U.S. Department of the Interior

Annual Report on Technology Transfer

FY 2017 Activities

August 2018

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I. Introduction

Technology transfer for the Department of the Interior (Department) includes a range of activities designed to disseminate scientific and technical information and knowledge between the Department, other Federal agencies and non-Federal entities. It includes, but is not limited to, publishing and exchanging scientific and technical information, protecting and licensing intellectual property rights, and sharing — or otherwise making available — for scientific or technical purposes the expertise and specialized scientific material and resources that the Department manages. In general, technology transfer activities within the Department are consistent with its mission to protect and manage the Nation's natural resources and cultural heritage, to make available scientific and other information about those resources, to honor trust responsibilities to Tribes, and to supply energy for the future.

This report describes the actions that the Department took in FY 2017 to advance technology transfer. These range from developing new technologies that would help identify various materials in water to improved methods to measure water quality in high biofouling environments. These activities demonstrate the innovation, expertise and dedication of the Department's employees, including its many scientists and engineers, to help reduce risks to public health, safety and the environment from natural and man-made hazards. The Data Appendix provides cumulative data tables requested by the Office of Management and Budget, and the National Institute of Standards and Technology for the Department for FYs 2011–2017. These tables include updates to previous years' data, where appropriate.

II. Advancing Technology Transfer in the Department of the Interior

The FY 2017 enacted budget for the Department of the Interior included $994.2 million for research and development. The majority of the funding was for applied research ($776.6 million), while basic research and basic development received $54.38 million and $163.3 million, respectively. The programs supported through these funds generate new and improved knowledge, information, and technology, which help the Department meet its mission objectives and are transferred to resource managers, stakeholders, and the general public.

The Department's bureaus have varying levels of involvement with scientific and technical research and innovation, and technology transfer. In FY 2017, as in previous years, the majority of technology transfer activities reported by the Department under the Federal Technology Transfer Act of 1986 (FTTA) were undertaken by the U.S. Geological Survey (USGS), which is the largest research and development (R&D) organization in the Department, both in terms of budget and personnel. Typically, USGS accounts for over 70 percent of the Department's R&D budget.

The Department's scientists, engineers, and other technical personnel advance the state of knowledge related to the resources it manages, and ensure that this information is accessible to resource managers, private industry, and the general public. The vast majority of the Department's technology transfer activities use traditional technology transfer mechanisms, such as publications of peer reviewed papers and reports, webpage postings, fact sheets, and

presentations at meetings and conferences. In 2017, DOI personnel authored or co-authored over 12,300 reports, books, fact sheets, and other publications, including almost 4,500 scientific publications.

Bureaus also use other conventional approaches to share scientific and technical resources and expertise with each other, universities and other entities to address resource management issues. For example, seven DOI bureaus are active participants in the network of seventeen Cooperative Ecosystem Studies Units (CESUs), a collaboration among 15 Federal agencies and more than 400 non-Federal partners (including universities, Tribes and tribal organizations, state agencies, museums, aquariums, arboretums, and conservation organizations). Each CESU is hosted by a university.

Bureaus that are active in research and development, or have research capabilities that complement U.S. commercial interests, may also utilize technology transfer agreements authorized by the FTTA to join forces with non-Federal partners. Such agreements allow the Department's bureaus and private sector industries to pool their expertise and resources to jointly create and advance technologies that could help fulfill agency missions while helping U.S. industries innovate and commercialize technologies, which can strengthen our national economy and create jobs. This report focuses primarily on, but is not limited to, aspects of technology transfer related to the FTTA.

FY 2017 Accomplishments

During FY 2017, the Department's scientific, technical, and engineering personnel continued to engage in a broad range of cooperative activities to develop and disseminate innovative technologies, including:

- Publishing over 12,300 reports, books, papers, fact sheets, and other publications, including almost 4,500 in scientific publications.
- Collaborating on 841 Cooperative Research & Development Agreements (CRADAs), of which 477 were initiated in FY 2017. During the previous year (FY 2016), the numbers were 873 and 511, respectively. In addition, the Department engaged in at least 247 other collaborative R&D relationships.
- Engaging in 783 non-traditional CRADAs, i.e., material use and facility use agreements, under the FTTA.
- Disclosing twelve (12) new inventions. In addition, five (5) patents were filed and (3) patents were received.
- Managing 15 active licenses for inventions and other intellectual property earning about $50,000 collectively.

III. Overview of Technology Transfer Activities

Table 1 shows that the Department's bureaus use, or are contemplating using, a variety of mechanisms to transfer information, knowledge, and technology within and outside their agencies.

Table 1: Principal Technology Transfer Mechanisms Identified by Each Bureau

	USGS	FWS	OSMRE	NPS	BSEE	Reclam-ation	BOEM	BLM
Technical/Scientific Publications	X	X	X	X	X	X	X	X
Workshops/Seminars	X	X	X	X	X	X	X	X
Educational Courses & Other Outreach	X	X	X		X	X	X	X
Cooperative Research and Development Agreements (CRADAs)	X	X		X		X		
Technical Assistance Agreements (TAAs)	X					X		
Facility Use/Service Agreements (FUSAs)	X					X		
Material Transfer Agreements	X			X		X		
Demonstration/Joint Projects					X	X		X
Patents	X	X		X		X		
Licenses	X	X		X		X		
Other Cooperative Ventures & Agreement Types	X	X	X	X	X	X		
Web and other mechanisms	X	X	X	X	X	X	X	X

IV. Technology Transfer Agreements

Table 2 provides a summary of new and active technology transfer agreements undertaken within the Department in FY 2017. There were a total of 841 active CRADAs in FY 2017, of which 477 were newly executed. In FY 2016, there were a total of 873 CRADAS (including 511 new ones).

Table 2: Collaborative Relationships for Research & Development (FY 2017)

	USGS	Recla-mation	NPS	BOEM	FWS	Total
● **CRADAs**, total active in the FY[(1)]	817	19	1	1	5	841[(5)]
- New, executed in the FY	470	7	0	1	1	477[(5)]
▪ Traditional CRADAs,[(2)] total active in the FY	49	4	1	1	5	58[(5)]
- New, executed in the FY	10	3	0	1	1	13[(5)]
▪ Non-traditional CRADAs,[(3)] total active in FY	768	15	0		0	783
- New, executed in the FY	460	6	0		0	466
● **Other collaborative R&D relationships[4]**						
▪ (Collaborative Agreements), total active in the FY	247	0			0	247
- New, executed in the FY	89	0			0	89

CRADA = Cooperative Research and Development Agreement
(1) "Active" = legally in force at any time during the FY. "Total active" is comprehensive of all agreements executed under CRADA authority (15 USC § 3710a).
(2) CRADAs involving collaborative research and development by a federal laboratory and non-federal partner.
(3) CRADAs used for special purposes -- such as, material transfer or technical assistance that may result in protected information. For USGS, Technical Assistance Agreements (TAA) and Facility Use/Service Agreement (FUSA) fit this category.
(4) Based on available data. These figures do not account for the majority of collaborative agreements that bureaus engage in under authorities other than the FTTA.
(5) For 2017, this number is two less than the sum of the preceding columns because one CRADA involved three bureaus: BOEM, FWS and USGS.

Table 3 summarizes invention and patenting activity within the Department during FY 2017 broken out by bureau. This activity was limited to USGS, Reclamation, and the National Park Service. The table indicates that twelve new inventions were disclosed, five new patent applications were filed and three new patents were issued.

Table 3: Invention Disclosure and Patenting (FY 2017)

	USGS	Recla-mation	Total
● New inventions disclosed in the FY[(1)]	10	2	12
● Patent applications filed in the FY[(2)]	4	1	5
● Patents issued in the FY	3	0	3

Table 4 provides a summary of the number of active licenses managed by the Department's bureaus.

Table 4: Active and Income Bearing Licenses (FY 2017)

	USGS	Reclam-ation	Total
● **All licenses**, number, total active in the FY	11	4	15
▫ New, executed in the FY	0	0	0
● **Income bearing licenses**	11	2	13

Additional data, broken out by bureau and covering FY 2013–FY 2017, are contained in the Data Appendix to this report. These show that total income in FY 2017 from all licenses amounted to about $50,000 (from 13 income bearing licenses), compared to $83,000 from 17 income-bearing licenses in the previous fiscal year.

Table 5 provides a summary of the scope and nature of technology transfer activities and mechanisms that the various bureaus implement currently or might implement in the future.

Table 5: Scope of Activities and Plans Related to the FTTA, by Bureau

Mission	Technology Transfer
U.S. Geological Survey (USGS). The mission of the USGS is to serve the Nation by providing reliable scientific information to describe and understand the Earth, minimize loss of life and property from natural disasters, manage water, biological, energy, and mineral resources, and enhance and protect our quality of life.	The USGS serves the Nation as an independent fact-finding agency that collects, monitors and analyzes scientific and technical information to provide scientific understanding about natural resource conditions, issues, and problems. The USGS makes this information and knowledge readily available to decision makers and the public. Thus, one of the USGS's main thrusts is broad and open dissemination of its knowledge and information. USGS also pursues technology transfer opportunities under the FTTA and the Stevenson-Wydler Act in a variety of ways (see Table 1).
U.S. Fish & Wildlife Service (FWS). The mission of the U.S. Fish & Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.	FWS's Research and Development (R&D) is primarily focused on providing the basis for effective conservation to meet its mission. The agency's primary research nexus with the private sector centers on the Fish and Aquatic Conservation Program. FWS Fish Technology Centers were established in 1965 to develop and improve fish culture technology and to provide assistance to Federal and State agencies, Tribes and other nations interested in aquaculture research and solutions. Today there are eight such centers working with industry and government to improve aquaculture opportunities.
Office of Surface Mining Reclamation and Enforcement (OSMRE). OSMRE helps States develop and implement their own approved surface coal mining programs.	OSMRE advances it mission by providing technical assistance, based on sound science and training, to its State and tribal partners to enhance their ability to maintain effective programs. Although OSMRE has no formal research and development activities, its Technology Development and Transfer program promotes and disseminates information on technological innovations to better protect the environment during mining and in reclaiming and restoring active and abandoned mines. The program also provides training to ensure that States, Tribes, and OSMRE's other partners continue to administer their surface mining programs efficiently and effectively.
National Park Service (NPS). The National Park Service preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of current and future generations. The NPS cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.	Technology transfer and employee inventions are addressed under the NPS benefits-sharing policy and procedural guidance (available at http://www.nps.gov/applications/npspolicy/DOrders.cfm). Benefits sharing occurs when NPS receives monetary or non-monetary benefits from the commercial use of a discovery or invention resulting from research originating under an NPS Scientific Research and Collecting Permit, or other NPS permit or authorization. Authorities under the FTTA are essential to the NPS benefits-sharing program.

Table 5: Scope of Activities and Plans Related to the FTTA, by Bureau

Mission	Technology Transfer
Bureau of Safety and Environmental Enforcement (BSEE). The BSEE works to promote safety, protect the environment, and conserve resources offshore through vigorous regulatory oversight and enforcement.	The BSEE R&D program operates through the Emerging Technologies Branch (ETB) and the Oil Spill Response Research program (OSRR) in the Response Research Branch. BSEE research is associated with operational safety, pollution prevention, and oil spill cleanup techniques and technologies. BSEE research results are used to inform regulatory decision making and to promote the use of Best Available and Safest Technology on the U.S. Outer Continental Shelf.
Bureau of Reclamation (Reclamation). The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.	Reclamation has the lead Federal responsibility for water management and hydropower in the 17 Western States. Its research program is highly applied towards development of solutions that increase efficiency, reduce maintenance costs, improve work safety, enhance infrastructure reliability, and increase the effectiveness of using desalination and other water treatment technologies to expand water supplies. The research programs use technology transfer fundamentals to help speed field deployment of new innovations.
Bureau of Ocean Energy Management (BOEM). The Bureau of Ocean Energy Management manages the exploration and development of the Nation's offshore energy and mineral resources in an environmentally and economically reasonable way. It seeks to appropriately balance economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.	BOEM's Environmental Studies Program (ESP) develops, conducts and oversees scientific research specifically to inform policy decisions regarding development of Outer Continental Shelf (OCS) energy and mineral resources. Research covers physical oceanography, atmospheric sciences, biology, protected species, social sciences, economics, submerged cultural resources and environmental fates and effects. BOEM also funds research into offshore renewable energy technology.
Bureau of Land Management (BLM). The BLM mission is to sustain the health, diversity, and productivity of America's public lands for the use and enjoyment of present and future generations. The Federal Land Policy and Management Act of 1976 (FLPMA) mandates that the BLM manage public land resources for a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and non-renewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific and historical values	BLM's science and technical focus has been on place-based applications to improve the management of public lands in accordance with FLPMA's multiple use mandate. Accordingly, it focuses on traditional technological transfer activities to help advance its multiple-use mandate.

