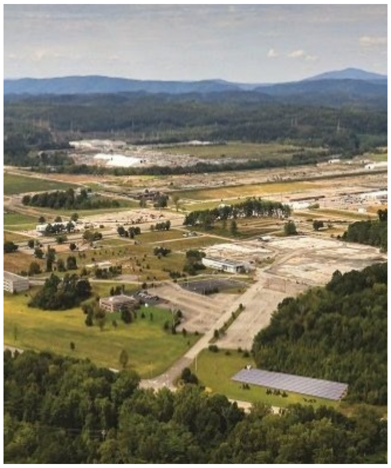


The East Tennessee Technology Park has changed greatly in recent years as remediation projects have been completed.

3

East Tennessee Technology Park

ETTP was built during World War II as part of the Manhattan Project. Formerly known as the K-25 Site, its primary mission was to enrich uranium for use in atomic weapons. After the war, the mission changed to include the enrichment of uranium for nuclear reactor fuel elements and recycling of uranium recovered from spent fuel, and the name changed to the "Oak Ridge Gaseous Diffusion Plant" (ORGDP). In the 1980s, a reduction in demand for nuclear fuel resulted in the shutdown of the enrichment process and production. The emphasis of the mission then changed to environmental management and remediation operations. In 1996, the name changed to the "East Tennessee Technology Park."

Environmental management and remediation consist of waste management, the cleanup of outdoor storage and disposal areas, the demolition and cleanup of facilities, land restoration, environmental monitoring, and the proper disposal of waste generated from production operations. Beginning in the 1990s, reindustrialization (the conversion of underused government facilities for use by the private sector) became part of ETTP's mission. State and federally mandated effluent monitoring and environmental surveillance involve the collection and analysis of air, water, soil, sediment, and biota samples from ETTP and surrounding areas. Monitoring results are used to assess exposures to the public and the environment, evaluate the performance of treatment systems, and identify concerns within permitted standards for emissions and discharges. On November 10, 2015, DOE and the US Department of the Interior signed a memorandum of agreement (MOA) establishing the Manhattan Project National Historical Park (DOE 2015). The MOA defines agency roles and responsibilities in park administration and provisions for enhanced public access, management, interpretation, and historic preservation. The ORGDP footprint is included within the Manhattan Project National Historical Park. Details are available on the Manhattan Project National Historical Park page of the National Park Service website, **here**, and the K-25 Virtual Museum website details its history through narrative, interviews, and photographs, found **here**.

3.1. Description of Site and Operations

Construction of the K-25 Site (Figure 3.1) began in 1943 as part of the World War II Manhattan Project. The plant's original mission was the production of enriched uranium for nuclear weapons. Enrichment was initially carried out in the S-50 thermal diffusion process facility, which operated for one year, and the K-25 and K-27 gaseous diffusion process buildings. Later, the K-29, K-31, and K-33 buildings were built to increase the production capacity of the original facilities by raising the assay of the feed material entering K-27. Following the war years, the site became officially known as ORGDP.

After military production of highly enriched uranium was concluded in 1964, the two original process buildings, K-25 and K-27, were shut down. For the next 20 years, the plant's primary mission was the production of low enriched uranium fabricated into fuel elements for nuclear reactors throughout the world. Other missions during the latter part of this 20-year period included developing and testing the gas centrifuge method of uranium enrichment and laser isotope separation research and development.

By 1985, the demand for enriched uranium declined, and the gaseous diffusion cascades at ORGDP were placed in standby mode. That same year, the gas centrifuge program was canceled. The decision to permanently shut down the diffusion cascades was announced in late 1987, and actions necessary to implement that decision were initiated soon thereafter. Because of the termination of the original and primary missions, ORGDP was renamed the "Oak Ridge K-25 Site" in 1989. Figure 3.2 shows the ETTP site areas before the start of decontamination and decommissioning (D&D) activities. In 1996, the K-25 Site was renamed the "East Tennessee Technology Park" to reflect its new mission.

Figure 3.3 shows the ETTP areas designated for D&D activities through 2023. The ETTP mission is to reindustrialize and reuse site assets through leasing and/or transferring excess or underused land and facilities and by incorporating commercial industrial organizations as partners in the ongoing environmental restoration, D&D, and waste treatment and disposal. The site is undergoing environmental cleanup of its land, as well as D&D of most of its buildings. The cleanup approach makes land and various types of buildings (e.g., office, manufacturing) suitable for private industrial use and for title transfer to the Community Reuse Organization of East Tennessee (CROET) or other entities such as the City of Oak Ridge. The long-term DOE goal for ETTP is to transfer as much of the site property as practicable out of DOE ownership and into CROET's control for the development of a commercial business and industrial park. The facilities may then be subleased or sold, with the goal of stimulating private industry and recruiting businesses to the area. These transfers also reduce maintenance costs for DOE, which frees up additional money for environmental cleanup. The reuse of key facilities through title transfer is part of the site's closure plan.

UCOR, the lead environmental management contractor for ETTP, supports DOE in the reindustrialization program as part of the continuing effort to transform ETTP into a private-sector industrial park in addition to a national park and conservation area. Unless otherwise noted, information about non-DOE entities located on the ETTP site is not provided in this document.

Figure 3.1. The K-25 Site in 1946

Figure 3.2. East Tennessee Technology Park since the start of decontamination and decommissioning activities in 1991

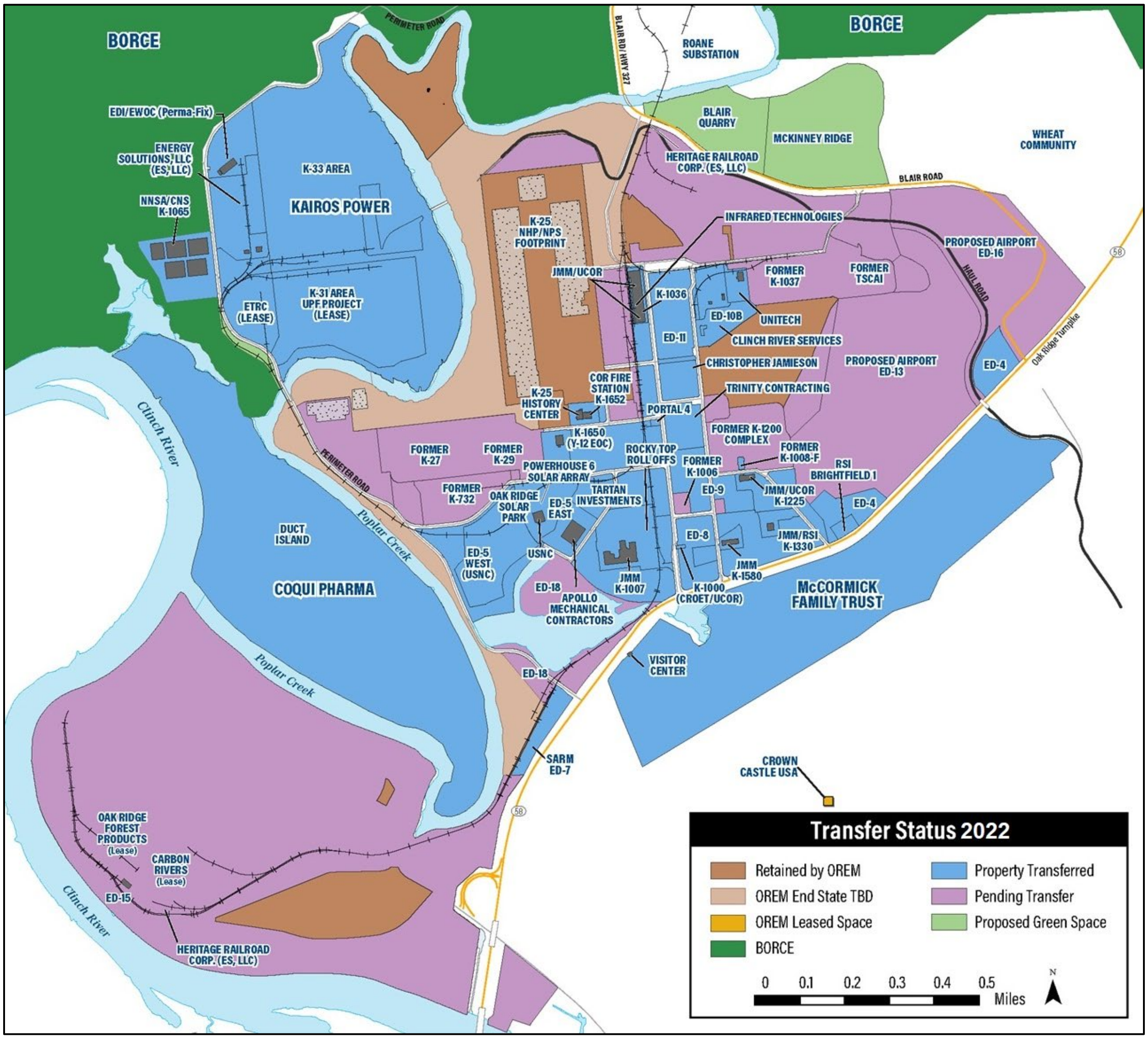


Figure 3.3. East Tennessee Technology Park in 2022, showing progress in reindustrialization

3.2. Environmental Management System

The UCOR Environmental Management System (EMS) is integrated with the UCOR Integrated Safety Management System. UCOR's EMS reflects the elements and framework contained in International Organization for Standardization (ISO) Standard 14001:2004, *Environmental management systems—Requirements with guidance for use* (ISO 2004). UCOR is committed to incorporating sound environmental management, protection, sustainability, and justice considerations in all business decisions, work processes and activities that are part of the DOE Environmental Management (EM) program in Oak Ridge, Tennessee. UCOR's environmental policy states, in part, "UCOR is committed to incorporating sound environmental management, protection, sustainability, and justice considerations in all our business decisions, work processes, and activities through the use of an EMS … and includes a commitment to continually improve the environmental performance of our operations … to protect and sustain human, natural, and cultural resources is inherent in our mission to complete environmental cleanup safely with reduced risks to the public, workers, and the environment." To achieve this, UCOR's environmental policy adheres to the following principles:

- **Leadership Commitment—**Integrate responsible environmental practices into project operations; factor environmental considerations and sustainability into project decisions that are appropriate for the nature and extent of our activities
- **Environmental Compliance—**Comply with all environmental laws, regulations and permits, including applicable or relevant and appropriate requirements
- **Sustainable Environmental Stewardship—** Minimize the effects of our operations on the environment through a combination of sustainable procurement improvements; increased waste reduction, reuse, and recycling; reduced greenhouse gas (GHG) emissions; sustainable, resilient remediation best management practices, and other science- and technology-based approaches
- **Partnership/Stakeholder Involvement—** Maintain partnerships through effective two-way communications with our client, suppliers, community, and other stakeholders

3.2.1. Sustainable Environmental Stewardship

Through a new UCOR Go Zero initiative designed to promote emission reductions and climate resilience, sustainability measures are being incorporated throughout UCOR's processes and activities via UCOR's EMS. The Go Zero initiative focuses on three primary goals: net zero GHG emissions; climate-ready operations and infrastructure; and education and partnerships to accelerate sustainability awareness and operational resilience.

3.2.1.1. Greenhouse Gas Emissions Reduction

UCOR is moving toward a net zero GHG emissions goal primarily through:

- Acquisition of electric vehicles
- Adoption of sustainable resilient remediation best management practices
- Transition to renewable and carbon-free energy
- Procurements that reduce Scope 3 GHG emissions
- Acquisitions that are increasingly sustainable through both systems and subcontract improvements
- A zero-waste goal for UCOR's occupied facilities and installations

In the area of renewable energy, Restoration Services, Inc. (RSI), in concert with UCOR, continued operations of ETTP's solar parks (Figure 3.4). Brightfield 1 is a 200-kW solar array located on a 0.405-ha (1-acre) tract purchased from CROET and built by RSI as part of UCOR's commitment to the revitalization of the former K-25 Site.

Figure 3.4. Oak Ridge Powerhouse Six Solar Farm

RSI self-financed the project using solar panels manufactured in Tennessee and partnering with other local small businesses for the installation. Power generated from Brightfield 1 is being sold to the Tennessee Valley Authority (TVA) through the City of Oak Ridge Electric Department using a TVA Generation Partners contract. The completed project was commissioned in April 2012 and is part of RSI's Brownfields to Brightfields initiative that works to develop restricted-use properties into solar farms. Brightfield 1 energy production in its first year was 110 percent more than projected, with no downtime due to maintenance issues. In calendar year (CY) 2022, Brightfield 1 produced 246, 500 kWh of energy.

In addition, through the cooperative efforts of DOE, UCOR, RSI, Vis Solis, Inc., CROET, and City of Oak Ridge, a second solar farm—the Powerhouse Six Solar Farm—was constructed on the west end of the park. It is a 1-MW solar farm that became operational in April 2015 and provides renewable energy, long-term lease income to CROET, and bolsters development at ETTP. This project continues to provide numerous benefits to the environment and the community at large, which include the following:

- Generates enough clean energy to power more than 100 homes
- Prevents pollution by removing the equivalent of 240 cars from the road annually (1,141 metric tons of CO_2)
- Provides brownfield reuse/redevelopment at ETTP
- Supports City of Oak Ridge renewable energy goals
- Supports TVA renewable energy initiatives
- Offers community economic development jobs and property tax income to City of Oak Ridge.
- Demonstrates benefits of ETTP reindustrialization.
- Supports DOE renewable energy goals.
- Demonstrates collaborative success between DOE and a public utility for renewable energy development

To steer the focus on the management of UCOR's upstream Scope 3 GHG emissions, UCOR initiated a Sustainable Supply Chain Council in fiscal year (FY) 2022. Through field-level testing of environmentally preferable product alternatives, sustainable procurement training and tools, expanded contract clauses, and other approaches, UCOR is incorporating sustainability and climate management into every aspect of its business and strengthening its resilience.

UCOR also continues to use environmentally sustainable products. Large quantity purchases are evaluated for less toxic alternatives. Other product purchases are first reviewed to determine if a recycled content material or biobased content alternatives are commercially available, and those alternatives are prioritized for purchase when feasible.

UCOR's exceptional electronics stewardship earned it an award in 2022 from the Global Electronics Council for its use of Electronic Product Environmental Assessment Tool™ methods and leadership in sustainable electronics procurement. This is the eighth consecutive year that UCOR has won an EPEAT™ award.

UCOR incorporates elements of Executive Orders (EOs) 14057 and 14008, climate science, source reduction, circularity, recycling, and pollution prevention (P2) and waste minimization practices in its work processes and activities. As an example, Figure 3.5 presents a selection of information on UCOR's 2022 P2 recycling activities related to solid waste reduction at ETTP. UCOR recycles much of its universal waste, municipal solid waste and scrap metal, reuses large amounts of construction and demolition debris, and encourages the reduction of waste wherever possible. UCOR's zero-waste program provides end-use avenues for products that are no longer useful to the current user, leading to a more circular economy. Products are reused or repurposed after use when possible. Products that cannot be reused or repurposed are recycled.

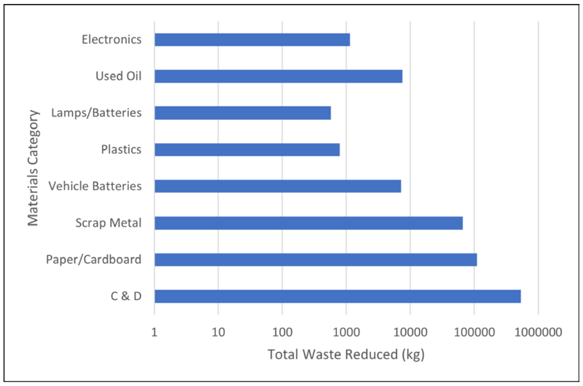


Figure 3.5. Pollution prevention recycling activities related to solid waste reduction at ETTP in FY 2022

In 2016, a significant improvement in the diversion of scrap metal was made, by petitioning and receiving agreement from the EPA and the Tennessee Department of Environment and Conservation (TDEC) to apply an unprecedented CERCLA screening process that allows noncontaminated scrap metal from CERCLA areas, previously excluded from commercial recycling services, to be safely shipped to commercial scrap-metal dealers for recycle. Effectively, the screening process removes the noncontaminated scrap metal from regulation under CERCLA; therefore, any non-CERCLA commercial scrap-metal recyclers can receive the material for recycle. This agreement continues to be successfully employed, allowing approximately 146,130 lb of scrap metal to be recycled in FY 2022 in lieu of land disposal and provides a path forward for additional waste diversion for the duration of the contract.

Some of the significant benefits of the scrap-metal recycling under this approval include:

- Provides funds from the recycling payments that are available to go back into the programs and support further actions in the Oak Ridge cleanup program
- Conserves valuable landfill space. As of FY 2022, 936,392 lb of scrap-metal recycled as a result of the screening process, diverting a valuable material from the landfill for reclamation, while saving capital cost, landfill capacity, historical operating costs, packing, and transportation
- Supports EPA, TDEC, and DOE programmatic environmental stewardship goals for waste diversion

The CERCLA screening process will continue to be used as more demolition and cleanup are continued at ETTP, ORNL, and Y-12.

3.2.1.2. Climate-ready Operations and Infrastructure

UCOR protects the DOE Oak Ridge Office of Environmental Management's (OREM) mission-critical assets by building climate-ready operations and infrastructure. The UCOR Vulnerability Assessment & Resilience Plan was developed to identify site-level risks to mission-critical assets and infrastructure posed by climate change. Current and projected climate hazards and trends were characterized using science-based resources. A risk matrix was prepared to help prioritize areas for focus for resilience solutions development and funding.

UCOR is more closely monitoring the impacts of weather events including performing post-weather event analyses to assess and trend the impacts to OREM's mission.

Sustainable resilient remediation best management practices are also being implemented to limit negative environmental impacts, maximize social and economic benefits, create resilience against increasing climate threats, and improve long-term risk management. UCOR is one of the DOE contractors having responsibilities for land management of portions of the ORR. The Natural Resources Management Team for ORR, centered at ORNL and partially funded by UCOR, is responsible for the creation and implementation of an Invasive Plant Management Plan. At ETTP, these efforts have included:

- Exposure Unit (EU)-29 demonstration field invasive plant control
- Powerhouse Trail privet control
- Wheat Church Vista invasive plant control

- Black Oak Ridge Conservation Easement kudzu and invasive plant control

For additional information, please see Chapter 6.

3.2.1.3. Education and Partnerships

Research has shown that the most sustainable outcomes come from a climate-aware workforce and community, and collaboration between stakeholders with mutual goals. UCOR is investing in specialized awareness and education efforts designed to develop a climate- and sustainability-focused workforce. Engaging activities featuring sustainability and climate management lessons are brought to the workers in the field. Other specialized training, such as a nine-month procurement-based climate foundations training was provided in FY 2022 to members of UCOR's supply chain management organization. These efforts are fostering a culture of sustainability and climate action throughout the workforce and developing resources to effectively implement OREM's sustainability goals.

In addition to building awareness and competency, UCOR is also leveraging partnerships to achieve its ambitious sustainability goals. These partnerships include other communities:

- Historic, predominantly minority Scarboro Community, focused on environmental justice and workforce development
- Historically Black Colleges and Universities and Minority Serving Institutions to increase awareness and access to environmental management careers
- Labor organizations to promote diversity in the workforce
- Oak Ridge High School mentorship program, educating local youth on sustainable practices

Additional collaborations have been established with public and private sectors, including:

- TVA for assistance in UCOR's renewable energy and electric vehicle transitions
- University of Tennessee for educational and opportunity awareness
- Other ORR contractors to develop the most efficient and collaborative approaches to accomplishing sustainability goals and climate resilience
- Suppliers to encourage efforts to reduce GHG emissions

UCOR reinforces good environmental stewardship and sustainability practices throughout the workforce with its Sustainability Leadership Awards, a competitive internal recognition program. Thirteen categories for nominations include topics such as energy management, acquisition and procurement, travel and commuting, and waste management. The program was expanded in 2023 to include a category for Diversity, Equity, and Inclusion to acknowledge that it is essential to sustainability and to encourage further development of these UCOR values. Four UCOR projects and one honorable mention were recognized in 2022, which are summarized below.

- The EU-21 Water Treatment System Team was recognized for treating trichloroethylene (TCE) using a Water Treatment System (WTS) to treat 282,000 gal of water on-site and saving $1,128,000 in water treatment off-site and 26.1 metric tons (MT) of greenhouse gas emissions for eliminating transportation, totaling a savings of $777,850 (i.e., operation of WTS vs. hauling/treating) since operating costs for the WTS totaled $357,665.
- The ORNL Waste Operations' Team was recognized for reusing the Activated-Carbon Free Granulated Activated Carbon (GAC) columns at Building 3608, converting the old GAC Feed Sump (F-1017) at Building 3608 to an unloading station for receipt of non-radiologically contaminated wastewater. Overall savings were $48,000 for diverting purchase of similar-sized Backwash Surge Tank, $40,000 by repurposing the GAC Feed Sump as a tanker unloading station, and conserving valuable landfill space at Environmental Management Waste

Management Facility (EMWMF) resulting in approximately 174 yd^3 in avoided disposal volume.

