

Case Study – Hawthorne Army Ammunition Depot



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Presentation Agenda

- **Motivation**
- **Case Study – HWAD: Whiskey Flat**
 - ▶ Background/Site History
 - ▶ Whiskey Flat Surface seeding
 - ▶ Whiskey Flat Subsurface seeding
- **Lessons Learned and Things to Consider**
- **Discussion/Questions**

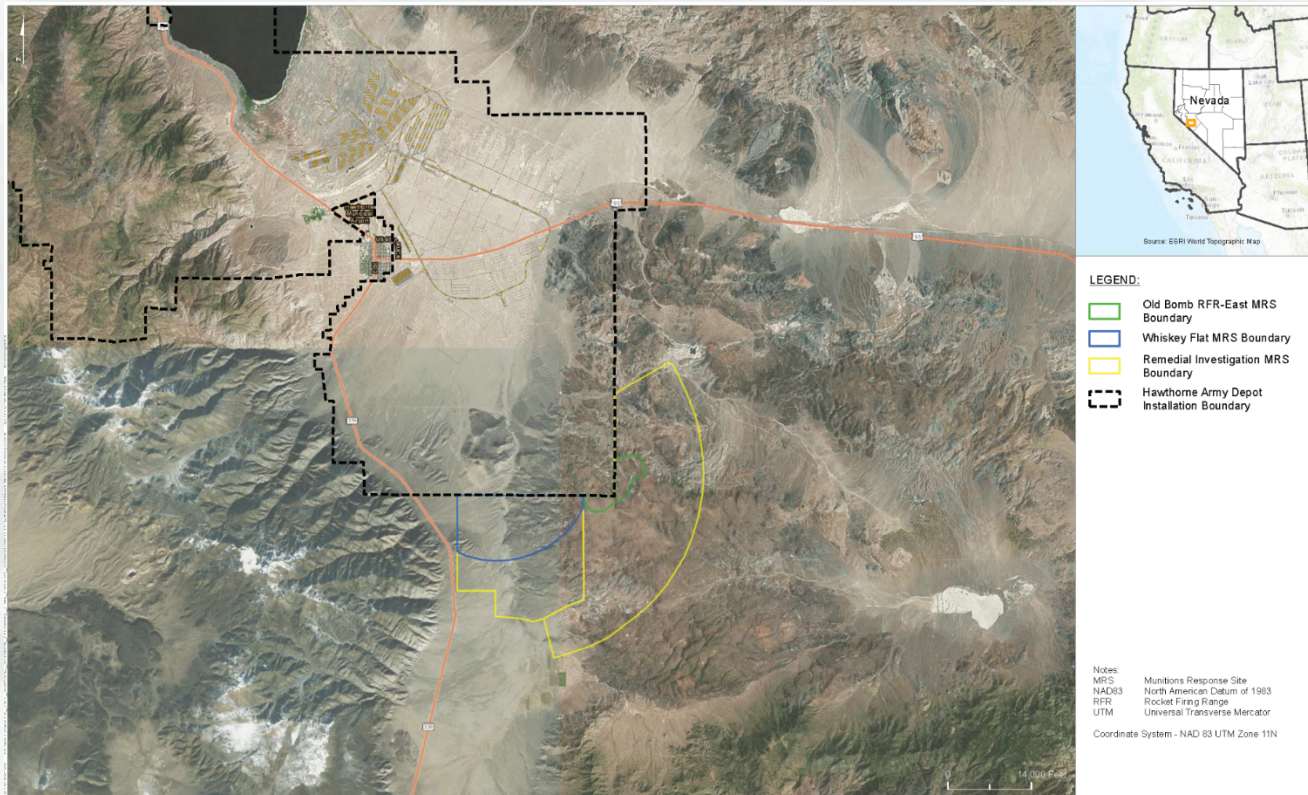


Motivation

- **Bring quality of analog surveys up to par with DGM survey practices (sort of)**
- **One of the first production scale AGC projects**
- **Share lessons learned and discuss things to consider when designing seeding plans for remedial actions**



Case Study: Hawthorne Army Ammunition Depot



Located south of Hawthorne, NV (approximately 130 miles south of Reno, NV)

Two MRSs border the active installation boundary:

- 1) Whiskey Flats
- 2) Old Bomb RFR-East

Whiskey Flats was used as a rocket testing range until about 1980

2011 RI recommended 4,349 acres in the Whiskey Flats area for surface and subsurface MEC removal



Whiskey Flat

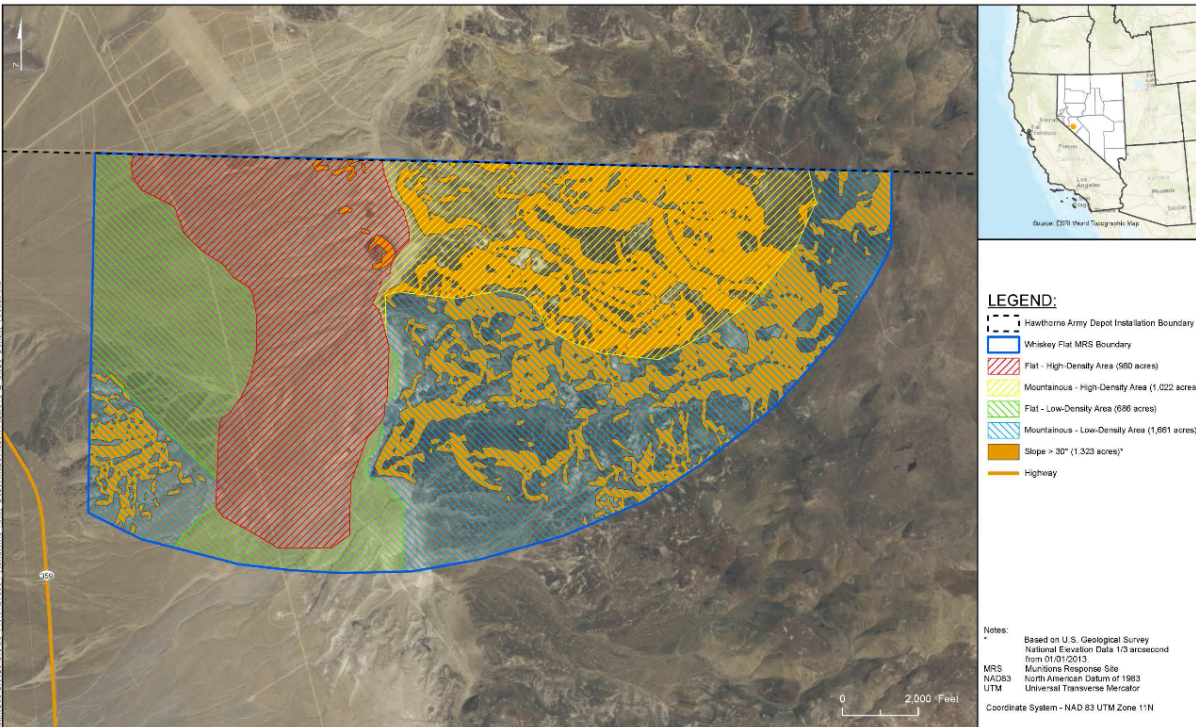
- **RI Conducted in 2011**

- ▶ **4,349 acres managed by DOI and BLM**

- ▶ **Recreational use and cattle grazing**

- ▶ **Separated into 4 subareas**

- Flat Low Density (686 acres)
- Flat High Density (980 acres)
- Mountainous Low Density (1,661 acres)
- Mountainous High Density (1,022 acres)