Subsequent sections briefly describe each bureau's technology transfer program and a sample of their activities in FY 2017. The tabular data requested by OMB Circular A-11 are reported in the Data Appendix, to the extent data are available.

V. U.S. Geological Survey

The United States Geological Survey (USGS) is a science bureau within the Department of the Interior whose mission is to serve the Nation by providing reliable scientific information to describe and understand the Earth, minimize loss of life and property from natural disasters, manage water, biological, energy, and mineral resources, and enhance and protect our quality of life. Under its science strategy outlined in "Facing Tomorrow's Challenges—U.S. Geological Survey Science in the Decade 2007-2017," USGS focuses on the following interdisciplinary mission areas: Ecosystems; Climate and Land Use Change; Energy and Minerals; Environmental Health; Natural Hazards; Water Resources; and Core Science Systems. These mission areas combine expertise from several Earth Science disciplines (e.g., hydrology, geology, biology) to address relevant issues of concern to people and other living things on the planet. Organization around these mission areas allows the USGS to better address the needs of the Nation, its customers and partners.

Delivery of science information is a primary purpose of the bureau. Technology transfer activities with the public and private sectors, including academia and non-profits, are, therefore, integral to fulfilling this purpose. They typically support the collection and transfer of scientific data (knowledge dissemination). In FY 2017, U.S. Geological Survey personnel, for example, authored or co-authored 11,993 reports, books, fact sheets, and other publications and information products, including over 4,165 scientific journal articles, 632 USGS Series scientific publications, and 4,010 abstracts. The USGS also cooperates with its public and private collaborators to help them maintain essential and necessary services, better understand the environmental consequences of their commercial and non-commercial activities, and develop new products and services. The USGS has 361 major laboratories and several hundred field offices located around the country.

Within the USGS, technology transfer that extends beyond traditional publications, meetings, and conferences, and is related to the Stevenson-Wydler Innovation Act and the FTTA is managed through the Office of Policy and Analysis (OPA). OPA staff service USGS Science Centers and offices throughout the country.

OPA, on behalf of the USGS, negotiates and drafts Cooperative Research and Development Agreements (CRADAs), Technical Assistance Agreements, Facility Use Agreements, Material Transfer Agreements, and Patent Licenses. OPA also manages the USGS intellectual property and inventions program; markets USGS technology opportunities; and facilitates partnerships with industry, non-profits, academic institutions, Tribal nations, and State agencies. OPA also provides training to USGS personnel on technology transfer and intellectual property matters.

In 2017, USGS had 817 active traditional and non-traditional CRADAs, the majority of which (768) were technical assistance and facility use agreements. By contrast, in FY 2016 it had 858 active CRADAs, including 829 non-traditional CRADAs. In addition, USGS executed 247 other collaborative agreements, managed a total of eleven (11) active licenses. It also filed four (4) patent applications and received three (3) patents.

USGS science and research contributes to a broad range of collaborative projects in the private and academic sector. The USGS provides unique analytical laboratory services to U.S., foreign, and academic partners through the USGS Facility Use program. Examples include:

Inter-American Development Bank – Scientific Information Related to Energy and Mineral Industries in the Caribbean and Latin America (LAC). USGS and the Inter-American Development Bank (IDB), established a CRADA to collaborate on research, and compile and develop geospatial information related to energy and mineral resources within Latin America and the Caribbean (LAC)

The IDB is the main source of multilateral financing for economic, social, and institutional development in the LAC region through loans, grants, guarantees, policy advice, and technical assistance to public and private sectors of its borrowing member countries. The IDB is seeking to develop knowledge products that contribute to promote sustainability and transparency in the extractive industries in the LAC region. The USGS, with its geotechnical expertise and global understanding of resource geology and extractive industries, is well positioned to provide the science and information needed by the IDB for this effort.

Figure 1 below provides an example of the type of product that can be created. It is taken from the recently completed first Project Annex, "Compilation and Analysis of Extractive Industry Geospatial Data from Latin America and the Caribbean (LAC)," available at https://pubs.er.usgs.gov/publication/ofr20171079. It shows a screenshot from an interactive geospatial PDF document that displays the following layers: active mines (orange circle), active mineral processing facilities (red triangle), oil and gas fields (dark green squares), mineral exploration sites (multicolored hexagons), oil and gas pipelines (blue lines), and oil and gas concessions / leasing areas (red lines). Additional layers that can be displayed include: electric power generating facilities, electric power transmission lines, petroleum provinces, cumulative oil production and potential oil and gas resources, railroads, and maritime mineral commodity exporting ports. The figure is derived from publicly available data, and some IDB proprietary data and methods.

The USGS-IADB joint work effort is taking place in phases. Additional Project Annexes, with specific objectives, tasks, and budget for each phase will be developed and implemented cooperatively. The USGS proposes to expand this collaborative work effort in subsequent phases to include work on a mineral resources inventory and, eventually, water resources and other hydrology projects.

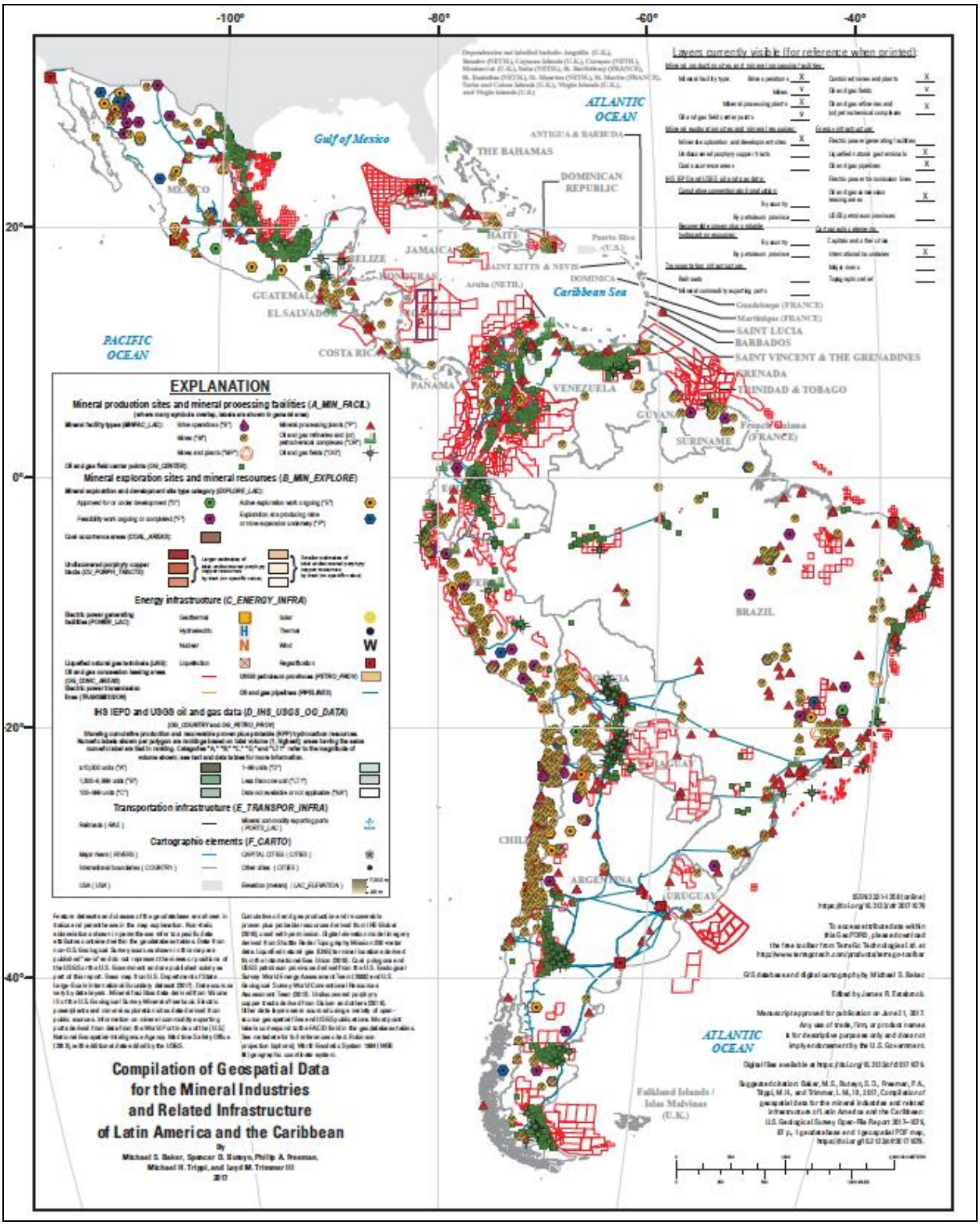


Figure 1.—The U.S. Geological Survey compilation of geospatial data for extractive industries in Latin America and the Caribbean. [Photo Credit: Map author: Michael Baker, USGS. Map editor: James Estabrook, USGS]

Subsurface Insights – Autonomous Web-enabled Electrical Resistivity Monitoring (AWERM) for Near-surface Process Monitoring. Subsurface Insights (SSI), a geophysical research and development company, is developing affordable electrical geophysical monitoring hardware and an associated back-end data analysis service, and has need of USGS expertise in the application and evaluation of electrical geophysical monitoring technologies for near-surface groundwater investigations.

The purpose of this CRADA is to provide a framework for cooperation between the USGS and SSI for development, testing, evaluation, and documentation of innovative autonomous electrical geophysical methods for monitoring subsurface processes. SSI will provide geophysical equipment for testing and evaluation, and access to web-based analytical and reporting services.

The Earth Systems Processes Division (ESPD) Hydrogeophysics Branch supports the USGS Water Mission through geophysical methods development research and provision of technical support and guidance on their use for groundwater investigations, and other applications of near-surface geophysics. The Branch evaluates application of state-of-the-art surface geophysical methods to assess groundwater problems, specifically methods for efficient, autonomous site monitoring.

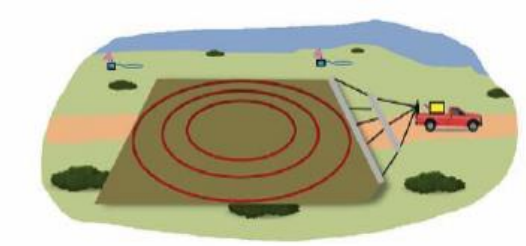
Time-lapse electrical geophysical methods provide information on the spatial distribution and temporal changes of bulk electrical properties. The spatial distribution of electrical properties can be interpreted in terms of lithology and fracture zones, and changes in bulk electrical properties can be interpreted in terms of water quality, temperature and saturation changes, geochemical reactions, and other underlying processes. The ability to delineate near-surface geology and monitor changes in water quality and other hydrologic factors is important for assessing the water resources of the nation, evaluating geologic and other time-dependent hazards, and for efficiently designing and monitoring groundwater remediation measures.

The USGS role will focus on system deployment and operation, and on evaluation of geoelectrical data and other system outputs. The anticipated outcome of this CRADA will be a cost-effective, field-validated electrical geophysical monitoring system which can be applied to a range of hydrologic and other near-surface monitoring problems.

Vista Clara, Inc. This CRADA provides a framework for cooperation on the development, testing, and demonstration of new rapid scanning nuclear magnetic resonance (NMR) technology for Earth science applications. Through collaboration with Vista Clara, Inc., a company that develops and manufactures advanced nuclear magnetic resonance (NMR) geophysical instruments, the USGS will help: (1) demonstrate the value of NMR methods in public-sector science applications, and (2) provide input and feedback at the R&D phase to help ensure that new instrument developments are well-aligned with future USGS and other public-sector science needs.

