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ENGINEERING TECHNICAL SUPPORT CENTER

Annual Report Fiscal Year 2017

EPA/600/R-18/277 December 2018

Engineering Technical Support Center Annual Report Fiscal Year 2017

By

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Office of Research and Development
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Notice/Disclaimer Statement

This report is intended to inform the public, Remedial Project Managers, On-Scene Coordinators, and Superfund Technology Liaisons of progress at the Engineering Technical Support Center (ETSC)-involved sites, cutting-edge remedial technologies, and ETSC operations.

This document received Office of Research and Development (ORD) internal peer review preceding the institutional clearance process.

Disclaimer: Mention of company trade names or products does not constitute endorsement by the U.S. Environmental Protection Agency and are provided as general information only.

Foreword

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, the EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory (NRMRL) within the Office of Research and Development (ORD) is the Agency's center for investigation of technological and management approaches for preventing and reducing risks from pollution that threatens human health and the environment. The focus of NRMRL's research program is on methods and their cost effectiveness for prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites, sediments and groundwater; prevention and control of indoor air pollution; and restoration of ecosystems. NRMRL collaborates with both public and private-sector partners to foster technologies that reduce the cost of compliance and to anticipate emerging problems. NRMRL's research provides solutions to environmental problems by developing and promoting technologies that protect and improve the environment; advancing scientific and engineering information to support regulatory and policy decisions; and providing the technical support and information transfer to ensure implementation of environmental regulations and strategies at the national, state, and community levels.

This report highlights the happenings and accomplishments of the Engineering Technical Support Center in fiscal year 2017.

Cynthia Sonich-Mullin, Director

National Risk Management and Research Laboratory

Acknowledgments

The Engineering Technical Support Center (ETSC) would like to acknowledge the contributions from Office of Research and Development scientists for their efforts in support of ETSC's mission. Special recognition goes to a number of our colleagues that have recently retired—their dedication and commitment to the EPA mission has had a positive impact on the health of our environment and nation. They will be missed. The ETSC extends thanks to our numerous clients in the Office of Science Policy, Office of Land and Emergency Management, Office of Superfund Remediation and Technology Innovation, the EPA Regions, the Superfund Technology Liaisons, On-Scene Coordinators, and their management for their patronage and financial support. The ETSC would also like to recognize the exemplary support provided by our contractors, Battelle Memorial Institute and RTI International, this year. Finally, the ETSC extends special thanks to everyone that provides document reviews, responds to technical request phone calls, and provides all other manner of assistance.

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List of Acronyms

AFFF	aqueous film-forming foam
ATSDR	Agency for Toxic Substances and Disease Registry
BLM	U.S. Bureau of Land Management
CDPHE	Colorado Department of Public Health and Environment
COC	contaminants of concern
EIP	Engineering Issue Paper
EPA	U.S. Environmental Protection Agency
ERP	Air Force Environmental Restoration Program
ETSC	Engineering Technical Support Center
EVOH	ethylene vinyl alcohol
FS	Feasibility Study
FY	fiscal year
GKM	Gold King Mine
LMMD	Land and Materials Management Division
NERL	National Exposure Research Laboratory
NHDES	New Hampshire Department of Environmental Services
NPL	National Priorities List
NRMRL	National Risk Management Research Laboratory
NRRB	National Remedy Review Board
OITA	Office of International and Tribal Affairs
ORD	Office of Research and Development
OSC	On-Scene Coordinator
OU	operable unit
PCBs	polychlorinated biphenyl
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PFAS	per- and polyfluoroalkyl substances
PRP	potentially responsible party
RARE	Regional Applied Research Effort
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	record of decision
RPM	Remedial Project Manager
SCMTSC	Site Characterization and Monitoring Technical Support Center
SSE	subsurface heat-generating event
SVE	soil vapor extraction
TCE	trichloroethylene
TSC	Technical Support Center
TSP	Technical Support Project
VOC	volatile organic compound

Executive Summary

The Engineering Technical Support Center (ETSC) is operated by the U.S. Environmental Protection Agency (EPA or Agency) Office of Research and Development's (ORD) National Risk Management Research Laboratory (NRMRL), Land and Materials Management Division (LMMD) in Cincinnati, Ohio. Created in 1987, ETSC is part of the Technical Support Project (TSP), a partnership between ORD and the Office of Land and Emergency Management (formerly the Office of Solid Waste and Emergency Response). The TSP consists of a network of EPA Regional Forums, the Environmental Response Team, and five specialized Technical Support Centers (TSCs). ETSC is one of five ORD TSCs.

ETSC's mission is to provide site-specific scientific and engineering technical support to Remedial Project Managers (RPMs), On-Scene Coordinators (OSCs), and other remediation personnel at contaminated sites. ETSC is primarily staffed with scientists and engineers from ORD/NRMRL/LMMD, thereby covering a broad range of skills and technical expertise. The ETSC collaborates with EPA programs and other federal agencies to deliver the latest methods, approaches, and technologies needed to characterize, remediate, and manage risk at contaminated sites. Additional assistance is provided by other ORD Laboratory or Division personnel, EPA Regional personnel, and external contractors and consultants as needed. ETSC's combined technical expertise supplements the work performed by responsible local, EPA Regional, or national authorities, allowing them to work more quickly, efficiently, and cost effectively, while also increasing the technical experience of the remediation team.

IMPACTS OF ETSC IN 2017

ETSC provides technical support for soil, sediment, groundwater, and mining-related contamination.

In FY17, the ETSC responded to over 600 requests for support at approximately 132 sites from all 10 EPA Regions, territories (Puerto Rico) and internationally (China, Romania, and Vietnam). Over 80 percent of the site-specific requests were on the Superfund National Priorities List (NPL).

The ETSC provided critical support to 12 of 21 Superfund sites targeted for immediate, intense action. For two of these sites, West Lake Landfill in Bridgeton, Missouri and the San Jacinto River Waste Pits in Harris County, Texas, EPA proposed final remedies.

Other requests ranged from characterization, monitoring, and remediation of soil and water contamination to ecological effects resulting from chemical exposures. ETSC also provided technical advice in the areas of engineering and prototype testing, environmental and human health risk assessment, and groundwater modeling.

ETSC led or contributed to 68 disseminated products, including conference presentations, technical workshops, peer-reviewed journal articles, and other technical reports and products.

In fiscal year 2017 (FY17), ETSC responded to 625 combined technical support requests from more than 130 sites across the 10 EPA Regions, and three international sites: China, Romania, and Vietnam. Twelve of these sites are on the 2017 Administrator's list of Superfund sites requiring immediate and intense action:

- Allied Paper Inc. / Portage Creek / Kalamazoo River (R5);
- American Cyanamid Co. (R2);
- Anaconda Co. Smelter (R8);
- Anaconda Copper Mine (R9);
- Bonita Peak Mining District (R8);
- Des Moines TCE (R7);
- Diamond Alkali Co. (R2);
- L.A. Clarke & Son (R3);
- Mohawk Tannery (R1);
- San Jacinto Waste Pits (R6);
- Tar Creek, Ottawa County (R6); and
- West Lake Landfill and Bridgeton Landfill (R7).

In total, ETSC's efforts directly supported 37 states, with approximately half of requests originating in California, Idaho, Missouri, New Jersey, New York, and Washington state.

Through interdisciplinary backgrounds and expertise, ETSC staff bring creative thinking to life by applying innovative engineering research to real-world scenarios. These innovations have the potential to produce long-lasting dividends and ultimately safer, sustainable, and healthier communities. The selected projects highlighted in this report provide insight to the unique role that ETSC plays as a bridge between environmental remediation—as applied research—and innovative engineering research in ORD. Several of these requests have generated substantial results (i.e., cost savings, effective/timely remediation results, patents, etc.), while others are working toward that end.

INNOVATION

A major component of affecting meaningful remediation lies in constructing and testing new, innovative treatment technologies through pilot and field research. ETSC teams spearhead cutting-edge field research in many areas, including:

- Biochemical reactors for potential treatment options at metal-rich acid mine drainage sites;
- Evapotranspiration covers for landfills and Superfund sites to assist in remediating volatile organic compounds (VOCs) and other compounds from soil;
- Permeable reactive barrier technologies to slow or stop groundwater contaminants from escaping sites;
- Groundwater pump and treat system design and optimization;
- Spatiotemporal fate and transport groundwater modeling to evaluate existing systems or guide remedy selection;
- Beneficial use of waste materials; and
- Engineering plan design reviews to ensure efficacy of selected site treatment or remedy, and cost efficiency.

ETSC implements proven technologies when viable, including the application of in-situ solidification, thermal desorption, and in-situ chemical oxidation.