- The Heritage Center Area Project was recognized for transferring six large electrical transformers from ETTP to the City of Oak Ridge for reuse. This action eliminated the threat of a spill of the 23,000 gal of mineral oil contained in the transformers, avoided 0.05 MT of GHG emissions by recycling the copper within the transformers, and saved the disposal and transportation costs of disposing the transformers (weighing 273,316 lbs) in the landfill.
- The ORR Landfill Team was recognized for removing and storing 3,349 dump trucks of excess soil for reuse as landfill cover for both ILF-V and CDL-VII instead of disposing as waste. The project calculated a savings of $669,800 in clean fill material that would otherwise have been procured from an outside vendor, and saved space in the spoil area.
- The Scarboro Workforce Project was recognized for hosting the Scarboro Community Workforce Workshop for the historically African American community (called Scarboro), providing several opportunities for employment and the opportunity to sign up for the East Tennessee Apprenticeship Readiness Program to over 40 of its residents.

Together, the projects represented sustainability accomplishments in resource conservation, waste diversion, waste reduction, and P2. These accomplishments were the result of teamwork, leveraging a number of work control and management tools to save landfill space, reduce the use of virgin material, mitigate hazards to the environment and workers, and increase work efficiencies.

In 2022, the Sustainability Leadership Award winning projects saved more than 226 MT of GHG emissions, 273,490 MT of waste from landfills, and prevented 282,000 gal of wastewater generation. In addition to lessening the impact on the environment, these P2 measures also saved more than $1.6 million.

3.2.2. Environmental Compliance

UCOR maintains various layers of oversight to ensure compliance with legal and other requirements. The methods of evaluation include independent assessments by outside parties, assessments conducted by functional or project organizations, and routine field walkdowns conducted by a variety of functional and project personnel. Assessments are prioritized and scheduled based on risk management principles and performed in accordance with procedures. Records are maintained for all formal assessments and audits. Issues identified in assessments are handled, as required, by ISO 14001:2004, Section 4.5.3, "Nonconformity, Corrective Action, and Preventive Action" (ISO 2004). For additional information, see Section 3.4.

3.2.3. Environmental Aspects/Impacts

Using a graded approach appropriate for EMS includes an environmental policy that provides a unified strategy for the management, conservation, and protection of natural resources; the control and attenuation of risks; and the establishment and attainment of all environmental, safety, and health (ES&H) goals. UCOR works continuously to improve its EMS to reduce impacts from activities and associated effects on the environment (i.e., environmental aspects) and to communicate and reinforce this policy to its internal and external stakeholders.

3.2.4. Environmental Performance Objectives and Targets

UCOR conserves and protects environmental resources by: (1) incorporating environmental protection and the elements of an enabling EMS into the daily conduct of business; (2) fostering a spirit of cooperation with federal, state, and local regulatory agencies; and (3) using appropriate waste management, treatment, storage, and disposal methods.

UCOR has established a set of core company-level EMS objectives that remain relatively unchanged from year to year. These objectives are generally applicable to all operations and activities throughout UCOR's work scope. The core environmental objectives are based on compliance with applicable legal requirements and sustainable environmental practices contained in DOE Order 436.1, *Departmental Sustainability* (DOE 2011b), and include the following:

- Comply with all applicable environmental regulations, permits, regulatory agreements, and DOE orders.
- Reduce or eliminate the acquisition, use, storage, generation, and/or release of toxic, hazardous, and radioactive materials; waste; and GHG through acquisition of environmentally preferable products, conduct of operations, removal and safe disposition, waste minimization, and sustainable practices.
- Reduce degradation and depletion of environmental resources and potential impact on climate change through post-consumer material recycling, energy, fuel, and water conservation efforts, use or promotion of renewable energy, community engagement, and transfer for reuse valuable real estate assets.
- Reduce the environmental impact on surface water and groundwater resources.
- Reduce the environmental impact associated with project and facility activities.

The EMS objectives and targets reduce the environmental impact of UCOR activities and accomplish the DOE sustainability goals. Each year, ETTP reports its performance in the DOE Sustainability Dashboard, which collects data such as energy and water usage, GHG generation, sustainable buildings, facility metering, waste diversion, renewable energy, sustainable acquisitions, and electronic stewardship.

The Office of Management and Budget's Environmental Stewardship Scorecard is used to track and measure site-level EMS performance. During FY 2022, UCOR received a "green" for EMS performance, indicating full implementation of EMS requirements.

3.2.5. Implementation and Operation

UCOR protects the safety and health of workers and the public by identifying, analyzing, and mitigating aspects, hazards, and impacts from ETTP operations, and by implementing sound work practices. All UCOR employees and subcontractors are held responsible for complying with all ES&H requirements during all work activities and are expected to correct noncompliant conditions immediately. UCOR's internal assessments also provide a measure of how well EMS attributes are integrated into work activities through the Integrated Safety Management System. UCOR has embodied its program for the environmental compliance and the protection of natural resources in a companywide environmental management and protection policy. The policy is UCOR's fundamental commitment to incorporating sound environmental management practices in all business decisions, work processes, and activities.

3.2.6. Pollution Prevention/Waste Minimization/Release of Property

UCOR's work control process requires that all waste-generating activities be evaluated for source reduction and that product substitution be used to produce less toxic waste, when possible. The reuse or recycling of building debris and other generated wastes is evaluated in all cases.

The ETTP EMS program fosters P2 at every level of its operations, from routine office recycling of paper, cardboard, and plastics, to unique reuse and recycling at the project-field level. UCOR's P2 program is successful because it is tightly bound to its work control process. Thus, many original applications of material reuse and recycling have resulted, many of which have been captured through its internal P2 awards program. Each year, the projects that are recognized in the P2 internal awards program are often the source of

UCOR's national-level awards nominations (e.g., DOE Headquarters annual award program).

DOE Order 458.1, *Radiation Protection of the Public and Environment* (DOE 2011a), requires that a process be in place to ensure that radiologically contaminated materials are not released to the public or the environment, except in compliance with permit effluent requirements or other agreements with regulatory agencies. Materials and equipment may be released to the public through an approved pollution prevention/recycling program or through property sales (procedure PROC-PR-2032, *Disposition of Personal Property* [UCOR 2020a], governs the process of releasing personal property), and real property may be transferred to the public through CROET.

Materials and equipment that are to be recycled or reused may follow one of two paths. If process knowledge is sufficient to establish that the materials and equipment have never been in contaminated areas (for example, empty beverage cans from a specified break area or an office building), then the materials may be released for recycling or reuse. Materials and equipment that have been in radiologic areas must be examined by trained radiologic control technicians and the results documented before the materials and equipment may be released. Materials and equipment that fail to meet the free release criteria are either decontaminated to the point that they meet the free release criteria or are properly disposed of at an appropriate disposal facility. The release of property from radiologic areas is governed by procedure PROC-RP-4516, *Radioactive Contamination Control and Monitoring* (Table 3.1). In addition to the types and quantities of recycled materials and equipment shown above in Figure 3.5, 404,607 kg of office furniture, office supplies, electronics, electrical equipment, and building materials were released to the public through property sales.

Real property to be transferred must meet the release criteria established by DOE Order 458.1 (DOE 2011a) and the appropriate record of decision (ROD). DOE ensures that these requirements are met through independent verification by a third party. Currently, this verification is performed by Oak Ridge Associated Universities (ORAU) through a direct contract with DOE. The direct contract with DOE ensures that the evaluation is conducted independently of UCOR, DOE's cleanup contractor. ORAU reviews historic data, facility use history, verification strategies, methodologies, techniques, and equipment. When ORAU deems it appropriate, additional sampling and/or radiological surveys are undertaken. Results of the evaluation and verification are summarized in a report to DOE that is then submitted to DOE Headquarters for approval as part of the transfer package. Section 3.8 contains a summary of the real property releases to the public.

Table 3.1. Surface contamination values and DOE Order 458.1 authorized limits for surface activity

Radionuclide	Removable	Total (fixed + removable)
Natural Uranium, ^{235}U, ^{238}U, and associated decay products	1,000	5,000
Transuranic, ^{226}Ra,^{228}Ra,^{230}Th,^{228}Th,^{231}Pa,^{227}Ac,^{125}I,^{129}I	20	100/500
Natural Th, ^{232}Th,^{90}Sr,^{223}Ra,^{224}Ra,^{232}U,^{126}I,^{131}I,^{133}I	200	1,000
Beta-gamma emitters except ^{90}Sr and others noted above	1,000	5,000
Tritium and Special Tritium Compounds	10,000	
Hard to Detect: Pu-241, C-14, Fe-55, Ni-59, and Ni-63	10,000	50,000

Note: *Limits are shown in dpm/100 cm*^{2}.

3.2.7. Competence, Training, and Awareness

The UCOR training program and qualification process ensures that needed skills for the workforce are identified and developed and documents knowledge, experience, abilities, and competencies of the workforce for key positions requiring qualification. Completion and documentation of training, including required reading, are managed by the Local Education Administration Requirements Network, or LEARN.

3.2.8. Communication

UCOR communicates externally regarding environmental aspects through the UCOR public website, found **here**, which includes a link to its environmental policy statement in *Environmental Management and Protection,* POL-UCOR-007 (UCOR 2020c), and a list of environmental aspects.

A number of other documents and reports that address environmental aspects and cleanup progress are also published and made available to the public (e.g., the *Oak Ridge Annual Site Environmental Report* [ASER], DOE 2022d, DOE-SC-OSO/RM-2022-01] and the annual cleanup progress report [UCOR 2023, *2022 Cleanup Progress—Annual Report on Oak Ridge Reservation Cleanup,* OREM-23-7632]).

UCOR participates in a number of public meetings related to environmental activities at the site (e.g., Oak Ridge Site Specific Advisory Board meetings, which include community stakeholders, public permit reviews, and public CERCLA decision document reviews). Written communications from external parties are tracked using the weekly Open Action Report.

3.2.9. Benefits and Successes of Environmental Management System Implementation

An EMS program provides many benefits to an organization's success. Based upon the simplified model of Plan-Do-Act-Check, it provides a framework by which work incorporates mitigation of environmental hazards into its work control and planning. This translates into many returns to the organization. UCOR uses EMS objectives and targets, an internal P2 recognition program, environmentally preferable purchasing, work control processes, and a recycle program to meet sustainability and environmental stewardship goals and requirements. The approach is outlined in UCOR's *Pollution Prevention and Waste Minimization Program Plan for the East Tennessee Technology Park, Oak Ridge, Tennessee* (UCOR 2022a, UCOR-4127/R10). The EMS program is audited by a third party triennially for conformance to the ISO 14001:2004 standard (ISO 2004) as required by DOE Order 436.1, *Departmental Sustainability, Attachment1 Contractor Requirements Document* (DOE 2011b), with the most recent having been conducted in 2021. The results of the audit were zero findings, two observations, and three proficiencies.

3.2.10. Management Review

A formal review/presentation with UCOR senior management is conducted once per year that addresses the ISO 14001:2004 (ISO 2004) required elements, including focus areas for the upcoming year. At least two of the senior managers are present for management reviews. The environmental policy is also reviewed during the annual EMS management review and revised, as necessary. Also, periodic reports are submitted to senior management on the status of EMS calendar year company-level objectives and targets.

3.3. Compliance Programs and Status

During 2022, ETTP operations were conducted in compliance with contractual and regulatory environmental requirements. There were no National Pollutant Discharge Elimination System (NPDES) noncompliances, nor did ETTP receive any Notices of Violation in 2022. Figure 3.6 shows the trend of NPDES compliance at ETTP since 2012. The following sections provide more detail on each compliance program and the environmental remediation-related activities in 2022. In addition, ETTP is tracked on EPA's

Enforcement and Compliance History Online database (FRS ID 110002471094).

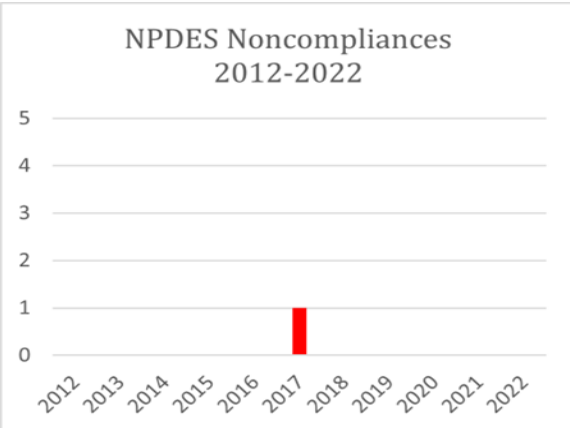


Figure 3.6. ETTP NPDES permit noncompliances since 2012

3.3.1. Environmental Permits Compliance Status

Table 3.2 contains a list of environmental permits that were in effect at ETTP in 2022. ETTP received no notices of environmental violations or penalties in 2022.

Table 3.3 presents a summary of environmental audits and oversight visits conducted at ETTP in 2022.

3.3.2. National Environmental Policy Act

The National Environmental Policy Act (NEPA) provides a means to evaluate the potential environmental impact of proposed federal activities and to examine alternatives to those actions. ETTP maintains compliance with NEPA through the use of site-level procedures and program descriptions that establish effective and responsive communications with program managers and project engineers to ensure NEPA is a key consideration in the formative stages of project planning.

For many of the current operations at ETTP conducted under CERCLA, NEPA reviews are conducted concurrently with the CERCLA planning process to ensure that NEPA values are incorporated into CERCLA projects and documentation. These NEPA values include analysis of cumulative, off-site, ecological, and socioeconomic impacts. Opportunities for early public involvement are also provided early in the CERCLA process which meet the requirements of NEPA.

For non-CERCLA activities, a checklist incorporating NEPA and EMS requirements has been developed as an aid for project planners which document the potential for impacts on the environment. This checklist is used to collect necessary information to conduct a NEPA review. NEPA reviews identify new or changing environmental aspects associated with proposed activities. During 2022, three NEPA review reports were generated to document UCOR activities: cleanout of a facility in preparation for demolition, construction of a storage yard, and removal of power poles and feeder lines from an environmentally sensitive area.

To streamline the NEPA review and documentation process of non-CERCLA work, the DOE Oak Ridge Office has approved generic categorical exclusion (CX) determinations that cover certain proposed activities (i.e., maintenance activities, facility upgrades, personnel safety enhancements). A CX is a category of actions defined in 40 *Code of Federal Regulations* (CFR) Part 1508.4 (EPA 1978) that does not individually or cumulatively have a significant effect on the human environment and for which neither an environmental assessment nor an environmental impact statement is normally required. One additional CX was developed in 2022 to cover UCOR structure demolition and site cleanup at ORNL.

3.3.3. National Historic Preservation Act

UCOR compliance with the National Historic Preservation Act (NHPA) on the ORR is achieved and maintained in conjunction with NEPA compliance. The scope of proposed actions is reviewed in accordance with the ORR Cultural Resource Management Plan (Souza et al. 2001).

Table 3.2. East Tennessee Technology Park environmental permits, 2022

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	NPDES permit for groundwater and storm water discharges	TN0002950	02-04-2022	03-31-2020 Remained in effect through 3-31-2022; New permit became effective on April 1, 2022	DOE	UCOR	UCOR
CWA	SOP—waste transportation project; Blair Road and Portal 6 sewage pump and haul permit	SOP-05068	07-01-2014	02-28-2019 Remains in effect	TTS	TTS	TTS
RCRA	Hazardous waste corrective action document (encompasses entire ORR)	TNHW-164	09-15-2015	09-15-2025	DOE	DOE/All[a]	DOE/All[a]

[a] *DOE and ORR contractors that are co-operators of hazardous waste permits.*

Acronyms:
CAA = Clean Air Act
CWA = Clean Water Act
DOE = US Department of Energy
ETTP = East Tennessee Technology Park
ID = identification (number)
NOA = Notice of Authorization
NPDES = National Pollutant Discharge Elimination System
ORR = Oak Ridge Reservation
PBR = Permit-by-Rule
RCRA = Resource Conservation and Recovery Act
SOP = state operating permit
TDEC = Tennessee Department of Environment and Conservation
TTS = Turnkey Technical Services, LLC.
UCOR = UCOR, an Amentum-led partnership with Jacobs

Table 3.3. Regulatory oversight, assessments, inspections, and site visits at East Tennessee Technology Park, 2022

Date	Reviewer	Subject	Issues
April 25	TDEC	ETTP NPDES Compliance Inspection	0

Acronyms:
COR = City of Oak Ridge
EPA = US Environmental Protection Agency
ETTP = East Tennessee Technology Park
NPDES = National Pollutant Discharge Elimination System
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation

3.3.3.1. NHPA Compliance at ETTP

There were 135 facilities at ETTP eligible for inclusion on the National Register of Historic Places, a US National Park Service program to identify, evaluate, and protect historic and archeological resources in the United States, and numerous other facilities that were not eligible for inclusion on the National Register of Historic Places. More than 800 facilities were demolished at ETTP.

To commemorate the historic contributions of the ETTP K-25 gaseous diffusion plant, the first such uranium processing plant in the world, a final mitigation plan was developed by DOE in 2012 in exchange for the demolition of the facility. The mitigation plan called for the designation of a commemorative area around the building's perimeter from which future surface development would largely be restricted; the demarcation of the building's footprint; the construction of a viewing platform; an online virtual museum; and the development of a history center within the ETTP Fire Station #4. The final MOA was signed in August 2012 between DOE, the State Office of Historic Preservation, the Federal Advisory Council on Historic Preservation, the City of Oak Ridge, and the East Tennessee Preservation Alliance (DOE 2012). The K-25 History Center opened to the public on February 27, 2020.

On December 16, 2022, the U.S. Army Corps of Engineers, which is overseeing the construction of the K-25 Viewing Platform, issued a solicitation for construction bids to select a contractor to build the facility. UCOR will be providing engineering support to the Corps during construction and will also procure and manage the fabrication and installation of exhibits for the viewing platform. These exhibits will enrich the visitor experience to the Viewing Platform by providing photos, facts, view scopes, and a scale model of the K-25 Building.

The K-25 History Museum and Viewing Platform complement the Manhattan Project National Historic Park established in 2015, which includes the footprint of the former K-25 Building (DOI 2015).

3.3.3.2. NHPA Compliance Throughout the ORR

In accordance with Section 106 of the NHPA, UCOR works with OREM to provide a system of review for UCOR D&D projects that have the potential to affect historic and archaeological resources on the ORR. The review process is guided by ORNL and Y-12 Programmatic Agreements, which follow the approach outlined in each site's Historic Preservation Plan, and also MOAs between DOE, the state of Tennessee, the Advisory Council on Historic Preservation, and consulting parties.

Undertakings by UCOR that affect facilities identified as historical and cultural resources in the Historic Preservation Plans undergo a three-tier system of review: (1) Level One—programmatic exclusions (no adverse effect on historic properties); (2) Level Two—internal review by the UCOR NHPA coordinator and/or OREM and/or the OREM Cultural Resources Management Coordinator; and (3) Level Three—review by the Tennessee State Historic Preservation Officer. DOE activities involving ORR artifacts of historical and/or cultural significance are identified before demolition and are catalogued in a database to aid in historic interpretation. In 2022, 11 Level One and 9 Level Two reviews were conducted for UCOR D&D activities.

3.3.4. Clean Air Act Compliance Status

The Clean Air Act (CAA), passed in 1970 and amended in 1977 and 1990, forms the basis for the national air pollution control effort. This legislation establishes comprehensive federal and state regulations to limit air emissions and includes five major regulatory programs: the National Ambient Air Quality Standards, State Implementation Plans, New Source Performance Standards, Prevention of Significant Deterioration permitting programs, and National Emission Standards for Hazardous Air Pollutants (NESHAPs). Airborne discharges from DOE Oak Ridge facilities, both radioactive and nonradioactive, are subject to regulation by EPA and the TDEC Division of Air Pollution Control.

Full compliance with CAA regulations and permit conditions was demonstrated in 2022. The ETTP ambient air-monitoring program, permitted source operations tracking, and record keeping provided documentation fully supporting a 100-percent compliance rate.

3.3.5. Clean Water Act Compliance Status

The objective of the Clean Water Act (CWA) is to restore, maintain, and protect the integrity of the nation's waters. This act serves as the basis for comprehensive federal and state programs to protect the waters from pollutants (see Appendix C for water reference standards). One of the strategies developed to achieve the goals of the CWA was EPA's establishment of limits on specific pollutants allowed to be discharged in US waters by municipal sewage treatment plants and industrial facilities. EPA established the NPDES permitting program to regulate compliance with pollutant limitations. The program was designed to protect surface waters by limiting effluent discharges into streams, reservoirs, wetlands, and other surface waters. EPA has delegated authority for implementation and enforcement of the NPDES program to the state of Tennessee.

In 2022, ETTP discharged storm water and groundwater to the waters of the state of Tennessee under the individual NPDES permit TN0002950, which regulates storm water discharges. Sewage discharges from routine breakrooms, restrooms, and change house showers were discharged to the City of Oak Ridge Rarity Ridge Wastewater Treatment Plant collection network.

3.3.6. National Pollutant Discharge Elimination System Permit Noncompliances

In 2022, compliance with ETTP NPDES storm water permit TN0002950 was determined by more than 120 laboratory analyses, field measurements, and flow estimates. The NPDES permit compliance rate for all discharge points for 2022 was 100 percent.

3.3.7. Safe Drinking Water Act Compliance Status

Since October 1, 2014, all water at the ETTP site is supplied by the City of Oak Ridge drinking water plant, located north of the Y-12 Complex in Oak Ridge, Tennessee. ETTP operations are in full compliance with this act.

3.3.8. Resource Conservation and Recovery Act Compliance Status

ETTP is regulated as a large-quantity generator of hazardous waste because the facility generates more than 1,000 kg of hazardous waste per month. At the end of 2022, ETTP had two hazardous waste Central Accumulation Areas, managed and operated by personnel of the Uranium Processing Facility, a Consolidated Nuclear Security, LLC owned project.

