PARSONS®

USING sUAS (DRONES) TO CHARACTERIZE MUNITIONS CONTAMINATION AT COMPLEX SITES

Hurricane Mesa Supersonic Test Site
Washington County, Utah

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35th SAGEEP
2nd Munitions Response Meeting
New Orleans, LA
April 5, 2023

AGENDA

Hurricane Mesa Test Site Profile

Investigation Challenges

Technical Solutions

Thermal vs Visible Spectrum

Investigation Results

sUAS Challenges

Questions?

HURRICANE MESA TEST SITE (HMTS)

WASHINGTON COUNTY, UTAH

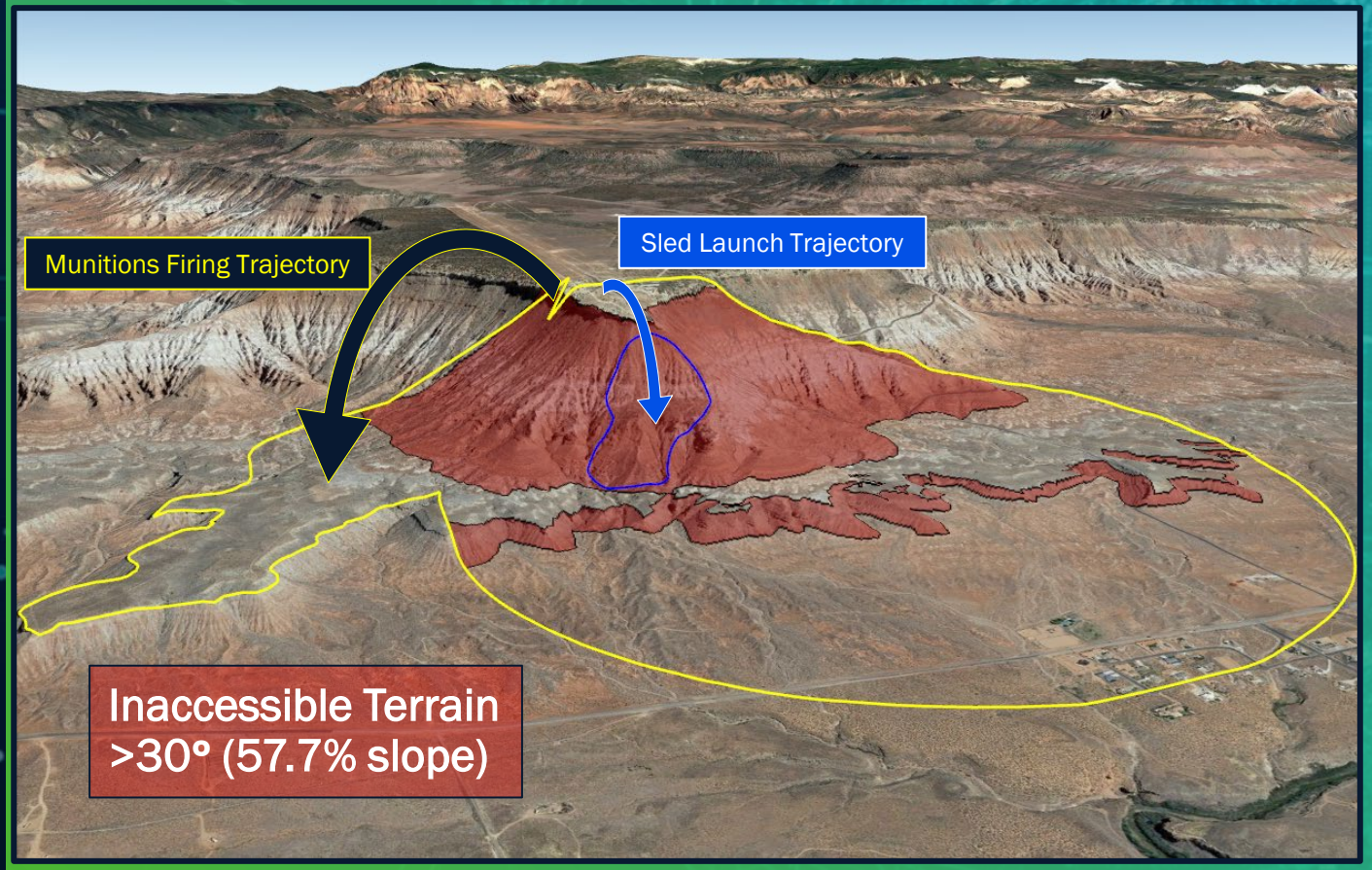
- The HMTS is part of a 3500-acre Hurricane Mesa Supersonic Research Site originally operated by the US Air Force and now by private contractors.
- 12,000’ track used for testing of supersonic aircraft ejection systems mounted to rocket-propelled sleds.
- Live-fire munitions training of rockets, mortars, projectiles, and grenades.
- <u>Project Scope</u>
  - RI @ 1,368-acre MRS (2020-2023)
  - Characterize nature/extent of munitions/DOD-related contamination