Whiskey Flat

RI Conducted in 2011

- ▶ Rocket testing range and potential kickout from detonation activities HWAD

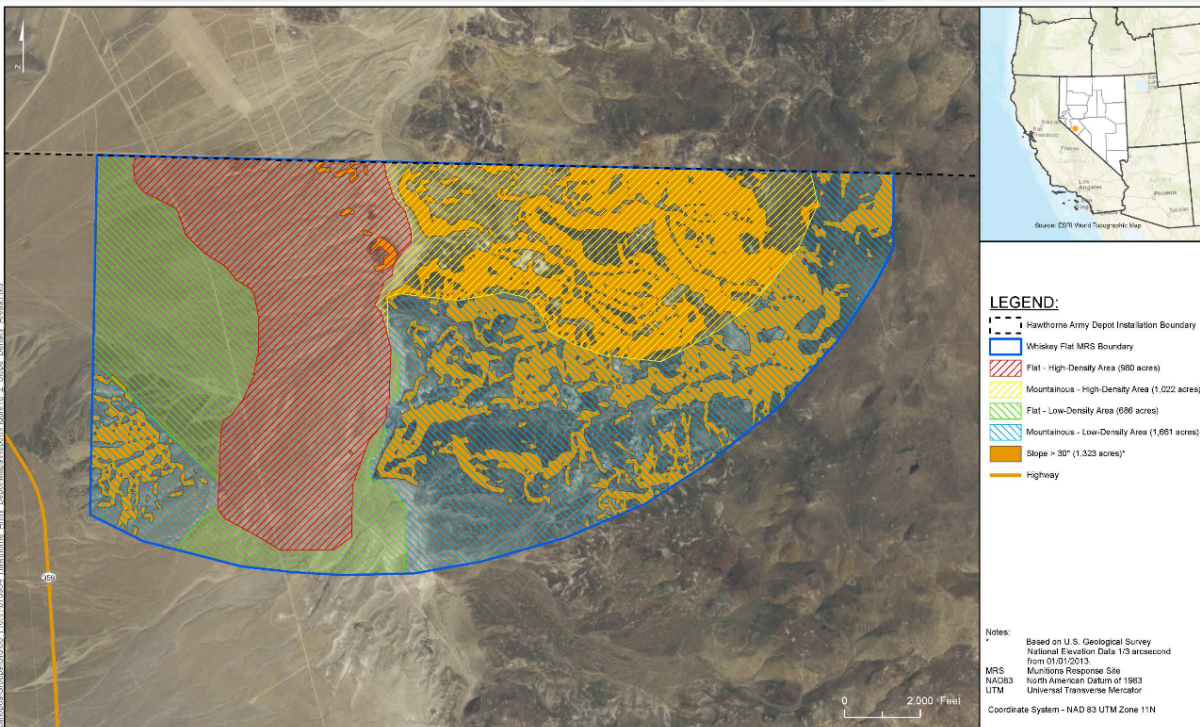
- ▶ 12 UXO items discovered

- ▶ MD identified

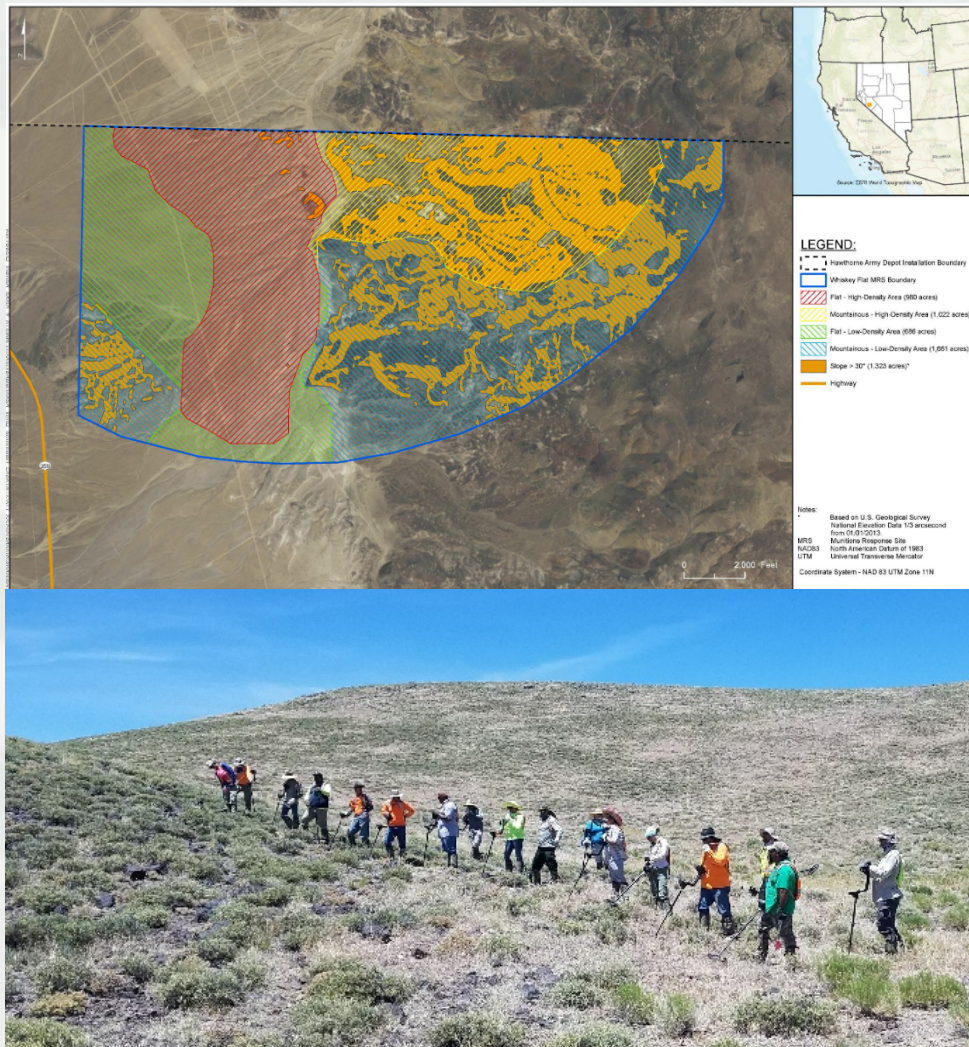
- 155-mm HE
- 105-mm HE
- 5-in rockets
- 2.75-in rockets
- 40-mm grenades

- ▶ Surface MEC removal throughout the MRS

- ▶ Subsurface removal in Flat High-Density subarea



Whiskey Flat: Flat Low-Density, Mountainous Low-Density, and Mountainous High-Density



- Approximately 3,369 acres total
- Selected remedy includes surface sweep to remove MPPEH
- PDT decided to seed both QC and QA surface seeds
- Sweep teams consisted of 15-20 operators using Minelab all-metals detectors



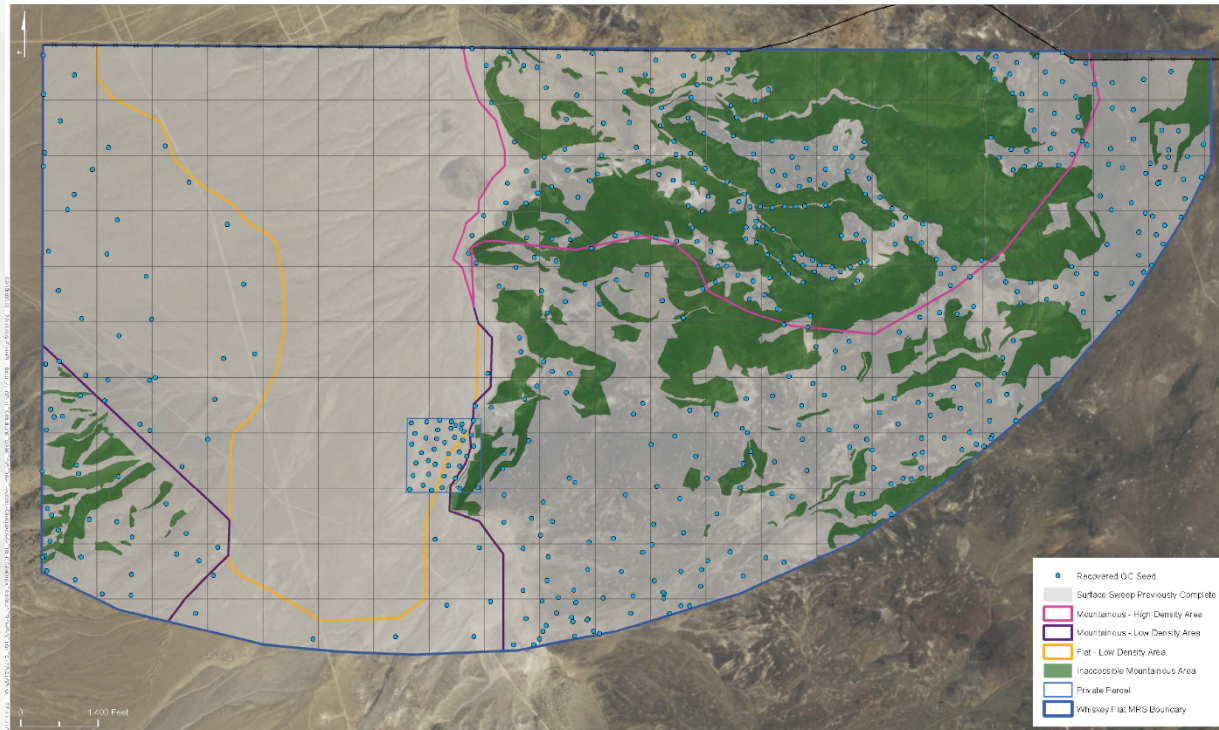
Whiskey Flat: Flat Low-Density, Mountainous Low-Density, and Mountainous High-Density

PDT Considerations

- How many surface seeds to plant?
 - ▶ Production rate = 10-20 acres/team/day
 - ▶ $3,369 \text{ acres} \div 10 \text{ acres/team/day} \approx 337 \text{ seeds}$ **MINIMUM**
- What type of surface seeds to plant?
 - ▶ Smallest expected munition is 40-mm grenade = small ISO
- What does a grid failure mean?
 - ▶ Is missing 1 seed indicative of a systemic failure?
 - ▶ Will grid need to be reworked?
 - ▶ Dependent on RCA
- What area will be reworked if a failure occurs?
 - ▶ The grid block?
 - ▶ The day's area?
 - ▶ Need to be able to isolate any systemic failures
 - ▶ PDT decided on 1000x1000 ft. grid blocks (~1 day's production)



Whiskey Flat: Flat Low-Density, Mountainous Low-Density, and Mountainous High-Density



- 318 QA surface seeds placed
- 464 QC surface seeds placed
- 782 surface seeds total
- Large portions of mountainous areas unable to survey due to steep terrain



Whiskey Flat: Flat Low-Density, Mountainous Low-Density, and Mountainous High-Density



- Sweep teams consisted of 15-20 operators using Minelab all-metals detectors

- Two field team leaders with GPS responsible for marking location of objects and daily coverage

