Fighter/ Prescribed Burn Worker	An outdoor maintenance worker is assumed to be responsible for planting, habitat monitoring or maintenance. A Fire Fighter/ Prescribed Burn Worker are responsible for firefighting, vegetation clearance, and preparation of fire breaks.	An outdoor maintenance worker, fire fighter, prescribed burn worker is expected to intrude below the surface up to a depth of 3 feet.	An outdoor maintenance worker is expected to frequently enter the area. A fire fighter and prescribed burn worker is expected to enter the site to fight uncontrolled fires and to prepare for a prescribed burn.	An outdoor maintenance worker fire fighter, and prescribed burn worker are expected to spend up to 8 hours per day in contact with the soil.
Construction Worker	A construction worker is assumed to be responsible for small construction jobs.	A construction worker is expected to intrude below the surface up to a depth of 5 feet.	A construction worker is expected to frequently enter the area.	A construction worker is expected to spend up to 8 hours per day in contact with the soil.

Table 2-2 Description of Receptors Evaluated Areas where Subsurface MEC Removals were not completed (Saturated Area)				
Receptor	Description	Level of Intrusion	Frequency of Entry	Intensity of Contact with Soil
Trespasser	Trespassers are expected to enter the area to walk around a fenced-off area	A trespasser is not expected to intrude below the surface.	A trespasser is expected to be infrequent.	A trespasser is expected to spend up to three hours in contact with the soil.
Outdoor Maintenance Worker	An outdoor maintenance worker is assumed to be responsible for planting, habitat monitoring or maintenance.	An outdoor maintenance worker is expected to intrude below the surface up to a depth of 3 feet.	An outdoor maintenance worker is expected to frequently enter the area.	An outdoor maintenance worker is expected to spend up to 8 hours per day in contact with the soil.
Construction Worker	A construction worker is assumed to be responsible for small construction jobs.	A construction worker is expected to intrude below the surface up to a depth of 5 feet.	A construction worker is expected to frequently enter the area.	A construction worker is expected to spend up to 8 hours per day in contact with the soil.

Table 2-3 Depth Below Ground Surface	
Score	**Description (a)(b)(c)(d)**
1	100% of detected MEC was removed considering the data quality for the site.
2	MEC > 5 feet bgs
3	MEC ≥ 4 feet bgs
4	MEC ≥ 3 feet bgs
5	MEC ≥ 2 feet bgs
6	MEC ≥ 1 feet bgs
7	No MEC on the surface and MEC below surface
8	Any MEC on surface

Notes:

(a) The shallowest MEC item found determines the depth below ground surface for the sector.

(b) If significant uncertainty exists about the depth of the MEC item, it may be appropriate to assign the next highest score.

(c) Depth should be based on actual field measurements of MEC items found.

(d) Detection and removal procedures meeting the DQOs for the sector based on clearly defined investigational objectives including reuse and the detection of designated MEC. If DQOs have not been established for the sector, the quality of data should be approved by the BCT to score a "1".

Table 2-4 Level of Intrusion	
Score	**Description (a)(b)**
1	Non-Intrusive: Activity on the ground surface, none below the surface
2	Minor Intrusions: Activity on ground surface and ground disturbances to a depth of one foot bgs
3	Moderate Intrusions: Ground disturbances to a depth of two feet bgs.
4	Significant Intrusions: Ground disturbances to a depth of four feet bgs
5	Highly Intrusive: ground disturbances greater than four feet bgs.

Notes:
(a) The deepest intrusion level expected for a given reuse determines the Intrusion Level of activity for the sector.
(b) If significant uncertainty exists about the depth of intrusion, it may be appropriate to assign the next highest score.