TNHW-164 is the hazardous waste corrective action document, which covers ORR areas of concern and solid waste management units.

In CY 2022, ETTP prepared and submitted to the TDEC Division of Solid Waste Management the CY 2021 annual report of hazardous waste activities. This report identifies the type and amount of hazardous waste that was generated, shipped off site, or is staged for shipment. In 2022, ETTP was in full compliance with this act.

3.3.9. Comprehensive Environmental Response, Compensation, and Liability Act Compliance Status

CERCLA, also known as "Superfund," was passed in 1980 and was amended in 1986 by the Superfund Amendments and Reauthorization Act. Under CERCLA, a site is investigated and remediated if it poses significant risk to health or the environment. The EPA National Priorities List is a comprehensive list of sites and facilities that have been found to pose a sufficient threat to human health and/or the environment to warrant cleanup under CERCLA. ORR is on the National Priorities List and numerous CERCLA decision documents are approved for ETTP site cleanup actions for both facility demolitions and soil remediation. In 2022, ETTP was in full compliance with this act.

3.3.10. East Tennessee Technology Park RCRA-CERCLA Coordination

The *Federal Facility Agreement for the Oak Ridge Reservation* (DOE 1992, FFA-PM/18-011, DOE/OR-1014) is intended to coordinate the corrective action processes of Resource Conservation and Recovery Act (RCRA) required under the *Hazardous and Solid Waste Amendments* permit with CERCLA response actions.

3.3.11. Toxic Substances Control Act (TSCA) Compliance Status–Polychlorinated Biphenyls

On April 3, 1990, DOE notified EPA Headquarters (as required by 40 CFR Part 761.205, *Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions* [EPA 1979]) that ETTP is a generator with on-site storage, a transporter, and an approved disposer of PCB wastes.

In 2022, ETTP operated one long-term PCB waste storage area on-site where nonradioactive PCB waste was stored in a facility that was not a RCRA-permitted storage facility. This storage area was closed in May 2022. At this time, no PCB-contaminated electrical equipment is in service at ETTP.

Because of the age of many ETTP facilities and the varied uses for PCBs in gaskets, grease, building materials, and equipment, DOE self-disclosed unauthorized use of PCBs to EPA in the late 1980s. As a result, DOE Oak Ridge Office and EPA Region 4 consummated a major compliance agreement known as the *Oak Ridge Reservation Polychlorinated Biphenyl Federal Facilities Compliance Agreement* (DOE 2018, ORR-PCB-FFCA), which became effective December 16, 1996, and was last revised on October 8, 2018, to Revision 6. The facilities that were included on the ORR-PCB-FFCA have been demolished and disposed.

ORR-PCB-FFCA specifically addresses the unauthorized use of PCBs in ventilation ducts and gaskets, lubricants, hydraulic systems, heat transfer systems, and other unauthorized uses; storage for disposal; disposal; cleanup and/or decontamination of PCBs and PCB items, including PCBs mixed with radioactive materials; and ORR records and reporting requirements. A major focus of the agreement is the disposal of PCB waste. As a result of that agreement, DOE and UCOR continue to notify EPA when additional unauthorized uses of PCBs, such as in paint, adhesives, electrical wiring, or floor tile, are identified at ETTP. This notification process is routinely incorporated into the CERCLA documentation for demolition and remedial actions (RAs).

The ETTP site prepares a PCB Annual Document Log (PCBADL) per 40 CFR Part 761.180(a) (EPA 1979). The written PCBADL is prepared by July 1 of each year and covers the previous calendar year. The PCBADL documents such things as container inventory, shipments, and PCB spills at the facility. Authorized representatives of EPA may inspect the PCBADL at the facility where they are maintained during normal business hours. The PCBADL must be maintained on-site for a minimum of three years. In 2022, ETTP was in full compliance with this act.

3.3.12. Emergency Planning and Community Right-to-Know Act Compliance Status

The Emergency Planning and Community Right-to-Know Act (EPCRA), which is also identified as Title III of the Superfund Amendments and Reauthorization Act, requires that facilities report inventory that exceed threshold planning quantities and releases of hazardous and toxic chemicals. The reports are submitted electronically and are available online for the local emergency planning committee, the state emergency response commission, and the local fire department. ETTP complied with these requirements in 2022 through the submittal of required reports as applicable under EPCRA Sections 302, 311, 312, and 313. ETTP had no reportable releases of hazardous substances or extremely hazardous substances, as defined by EPCRA, in 2022.

3.3.12.1. Chemical Inventories (EPCRA Section 312)

Inventories, locations, and associated hazards of hazardous and extremely hazardous chemicals were submitted in an annual report to state and local emergency responders, as required by EPCRA Section 312. Of the ORR chemicals identified for 2022, eight chemicals were located at ETTP. These chemicals were diesel fuel, unleaded gasoline, sulfuric acid (including large, lead-acid batteries), Chemical Specialties, Inc. Ultrapoles, Flexterra FGM erosion control agent, sodium polyacrylate, CETCO Quik-Solid, and various lubricating oils.

3.3.12.2. Toxic Chemical Release Reporting (EPCRA Section 313)

EPCRA Section 313 requires facilities to complete and submit a toxic chemical release inventory (TRI) form (Form R) annually. Form R must be submitted for each TRI chemical that is manufactured, processed, or otherwise used in quantities above the applicable threshold quantity. The reports address releases of certain toxic chemicals to air, water, land, and waste management, recycling, and P2 activities.

Threshold determinations and reports for each of the ORR facilities are made separately. Operations involving TRI chemicals were compared with regulatory thresholds to determine which chemicals exceeded the reporting thresholds based on amounts manufactured, processed, or otherwise used at each facility. After threshold determinations were made, releases and off-site transfers were calculated for each chemical that exceeded the threshold quantity. In 2022, there were no chemicals that met the reporting requirements.

3.3.12.3. Environmental Justice

UCOR strives to increase environmental justice efforts by advocating for and facilitating underserved and marginalized communities' involvement in environmental decision making. UCOR incorporates elements of EO 14008, Justice40 Initiative, and environmental justice initiatives into its community investment and commitment and workforce development programs. UCOR aspires to attract and maintain a diverse workforce that will promote the next generation of cleanup. This goal is achieved by increasing awareness and access to environmental management careers in minority and underserved communities; collaborating with labor organizations to promote diversity in the labor workforce; partnering with Historically Black Colleges and Universities and Minority Serving Institutions; and maintaining a culture of inclusion and accountability.

UCOR aims to create innovative tactics to bridge the gap between our work and the community. UCOR and DOE have partnered with the historic, predominantly minority Scarboro Community throughout its contract. The UCOR senior leadership team has cultivated relationships with Scarboro Community leaders and meet with them often to provide updates on environmental cleanup projects. A meeting was established with Scarboro Community members to best understand how benefits can be shared with the community. In this meeting, community leaders said they want to receive on-going information about economic benefits and opportunities for employment to help socio-economic growth in their area. UCOR sponsored a workforce workshop at the Scarboro Community Center. Information was presented on apprenticeships, careers at UCOR, and small business opportunities. The workshop is part of ongoing outreach effort to increase UCOR's environmental justice initiatives, identify barriers to employment, and build and maintain a skilled and diverse workforce. The workshop featured several UCOR staff augmentation companies, the American Job Center, the Knoxville Building & Construction Trades Council, and the Knoxville Urban League. The event allowed community members to speak to each vendor depending on their specific employment paths and interests.

UCOR keeps frequent communication establishing Environmental Justice E-mail Blast to the Scarboro Community. The email updates the community on available job opportunities and events at UCOR. This informal medium provides a direct pipeline of information to the community and facilitates opportunities for two-way communication with members of the community. The distribution reaches 80-plus key stakeholders in and around the Scarboro Community.

UCOR provided information about grant opportunities to an environmental non-profit organization, Socially Equal Energy Efficient Development, which provides pathways out of poverty for young adults through career readiness training, environmental education, and community engagement. Representatives of UCOR introduced environmental justice topics and initiatives and provided the organization with resources to apply for J40 and environmental grant opportunities.

UCOR has established formal Memoranda of Understanding with a Minority Serving Institution, Florida International University in Miami, Florida. The company hosted site visits with its HBCU Partnership schools, Tennessee State University in Nashville, Tenn., and Benedict College in Columbia, S.C., to grow DOE's future workforce. UCOR hosted two interns from the Mentorship for Environmental Scholars Program, which provides HBCU students with exposure to DOE EM careers. These actions support our mission and increase our environmental justice efforts.

3.4. Quality Assurance Program

Integrated Assessment and Oversight Program

Quality assurance (QA) program implementation and procedural and subcontract compliance are verified through the UCOR integrated assessment and oversight program. The program identifies the processes for planning, conducting, and coordinating assessment and oversight of UCOR activities, including both self-performed and subcontracted activities, resulting in an integrated assessment and oversight process. The program is composed of three key elements: (1) external assessments conducted by organizations external to UCOR, (2) independent assessments conducted by teams composed of UCOR personnel who are not directly involved with the project/function being assessed, and (3) management assessments and surveillances conducted as self-assessments and surveillances by the organization or on behalf of the organization manager.

Self-assessments are performed by the organization/function with primary responsibility for the work, process, or system being assessed. Organizations and functions within the company plan and schedule self-assessments. Self-assessments encompass both formal and informal assessments. The formal self-assessments include management assessments and surveillances, and subcontractor oversight. Informal self-assessments include weekly inspections and routine walkthroughs conducted by subcontractor coordinators, ES&H, and QA representatives, quality engineers, and line managers.

Conditions adverse to quality identified from internal and external assessments are documented, causal analyses are performed, and corrective actions are developed and tracked to closure. Analyses are conducted periodically to identify trends for management action. Senior management evaluates data from those processes to identify opportunities for improvement.

3.5. Air Quality Program

The state of Tennessee has been delegated authority by EPA to convey the clean air requirements that are applicable to ETTP operations. New projects are governed by construction and operating permit regulatory requirements. The owner or operator of air pollutant emitting sources is responsible for ensuring full compliance with any issued permit or other generally applicable CAA requirement. During 2022, ETTP DOE EM operations were under UCOR responsibility for regulatory compliance.

3.5.1. Construction and Operating Permits

UCOR ETTP operations are subject to CAA regulations and permitting under TDEC Air Pollution Control rules that are specific to stationary fossil-fueled reciprocating internal combustion engines for emergency use. TDEC originally issued an operating permit (069346P) covering six stationary emergency reciprocating internal combustion engine (e-RICE) units on March 3, 2015. An amended permit was issued on November 22, 2016, that removed one permanently shut-down unit. The last operating permit was amended on November 22, 2016, and covered four stationary e-RICE generators and one stationary e-RICE firewater booster pump. On July 19, 2018, TDEC provided a Notice of Authorization to UCOR for coverage under Permit-by-Rule for all of the ETTP stationary e-RICE (TDEC 2017b). During 2020 all generators and the firewater booster pump were either removed from the ETTP site or transferred to new owners; UCOR then surrendered its Permit-by-Rule authorization. No stationary e-RICE units were operated by UCOR at ETTP in 2022.

All other ETTP operations that emit low levels of air pollutants have been classified as insignificant under TDEC rules. Any planned stationary sources that may emit air pollutants are evaluated and compared against applicable pollutant emission limits to document this classification and pursue permitting if required under TDEC regulations.

3.5.1.1. Generally Applicable Permit Requirements

ETTP is subject to a number of generally applicable requirements that involve management and control. Asbestos, ozone-depleting substances (ODSs), and fugitive particulate emissions are specific examples.

Control of Asbestos

ETTP's asbestos management program ensures all activities involving demolitions and all other actions involving asbestos-containing materials (ACM) are fully compliant with 40 CFR Part 61, Subpart M, *National Emission Standards for Hazardous Air Pollutants*, "National Emission Standard for Asbestos" (EPA 1984, EPA 1990). This includes using approved engineering controls and work practices, inspections, and monitoring for proper removal and waste disposal of ACM. Most demolition and ACM abatement activities at ETTP are governed under CERCLA. Under this act, notifications of asbestos demolition or renovations, as specified in 40 CFR Part 61.145(b), are incorporated into CERCLA document regulatory notifications.

Non-CERCLA planned demolition or renovation activities were individually reviewed for applicability of the TDEC notification requirements of the rule. During 2022, one Notification of Demolition and/or Asbestos Renovation was submitted to TDEC for non-CERCLA ETTP activities. There were no regulated asbestos containing material demolitions during 2022.

The rule also requires an annual notification for all nonscheduled, minor asbestos renovations if the accumulated total amount of regulated or potentially regulated asbestos exceeds stipulated thresholds. For 2022, the total ETTP projected nonscheduled amounts were below thresholds that would require the submittal of an annual notification to TDEC. No releases of reportable quantities of ACM occurred at ETTP during 2022.

Stratospheric Ozone Protection

The management of ODSs at ETTP is subject to regulations in 40 CFR Part 82, Subpart F, "Recycling and Emissions Reduction" (EPA 1993); these regulations require preparation of documentation to establish that actions necessary to reduce emissions of Class I and Class II refrigerants to the lowest achievable level have been observed during maintenance activities at ETTP. The applicable actions include, but may not be limited to, the service, maintenance, repair, and disposal of appliances containing Class I and Class II refrigerants, such as motor vehicle air conditioners. In addition, the regulations apply to refrigerant reclamation activities, appliance owners, manufacturers of appliances, and recycling and recovery equipment. Figure 3.7 illustrates the historical on-site ODS inventory at ETTP. During 2022, the ODS inventory was zero.

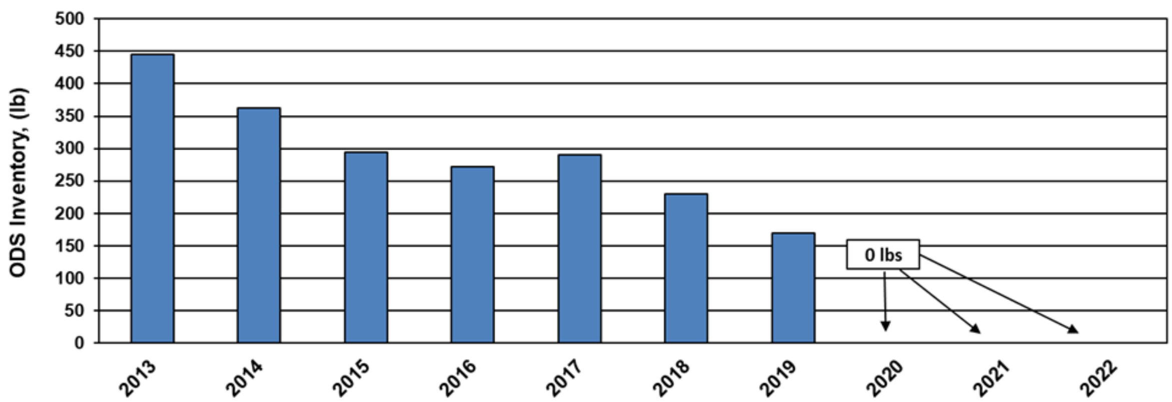


Figure 3.7. East Tennessee Technology Park total on-site ozone-depleting substances inventory, 10-year history

3.5.1.2. Fugitive Particulate Emissions

ETTP has been the location of major building demolition activities, soil remediation activities, and waste debris transportation with the potential for the release of fugitive dust. All planned and ongoing activities include the use of dust control measures to minimize the release of visible fugitive dust beyond the project perimeter. This includes the use of specialized demolition equipment and water misters. Gravel roads in and around ETTP that are under DOE control are wetted with water, as needed, to minimize airborne dusts caused by vehicle traffic.

3.5.1.3. Radionuclide National Emission Standards for Hazardous Air Pollutants

Radionuclide airborne emissions from ETTP are regulated under 40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants (Rad-NESHAP)* (EPA 1989). Characterization of the impact on public health of radionuclides released to the atmosphere from ETTP operations was accomplished by conservatively estimating the dose to the maximally exposed member of the public. The dose calculations were performed using the Clean Air Assessment Package (CAP-88) computer codes, which were developed under EPA sponsorship for use in demonstrating compliance with the 10 mrem/year effective dose National Emission Standards for Hazardous Air Pollutants for radionuclides (Rad-NESHAP) emission standard for the entire DOE ORR. Source emissions used to calculate the dose are determined using EPA-approved methods that can range from continuous sampling systems to conservative estimations based on process and waste characteristics. Continuous sampling systems are required for radionuclide-emitting sources that have a potential dose impact of not less than 0.1 mrem per year to any member of the public. The only ETTP Rad-NESHAP source that operated during 2022—the K-1407 Chromium Water Treatment System (CWTS) Volatile Organic Compound (VOC) Air Stripper is considered minor based on emissions evaluations using EPA-approved calculation methods. A minor

Rad-NESHAP source is defined as having a potential dose impact on the public that is less than 0.1 mrem/year. Compliance is demonstrated using data collected by the ETTP ambient air monitoring program.

Quarterly radiochemical analyses are performed on composited samples collected at all ETTP ambient air sampling stations. The selected isotopes of interest were ^{234}uranium (^{234}U), ^{235}uranium (^{235}U), and ^{238}uranium (^{238}U), with the ^{99}technetium (^{99}Tc) inorganic analysis results included as a dose contributor. The concentration for each of the nuclides at each monitoring station are presented in Table 3.4 for the 2022 reporting period. Only one radionuclide analyzed at ETTP ambient air locations was detected; that result was for ^{235}U at station K11 in the second quarter of 2022. Dose calculations using the concentration results are included in Chapter 7, Table 7.5.

Table 3.4. Radionuclides in ambient air at East Tennessee Technology Park, January 2022 through December 2022

Station	Concentration (µCi/mL)[a]			
	^{99}Tc	^{234}U	^{235}U	^{238}U
K11[b]	ND[c]	ND	2.5E-19	ND
K12[b]	ND	ND	ND	ND

[a] *µCi/mL = microcuries/milliliter*
[b] *K11 and K12 represent an on-site business exposure equivalent to half of a yearly exposure at this location.*
[c] *ND = not detectable*

3.5.1.4. Quality Assurance

QA activities for the Rad-NESHAP program are documented in the *Quality Assurance Program Plan for Compliance with Radionuclide National Emission Standards for Hazardous Air Pollutants, East Tennessee Technology Park, Oak Ridge Tennessee* (UCOR 2018, UCOR-4257/R2). The plan satisfies the QA requirements in 40 CFR Part 61, Method 114 (EPA 1989), for ensuring that the radionuclide air emission measurements from ETTP are representative of known levels of precision and accuracy and that administrative controls are in place to ensure prompt response when emission measurements indicate an increase over normal radionuclide emissions. The requirements are also referenced in TDEC regulation 1200-3-11-.08, *Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities*, TDEC 2018). The plan ensures the quality of ETTP radionuclide emission measurement data from continuous samplers and minor radionuclide release points. Only EPA preapproved methods are referenced through the *Compliance Plan National Emission Standards for Hazardous Air Pollutants for Airborne Radionuclides on the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/ORO/2196, DOE 2020).

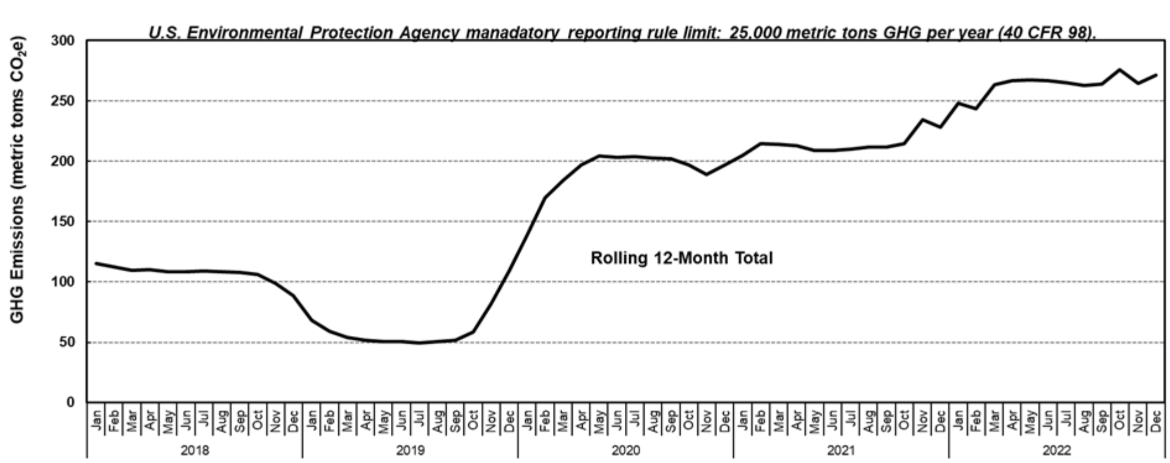
3.5.1.5. Greenhouse Gas Emissions

The EPA rule for mandatory reporting of GHGs (also referred to as the "Greenhouse Gas Reporting Program") was enacted October 30, 2009, under 40 CFR Part 98 (EPA 2009). According to the rule in general, the stationary source emissions threshold for reporting is 25,000 MT of CO_2 equivalent (CO_2e) or more of GHGs per year. The rule defines GHGs as:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons
- Perfluorocarbons
- Sulfur hexafluoride (SF_6)

A review was performed of ETTP processes and equipment categorically identified under 40 CFR

Part 98.2 (EPA 2009), whose emissions must be included as part of a facility's annual GHG report, starting with the CY 2010 reporting period. Based on total GHG emissions from all ETTP stationary sources during 2022, ETTP did not exceed the annual threshold limit and therefore was not subject to mandatory annual reporting under the GHG rule during this performance period. The total GHG emissions for any continuous 12-month period beginning with CY 2008 have not exceeded 12,390 MT CO_2e of GHGs. The most significant decrease in stationary source emissions was due to the permanent shutdown of the TSCA Incinerator in 2009. The remaining sources are predominantly comfort heating systems, hot water systems, and power generators. Figure 3.8 shows the five-year trend up through 2022 of ETTP total GHG stationary emissions. For CY 2022, GHG emissions totaled 264 MT CO_2e, which is 0.11 percent of the 25,000 MT CO_2e per year threshold for reporting.