The ETSC also organizes meetings and publishes reports on significant developments in environmental engineering in the form of Engineering Issue Papers (EIPs), peer-reviewed journal publications, technical workshops, and conference presentations and posters. In FY17, ETSC contributed to 67 dissemination products and has one member on EPA's Superfund National Remedy Review Board (NRRB).

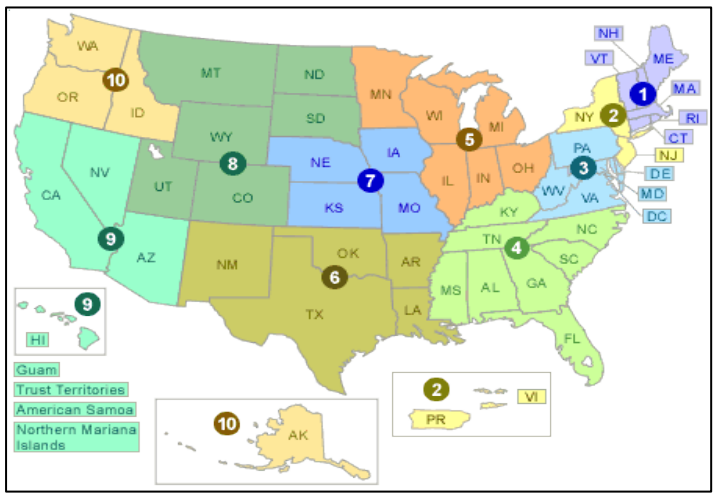
The National Impact of Our Work

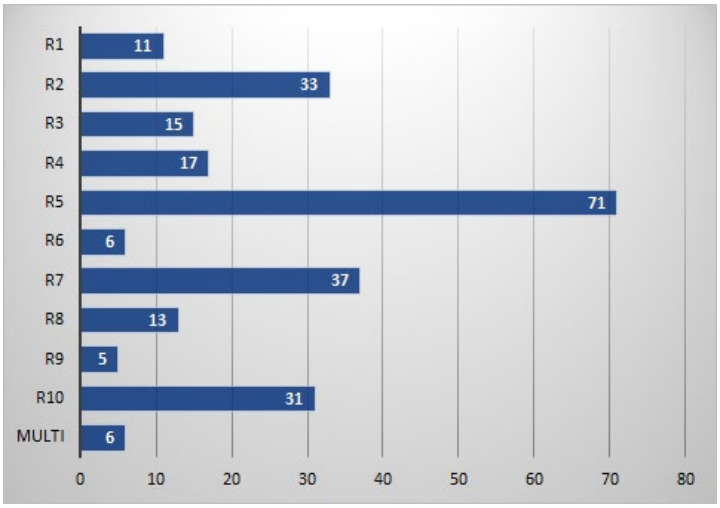
In FY17, the ETSC received 625 technical support requests across the 10 EPA Regions. Approximately 39 percent (245) of the technical requests fulfilled were related to directly supporting remediation efforts through technology review, remediation technology support, and feasibility studies at specific sites.

Sixty-one percent of the technical support requests involved the collection and interpretation of data with sampling, modeling, and analytical support.

Technical support requests in FY17 most widely relied upon the provision of technical advice, document reviews, engineering and prototype testing, and the development of knowledge products such as Engineering Issue Papers.

ETSC has provided long-term, continuous support to many high-priority Superfund sites, including 12 of the 21 sites on the EPA Administrator's 2017 list of sites requiring immediate, intense action and four of the 31 sites on the EPA's list of sites with potential for redevelopment.





In FY17, the ETSC provided technical support to all 10 EPA Regions. Most requests were from Region 5 and include dissemination activities and general technical advice that was not tied to a specific Superfund site.

ETSC provided support to 12 sites requiring immediate, intense action in FY17:

- Allied Paper Inc. / Portage Creek / Kalamazoo River (R5);
- American Cyanamid Co. (R2);
- Anaconda Co. Smelter (R8);
- Anaconda Copper Mine (R9);
- Bonita Peak Mining District (R8);
- Des Moines TCE (R7);
- Diamond Alkali Co. (R2);
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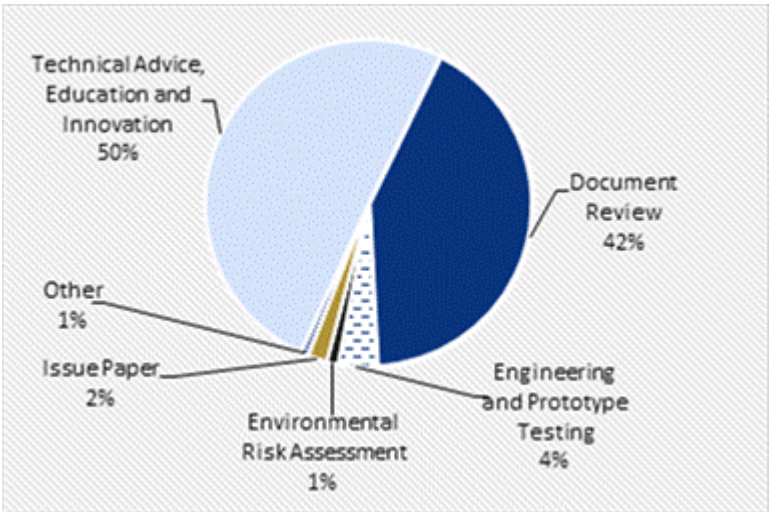
- West Lake Landfill and Bridgeton Landfill (R7).

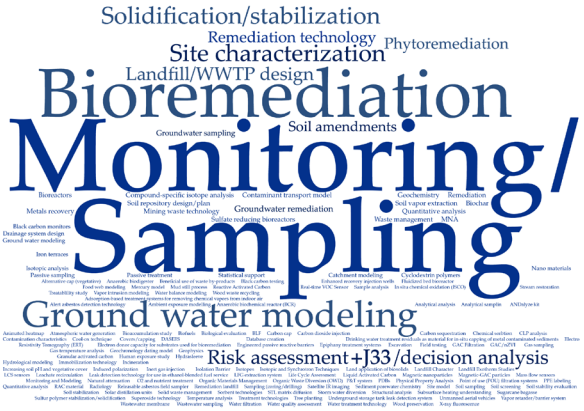


In FY17, the ETSC provided significant support towards providing technical advice, education and innovation products, and document review. Examples of this type of support range from identifying appropriate technology for COCs in various media to providing feedback on potential remedial activities at specific sites.

ETSC provided support to four sites with potential for redevelopment in FY17:

- Allied Paper, Inc./Portage Creek/Kalamazoo River (R5);
- Bunker Hill Mining & Metallurgical Complex (R10);
- Mohawk Tannery (R1); and
- New Bedford (R1).

Word cloud of the contaminants of concern (COCs) the technical support request addressed



Word cloud of most frequently used technologies to address technical support requests

ETSC provides support for many Superfund sites across the country, many of which are on the NPL. These sites include abandoned mines and legacy contamination from smelters, chemical manufacturing facilities, paper manufacturing facilities, and more. In FY17, the top 25 percent of requests dealt with PFAS, dioxin, lead, and metal contamination.

More than 160 different technologies were referenced, reviewed, or used in the support ETSC provided in FY17. Shown above are the top 40 technologies most used. The largest share of requests (14 percent) were related to monitoring and sampling of media, followed by bioremediation (9 percent), and decision support (7 percent).

International Partnerships

ETSC developed international partnerships by providing technical assistance to three countries in FY17: China, Vietnam, and Romania. In China, Ministry of Science and Technology (MOST) officials and the U.S. EPA are working on a collaborative effort to identify similar environmental issues impacting both countries to solve in parallel. Six projects are ongoing under this effort, with one of the projects a collaboration with the ETSC focused on providing additional information on metal uptake and bioavailability in sediments and soils.

In Vietnam, pesticide and dioxin contamination issues have been encountered at historic U.S. military installations. In FY14, ETSC collaborated with the Joint Advisory Committee for Vietnam, U.S. State Department, U.S. Department of Health and Human Services, the Centers for Disease Control and Prevention, and internal EPA entities, including ORD/National Exposure Research Laboratory (NERL) and the Office of International and Tribal Affairs (OITA) to provide input on evaluating and selecting the best remedial solutions for these legacy military sites. In FY17, ETSC continued the collaboration meeting with representatives from the Vietnamese government and colleagues in OITA to discuss solutions to ongoing issues and potential remedial solutions for affected sites.

In Romania, ETSC members have continued their collaborations with universities and environmental health organizations on metals contamination in mining communities, and their impacts on soil and water. This collaboration builds analytical capabilities in their country and allows open discussions regarding options for large-scale decontamination and cleanup for impacted areas.

