Team Name: Contamination Characterization Through Airborne Hyperspectral Imagery (HSI)

Nominator: Jim Belcher, Acting Program Director, Hazardous Waste Program

Nominating Department: [*Nominations must include names of all agencies/departments/organizations/businesses, etc.*]
Missouri Department of Natural Resources

Category: Technology In Government

Executive Summary: [*Executive summary page must be 12 points, Times New Roman font, and left justified. Attach the executive summary to the front of the nomination*] Contamination from mining and smelting in southern Missouri is widespread, and continues to impact human health and the environment. Locating the vestiges of mining and characterizing the extent of contamination is an on-going, long-term task. Implementing a cost-effective technology for wide area characterization would help focus limited assets on the highest priority areas for potential cleanup. Hyperspectral Imagery (HSI) sensors collect spectral data that can be used to identify spectral signatures of certain contaminants. Airborne HSI systems collect spectral data across large areas and can provide the data to spectral analysts and environmental project managers in a timely manner to support planning, remediation, monitoring and emergency response. In other words, by flying over potentially contaminated sites, specialized equipment can detect the contamination and visually "show" where it is.

HSI has many proven environmental applications, but most airborne and satellite data has been too expensive for routine use by the states. The Civil Air Patrol (CAP) acquired 16 Airborne Real-Time Cueing Hyperspectral Enhanced Reconnaissance aircraft with HSI and High Resolution Imagery sensors in 2005. That year, the Missouri Department of Natural Resources (MDNR) obtained a grant from EPA for a Pilot Project to determine if the sensors could be used for environmental and environmental emergency response purposes. The Pilot Project was successful in identifying several potential applications. The Department was instrumental in establishing a Memorandum of Understanding between the state and Missouri Wing CAP that allows any state agency to request non-emergency support. CAP's operating costs make the HSI technology affordable. Follow-on funding from EPA continued the evaluations and established procedures for tasking and analysis.

Since 2005, the program has provided information about significant problems with a closed landfill, asbestos deposition from the Praxair fire in St. Louis, the extent of airborne lead deposition from an active smelter, and locations of abandoned mine wastes. In cities and towns around Missouri this project has shown its worth. For example, it identified potential sources of elevated lead levels in residential wells around a town in southwest Missouri and traced the source of heavy metal contamination in a park to the site of a former smelter. Analysis also identified several potential sites of exposed mine waste in residential areas around the state. In 2007, the department began collaborating with the US Geological Survey (USGS) on applications of HSI. As other users and agencies in need of the technology grew, a working group was formed that include other states and federal agencies. The MDNR is working with USGS on identifying lead stress in vegetation to support surveys of residential areas affected by dust along haul roads. In 2010, MDNR began supporting other state and federal agencies in developing programs. It established a yearly program to monitor covenant compliance at former Minuteman II sites to meet the U.S. Air Force's inspection requirements. Missouri's Division of State Parks imaged Johnson's Shut-ins State Park, where a reservoir failed releasing thousands of gallons of water and damaging the surrounding areas. HSI and its components have many beneficial uses to the state of Missouri and MDNR continues to create partnerships that help this project scope grow and thereby increase the benefits to the citizens of that state and the natural resources.

The Pilot Project report, a Summary Report for 2005 to 2009, and other project material are available at http://www.dnr.mo.gov/env/hwp/hsi/hsi-project.htm.

I. GENERAL INFORMATION

Department: Missouri Department of Natural Resources

1. Project or team name.
Contamination Characterization Through Airborne Hyperspectral Imagery (HSI)

2. List the name of all team members, job titles, state agency department, and/or community organization. [please list alphabetically by last name]

Branden Doster, PE, Environmental Engineer III, Missouri Department of Natural Resources
Shawn Muenks, Environmental Engineer II, Missouri Department of Natural Resources
Nick Carbone, Planner II, Missouri Department of Natural Resources
Clayton Blodgett, Ph.D., University of Missouri Columbia, Missouri Resource Assessment Partnership (MoRAP)
Ronnie Lea, GIS Specialist/RS Analyst, University of Missouri Columbia, Missouri Resource Assessment Partnership (MoRAP)
Colonel John A. Mais, Wing Commander, Missouri Wing Civil Air Patrol (MoWING CAP)
Major Mike Hackley, ARCHER Operator, MoWING CAP