Note: *Shown in carbon dioxide equivalent (CO2e)*
Acronyms:
CFR = Code of Federal Regulations *GHG = greenhouse gas*

Figure 3.8. East Tennessee Technology Park stationary source greenhouse gas emissions tracking history

The increase starting in 2020 resulted from the leasing of several large bays in Building K-1036; these bays are heated with natural gas.

EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, was published in the Federal Register on October 8, 2009. The purpose of this order was to establish policies for federal facilities that will increase energy efficiency; measure, report, and reduce GHG emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and storm water management; eliminate waste; recycle; and prevent pollution at all such facilities. While the order deals with a number of environmental media, only its applicability to GHG is considered here. The EO defines three distinct scopes for purposes of reporting:

1. Scope 1 is essentially direct GHG emissions from sources that are owned or controlled by a federal agency.
2. Scope 2 encompasses GHG emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency.
3. Scope 3 involves GHG emissions from sources not owned or directly controlled by a federal agency, but related to agency activities, such as vendor supply chains, delivery services, and employee business travel and commuting.

One goal of this order was to establish a FY 2020 Scopes 1 and 2 reduction target of 28 percent, as compared to the 2008 baseline year.

EO 13693, *Planning for Federal Sustainability in the Next Decade,* was published in the Federal Register on March 25, 2015. This order superseded EO 13514 and established a new Scope 1 and Scope 2 federal-wide total reduction target of 40 percent by 2025, as compared to the 2008 baseline year. For reporting purposes, GHG emission data are compared to both goals.

EO 13834, *Efficient Federal Operations*, was published in the Federal Register on May 22, 2018. This order superseded EO 13693. It requires continued tracking and reporting of GHG emissions, but no specific federal-wide total reduction target.

The information reported here includes GHG emissions from the industrial landfills at Y-12 that are managed and operated by UCOR. The landfills are not part of the contiguous ETTP site; however, DOE requested that UCOR, as the operator, include landfill GHG emissions with ETTP reporting in the Consolidated Energy Data Report. To be consistent with reporting this information, the landfill emissions are also included with ETTP ASER data. Figure 3.9 shows the trend toward meeting both the original EO 13514 Scopes 1 and 2 GHG emissions reduction target of 28 percent by FY 2020 and the EO 13693 Scopes 1 and 2 GHG emissions reduction target of 40 percent by FY 2025.

Scopes 1 and 2 GHG emissions for FY 2022, including the landfills, totaled 15,676 MT CO2e, which is a 75 percent reduction from emissions in the FY 2008 baseline year.

Figure 3.10 shows the relative distribution and amounts of all ETTP FY 2022 GHG emissions for Scopes 1, 2, and 3, including the industrial landfills at Y-12. Total GHG emissions remain well below the levels first reported in the 2008 baseline year as demolition and remediation efforts continue at ETTP. Many of the early reductions were due to lower on-site combustion of fuels (stationary and mobile sources), lower consumption of electricity, and a smaller workforce. The total amount of GHG emissions for Scopes 1, 2, and 3, including landfills at Y-12, for FY 2022 was 21,614 MT CO_2e.

3.5.1.6. Source-Specific Criteria Pollutants

ETTP operations included one functioning minor stationary source, the CWTS, with a potential to emit any form of criteria air pollutant. This unit is equipped with an air stripper to remove VOCs from the influent stream. Potential total VOC emissions from the CWTS air stripper were calculated to be 0.005 ton/year in 2022, as compared to an emission limit of 5 tons/year.

A variety of minor pollutant-emitting sources released airborne pollutants from ETTP operations, such as vents, and fugitive and diffuse activities. The emissions from all stacks and vents are evaluated following approved methods to establish their low emissions potential. This is done to verify and document their minor source permit exempt status under all applicable state and federal regulations.

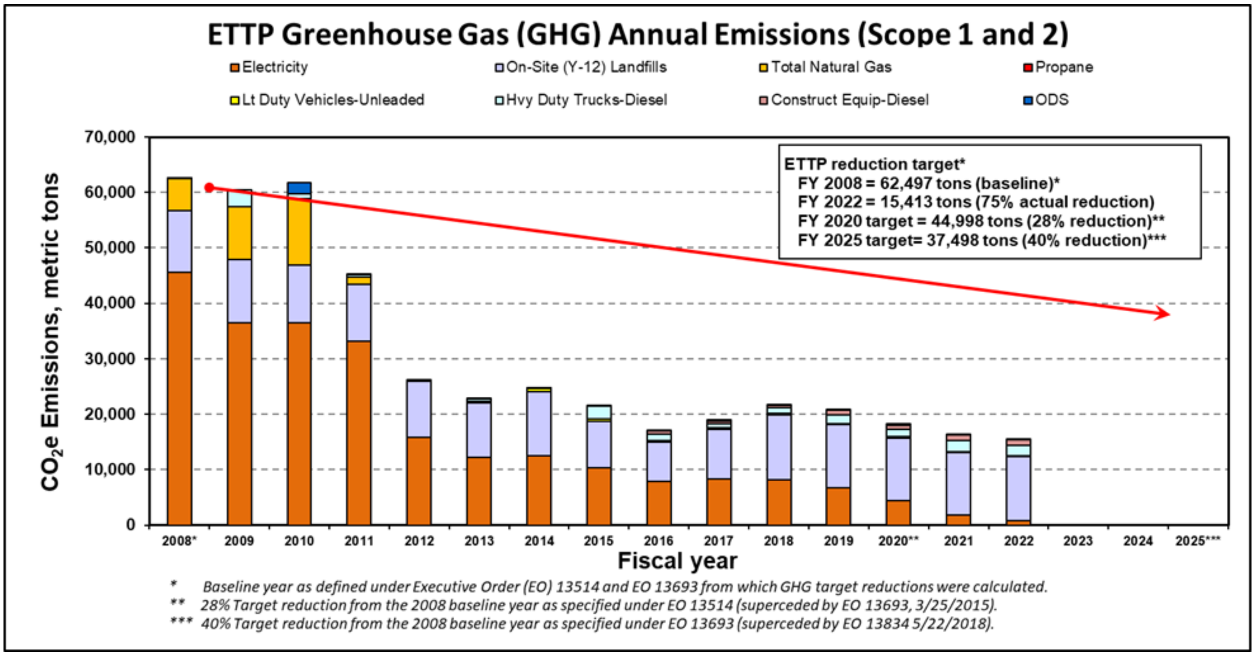
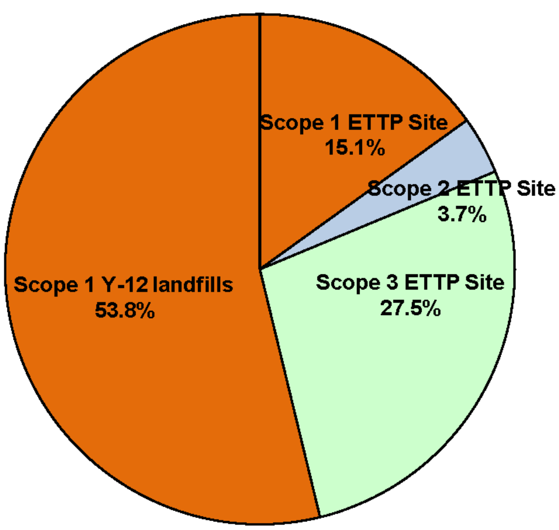


Figure 3.9. East Tennessee Technology Park greenhouse gas annual emissions (Scopes 1 and 2, including industrial landfills at Y-12)



ETTP FY 2022 Greenhouse Gas Emissions: 21,614 tons

Scope 1: ETTP Site Releases
Onsite stationary fossil fuel combustion, 264
Onsite fugitives and refrigerants, 10 tons
Onsite mobile source fuel combustion, 2,983 tons

Scope 1: Y-12 Industrial Landfills
Y-12 Industrial Landfills, 11,626 tons

Scope 2: Indirect GHG Releases
Electricity purchase, 793 tons

Scope 3: Indirect GHG Releases
Business air travel, 36 tons
Business ground travel, 10 tons
Employee commuting, 5,885 tons
Contracted wastewater treatment, 7 tons

Acronyms:
ETTP = East Tennessee Technology Park
GHG = greenhouse gas
Y-12 = Y-12 National Security Complex

Figure 3.10. Fiscal year 2022 East Tennessee Technology Park greenhouse gas emissions by scope

3.5.1.7. Hazardous Air Pollutants (Nonradionuclide)

Unplanned releases of hazardous air pollutants are regulated through the risk management planning regulations under 40 CFR Part 68 (EPA 1994). To ensure compliance, periodic inventory reviews of ETTP operations were performed that used monthly data obtained through the EPCRA Section 311 reporting program. This program applies to any facility at which a hazardous chemical is present in an amount exceeding a specified threshold. A comparison of the EPCRA 311 monthly Hazardous Materials Inventory System chemical inventories at ETTP with the risk management plan threshold quantities listed in 40 CFR Part 68.130 (EPA 1994) was conducted. This is an ongoing action that documents the potential applicability for maintaining and distributing a risk management plan and ensuring threshold quantities are not exceeded.

ETTP personnel have determined that there are no processes or facilities containing inventories of chemicals in quantities exceeding thresholds specified in rules pursuant to CAA, Title III, Section 112(r), "Prevention of Accidental Releases." Therefore, activities at ETTP are not subject to the rule. Procedures are in place and implemented to continually review new processes, process changes, or activities with the rule thresholds.

3.5.2. Ambient Air

Compliance of fugitive and diffuse sources is demonstrated based on environmental measurements. The ETTP Ambient Air Quality Monitoring Program is designed to provide environmental measurements to accomplish the following:

- Tracking of long-term trends of airborne concentration levels of selected air contaminant species
- Measurement of the highest concentrations of the selected air contaminant species that occur in the vicinity of ETTP operations
- Evaluation of the potential impact on air contaminant emissions from ETTP operations on ambient air quality

The three sampling programs in the ETTP area are designated as the environmental compliance and protection (EC&P) program, TDEC program, and the ORR perimeter air monitoring program. Figure 3.11 shows an example of a typical EC&P program air monitoring station. Figure 3.12 shows the locations of all ambient air sampling stations in and around ETTP that were active during the 2022 reporting period.

The EC&P program consisted of two sampling locations throughout 2022. All projects are operating similar high-volume sampling systems. The EC&P, TDEC, and perimeter air monitoring samplers operate continuously with exposed filters collected weekly. The radiological monitoring results for samples collected at the one ETTP area perimeter air monitoring station are the responsibility of UT-Battelle, LLC. TDEC is responsible for the data collected from their samplers. UT-Battelle, LLC and TDEC results are not included with the EC&P data presented in this section. However, results from the other programs are requested periodically for comparison.

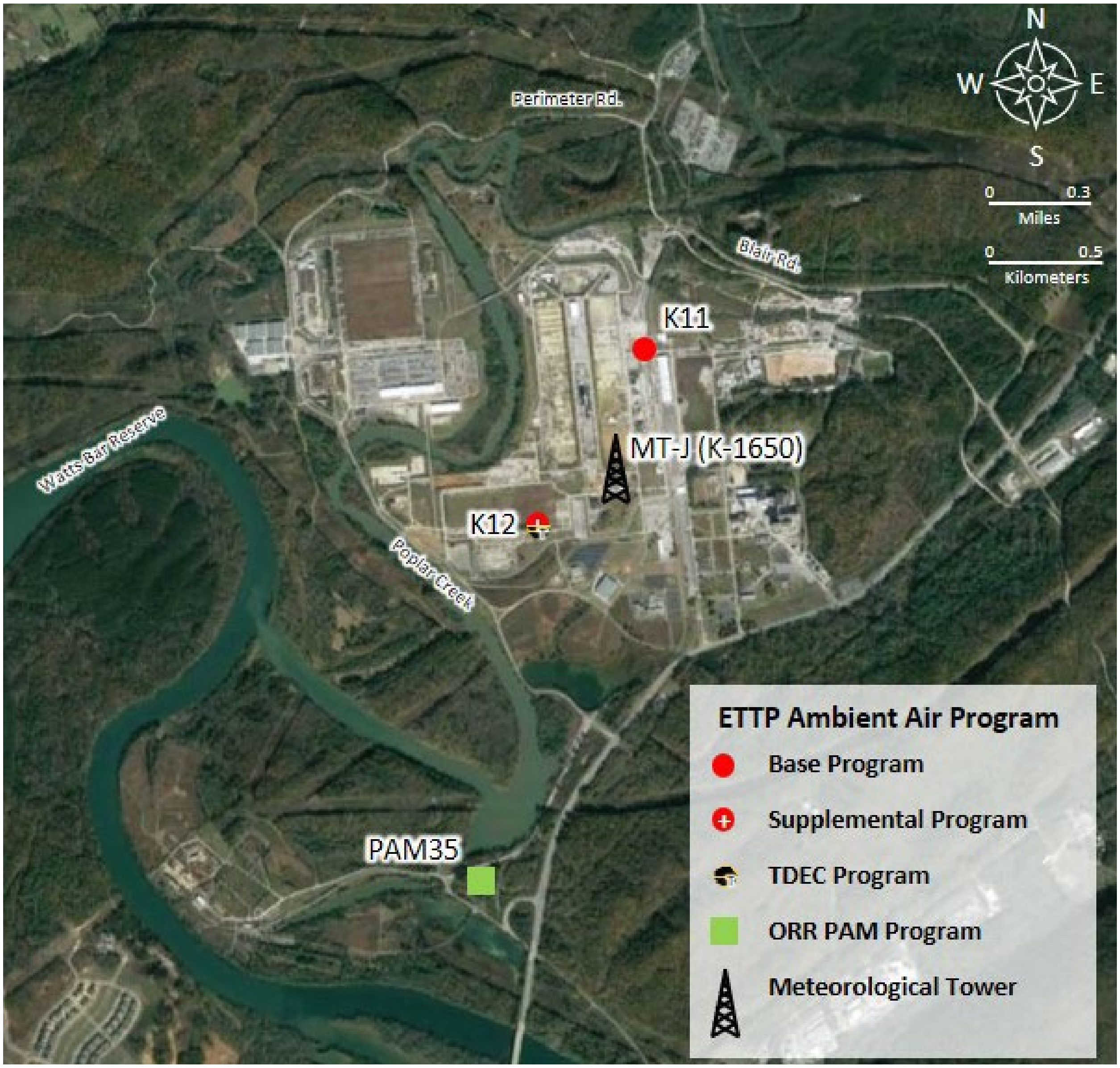
The analytical parameters were chosen with regard to existing and proposed regulations and with respect to activities at ETTP. The principal reason for EC&P program stations is to demonstrate that radiological emissions from the demolition of ETTP gaseous diffusion buildings, supporting structures, and associated remediation activities are in compliance with the annual dose limit to the most exposed members of the public that are either on-site (on ORR) or off-site. K11 and K12 were key sampling locations regarding the potential dose impact on the most exposed member of the public at an on-site business location during slab removals, small structures demolition, excavation and removal of contaminated soils, and other activities.

Changes of emissions from ETTP will warrant periodic reevaluation of the parameters being sampled. Ongoing ETTP reindustrialization efforts will also introduce new locations for members of the public that may require adding or relocating monitoring site locations. To ensure understanding of the potential impacts on the public and to establish any required emissions monitoring and controls, a survey of all on-site tenants is reviewed every six months through a request for the most recent ETTP reindustrialization map.

All EC&P program stations collected continuous samples for radiological analyses during 2022. These analyses of samples from the EC&P stations test for the isotopes ^{234}U, ^{235}U, ^{238}U, and ^{99}Tc.

Stations K11 and K12 are located to provide a conservative measurement of the impact to on-site members of the public.

Figure 3.11. East Tennessee Technology Park ambient air monitoring station



Acronyms:
ETTP = East Tennessee Technology Park
MT = meteorological tower
ORR = Oak Ridge Reservation
PAM = perimeter air monitoring
TDEC = Tennessee Department of Environment and Conservation

Figure 3.12. East Tennessee Technology Park ambient air monitoring station locations

3.6. Water Quality Program

Water quality is monitored via multiple programs at ETTP. Storm water monitoring is conducted through the NPDES Program (Section 3.6.1) and the Storm Water Pollution Prevention Program (Section 3.6.2). Surface water monitoring is conducted through the Environmental Monitoring Program (EMP) (Section 3.6.3). Groundwater monitoring is conducted through the Water Resources Protection Program (Section 3.6.4).

3.6.1. National Pollutant Discharge Elimination System Permit Monitoring

NPDES monitoring is conducted to demonstrate compliance with the ETTP NPDES Permit. The previous ETTP NPDES permit in effect during the first months of 2022 became effective on April 1, 2015, and expired on March 31, 2020, but the expired permit continued in effect until the new permit was issued by the state of Tennessee. The new permit was issued on February 4, 2022, and became effective on April 1, 2022. Under the new ETTP NPDES Permit in effect during 2022, 20 representative outfalls are monitored annually (Figure 3.13). All twenty (20) representative outfalls are sampled annually for total suspended solids (TSS), pH, and flow. Additionally, select outfalls are sampled annually for zinc (Outfall 142), oil and grease (Outfall 190), PCBs (Outfalls 280, 690), benzidine (Outfall 430), and semiannually for total chromium and hexavalent chromium (Outfall 170). There were no permit noncompliances in 2022.

Figure 3.13. Storm water outfall monitoring

3.6.2. Storm Water Pollution Prevention Program

In addition to the NPDES permit required monitoring, storm water is also monitored for a variety of substances, including radionuclides, metals, and organic compounds (UCOR-4028b, *East Tennessee Technology Park Storm Water Pollution Prevention Program Sampling and Analysis Plan, Oak Ridge, Tennessee*, UCOR 2022). Routine storm water pollution prevention plan (SWPPP) monitoring is conducted at various locations that vary from year to year depending on activities going on within the drainage basins and historical monitoring results. SWPPP monitoring includes radiological monitoring, D&D and RA monitoring, CERCLA Phased Construction Completion Report (PCCR) monitoring, legacy contamination monitoring, and investigative monitoring.

3.6.2.1. Radiologic Monitoring of Storm Water

Radiological monitoring is conducted to determine compliance with applicable dose standards. Composite samples from five outfalls were collected following a rain event and analyzed for gross alpha activity, gross beta activity, and specific radionuclides. The estimated discharge of radionuclides from ETTP via the storm water drainage system was calculated based on the radiological monitoring results, daily rainfall data for CY 2022, and flow rates. Table 3.5 presents the total calculated discharge of radionuclides from storm water discharged to off-site waters from ETTP in CY 2022.

Table 3.5. Radionuclides released to off-site waters from the East Tennessee Technology Park storm water system in 2022

Isotope	^{234}U	^{235}U	^{238}U	^{99}Tc
Activity level (curies)	0.008	0.00078	0.0061	0.049

3.6.2.2. Demolition and Remedial Action Monitoring of Storm Water

Demolition and RA monitoring is conducted to evaluate the effectiveness of Demolition and RAs and to ensure that storm water controls are preventing sediment and contaminants from discharging into receiving waters. Grab samples from select outfalls are collected prior to the start of demolition/RAs, following each 1-in. rain event during demolition/RAs, and after completion of demolition/RA activities.

3.6.2.3. K-25 Building ^{99}Tc Contaminated Soil Remedial Action Monitoring

Demolition of the K-25 Building was completed in 2014. The last section of the east wing that was demolished was contaminated with the radioactive isotope ^{99}Tc. Rain and dust control water that contacted the ^{99}Tc-contaminated piping and other building materials is believed to have caused the migration of ^{99}Tc into soils beneath the east wing debris pile during demolition. Remediation of the ^{99}Tc-contaminated soils within the K-25 footprint was completed in 2020. Storm water monitoring in Outfalls 190 and 490, located downgradient of the former K-25 Building, continued in 2022.

Outfall 190 is sampled quarterly. Except for the sample collected in July 2021, ^{99}Tc has not been detected in storm water samples from Outfall 190 since July 2013. Based on this data, it does not appear that ^{99}Tc-contaminated groundwater from the K-25 Building D&D project is discharging to Mitchell Branch via Outfall 190.

Outfall 490 is sampled semiannually. Technetium-99 was detected in the storm water samples from Outfall 490 in January 2022 and August 2022 but was well below the reference standard of 390,000 picocuries/liter (pCi/L). Outfall 490 discharges into the K-1007-P1 Pond. Discharges from the K-1007-P1 Pond to Poplar Creek are monitored routinely as an exit pathway location per the ETTP EMP. The ^{99}Tc data is evaluated to determine the contribution of ^{99}Tc from the Outfall 490 drainage area to the total ^{99}Tc discharge from the K-1007-P1 pond, as further discussed in Section 3.6.3, "Surface Water Monitoring."