The Impact of Our Work at Select Sites

In FY17, the ETSC received 625 technical support requests from 132 contaminated sites across the United States. The projects and technical support requests presented here highlight only a few of the many technical support requests actioned. They are organized by mining operations, materials management, highly complex site investigations, and contaminant-specific site support for polychlorinated biphenyls (PCBs), lead and per- and polyfluoroalkyl substances (PFAS) that include PFOA and PFOS. Each site highlighted includes the EPA Region the request originated from, a summary of the site, and a description of ETSC's contribution to the technical support request.

Mining Operations

Anaconda Copper Mine (Region 9)

The Anaconda Copper Mine site of Mason Valley, Nevada covers more than 3,600 acres. The site is bordered by the Singatse Range and the town of Weed Heights to the west, agricultural fields and homes to the north, U.S. Bureau of Land Management (BLM)-managed public land to the south, and the Walker River and the city of Yerington to the east. Portions of the site are privately owned, while others are BLM-managed public lands (US EPA, 2018a). Mining at the site began in 1918. From the 1950s to late 1970s, Anaconda conducted open-pit mining and milling operations, as well as copper oxide and copper sulfide ore processing. These activities created large amounts of liquid and solid wastes, such as tailing piles, waste rock areas, liquid waste ponds, leach vats, heap leach pads, and evaporation ponds. In total, the mining operations generated approximately 360 million tons of ore and debris and 15 million tons of overburden, resulting in 400 acres of waste rock, 900 acres of contaminated tailings, and 300 acres of disposal ponds. After Anaconda operations ceased in 1982 and dewatering of the pit stopped, groundwater accumulated to form the Pit Lake, a 1-mile long, 800-foot deep lake with approximately 40,000 acre-feet of water that continues to increase at a rate of 2.5 acre-feet per year.

Between 1982 and 2000, some copper extraction from tailings and waste rock as well as metal salvage and transformer recycling occurred, followed by leaching operations, and the construction of an electrowinning plant and five heap leach pads to produce copper from existing tailings and new ore. Approximately 250 acres of heap leach piles and 12 acres of heap leach solution collection ponds resulted. All operations ceased in 2000 (US EPA, 2018a).

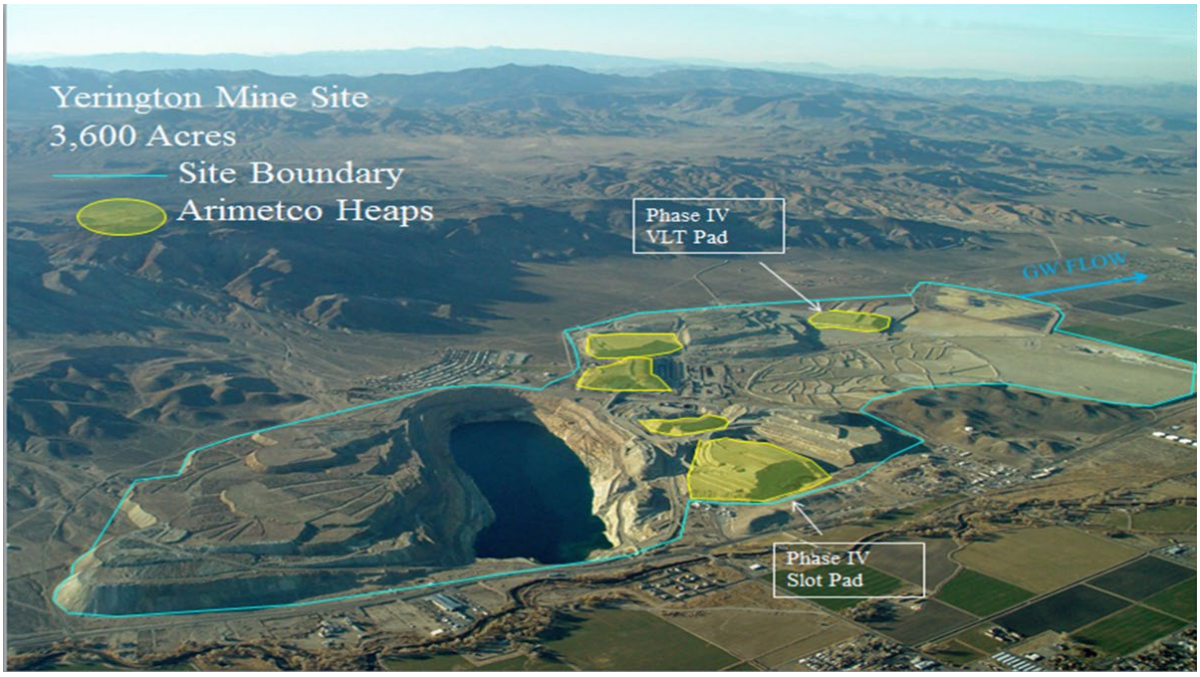
Today, the main site contaminants of concern are metals (arsenic, beryllium, boron, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, uranium, zinc) and radioisotopes (uranium-234, uranium-235, uranium-238, thorium-230, thorium-232, radium-226, radium-228) (US EPA, 2018a). EPA is in the process of proposing the site for the National Priorities List (NPL).

As early as the 1980s, an interception pumpback well system was installed to control a contaminated groundwater plume. Triggered by Yerington Paiute Tribe groundwater sampling that indicated arsenic levels exceeded EPA drinking water standards, the Nevada Department of Environmental Protection and EPA conducted an expanded site investigation in

2000. In the following years, several emergency removals were conducted at the site (US EPA, 2018a).

Between 2005 and 2011, EPA conducted remedial activities, including ordering an on- and off-site radiation survey, continued operations of the groundwater pumpback well system and heap leach fluids management system, continuation of process area investigations, domestic well sampling, and implementation of a groundwater study. More than 6,000 tons of soil contaminated with radiological materials were removed in 2010 after EPA conducted a 2007 radiological removal assessment in the process area. As a result of this assessment, several leaking heap leach fluid management ponds were either repaired or removed; kerosene-contaminated soil was removed and treated via bioremediation; evaporation ponds were capped; asbestos, radiological, and hazardous waste materials were removed; and a radiological screening assessment was conducted.

In 2017, the ETSC provided assistance to Region 9 on performing a trends analysis of groundwater data and preparing a proposal to evaluate the stability of the contaminated groundwater plume. The ETSC also addressed a request to review the Yerington Paiute Tribe's technical position with respect to the background conditions and groundwater plume stability in the site area.



The Anaconda Copper Mine Site in Yerington, Nevada consists of more than 3,600 acres. The yellow areas are heap leach pads that are undergoing cleanup. Water that drains from the mine tailings is funneled into evaporation ponds that are expected to reach full capacity by 2019, which is why Anaconda needs to be on the fast track for cleanup funding. This site is on the EPA Administrator's 2017 list for immediate action. (Figure source: UNR, 2016).

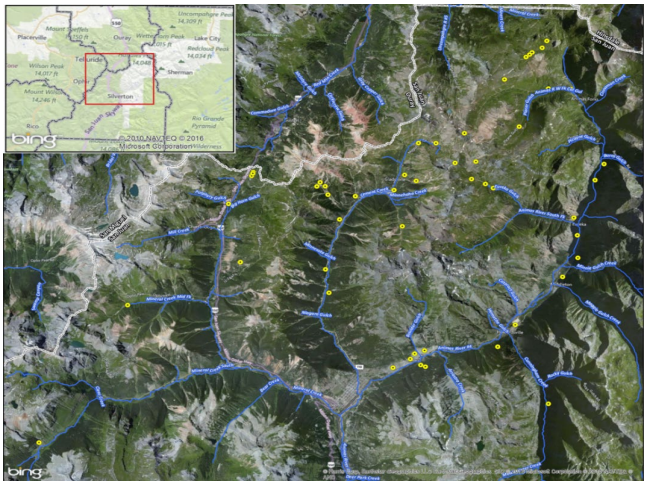
Bonita Peak Mining District (Region 8)

The Bonita Peak Mining District in San Juan County, Colorado consists of 48 historic mines or mining-related sources that release metals from acid mine drainage into the water and sediments of the Mineral Creek, Cement Creek, and Upper Animas River drainage areas (US EPA, 2018b). This site is on the EPA's list of Superfund sites targeted for immediate, intense action.

Between 2005 and 2014 EPA evaluated whether the upper Cement Creek area, which experienced a significant decline in water quality, would qualify for inclusion on the NPL. During this time, EPA's Superfund Remedial Program contributed resources for water quality sampling, ecological risk assessment, and data analysis, as well as for the investigation and closure (bulkheading) of the Red and Bonita Mine tunnel. In addition, various reclamation activities in the Upper Animas watershed were conducted by Sunnyside Gold Corporation, the BLM, and the State of Colorado (US EPA, 2018b).