HMTS Ejection System Sled Track

Hurricane Mesa, Virgin UT

INVESTIGATION CHALLENGES

Biggest challenge: *Steep Terrain*. How do we characterize the inaccessible portions of the MRS without visiting them?



- Hurricane Mesa is surrounded by sheer cliffs and steep slopes dropping 1,000'-3,000' to the valley floor.
- ~500 acres (36%) of the MRS contain cliffs/slopes >30° (57.7% slope) and are inaccessible to traditional terrestrial characterization survey methods (DGM/AGC)
- Known munitions contamination within the inaccessible areas (particularly at end of sled track) but the extent of contamination had not been investigated and was unknown.

TECHNICAL SOLUTIONS

Approach Summary: Utilize Small Unmanned Aerial Systems (sUAS), or Drones, to collect photogrammetry data to support characterization of inaccessible areas

Two-Phased Approach

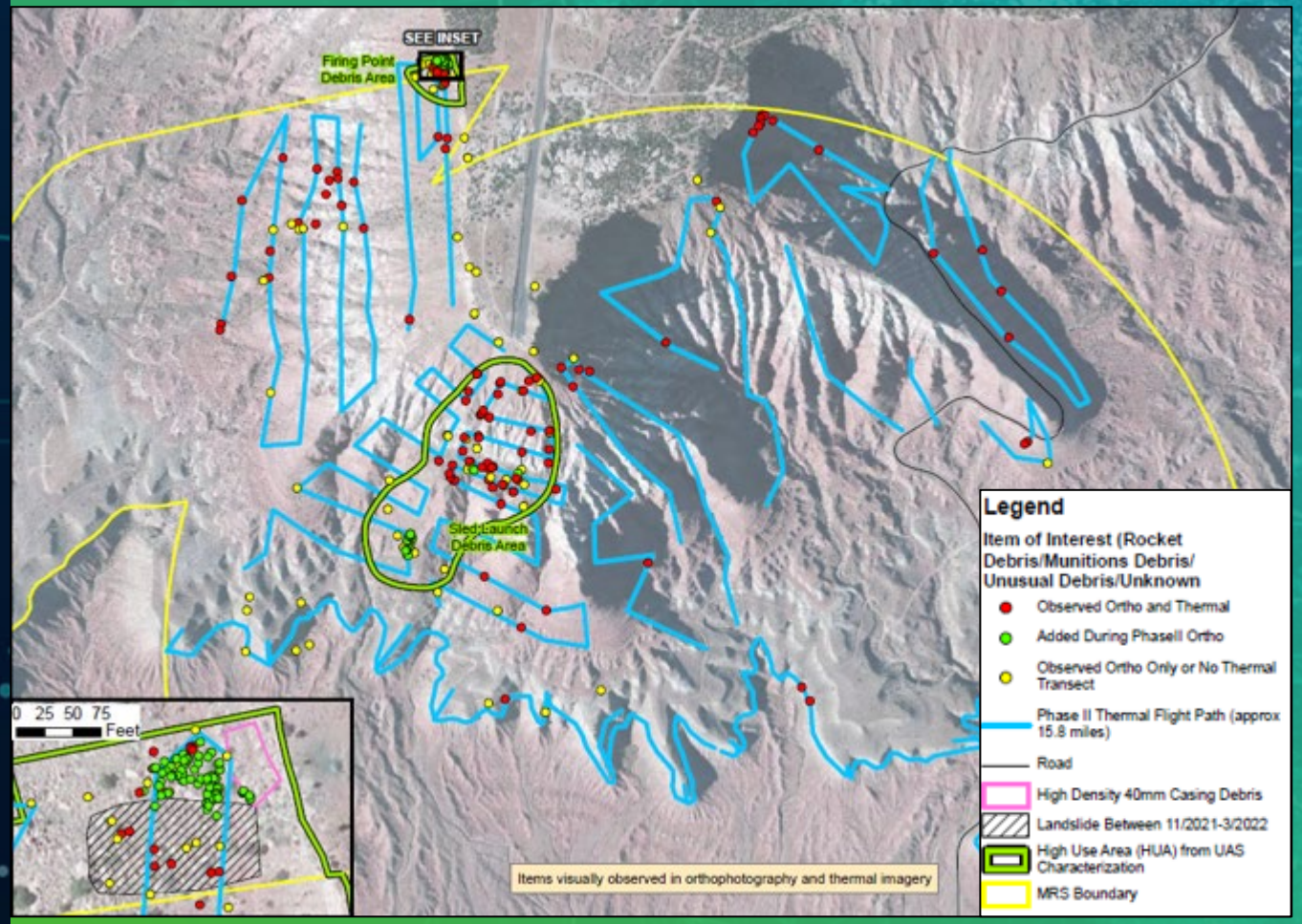
1) Collect 673 acres of Preliminary 4K (2cm) resolution Ortho-photogrammetry Data across inaccessible areas to identify IOIs on the surface and to identify HD areas (100' flight elevation)
   - Also collected sub-meter accurate elevation modeling data to support design of follow on Phase 2 sUAS surveys