Surface-NMR is currently the only geophysical method that can provide direct detection of groundwater without invasive drilling, and has robust sensitivity to hydrogeologic parameters, including total/effective porosity and permeability. This R&D effort is a leap forward in Vista Clara's proven track record of historic innovations in NMR geophysics. It will, as shown in the

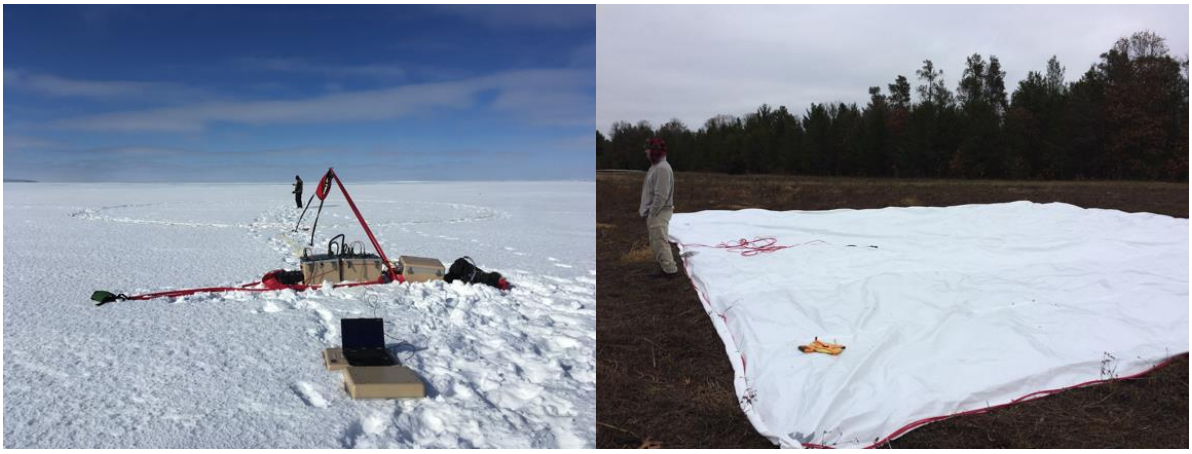
following illustration, transform surface-NMR into a mobile scanning method for rapid mapping of hydrogeologic properties, providing orders of magnitude improvements in measurement speed, cost-efficiency, and success-rate. This valuable technology will redefine practical capabilities for non-invasive mapping of aquifer parameters, and advance customers' ability to successfully remediate, protect, and manage groundwater resources.



Conceptual diagram of a towable surface NMR platform. [Photo Credit: Elliot Grunewald, Vista Clara, Inc.]

The primary objective of the USGS is to help demonstrate the value of these new technological developments for existing and future groundwater projects. These demonstration projects are also expected to yield new data that will advance scientific understanding at present USGS study sites. Through participation in the development and testing phase, USGS scientists aim to work at the forefront of this innovative new technology, and to build new skills that have potential benefit to future projects.

In 2017, two demonstration efforts were undertaken to begin testing new hardware and software developments. The first was at a remote site on the North Slope of Alaska, where scientific questions involved detecting unfrozen water beneath snow and frozen sediments. Here, instruments were towed across the snow using sleds (see below). At a second field site in Wisconsin, NMR instruments were towed across farm fields on a large tarp to map the distribution of shallow groundwater and clay confining layers.



Field deployments of rapid scan instrumentation in Alaska (left) [Photo Credit: Elliot Grunewald, Vista Clara, Inc.] and Wisconsin (right) [Photo Credit: Burke Minsley, USGS]

Development of fine-scale temperature models in the Delaware River. The USGS entered into a CRADA with the Academy of Natural Sciences of Drexel University to develop models to

project temperatures in the Delaware River for use in decision support tools and ecosystem service models.

The Delaware River supports multiple competing water demands including recreation, saltwater repulsion, flood mitigation, and endangered species. USGS researchers at Fort Collins Science Center (FORT) developed the Riverine Environmental Flow Decision Support System (REFDSS) as part of the Department of the Interior's and USGS's WaterSMART initiative to evaluate flow management practices and their effects on aquatic species within the Delaware River Basin. This knowledge will assist managers at the National Park Service and the U.S. Fish and Wildlife Service). The REFDSS models habitat availability for key recreational and ecologically important species at 11 sites in the upper Delaware River Basin, three of which lie within the Upper Delaware Scenic and Recreational River National Park.

The Delaware River was also selected as one of USGS's focal areas for the Sustaining Ecological Capital program (SEC), designed to incorporate ecosystem services into Federal planning. Researchers from USGS Northern Appalachian Research Laboratory (NARL) and FORT have been collaborating to evaluate the economic benefit of clean water provided by freshwater mussels and incorporate this information into the REFDSS. A critical component to both the USGS-led WaterSMART and SEC initiatives, however, is the effects of stream temperature on the habitat of and ecosystems services provided by freshwater organisms. Funding provided by the William Penn Foundation through Drexel University was awarded to USGS NARL and FORT to:

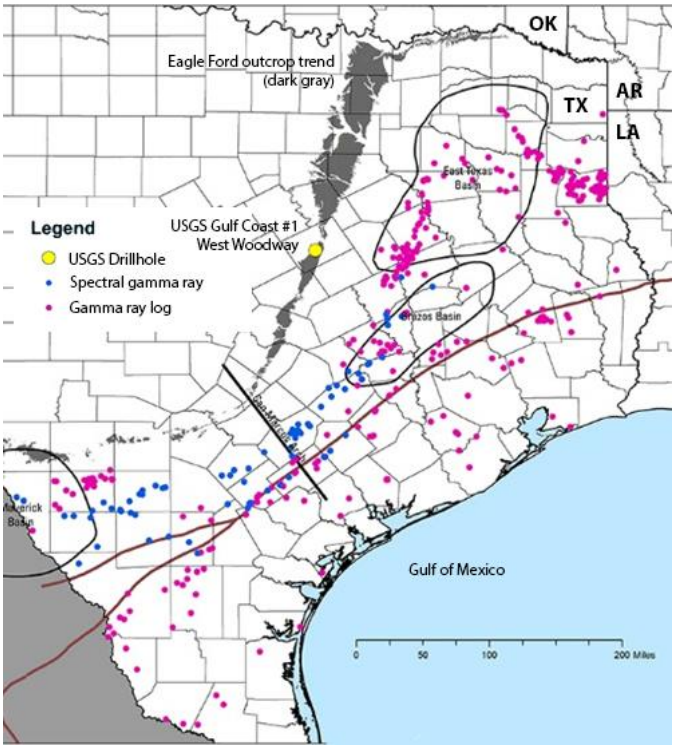
- Test available technology for collecting high-resolution temperature data;
- Develop predictive high-resolution temperature models for multiple sites;
- Determine thermal tolerances for key aquatic species;
- Determine relationships between temperature and key ecosystem services;
- Incorporate these findings into the REFDSS for use by resource managers.

This thermal research component in the Delaware River will broaden the applicability of the REFDSS as a research and management tool and provide additional sought-after data pertaining to other endangered and invasive species of interest. The ability to incorporate a thermal component into the REFDSS and the SEC through funding from Drexel University will greatly enhance these highly valuable scientific endeavors in the basin and facilitate informed decision making by managers and stakeholders as they relate to both ecology and water quality of the basin.

Researchers SCUBA dive to deploy fiber-optic temperature sensing cable on the bottom of the river to develop thermal maps of the river bottom. [Photo Credit: Leanne Hanson, USGS]

Researchers use unmanned aircraft with mounted thermal cameras to develop temperature maps of the river. [Photo Credit: Leanne Hanson, USGS]

West Woodway Rock Core Technical Assistance Agreements (TAAs). The USGS Gulf Coast Petroleum Systems Team has initiated a project to improve understanding of the hydrocarbon potential of the Cretaceous Eagle Ford Group in northeast Texas. Specifically, the USGS has obtained a drill core and a set of geophysical well logs through the Eagle Ford Group in West Woodway, Texas. The cored interval contains approximately 270 feet of Eagle Ford Group mudstone with Cretaceous Georgetown Limestone at the base and Cretaceous Austin Chalk at the top. Because the Eagle Ford is currently one of the most significant oil-bearing continuous resource in the United States, the geographic location of the core is strategic to evaluating the regional relationships between the prolific Eagle Ford Group in west Texas to the prospective Eagle Ford and Eaglebine units in northeast Texas.



Location of USGS Gulf Coast #1 West Woodway (Coordinates: N31.495073, W97.224006) at West Woodway, Texas [Photo credit: Scott Kinney and Stan Paxton, USGS]

The goal of this collaborative project and the associated tasks is to promote scientific collaboration and research activities that contribute to improved understanding of the (1) stratigraphy, (2) depositional environment, and (3) burial history of the Eagle Ford Group mudstones in northeastern Texas.

The USGS Gulf Coast Petroleum Systems Team seeks to leverage federal funds (spent on acquiring the core) through cooperation among non-federal technical-area experts to enhance the scientific value of the Eagle Ford Group core. The non-federal technical area experts are collaborating with USGS under the terms of various technology transfer agreements. The specific research and development activities to be conducted by each of the experts are described within each TAA in the Statement of Work (SOW) section of the agreement. The parties involved in collaborations include geoscientists from the Bureau of Economic Geology at the University of Texas – Austin, Texas Christian University, and Texas A&M.

VI. U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (FWS) is dedicated to the conservation, protection, and enhancement of fish, wildlife and plants, and their habitats. FWS is the only agency in the Federal Government whose primary responsibility is managing fish and wildlife resources for the American public. It manages more than 855 million acres of lands and waters in the National Wildlife Refuge System, including seven national monuments, 566 national wildlife refuges, and 38 wetland management districts. FWS also operates 72 National Fish Hatcheries, which, in conjunction with its nine Fish Health Centers and eight Fish Technology Centers (including the Conservation Genetics Lab in Alaska), restore native aquatic populations, mitigate for fish lost as a result of Federal water projects, and support recreational fisheries throughout the United States.

Research and Development (R&D) within FWS is primarily focused on applying the latest scientific and technical information to fulfill its mission of working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. The transfer of FWS's technology and knowledge to the public and collaborators accelerates the adoption and use of agency research while improving the economic and societal impact from its R&D investments to help solve natural resource problems.

The technology transfer function of FWS is shared among several programs, including Science Applications; Fish and Aquatic Conservation (FAC); and Policy, Performance, and Management (PPM) Programs. The vast majority of FWS's technology transfer is done via dissemination to the public and scientific community through traditional avenues such as peer reviewed papers, reports, and fact sheets.

FWS employees are actively involved in the larger scientific community and participate in scientific societies and meetings and conferences and publish scientific research. Sharing scientific and technical information via public outreach and partnerships is a high priority for FWS. For example, the FWS is a partner to all units within the 17 Cooperative Ecosystem Studies Units (CESU) Network, allowing it to be involved in interdisciplinary and multi-agency research projects with the host university and other non-federal partners. Each year the FWS pursues dozens of projects through the CESU network including surveying and monitoring efforts, climate change vulnerability assessments, streamflow projections, and many others.

Scientists within the agency published 322 scholarly articles, papers, or book chapters in publications focused on diverse topics such as landscape ecology, restoration, toxicology, natural resources management, aquatic ecology, ornithology, and mammology. FWS also manages two

online peer reviewed publications focused on the practical application and integration of applied science to wildlife conservation and management — the *Journal of Fish and Wildlife Management* and the *North American Fauna Monograph Series*. These electronic journals are in the public domain. FWS also uses its research to help inform a wide range of wildlife management decisions in the interest of the general public. For example, the National Wildlife Refuge Inventory and Monitoring Program systematically obtains a range of biological data about the status, trends and management responses of species and habitats within the Refuge System. Those data inform and improve conservation of fish, wildlife, and plant natural resources. In 2017, the two scientific journals were queried at least 190,000 times in scholarly searches.