In 2015, the Colorado Department of Public Health and Environment (CDPHE) conducted a Superfund Site Assessment of the area and asked EPA to postpone listing the site on the NPL. In 2015–2016, the Superfund Removal Program installed an engineered concrete bulkhead in the adit of the Red and Bonita Mine, and conducted an investigation and assessment of the Gold King Mine (GKM). As part of an emergency removal action after a 2015 accidental release of 3 million gallons of mine tunnel water at GKM (US EPA, 2018c), an interim water treatment plant was installed to treat ongoing acid mine drainage being discharged from the mine (US EPA, 2018b).

In 2017, EPA Region 8 requested technical assistance in determining which contaminants need to be addressed on site, to what levels, and how to use the information in determining the appropriate technology to use. The ETSC assisted with the development of a remedial decision tree and in the design of the Remedial Investigation/Feasibility Study (RI/FS). ETSC also supported Region 8 with the proper questions to ask technology vendors, and the methods for selecting appropriate remediation technologies at the site. ETSC compiled technologies that were reviewed for the site along with a description of the technology to assist with knowledge management and later requests for support at this site.



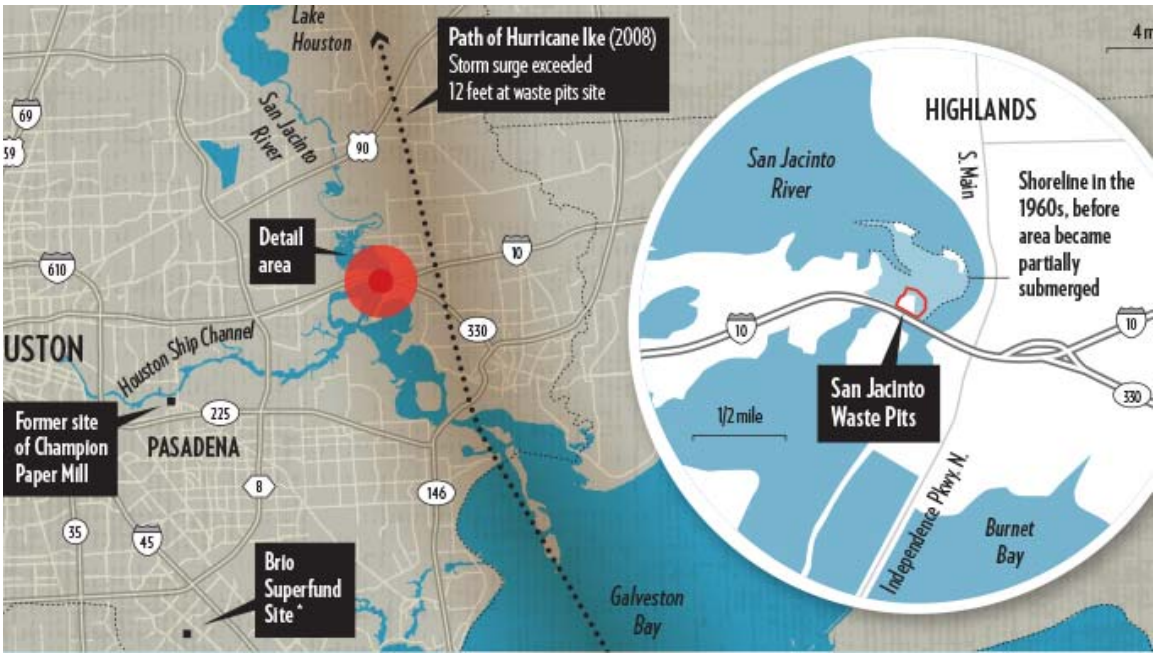
The Bonita Peak Mining District site consists of 48 historic mines or mining-related sources where ongoing releases of metal-laden water and sediments are occurring within the Mineral Creek, Cement Creek, and Upper Animas River drainages in San Juan County, Colorado. This figure illustrates the size and complexity of the drainage area from the ridgeline of the mountain peaks. (EPA, 2018b).

In 2017, the EPA, U.S. Forest Service, BLM, and CDPHE conducted an RI/FS inclusive of a human health risk assessment, ecological risk assessment and a hydrologic study of the Bonita Peak groundwater system. The results from the collaborative study will assist in the decision on future cleanup options for the site (US EPA, 2018b).

Materials Management

San Jacinto River Waste Pits (Region 6)

The San Jacinto River Waste Pits Superfund Site in Channelview (Harris County), Texas consists of various impoundments installed in the 1960s to accommodate the disposal of solid and liquid pulp and paper mill wastes. The site includes surrounding areas with impacted soil and sediment from those impounded waste materials. The northern set of impoundments is approximately 14 acres on a partially submerged 20-acre parcel on the western bank of the San Jacinto River. The southern impoundment is less than 20 acres and located on a peninsula extending south of I-10 (US EPA, 2017a). Submergence is largely a result of land subsidence due to groundwater extraction, and facilitates hazardous materials entering the San Jacinto River with polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (dioxins and furans) being the main constituents of concern. The site was placed on the NPL in 2008 (US EPA, 2017a). This site is on the Administrator's list requiring immediate action.



The San Jacinto Waste Pits site consists of impacted soil and sediment from waste impoundments. Advisories on the dangers of eating crab and fish in the surrounding waters are in place because of dioxin and PCB contamination. (Figure source: Davis, 2015).

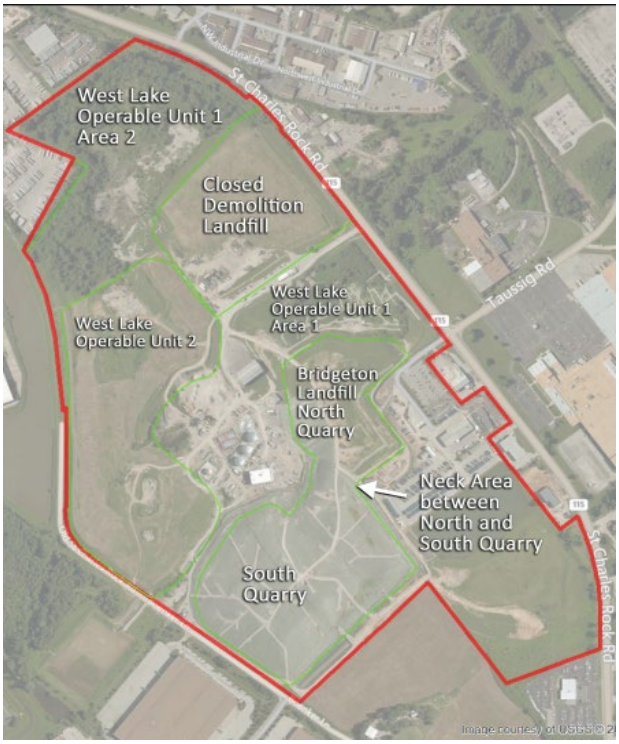
In 2010 and 2011, a temporary cap was constructed over the northern waste pits, which required repeated repairs in subsequent years. Additional deterioration caused by a 2016 spring flood, and flooding related to Hurricane Harvey in September 2017, resulted in the complete erosion of the armor stone and the underlying geotextile of portions of berms and the cap; in total the cap was compromised in 36 areas (US EPA, 2017a).

In 2016, EPA announced their Proposed Plan for Cleanup and issued a decision of a selected remedy for addressing contamination at the site in 2017. The remediation approach included partial removal of the existing temporary armored cap, removal of approximately 162,000 cubic yards of waste material beneath the northern impoundment armored cap, and excavation of approximately 50,000 cubic yards of waste material from the southern impoundment to a depth of 10 feet below grade in the peninsula south of I-10 (US EPA, 2017a).

In FY17, ETSC invited comments and received feedback on a proposal to create a water quality database. ETSC scientists prepared a journal article describing the work done, suggested action levels for dioxins in the river sediment, and completed a literature review to assist with site modeling.

West Lake Landfill (Region 7)

The West Lake Landfill in Bridgeton, Missouri is a Superfund site on the 2017 Administrator's list for immediate action. The site consists of several inactive and unlined landfill units containing radioactive waste and covers approximately 52 acres. The area was originally developed as a limestone quarry, which opened in 1939. The pits, created from the quarry operation, were used to dispose of municipal waste beginning in the 1950s. In 1973, radioactive leached barium sulfate from the Manhattan Project was mixed with soil and placed in the landfill as daily cover or fill. The site was added to the NPL in 1990. The site has since been divided into three operable units dealing with the radiologically impacted material (operable unit [OU]-1), the non-radiological impacted material (OU-2), and the groundwater (OU-3) (US EPA, 2018d).