3.6.2.4. K-1203 Sewage Treatment Plant Post-Demolition and Remedial Action Monitoring

Outfall 05A is located in the former K-1203 Sewage Treatment Plant (STP) area. Demolition of K-1203 was completed in 2019; RAs, including rerouting of the Outfall 05A discharge, were completed in 2020; and storm water monitoring continued through August 2022. Samples from the newly designated outfall (referred to as Outfall 05A-2 but officially listed on the ETTP NPDES Permit as Outfall 05A) are collected and analyzed for metals. Metal concentrations have fluctuated but continue to show an overall decrease over time.

3.6.2.5. EU-21 Remedial Action Monitoring

The EU-21 area is located between the east and west wings of the former K-25 Building and includes the slab associated with the former K-1024 Maintenance Shop. The K-1024 Maintenance Shop was used for the repair and calibration of instruments and equipment used in the K-25 uranium enrichment process. The maintenance shop used solvents, including TCE, for cleaning instruments and equipment. As an accepted practice at the time, solvents were frequently discharged into the floor drains, then entered the storm drain network. The main source of TCE in the EU-21 area is presumed to be from

Catch Basin 7097, located on the south side of the former K-1024 Building. Although TCE is the primary contaminant of concern for the EU-21 soil RA, mercury droplets were discovered during removal of buried pipe. K-1024 was also used for cleaning mercury from line recorder chemical traps between 1946 and 1947 and the equipment shop had a problem with spilled mercury and mercury vapors.

Prior to the soil RA, the storm drain system within the proposed excavation and clean layback footprints was isolated from the active system in order to prevent sediment and contaminants from discharging to Poplar Creek via Outfalls 230 and 240. Outfall 210 receives water from the storm drain system located on the east side of the K-25 east wing (well outside of the excavation and layback footprints). All of the catch basins located on the west side of the K-25 west wing were previously plugged under a separate program.

Baseline samples were not collected prior to the start of the soil RA due to dry conditions. Monitoring of Outfalls 210, 230, and 240 is being conducted during 1-in. rain events and analyzed for VOCs, metals, mercury, and TSS. TCE has not been detected in any of the samples collected from Outfalls 210, 230, or 240 in 2022. Several other parameters have been detected, but only PCBs, mercury and lead exceeded reference standards during the February 2022 and April 2022 rain events. Storm water monitoring will continue following each 1-in. rain event until the RA is complete. A final sampling event will be conducted once excavation and waste shipments have been completed.

3.6.2.6. Monitoring of Outfalls Designated in the CERCLA Phased Construction Completion Reports

When environmental restoration activities at ETTP are conducted in phases, progress may be documented in a CERCLA PCCR. When this occurs, a PCCR is prepared to document the completed work (e.g., demolition) and interim requirements for remaining slabs. If radiological surveys indicate that a slab exceeds the release criteria in DOE Order 5400.5, Chg. 2, *Radiation Protection of the Public and the Environment* (DOE 1993a), then interim access controls are implemented, the slab is posted, and the slab is included in the radiological surveillance and monitoring program. Environmental requirements in the radiological surveillance and monitoring program include sampling designated outfall(s) once every NPDES permit cycle for gross alpha activity, gross beta activity, uranium isotopes, and ^{99}Tc. The designated outfall(s) are selected based on the drainage area and proximity to the slab(s).

Two outfalls were designated for sampling in CERCLA PCCRs in 2022. Grab samples were collected from Outfalls 40 and 490 and analyzed for gross alpha activity, gross beta activity, uranium isotopes, and ^{99}Tc. The CERCLA PCCR monitoring results are presented in Table 3.6.

3.6.2.7. Legacy Mercury Contamination Monitoring of Storm Water

Legacy mercury contamination monitoring is conducted to evaluate mercury concentrations over time and to determine if non-representative outfalls are contributing mercury to site waterways.

Outfalls 180 and 190 discharge storm water from large areas on the north side of ETTP into Mitchell Branch. There were numerous historical mercury operations within Outfalls 180 and 190 drainage areas and the Mitchell Branch subwatershed. Due to contaminated sediment within storm water networks and potential infiltration into the piping, these are potential contributors to the continuing legacy mercury discharges to Mitchell Branch. As described in Section 3.6.2.2, Outfall 05A/05A-2 routes storm water runoff and groundwater infiltration from the former K-1203 STP area to the former discharge pipe used by the K-1203 STP and into Poplar Creek. Based on the decreasing concentrations of metals, including mercury, in the samples collected from Outfall 05A/05A-2, it appears that legacy contamination in the Outfall 05A/05A-2 area has been reduced due to demolition of the K-1203 STP, subsequent RAs, and revegetation of the K-1203 footprint.

The mercury concentrations detected in Outfalls 180, 190, and 05A/05A-2 during 2022 are presented in Table 3.7. The mercury concentrations over time in Outfalls 180, 190, and the K-1700 Weir on Mitchel Branch and 05A/05A-2 on Poplar Creek are presented in Figures 3.14 and 3.15, respectively. In 2022, only one mercury result from April 2022 at Outfall 180 exceeded the reference standard of 51 nanograms/liter (ng/L). The mercury concentrations at these outfalls fluctuate but show an overall decreasing trend over time.

Table 3.6. CERCLA PCCR monitoring results for 2022

Parameter	Reference standard	Outfall 240 (4/12/2022)	Outfall 490 (10/31/2022)
Associated Slab(s)		K-2500-H slab	K-101 slab
Alpha activity (pCi/L)[a]	15	**7.69**	**2.25 U**
Beta activity (pCi/L)	50	**7.5**	**49.8**
^{99}TC (pCi/L)	390,000	**4.91 U**	**84.3**
$^{233/234}$U (pCi/L)	1,200	**1.45**	**0.91 U**
$^{235/236}$U (pCi/L)	1,300	**-0.00966 U**	**0.18 U**
^{238}U (pCi/L)	1,400	**0.566 U**	**0.4**

[a] *pCi/L = picocuries/liter*

Note: *Results in bold exceed the reference standard. Reference standards for gross alpha and gross beta measurements correspond to the National Primary Drinking Water Standard (40 CFR Part 141, National Primary Drinking Water Regulations, Subparts B and G, EPA 1975). Reference standards for radionuclides equal the derived concentration standard (DCS) for ingested water (DOE-STD-1196-2021, Derived Concentration Technical Standard, DOE 2021b).*

Table 3.7. Mercury results for Outfalls 180, 190, and 05A/05A-2 in 2022

Sampling location	Reference standard (ng/L)[a]	1/10/2022 (ng/L)	1/24/2022 (ng/L)	4/12/2022 (ng/L)	4/28/2022 (ng/L)	8/8/2022 (ng/L)	11/1/2022 (ng/L)
Outfall 180	51	15.9	14.5	39.3	**95.2**	39.9	46.2
Outfall 190	51	-	6.1	-	5.12	3.94	4.5
		2/3/2022 (ng/L)	**6/7/2022 (ng/L)**	**8/11/2022 (ng/L)**			
Outfall 05 A/05A-2	51	6.54	6.47	7.4			

[a] *ng/L = nanograms/liter*

Note: *Results in bold exceed the reference standard. The reference standard for mercury corresponds to TDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria.*

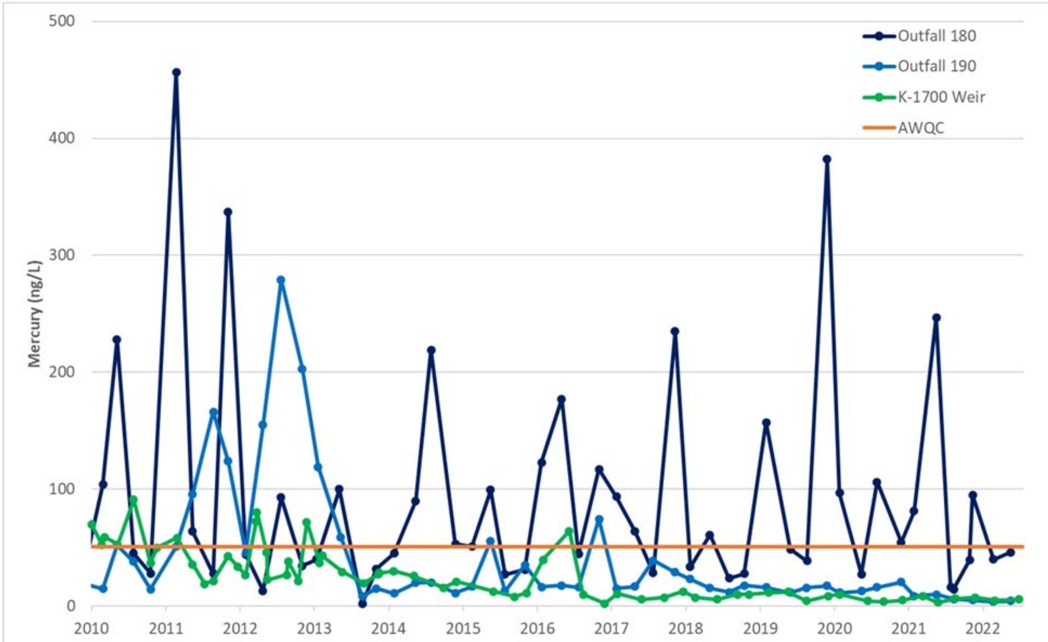
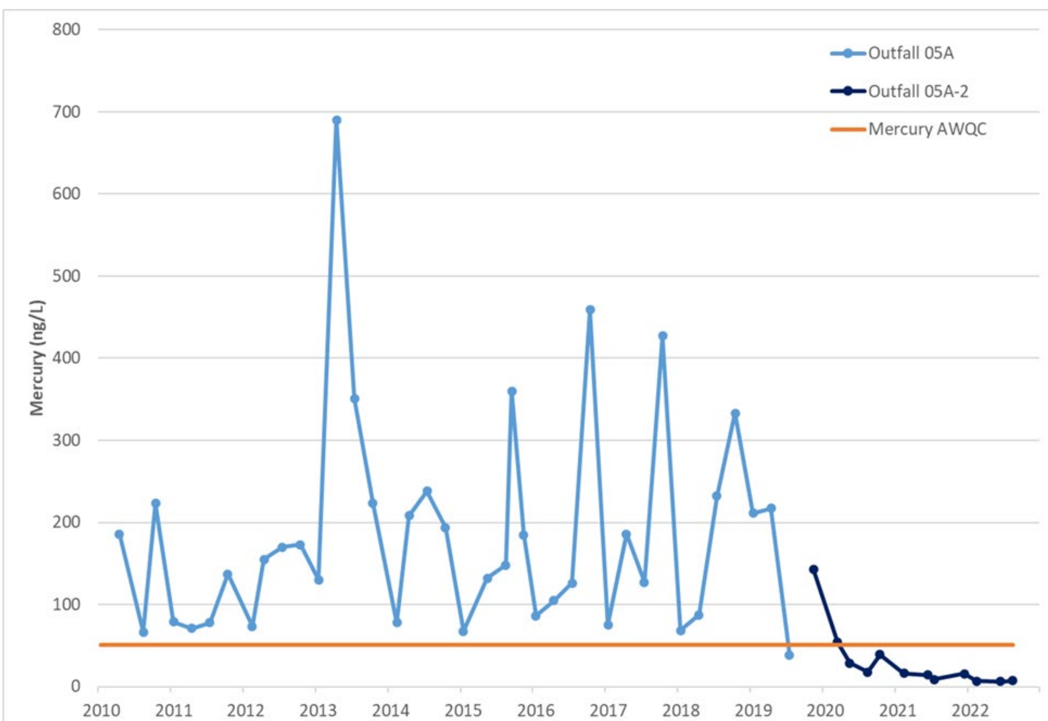


Figure 3.14. Mercury concentrations at Outfalls 180 and 190, and the K-1700 Weir



Acronym:
AWQC = ambient water quality criterion

Figure 3.15. Mercury concentrations at Outfall 05A/05A-2

3.6.2.8. Investigative Monitoring of Storm Water

Investigative monitoring is conducted based on elevated analytical results, CERCLA requirements, and/or changes in site conditions. Investigative monitoring was conducted at Outfall 690, as well as the Outfall 780 network in 2022.

Outfall 690. Outfall 690, was sampled to evaluate the current concentrations of PCBs and to evaluate the current contaminant trends observed at this outfall. Grab samples were collected when storm water runoff was observed discharging and analyzed for PCBs.

During the April 2022 sampling effort, PCBs were detected in Outfall 690. The result of 0.0354 J ug/L exceeded the reference standard of 0.00064 ug/L for PCBs. A sample was not taken during the third quarter of 2022 due to no flow conditions. In the fall of 2022, the oil water separator associated with Outfall 690 was filled in and the storm water system was modified to divert water to surface sheet flow via a newly installed bubbler. This action also removed the headwall of Outfall 690 and modified the system so that the outfall no longer discharges.

Outfall 780 Network. Outfall 780 is located in the Powerhouse Area. In 2018, a select group of non-representative outfalls was sampled to determine if they were contributing mercury and PCBs to site waterways. Outfall 780 had elevated concentrations of mercury and PCBs. Recent activities being conducted in the area were not suspected as the cause of the elevated mercury and PCB concentrations, although process knowledge indicated that they could be legacy contaminants. Outfall 780 once carried storm water runoff from former Buildings K-724 and K-725. These buildings were originally part of the S-50 Thermal Diffusion Plant; Building K-725 was later used for beryllium processing. It contained mercury traps that occasionally released mercury. In addition, mercury was reportedly “swept down the floor drains” and into the storm drain system during cleanup activities in the 1970s. Mercury may also have been present in the dust collection system and transported to the storm drain system via storm water runoff during demolition of K-725 in the 1990s. Outfall 780 also received storm water from the K-722 area, where approximately 1,000 gal of oil was landfarmed for dust suppression in the 1980s.

A commercial wood yard and chipping facility operates at the K-722 site. While it is doubtful that these operations caused an increase in mercury or PCBs in the Outfall 780 drainage network, in 2021 they appeared to discharge water from an unknown source. This discharge was dark brown and appeared in relatively small quantities on an ongoing basis. Before the facility began operation, Outfall 780 was dry and did not discharge water to the Clinch River except during substantial storm events. It is possible that the discharge from this facility may be mobilizing contaminants that have been dormant in the Outfall 780 network for years.

Outfall 780 was sampled in February 2022 for a wide variety of parameters. PCBs, copper, lead, and mercury were detected in elevated concentrations that exceeded their respective reference standards. Additional monitoring of legacy contaminants will be conducted as part of the SWPPP in 2023.

3.6.2.9. Chromium Water Treatment System and Plume Monitoring

The CWTS (Figure 3.16) was constructed to intercept a plume of contaminated groundwater before it enters Mitchell Branch.

The CWTS consists of interceptor wells, pumps, holding tanks, a treatment system, and an air stripper. Effluent is discharged through the pipeline that originally carried effluent from the Central Neutralization Facility (which was previously demolished). In CY 2022, monitoring was conducted at monitoring well 289 (TP-289), the chromium collection system wells, Outfall 170,

Figure 3.16. The Chromium Water Treatment System

and Mitchell Branch kilometer (MIK) 0.79. Figures 3.17 and 3.18 show the results for the analyses for total chromium and hexavalent chromium, respectively.

The analytical data indicate that both total and hexavalent chromium levels at TP-289 and the collection wells may fluctuate slightly but are relatively consistent over the long term. In 2022, levels of total chromium and hexavalent chromium at Outfall 170 and MIK 0.79 exhibited wider variability. After years of low concentrations, results for hexavalent chromium at Outfall 170 equaled or exceeded the ambient water quality criterion (AWQC) of 11 micrograms/liter (µg/L) in three of five samples collected in 2022. Results for total chromium at Outfall 170 were within historic ranges, and well below the AWQC in 2022. The levels of both hexavalent and total chromium at MIK 0.79 fluctuated in 2022, but remained below the AWQC for hexavalent chromium of 11 µg/L and well below the total chromium AWQC of 164 µg/L. These results demonstrate the continuing positive impact of the collection well system to minimize the release of chromium into Mitchell Branch.