Patents: In FY 2017, PPM continued to help the National Wildlife Refuge System pursue a patent filed for one of its program employees. The patent is for a handheld data-logging apparatus, which may help fight invasive plant species on both public and private lands. The apparatus incorporates a global positioning system (GPS) receiver and microcontroller integrated into a conventional handheld spray unit. As an operator dispenses a chemical using the apparatus, the microcontroller records (among other things) the volume of chemical dispensed and the GPS location of the sprayer. The recorded data is processed and stored on a removable USB thumb drive. The operator can download the data from the thumb drive and manipulate the data using a conventional spreadsheet program or a commercially-available geographic information system program. PPM has a previously established intra-agency agreement with the Bureau of Reclamation to tap into the latter's interagency agreement with USDA's Agricultural Research Service (ARS) to obtain patent law expertise. The U.S. Patent and Trademark Office had issued a non-final rejection, but FWS continued the pursuit of the patent and (with the assistance of the Agricultural Research Service) requested that the Patent and Trade Office reconsider, which they did. The patent will add to the four obtained by FWS since 1998. These include patents, such as one for calcein detection devices developed at the FWS Northeast Fishery Center in Lamar, PA, for detecting non-invasively-marked hatchery-reared Atlantic salmon for up to 3 years post-marking, which has been licensed exclusively to Western Chemical (Ferndale, Washington).

CRADAs: In FY 2017, FWS maintained the four CRADAs it has in place through the Aquatic Animal Drug Approval Program (AADAP) within FAC. In addition, FWS entered into a joint CRADA involving USGS and BOEM (on behalf of DOI) and Bird Studies, Canada, in FY 2017.[1]

Following is a brief description of FWS programs and entities engaged in technology development and transfer activities.

National Conservation Training Center. FWS Conservation Library at the National Conservation Training Center (NCTC) in Shepherdstown, West Virginia, provides a searchable collection of selected documents, images, historical artifacts, audio clips, publications, and video, most of which are in the public domain. FWS also makes internal publications, reports, and other information available to the public through FWS website. Collections of current and

[1] To avoid double- and triple-counting, because this CRADA is already accounted for in the USGS tally of CRADAs, it is not included in the tallies for the other bureaus in Section IV and the data tables in the Appendix.

legacy publications are available online from the NCTC library catalog and websites. NCTC also maintains links to biological and technical publications, as well as additional publications regarding birds, wetlands, fish hatcheries, and National Wildlife Refuges.

NCTC also hosts publicly-accessible webinars dealing with a variety of scientific and technical issues that affect the nation's fish and wildlife resources. During FY 2017, NCTC hosted 57 online science, technology, and education webinars and e-courses related to managing the nation's fish, wildlife, and plant resources. These are an important component of FWS's traditional technology transfer activities.

Fish and Aquatic Conservation Program. The bureau's primary research nexus with the private sector centers on programs and facilities within the Fish and Aquatic Conservation (FAC) Program. The program includes a network of Fish Hatcheries, Fish and Wildlife Conservation Offices, Fish Health Centers, Fish Technology Centers, the Conservation Genetics Laboratory in Anchorage, Alaska, and the Aquatic Animal Drug Approval Partnership (AADAP). These centers and programs provide assistance and support to conservation partners of FWS, including Federal, State, tribal, and non-governmental organizations that cover a broad range of disciplines including biostatistics, population ecology, genetics, nutrition, and fish health and pathology.

FWS Aquatic Animal Drug Approval Partnership. AADAP currently has four CRADAs in place. Individual CRADAs have been established with AquaTechnics, Inc. (Sequim, WA), Merck Animal Health (Summit, NJ), Aquatic Life Sciences (Ferndale, WA), and Frontier Scientific (Logan, UT). These agreements permit the parties to identify research opportunities that support development of new aquatic animal drugs, broaden the U.S. technology base, and support accomplishment of FWS scientific mission objectives.

Fish Technology Centers. Most of the eight Fish Technology Centers (FTCs) were established in 1965 to develop and improve fish culture technology and provide assistance and advice on fish culture to National Fish Hatcheries, other Federal and State agencies, Tribes, other Nations, and the aquaculture industry. The FTCs developed culture techniques and fish diets now used around the world, including dehydrated long-lasting feeds that revolutionized the fish-culture industry. Results of studies conducted by FWS scientists are published in peer-reviewed journals and management recommendations are communicated within the Service and to our partners through conservation science partnerships.

- **Nutrition and Diet Development Laboratories.** These facilities allow for the manufacture of experimental larval, fingerling, and broodstock fish feeds and the testing of many different kinds of ingredients to improve fish nutrition, performance, and quality. This program also develops specialized diets for use in captive rearing of endangered fish species.

- **Physiology Laboratories**. These laboratories support conservation- and management-related needs of FWS and its partners, including, but not limited to, understanding the physiological needs of fish to support conservation and/or commercial opportunities.

- **Conservation Genetics Laboratories.** These laboratories support conservation and management related needs of FWS and its partners, including, but not limited to: (a) using genetic DNA methods to meet real-time fishery needs to conserve and manage

species; (b) assisting with Endangered Species Act status reviews and recovery planning via baseline data on genetic population structures and genetic monitoring and evaluation of listed populations and species; (c) establishing and maintaining genetic tissue/DNA repositories for imperiled species; and (d) characterizing diversity within and among wild populations.

- **Ecology Laboratories.** These laboratories focus on understanding the physiological requirements and tolerances of threatened and endangered species. Less-invasive or non-invasive tools, such as measurement of plasma sex steroids and ultrasound, are used to determine gender, stage of sexual maturity, and spawn readiness of individual fish in wild and captive populations of threatened and endangered species. These laboratories also provide contract services to federal and state agencies, universities, and NGOs for a variety of analyses employing these less-invasive tools, as well as blood chemistry analysis, histology, proximate analysis, and radio-immunoassays.

- **Fish Health Centers.** FWS's Fish Health Centers play an integral role in applied science and technical transfer. Their scientists are leaders both nationally and internationally in the diagnosis of wildlife diseases and in the science of aquatic animal health, developing and validating tests that benefit, and are adopted by, the aquaculture industry. Fish Health Centers work closely with Federal, State, Tribal, academic, and NGO partners to promote the scientific management of fisheries and aquaculture by reducing the effects of wildlife pathogens.

Aquatic Invasive Species. FWS Aquatic Invasive Species program works to prevent the transfer and introduction of exotic, introduced, non-native, and other potentially harmful species and to develop early detection and rapid response capabilities. For example, the program worked with numerous partners to develop methods for detecting minuscule amounts of free-floating DNA (environmental DNA or eDNA) in water samples to confirm the presence (or absence) of species at levels undetectable by traditional sampling methods. This innovative technology is now being applied widely in monitoring programs and, as it continues to be further developed and refined, will significantly benefit both FWS programs and partners by allowing earlier detections of invasive species.

FAC is also applying rapid screening tools it has developed to help determine a species' risk for invasion. Knowledge of both low- and high-risk species will help industry, states, and consumers make responsible choices about which species to acquire and use. In addition, these tools will help state agencies make decisions on potentially invasive species and work with industry to manage risky species in their jurisdictions. For example, Michigan's Public Act 537, established new protections to minimize the risk of invasive species that require, among other things, the use of the Service's risk assessment protocol.

VII. Office of Surface Mining Reclamation and Enforcement

The Office of Surface Mining Reclamation and Enforcement (OSMRE) is responsible for ensuring, through a nationwide regulatory program, that coal mining is conducted in a manner

that protects communities and the environment, restores the land to beneficial use following mining, and mitigates the effects of past mining by aggressively pursuing reclamation of abandoned mine lands. OSMRE achieves this in part by providing technical assistance based on sound science, and training to its State and Tribal partners to enhance their ability to maintain effective programs.

The goals that underlie OSMRE's Technology Development and Transfer program include: (a) increasing the technical knowledge of the reclamation of active and abandoned coal mines; (b) developing and enhancing working relationships among the bureau's partners in Federal, State, and tribal governments, and industry and academia; and (c) leveraging its resources through partnerships. OSMRE accomplishes these goals via the Technical Innovation and Professional Services (TIPS) program, the National Technical Training Program (NTTP), and the National Technology Transfer Team (NTTT).

Technical Innovation and Professional Services (TIPS). The goal of TIPS is to provide State, Tribal, and OSMRE personnel with a comprehensive set of analytical tools to aid in technical decision-making related to regulatory and reclamation processes. The services provided are centered around off-the-shelf scientific and engineering computer software and technical hardware supported by OSMRE in partnership with the states and tribes. TIPS hardware is available for loan to SMCRA states and Tribes to advance reclamation projects nationwide.

TIPS is a national program that continues to research and apply emerging technologies to SMCRA workflows. Currently, TIPS assistance includes providing commercial software applications and hardware to State, Tribal, and OSMRE offices at considerable cost savings by sharing the commercial licenses for 28 commercially available software applications via the Internet and OSMRE Wide Area Network. These software applications cover a wide range of regulatory and abandoned mine lands (AML) subjects. The customer base covers over 90 State, Tribal and OSMRE office locations throughout the country – about 2,000 users.

The TIPS suite of scientific, hydrologic, and mapping core software aids the technical decision-making associated with a wide variety of tasks that surface mining agencies have to perform regularly: (1) conducting reviews of permits, (2) performing cumulative hydrologic impact assessments, (3) quantifying potential effects of coal mining, (4) preventing acid mine drainage, (5) quantifying subsidence impacts, (6) measuring revegetation success, (7) assisting in the design of abandoned mine lands projects, and (8) providing the scientific basis for environmental assessments and environmental impact statements.

Demand for TIPS tools and support continues to increase, especially in geospatial data, and mobile computing tools for field use. TIPS is offering more on-site training to accommodate the use of mobile computing devices by inspectors. Mobile computing increases efficiency in resolving issues with primacy state staff and industry. TIPS software users in states, tribes and OSMRE logged over 70,000 TIPS core software sessions in FY 2017, aiding the permitting process and abandoned mine land reclamation.

In addition, the TIPS program continues to develop and enhance the GeoMine Web Application, and conduct training programs using the software and TIPs tools provided to the State, Tribal,

and Federal offices to ensure that all agencies with SMCRA responsibilities are using the same advanced software and hardware tools to conduct the business required by the Act. These activities are discussed in more detail below.

- GeoMine Web Application: The GeoMine Web Application, which was developed by OSMRE in collaboration with the Fish and Wildlife Service, Environmental Protection Agency, Army Corps of Engineers, and coal mining regulatory authorities in Kentucky, Tennessee, Virginia, and West Virginia, is an interactive web-based digital map of coal mining and reclamation activities in the United States. GeoMine supports decision-making associated with surface coal mining activities by improving accessibility to data, improving the timely delivery of authoritative information, and enhancing understanding and visualization of geospatial data at various scales. It also helps mines comply with the requirements of SMCRA, the Clean Water Act (CWA) and the Endangered Species Act (ESA). The application displays geospatial data that is already publicly available from each contributing coal-producing State and Tribe nationwide. The data is also linked to the national Geoplatform making data easily searchable and integrated with data published by other agencies. This transparency allows the public to better understand the impacts of both coal mining and reclamation activities. The OSMRE also continued digitizing mine boundary maps in the western United States through various AmeriCorps programs, including the Environmental Stewards Program, as well as college students from OSMRE's Mid-Continent and Western Regions.

- TIPS Training Program: The TIPS Training Program is a collaborative effort among OSMRE, states, and tribes. Course developers and instructors are reclamation experts who use TIPS software to solve a wide-range of complex permitting, enforcement and abandoned mine land problems. Although most of TIPS tools are off-the-shelf applications, TIPS training is tailored exclusively to mining and reclamation uses. TIPS courses are delivered on-site at the customer's request, and in training centers located in OSMRE's Regional Offices: Denver, Colorado; Alton, Illinois; and Pittsburgh, Pennsylvania.

  In FY 2017, the TIPS training program received a customer satisfaction rating of 99 percent, meeting the annual GPRA goal. Thirty instructor-led classes were held in FY 2017 with 377 students completing class sessions. Additionally, seven students attended two on-line self-study training classes sponsored by TIPS, bringing the FY 2017 total to 384 students. Three of the 30 on-site training classes were conducted at state office locations to meet the specific training needs of particular groups of students throughout the SMCRA community. In FY 2018, TIPS plans to hold 28 instructor-led, classes (including three state office special sessions in Ship Rock, Arizona, Virginia, and West Virginia), and three on-line training classes.