The West Lake Landfill in Missouri is one of the most extensively supported Superfund site by the ETSC. This closed, unlined mixed-waste landfill includes radioactive waste. (Figure source: US EPA, 2017b).

The EPA has conducted multiple investigations on the site since its addition to the NPL, including recent site characterization to refine previous estimates regarding the extent of the radiologically impacted material on the site. The EPA issued a Record of Decision (ROD) in 2008 to install a protective cap over the landfill to prevent exposures and perform long-term monitoring. This ROD was reevaluated by the Agency in 2010 and additional site characterization and removal actions were conducted. In 2012 and 2015, EPA Region 7 required additional data collection to support remedial options for OU-1 (US EPA, 2017b). Additionally, the EPA performed air monitoring from 2014 to 2015 in the areas surrounding the site, and a pyrolysis study to better

understand potential drivers for radon emanation at the site. A subsurface smoldering reaction is occurring in the non-radioactive portion of the site of OU-2 (US EPA, 2018d).

West Lake Landfill is one of the most extensively supported Superfund sites by the ETSC, including 23 separate requests initiated in FY17. The ETSC provides resources to review documents, summarized critical data sets, and routinely created monthly and annual monitoring and analysis reports of various landfill data. In 2017, ETSC staff drafted an annual report for this complicated project.

Resources were also provided to support the creation of a Quality Assurance Project Plan, review the work plan for the ethylene vinyl alcohol (EVOH) cover system, and support a Freedom of Information Act request to further support this project.

In FY17, ETSC reviewed data and reports from the Missouri Department of Natural Resources Bridgeton Landfill (OU-1) website regarding landfill gas extraction wells, gas interceptor wells, temperature monitoring points, and related infrastructure to assess the presence and progression of any subsurface heat-generating event (SSE). ETSC also responded to a request for assistance with Bridgeton geochemistry data, and fate and transport modeling. ETSC is also collaborating with the Site Characterization and Monitoring Technical Support Center (SCMTSC) who developed a sampling plan for the outer area of the landfill using spatial statistical methods to assist in determining the extent of contamination outside the landfill. The ETSC will continue supporting this complex project to analyze data sets and better understand the real and potential effects of an SSE occurring in OU-2, review various fire and heat suppressant technologies such as inert gas injection and fire break, and provide laboratory equipment and staff expertise to further support the remediation activities going forward.

SAMPLING ASSISTANCE & ANALYSIS

A well-designed sampling plan is a critical component in site characterization and assessment. ETSC staff help design and review sampling plans to ensure the collected data are representative and sufficient to make evidence-based decisions. ETSC also assists with selecting field methods and procedures and analysis of sampling results.

In FY17, ETSC fielded more than 70 requests related to sampling assistance and analysis, including the following:

- Reviewed the sampling and analysis plan proposed for sampling PFAS in wells at the **Fairchild AFB (Region 10)** and later validated analytical results as part of a site investigation effort;
- Discussed sampling needs for VOC/SVOC analysis with the RPM at the **GCL Tie and Treating, Inc. site (Region 2)**;
- Provided technical advice on additional sampling points to develop a more comprehensive model to evaluate groundwater contamination migration and evaluate performance of the current extract and treat system at the **Former AC Rochester Facility (Region 2)**; and
- Analyzed the Navy's sampling plan for PFAS sampling in groundwater and drinking water at the **Naval Air Station, Whidbey Island (Region 10)**.

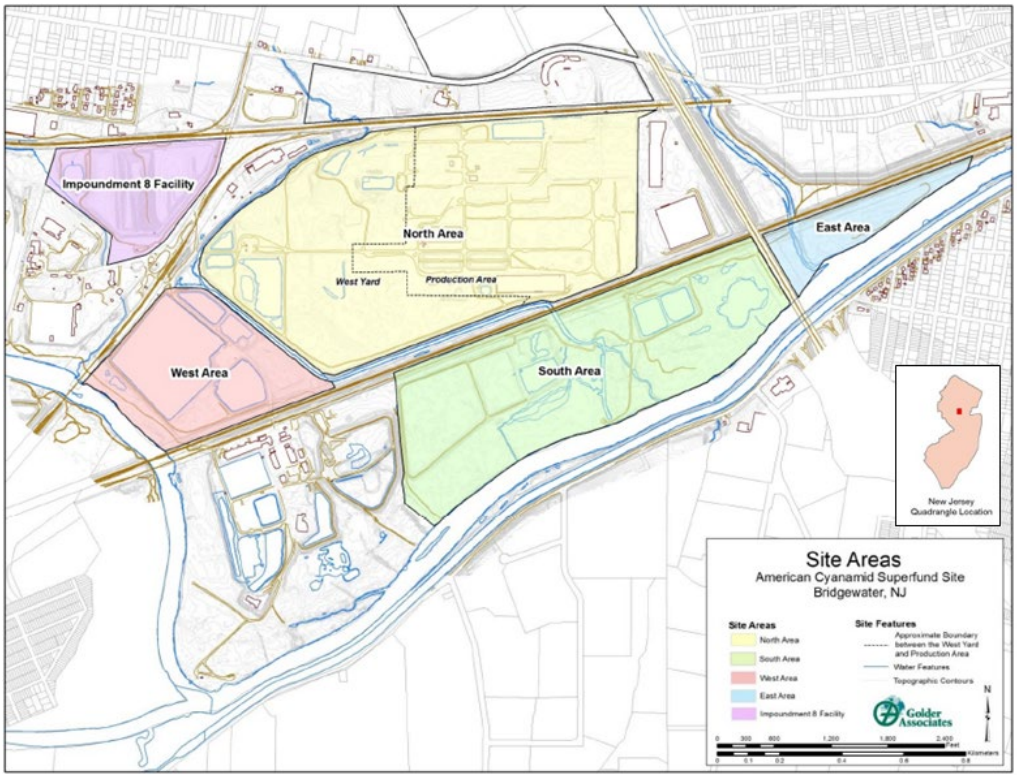
Highly Complex Site Investigations

American Cyanamid Co. (Region 2)

The 435-acre American Cyanamid Superfund Site is in an industrial/commercial area of Bridgewater Township, New Jersey. This site was added to the NPL in 1983 and is currently on the EPA's list of Superfund sites targeted for immediate, intense action. Over its nearly 100-year history, the site was home to the manufacturing of rubber, rubber chemicals, dyes, pigments, fungicides, petroleum-based products, and pharmaceuticals (NJ DEQ, 2011). All manufacturing stopped at the site in 1999. The soil is contaminated with VOCs, cyanide, PCBs, and metals, with the shallow and deep aquifers contaminated with metals and VOCs. Four hazardous waste lagoons and 16 surface storage impoundments containing tars, wastewater sludge, iron oxide, and general plant debris were on-site when remedial activities began in the early 1980s. A 140-acre parcel of the site was remediated and eventually approved for redevelopment in 1998 for the Bridgewater Promenade retail center, the Somerset Patriots TD Bank Ballpark, and an NJ Transit parking lot. Wyeth Holdings, a subsidiary of Pfizer Corporation, acquired the site in 2009 and assumed responsibility for remediating the remaining 435 acres.

Six impoundments and two of the lagoons have been remediated by dewatering and solidifying the waste materials, which were then placed in an on-site, state-of-the-art RCRA Subtitle C containment cell (NJ DEQ, 2011). As of 2015, two other impoundments (15 and 16) have been completed by excavation, and off-site recycling of 81,000 cubic yards of iron oxide has also been completed. Soils beneath the impoundment areas have been used in revegetation efforts as part of the site-wide remedy (US EPA, 2018e). Permanent remedies for impoundments 1 and 2 that contain acid tar sludge are being evaluated separately due to their highly complex nature and proximity to the Raritan River (US EPA, 2018e). A focused feasibility study is currently being conducted and a remedy recommendation is expected in early 2018 (US EPA, 2018e). Under a removal action, a groundwater removal system consisting of a collection trench, a containment wall, and an interim groundwater treatment system has been addressing benzene seeps into the Raritan River since 2012 (US EPA, 2018e). A site-wide remedy is currently under design and will address the remaining impoundments, contaminated site soils, and groundwater issues (US EPA, 2018e).

ETSC evaluated the optimal treatment system for the site, including mechanical dewatering and thermally enhanced in-situ solidification. ETSC also assisted with identifying response actions, developing an evaluation protocol for each technology, and interpreting data obtained from each method. Remedial technologies were tested on a pilot scale for a 9-month period in FY16. ETSC members involved in this project received an EPA National Honor Award (Bronze medal) for the successful implementation of these pilot-scale studies. In FY17, ETSC met with the site potentially responsible party (PRP) and reviewed the FS Report for impoundments 1 and 2 (OU-8) and provided comments regarding various in-situ thermal technologies. ETSC's effort contributed to the development and implementation of a full-scale system to treat waste and contamination, which is a major step towards the total remediation.



