Background

The Military Munitions Response Program (MMRP) is charged with characterizing and, where necessary, remediating munitions-contaminated sites. When a site is cleaned up, it is typically mapped with a geophysical system, based on either a magnetometer or electromagnetic induction (EMI) sensor, and the locations of all detectable signals are excavated. Many of these detections do not correspond to munitions, but rather to other harmless metallic objects or geology: field experience indicates that often in excess of 90% of objects excavated during the course of a munitions response are found to be nonhazardous items. Current technology, as it is traditionally implemented, does not provide a quantitative, validated means to discriminate between hazardous munitions and nonhazardous items.

Remediation of the entire site inventory using current practices is cost prohibitive and estimated completion dates for munitions response on many sites are decades out. If the savings possible from classifying objects as either munitions or other harmless objects were realized, the limited resources of the MMRP could be used to accelerate the cleanup of munitions response sites that are currently forecast to be untouched for decades. In response to this need, the Environmental Security Technology Certification Program (ESTCP) initiated a pilot program that is validating the application of a number of recently developed classification technologies in a comprehensive approach to munitions response. Visit www.serdp-estcp.org under Featured Initiatives > Munitions Response Initiatives > Classification Applied to Munitions Response for more details.

Program Objectives

The objectives of the pilot program are to:

- Test and validate classification capabilities of currently available and emerging technologies on real sites under operational conditions
- Investigate how classification technologies can be implemented in cleanup operations in cooperation with regulators and program managers

Technology Approach

The pilot program entails a series of demonstrations at live sites of increasing difficulty. The demonstrations to date consist of several combinations of data-collection platforms and analysis approaches, ranging from careful application of commercial EM61 survey instruments to advanced EMI systems specially designed to maximize detection and classification of munitions.

After the survey systems complete data acquisition, all locations for which the sensor detected a signal that could potentially correspond to a munitions item are marked for investigation. Multiple groups demonstrate classification approaches. Mature, physics-based analysis methods are used to estimate properties of buried objects, such as size, depth, aspect ratio, remnant magnetization, and electromagnetic decay rates—properties that may be useful in distinguishing munitions from other sources. Advanced classification algorithms use this information to determine whether a signal is likely to arise from a munitions item or another source.

Sites are seeded with inert munitions and all anomalies are dug to confirm technology performance. Demonstrators are scored based on their ability to eliminate nonhazardous items while retaining all detected munitions.
### Previous Demonstrations

The former Camp Sibert, Alabama, a site with a single munitions type and benign conditions, was selected as the first site in 2007 to establish a performance baseline. At this simple site, well over half the clutter could be eliminated with all, or nearly all, the munitions correctly classified. A next-generation EMI sensor achieved nearly perfect results.

A demonstration at a more difficult site, the former Camp San Luis Obispo, California, followed in 2009. The hillside range used for the demonstration contained four known munitions types: 60-mm, 81-mm, and 4.2-in mortars and 2.36-in rockets. Three additional munitions types were discovered during the course of the demonstration. At this site, analysis of MetalMapper data collected in cued mode resulted in correct classification of nearly 1,000 of the approximately 1,300 non-munitions items while identifying 100% of the targets of interest.

In 2010, a demonstration was conducted at the former Camp Butner, North Carolina. This site is known to be contaminated with items as small as 37-mm projectiles as well as fragments from larger munitions, adding yet another layer of complexity. The advanced sensors were able to correctly identify all UXO while correctly classifying more than 1,900 of the 2,100 clutter items.

### 2011 Demonstrations

This series of demonstrations included production UXO contractors as participants. Highlights include:

**Former Camp Beale, California**

This demonstration was designed to investigate classification at a site that is partially wooded with a mix of munitions types. The MetalMapper was demonstrated in the open part of the site by two production contractors, and three developmental man-portable EMI sensors were demonstrated under the trees, Figure 1. Classification using cued data from the handheld systems was successful; most analysts were able to correctly identify all the targets of interest while eliminating up to 80% of the clutter. In the open field, the production geophysicists were able to correctly classify 70% of the clutter while identifying 100% of the targets of interest.

**Former Pole Mountain Target and Maneuver Area, Wyoming**

The Pole Mountain demonstration area comprised 50 acres with moderate anomaly density. Cued MetalMapper data were collected by a production firm and analyzed by geophysicists from production firms and the U.S. Army Corps of Engineers as well as the developers of the analysis methods. The best performers at this demonstration were able to correctly classify 90% of the clutter while identifying 100% of the targets of interest.

### Future Sites

Demonstrations at future sites will focus on increasingly difficult conditions such as heavy vegetation and obscured sky view as well as the development of implementation strategies in conjunction with site stakeholders.

### Expected Benefits

The pilot program is providing transparent and documented demonstrations of the current capabilities of both mature and emerging classification technologies in real-world conditions. The goal of the program is to ultimately reduce the cost and accelerate the timeline to remediate munitions-impacted sites. These studies are the initial phases of a continuing effort that will span several years.