Table 2-5 Migration/Erosion Potential	
Score	**Description (a)**
1	Very Stable: MEC will not migrate. Erosion is equal to or less than the site-wide average of 3/100 inches
2	Minor Migration: Recurring and extreme natural events may cause MEC to migrate upward, potentially reaching the intrusion level, over a period of time (more than two five-year reviews). Annual Erosion is greater then the average site-wide condition but less than one inch **(b)**.
3	Significant Migration: Recurring and extreme natural events will bring MEC to the surface within the first recurring review. Annual Erosion is more than one inch **(c).**

Notes:

(a) The Migration/Erosion Factor should consider the potential for changes in the depth of MEC due to erosion. The presence of human activities, streams, gullies, or steep slopes in an area may require a more thorough investigation of the potential for erosion.

(b) Average annual site-wide erosion potential is 3/100 inches.

(c) Significant erosion at Fort Ord is likely limited to areas disturbed by human activity, such as roads or firebreaks.

Table 2-6 Accessibility Factor Scoring Matrix				
		Migration/Erosion Potential		
Depth Below Ground Surface	**Level of Intrusion**	**1. Very Stable**	**2. Minor Migration**	**3. Significant Migration**
1. 100% of detected MEC removed considering data quality for the area.	1. Non-Intrusive (surface only)	1	1	1
	2. Minor Intrusion (<1 foot bgs)	1	1	1
	3. Moderate Intrusion (<2 feet bgs)	1	1	1
	4. Significant Intrusion (<4 feet bgs)	1	1	1
	5. Highly Intrusive (>4 feet bgs)	1	1	1
2. MEC > 5 feet bgs	1. Non-Intrusive (surface only)	1	1	1
	2. Minor Intrusion (<1 foot bgs)	1	1	1
	3. Moderate Intrusion (<2 feet bgs)	1	1	1
	4. Significant Intrusion (<4 feet bgs)	1	2	3
	5. Highly Intrusive (>4 feet bgs)	3	3	4
3. MEC > 4 feet bgs	1. Non-Intrusive (surface only)	1	1	1
	2. Minor Intrusion (<1 foot bgs)	1	1	1
	3. Moderate Intrusion (<2 feet bgs)	1	1	2
	4. Significant Intrusion (<4 feet bgs)	3	3	4
	5. Highly Intrusive (>4 feet bgs)	5	5	5
4. MEC > 3 feet bgs	1. Non-Intrusive (surface only)	1	1	1
	2. Minor Intrusion (<1 foot bgs)	1	1	2
	3. Moderate Intrusion (<2 feet bgs)	1	2	3
	4. Significant Intrusion (<4 feet bgs)	5	5	5
	5. Highly Intrusive (>4 feet bgs)	5	5	5
5. MEC > 2 feet bgs	1. Non-Intrusive (surface only)	1	2	3
	2. Minor Intrusion (<1 foot bgs)	3	3	4
	3. Moderate Intrusion (<2 feet bgs)	5	5	5
	4. Significant Intrusion (<4 feet bgs)	5	5	5
	5. Highly Intrusive (>4 feet bgs)	5	5	5
6. MEC > 1 feet bgs	1. Non-Intrusive (surface only)	4	5	5
	2. Minor Intrusion (<1 foot bgs)	5	5	5
	3. Moderate Intrusion (<2 feet bgs)	5	5	5
	4. Significant Intrusion (<4 feet bgs)	5	5	5
	5. Highly Intrusive (>4 feet bgs)	5	5	5
7. No MEC on the surface and MEC below surface	1. Non-Intrusive (surface only)	4	5	5
	2. Minor Intrusion (<1 foot bgs)	5	5	5
	3. Moderate Intrusion (<2 feet bgs)	5	5	5
	4. Significant Intrusion (<4 feet bgs)	5	5	5
	5. Highly Intrusive (>4 feet bgs)	5	5	5
8. Any MEC on the surface	1. Non-Intrusive (surface only)	5	5	5
	2. Minor Intrusion (<1 foot bgs)	5	5	5
	3. Moderate Intrusion (<2 feet bgs)	5	5	5
	4. Significant Intrusion (<4 feet bgs)	5	5	5
	5. Highly Intrusive (>4 feet bgs)	5	5	5

Accessibility Factor scores are defined as:
1. Least Potential for Accessibility.
2. Not Likely to be Accessible.
3. May be Accessible.
4. Likely to be Accessible.
5. Greatest Potential for Accessibility.