- At the end of a sweep, the line would pivot and walk in the opposite direction

- Operators tested twice daily at IVS



Whiskey Flat: Flat Low-Density, Mountainous Low-Density, and Mountainous High-Density



- 3 missed QC seeds
- 5 missed QA seeds
- Resulted in 8 grid blocks being re-worked by teams until all seeds were recovered
- Missed seeds in failed grids were left in place and additional QC/QA seeds were planted (~2-3)



Whiskey Flat: Flat Low-Density, Mountainous Low-Density, and Mountainous High-Density



Corrective Actions

- Rework failed grids with additional QC/QA seeds
- Slow pace
- Search in/around bushes
- Sweep line rotation
- Implement surveying string to ensure proper line spacing



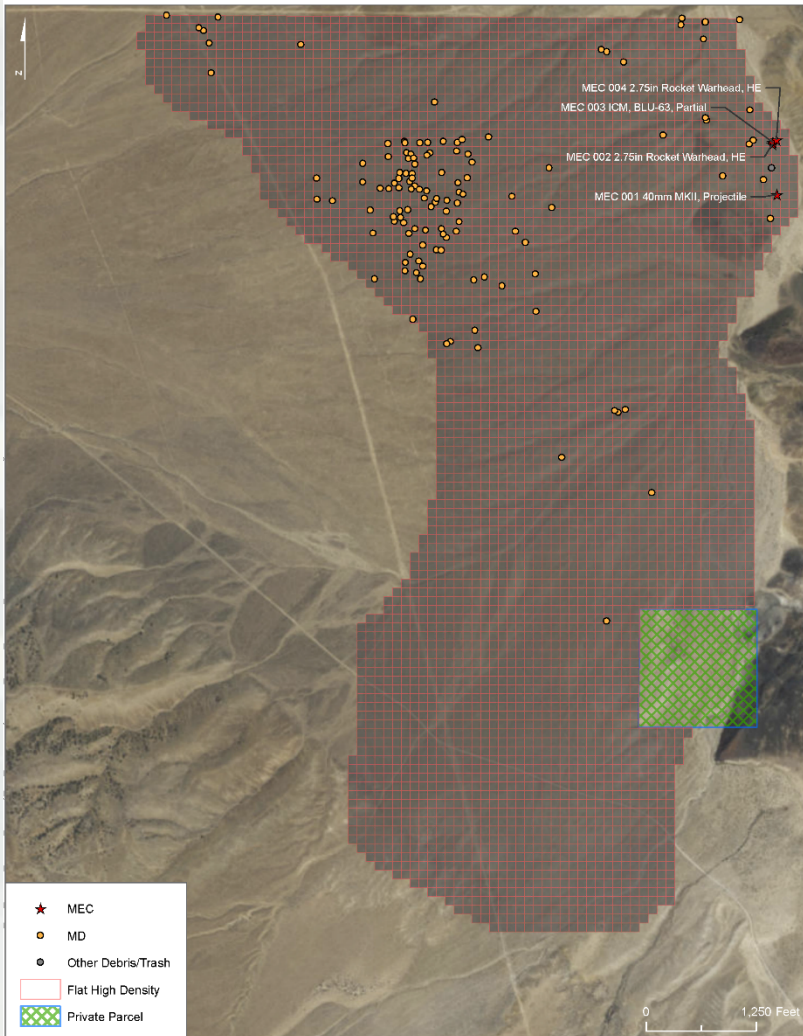
Discussion

QC/QA seeding resulted in:

- Early identification of systemic errors and prevention of future errors
- Evaluation of surface sweep quality
- Failed grids being re-worked to ensure project RAOs were met
- Confidence in final product



Whiskey Flat: Flat High-Density



- 980 acres
- 100% surface sweep (No QC/QA seeds)
- Dynamic detection with EM61 towed array
- Cued survey with AGC instrument
- Estimated 28,000 targets
- Northwestern portion of MRS has inaccessible terrain (<math><30^\circ</math> slope); anticipated mag-and-dig areas

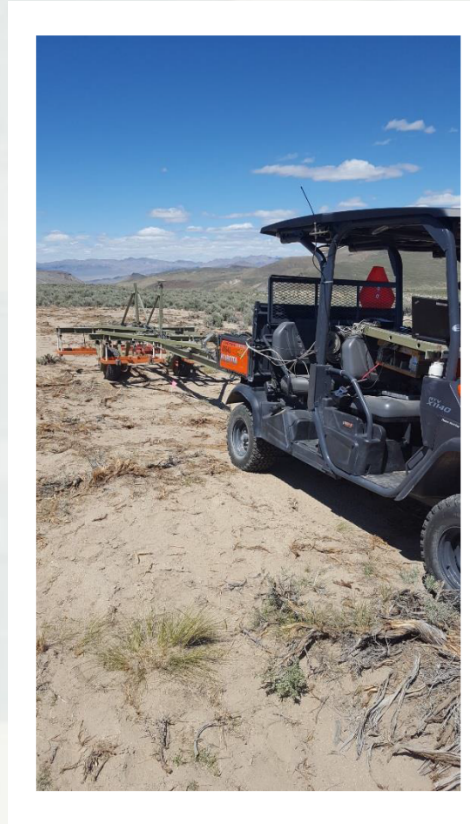


Seeding Considerations – Number of Seeds

- **Number of Seeds**

- ▶ Production rate

- Dynamic Detection (~6 acres/day)
 - 980 acres / 6 acres/day ≈ 163 days



Seeding Considerations – Number of Seeds

■ Number of Seeds

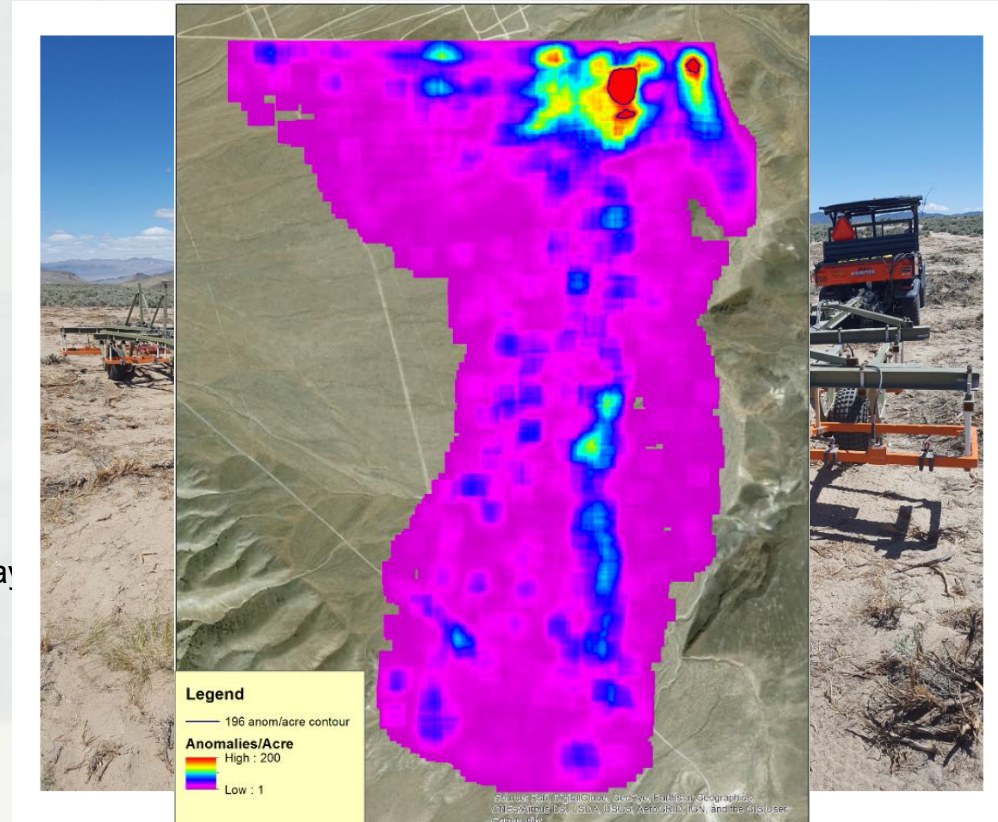
- ▶ Production rate
 - Dynamic Detection (~6 acres/day)
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- ▶ Number of instruments
 - 2 towed arrays
 - 3 person portable
 - 2 AGC instruments



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 - Dynamic Detection (~6 acres/day)
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- ▶ Number of instruments
 - 2 towed arrays
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 - 2 AGC instruments
- ▶ Anomaly density
 - Cued Survey (~165 targets/day)
 - 28,000 targets / 165 targets/day ≈ 170 days