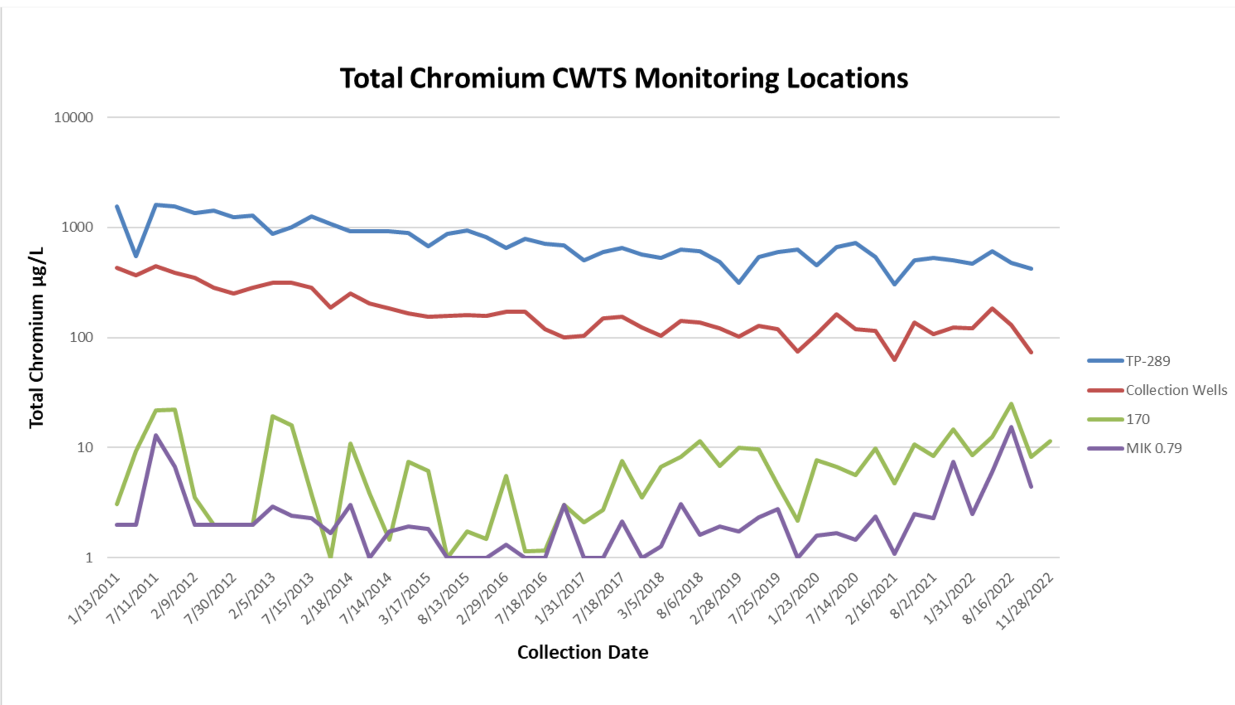


Figure 3.17. Total chromium sample results for the chromium collection system

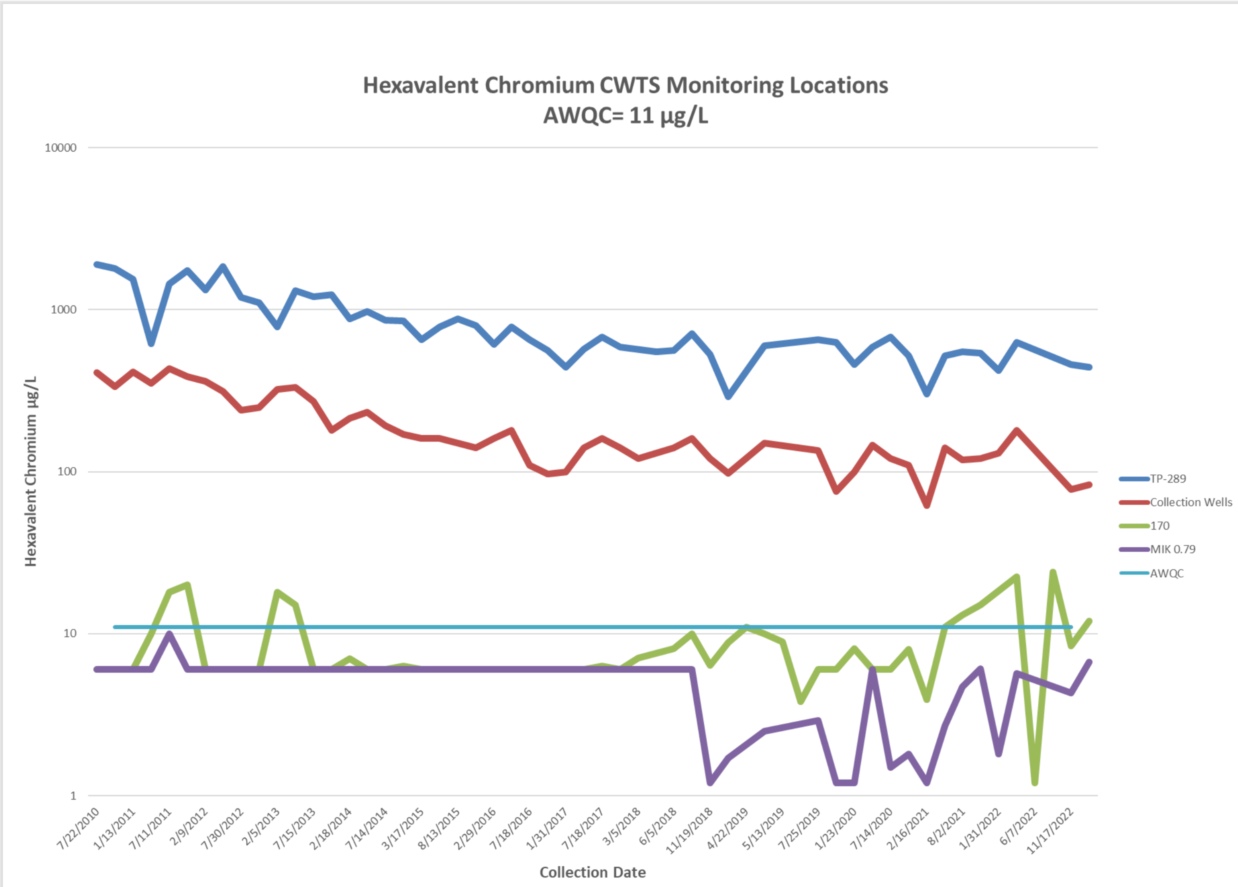
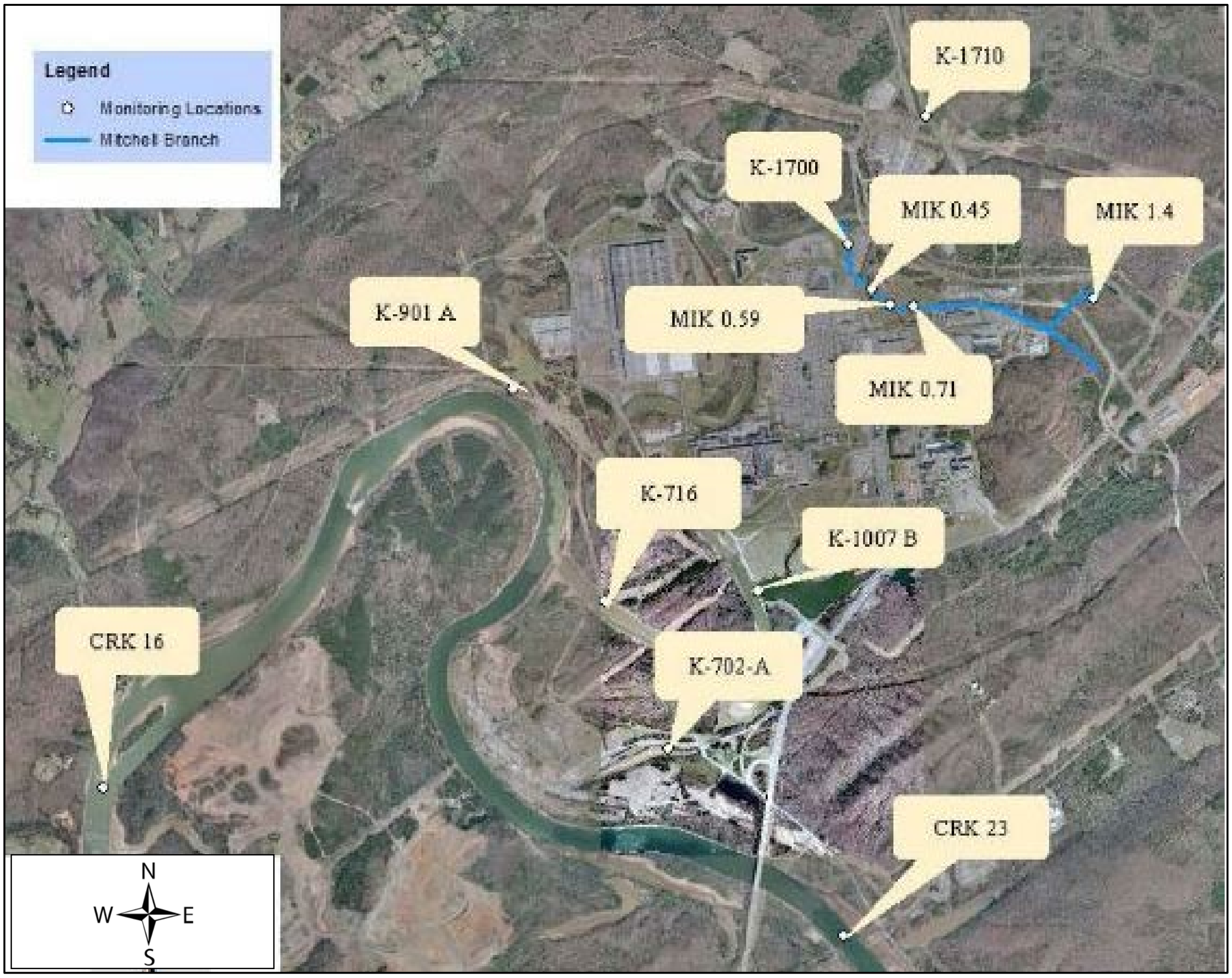


Figure 3.18. Hexavalent chromium sample results for the chromium collection system

3.6.3. Surface Water Monitoring

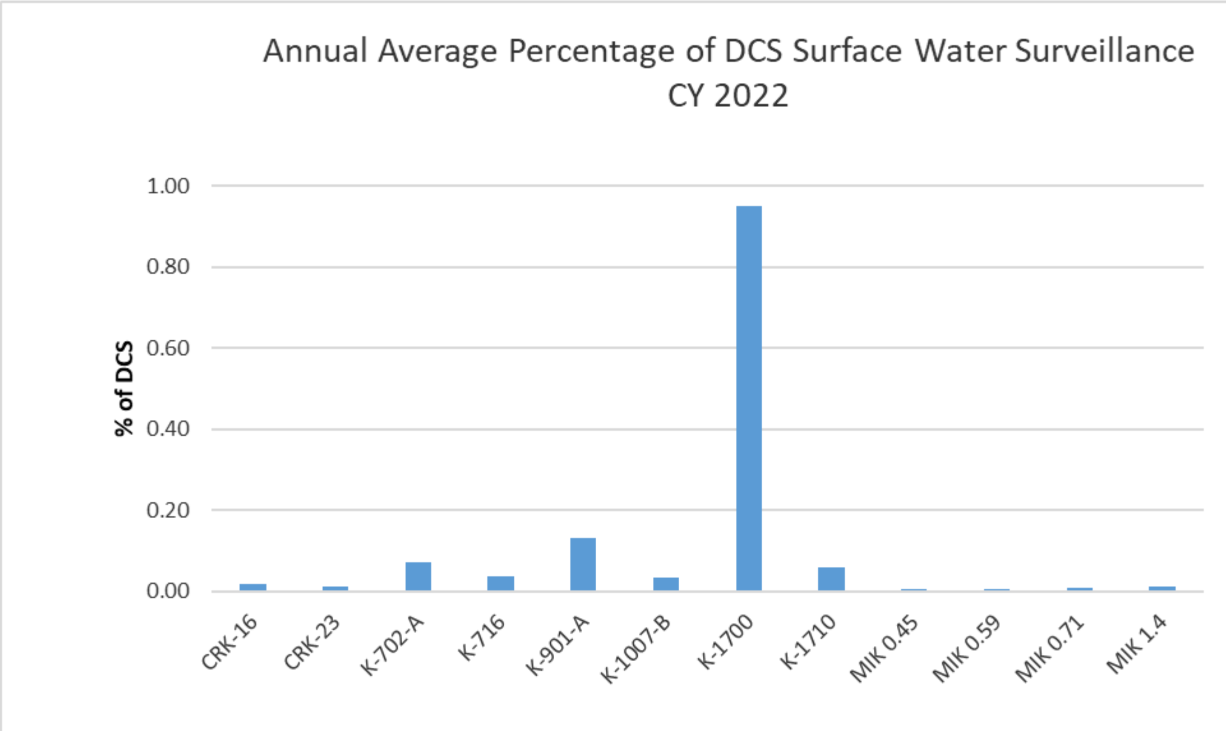
During 2022, the ETTP EMP personnel conducted environmental surveillance activities at 12 surface water locations (Figures 3.19 and 3.20) to monitor surface water conditions at watershed exit pathway locations (K-1700, K-1007-B, and K-901-A) or ambient stream conditions (Clinch River kilometers [CRKs] 16 and 23; K-1710; K-716; the K-702-A slough; and MIKs 0.45, 0.59, 0.71, and 1.4). Monitoring locations K-1700 and MIKs 0.45, 0.59, 0.71, and 1.4 were sampled quarterly; and monitoring locations CRKs 16 and 23, K-716, K-1007-B, K-901-A, and the K-702-A slough were sampled semiannually.

Figure 3.19. Surface water surveillance monitoring



Acronyms:
CRK = Clinch River kilometer
MIK = Mitchell Branch kilometer

Figure 3.20. East Tennessee Technology Park Environmental Monitoring Program surface water monitoring locations



Acronyms: *CRK = Clinch River kilometer   DCS = derived concentration standard   MIK = Mitchell Branch kilometer*

Figure 3.21. Annual average percentage of derived concentration standards at surface water monitoring locations, 2022

Results of radiological monitoring were compared with the derived concentration standard (DCS) values in DOE Standard 1196, *Derived Concentration Technical Standard* (DOE 2021b). Radiological data are reported as fractions of DCSs for reported radionuclides, and the fractions for all of the isotopes are added together to produce the sum of fractions (SOF) and averaged to produce a rolling 12-month average. The average SOF is recalculated whenever new data become available. If the average SOF for a location exceeds the DCS requirement of remaining below 1.0 (100 percent) for the year, a formal source investigation is required. Sources exceeding DCS requirements would need an analysis of the best available technology to reduce the SOF of the radionuclide concentrations to less than 1.0 (100 percent). In 2022, the monitoring results yielded SOF values of less than 0.01 (1 percent of the allowable DCS) at all surface water surveillance locations at ETTP (Figure 3.21). At K-1700, the annual average SOF was 0.0095 (0.95 percent). At MIKs 0.45, 0.59, and 0.71, quarterly monitoring is conducted for ^{99}Tc only.

EMP surface water monitoring results show that conditions in the ETTP waterways usually meet Ambient Water Quality. There was one exception during the third quarter of 2022: a failure to meet the minimum required level of dissolved oxygen (5.0 mg/L).

Depending on the monitoring location, water samples may be analyzed for pH, selected metals, and VOCs. In 2022, 1834 analytical results and 169 field readings were collected under the EMP. The vast majority of these results were well within the appropriate AWQC. There was one exception during the third quarter of 2022: a failure to meet the minimum required level of dissolved oxygen (5.0 milligrams/liter [mg/L]). Dissolved oxygen levels were measured at 4.5 mg/L at K-901-A. This reading was collected at a time of elevated temperatures and very low flow due to the drought conditions, which favor high biological activity and the resulting depletion of dissolved oxygen. This reading was within historic ranges at this location.

Figure 3.22 illustrates the concentrations of TCE from the Mitchell Branch monitoring locations. Although VOCs are routinely detected at K-1700 and MIK 0.45, they are rarely detected at other surface water surveillance locations across ETTP. In the samples collected on November 22, 2016, results for several VOCs, including TCE and cis-1,2-dichloroethene, at several of the Mitchell Branch monitoring locations were reported at levels significantly higher than seen in recent monitoring. It should be noted that the November 22, 2016, sample date was at the end of an extended dry weather period that began in August 2016. Furthermore, even at the increased levels, the results are still well within the AWQC. Concentrations of TCE and total 1,2-dichloroethylene (1,2-DCE) are below the AWQCs for recreation, organisms only (300 µg/L for TCE and 10,000 µg/L for trans-1,2-DCE), which are appropriate standards for Mitchell Branch. In addition, vinyl chloride has sometimes been detected in Mitchell Branch water. VOCs have been detected in groundwater in the vicinity of Mitchell Branch and in building sumps discharging into storm water outfalls that discharge into the stream; these compounds have generally not been detected in storm water during the monitoring of network discharges. It appears that the primary source of these compounds is contaminated groundwater.

Since CWTS was installed, chromium levels in Mitchell Branch have dropped dramatically, with levels of total chromium being routinely measured at less than 6 µg/L (Figure 3.23). In 2022, hexavalent chromium levels in Mitchell Branch were all below the AWQC of 11 µg/L.

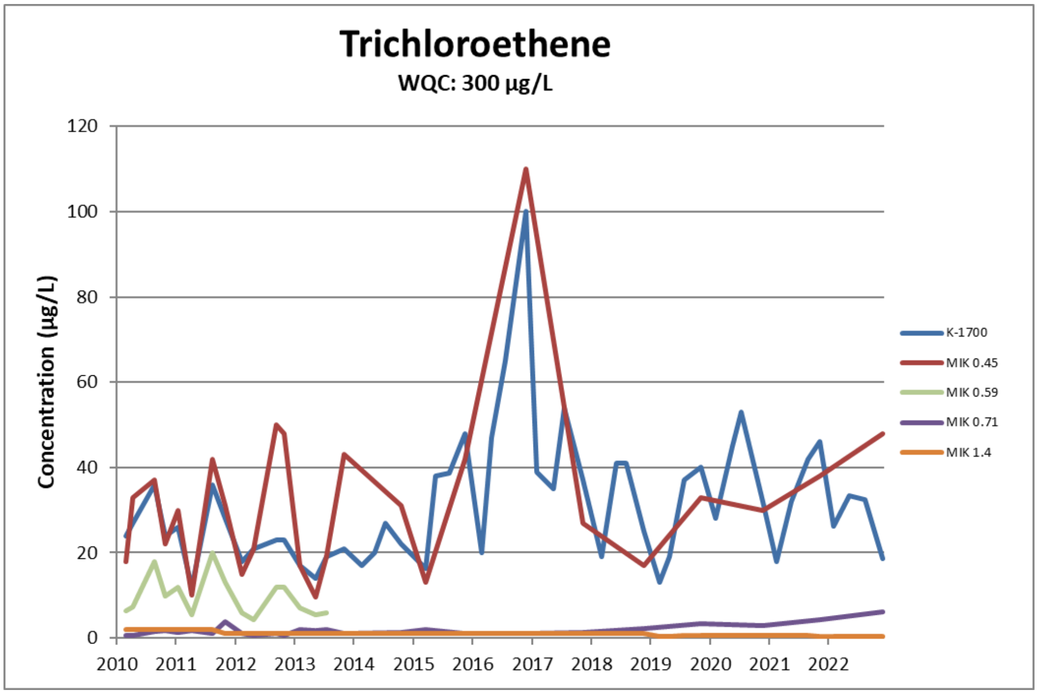
In CY 2022, ETTP did not conduct surface water monitoring for per- and polyfluoroalkyl substances (commonly known as "PFAS"). Instead, groundwater was sampled for these compounds. See Section 3.6.4 for details.

3.6.4. Groundwater Monitoring at ETTP

ETTP was divided into two zones to complete the primary source RA work. Zone 1 comprises 1290 acres outside the ETTP main plant area, and Zone 2 comprises 806 acres of the ETTP main plant area. Actions have been ongoing to characterize and address soil, buried waste, and subsurface structures for protection of human health and the environment and to limit further groundwater contamination through source reduction or removal.

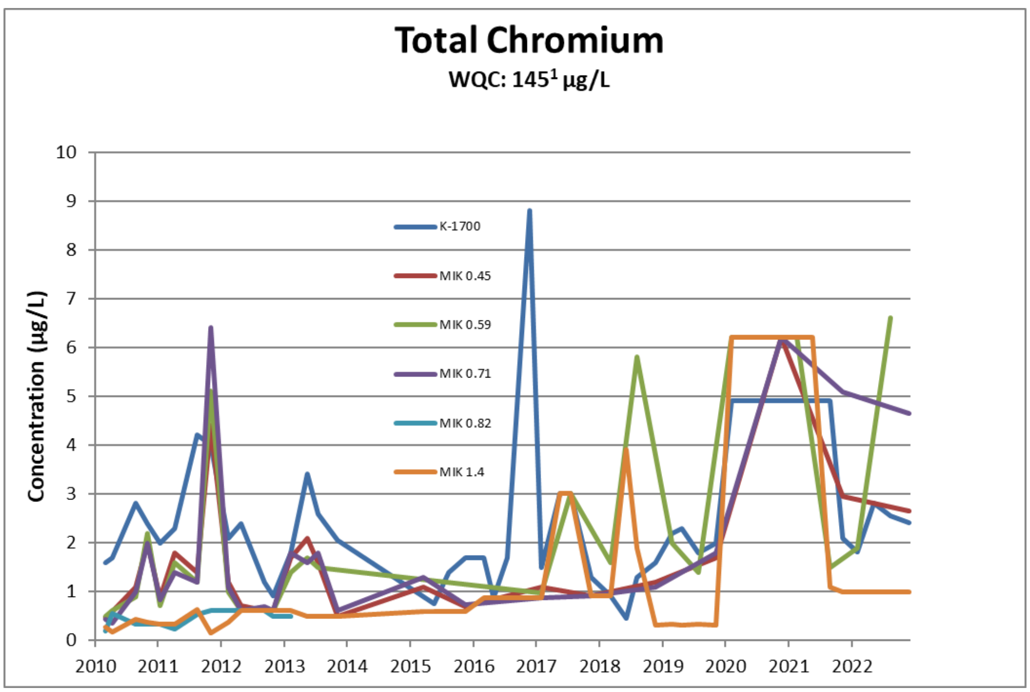
In FY 2022, planning for the ETTP continued as follows:

- The *East Tennessee Technology Park Main Plant Groundwater Focused Feasibility Study, Oak Ridge, Tennessee* (DOE 2021a) and the *Proposed Plan for an Interim Record of Decision for Groundwater in Main Plant Area at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2022b) were submitted to EPA and TDEC for review, and comments were received.



Acronym: *MIK = Mitchell Branch kilometer*

Figure 3.22. Trichloroethene concentrations in Mitchell Branch



Note: *(1) The AWQC for Cr(III), which is hardness-dependent, is 145 µg/L, based on a hardness of 227 mg/L in the receiving waters. The AWQC for Cr(VI) is 11 µg/L.*
Acronyms: *AWQC = ambient water quality criterion MIK = Mitchell Branch kilometer*

Figure 3.23. Total chromium concentrations in Mitchell Branch

- The *Remedial Investigation/Feasibility Study Report for the K-31/K-33 Area at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2893&D2, DOE 2021d) was approved by EPA and TDEC through an erratum, and the *Proposed Plan for the Record of Decision for Groundwater in the K-31/K-33 Area at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2922&D1, DOE 2022c) was submitted to EPA and TDEC for review, and comments were received.
- The *Zone 1 Groundwater Plumes Remedial Investigation Work Plan, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2903&D2, DOE 2021c) was submitted to EPA and TDEC for review and comments were received.

The data screen and trend assignments show contaminant concentration trends are highly variable across the site. Maximum contaminant levels (MCLs) are used as screening levels for groundwater and are not performance standards. A summary of the groundwater sampling follows:

- VOC concentrations in wells monitored downgradient of K-1070-C/D show a broad area is affected by past-disposal releases of liquid VOCs at the G-Pit. While trend evaluations for data collected within the most recent 5 years indicate stable, indeterminate, or decreasing concentrations, the persistent, high concentrations of these VOCs in nearby wells suggest an ongoing contaminant source release.
- In the K-31/K-33 area, chromium and nickel continue to be measured periodically at levels slightly greater than the MCL and Tennessee groundwater criteria at two wells (BRW-030 and UNW-043). However, in FY 2022, concentrations of chromium exceeded the MCL only at well UNW-043 and nickel concentrations were below Tennessee groundwater criteria.
- At the K-27/K-29 area, groundwater contamination migrates toward Poplar Creek in both north and south directions from area facilities. Alpha activity and total uranium concentrations in BRW-016 continued to decline in FY 2022 after well cleanout was conducted for BRW-016. This well was inundated by water from D&D runoff in FY 2019. Vinyl chloride (VC) exceeds the MCL in the northern portion of the K-27/K-29 area north exit pathway. Nickel equaled or exceeded its Tennessee groundwater criteria screening concentration (0.1 mg/L) in the unfiltered samples from two wells (UNW-038 and UNW-096) in the south/west exit pathway. TCE also exceeded the MCL screening concentration (0.005 mg/L) in these two wells. The five-year TCE trends in the K-27/K-29 southern area are stable to increasing.
- Monitoring results from wells in the K-1407-B/C Ponds area are generally consistent with results from previous years and show several-fold concentration fluctuations in seasonal and long-term periods. The detection of VOCs at concentrations above 1000 μg/L and the relatively steady concentrations over recent years suggest the presence of dense non-aqueous phase liquid in the vicinity of the former K-1407-B Pond.
- VOCs are present in groundwater at the now-remediated K-1070-A Burial Ground in the northwestern portion of ETTP. Groundwater contaminated primarily with TCE discharges at downgradient spring 21-002. Although TCE concentrations fluctuate above and below the MCL screening concentration of 5 μg/L, 8 of the last 12 samples collected at spring 21-002 have exceeded the MCL for TCE.

Groundwater beneath the K-720 Fly Ash Pile in EU Z1-11 is contaminated with metals. The potential surface water discharges are dependent upon the soil cover that is in place as a protective action. Activities conducted at the K-720 Ash Pile in FY 2022 included inspections for changes in features, such as presence of any new seepage areas on the periphery or downgradient of the ash pile, changes in conditions at the surface water monitoring locations, changes in the northern drainage ditch or other surface water drainages, changes in appearance or dimension of the sluice pond, evidence of rodent damage, changes in the seep directly south of the covered ash pile, evidence of visible subsidence or settlement of the soil cover, inspections of the vegetative cover and wetland, and inspections of warning signs. An existing seep on the south side remains unchanged. Also, bottom ash is visible along the northern ditch and banks of the pond on the west side, but there is no change from previous inspections. A maintenance request was initiated on December 1, 2021, to assess a beaver dam at the end of the northern ditch and a possible culvert blockage. It was noted on the April 21, 2022, inspection that pH at the seep collector is 6.61.