Table 2-7 MEC Density	
Score	**Description***
1	100% of detected MEC removed to level of intrusion
2	Low MEC density (<0.1 items per acre)
3	Medium MEC Density (0.1 to 1 item per acre)
4	High MEC Density (>1 item per acre)

*Detection and removal procedures meeting the DQOs for the site based on clearly defined investigational objectives including reuse on the detection of designated MEC. If DQOs have not been established for the sector, the quality of data should be approved by the BCT to score a "1".

Table 2-8 MEC Density Based on Removal from Grids Adjacent to Saturated Area												
	Number of Items				**Density***				**MEC Density Score**			
MEC Hazard	**1**		**3**		**1**		**3**		**1**		**3**	
Depth (feet)	**1**	**4**	**1**	**4**	**1**	**4**	**1**	**4**	**1**	**4**	**1**	**4**
	2	0	4	3	0.3	0	0.6	0.4	3	1	3	3

Notes:
*Site is 7.2 acres. Densities are based on the number of items/acre found during removal action.
** Item with MEC Hazard 2 was not encountered.

Table 2-9 Intensity of Contact with Soil	
Score	**Description**
1	Very Low: <1 hour/day
2	Low: <3 hours/day
3	Moderate: <6 hours/day
4	High: <9 hours/day
5	Very High: ≥9 hours/day
Notes: Direct contact with soil can range from simply walking on the ground to digging in the soil.	

Table 2-10 Frequency of Entry	
Score	**Description**
1	Rare: It is not likely to occur (less than once per year to once per year)
2	Infrequent: Will seldom occur (less than once per season to once per month
3	Occasional: Will likely occur from time to time (more than once per month)
4	Frequent: Will occur frequently (once a week to more than once a week)
Note: UXO-trained professionals and others covered by MEC-specific health and safety plans are not considered in the Frequency of Entry scoring.	

Table 2-11 Exposure Factor Scoring Matrix (a)						
		Intensity of Contact with Soil				
Frequency of Entry	**MEC density**	1. Very Low: ≤1 hour/day	2. Low: ≤3 hours/day	3. Moderate: ≤6 hours/day	4: High: ≤9 hours/day	5. Very High: >9 hours/day
1. Rare	1. 100% of detected MEC removed to intrusion depth	1	1	1	1	1
	2. Low MEC Density	1	2	2	3	3
	3. Medium MEC Density	2	3	3	3	3
	4. High MEC Density	3	3	3	4	4
2. Infrequent	1. 100% of detected MEC removed to intrusion depth	1	1	1	1	1
	2. Low MEC Density	1	2	2	3	3
	3. Medium MEC Density	2	3	3	4	4
	4. High MEC Density	3	3	4	4	4
3. Occasional	1. 100% of detected MEC removed to intrusion depth	1	1	1	1	1
	2. Low MEC Density	2	2	3	3	3
	3. Medium MEC Density	3	3	4	4	4
	4. High MEC Density	3	4	5	5	5
4. Frequent	1. 100% of detected MEC removed to intrusion depth	1	1	1	1	1
	2. Low MEC Density	2	2	3	4	4
	3. Medium MEC Density	3	4	4	5	5
	4. High MEC Density	4	5	5	5	5

(a) Exposure Factor scores are defined as:
1. Least Potential for Exposure.
2. Not Likely to be Exposed.
3. May be Exposed.
4. Likely to be Exposed.
5. Greatest Potential for Exposure.

Table 2-12 MEC Hazard Classification	
Score	**Description (a)**
0	Inert MEC, will cause no injury **(b)**
1	MEC that will cause an injury, or in extreme cases could cause major injury or death to an individual if functioned by an individual's activities **(c)**
2	MEC that will cause major injury, or in extreme cases could cause death to an individual if functioned by an individual's activities **(d)**
3	MEC that will kill an individual if detonated by an individual's activities

(a) MEC type must only be determined by UXO-trained personnel.
(b) Inert describes the condition of Munition, or component which contains no explosive, pyrotechnic, or chemical agent.
(c) An injury is defined as a flesh wound or minor burn.
(d) A major injury is defined as the loss of sight, hearing or limbs, or major burn.