The 435-acre American Cyanamid Co. site outside of Newark, New Jersey contains soil contaminated with VOCs, cyanide, PCBs, and metals from various industrial activities. (US EPA, 2014).

Mohawk Tannery (Region 1)

The former Mohawk Tannery facility (a.k.a. Granite State Leathers) is located on 30 acres approximately 3.5 miles upstream from the confluence of the extensively fished Nashua and the Merrimack Rivers and surrounding wetlands in Nashua, New Hampshire. The currently inactive facility produced leather tanned hides between 1924 and 1984 (US EPA, 2018f). During its operation, the facility discharged wastewater containing hazardous substances such as chromium, zinc, and phenol directly into the Nashua River and disposed of sludge containing hazardous substances such as chromium, pentachlorophenol, phenol, and 2,4,6-trichloropehenol into several on-site, unlined disposal areas (US EPA, 2018f). Approximately 5,000 people obtain drinking water from groundwater wells within a 4-mile radius of the site. The site is on the EPA's list of Superfund sites targeted for immediate and intense action due to its redevelopment potential.

Only limited investigations have been undertaken at the site since June 2005 (other than a 2009 treatability study of the sludge lagoons) until a resolution of the funding mechanism (e.g., private developer or finalization of the site on the NPL) for site cleanup is reached (US EPA, 2018f). In June 2012, the City of Nashua funded the complete demolition and asbestos abatement needed to remove the remaining former tannery buildings (excluding the slabs). These buildings had become a visible nuisance and had been suspiciously burned on several occasions prior to demolition in 2012. In

addition, EPA and the New Hampshire Department of Environmental Services (NHDES) did several field investigations within the southernmost 15-acre parcel of the overall 30-acre site. The purpose of these investigations was to evaluate whether all or part of this undeveloped area can be considered for delisting from the rest of the NPL site.

The potential threat to groundwater from the estimated 60,000 cubic yards of sludge in the unlined disposal areas remains. A local developer who is exploring the option of acquiring the site for redevelopment completed a bench-scale treatability study in 2009 to evaluate Portland cement and various additives to determine potential solidification/stabilization options for the contaminated soils and sludges on-site. The developer also submitted a draft remedial action plan to EPA (ETSC) and NHDES. The agencies reviewed both documents and are working with the developer and the City of Nashua regarding cleanup strategies and redevelopment potential at the site (NHDES, n.d.; US EPA, 2018f).

PCB Contamination

LCP Chemicals, Inc. Superfund Site (Region 2)

Various industrial operations occurred between 1919 and 1994 at the LCP Chemicals, Inc. site in Linden, New Jersey, including a petroleum refinery, an electric power generation facility, and a mercury cell chlor-alkali plant. These activities led to widespread contamination of the soil, groundwater, surface water, and sediment with mercury, PCBs, and other hazardous substances. The site was placed on the NPL in 1996.

The 26-acre site is being addressed in one long-term cleanup phase. Site investigations and a feasibility study were completed in 2013 and EPA selected a remedy for the site in February 2014. The cleanup remedy includes: a capping system to prevent direct contact with soils and exposure to mercury vapor; treatment of the soil containing visible elemental mercury by mixing in sulfur to convert the mercury to mercuric sulfide; excavation and on-site disposal of sediments and marsh soils from the Northern Off-Site Ditch and the downstream portion of the South Branch Creek; restoration of the excavated areas; controlled demolition of the site's buildings; recycling of non-porous material; placement of porous material under the cap; containment and collection of the overburden groundwater layer by a barrier wall and collection/disposal system; and groundwater monitoring (US EPA, 2018g). The remediation is estimated to take 30 years and cost $36.3 million.

The LCP Chemicals, Inc. site borders the Elizabeth River in New Jersey and an environmentally sensitive area of high quality wetlands, marshlands, and river shallows. EPA and the U.S. Army Corps of Engineers worked on a design for the selected remedy in FY17.

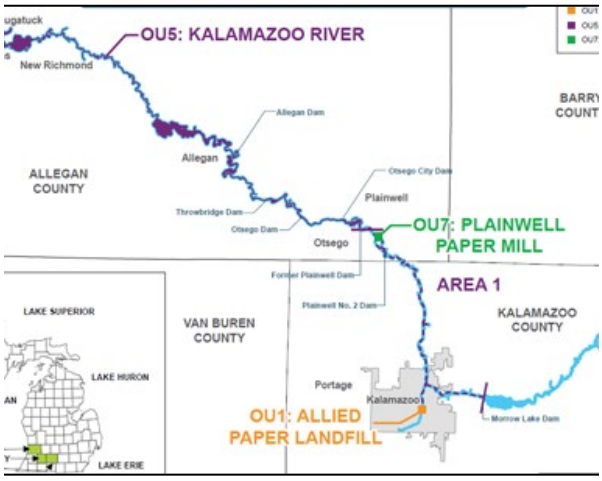
EPA and the U.S. Army Corps of Engineers are currently preparing a design for the selected remedy. In FY17, the ETSC proposed off-site sampling of PCBs near the LCP Chemicals Superfund site to test a new remediation technology researched by Louisiana State University and to create a Regional Applied Research Effort (RARE) proposal. ETSC staff also fielded several requests to review technical documents related to site remedial design activities. After the design is finalized,

EPA will seek to have the site's PRPs implement the remedy.

Allied Paper Inc. / Portage Creek / Kalamazoo River (Region 5)

The Allied Paper Inc./Portage Creek/Kalamazoo River Superfund site covers portions of three counties in southwestern Michigan. The site includes five disposal areas, six paper mill properties, an 80-mile stretch of the Kalamazoo River (a tributary of Lake Michigan), and a 3-mile stretch of Portage Creek (a tributary of the Kalamazoo River). Various paper manufacturing and disposal operations were conducted at the site until the early 1980s. The primary contaminants of concern are PCBs resulting from accidental introduction of carbonless copy paper in the recycled paper stream. Carbonless copy paper waste was mixed into the residuals during the paper-recycling process. The residuals from this process consisted of chlorinated waste (including the carbonless copy paper), clay, and wood/paper pulp. These residuals were fluidized, pumped, and dewatered in large on-site retention cells on the Allied Paper property.

Cleanup started upstream on the Kalamazoo River with the removal of PCB sources. In 2017, cleanup focused on three OUs: Allied Paper Landfill, Plainwell Paper Mill, and Kalamazoo River areas 2, 4 and 5. For the Allied Paper Landfill, ETSC has been working with the bankruptcy Trustee for the Landfill to implement the cleanup plan, including consolidation and capping of the waste into a 27-acre area and conducting long-term groundwater monitoring. Eventually, the City of Kalamazoo hopes to retain a portion of the site for future reuse and redevelopment. For the Kalamazoo River Area 2 (between the former Plainwell Dam and the Otsego City Dam), the approved cleanup activities included removal of the Otsego City Dam, realignment of the river to create a single stable channel, bank soil and PCB "hot spot" excavation, capping of the anabranch areas where streams break away from the main river and rejoin further downstream, and long-term monitoring. So far, more than 11,000 feet of riverbank have been cleaned up by removing more than 30,000 tons of PCB-contaminated soils and sediments.



Operations from seven paper mills at the Allied Paper Inc. / Portage Creek / Kalamazoo River Site led to PCB contamination along 77 miles of the Kalamazoo River and a 3-mile stretch of the Portage Creek in Southwestern Michigan. ETSC reviewed a bioremediation technology for the site in FY17. (Figure source: US EPA, 2015).

For the Kalamazoo River Area 4 (between the Otsego Township Dam and Trowbridge Dam), a draft investigation report was submitted and is under EPA review. At the Kalamazoo River Area 5 (between the Trowbridge Dam and Allegan City Dam), field investigations have begun. At the Plainwell Mill OU, the cleanup plan required the excavation and off-site disposal of contaminated soil. The cleanup work plans were finalized in September 2016, and Pre-Design Investigation work was completed in 2017 with cleanup work anticipated to begin in Summer 2018 (EPA, 2018h).

ETSC members met with a vendor, Biopath Solutions, and representatives for Region 5 for context and reviewed the vendor's bioremediation technology to determine its appropriateness for remediating PCBs at the site. The support team that worked on this project was nominated for a national Superfund program award.