The K-1407-B Pond, constructed in 1943, was primarily used for settling metal hydroxide precipitates generated during neutralization and precipitation of metal-laden solutions treated in the K-1407-A Neutralization Unit. It also received discharge from the K-1420 Metals Decontamination Building, K-1420 plating wastes that generated F006 hazardous wastes pond sludge, and wastes from the K-1501 Steam Plant. The K-1407-C Pond, constructed in 1973, was primarily used to store potassium hydroxide scrubber sludge generated at ETTP. It also received sludge from the K-1407-B Pond. When the K-1407-B Pond reached maximum sludge capacity, it was dredged, and the sludge was transferred to the K-1407-C Pond. The *Remedial Action Report for the K-1407-B Holding Pond and the K-1407-C Retention Basin, Oak Ridge, Tennessee* (DOE/OR/01-1371&D1, DOE 1995) proposed semiannual groundwater monitoring for nitrate, metals, VOCs, and selected radionuclides, including gross alpha and beta activity, ^{99}Tc, ^{90}Sr, ^{137}Cs, ^{230}Th, ^{232}Th, ^{234}U, and ^{238}U. Target concentrations for these parameters were not established (DOE/OR/02-1125&D3, DOE 1993b; DOE/OR/01-1371&D1, DOE 1995). However, as recommended by EPA with concurrence from TDEC, monitoring for the constituents listed for the K-1407-B Pond is conducted in wells UNW-003, UNW-009, and the Mitchell Branch Weir (K-1700 Weir), shown on Figure 3.24. The primary groundwater contaminants in the K-1407-B/C Ponds area are VOCs. VOCs are widespread and persistent in this portion of ETTP, including contaminant sources upgradient of the ponds. Figure 3.24 presents the combined unconsolidated and bedrock plume boundaries for total VOCs.

DOE has compiled analytical data from groundwater monitoring well UNW-003 to evaluate concentration trends for regulated contaminants. Data are compared to EPA's National Primary Drinking Water Regulations MCLs or maximum contaminant level derived concentrations (MCL-DCs) for radionuclides, for screening purposes and for identifying constituents and wells for trend analysis. The MCLs and MCL-DCs are not criteria identified in the K-1407-B/C Ponds ROD.

In recent years, large seasonal variations in VOC concentrations have been measured at well UNW-003. DOE suspects a dense non-aqueous phase liquid source exists somewhere beneath the former pond site based on persistent high VOC concentrations in both shallow and deeper groundwater wells. Data are consistent in showing significant decreasing contaminant concentration trends for four VOCs at this location over the past 10 years. However, stable trends are present for the annual maximum concentration evaluations over the past 10 years for three of these four VOCs (i.e., tetrachloroethene [PCE], TCE, and VC). The FY 2022 results from UNW-003 remain consistent with the plume boundary depicted in Figure 3.24.

No other analytes were detected in wells UNW-003 or UNW-009 at concentrations greater than or equal to 80 percent of their respective MCLs or MCL-DCs in FY 2022. It is important to note that VOCs are generally not detected at UNW-009, located downgradient of the K-1407-C Pond. Since 2017, only low, estimated concentrations of cis-1,2-DCE have been detected at this well.

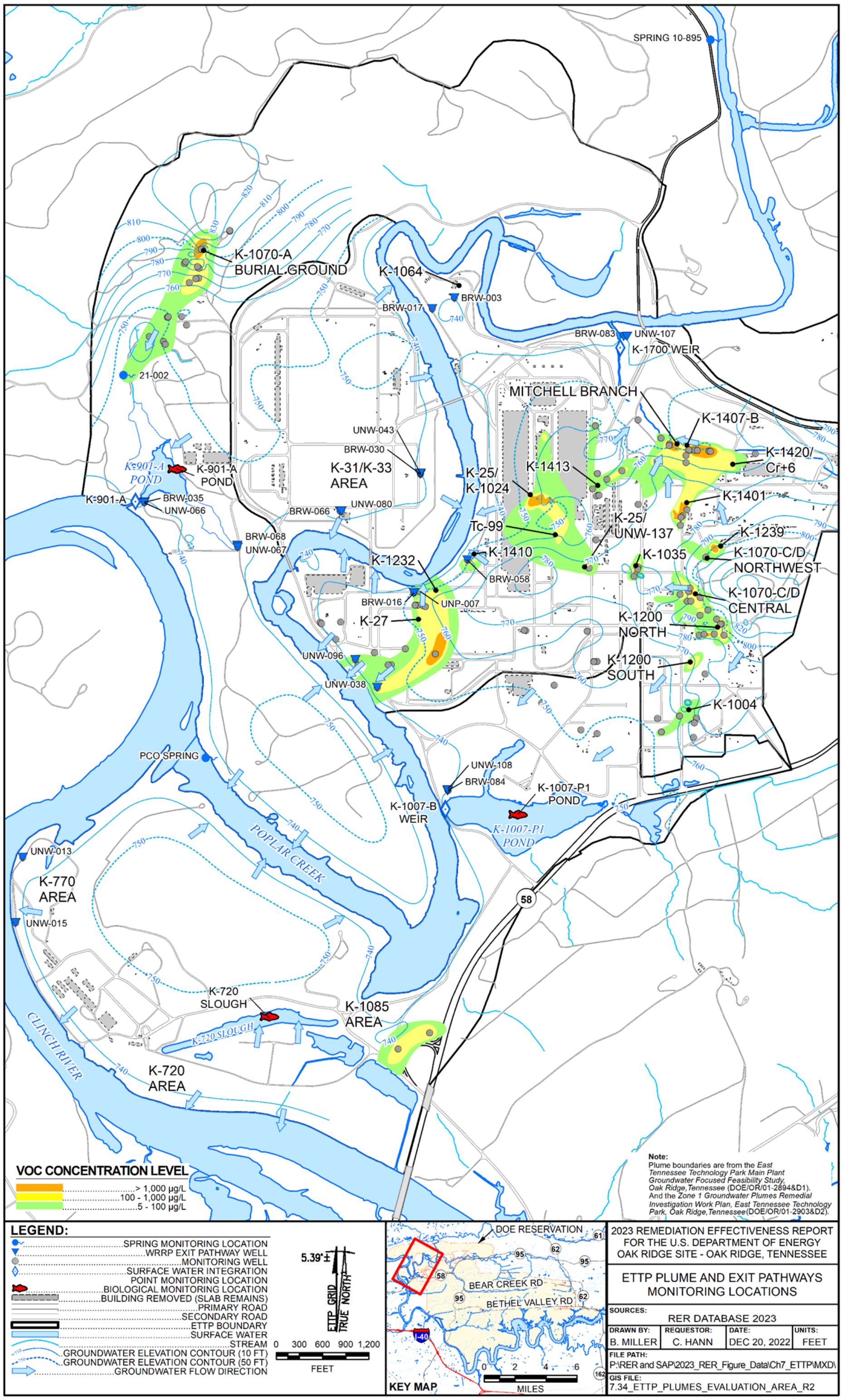


Figure 3.24. East Tennessee Technology Park volatile organic compound and ^{99}Tc plumes

The K-1070-C/D G-Pit was the primary source of organic contaminant releases to soil and groundwater in the area immediately west of the K-1070-C/D Waste Disposal area. The K-1071 Concrete Pad, located in the southeastern portion of the K-1070-C/D area, was determined to pose an unacceptable health risk to workers from future exposure to soil radiological contaminants (DOE/OR/02-1486&D4). The contents of the pit were excavated and a soil cover was placed over the concrete pad earlier. Residual contaminated groundwater in the K-1070-C/D G-Pit and Burial Ground area will be addressed in a future decision. Monitoring locations, analytical parameters, and cleanup levels were not specified for groundwater monitoring at the K-1070-C/D Burial Ground, although the primary contaminants of concern (COCs) in that area are VOCs. Semiannual samples collected at wells and surface water locations outside the perimeter (downgradient) of the K-1070-C/D Burial Ground are analyzed for VOCs and general water quality parameters. Monitoring at the site focuses on providing data for evaluating changes in contaminant concentrations near the source units or potentially discharging to surface water within the ETTP boundaries.

Following G-Pit remediation, monitoring wells UNW-114, TMW-011, and UNW-064 (see Figure 3.24) were selected to monitor the VOC plume leaving the K-1070-C/D Burial Ground because they were located in the principal known downgradient groundwater pathway. Well monitoring results show elevated VOC concentrations. The VOC concentrations at these three wells began to decrease prior to excavating the G-Pit contents (during FY 2000) and continue to decrease. Although 1,1,1-TCA was formerly present at concentrations far greater than its 0.2-mg/L MCL, natural biodegradation and advective groundwater processes within the monitoring zone have reduced 1,1,1-trichloroethane (1,1,1-TCA) concentrations to less than the drinking water standard. Several direct-push technology monitoring points were installed to the west of UNW-114 during investigations conducted in 2005. The purpose of these monitoring points was to investigate groundwater contamination in an area along potential geologically controlled seepage pathways that may have connected the G-Pit contaminant source to the former SW-31 spring. DOE continues to monitor to measure VOC concentrations and their fluctuations downgradient of G-Pit.

DOE has compiled analytical data from K-1070-C/D groundwater monitoring to evaluate concentration trends for regulated contaminants. Data are compared to EPA's National Primary Drinking Water Regulations MCL, for screening purposes; however, MCLs are not identified as criteria in the ROD (DOE/OR/02-1486&D4). Groundwater contaminant trends in the area downgradient of the G-Pit source are mostly stable to indeterminate, with decreasing trends for PCE and TCE at well UNW-114 for the 10-year evaluation period. No contaminants exhibit an increasing trend over the past 5- and 10-year periods. Seasonal variations in VOC concentrations are very commonly observed. The FY 2022 results from UNW-114, UNW-064, and TMW-011 remain consistent with the plume boundary.

Well UNW-114 is closest to the source area and has a 10-ft screened interval placed in weathered bedrock material at an elevation of 774.95 ft above mean sea level (AMSL). Monitoring data for well UNW-114 show concentrations of most VOCs have been variable since 2005.

Well UNW-064 (10-ft well screen placed just above bedrock at an elevation of 783.87 ft AMSL) is located slightly further downgradient from the contaminant source area than UNW-114 and its monitoring data exhibit a slightly different behavior. Similar to the overall trend observed at UNW-114, the majority of VOC concentrations at UNW-064 decreased from about 2002–2005. Trend evaluations for VOCs in well UNW-064 for a 10-year period indicate no significant trend for 1,1-DCE and TCE and a stable trend for VC. The most-recent five-year period trends indicate a stable trend for 1,1-DCE; a decreasing trend for TCE, with a stable trend for the annual maximum concentrations; and no trend for VC.

Well TMW-011 (10-ft well screen placed just above bedrock at an elevation of 762.8 ft AMSL) is located furthest from the contaminant source area near the base of the hill below K-1070-C/D. VOC concentrations at TMW-011 tend to fluctuate in a fashion similar to those at UNW-064, except the seasonal signature is reversed, with higher concentrations in summer than during winter. This relationship suggests groundwater recharge during winter tends to dilute the VOCs near TMW-011 rather than cause a pulse of higher concentration groundwater, as was observed at the mid-slope location near UNW-064.

Overall, throughout the monitoring period of record, there have been decreases in the parent VOC (1,1,1-TCA and TCE) concentrations, with slight increases in concentrations of some of the degradation pathway compounds (e.g., 1,1-dichloroethane and VC) in the vicinity of the source (UNW-064 and UNW-114). The FY 2022 increase in VC concentrations at UNW-064 and UNW-114, which generally correlate to TCE and other precursor compound (i.e., cis-1,2-DCE) concentration decreases, likely represents the result of natural biodegradation from intrinsic dehalogenating bacteria in groundwater in the vicinity of these wells.

Figure 3.24 presents the current sitewide contaminant plume map for the sum of VOC plumes from the Main Plant Area Focused Feasibility Study (FFS) (DOE 2022b), K-31/K33 Remedial Investigation/Feasibility Study (DOE 2021d), and Zone 1 Remedial Investigation Work Plan (DOE 2021c). Figure 3.24 also shows the locations of exit pathway monitoring wells throughout the ETTP site that are routinely sampled by the Water Resources Restoration Program (WRRP) for known COCs, inferred groundwater flow directions in plume areas, and direction of surface water flow. As shown, the inferred groundwater flow directions are based on the water table piezometric surface contours. Shallow groundwater plumes generally flow in conformance to the local gradients, although in some areas, especially where geologic structures such as bedrock folding, fracturing, and karst development occur, groundwater may flow through secondary porosity features in directions oblique to inferred gradients.

For each of these exit pathway wells, DOE has compiled analytical data for groundwater contaminants for the past 10 years. The compiled data are compared to EPA's National Primary Drinking Water Regulations MCLs or MCL-DCs for radionuclides. The summary of M-K trend evaluations for the exit pathway wells in increments of the past 10 years and the last 5 years of monitoring show that, in general, contaminants that have exceeded their respective MCL concentrations have decreased in concentrations based on maximum measured concentrations in each monitoring interval evaluated and compared to FY 2022 data. The assignment of M-K trends shows mixed results of statistically significant decreases in some cases, increasing trends in other cases, and some instances in which trends are indeterminate or stable. Some metals (e.g., chromium and nickel) tend to be measured at or above MCL concentrations, with a tendency for particle-associated metals to lead to these MCL exceedances based on often-lower metal concentrations in filtered sample aliquots.

The Mitchell Branch groundwater exit pathway is monitored using surface water data from the K-1700 Weir on Mitchell Branch and wells BRW-083 and UNW-107.

Wells BRW-083 and UNW-107, located near the mouth of Mitchell Branch, have been monitored since 1994. Detection of VOCs in groundwater near the mouth of Mitchell Branch is considered an indication of the migration of the Mitchell Branch VOC plume complex. The intermittent detection of VOCs in this exit pathway is thought to be a reflection of variations in groundwater flowpaths that can fluctuate with seasonal hydraulic head conditions, which are strongly affected by rainfall and long-term and short-term Watts Bar Reservoir fluctuations. During FY 2022, no VOCs were detected in semiannual samples from either of these monitoring wells. In addition, no concentrations of VOCs in the 10-year or 5-year evaluation periods exceeded 80 percent of their respective MCLs. Gross alpha activity was not equal to nor exceeded 80 percent of the MCL in FY 2022.

Exit pathway wells BRW-003 and BRW-017 monitor metals and VOCs in groundwater at the K-1064 Peninsula Burn area. Metals detected in groundwater at the site include antimony, zinc, and arsenic; however, only arsenic concentrations were equal to or exceeded 80 percent of its MCL. Arsenic was detected in unfiltered samples collected in FY 2022 from both wells, with a maximum concentration of 0.008 mg/L in well BRW-003, which equals 80 percent of the MCL. The maximum concentration for filtered samples for arsenic collected in 2022 from well BRW-003 was only half (0.004 J mg/L) of the maximum unfiltered concentration. Arsenic concentrations in both unfiltered and filtered samples from well BRW-003 have shown long-term decreases during the period between 2004–2022. Historically, VOC contaminants exceeded MCLs in wells BRW-003 and BRW-017; however, regulated VOC concentrations have declined to below screening levels, with the exception of TCE, which has not exceeded its 0.005-mg/L MCL within the past 10 years and was not equal to nor exceeded 80 percent of the MCL during FY 2022.

Groundwater is monitored in four wells (BRW-066, BRW-030, UNW-080, and UNW-043) that lie between the K-31/K-33 area and PC. VOCs are not COCs in this area; however, within the past 10 years, five metals (antimony, arsenic, chromium, lead, and nickel) have exceeded 80 percent of their MCLs. During FY 2022, only chromium and nickel were detected at concentrations equal to or exceeding 80 percent of the MCL. Chromium was detected in FY 2022 in filtered and unfiltered samples from BRW-030, UNW-080, and UNW-043, with concentrations above its MCL screening concentration (0.1 mg/L) in UNW-043 filtered and unfiltered samples. Trend evaluations for chromium in wells BRW-030 and UNW-043 indicate significant upward trends for the 5-year and 10-year evaluation periods for both unfiltered and filtered samples from BRW-030 and for filtered samples from UNW-043. However, chromium concentrations for unfiltered samples from BRW-030, where historical concentrations have exceeded the MCL, were below the MCL in the FY 2022 sample results. Chromium concentrations for unfiltered samples from UNW-043 show a downward trend over the 10-year period, with no determinate trend in the annual maximum concentrations, and an upward trend for the five-year period. Chromium concentrations in UNW-080 were less than 80 percent of the MCL in FY 2022. Nickel was detected in FY 2022 in filtered samples from UNW-043 at concentrations above 80 percent of the MCL screening concentration (0.1 mg/L), but below the MCL. In unfiltered samples from UNW-043, nickel was not detected above 80 percent of the MCL screening concentration. Trend evaluations for nickel in UNW-043 indicate declining 5-year and 10-year concentrations trends at this well. Nickel was detected in FY 2022 below 80 percent of the MCL screening concentration in UNW-080 filtered and unfiltered samples.

Groundwater discharges toward PC in both a northward pathway beneath the K-1232 area and in a south-to-westward pathway, as shown earlier on Figure 3.24. Two wells (BRW-016 and BRW-058) in the northern plume near K-27/29 and two wells (UNW-038 and UNW-096) in the south/western plume have been designated for exit pathway monitoring.

During FY 2019, a high alpha activity result occurred in well BRW-016 in September 2019. This result was likely caused by infiltration of water down the well bore associated with D&D activities in the area. DOE redeveloped the well to remove residual infiltrated contamination to the extent practical. The well was pumped and swabbed to remove as much sediment and contaminated water as possible and was returned to service. A subsequent sample collected in March 2020 showed large reductions in contaminant concentrations compared to the levels measured prior to well redevelopment, and the August 2020 alpha activity decreased further but remained greater than the 15-pCi/L MCL screening concentrations. Alpha activity remained lower in FY 2022 with a concentration of 110 pCi/L but remained greater than the MCL screening concentration. VOCs have exceeded MCLs in the K-27/K-29 area northern pathway. However, in FY 2022, VC was the only VOC detected above its MCL screening concentration (0.002 mg/L), with a maximum detected concentration of 0.011 mg/L in well BRW-058. Trend evaluations for well BRW-058 indicate significant upward trends for the prior 10-year period and a stable trend over the five-year period for VC at this well. TCE concentrations were less than 80 percent of the MCL in FY 2022, and cis-1,2-DCE was detected at low levels in samples from well BRW-058 at concentrations greater than 80 percent of the MCL screening concentration, but less than the MCL. The presence of cis-1,2-DCE and VC in the area is indicative that a small degree of intrinsic degradation of the parent TCE is occurring in this part of the ETTP site.

In the south/west exit pathway from the K-27/K-29 area, TCE is persistent in the exit pathway wells, with stable trends at well UNW-038 and increasing trends at well UNW-096 over the 10-year and 5-year periods. Chromium concentrations were greater than 80 percent of the MCL in samples from well UNW-096, but less than the MCL in FY 2022. Nickel concentrations equaled or exceeded the Tennessee MCL of 0.1 mg/L in wells UNW-038 and UNW-096 in unfiltered FY 2022 samples, with maximum concentrations of 0.1 and 0.13 mg/L, respectively. In well UNW-096, nickel concentrations in filtered FY 2022 samples also exceeded the Tennessee MCL with a maximum concentration of 0.13 mg/L.

Wells BRW-084 and UNW-108 are exit pathway monitoring locations at the northern edge of the K-1007-P1 Holding Pond (Figure 3.24). No regulated contaminants have equaled or exceeded 80 percent of their respective MCLs in the FY 2022 samples. Alpha activity was present at levels less than 80 percent of the 15-pCi/L MCL screening concentration in samples from well UNW-108 in FY 2022, and TCE was detected below 80 percent of the MCL screening concentration (0.005 mg/L) in FY 2022 at BRW-084.

Exit pathway groundwater in the K-901-A Holding Pond area (Figure 3.24) is monitored by four wells (BRW-035, BRW-068, UNW-066, and UNW-067) and two springs (21-002 that flows into the K-901-A Holding Pond, and PC-0 that discharges into PC on the west side of Duct Island). No regulated contaminants equaled or exceeded 80 percent of the MCL at any of the four wells in FY 2022 samples.

TCE is the most significant groundwater contaminant detected in the springs. Spring PC-0 was added to the sampling program in 2004. During April–October each year, spring PC-0 is submerged beneath the Watts Bar Lake level. In the late winter of 2012, DOE installed a sampling pump in the spring mouth to allow year-round sampling. The contaminant source for spring PC-0 is presumed to be legacy waste disposed of at the former K-1070-F located on Duct Island. The TCE concentrations in spring PC-0 have varied between non-detectable levels and 26 µg/L and have decreased from their highest measured value in 2006. During FY 2022, the maximum TCE concentration in spring PC-0 quarterly samples was 11 µg/L measured in a sample collected in November 2021. The TCE concentrations in the remaining FY 2022 samples were all below the MCL screening concentration of 5 µg/L.

TCE that originates from the now-remediated K-1070-A Burial Ground is the principal contaminant detected at spring 21-002 (Figure 3.24).