Table 2-13 Overall MEC Risk Scoring Matrix (a)						
		Exposure				
MEC Type	**Accessibility**	1. Least Potential for Exposure	2. Not Likely to be Exposed	3. May be Exposed	4. Likely to be Exposed	5. Greatest Potential for Exposure
O. Inert MEC	1. Least potential for Accessibility	A	A	A	A	A
	2. Not Likely to be Accessible	A	A	A	A	A
	3. May be Accessible	A	A	A	A	A
	4. Likely to be Accessible	A	A	A	A	A
	5. Greatest Potential for Accessibility	A	A	A	A	A
1. MEC that will cause injury	1. Least potential for Accessibility	A	A	A	B	B
	2. Not Likely to be Accessible	A	B	B	B	B
	3. May be Accessible	A	B	B	C	C
	4. Likely to be Accessible	B	B	C	D	D
	5. Greatest Potential for Accessibility	B	C	D	D	D
2. MEC that will cause major injury	1. Least potential for Accessibility	A	A	B	B	B
	2. Not Likely to be Accessible	A	B	B	C	C
	3. May be Accessible	A	B	C	D	D
	4. Likely to be Accessible	B	C	D	D	E
	5. Greatest Potential for Accessibility	B	C	D	E	E
3. MEC that will kill	1. Least potential for Accessibility	A	B	B	C	C
	2. Not Likely to be Accessible	B	B	C	D	D
	3. May be Accessible	B	C	D	E	E
	4. Likely to be Accessible	C	C	D	E	E
	5. Greatest Potential for Accessibility	C	D	E	E	E

Notes: (a) The Overall MEC Risk scores are defined as:

A. Lowest risk
B. Low risk
C. Medium risk
D. High risk
E. Highest risk

Table 2-14 MEC Risk Assessment Analysis Results Areas where Surface and Subsurface MEC Removals were completed										
Receptor	**MEC Depth Below Ground Surface**	**Level of Intrusion**	**Migration/ Erosion Potential**	**Accessibility Factor Score[1]**	**MEC Density**	**Intensity of Contact with Soil**	**Frequency of Entry**	**Exposure Factor Score[2]**	**MEC Hazard**	**Overall MEC Risk Score[3]**
Table Used for Determination	1-3	1-4	1-5	1-6	1-7 and 1-8	1-9	1-10	1-11	1-12	1-13
Recreational User	1	2	1	1	1	2	4	1	3	A
Outdoor Maintenance/ Fire Fighter/ Prescribed Burn Worker	1	4	1	1	1	4	4	1	3	A
Construction Worker	1	5	1	1	1	4	4	1	3	A

Notes:

[1] The accessibility factor is determined by combining the MEC Depth below ground surface, level of intrusion, and migration/erosion potential.
[2] The exposure factor is determined by combining the MEC density, intensity of contact with soil, and frequency of entry.
[3] The overall MEC risk is determined by combining the accessibility, exposure, and MEC hazard factors.

Table 2-15 MEC Risk Analysis Recreational User Areas where Surface and Subsurface MEC Removals were completed			
Sector	**MRS 16**		
Proposed Property Reuse	**Habitat Reserve and Management**		
Receptor Type	**Recreational User**		
Analysis	**Post Remedial Action**		
MEC Risk Score	**A**	Accessibility 1	MEC items are not accessible because a removal to depth has been completed and all detected MEC items have been removed, the work was completed according to a BCT approved work plan, and the recreational user is not expected to intrude below the surface. The area is on flat to gently sloping terrain and is not expected to be significantly affected by erosion.
		Exposure 1	The Frequency of Entry for a recreational user is frequent and the Intensity of Contact with Soil is moderate: however, a removal to depth has been completed and all detected MEC items have been removed. The work was completed according to the BCT approved work plan; therefore, the potential for Exposure is low.
		MEC Type **3**	Type 3 items recovered include a 37mm projectile, an anti-tank rifle grenade, and 2.36-inch antitank rockets. Some Type 1 items include a missile stimulant, 35mm sub caliber practice rocket, smoke rifle grenade, and surface trip flares. All items at Fort Ord are assumed to be fuzed (if not inert) and portable.
		Data Quality	The data used was collected according to the BCT approved work plan and is considered usable for performing the risk assessment.