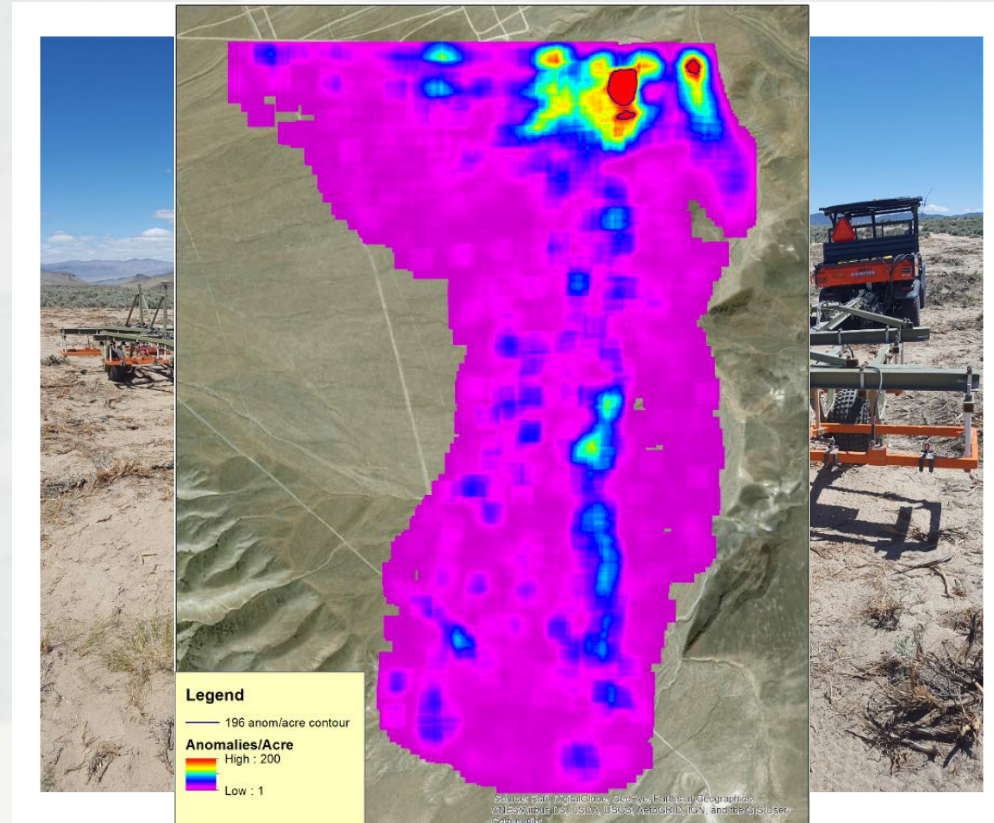


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 - 2 towed arrays
 - 3 person portable
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 - Cued Survey (~165 targets/day)
 - 28,000 targets / 165 targets/day ≈ 170 days

To achieve 1 seed/instrument/day for both DGM and AGC we need a **MINIMUM** number of 170 QC seeds



Seeding Considerations – Depth/Orientation

- RAO requires removal of MEC to a depth of 2 feet below ground surface

So what can we detect?



Seeding Considerations – Depth/Orientation

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So what can we detect?

- Estimated background noise ≈ 0.75 mV
- Detection threshold set to 5x background
= 3.75 mV

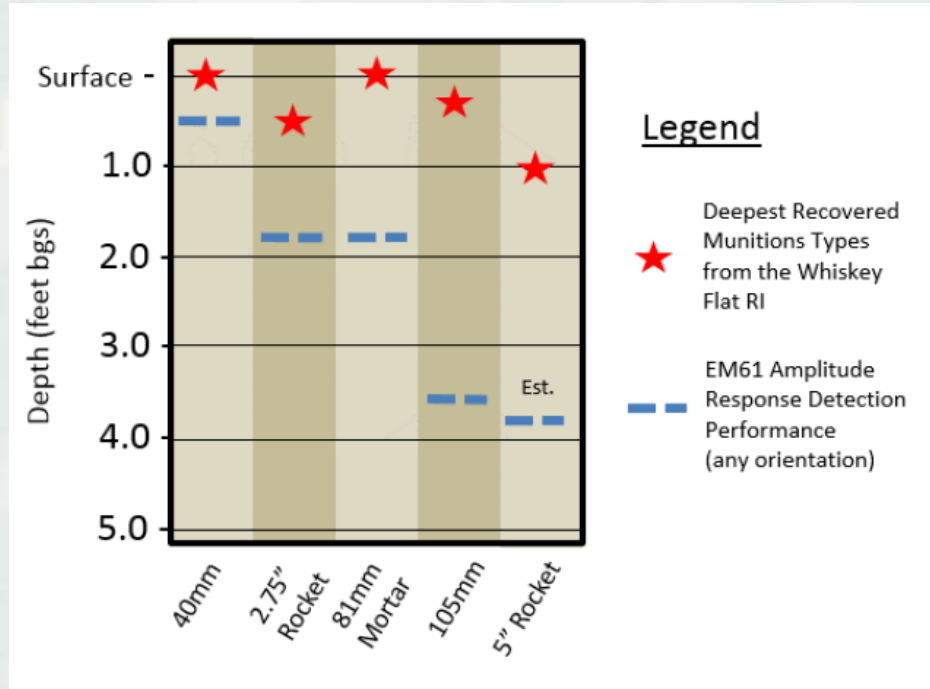


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- RAO requires removal of MEC to a depth of 2 feet below ground surface

So what can we detect?

- Estimated background noise ≈ 0.75 mV
- Detection threshold set to 5x background = 3.75 mV
- Suspected MEC on site
 - ▶ 155-mm HE
 - ▶ 5-in rockets
 - ▶ 105-mm HE
 - ▶ 81-mm HE
 - ▶ 2.75-in rockets
 - ▶ 40-mm grenades

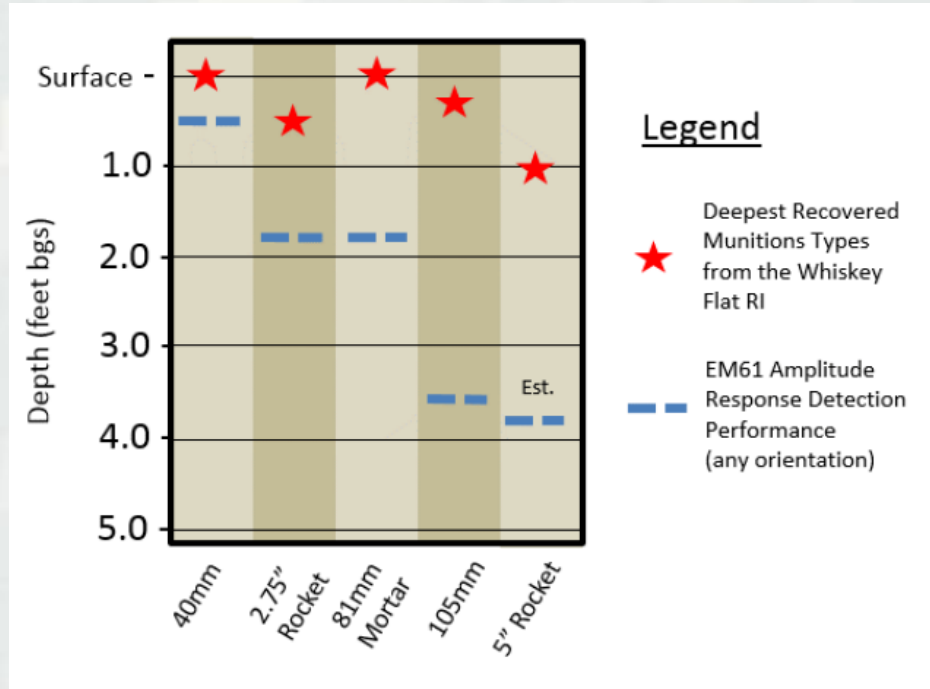


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 - ▶ 40-mm grenades



SO WE KNOW WE CAN:

- 1) Detect smallest expected munition to 6 inches (worst case scenario under edge of coil)
- 2) Detect 2.75" rocket and 81mm mortar to RAO requirement
- 3) Everything else easily detected

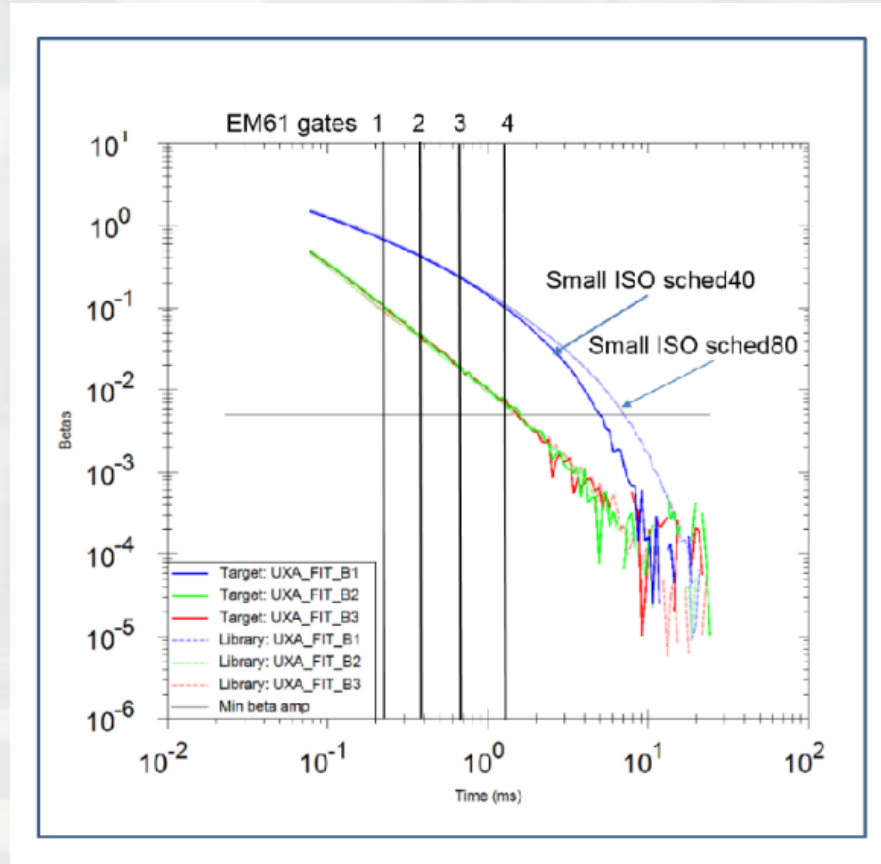


Seeding Considerations – Type

Types of seeds:

- Small ISO to represent 40mm grenade (smallest expected munition)
- Medium ISO to represent 2.75” rocket and 81mm
- Schedule 40 ISOs
 - ▶ No difference for EM61 detection survey
 - ▶ More difficult to classify for cued survey

More conservative from USACE perspective



Seeding Considerations – Depth/Orientation/Type

- RAO requires removal of MEC to a depth of 2 feet below ground surface
- QC seed depths at 100% max depth:
 - ▶ Small ISOs: 0-13 cm (40 mm surrogate)
 - ▶ Medium ISOs: 0-57 cm (2.75" and 81mm surrogate)
 - ▶ Equally distributed between 25%, 50%, 75%, and 100% max depth
- QC seed orientations ranging from least favorable to most favorable orientation
 - ▶ Equally distributed between 0°, 45°, and 90° inclination and azimuth



Seeding Considerations – Validation Seeds

Number of Validation Seeds?

Same as QC seeds:

- Production Rate
- Number of instruments
- Anomaly density (AGC)

BUT....



Seeding Considerations – Validation Seeds

Number of Validation Seeds?

Same as QC seeds:

- Production Rate
- Number of instruments
- Anomaly density (AGC)

BUT....

Depth/Orientation/Type of Seeds?

Matrix Spike!

- Easy to detect (shallower than max depth)
- Easy to classify (AGC)

Similar to testing accredited
laboratories

If validation seed is not detected or
incorrectly classified, something
VERY wrong

IMMEDIATELY initiate RCA process



Seeding Considerations

Where does all of this information go?



Seeding Considerations

Where does all of this information go? The QC/Validation Seeding Plan!

Must be submitted and approved **PRIOR** to beginning field work!

- Details numbers, depths, orientation, types of seeds and all assumptions (production rates, anomaly densities, etc.)

- Submitted in conjunction with QC firewall plan

**CLOSE-HOLD INFORMATION – DO NOT
DISTRIBUTE**

FINAL
Validation Seeding Plan
Whiskey Flat MRS Remedial Action
Hawthorne Army Depot
Hawthorne, Nevada



Prepared by
Army Corps of Engineers
Sacramento District

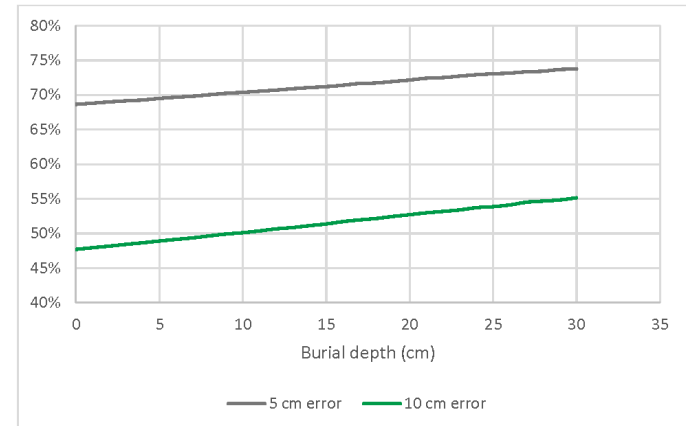


HWAD Seeding Considerations – Deviations from AGC QAPP

Detection Survey Repeatability MQO

- AGC QAPP specifies 100% QC seeds must be greater than 75% of minimum predicted response
- Minor variations in terrain (+/- 10 cm) can cause large variations in response
- Result in MQO failure not indicative of a systematic problem
- PDT decided that 95% of QC seeds must be greater than 75% of minimum predicted response

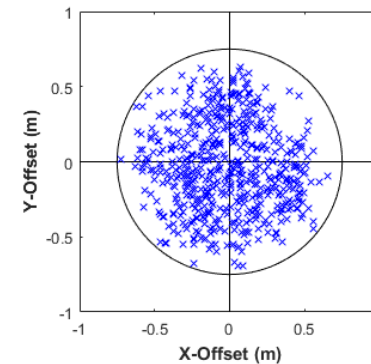
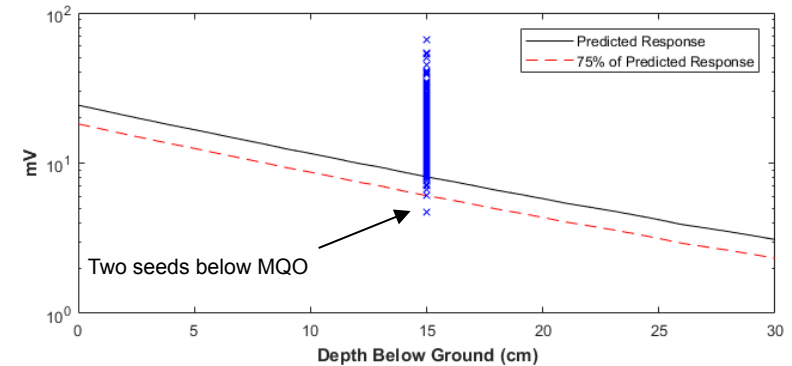
Figure 22-1. Percent of Anticipated Response for Targets that are Deeper than Assumed Depth



HWAD Seeding Considerations – Deviations from AGC QAPP

Detection Survey Repeatability MQO

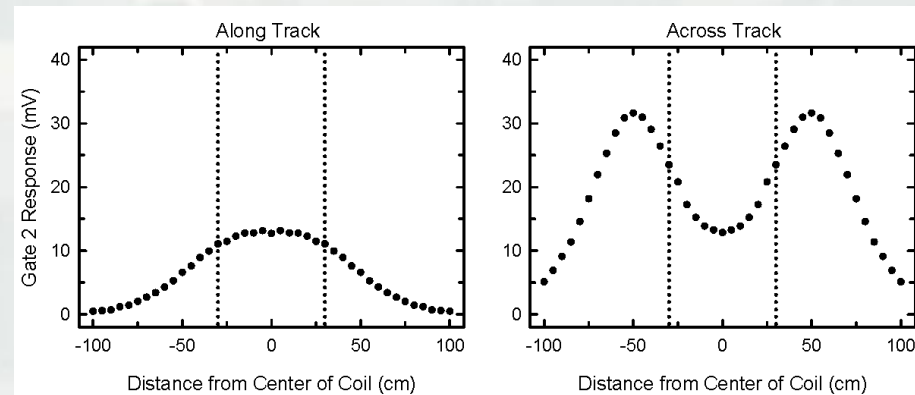
- Two QA seeds fall below 75% predicted response
- All QA seeds pass detection positioning MQO
- Due to non system-related measurement errors



HWAD Seeding Considerations – Deviations from AGC QAPP

Detection Survey Positioning Accuracy

- AGC QAPP specifies 100% QC seeds must be detected within a 40 cm radius of ground truth.
- PDT decided that QC seeds must be detected within a 75 cm radius of ground truth.



- Not achievable 100% of the time with EM-61
 - ▶ Peak offset at ½ sensor width (50 cm)
 - ▶ GPS error
 - ▶ Sensor tilt
 - ▶ Gridding/interpolation effects
- Primarily targeting large items
 - ▶ 155 mm HE
 - ▶ 105 mm HE
 - ▶ 5 in rockets
 - ▶ 2.75 in rockets



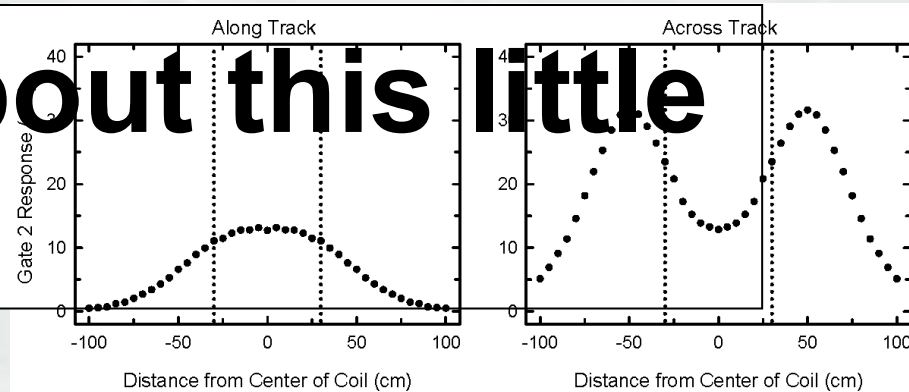
One 40mm HE Projectile and Two 5 Inch HE Rocket Warheads Destroyed



HWAD Seeding Considerations – Deviations from AGC QAPP

De
 ■AG
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 ■PD
BUT....What about this little guy?

a 75 cm radius of ground truth.