Lead Contamination at the John T. Lewis / Anzon Factory Site (Region 3)

The John T. Lewis facility is in the Kensington and Port Richmond area of Philadelphia, Pennsylvania. From 1849 to 1996, lead products including lead paint were produced at the John T. Lewis facility. These operations contaminated the on-site and nearby off-site soils with lead and other metals. The area currently consists of residential homes mixed with industrial, commercial, and educational/service facilities. The community expressed concerns about lead in the soils of residential areas, eating home-grown vegetables grown in potentially contaminated soils, and potential cancer effects of lead exposure. The City of Philadelphia, the Pennsylvania Department of Environmental Protection, EPA, the Pennsylvania Department of Health, and Agency for Toxic Substances and Disease Registry (ATSDR) have conducted numerous environmental and public health investigations around the site since the 1970s.

The abandoned John T. Lewis factory is in a densely populated area of Philadelphia. Lead contamination has been found on-site and at surrounding areas, posing health risks to the nearby community. (Figure source: City of Philadelphia as published in Ruderman et al., 2017).

In 2014, the ATSDR evaluated 2009 and 2011 EPA soil sampling data for a few residential properties near the former John T. Lewis site, and evaluated exposure to lead and arsenic from residential soils (ATSDR, 2014). One important finding from this study was that more than 75 percent of children (age 6 months to 7 years) who regularly play in the yards that were sampled could be exposed to lead in soil at levels high enough to raise their average blood lead levels above the Centers for Disease Control and Prevention current childhood blood lead reference level of 5 µg/dL. ATSDR also concluded that soil levels were 'high' throughout the Kensington and Port Richmond area, and could adversely affect children (ATSDR, 2014).

The ETSC, through a Region 3 request, is currently working on a research project within NRMRL and the National Exposure Research Laboratory (NERL) to investigate residential lead contamination. The ETSC is also conducting a lead isotopic source attribution effort to determine the extent, if any, of off-site lead transport.

PFOA and PFOS Contamination at the Fairchild Air Force Base (Region 10)

The Fairchild Air Force Base site in Spokane County, Washington consists of 5,823 acres and 1,259 buildings. The base primarily maintains and repairs large bombers and tankers. During past base activities, more than 4,000 drum equivalents of carbon tetrachloride and other solvents, paint wastes, plating sludges containing cadmium and lead, and related industrial wastes were disposed at four main waste areas including two landfills and waste lagoons, encompassing a total of 85 acres. EPA placed the site on the NPL in 1989.

Under the Air Force Environmental Restoration Program (ERP), 37 ERP sites and two areas of concern have been identified at the site since the early 1980s. Remediation activities included removal of 12,000 tons of contaminated soil and concrete, and treatment of 310,300 gallons of contaminated groundwater at former underground storage tank sites in the airfield area (Secretary of Defense, 2012). One of the ERP sites, the Craig Road Landfill, was considered the source of a large trichloroethylene (TCE) plume (Bell Legal Group, 2010) with concentrations at more than three times the cleanup level, which extends to 200 feet below ground surface (Secretary of Defense, 2012). Remedial activities included a solar-powered in-situ bioreactor that pumps groundwater through a mulch bed with an added carbon source (recycled cheese whey) to degrade the TCE. This was supplemented by a phytoremediation study to quantify the annual amount of TCE that was removed by a poplar tree stand.

Cheese whey being applied during the construction of the sustainable bioreactor demonstration project. Fairchild AFB worked cooperatively with a local creamery to enable the reuse of cheese whey, a byproduct from creamery processes. The cheese whey served as a necessary carbon source within the construction of the solar-operated bioreactor and promotes the breakdown of contaminants in groundwater and using natural processes. (Figure source: Secretary of Defense, 2012).

The study concluded that measured removal rates were substantial, and calculated that the TCE mass in groundwater below the poplar tree stand decreased 10 percent in a 5-year span. Based on a 2011 ROD between the Air Force, EPA, and State of Washington, efforts were made to further delineate the nature and extent of the plume and address vapor intrusion issues. Remedies consisted of optimization of the existing groundwater extraction and treatment system, operating in conjunction with dual-purpose remediation wells for soil vapor extraction and in-situ chemical oxidation injections. These measures improved TCE removal from groundwater by 600 percent (Secretary of Defense, 2012).

In 2017, PFOS and PFOA concentrations above EPA lifetime health advisory levels were detected in two groundwater wells used to supply the city of Airway Heights (City of Airway Heights and Fairchild Air Force Base, 2017). The contamination is from the on-site fire-fighting training exercise and aircraft accident response sites where aqueous film-forming foam (AFFF), a fire-fighting agent, has been in use. To-date responses to the contamination included transition to an alternative PFOS-free AFFF, testing of all drinking water sources used by the base, and testing of potentially affected private wells along the base perimeter (Liapis, 2017).

In FY17, ETSC reviewed the Air Force's proposed sampling and analysis plan for PFOS for the base. Upon review, ETSC requested additional sampling metrics and information to better evaluate the presence and concentrations of PFOS. ETSC personnel then reviewed and validated analytical results from the on-base PFOS/PFOA groundwater sampling that was performed at as part of the AFFF Release Areas Site Investigation.

RISK ASSESSMENT & DECISION ANALYSIS

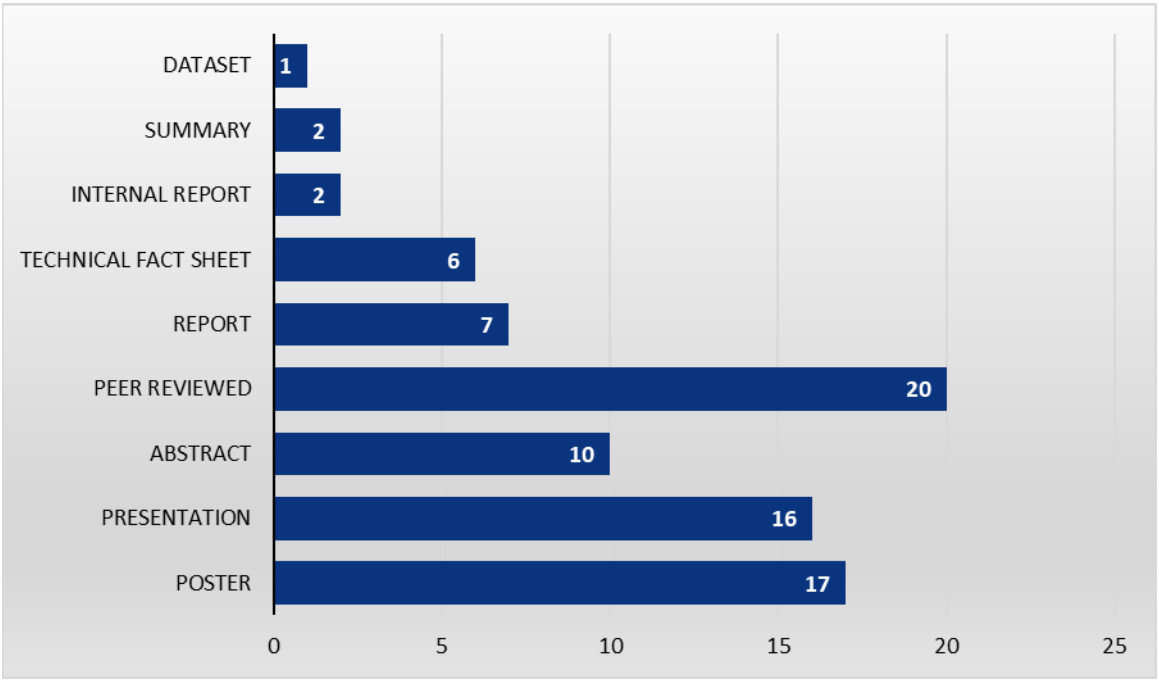
ETSC routinely provides guidance on site-specific information to assess risks and support decision making. ETSC staff develops decision trees, assists with remedy selection, develops cleanup plans, and uses models and decision support tools to recommend next steps. ETSC also develops general guidance documents and procedures to disseminate knowledge to others in the environmental field.

In FY17, ETSC provided risk assessment and decision analysis support to more than 13 unique sites. Some examples of this support include the following:

- Provided expertise to evaluate metals, specifically arsenic and mercury in fish tissue, for a site-specific biological evaluation;
- Developed a generalized approach and analytical method to screen and assess risks from total petroleum hydrocarbons contamination;
- Assisted with identifying which contaminants need to be addressed on site, to what levels, and how to use that information to determine potential treatment technologies for the Bonita Peak Mining District (Region 8); and
- Delivered a presentation on risk-reduction strategies for dioxin in soils to representatives of the Vietnamese government.