Table 2-16 MEC Risk Analysis Outdoor Maintenance/Fire Fighter/ Prescribed Burn Worker Areas where Surface and Subsurface MEC Removals were completed			
Sector	**MRS 16**		
Proposed Property Reuse	**Habitat Reserve and Management**		
Receptor Type	**Outdoor Maintenance/Fire Fighter/ Prescribed Burn Worker**		
Analysis	**Post Remedial Action**		
MEC Risk Score	**A**	Accessibility 1	MEC items are not accessible because a removal to depth has been completed and all detected MEC items have been removed, the work was completed according to a BCT approved work plan. The outdoor maintenance / fire fighter/ prescribed burn worker is expected to conduct significant intrusion below the surface. The area is on flat to gently sloping terrain and is not expected to be significantly affected by erosion.
		Exposure 1	The Frequency of Entry for an outdoor maintenance / fire fighter/ prescribed burn worker is frequent and the Intensity of Contact with Soil is high: however, a removal to depth has been completed and all detected MEC items have been removed. The work was completed according to the BCT approved work plan; therefore, the potential for Exposure is low.
		MEC Type **3**	Type 3 items recovered include a 37mm projectile, an anti-tank rifle grenade, and 2.36-inch antitank rockets. Some Type 1 items include a missile stimulant, 35mm sub caliber practice rocket, smoke rifle grenade, and surface trip flares. All items at Fort Ord are assumed to be fuzed (if not inert) and portable.
		Data Quality	The data used was collected according to the BCT approved work plan and is considered usable for performing the risk assessment.

Table 2-17 MEC Risk Analysis Construction Worker Areas where Surface and Subsurface MEC Removals were completed			
Sector	**MRS 16**		
Proposed Property Reuse	**Habitat Reserve and Management**		
Receptor Type	**Construction Worker**		
Analysis	**Post Remedial Action**		
MEC Risk Score	**A**	Accessibility 1	MEC items are not accessible because a removal to depth has been completed and all detected MEC items have been removed, the work was completed according to a BCT approved work plan. The construction worker is expected to conduct significant intrusion below the surface. The area is on flat to gently sloping terrain and is not expected to be significantly affected by erosion.
		Exposure 1	The Frequency of Entry for a construction worker is frequent and the Intensity of Contact with Soil is high: however, a removal to depth has been completed and all detected MEC items have been removed. The work was completed according to the BCT approved work plan; therefore, the potential for Exposure is low.
		MEC Type **3**	Type 3 items recovered include a 37mm projectile, an anti-tank rifle grenade, and 2.36-inch antitank rockets. Some Type 1 items include a missile stimulant, 35mm sub caliber practice rocket, smoke rifle grenade, and surface trip flares. All items at Fort Ord are assumed to be fuzed (if not inert) and portable.
		Data Quality	The data used was collected according to the BCT approved work plan and is considered usable for performing the risk assessment.