■Not achievable 100% of the time with EM-61

- ▶ Peak offset at ½ sensor width (50 cm)
- ▶ GPS error
- ▶ Sensor tilt
- ▶ Gridding/interpolation effects

■Primarily targeting large items

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- ▶ 105 mm HE
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HWAD Seeding Considerations – Deviations from AGC QAPP

Detection Survey Positioning Accuracy

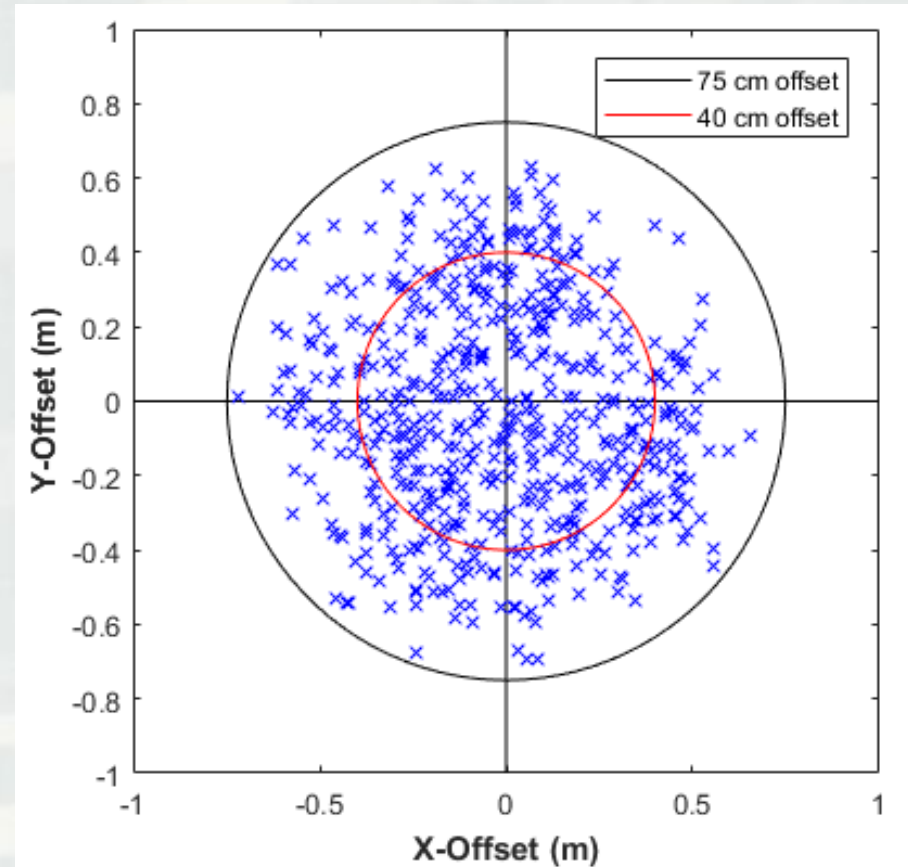
- Footprint of TEMTADS 2x2 is 80 cm
- 40 mm will still fall within footprint of AGC instrument at the expense of more cued shots
- PDT decided this was acceptable and a 75 cm Detection Survey Positioning Accuracy MQO was agreed upon.



HWAD Seeding Considerations – Deviations from AGC QAPP

Detection Survey Repeatability MQO

What if we had used a 40 cm offset?

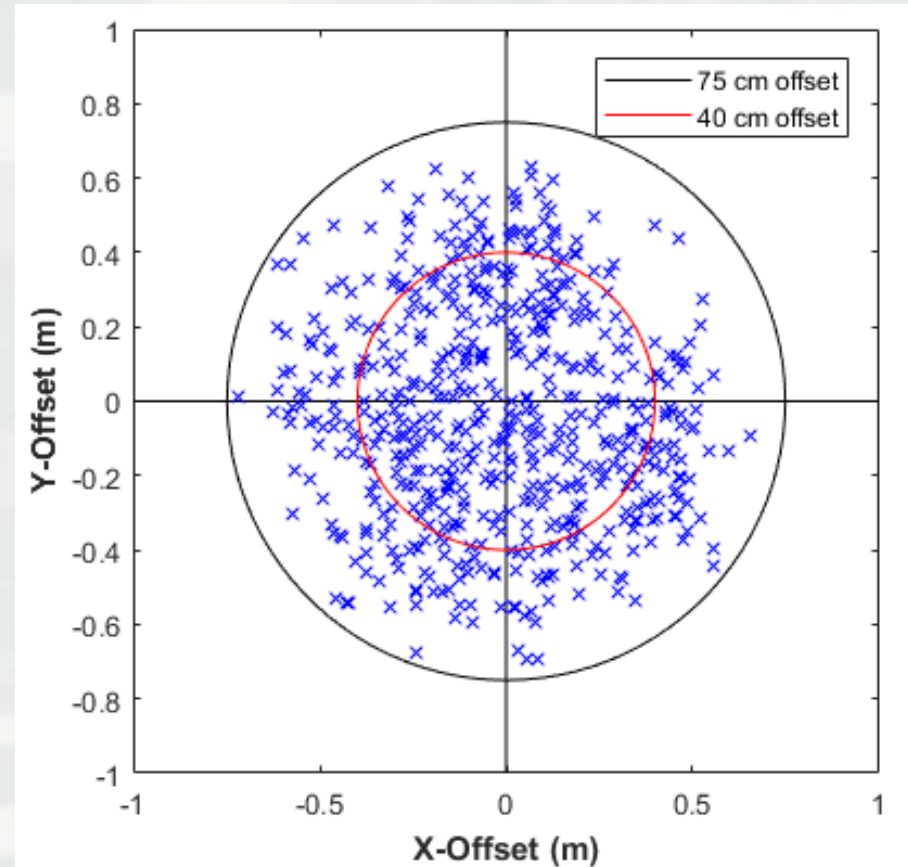


HWAD Seeding Considerations – Deviations from AGC QAPP

Detection Survey Repeatability MQO

What if we had used a 40 cm offset?

47 % Failure



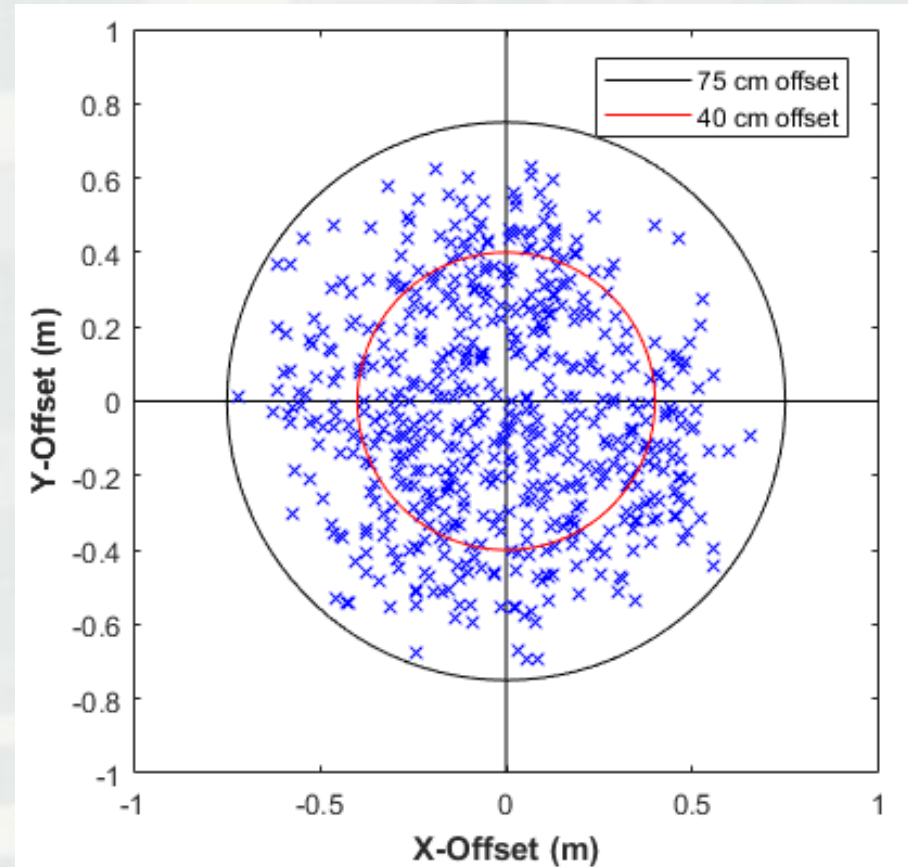
HWAD Seeding Considerations – Deviations from AGC QAPP

Detection Survey Repeatability MQO

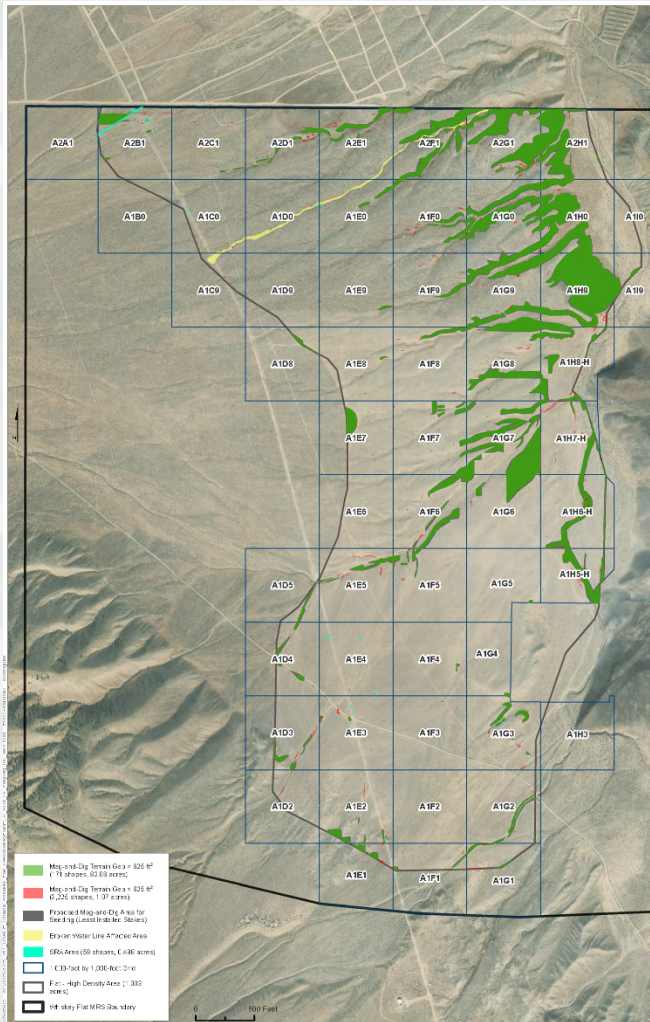
What if we had used a 40 cm offset?