DJI Mavic 2 Pro with Hasselblad 4k camera

2) Collect 15.8 miles of focused characterization data over identified HD Areas (65' flight elevation)
   - Additional 4K (2cm) resolution photography for better imagery of previously identified IOIs
   - Thermal Spectrum Imagery to identify IOIs that may not be identifiable in visible spectrum photography
   - Characterize HD areas as HUAs

DJI M210 with Zenmuse XT2 thermal sensor & CMOS 4k camera

sUAS CHARACTERIZATION RESULTS



Phase 1 (Visible Spectrum 4K Photography only)

151 IOIs

2 HD Areas

Phase 2 Thermal Imagery

119 IOIs

Phase 2 Visible Spectrum 4K Photography

50 additional IOIs not visible in thermal imagery

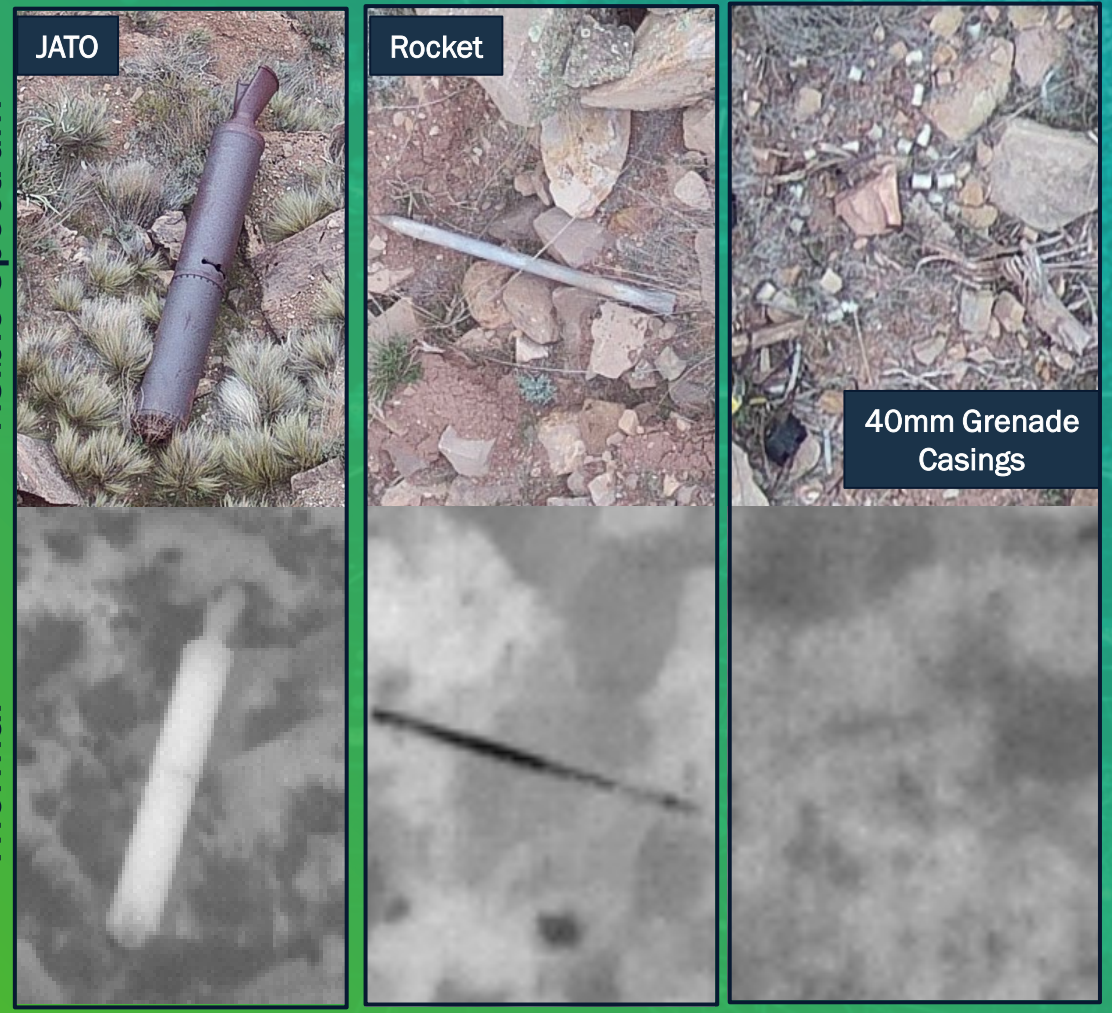
Total Phase 1 & 2

320 IOIs

2 Confirmed HUAs

- Since the chosen IOIs were already biased to only include munitions/AETC items, both HD areas were confirmed as HUAs.