Table 2-18 MEC Risk Assessment Analysis Results Areas where Subsurface MEC Removals were not completed (Saturated Area)										
Receptor	**MEC Depth Below Ground Surface**	**Level of Intrusion**	**Migration/ Erosion Potential**	**Accessibility Factor Score[1]**	**MEC Density**	**Intensity of Contact with Soil**	**Frequency of Entry**	**Exposure Factor Score[2]**	**MEC Hazard**	**Overall MEC Risk Score[3]**
Table Used for Determination	1-3	1-4	1-5	1-6	1-7 and 1-8	1-9	1-10	1-11	1-12	1-13
Trespasser	7	2	1	5	3	2	2	3	3	E
Outdoor Maintenance/ Fire Fighter/ Prescribed Burn Worker	7	4	1	5	3	4	4	5	3	E
Construction Worker	7	4	1	5	3	4	4	5	3	E

Notes:

[1] The accessibility factor is determined by combining the MEC Depth below ground surface, level of intrusion, and migration/erosion potential.
[2] The exposure factor is determined by combining the MEC density, intensity of contact with soil, and frequency of entry.
[3] The overall MEC risk is determined by combining the accessibility, exposure, and MEC hazard factors.

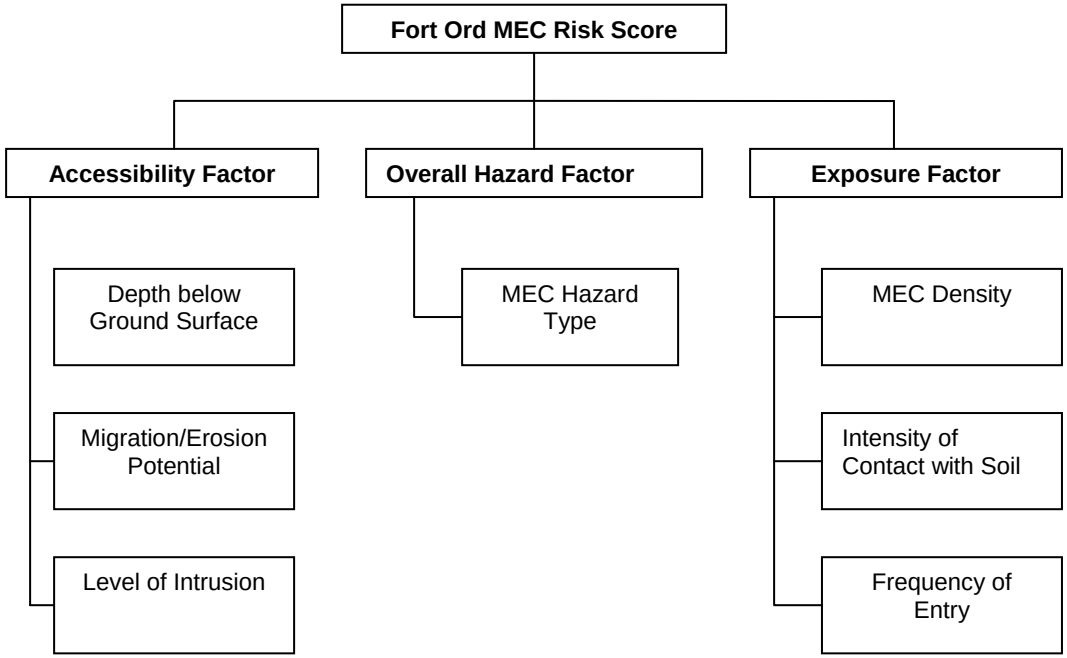
Table 2-19 MEC Risk Analysis Trespasser Areas where Surface and Subsurface MEC Removals were not completed			
Sector	**MRS 16**		
Proposed Property Reuse	**Habitat Reserve and Management**		
Receptor Type	**Trespasser**		
Analysis	**Post Remedial Action**		
MEC Risk Score	**E**	Accessibility 5	Surface MEC removal has been completed. MEC items may be accessible in the subsurface if present. The trespasser is not expected to intrude below the surface. The area is on flat to gently sloping terrain and is not expected to be significantly affected by erosion.
		Exposure 3	The Frequency of Entry for a trespasser is infrequent and the Intensity of Contact with Soil is low: however, a removal to depth was not completed; therefore, there is a potential that a trespasser may be exposed.
		MEC Type **3**	Type 3 items recovered include a 37mm projectile, an anti-tank rifle grenade, and 2.36-inch antitank rockets. Some Type 1 items include a missile stimulant, 35mm sub caliber practice rocket, smoke rifle grenade, and surface trip flares. All items at Fort Ord are assumed to be fuzed (if not inert) and portable.
		Data Quality	The data used was collected according to the BCT approved work plan and is considered usable for performing the risk assessment.