Dissemination and Knowledge Sharing

ETSC disseminates its important work in a variety of formats to broaden its reach. In FY17, 67 scientific communication products, of the types noted in the figure below, were produced.



In collaboration with researchers from EPA Regions, other government agencies, states and universities, ETSC-assigned staff published 20 peer-reviewed journal articles in FY17, including the following:

1. **Butler, B**., and **R. Ford**. Evaluating relationships between total dissolved solids (TDS) and total suspended solids (TSS) in a mining-influenced watershed. Mine Water and the Environment. (2017)
2. Karna, R., **T. Luxton**, K. Bronstein, J. Redmon and **K. Scheckel**. State of the science review: Potential for beneficial use of waste by-products for in-situ remediation of metal-contaminated soil and sediment. Critical Reviews in Environmental Science and Technology. 47:65-129 (2016).
3. Karna, R., M. Noerpel, A. Betts, and **K. Scheckel**. Lead and arsenic bioaccessibility and speciation as a function of soil particle size. Submitted to Journal of Environmental Quality.
4. **Huling, S**., R. Ross, K. Prestbo. In-situ chemical oxidation: Permanganate oxidant volume design considerations. Groundwater Monitoring & Remediation. 37(2):78-86 (2017).
5. **Al-Abed, S**., **P. Pinto**, **J. McKernan**, E. Feld, and S. Lomnicki. Mechanisms and effectivity of sulfate reducing bioreactors using a chitinous substrate in treating mining influenced water. Chemical Engineering Journal. 323: 270-277.
6. **Pinto, P**., **S. Al-Abed**. Assessing metal mobilization from industrially lead-contaminated soils located at an urban site. Applied Geochemistry. 87:31-40 (2017).

7. Eckley, C., **T. Luxton**, J. Goetz, and **J. McKernan**. Water-level fluctuations influence sediment porewater chemistry and methylmercury production in a flood-control reservoir. Environmental Pollution. 222: 32–41 (2017).
8. Gitipour, A., S. **Al-Abed, S**. Thiel, **K. Scheckel**, and **T. Tolaymat**. Nanosilver as a disinfectant in dental unit waterlines: Assessment of the physiochemical transformations of the AgNPs. Chemosphere. 173: 245–252 (2017).
9. Griggs, J.L., K.R. Rogers, C. Nelson, **T. Luxton**, W.E. Platten, and K.D. Bradham. In vitro bioaccessibility of copper azole following simulated dermal transfer from pressure-treated wood. Science of The Total Environment. 598: 413-420 (2017).
10. He, Y, **S. Al-Abed** and D. Dionysiou. Quantification of carbon nanotubes in different environmental matrices by a microwave induced heating method. Science of the Total Environment. 580: 509–517 (2017).
11. Ivask, A., **K. Scheckel**, P. Kapruwan, V. Stone, H. Yin, N. Voelcker, and E. Lombi. Complete transformation of ZnO and CuO nanoparticles in culture medium and lymphocyte cells during toxicity testing. Nanotoxicity. 11(2): 150-156 (2017).
12. Koralegedara, N., H. Nadeesha, **S. Al-Abed**, S. Rodrigo, R. Karna, **K. Scheckel**, and D. Dionysiou. Alterations of lead speciation by sulfate from addition of flue gas desulfurization gypsum (FGDG) in two contaminated soils. Science of the Total Environment. 575: 1522-1529 (2017).

WORKSHOPS

The ETSC staff frequently leads and participates in workshops. In FY17, Steve Rock presented "**Introduction to Phytoremediation**" in San Francisco, CA, July 18-19. Case studies were discussed during the EPA/Inter-Agency Phytoremediation Workshop: Phytoremediation Applications for Contaminated Site Cleanup, which was sponsored by ORD and Region 9.

The purpose of this workshop was to provide participants with an opportunity to learn, examine, and discuss current and emerging approaches related to phytoremediation to control sources, plumes, and vapor inhalation threats at contaminated sites.

Workshop participants included contaminated site RPMs, OSCs, remediation researchers and practitioners, and federal, state, local and tribal decision makers, including NASA, USGS, and DOD. The ETSC Director, John McKernan, was also involved with this training.

13. Koralegedara, N. H., **S.R. Al-Abed**, M.K.J. Arambewela, and D.D. Dionysiou. Impact of leaching conditions on constituents release from Flue Gas Desulfurization Gypsum (FGDG) and FGDG-soil mixture. Journal of Hazardous Materials. 324 (Special Issue): 83-93 (2017) DOI: 10.1016/j.jhazmat.2016.01.019 SHC 3.63.3.
14. Neamtiu, I., **S. Al-Abed**, **J. McKernan**, C. Baciu, E. Gurzau, A. Pogacean and S. Bessler. Metals contamination in environmental media in residential areas around Romanian mining sites. Reviews on Environmental Health. 32(1-2) (2017) DOI: 10.1515/reveh-2016-0033.
15. Punshon, T., B. Jackson, A. Meharg, T. Warczak, **K. Scheckel** and M. Guerinot. Understanding arsenic dynamics in agronomic systems to predict and prevent uptake by crop plants. Science of the Total Environment. 581-2: 209–220 (2017) DOI: 10.1016/j.scitotenv.2016.12.111 SHC 2.62.3
16. **Tolaymat, T**., A. Genaidy, W. Abdelraheem, D. Dionysiou and C. Andersen. The effects of metallic engineered nanoparticles upon plant systems. Science of the Total Environment. 579: 93-106 (2017) DOI: 10.1016/j.scitotenv.2016.10.229 CSS18.02.01

17. **Tolaymat, T**., A. El Badawy, A. Genaidy, and W. Abdelraheem. Analysis of metallic and metal oxide nanomaterial environmental emission. Journal of Cleaner Production. 143: 401-412 (2017) DOI: 10.1016/j.jclepro.2016.12.094
18. Wang, P., E. Lombi, S. Sun, **K. Scheckel**, A. Malysheva, B. McKenna, N. Menzies, F. Zhao, and P. Kopittke. Characterizing the uptake, accumulation and toxicity of silver sulfide nanoparticles in plants. Environmental Science: Nano 4:448-460 (2017) DOI: 10.1039/c6en00489j CSS18.02.01
19. Whitacre, S., N. Basta, B. Stevens, V. Hanley, R. Anderson, and **K. Scheckel**. Modification of an existing in vitro method to predict relative bioavailable arsenic in soils. Chemosphere. 180: 545-552 (2017) DOI: 10.1016/j.chemosphere.2017.03.134 SHC 2.62.3
20. Wohlleben, W., C. Kingston, J. Carter, E. Sahle-Demessie, S. Vazquez-Campos, B. Acrey, C.Y. Chen, E. Walton, H. Egenolf, P. Muller, and R. Zepp. NanoRelease: Pilot interlaboratory comparison of a weathering protocol applied to resilient and labile polymers with and without embedded carbon nanotubes. Carbon, 113: 346-360. (2017) DOI:10.1016/j.carbon.2016.11.011.

Engineering Issue Papers (EIPs) are prepared when knowledge gaps on a technical subject are identified. EIPs provide a state-of-the-science review of technologies available for contaminated site cleanup. Once finalized, EIPs are used to support office, RPM, OSC, or EPA Regional decisions. ETSC conducts an extensive literature review on the current understanding of the theory, design, and implementation of various remedial or treatment technologies that forms the basis of the EIPs. Leading engineers and scientists inside the Agency, federal government community, academia, or the contracting community may also be consulted for input.

ENGINEERING ISSUE PAPER: SOIL VAPOR EXTRACTION

ETSC drafted an EIP on soil vapor extraction (SVE) in FY17 that summarizes the state-of-the-science regarding the widespread use of SVE as a major treatment technology for removing VOCs from soil. SVE can be applied alone or as an integral component of more complex remedial technologies that volatilize subsurface contaminants (e.g., thermal remediation, air sparging). This EIP also provides information describing SVE and its applicability and limitations; site characterization; design and construction; performance monitoring, evaluation, optimization, and shutdown; complementary technologies; costs; case studies; and references for further information.

Other key reports published in FY17 include the following:

- Adsorption-based Treatment Systems for Removing Chemical Vapors from Indoor Air;
- Pre-Dredge Sediment Characterization of the Ottawa River;
- Methods and Metrics for Evaluating Environmental Dredging at the Ashtabula River Area of Concern (AOC);
- Pilot-Scale Demonstration of In-Situ Chemical Oxidation Involving Chlorinated Volatile Organic Compounds—Design and Deployment Guidelines (Parris Island, SC, U.S. Marine Corp Recruit Depot, Site 45 Pilot Study); and
- Organic Waste Diversion in Columbia, South Carolina, Feasibility Study.

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