  While many TIPS courses are facilitated by an instructor in a traditional classroom, the TIPS Training Program continues to actively expand online opportunities and provide "just-in-time" training resources for its customers. Over 100 online courses are available through the TIPS Virtual Campus and ESRI for GIS modeling and mapping. TIPS utilizes its Virtual Campus and continues to educate instructors on techniques to teach in an on-line environment.

National Technical Training Program (NTTP). Established in 1985, NTTP is an ongoing training program designed to aid the bureau's mission by increasing the technical competence and professionalism of State, Tribal and OSMRE regulatory and reclamation staff. The NTTP provides comprehensive training in the skills needed to carry out the mandates of SMCRA. The entire program, from identification of training needs through course development and presentation, is a cooperative effort between State, Tribal, and OSMRE offices. The NTTP utilized 160 subject matter expert instructors (mostly volunteers) from State, Tribal, and OSMRE offices in FY 2017, to teach classes. The instructors are experts in mining regulatory and reclamation practices who keep abreast of changing technologies, evolving methodologies, and policies to ensure the training reflects the best protection and land restoration practices.

In FY 2017, NTTP trained 696 students from State, Tribal and OSMRE programs. It offered 39 training sessions covering technical, legal, and programmatic subjects ranging from best practices and technologies to protect society and the environment from the adverse effects of surface and underground mining to methods to restore land use capabilities. The course subjects are, where possible, tailored to conditions and characteristics specific to each mining region, and offered in or near those regions. Course subjects include a wide variety of technical areas for a variety of practical applications including design of abandoned mine land restoration, proper inspection tools and techniques, soils and revegetation, identification and handling of acid/toxic forming materials, water quality assessment, legal aspects of enforcement procedures, and preparation of evidence and testimony. In FY 2017, the program achieved an overall effectiveness rating of 93 percent, based on student and supervisor responses regarding the value of the training in their current positions.

National Technology Transfer Team. The OSMRE National Technology Transfer Team (NTTT) brings together members of OSMRE, State, and Tribal SMCRA programs, as well as representatives from the Interstate Mining Compact Commission, and the National Association of Abandoned Mine Land Programs in order to coordinate understanding of mining related issues across the country. The team manages and promotes the Applied Science Program, whose goal is to develop and demonstrate improved technologies to address environmental issues related to the mining of coal and the reclamation of the land after mining. The program has accomplished this by funding studies by universities, non-profit organizations, and SMCRA Regulatory Authorities covering topics such as coal mine reclamation, revegetation, blasting, hydrology, coal mine voids and fires, soil productivity, acid mine drainage, and other topics relevant to environmentally responsible mining and reclamation. The Applied Science Program had 21ongoing projects at the beginning of FY 2017, of which 2 were completed during that fiscal year. Seven Technical Investigations funded in FY 2015 are on track to be completed in FY 2018 and twelve Applied Science projects funded in FY 2016 are on track to be completed in FY 2019. Reports on these projects and investigations are available at: https://www.osmre.gov/programs/tdt/appliedscience/projects.shtm.

The team also hosts and participates in technology transfer activities such as workshops, forums, and symposia, in order to collaborate with partners outside the SMCRA community. This aspect of the team's activities is currently being expanded to take advantage of newer web-based

options, such as webinars, and YouTube, and of social media, such as Twitter, Facebook, Instagram and Snapchat.

VIII. National Park Service

As part of its mission, the National Park Service (NPS) actively manages the natural, cultural and historical resources entrusted to it. This management includes preserving and maintaining these resources and, where necessary, preventing impairment, mitigating adverse impacts, or restoring these resources. The vast majority of these activities are undertaken at the level of each individual park unit, but service-wide networks, programs, and centers make related scientific contributions in areas, such as inventory and monitoring, and preservation technology.

Scientific activities within the NPS focus on improving the understanding and management of park natural and cultural resources. In cooperation with partners, the NPS also works to preserve and interpret similar resources outside parks. The information generated by these activities is shared with park managers and stakeholders, including public and private land managers, as well as the broader public, largely through interpretive programs, exhibits, conferences, meetings, training, and standard publication media such as reports, newspapers, journals, magazines, fact sheets, and webpage postings.

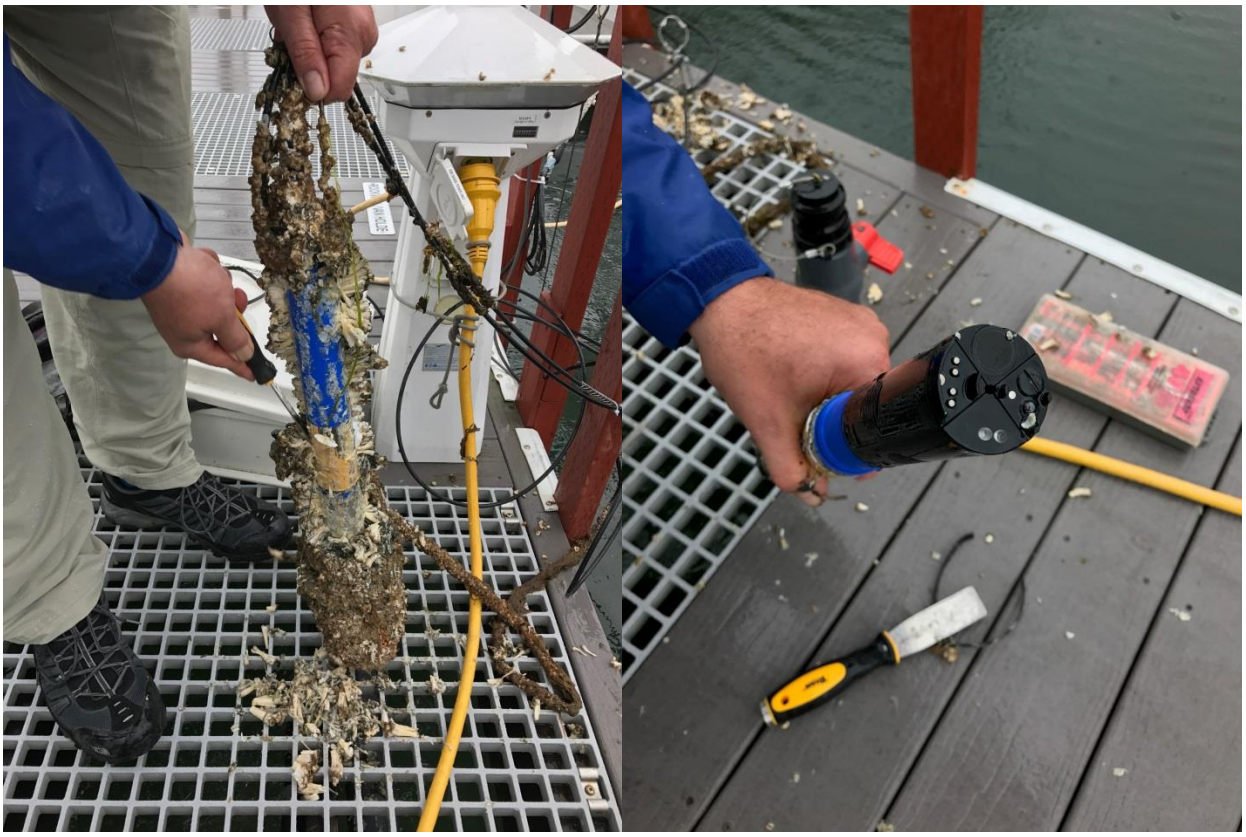
In order to expand the range of expertise and tools available to it, the NPS participates in many collaborative ventures with universities and other governmental and non-governmental organizations, including the Cooperative Ecosystem Studies Unit Network.

The NPS Cultural Programs include the National Center for Preservation Technology and Training (NCPTT), which was created by Congress to fill a fundamental need for research and technology transfer among Federal, State, and local historic preservation programs. The NCPTT serves as a research and development laboratory for historic preservation and advances the application of science and technology to preservation problems. The NCPTT also supports applied research, partners with professional and scientific organizations, publishes technical guidance for preservation professionals, and trains students and practitioners in the latest preservation techniques.

The NPS also encourages qualified scientists to undertake research on parks' physical, biological, and other resources under the aegis of park Scientific Research and Collecting Permits and other permits. Such permits are issued for scientific and educational purposes only. The collected specimens and other materials and components of such specimens and materials may not be used for commercial or other revenue-generating purposes. Parties proposing commercial use of research results must enter into an agreement to share benefits with the NPS or an agreement in which the NPS explicitly declines to share benefits. In accordance with the National Parks Omnibus Management Act of 1998, which authorizes the Secretary of the Interior to enter into negotiations with the research community and private industry for equitable, efficient benefits-sharing arrangements, the NPS has developed policies and procedures to implement benefits sharing. For each benefits-sharing agreement, the NPS proposes to choose an applicable agreement type from among several available authorities. The CRADA,

authorized by the FTTA, is one such option. For further information on NPS benefits sharing, see: http://www.nps.gov/applications/npspolicy/DOrders.cfm.

Device to Facilitate Water Quality Measurement in High Biofouling Environments. The Gulf Coast Inventory and Monitoring Network has a CRADA with In-Situ, Inc., to develop and test a NPS employee's invention and evaluate its potential for commercial manufacture and sale. The device enables currently available datasondes, which are used to measure water quality, to greatly increase the length of unmanned or continuous monitoring deployments in biofouling environments. It may also increase accuracy under turbulent flow conditions. The device modifies the calibration chamber of the sondes so that instrument/sensor drift, rather than water quality conditions, drives recalibration frequency requirements. By extending service intervals, this device may reduce operational costs by 50% or more.



The modified datasonde is removed from a dock on Vashon Island, Puget Sound Washington June 8, 2017. This trial, one of five in different high-fouling environments, showed that the invention can eliminate biofouling in a cold water, high biofouling marine environment. LEFT: The invention connected to an In-Situ AT600 datasonde is removed from the Puget Sound after a six-month deployment. Inventor Joe Meiman scrapes off a 2 cm thick barnacle growth that totally encapsulated the invention and datasonde. RIGHT: The sensors of the same AT600 shown at left. While the six-month exposure to the environment resulted in extreme barnacle growth, the sensors remained clean and functioning within normal ranges. [Photo credit: Joe Meiman, NPS, 2017].

In FY 2017, the CRADA partners installed the invention in five locations representing different fouling environments: warm and cold water marine biofouling, warm water marine sediment fouling, riverine sediment fouling and lacustrine biofouling. Datasondes modified by the

invention were deployed side-by-side with comparable unmodified datasondes, which were maintained at regular intervals (two to four weeks). The modified datasondes were left unattended for a minimum of six months, after which they were retrieved and evaluated for performance. The invention eliminated fouling of the sensors in four of the five tests and reduced it in the fifth test.

IX. Bureau of Reclamation

The Bureau of Reclamation (Reclamation) is a water management agency whose mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Reclamation is the largest supplier and manager of water in the 17 western States and the Nation's second largest producer of hydroelectric power. Reclamation manages water for agricultural, municipal and industrial uses, and provides flood risk reduction and recreation for millions of people. According to the Department of the Interior's Economic Report Fiscal Year 2016, Reclamation's activities, including recreation, contribute over $48.1 billion to the economy and support over 388,000 jobs. Reclamation owns 76 power plants and operates and maintains 53 of those plants. The 53 hydroelectric power plants account for 19 percent of the hydroelectric generating capacity in the United States. Annually, Reclamation generates 37 billion kilowatt hours of electricity, enough to supply over 3.4 million U.S. households and collects over $1 billion in gross power revenues for the Federal government.