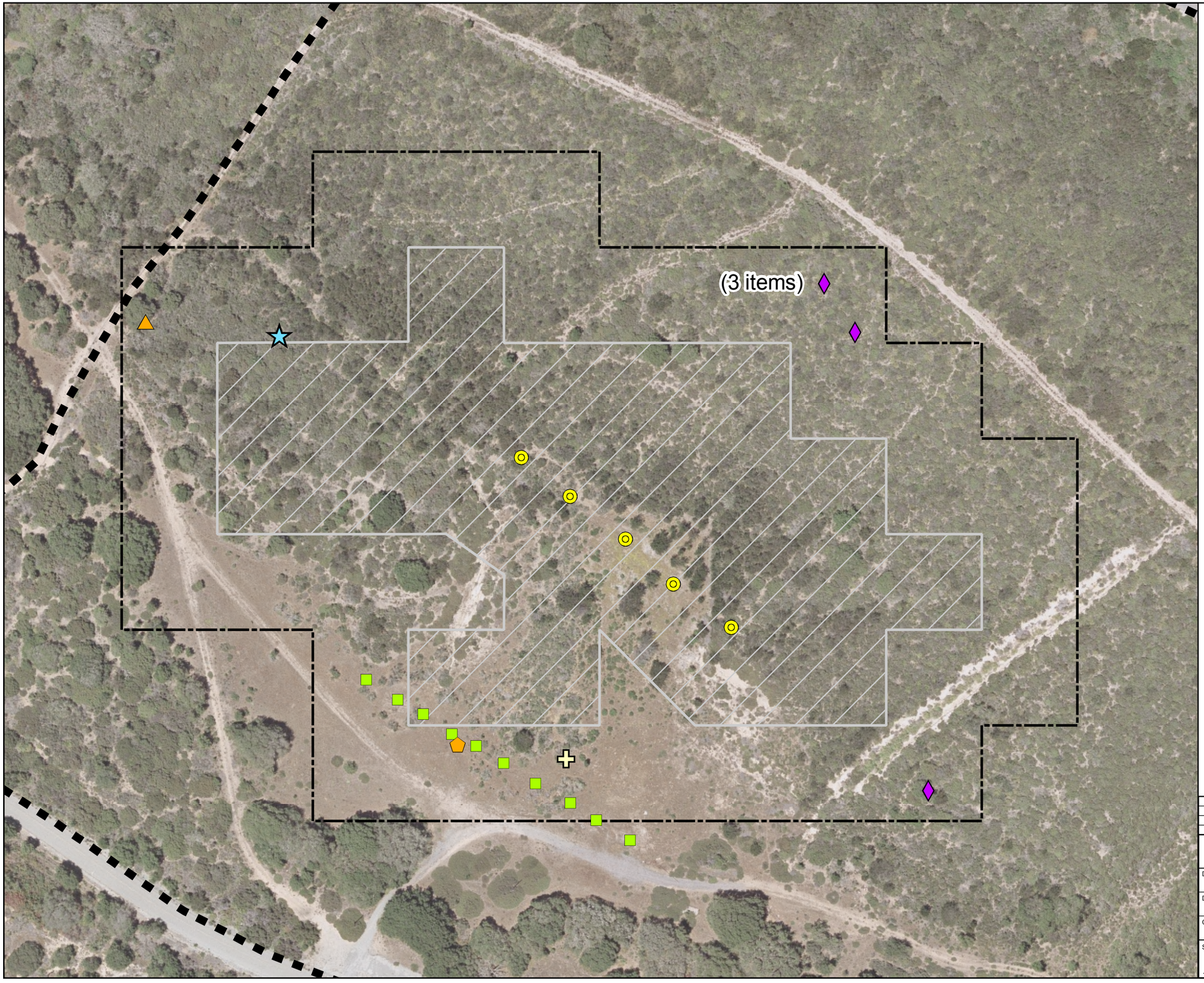
Table 2-20 MEC Risk Analysis Outdoor Maintenance Worker Areas where Surface and Subsurface MEC Removals were not completed			
Sector	**MRS 16**		
Proposed Property Reuse	**Habitat Reserve and Management**		
Receptor Type	**Outdoor Maintenance Worker**		
Analysis	**Post Remedial Action**		
MEC Risk Score	**E**	Accessibility 5	Surface MEC removal has been completed. MEC items may be accessible in the subsurface if present. The outdoor maintenance worker is not expected to intrude below the surface. The area is on flat to gently sloping terrain and is not expected to be significantly affected by erosion.
		Exposure 5	The Frequency of Entry for a outdoor maintenance worker is infrequent and the Intensity of Contact with Soil is low: however, a removal to depth was not completed; therefore, there is a potential that a trespasser may be exposed.
		MEC Type **3**	Type 3 items recovered include a 37mm projectile, an anti-tank rifle grenade, and 2.36-inch antitank rockets. Some Type 1 items include a missile stimulant, 35mm sub caliber practice rocket, smoke rifle grenade, and surface trip flares. All items at Fort Ord are assumed to be fuzed (if not inert) and portable.
		Data Quality	The data used was collected according to the BCT approved work plan and is considered usable for performing the risk assessment.