47 % Failure

- Should be using AGC for dynamic detection
- EM61 dynamic detection followed by AGC should be carefully considered by PDTs (what types of munitions are you looking for? For HWAD...mostly larger items)



HWAD Seeding Considerations – Mag-and-Dig Gaps

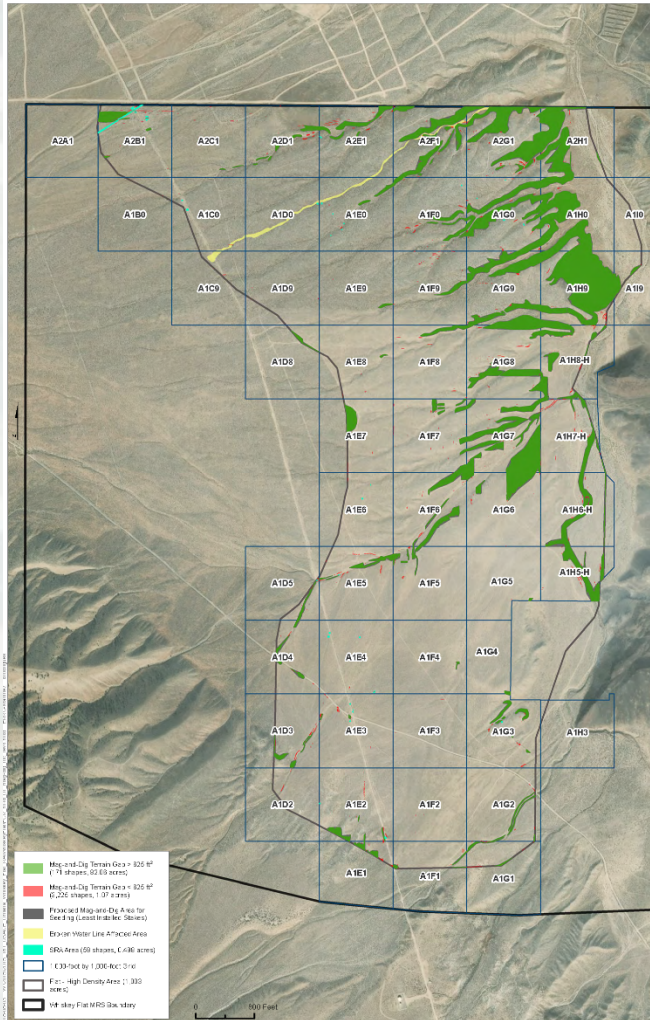


- Approximately 93.5 acres inaccessible to DGM towed array – Designated for mag-and-dig
- Irregularly shaped gaps of varying size (lots of small, ‘awkward’ mag-and-dig polygons)

How do we seed these?



HWAD Seeding Considerations – Mag-and-Dig Gaps



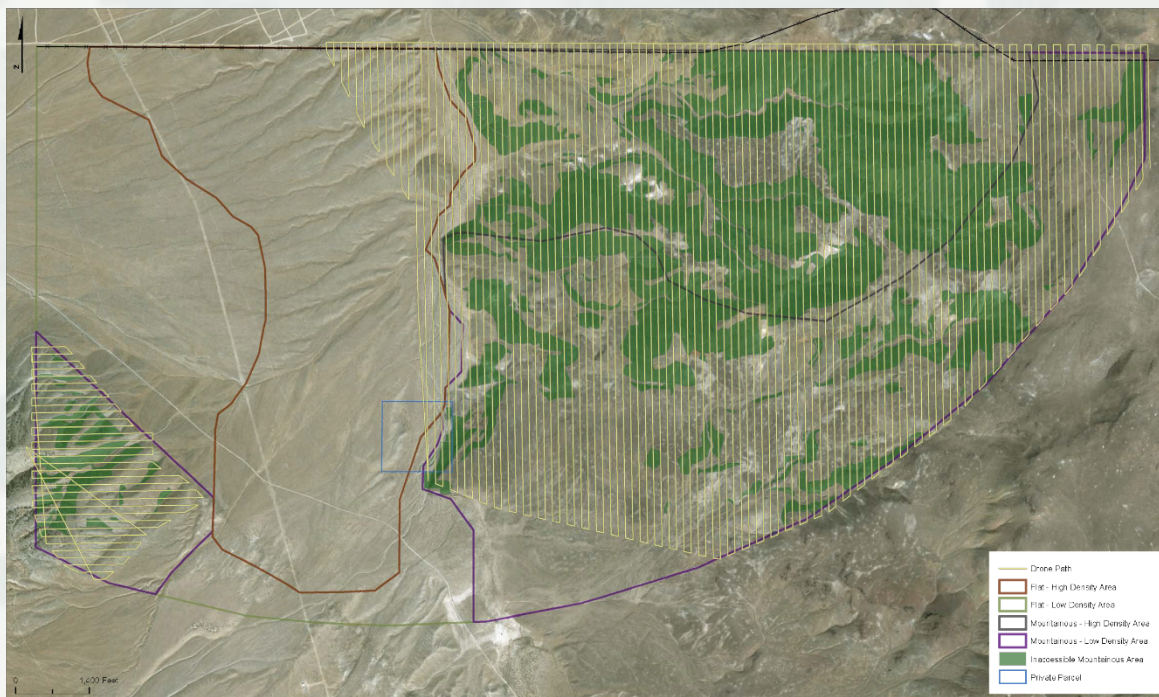
- PDT decided that any gaps greater than 625 sq. ft. (1/4 grid) will be seeded
- Due to irregularly shaped polygons, PDT decided to seed at a rate of 1 seed/team/day rather than 1 seed/**OPERATOR**/day
- Gaps less than 625 sq. ft. will undergo 100% QC and 100% QA inspection



HWAD Visual Reconnaissance Seeding

Aerial Survey

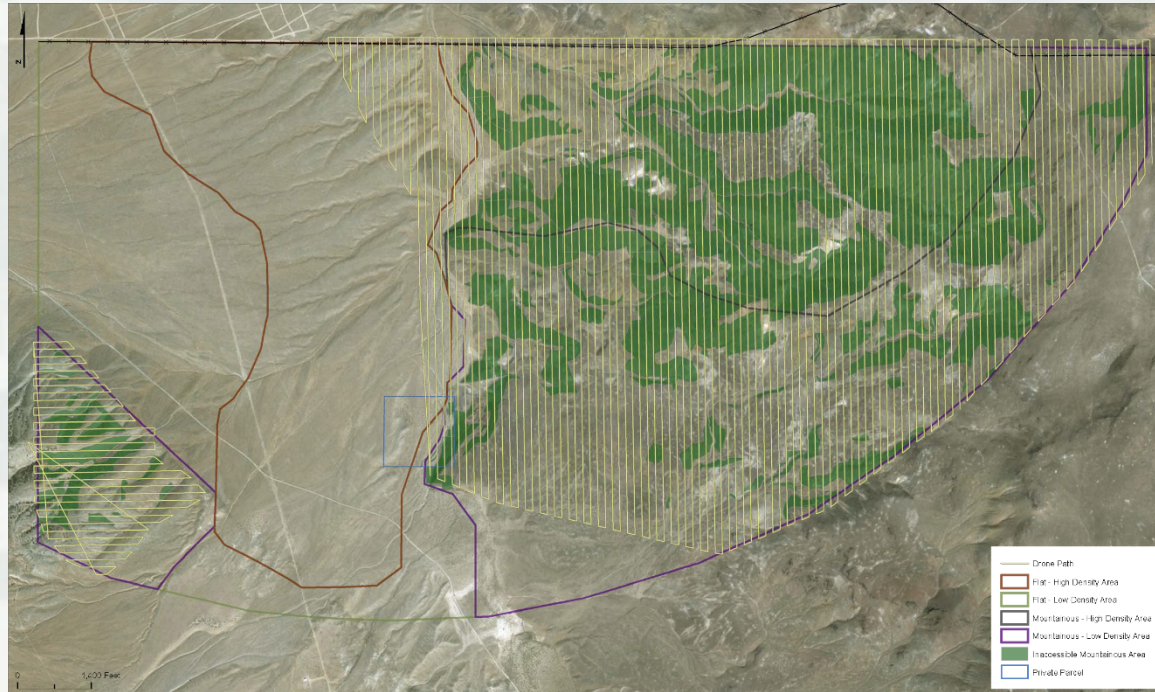
- Drone survey over 100% of Whiskey Flat Mountainous areas
- Aerial photographs covering 100% of Mountainous areas at 2 cm resolution
- 100% inspection of aerial photographs in inaccessible areas by UXO Tech II



HWAD Visual Reconnaissance Seeding

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- Aerial photographs covering 100% of Mountainous areas at 2 cm resolution
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Do we seed this?