THERMAL SPECTRUM IMAGERY OVERVIEW

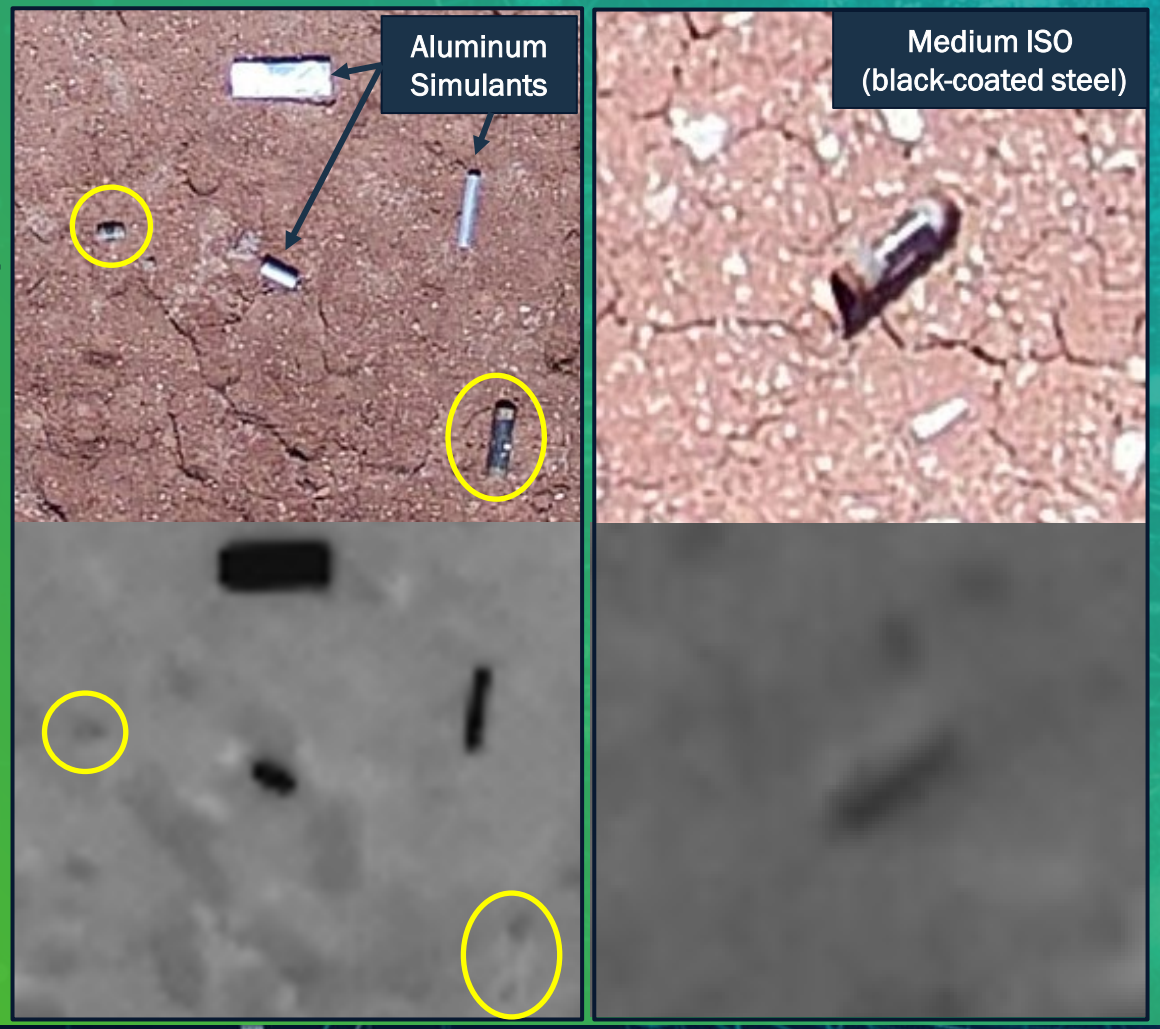


Thermal Signature Key (White-Hot)		
Item	**Relative Emissivity (to native HMTS soil)**	**Visual Cue**
JATO (steel)	Very High	Bright White
Wood	Medium	Very Light Grey
Rocks	Medium	Light Grey
Native HMTS Soils	Control	Control
40mm grenade casings (oxidized aluminum alloy)	Very Similar to soil	Not identifiable
ISOs (iron oxide “black” coated steel)	Low	Medium Grey
Brush	Low	Dark Grey
Rockets (aluminum)	Very Low	Dark Black
Aluminum Simulant	Very Low	Dark Black

Higher Emissivity

Lower Emissivity

VISIBLE SPECTRUM IMAGERY vs THERMAL SPECTRUM IMAGERY



Major Takeaways:

- Materials on the high end (Steel; JATO) and low end (Aluminum; Rockets & Simulants) of the thermal emissivity spectrum are easy to spot in thermal imagery.
- Materials with emissivity similar to native soil (oxidized aluminum alloys; 40mm grenade casings) and (black-coated steel; ISOs) are hard to see in thermal imagery.
- In general, visible specturm imagery was more reliable for detecting the types of munitions present at HMTS

sUAS INVESTIGATION RESULTS SUMMARY

- Parsons characterized munitions contamination over 500 acres of previously uninvestigated and inaccessible terrain,
- Identified 320 individual munitions related items,
- Developed a geo-referenced database and photo mosaic containing IOIs,
- Calculated across-site (inaccessible areas) IOI densities and located & bound 2 HUAs.