3. Describe the project (*200 words or less*)
Contamination from mining and smelting in southern Missouri is widespread, and continues to impact human health and the environment. Locating the vestiges of mining and characterizing the extent of contamination is an on-going, long-term task. Implementing a cost-effective technology for wide area characterization would help focus limited assets on the highest priority areas. Other contamination from other process and releases pose a similar problem. Hyperspectral Imagery (HSI) sensors collect spectral data that can be used to identify spectral signatures of certain contaminants. Airborne HSI systems collect spectral data across large areas and can provide the data to spectral analysts and environmental project managers in a timely manner to support planning, remediation, monitoring and emergency response. In other words, by flying over potentially contaminated sites, specialized equipment can detect the contamination and visually "show" where it is.

4. Nomination category.
(*Check only one*)

☐ INNOVATION   ☐ CUSTOMER SERVICE

☐ EFFICIENCY/PROCESS IMPROVEMENT   ☒ TECHNOLOGY IN GOVERNMENT

5. Describe why you selected this nomination category.
The Hyperspectral Imagery (HSI) Projects have evaluated environmental applications of a technology that Civil Air Patrol (CAP) has made available to state and federal agencies. Federal agencies have had access to HSI for large research projects, but routine access for environmental projects by both state and federal agencies has been limited due to costs and long turnaround times. The CAP HSI sensor, developed for search and rescue, emergency response and other missions, has many other potential applications, and its operating costs make it available to state and federal agencies. MDNR and EPA have used the sensor for lead mining related projects, supported other agencies use of the technology, and continue to review other applications.

1. When did the team begin?

The MDNR obtained a grant from EPA in 2005 to conduct a Pilot Project. The team began with the state FY 2005 funding.

2. When did the team implement this project?

The 2005 Pilot Project showed promise for environmental emergency response and characterizing mining related contamination. The Department obtained additional funding from EPA to continue the project, and collected additional imagery in 2007 and 2008. The 2010 project focused on supporting use and evaluation of additional applications for other state and federal agencies.

3. How long has the project been implemented?

☐ 0 - 3 Months   ☐ 4 – 6 Months   ☐ 7 - 9 Months

☐ 10 – 12 Months   ☐ 12 or more   ☒ On-going Project

1. What did the team accomplish? (*150 words or less*)

The team was the first to demonstrate potential environmental applications of CAP's new HSI system. The 2005 Pilot Project included researching existing applications of multi-spectral and HSI for environmental contamination characterization and coordinating with other state and federal agencies to identify potential applications for evaluation. The Pilot Project established a process for collection and analysis of the HSI imagery that involved the site project managers input and shortened turnaround times to meet site planning, remediation and long-term monitoring cycles. The team was instrumental in establishing a Memorandum of Understanding between the state of Missouri and Missouri Wing CAP that allows any state agency to task and fund non-emergency use of CAP assets.

The team implemented or identified the following HSI applications.
- Monitoring and long-term stewardship of hazardous waste sites
- Locating abandoned mining operations
- Locating mine waste through vegetation stress
- Airborne contamination deposition

2. Which of the following describes the benefits of the accomplishment? (Check all that apply and provide an explanation)

☒ cost reduction   ☒ time savings

☒ improved process   ☒ other: (describe) Information on large areas and areas not previously
accessible due to terrain or permission.

3. Explain how the accomplishments of the team are beyond regular duties and responsibilities (*150 words or less*).

The pilot project was selected as part of an EPA Competitive Grant Program. Submission of the proposal and implementation of the project were beyond the regular duties of MDNR personnel. EPA funds a variety of MDNR environmental missions and projects. The initial pilot project funding was in addition to the normal EPA awards, and submitted as an initiative of the MDNR personnel with the approval of the Program Director.

MDNR personnel are coordinating with EPA and other state and federal agencies to share information as this technology advances. Correspondence through sharing of ideas and accomplishments with other agencies will be key to expanding applications of the HSI system. With the signing of the Memorandum of Understanding

with CAP, other state agencies are using this system in their projects, thus expanding use beyond environmental issues. This project required a great deal of initiative, experience and partnering with many agencies and groups.

