ATTACHMENT A
RISK ASSESSMENT THEORY

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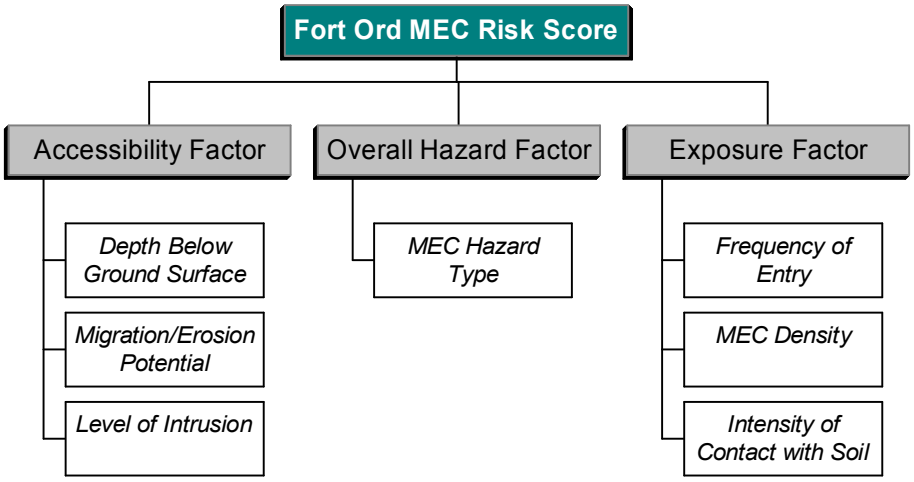
Attachment A – Risk Assessment Theory

1.0 General Overview

The Fort Ord MEC Risk Assessment Protocol (Malcolm Pirnie, 2002) is a qualitative risk assessment approach based on seven input factors. The input factors are both qualitative and quantitative. Two process matrices combine six of the input factors into scores for Accessibility and Exposure. A third process matrix combines the scores for Accessibility, Exposure, and Overall Hazard (the seventh input factor) into a single qualitative score for estimating MEC Risk. The seven input factors are shown in Figure 1 below.

Figure 1. Fort Ord MEC Risk Assessment



2.0 Definition of Input Factors and Assumptions

The following sections provide each of the input factors and the matrices used to determine an Overall MEC Risk score. For more information on the scoring process, please refer to the *Fort Ord Ordnance and Explosives (OE) Risk Assessment Protocol* (Malcolm Pirnie, 2002).

2.1. Accessibility Factor

The Accessibility Factor reflects how likely it is that the MEC items in the area are accessible by considering the three input factors as describe here. Depth below ground surface (Table A-1) refers to the minimum depth of a MEC item below the surface, while, level of intrusion (Table A-2) considers the depth of soil intrusion for proposed activities, and migration/erosion potential (Table A-3) examines whether the depth of a MEC item will change from soil movement. A score is assigned for each of the three input factors using well-defined, set criteria, and then a scoring matrix combines the three input factors to produce a score for the accessibility factor.

The following tables identify the scoring for each of the input factors used to determine the Accessibility Factor.

Table A-1. Depth Below Ground Surface

Score	Description [a] [b] [c]
1	100% of detected MEC removed considering data quality for the area (d)
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 area.
[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 area based on clearly defined investigational objectives including reuse and the detection of designated MEC. If DQOs have not been established for the area, the quality of data should be approved by the BCT to score a '1'.

Table A-2. 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 area.
[b] If significant uncertainty exists about the depth of intrusion, it may be appropriate to assign the next higher score.

Table A-3. Migration/Erosion Potential

Score	Description [a]
1	Very Stable: MEC will not migrate. Annual 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 long period of time (more than two five-year reviews). Annual erosion is greater than 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 change in depth of a MEC item 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 will likely be limited to areas disturbed by human activity, such as roads or firebreaks.

The Accessibility score is determined using the qualitative scoring matrix given in Table A-4.