Table 2-21 MEC Risk Analysis Construction Worker Areas where Surface and Subsurface MEC Removals were not completed			
Sector	**MRS 16**		
Proposed Property Reuse	**Habitat Reserve and Management**		
Receptor Type	**Construction Worker**		
Analysis	**Post Remedial Action**		
MEC Risk Score	**E**	Accessibility 5	Surface MEC removal has been completed. MEC items may be accessible in the subsurface if present. The construction worker is expected to conduct significant intrusion below the surface. The area is on flat to gently sloping terrain and is not expected to be significantly affected by erosion.
		Exposure 5	The Frequency of Entry for a construction worker is frequent and the intensity of contact with soil is high. A removal to depth was not completed; therefore the potential for Exposure is significant.
		MEC Type **3**	Type 3 items recovered include a 37mm projectile, an anti-tank rifle grenade, and 2.36-inch antitank rockets. Some Type 1 items include a missile stimulant, 35mm sub caliber practice rocket, smoke rifle grenade, and surface trip flares. All items at Fort Ord are assumed to be fuzed (if not inert) and portable.
		Data Quality	The data was collected according to the BCT approved project work plan and is considered useable for performing the risk assessment.

Figures

Figure 1-1
Fort Ord MEC Risk Assessment Protocol Process





Legend

- MRS 16 Boundary
- Saturated Area
- 100-ft Buffer from Saturated Area
- Possible Firing Point (1949)
- Possible Target (1949)

Military Munitions and Explosives of Concern - UXO

- Flare, surface, trip, M49 series
- Grenade, rifle, AT, M9 series
- Projectile, 37mm, LE, MK I
- Rocket, 2.36inch, HEAT, M6
- Rocket, 35mm, subcaliber, practice, M73

N

0 100 200

Feet

REVISION	DATE	DESCRIPTION	CHKD	APPR

Shaw® Shaw Environmental, Inc.

Department of the Army
Sacramento District, Corps of Engineers
Sacramento, California

DESIGNED: J. MOSER
DRAWN: K. BLACK
CHECKED: P. KELSALL

FIGURE 2-1
SUBSURFACE MEC RECOVERED FROM AREA ADJACENT TO THE SATURATED AREA
MRS 16
FORMER FORT ORD, CALIFORNIA

SUBMITTED: DATE

SCALE: SPEC. No.
SHEET FILE No. MRS16_MEC_SatBorder