Reclamation R&D – Reclamation's R&D is primarily focused on applications to identify and develop solutions related to the broad spectrum of water and hydropower related issues. Reclamation's Research and Development Office manages two appropriated R&D programs. The Science and Technology (S&T) Program and the Desalination and Water Purification Research (DWPR). The S&T Program is the primary R&D program for Reclamation, and funds intramural research that spans the spectrum of water and water related resources challenges. The program also enlists crowd-sourced innovation via technology prize competitions addressing some of Reclamation's most difficult challenges in infrastructure, water availability, and environmental compliance. S&T Program goals are to identify and develop cost effective solutions to the technical and scientific problems affecting accomplishment of Reclamation's mission and to communicate those solutions to Reclamation offices, its stakeholders, other water and power management officials, and the general public. The DWPR Program invests in extramural R&D that advances the capabilities of water treatment technologies to enable them to be used more broadly for the creation of new water supplies. Such new supplies can relieve water stress on Western communities, Tribes, Western river basins supporting Reclamation projects, and the Nation as a whole. The program also supports operation and maintenance of the Brackish Groundwater National Desalination Research Facility, which hosts federal and non-federal R&D clients conducting bench-scale studies to pilot-scale demonstrations.

Roosevelt Dam [Photo credit: Dave Walsh, Bureau of Reclamation].

Reclamation Technology Transfer – Although Reclamation's R&D focuses on water and power issues specific to the arid and variable climates characteristic of the Western U.S., the new solutions, tools, and information developed can have broad applicability regardless of location or jurisdiction. The transfer of Reclamation's technology and knowledge across the national and international communities of practice maximizes public benefits of Reclamation's R&D investments.

The majority of Reclamation's technology advancements are transferred through public dissemination via the R&D office website (www.usbr.gov/research), while others require the capabilities and know-how of the private sector to mature, mass produce and otherwise commercialize the technology into market-ready products. Reclamation's research nexus with industry is typically in the area of hydroelectric power generation, water infrastructure, water conservation, and desalination/water purification technologies. Recreation R&D Office produced 56 research reports in FY 2017.

If an industry partner is needed to ultimately transfer the technology into a market-ready product, Reclamation utilizes the authorities available under Federal technology transfer legislation to protect intellectual property, as needed, and form research and licensing partnerships with U.S. manufacturing industries. Reclamation's R&D Office implements these authorities on behalf of the bureau, and serves as the Bureau's Office of Research and Technology Applications (ORTA), as required by 15 USC § 3710(b).

Reclamation also works to create more awareness across U.S. industries and other non-governmental organizations about the specialized research resources (people, lands, and facilities) that they can access through technology transfer agreements authorized by 15 USC § 3710a. In addition to physical research laboratories, Reclamation's R&D assets include engineering and scientific expertise, and extensive water storage, water delivery and hydropower facilities that offer unsurpassed real-world laboratories for field tests, evaluations, and demonstrations of new technologies and processes related to water and hydropower. Although the majority of its R&D activities do not involve development of patents or industry involvement to mature technologies into viable products, the technology transfer activities that Reclamation conducts under the authorities of the Federal technology transfer legislation are an important subset of its technology transfer responsibilities.

Highlights of activities conducted under the Federal Technology Transfer Act during FY 2017 include the following:

Evaluate cavitation damage and turbine runner replacement costs for hydropower plants. Reclamation has entered into a Cooperative Research and Development Agreement (CRADA) with General Electric (Alstom) to evaluate cavitation, rough zone, and fatigue work at one of Reclamation's power plants. Turbine runner cavitation-erosion, excessive vibrations, and fatigue to the hydropower turbines are complex issues and add costs to the hydropower industry and its consumers. Developing new technologies and methods to detect and evaluate cavitation will provide Reclamation and other hydropower operators with better decision tools on conditions, operations, and scheduling maintenance to determine when to take a machine out of service for repairs. Such research can increase efficiency, reduce operation and maintenance costs within Reclamation's hydropower fleet, lower the cost of electricity to its consumers, and help improve hydropower generation worldwide.

Reclamation's contributions to the CRADA (in-kind funds provided by both Grand Coulee Power plant and the Science and Technology Program) include expertise on past cavitation research techniques, research expertise, Operation & Maintenance expertise, and the use of Reclamation's Grand Coulee facilities. GE's contributions include background intellectual property, market insight, research expertise, and specialized experience of a major hydropower manufacturer.

Testing New Technologies for Hydropower Generation Applications. Since approximately 85 percent of power is generated by thermal and other non-hydro power generation methods, industry is primarily focused on developing and supplying power generation technologies and equipment that are designed specifically for non-hydropower generation applications. As such, Reclamation commonly tries to determine if such technologies and equipment are suitable, or can be modified, for hydropower generation applications. Reclamation is using its in-house developed Hardware-in-the-loop Generator Simulator to test manufacturers speed governor, voltage regulator, and power system stabilizer controllers.

In FY 2017, Reclamation entered into Material Transfer Agreements (MTAs) to receive and test power generation equipment including digital excitation controllers, digital power system stabilizers, and three phase power bridges. These systems were developed by U.S. hydropower manufacturers including Andritz Hydro, L&S Electric, Inc., and Schneider Electric Systems, Inc. Under the MTAs, Reclamation conducted tests to determine their suitability for hydropower generation applications and provided each manufacturer with a report stating what tests were performed and whether or not the tests passed or failed.

The MTAs help Reclamation prepare and adapt manufactures' equipment to work properly prior to their installation in hydro facilities. This reduces both engineering time needed to commission the equipment, and lost revenues caused by longer generator outages.

The MTAs have also allowed hydropower manufacturers to gain insights on the feasibility and requirements to manufacture and market their products to the global hydropower generation community. They also gained access to Reclamation's technical expertise and laboratory facilities not readily available in the private sector that are able to test and evaluate technologies for hydropower applications. As one manufacturer put it: "This is like the real power plant environment but without the stress and pressure of commissioning/testing our system on the real

generator!" Another manufacturer noted, "Even though our system has undergone rigorous testing by many experts, the Reclamation Hardware-in-the-Loop generator simulator has enabled us to find and resolve some unknown issues with our system before releasing it to the customers!"

Evaluate impacts of hydrokinetic energy to canal operation and infrastructure. In FY 2017, Reclamation and Denver Water entered into a CRADA to evaluate hydrokinetic energy (HK) performance and impacts to canal operation and infrastructure.

HK energy is a renewable energy resource that obtains energy from moving water in open channel systems. Reclamation has over 1,600 miles of canals and is interested in understanding this resource and its impacts on existing canal operation and infrastructure.

A pilot field demonstration is being conducted with Denver Water to install HK turbines in the South Boulder Canal. If the proposed HK technology proves effective with minimal impacts to canal systems, it may provide another source of renewable energy for canal owners, including Reclamation.

Reclamation's contributions to the CRADA include technical expertise on collecting and analyzing data of hydraulic impacts to canal operation. Denver Water's contributions include providing a test site at the South Boulder Canal for installing and testing HK devices, materials and equipment, and technical expertise in evaluating HK performance.

HK technologies installed at South Boulder Canal. [Photo credit: Reclamation, Josh Mortensen.]

X. Bureau of Safety and Environmental Enforcement

The Bureau of Safety and Environmental Enforcement (BSEE) works to promote safety, protect the environment, and conserve resources offshore through vigorous regulatory oversight and enforcement. BSEE's R&D focus is on offshore operational oil, gas, and renewable energy issues.

Within BSEE, the Office of Offshore Regulatory Programs (OORP) develops standards and regulations to enhance operational safety and environmental protection for the exploration, development, and production of offshore oil and natural gas on the U.S. Outer Continental Shelf (OCS). OORP conducts standards research, inspection policy evaluations, technology risk analysis, and data interpretations to manage compliance programs governing oil, gas, and mineral operations on the OCS.

The Oil Spill Preparedness Division (OSPD) is responsible for developing standards and guidelines to ensure that offshore operators are prepared to respond to an offshore oil spill. It also ensures their Oil Spill Response Plans comply with regulatory requirements. OSPD plays a critical role in the review and creation of policy, guidance, direction and oversight of activities related to the agency's role in ensuring industry's preparedness for oil spill response. The Division oversees the Oil Spill Response Research (OSRR) program, and works closely with sister agencies, such as the U.S. Coast Guard, the National Oceanic and Atmospheric Administration, and Environmental Protection Agency to continually enhance response technologies and capabilities.

BSEE R&D programs operate through OORP's Emerging Technologies Branch (ETB), and OSPD's Response Research Branch (RRB). The ETB, established in 2012 to replace the Technology Assessment and Research (TA&R) group, is the agency's focal point on operational safety and pollution prevention research. It also helps ensure that industry's OCS operations incorporate the use of Best Available and Safest Technologies (BAST), as required in the 1978 Outer Continental Shelf Lands Act amendments. OSPD's Oil Spill Response Research (OSRR) program was established through the Oil Pollution Act of 1990 to research oil spill response technology and operational techniques. OSPD also operates the Ohmsett Facility in Leonardo, NJ, which serves as the National Oil Spill Response Research and Renewable Energy Test Facility. The Ohmsett facility is available to provide independent and objective performance testing of full-scale oil spill response equipment and marine renewable energy devices. Additionally, the facility is available to help improve existing technologies through research and development.

The majority of the bureau's technology advances are transferred through public dissemination. In addition to making the final reports of research projects publicly available on its website, BSEE also makes its research results available via conferences such as the annual Clean Gulf Conference, and other fora, such as the Pacific States-British Columbia Oil Spill Task Force Annual Meeting and the Ocean Energy Safety Institute's Public Research Forum.

BSEE's primary research synergy is with state, federal, and international government organizations; the oil/gas and renewable energy industries; and oil spill response organizations. It is typically in the area of ensuring that the best available and safest technology is used on the US OCS and the best available science is utilized in regulatory decision making. Additional information and research deliverables are available at: https://www.bsee.gov/what-we-do/research/tap and https://www.bsee.gov/what-we-do/oil-spill-preparedness/oil-spill-response-research.

BSEE is a member of the International Committee on Regulatory Authority Research and Development (ICRARD), which focuses on transferring knowledge worldwide between governmental entities in the area of health, safety, and environment in the petroleum sector. Although membership is only available to government entities, ICRARD cooperates with industry to coordinate and transfer technology.

BSEE is also a member of the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR). Comprised of 15 Federal agencies, ICCOPR was established as part of the Oil Pollution Act of 1990 to "coordinate a comprehensive program of oil pollution research, technology development, and demonstration among the Federal agencies, in cooperation and coordination with industry, universities, research institutions, state governments, and other nations, as appropriate."

BSEE is a member of the International Regulators' Forum (IRF). This organization consists of ten member international countries, whose goal it is to provide leadership on safety and safety-related regulatory matters for offshore oil and gas activities. Norway, Canada, Brazil, and the U.K. are some of the other members.

The following are examples of publicly available research projects, completed or ongoing, in FY 2017, which would, among other things, advance technological options and transfer knowledge about best technological practices to industries and regulators operating on the OCS.

The combined sensors mounted on a tripod to be placed underwater with a video camera and underwater control computer. [Photo credit: BSEE]

Oil Leak Detections with a Combined Fluorescence Polarization Instrument and a Wide Band Multi-Beam Sonar: This project developed and tested a prototype sensor that integrated two partial solutions (fluorescence and sonar) with a goal to operate at a suitable standoff distance, interrogate a wide area, and provide real-time data feed from the subsea environment. A combined telescopic fluorescence instrument and a wide band multi-beam sonar (WBMS) were developed as dual sensors for detecting underwater oil leaks and plumes. The fluorescence instrument responds only to materials showing fluorescence polarization, and therefore is able to distinguish oil from other fluorescing species in water. The WBMS is as an acoustic sensor that provides 2D as well as 3D topology for mapping and water column imagery. The integration of the two sensors resulted in a more definitive identification and mapping of oil in the water column in time and space. Evaluations of the integrated sensors were done in a test pool as well as in open water. Results showed that the

combined sensors are very effective in detecting and identifying oil plume in the water column. This technology is aimed at improving real-time data to inform responders during an oil spill.

Tagging of Oil under Ice-Phase II: Ice Floe Tracking System: This project is to enhance the capabilities of the previously developed Lamb-wave Detection Geo-Referencing Identification and Satellite (LDGRIDSAT) tag and Underwater Identification (UWID). The first generation tags were developed to relay latitude and longitude and were designed to minimize power consumption and have a robust and environmental suitable casing. This project will increase the tags' capabilities to relay meteorological conditions and increase the operational range. During an oil spill response, this information is essential to the incident command post and their efforts in coordinating appropriate measures to mitigate the oil spill. These second generation LDGRIDSAT and UWID tags will be deployed under an ice flow off the coast of Barrow, AK, in March 2018. If the field test is successful, this technology will have demonstrated a technology readiness level of 8 (out of 9) for oil spill response.