Table A-4. Accessibility Factor Scoring Matrix [(a)]

Depth Below Ground Surface	Level of Intrusion	Migration/Erosion Potential		
		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	1	3
	2. Minor Intrusion (<1 foot bgs)	1	2	3
	3. Moderate Intrusion (<2 feet bgs)	3	3	4
	4. Significant Intrusion (<4 feet bgs)	5	5	5
	5. Highly Intrusive (>4 feet bgs)	5	5	5
6. MEC > 1 foot 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
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

Notes: [(a)] 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

2.2. Exposure Factor

The exposure factor assesses how likely it is that someone will be exposed to the MEC item if they are in the area by considering the following three input factors: MEC density, intensity of contact with soil, and frequency of entry. MEC density (Table A-5) is the density of MEC items (excluding scrap) within the level of intrusion; intensity of contact with soil (Table A-6) is a hours/day assessment of the receptor's contact with soil based on proposed site-use; and frequency of entry (Table A-7) refers to the number of people entering an area based on proposed site-use. A score is assigned for each of the three input factors using well-defined, set criteria, and then a scoring matrix combines the three input factors to produce a score for the exposure factor.

Table A-5. MEC Density

Score	Description [a] [b] [c]
1	100% of detected MEC removed to Level of Intrusion (d)
2	Low MEC Density (< 0.1 items per acre) (e)
3	Medium MEC Density (0.1 to 1 item per acre)
4	High MEC Density (> 1 item per acre)

Notes:
[a] MEC density depends on actual MEC items in the Level of Intrusion from Table A-2. MEC scrap should not be considered.
[b] If significant uncertainty exists about MEC density, it may be appropriate to assign the next higher score.
[c] Density should be based on actual field measurements of MEC items.
[d] Detection and removal procedures meeting the DQOs for the area based on clearly defined investigational objectives including reuse and the detection of designated MEC. If DQOs have not been established for the area, the quality of data should be approved by the BCT to score a '1.'
[e] As available, the measurement of number of items per acre should be determined from the aerial extent of the area and the Level of Intrusion.

Table A-6. Intensity of Contact with Soil

Score	Description [a] [b]
1	Very Low: < 1 hours/day
2	Low: < 3 hours/day
3	Moderate: < 6 hours/day
4	High: < 9 hours/day
5	Very High: > 9 hours/day

Notes:
[a] Activities involving direct contact with soil should be considered in this category. Direct contact with soil can range from walking on the soil to digging in the soil.
[b] If significant uncertainty exists, in the intensity of contact with soil, it may be appropriate to assign the next higher score.

Table A-7. Frequency of Entry

Score	Description [a] [b]
1	Rare: 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)

Notes:
[a] UXO-trained professionals and others covered by MEC-specific health and safety plans should not be considered in the Frequency of Entry categories.
[b] Depending on the type of area, different areas may have different entry frequencies for the same activity.

The Exposure Factor score is determined using the qualitative scoring matrix given in Table A-8.

Table A-8. Exposure Factor Scoring Matrix [a]

Frequency of Entry	MEC Density	Intensity of Contact with Soil				
		1. Very Low: < 1 hours/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

Notes:
[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

2.3. Overall Hazard Factor

The overall hazard factor examines how hazardous the MEC item itself is. This is based on the type of MEC item present, which must be determined by UXO-trained personnel. The overall hazard factor is then given a score based on how likely the MEC type is to cause injury and how severe the injury may be.

Table A-9. MEC Hazard Classification

Score	Description [a]
0	Inert MEC, will cause no injury [b]
1	MEC that will cause an injury [c], or in extreme cases could cause major injury or death, to an individual if functioned by an individual's activities
2	MEC that will cause major injury [d], or in extreme cases could cause death, to an individual if functioned by an individual's activities
3	MEC that will kill an individual if detonated by an individual's activities

Notes:
[a] MEC Type must only be determined by **UXO-TRAINED PERSONNEL**.
[b] Inert describes the condition of a munition, or component thereof, which contains no explosive, pyrotechnic, or chemical agent.
[c] An injury is defined as a flesh wound or a minor burn.
[c] A major injury is defined as the loss of sight, hearing, or limb, or a major burn.

2.4. Overall MEC Risk

The overall MEC risk is determined by the accessibility factor, the exposure factor, and the overall hazard factor. The three factors are combined in a matrix to yield an overall MEC risk score designated by the letters A through E, where A represents the lowest risk, and E represents the highest risk. The scoring matrix for the overall MEC risk score is given in Table A-10 below. Information on the MEC type and accessibility factors is in the first two columns, while exposure factor information is given in a row across the top.

Table A-10. Overall MEC Risk Scoring Matrix [(a)]

MEC Type	Accessibility	Exposure				
		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
0. 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 an 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 a 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) Overall MEC Risk scores are defined as:
A. Lowest Risk
B. Low Risk
C. Medium Risk
D. High Risk
E. Highest Risk