IV. MEASUREMENT/EVALUATION

1. **Describe how the success of the project was measured and what outcomes were achieved.** (description should not exceed *300-500 words*)

This project, since its inception, has flown six missions throughout the state of Missouri. It has provided valuable information to not only the state of Missouri but the U.S. Air Force, the EPA and other state including Colorado. This project and its uses continue grow beyond the initial concept. Within it Missouri it has been beneficial to the State Emergency Management Agency, the Civil Air Patrol, the Division of State Parks, the Environmental Emergency Response Team, as well as other state agencies.

In a comparison between a commercial HSI fly over versus a Civil Air Patrol the cost savings is notable. A fly over by a commercial HSI would cost in excess of $20,000 a day, in comparison to the Civil Air Patrol which costs $2,000 a day. This exorbitant rate by the commercial pilots would have prevented states from even considering flyovers or the use of HSI. But because of this partnership between the Civil Air Patrol and MDNR other states and Missouri state agencies can benefit from this technology. This project also has the added benefit of providing flight time to the pilots within the Civil Air Patrol Program.

The Pilot Project grant proposal and subsequent EPA funding included work plans with measures of effectiveness, activities and outcomes. The team uses these to measure and evaluate the project. Periodic reporting to EPA addresses specific actions related to each measure. The following are examples of just some of measures, activities and outcomes from work plans.

Pilot Project:
Measure: Provide high-resolution imagery of areas immediately following a large-scale disaster for real-time presentation to emergency coordinators at State Emergency Management Agency Operations Center.
Outcome: Successfully achieved by providing high-resolution imagery of large-scale disaster sites.

Follow-on Projects:
2007 - 2009
Measure: Expand imagery collection and analysis of mine related contamination in southwest Missouri. Continue analysis of mine waste, abandoned mine shafts and smelter airborne contamination deposition signatures to determine extent of contamination and locate abandoned mining activity. Continue analysis of vegetation spectral signatures as an indicator of lead contamination.
Outcome: Achieved above measure and continued development of cost effective technology for wide area analyses and field investigations of mine related contamination to support and focus pre-survey planning.

2010
Measure: HSI Coordination and Knowledge Transfer – Apply HSI collection, analysis and products for remediation project planning and monitoring to state and federal agencies. Provide information on HSI and share knowledge of promising applications with other agencies including EPA. Support program implementation, product development and field verification. Continue participation in the working group and expand HSI expertise and applications.
Outcomes: Coordinate other State and Federal agency use of HSI regarding knowledge transfer. Transfer technical and institutional knowledge to other agencies. Maintain and share previously collected HSI data with other agencies and individuals. Assist others in further development of HSI capabilities and environmental applications.

2. **Are the benefits derived from this project:** (Check only one.)

☒ Recurring   ☐ One-time

V. RECOGNITION/AWARDS

1. **Has this project ever been nominated for the Governor's Award for Quality and Productivity? If yes, when?**

Yes, 2008

2. **If yes, for which category was it nominated?**

Technology in Government

3. **Has this project received any other awards or recognition in the past? If yes, describe.**

No

VI. NOMINATOR'S INFORMATION

NOMINATING DEPARTMENT – Missouri Department of Natural Resources

Name	Signature	Telephone Number	E-Mail Address
Jim Belcher	*Rubn Zamarryi for*	573-751-2747	Jim.belcher@dnr.mo.gov

VII. DEPARTMENT COORDINATOR INFORMATION

DEPARTMENT

Name	Signature	Telephone Number	E-Mail Address
Pat Smith	*Pat Smith*	573-522-9395	Pat.smith@dnr.mo.gov

VIII. DEPARTMENT DIRECTOR APPROVAL

DEPARTMENT DIRECTOR'S NAME	DEPARTMENT DIRECTOR'S SIGNATURE*
Mark N. Templeton	

Nomination must be signed ONLY by the Department Director to be eligible for consideration.
Nominations not signed by the Department Director will be returned.