Deploying LDGRIDSAT tag from helicopter. [Photo credit: BSEE].

Composite Repair Guideline Document for nonmetallic Repairs for Offshore Applications is a study jointly funded by BSEE and the U.S. Department of Transportation, Hazardous Materials Safety Administration (PHMSA). Composite repair technologies are used extensively to repair onshore and offshore pipeline systems around the world. During the course of this study, Stress Inc. evaluated the use of composite repair technologies for reinforcing offshore pipelines and risers, as well as onshore pipelines with the objective to develop industry-specific guidance for BSEE and PHMSA for the repair of offshore and onshore pipelines. A series of workshops involving key stakeholders (i.e. regulators, operators, and service companies) was also undertaken to solicit input, and deliver project findings. The guidance was focused on the design, implementation, installation, quality control, and monitoring of onshore and offshore pipelines. This study provides the foundation for any future regulations, Notice to Lessees and/or policy guidelines that may be developed by BSEE concerning the use of composite wrap repairs for OCS operations in all regions.

The study included fabrication of pipeline samples, subjecting them to simulated seawater under cyclic thermal and pressure loading, repairing the samples using commercially available composite systems. The repairs were tested using a 10,000-hr pressure hold and 90-day ultra violet (UV) exposure, cyclic thermal loading, cyclic pressure, burst, axial tension, and bending tests. The study indicated that installation techniques should be verified as part of the protocol for offshore/subsea qualification. The study also indicated that additional verification should be

required to confidently use a composite repair inspection technology as part of an integrity management program.

Photograph of samples after completion of 10,000 hour hold. [Photo credits: BSEE]

Study of High Pressure High Temperature Zones in the Gulf of Mexico: Reliable information about high pressure/high temperature (HPHT) zones in exploration wells is critical to the oil and gas (O&G) industry. BSEE receives information from all wells drilled in the Gulf of Mexico (GOM) OCS, but this data is not available to the entire industry. In this study, using data collected from 2000 to 2016, pressure and temperature data were evaluated for wells drilled at shallow and deep water depths. Predictive models were developed using regression analysis to determine pressure and temperature at various formation depths in the GOM. The study was prepared by Tetrahedron Inc. Its adopted methodology, including all equations and charts depicting HPHT at several depth intervals, was shared with the O&G industry on July 2017. The study has identified 464 HPHT wells in deepwater (water depths ≥1,000 ft.) out of 1,457 wells and 203 HPHT wells in shallow waters (water depths <1,000 ft.) out of 3,818 wells. The study showed that both formation pressure and temperature increase faster in shallow than in deep waters. This is due to the effect of water temperature, which decreases with depth, and water density, which is smaller than formation density. The results indicated the methodology does a more-than-adequate job in estimating pressure at various subsea depths.

XI. Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) manages the Nation's offshore energy and mineral resources in an environmentally and economically responsible way. It ensures access to and fair return for conventional and renewable energy and mineral resources of the OCS to help meet the energy demands and mineral needs of the Nation while also balancing such access with the protection of the human, marine, and coastal environments.

As the Nation's offshore energy and mineral resource manager, BOEM is committed to using the best available science across a range of relevant disciplines that provide the scientific and technical foundation and the human capital needed to make sound decisions at all levels of the organization. Management of the energy and mineral resources of the OCS is governed by the OCS Lands Act, which establishes procedures for leasing, exploration, and development and production of those resources, including oil, gas, offshore renewable energy, and marine minerals such as sand and gravel used for coastal restoration projects.

BOEM's Office of Environmental Programs (http://www.boem.gov/Environmental-Stewardship/) conducts environmental reviews, including National Environmental Policy Act (NEPA) analyses and compliance documents for each major stage of energy development planning. These analyses inform BOEM's decisions on its National OCS Oil and Gas Leasing Program as well as a variety of other conventional and renewable energy leasing and development activities. Additionally, BOEM's scientists conduct and oversee environmental studies to help make the best policy decisions relating to management of energy and marine mineral resources on the OCS through its Environmental Studies Program (ESP).

BOEM's three regional offices, strategically located in New Orleans, Louisiana, Camarillo, California, and Anchorage, Alaska, manage oil and gas resource evaluations, environmental studies and assessments, leasing activities, including the review of plans for exploration, development and production, fair market value determinations, and geological and geophysical permitting.

BOEM Environmental Studies Program

BOEM's Environmental Studies Program strives to apply the best science available for informed decision-making. It plans, conducts and oversees world-class scientific research to inform policy decisions regarding leasing and development of OCS energy and mineral resources. BOEM works to manage the exploration and development of the Nation's offshore resources in a way that appropriately balances economic growth, energy development, and environmental protection through oil and gas leases, renewable energy development, and environmental reviews and studies. BOEM's environmental studies cover a broad range of disciplines including archaeological resource protection, physical oceanography, meteorology and air sciences, biology, protected species, social sciences and economics, submerged cultural resources evaluation, and the overall environmental effects of energy development. BOEM continues to be a leading contributor to the growing body of scientific knowledge about the Nation's marine and coastal environment.

BOEM oversees scientific research conducted through contracts, partnerships with other governmental bureaus, cooperative agreements with State institutions or universities and interagency agreements. These arrangements enable the Bureau to leverage resources, meet national priorities and satisfy common needs for robust scientific information. Many of the Bureau's studies are collaborations with partners under the umbrella of the National Oceanographic Partnership Program.

BOEM Technology Transfer

BOEM's technology transfer activities include the dissemination of information, knowledge and technologies to the various regions, and to commercial entities and other stakeholders with interests in the OCS. Virtually all these activities are undertaken using authorities provided to the BOEM other than the Federal Technology Transfer Act of 1986 (FTTA). In fact, BOEM has only one Collaborative Research and Development Agreement (CRADA) that relies on that Act. This multi-bureau CRADA, developed collaboratively with USGS and FWS with Bird Studies Canada (BSC), an international non-profit entity, enables DOI bureaus to formally participate in a cross continent wildlife tracking system known as the Motus system. Studies undertaken by or through funding from BOEM are available to the public through the Environmental Studies Program Information System (ESPIS), and technical summaries of more than 700 BOEM-sponsored environmental research projects, as well as copies of more than 2,000 research reports, are available for online full text search (http://www.boem.gov/studies).

BOEM also partners with BSEE to select and fund research into renewable energy to facilitate industry development, and promote operational safety and pollution prevention through BSEE's Technology Assessment Program. More information on this research is available at https://www.boem.gov/Technology-Assessment/.

Many large interdisciplinary projects with funding from BOEM have included partnerships with other Federal agencies and academic institutions as well as private companies directed towards offshore ecosystem studies that utilize state-of-the-art technologies such as autonomous underwater vehicle surveys, deep-water human-occupied submersibles and remotely operated vehicles. Many projects have developed innovative imaging technologies and digital analysis techniques for establishing long-term biological monitoring stations in deep water. These partnership studies have leveraged expertise and technologies to meet common management goals.

Following are a few examples of BOEM's ongoing scientific research and development activities, including some conducted in cooperation with other parties.

Passive Acoustic Monitoring: BOEM's Environmental Studies Program is deploying Passive Acoustic Monitoring (PAM) technology in the Atlantic Ocean and Gulf of Mexico (GOM) for baseline information on sound in the ocean. These include a GOM Region (GOMR)-led effort to establish long-term hydrophone (acoustic monitoring) stations in the Northern Gulf of Mexico to help characterize the underwater acoustic environment there, and the noise impacts to protected species, primarily cetaceans, that may occur due to BOEM regulated seismic, decommissioning, drilling, and vessel activity in the Gulf of Mexico Outer Continental Shelf (OCS). Similarly, BOEM's Office of Renewable Energy Programs (OREP) is gathering and analyzing PAM data

collected in close proximity to Atlantic Wind Energy Areas (WEAs) to monitor marine life and help mitigate noise produced from the construction and operation of OCS wind energy facilities in conjunction with industry's efforts and through the Real-Time Opportunity for Development of Environmental Observations (RODEO) project. Also, BOEM co-funds the Atlantic Deepwater Ecosystem Observatory Network (ADEON) project which was awarded through the National Ocean Partnership Program (NOPP), a Federally-mandated initiative that coordinates and develops collaborative ocean research efforts among Federal, state and tribal governments, academia, private industry, and non-governmental organizations. This Network aims to take measurements of both the natural and human factors active in this region to inform the ecology and soundscape of the OCS.

Developing the Next Generation of Animal Telemetry: BOEM's Headquarters Office of Environmental Programs (OEP) is working with NASA to advance the ability to monitor animal movements by leveraging NASA's network of small satellites. Effective research and monitoring require an understanding of where animals go and what they do when they go to a particular place; this is accomplished through various types of telemetry. Wildlife telemetry is a critical tool both within and external to, the federal government. However, there are limitations to today's animal telemetry technology, including lack of sufficient satellite vendors, data costs and limited spatial coverage. By partnering with NASA, BOEM is working to reduce these limitations and facilitate a common communications network for space-based monitoring, improving data accessibility and cost efficiency for energy development across public and private sectors.

Spatial and Acoustic Ecology of Pelagic Megavertebrates: BOEM's OEP has engaged in a Cooperative Agreement via CESU partner, University of North Carolina at Wilmington, to better understand the sightings, movement and acoustic behavior of understudied marine mammals. A component of this project is improving BOEM's ability to receive data from ocean users and disseminate important information to industry. This network, tentatively known as OceanSmart, will involve partnership with industry to disseminate and receive spatial data paving the way for improved situational awareness for regulatory compliance.

XII. Bureau of Land Management

The Bureau of Land Management (BLM), with its extensive and complex multiple use land-management mission across 245 million surface and 700 million sub-surface acres, manages 1 in every 10 acres of land in the United States. The BLM's multiple-use and sustained yield mandate, set forth in the Federal Land Policy and Management Act of 1976, directs it to manage America's public land resources for a variety of uses, such as energy and minerals development, livestock grazing, recreation, and timber harvesting, while also protecting a wide array of natural, cultural, and historical resources for the use and enjoyment of present and future generations. BLM works with partners to promote multiple uses of those lands through shared conservation stewardship and to facilitate opportunities for energy development that create jobs, help support local communities, and establish America's energy dominance. In fiscal year 2016, the diverse activities authorized on BLM-managed lands generated $75 billion in economic output throughout the country—more than any other agency within the Department of the

Interior. This economic activity supported 372,000 jobs and also contributed substantial revenue to the U.S. Treasury and state governments, mostly through royalties on minerals.

The BLM regularly gathers, maintains, and publishes various types of data to inform stakeholders and the general public about its stewardship responsibilities. This data includes detailed information on the commercial uses of the public lands (such as energy development, livestock grazing, mining, and timber harvesting); recreational activities; revenues from these activities; wild horse and burro management, including figures relating to on-range herd populations, removals from the range, and national adoption figures; cadastral (mapping) surveys; conservation of rangeland resources and more than 870 special units, such as wilderness areas, that are part of the BLM's 32 million-acre National Conservation Lands system; and the socio-economic impacts of public land management.

Examples of FY 2017 technology transfer activities include the following bureau-wide and program-specific efforts:

Maintaining and Publishing Quality Land Management Data: The BLM compiles, maintains and publishes approximately 20 sets of national data. These include the national Public Land Survey System (PLSS), and detailed information on BLM Administrative Unit Boundaries, Surface Management Agency, Grazing Allotments, and Wild Horse and Burro Herd Areas, among others. The PLSS data set is used, maintained and published in partnership with other federal agencies as well as tribal, state and local governments. The Western Governors' Association (WGA) recognizes the published PLSS data set (also referred to as Cadastral National Spatial Data Infrastructure CadNSDI), land record modernization and cadastral data as "… critical for maintaining livable communities, encouraging economic development and developing tools that give community leaders the ability to manage both." The states of Utah and Montana host PLSS data on their web sites for publication and distribution and the data is used by the Bureau of Census to standardize the mapping of state, county and other jurisdictional boundaries. This PLSS data set also serves as the basis for automating the mapping of land transactions such as oil and gas leasing, permitting, timber sales and the withdrawal of lands for military use or preservation.