- Visible Spectrum Photogrammetry was very successful at locating IOIs of all size and compositions,
- Thermal Spectrum Imagery was very successful at locating some items (JATO & rockets) but not successful at locating others (40mm grenades & seeds),
- No IOIs were only identifiable in thermal imagery, all 119 thermal IOIs at HMTS were also identifiable in visible spectrum,
- Thermal Imaging needs further advancement to make it more effective at detecting a wider range of materials and munitions types before being used as a primary detection technology.

sUAS CHALLENGES AT HMTS

- Regulators required placement of simulants (seeds) around site to prove the detection capabilities of imaging technologies
  - We placed 30+ seeds across site; took longer to place seeds than to fly missions
- Even minor weather events can greatly impact sUAS flight performance and cause delays to surveys
  - Lost several days due to inclement weather (wind, rain, cloud cover)
  - Thermal flights had to be planned around optimal sun hours/angles to allow for metallic items to heat up enough to be visible in thermal spectrum
- Processing the data was very time consuming, many of the commercially available drone processing software programs are unreliable or buggy given the number of images being processed and crashed often resulting in some re-processing of data. Total software computing time and manual analysis took over 300 hours to complete.
- Data Management is challenging due to enormous size of datafiles. Our Final Data package was approximately 3 Terabytes.

KEY CONTRIBUTORS

Special Thanks to:

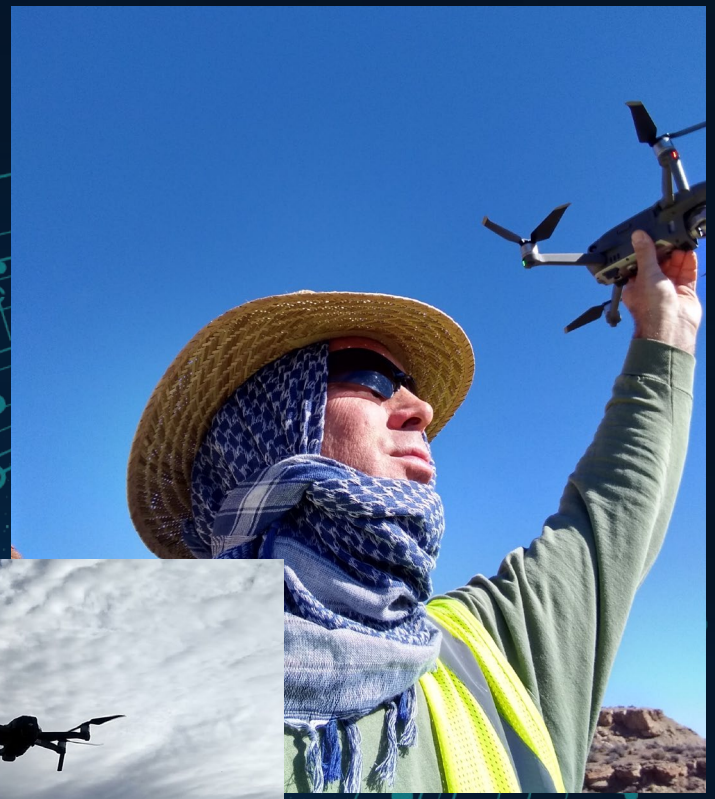
Ms. Carrie Nelson, USACE-SPK Project Manager

Mr. Kyle Lindsay, USACE-SPK Geophysicist

Mr. Brett Lyons, Parsons sUAS Pilot & Data Analyst

Ms. Carrie Ross, Parsons Project Manager

QUESTIONS?



ACRONYMS & DEFINITIONS

AETC – Aircraft Ejection System Test Component

HMTS – Hurricane Mesa Supersonic Research & Test Site FUDS

Inaccessible Terrain – Terrain with slopes greater than 30° (57.7% grade); too steep for personnel to access safely.

IOI - Item of Interest (munitions or aircraft ejection system component contamination)

JATO – Jet Assisted Take Off

sUAS – Small Unmanned Aerial System (Drone)

Thermal Specturm – Range of wavelengths considered solely with respect to emission of heat. All thermal images shown here are “White Hot”.