HWAD Visual Reconnaissance Seeding

Aerial Survey YES!



Blind seeded with
6 inert 5-in rockets
(~1 seed/survey
day)

All seeds
successfully
identified during
data review



HWAD Visual Reconnaissance Seeding

Aerial Survey



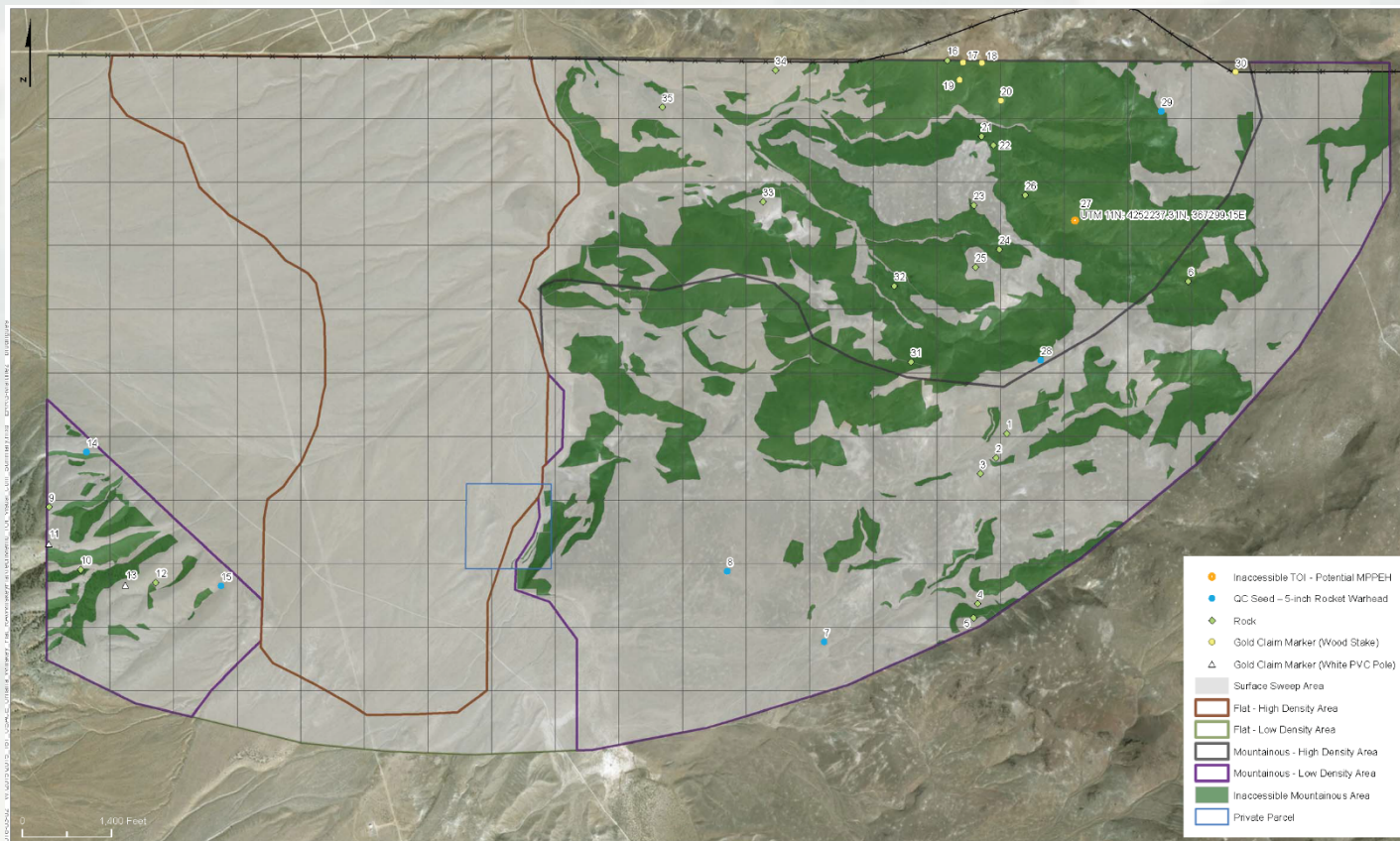
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HWAD Visual Reconnaissance Seeding

Aerial Survey



- 35 TOI identified during inspection

- 34 of the TOI investigated

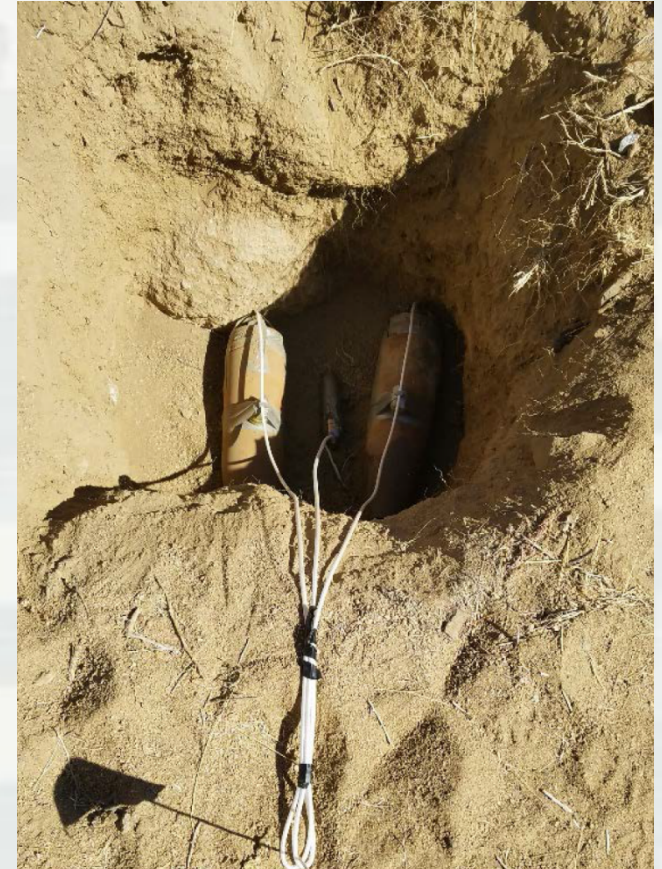
- 1 TOI inaccessible

- All TOI observed in the field as QC seeds, gold claim markers (wooden/PVC posts), or rocks that were shaped like UXO



What can we say overall about the analog work?

- 3 QC failures and 5 QA failures
- The contractor and USACE looked at statistics to see what would be the worst case scenario of the missed seeds
- Binomial confidence interval
 - ▶ 97% seed recovery rate
 - ▶ 1,122 pounds of MD recovered
 - ▶ No MEC items found
- Making a few assumptions we arrived at a maximum probability of MEC being on site is 1.55%
- Also consider
 - ▶ MEC must be encountered (small probability)
 - ▶ MEC must detonate (small probability)
- $1.55\% \times \text{small probability} \times \text{small probability} = \text{VERY SMALL PROBABILITY}$



What can we say overall about the digital work?

- Data collection still ongoing
- All QC/QA seeds have been detected within MQO specifications to date
- Larger allowable detection offset due to larger munitions acceptable
- Assumptions regarding classification of smaller munitions (40 mm) will be thoroughly tested by QA seeds during cued analysis
- Accurately identified larger munitions in inaccessible areas with aerial photography



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- **DATA SUPPORTING ACHIEVING RAOs**



Seeding Considerations

■ Technical Considerations

- ▶ **Number, depth, orientation, and type of seeds?**
- ▶ Can the technology meet the MQOs?
- ▶ What areas will need to be re-worked in the case of a grid failure?
- ▶ What is the impact of a seed failure on data usability?
- ▶ Is there a plan in place for areas that are inaccessible to specific technologies?
- ▶ Should the team consider seeding for aerial surveys or other less often used methods?



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- ▶ **Should the team consider seeding for aerial surveys or other less often used methods?**



Seeding Considerations

- **Projects will know more about the quality of analog sweeps and DGM data:**
 - ▶ Percentage of seed items missed during initial week.
 - ▶ Documentation of area covered (seed items at boundary lines, vegetation, etc.)
 - ▶ Improvement in process as work advances
 - ▶ Confidence in final product



Bottom Line

- **Projects need this seeding....PERIOD**
- **YES...it will cost projects money (both contractor and USACE)**
 - ▶ Purchased over 1400 small ISOs
 - ▶ Database maintenance
 - ▶ QC subsurface seeding
 - ▶ QA submittal packages
 - ▶ QC seeding plan
- **BUT....** If you don't do this seeding just to save a few dollars, you will **NOT** get the product you need and you will **FAIL** to meet project objectives



Questions?