In coordination with partners, the BLM conducted and released a landscape-scale assessment of the San Luis Valley of Colorado to inform mitigation strategies for solar energy development that is ongoing through a concurrent Solar Regional Mitigation Strategy (SRMS) development process. Although this assessment was prepared with focus on mitigation planning for utility-scale solar energy development, the assessment is intended to have applicability to other resource and conservation issues and future land management decisions. It is anticipated that this assessment will inform other BLM land use planning activities in the region (e.g., Rio Grande del Norte National Monument planning efforts). The results, including geospatial data, maps and models are available to the public on the Landscape Approach Data Portal, a portal for geospatial data, maps, models and reports produced by BLM's landscape initiatives including the Assessment, Inventory & Monitoring (AIM) strategy, BLM National Data, Fire & Invasives Assessment, Integrated Rangeland Fire Management Strategy, and Rapid Ecoregional Assessments (REAs). In 2017, the BLM collaborated with partners to develop an online tool called SAGE Viewer to disseminate science and data to the public regarding the 2015 BLM

sage-grouse land use plan amendments. Access to these data and documents is provided on the Landscape Approach Data Portal and can assist with scoping, planning or prioritization of various land use activities such as energy development or habitat restoration projects.

Increased Access to and Use of Data and Information: The BLM increased public access to data and information through a variety of technologies and applications, including the BLM's Geographic Information System (GIS) Transformation Project, Landscape Approach Data Portal; BLM Navigator, a one-stop shop for keyword and geospatial search of BLM data; and the BLM Library. The BLM Library, located at the National Operations Center in Denver, exists to serve BLM employees and to assist members of the general public. It provides access to BLM's extensive library catalog, publications, journals, databases, and subject guides. In FY 2017, the library website was visited over 14,800 times by the public and about 3,000 times by BLM employees.

BLM provides data to government clearing houses, such as data.gov, recreation.gov, and data.doi.gov. These tools make it easier for the public to view, explore and acquire data that the BLM uses to help manage public lands for multiple uses such as energy development, livestock grazing, recreation and cultural resources.

The BLM is providing all of its historic and newly acquired imagery to the public via USGS-EROS. To assist people in using this information, the BLM also initiated a learning outreach effort to BLM state and field offices regarding the use of Google Earth Engine for scientific resource management. Google Earth Engine is an online architecture allowing the processing, analysis, and derivation of management products from remotely sensed imagery, and other geospatial information about BLM lands across the US. Additionally, BLM provided photogrammetric training for terrestrial and Unmanned Aerial Systems projects to a variety of constituencies including: federal agencies, non-profit organizations, universities, and K-12 student groups. These classes focus on the proper capture, processing, analysis, and use of imagery for natural and cultural resource management.

Assessment, Inventory, and Monitoring (AIM): BLM's Assessment, Inventory, and Monitoring program is working to develop aquatic and terrestrial indicators and monitoring protocols. AIM data is used to report on land health, the effectiveness of its Resource Management Plans, and conditions relative to habitat needs of sagebrush obligate species. AIM data is available through the public facing version of the Terrestrial Assessment, Inventory, and Monitoring (AIM) Database (TerrADat) which houses the terrestrial data generated by the AIM program, and is used to report on the condition of BLM lands, and by extension, some resources managed by the Bureau. Various state government agencies, such as the Nevada Department of Wildlife, Wyoming Game and Fish, and the Alaska Department of Environmental Conservation, are engaged in data collection that is compatible with AIM. AIM data is utilized by a wide variety of federal and state agencies, universities, non-governmental organizations, private industry, and the public.

BLM Partnered with Utah State University, and other federal agencies (e.g., NPS, USFS, USFWS) to support the National Aquatic Monitoring Center (NAMC). NAMC encourages and fosters scientifically sound aquatic monitoring activities on public lands. NAMC's primary foci

are the use of aquatic macroinvertebrates as bioindicators of freshwater biological integrity under the Clean Water Act and the development of scientifically defensible aquatic monitoring and assessment tools. NAMC processed over 1500 macroinvertebrate samples in FY 2017 for over a dozen state and federal agencies and supported web-based interfaces to publically serve all monitoring data. An example focus of NAMC is the identification of aquatic invasive invertebrates in efforts to document distributions and ultimately prevent their spread to uninhabited water bodies.

BLM's National Conservation Lands: BLM's National Conservation Lands division works with scientific partners and local communities to address BLM's management-focused research needs. BLM encourages scientists to perform research on National Monuments and Conservation Areas and communicate their findings to the public. All research projects performed on BLM's National Conservation Lands have a public outreach component including presentations, reports, and publications. In 2017, projects performed on National Conservation Lands with local partners and Cooperative Ecosystem Studies Units (CESU) networks included pollinator habitat studies, paleontology resources inventories, assessing wetland conditions, studying wild horse and burro demography, and testing the use of remote sensing data for rare species survey work.

Cultural Heritage and Paleontology: The BLM Cultural Heritage and Paleontology programs partner with museums, universities, and others to conduct research, inventory the public lands and learn about the location and significance of cultural and paleontological resources, manage important cultural and scientific collections of artifacts and specimens from the public lands, and share research results with the public and across research communities. In addition, BLM partners with state historic preservation offices, state geologic surveys, Indian tribes, museums, and universities, as appropriate, to facilitate research and better manage cultural and paleontological sites and locality information. The relationship is often reciprocal, with scientific data shared by BLM and partners. These partnerships address requirements of the National Historic Preservation Act of 1966, the Archaeological Resources Protection Act of 1979, and the Paleontological Resources Preservation Act of 2009.

A critical development in FY 2017 is the successful pilot of a National Cultural Resource Dataset, drawing data from state historic preservation offices on survey areas and site inventory information. This system will provide high level cultural resource data to streamline and facilitate planning for both BLM and industry land users, as well as disseminate broader scale cultural information for future research.

XIII. Conclusion

During FY 2017, the Department's technology transfer activities included:

- Publishing over 12,300 reports, books, papers, fact sheets, and other publications.
- Engaging in 841 Cooperative Research & Development Agreements (CRADAs), and at least 247 other collaborative R&D relationships.

- Executing 783 non-traditional CRADAs, i.e., technical assistance, material use and facility use agreements.
- Disclosing twelve (12) new inventions, filed five (5) new patents and received three (3) patents.
- Managing fifteen (15) active licenses for inventions and other intellectual property. Thirteen (13) of these were income-bearing and collectively earned over $50,000.

DATA APPENDIX

The following tables provide cumulative data for the Department. Data for individual bureaus are available on line at https://www.doi.gov/techtransfer/annual-reports.

Data are provided if they are collected and readily available. Note that a blank cell or N/A indicates either zero, the data is not collected, or it is otherwise unavailable. These tables include updates to previous years' data, where appropriate.

Table 1: Invention Disclosures and Patents

		FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Invention Disclosures							
1	Number of new inventions disclosed	5	10	9	6	7	8	12
	Patents							
2	Number of patent applications filed	2	3	8	4	8	4	5
3	Number of patents received	1	3	4	2	3	1	3

Table 2: Income Bearing Licenses

		FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Income Bearing Licenses							
4	Number of income bearing licenses	22	22	16	14	18	17	13
5	Exclusive licenses	3	12	4	5	7	8	7
6	Partially exclusive licenses	0	0	0	0	0	0	0
7	Non-exclusive licenses	19	10	12	9	11	9	6
	Elapsed Amount of Time for Granting Licenses							
8	Average (months)	12	12	12	12	4.5	N/A	N/A
9	Minimum (months)	12	12	12	12	2	N/A	N/A
10	Maximum (months)	12	12	12	12	8	N/A	N/A
"0" indicates that there are no incidences of a mechanism that is being used by the agency, and "N/A" that data is not available at time of report.								

Table 3: Licensing Income ($)

		FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Total income (all licenses active in FY)	114963	75975	96250	58248	105580	82997	50,090
	Total income distributed	110678	71450	91813	55690	97198	81559	49,990
	Total income from patent licenses	114963	75975	96250	58248	105580	82997	50,090
	Total income distributed	110678	71450	91813	55690	97198	81559	32,557
	Disposition of Earned Royalty Income							
17	Total amount of Earned Royalty Income received	103963	64651	96250	58248	105580	81997	50090
	Total amount of ERI distributed	110678	71450	91813	55690	97198	81559	48990
20	Licenses terminated for cause	0	0	0	0	0	0	0
"0" indicates that there are no incidences of a mechanism that is being used by the agency, and "N/A" that data is not available at time of report.								

Table 3A: License Activity

	Metric	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	Licenses, Total Active	25	26	20	18	20	22	15
	New Licenses	2	1	3	0	3	0	0
	Invention Licenses, Total Active	23	24	20	16	18	20	13
	New Invention Licenses	2	1	3	0	3	0	0
	Income Bearing Licenses, Total Active	22	22	16	15	18	17	13
	Income Bearing Exclusive Licenses	3	12	4	5	7	8	7

Table 4: CRADAs

		FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
	CRADAs							
21	Number of active CRADAs	351	379	476	601	826	873	841
22	Number of newly executed CRADAs	295	284	376	423	586	511	477
	Traditional CRADAs							
25	Active traditional CRADAs	22	28	21	35	38	37	58
26	Newly executed traditional CRADAs	13	5	2	11	12	9	13
	Non-traditional CRADAs							
27	Active non-traditional CRADAs	327	351	455	566	787	836	783
28	Newly executed non-traditional CRADAs	282	279	378	411	574	505	466
	Other collaborative R&D relationships							
	(Collaborative Agreements), total active in the FY	209	283	322	292	318	319	247
	New, executed in the FY	155	165	137	112	121	126	89
"0" indicates that there are no incidences of a mechanism that is being used by the agency.								

Frequently-Used Acronyms

AADAP	Aquatic Animal Drug Approval Program
ARS	Agricultural Research Service (within USDA)
BAST	Best Available and Safest Technologies
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CESU	Cooperative Ecosystem Studies Units
CRADA	Cooperative Research & Development Agreements
CWA	Clean Water Act
DHS	Department of Homeland Security
eDNA	environmental DNA
EPA	Environmental Protection Agency
EPM	Electron Microprobe
ESA	Endangered Species Act
ETB	Emerging Technologies Branch
FAC	Division of Fisheries and Aquatic Conservation
FEMA	Federal Emergency Management Agency
FTC	Fish Technology Center
FTTA	Federal Technology Transfer Act of 1986
FUSA	Facility Use/Service Agreement
FWS	Fish and Wildlife Service
GSA	General Service Administration
GSS	Global Security Systems
MHEP	Minority Higher Education Program
MTA	Material Transfer Agreement
NASA	National Aeronautics & Space Administration
NCPTT	National Center for Preservation Technology and Training
NCR	Natural and Cultural Resources
NCTC	National Conservation Training Center
NDRF	National Disaster Recovery Framework
NEPA	National Environmental Policy Act

NFPP	National Fish Passage Program
NGA	National Geospatial-Intelligence Agency
NGO	Non-governmental Organization
NIST	National Institute of Standards & Technology
NOAA	National Oceanic & Atmospheric Administration
NPS	National Park Service
NRF	National Response Framework
NTTP	National Technical Training Program
NTTT	National Technology Transfer Team
OCS	Outer Continental Shelf
OEPC	Office of Environmental Policy and Compliance
OPA	Office of Policy and Analysis (within USGS)
ORTA	Office of Research and Technology Applications
OSMRE	Office of Surface Mining Reclamation and Enforcement
OSPD	Oil Spill Preparedness Division
PHMSA	Pipeline and Hazardous Materials Safety Administration
R&D	Research & Development
READ	Resource Advisor
RSF	Recovery Support Function
SEM	scanning electron microscope
SMCRA	Surface Mining Control and Reclamation Act of 1977
TAA	Technical Assistance Agreement
TIPS	Technical Innovation and Professional Services
UAS	Unmanned Aerial System (or drone)
USACE	US Army Corps of Engineers
USAID	US Agency for International Development
USDA	US Department of Agriculture
USGS	United States Geological Survey