The conceptual behavior of this contaminant plume is described by higher concentration, but lower flow, during the dry season with apparently subdued effects of rainfall on spring TCE concentrations. During the wet season, the overall TCE concentrations at spring 21-002 are lower; however, wet-season, increased rainfall-driven, groundwater-flow pulses push TCE concentration pulses through conduits that discharge at spring 21-002. Eight of the last 12 samples collected at spring 21-002 have exceeded the MCL screening concentration of 5 µg/L. Because water that discharges from the springs monitored in the ETTP area originates mostly from shallow flow systems, the flow rates and dissolved contaminant concentrations are highly variable. For this reason, no contaminant trend direction can be confidently assigned to the spring data.

Exit pathway groundwater monitoring is also conducted at the K-770 area, where wells UNW-013 and UNW-015 are used to assess radiological groundwater contamination along the CR (Figure 3.24). Alpha activity measured in samples from well UNW-015 has exceeded the

15-pCi/L MCL once within the past 10 years. During FY 2022, the maximum alpha activity was 8.6 pCi/L, which is below 80 percent of the 15-pCi/L MCL, and no other regulated contaminants exceeded 80 percent of their MCLs.

3.7. Biological Monitoring

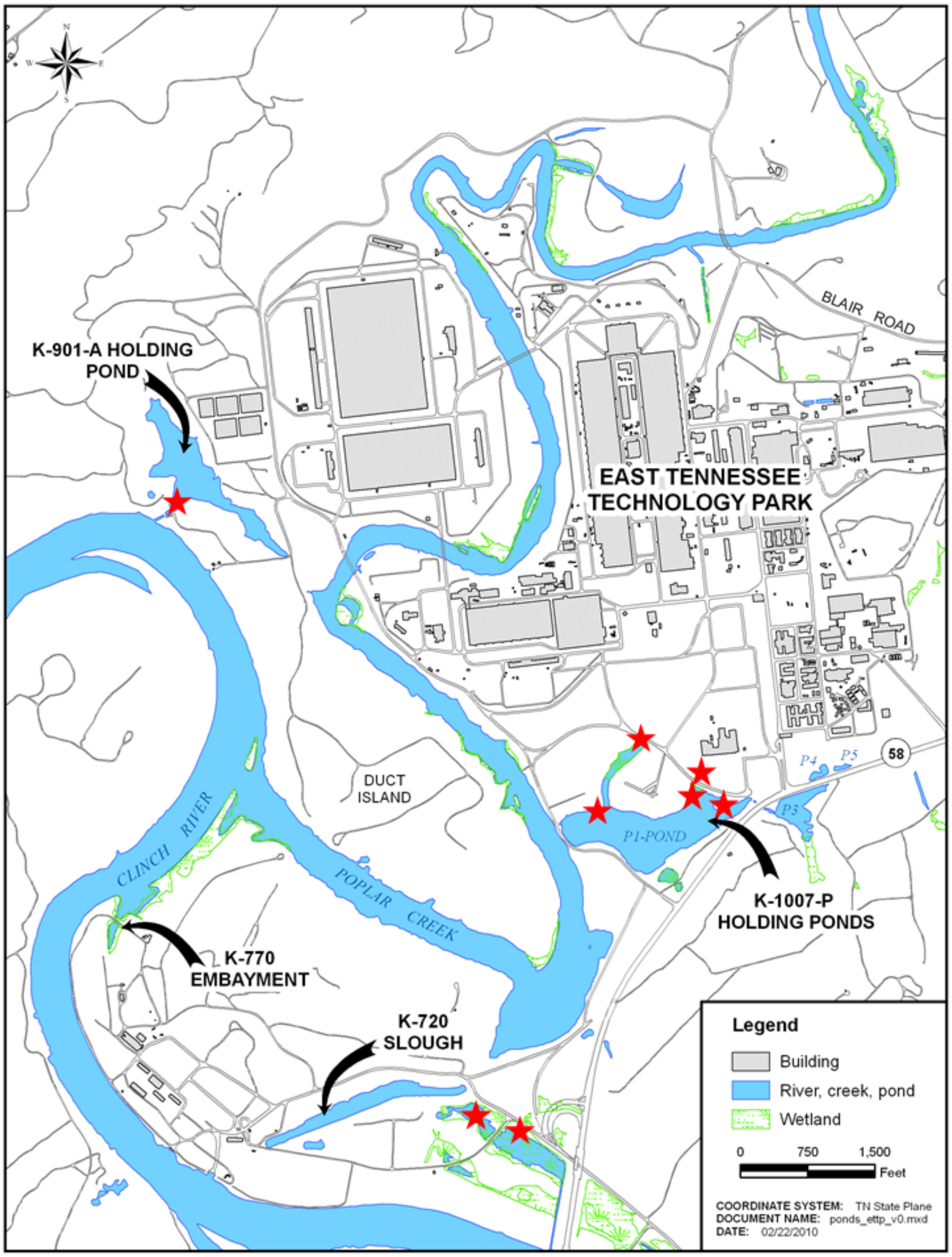
The ETTP Biological Monitoring and Abatement Program (BMAP) consists of two tasks designed to evaluate the effects of ETTP legacy operations on the local environment, identify areas where abatement measures would be most effective, and test the efficacy of the measures. The results from this program will support future CERCLA cleanup actions. These tasks are: (1) bioaccumulation studies, and (2) instream monitoring of biological communities. Figure 3.25 shows the major water bodies at ETTP and Figure 3.26 shows the BMAP monitoring locations along Mitchell Branch.

3.7.1. Task 1: Bioaccumulation Monitoring

Bioaccumulation monitoring for the ETTP BMAP has focused on evaluating the impact of PCB discharges into the environment because of historical operations at the ETTP complex. It was previously assumed that mercury (Hg) flux into Poplar Creek and the Clinch River originated largely from Y-12 Complex discharges into East Fork Poplar Creek. However, more recent monitoring has shown that water in ETTP storm drains and biota from lower Mitchell Branch have elevated mercury concentrations. Mercury bioaccumulation monitoring is routinely conducted in the watersheds adjacent to ETTP by the Y-12 and ORNL BMAPs, both on and off ORR. The available Hg bioaccumulation monitoring data will be presented in the following subsections with long-term trends in PCB contamination in resident fish and caged clams from ETTP waters.

Because the consumption of contaminated fish represents the largest dose of Hg and many other bioaccumulative contaminants to humans, fish fillet concentrations are relevant to assessing human health risks, whereas whole body fish are relevant to assessing ecological risks. Largemouth bass (*Micropterus salmoides*) and various sunfish species are used to monitor Hg and PCB fillet concentrations, and gizzard shad (*Dorosoma cepedianum*) and bluegill (*Lepomis macrochirus*) are used to monitor whole body concentrations at various locations over time. Largemouth bass are larger, upper trophic level predatory fish and are, therefore, susceptible to Hg and PCB bioaccumulation. Fillet concentrations in these fish represent the near maximum potential dose to humans, if eaten. Largemouth bass tend to live in larger, deeper pools of water and are collected in the ponds at ETTP (K-1007-P1 Pond, K-901-A Pond, and K-720 Slough) as well as in off-site river and reservoir locations. Sunfish are short-lived and have small home ranges, so fillet Hg and PCB concentrations in these fish are representative of exposure at the site of collection. These fish are used in long-term studies to monitor changes in bioaccumulation at a given site over time. Collections of sunfish are restricted to sizes large enough to be taken by sport anglers (generally 50–150 g total weight) to minimize effects of covariance between size and contaminant concentrations, as well as for spatial and temporal comparability. The target sunfish species for bioaccumulation studies in Mitchell Branch and other ORR stream sites is redbreast sunfish (*Lepomis auritus*), but where these fish are not present, other species with similar feeding habits (e.g., bluegill sunfish [*Lepomis macrochirus*]) are collected. For bioaccumulative contaminants such as Hg and PCBs, fish bioaccumulation data have become important measures of compliance for both the CWA and CERCLA.

For Hg, the EPA National Recommended Water Quality Criterion for Hg in fish (0.3 micrograms/gram [μg/g]) is used as the trigger point for fish consumption advisories in Tennessee, the target concentration for NPDES permit compliance, and the threshold for impairment designations that require a Total Maximum Daily Load (TMDL) assessment. In addition to fish Hg limits, the state of Tennessee continues to use the statewide AWQC for Hg of 51 ng/L in water, based on organisms only, and 50 ng/L for recreation-water and organisms. Regulatory guidance and human health risk levels have varied more widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. The Tennessee water quality criteria for individual Aroclors and total PCBs are both 0.00064 µg/L under the recreation designated use classification and are the target for PCB-focused TMDLs, including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudon). However, most conventional PCB water analyses have detection limits much higher than the PCB AWQC.

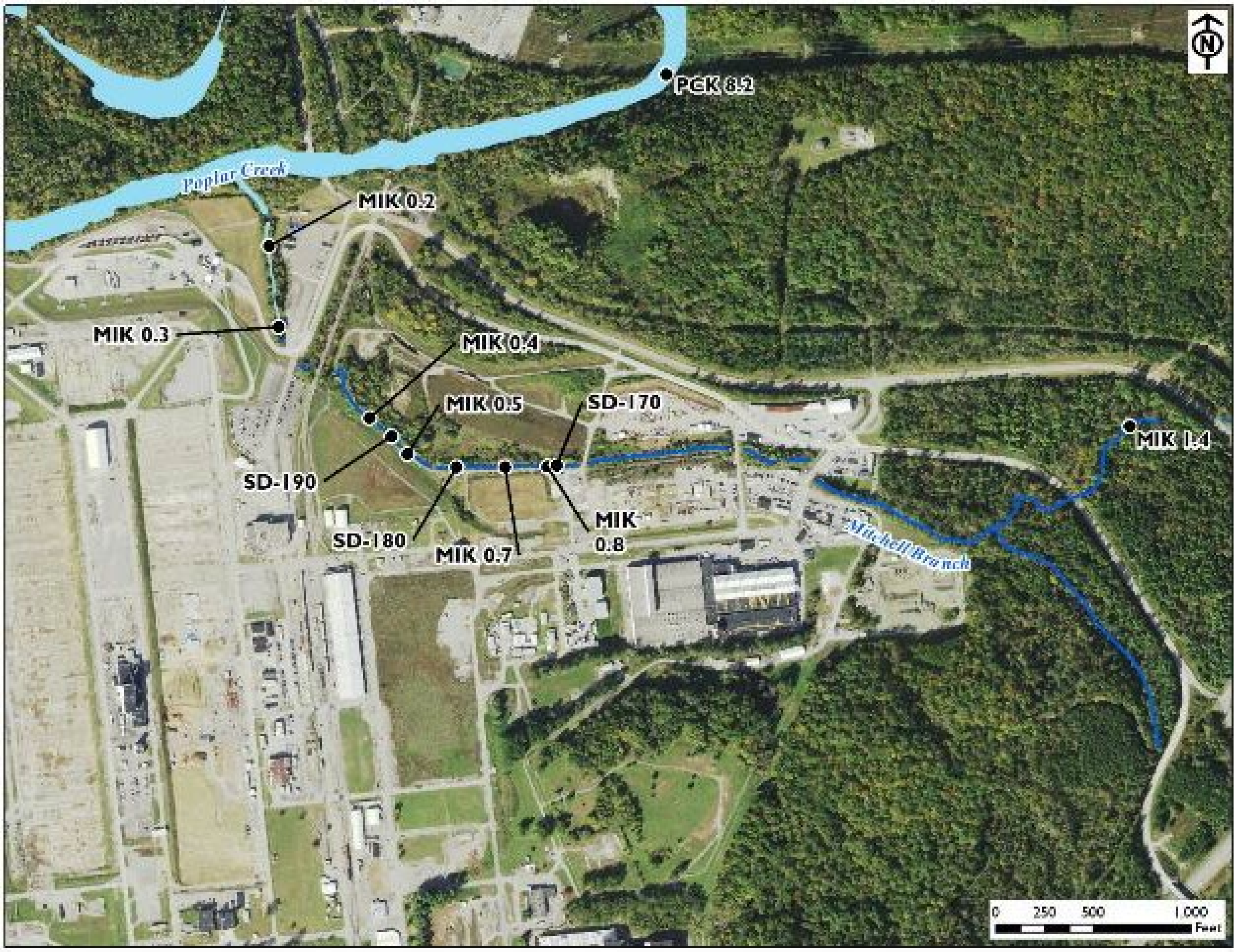


Note: *Red stars indicate clam sampling locations in and around the ETTP complex in 2022 (Mitchell Branch sites not shown).*

Acronyms:

CRM = Clinch River mile PCK = Poplar Creek kilometer MIK = Mitchell Branch kilometer SD = storm drain

Figure 3.25. Water bodies at the East Tennessee Technology Park



Acronyms:
BMAP = Biological Monitoring and Abatement Program
MIK = Mitchell Branch kilometer
SD = storm drain/storm water outfall

Figure 3.26. Major storm water outfalls and biological monitoring locations on Mitchell Branch

Therefore, in Tennessee and in many other states, assessments of impairment for water body segments, as well as public fishing advisories for PCBs, are based on fish tissue concentrations. Historically, the US Food and Drug Administration threshold limit of 2 µg/g in fish fillet was used for PCB advisories; then for many years in Tennessee, an approximate range of 0.8 to 1 µg/g was used, depending on the data available and factors such as the fish species and size. The remediation goal for fish fillet at the ETTP K-1007-P1 Pond is 1 µg/g. Most recently, the water quality criterion that has been used by TDEC to calculate the fish tissue concentration triggering a determination of impairment and a TMDL, and this concentration is 0.02 µg/g in fish fillet. The fish PCB concentrations at and near ETTP are above this most conservative concentration.

In addition to monitoring for human health and ecological risks as well as long-term trends, bioaccumulation monitoring also includes investigations of sources of contamination to ETTP waterways. Caged Asiatic clams (*Corbicula fluminea*) are used as bioindicators of contaminant sources in Mitchell Branch and other sites around ETTP. These clams are collected from an uncontaminated reference site (Little Sewee Creek in Meigs County, Tennessee) and are divided into groups of 10 clams of equal mass. In 2022, clams were placed in baskets to be deployed at strategic locations around ETTP (i.e., in and around storm drains) for a four-week exposure period (May 12–June 9, 2022). Two clam baskets were placed at each site with 10 clams in each basket.

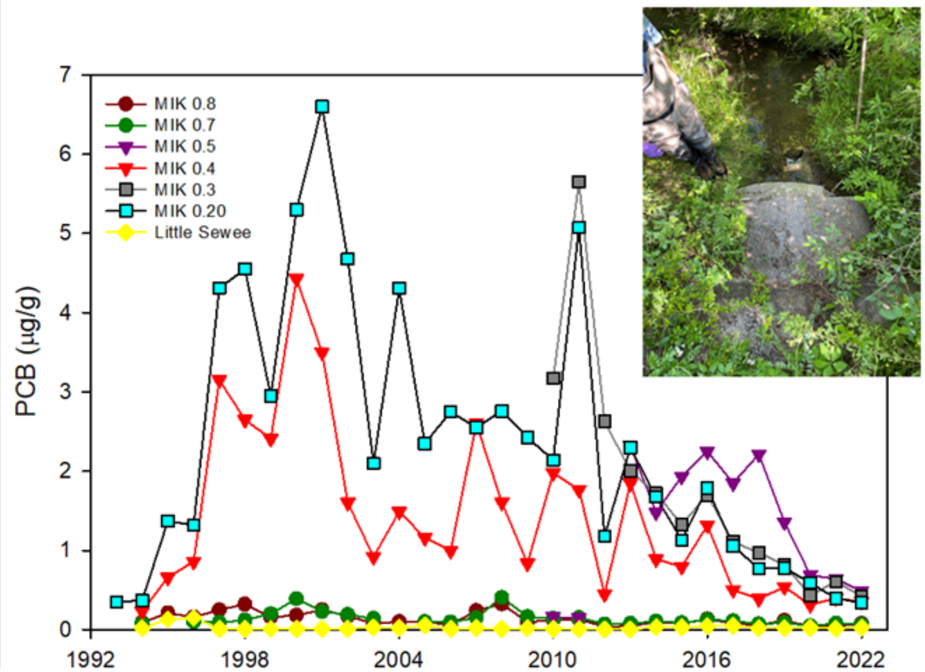
Because these animals are sedentary filter feeders, they accumulate contaminants that are present in the water and in suspended particles at a given site. They are useful indicators of the bioavailable (and therefore potentially toxic) portion of contaminants that enter the environment at a given location, and they provide spatial resolution of contamination on a finer scale than is possible with fish bioaccumulation studies. Caged clams have been used for more than 25 years to evaluate the importance of storm drains and other inputs of PCBs into the waterways around ETTP and for the past 10 years to monitor total mercury (Hg_T) and methylmercury (MeHg) inputs to Mitchell Branch. Whereas most of the Hg in the environment is inorganic mercury (Hg^{2+}), a small fraction of Hg^{2+} is converted to the more toxic and bioaccumulative MeHg. Because MeHg biomagnifies in aquatic systems, increasing in concentration as it moves up through the food chain, more than 90 percent of the Hg in upper trophic level fish is MeHg. Clams, which feed on periphyton and detritus at the base of the food chain, have a much smaller proportion of MeHg in their tissues but are still good indicators of MeHg hot spots and sources. The soft tissues of the clams from each cage were homogenized, and aliquots were taken for PCB and Hg analysis.

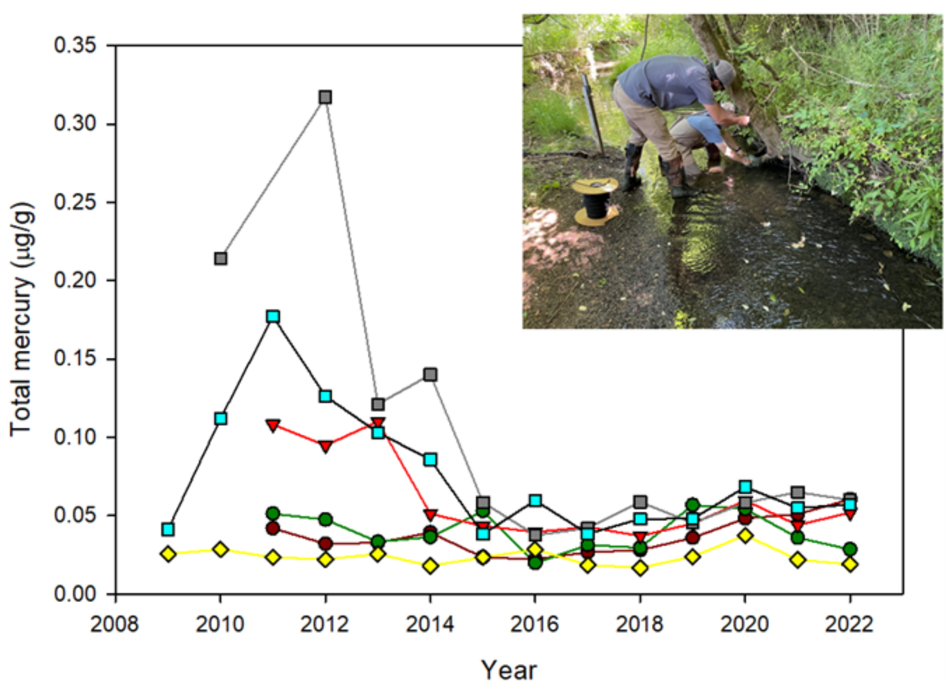
To assess spatial and temporal variability in exposure to PCBs following remediation activities, water samples have been collected for analysis of aqueous PCBs and TSS from the outfalls of K-1007-P1 and K-901-A, upper and lower storm drain (SD)-100, and an uncontaminated reference site (upper First Creek, ORNL). Samples are collected four times each year (March/April, June, July, and August).

3.7.1.1. Mitchell Branch

Figure 3.27 shows long-term monitoring results in caged clams deployed at various sites in Mitchell Branch. The lower portion of this stream (MIK 0.5, SD-190, MIK 0.2) has historically been a hot spot for both Hg and PCB contamination. In 2022 PCB concentrations in biota in this stretch of the creek continued to be slightly elevated (~0.3–0.5 µg/g) with respect to other Mitchell Branch and reference sites. Although there is considerable interannual variability, PCB concentrations in clams placed in lower Mitchell Branch appear to be generally trending downward since peak years in 2000–2001. While there was a slight bump up in PCB concentrations at Mitchell Branch sites in 2016, concentrations since then have dropped back down, continuing the overall decreasing trend. PCB concentrations in the upper portion of Mitchell Branch were similar to previous years' concentrations and were slightly elevated (0.08 µg/g) with respect to the reference site (0.02 µg/g).

Mercury concentrations in clams deployed in Mitchell Branch in 2022 were generally similar to concentrations seen in 2021 and were only slightly elevated in Mitchell Branch relative to the reference site (Figure 3.28). Within the Mitchell Branch system, the highest Hg concentrations were seen in clams deployed at SD180 (0.13 µg/g). Mercury concentrations in clams deployed at the K-1007-P1 and K-901-A Ponds were again comparable to reference site concentrations. Clams deployed at the north Beaver Pond had Hg concentrations similar to those of the reference site (clams deployed at the south Beaver Pond experienced complete mortality). Unlike in fish tissue, MeHg in the soft tissues of clams generally made up a small proportion of Hg_T (Figure 3.28). MeHg concentrations in clams mostly remained low in 2022, comparable to or slightly lower than concentrations in 2021, with the exception of a slight increase at MIK0.2 (0.03 µg/g). Clams deployed at the Oxbow lake had similar PCB concentrations and slightly higher Hg concentrations than the reference site.



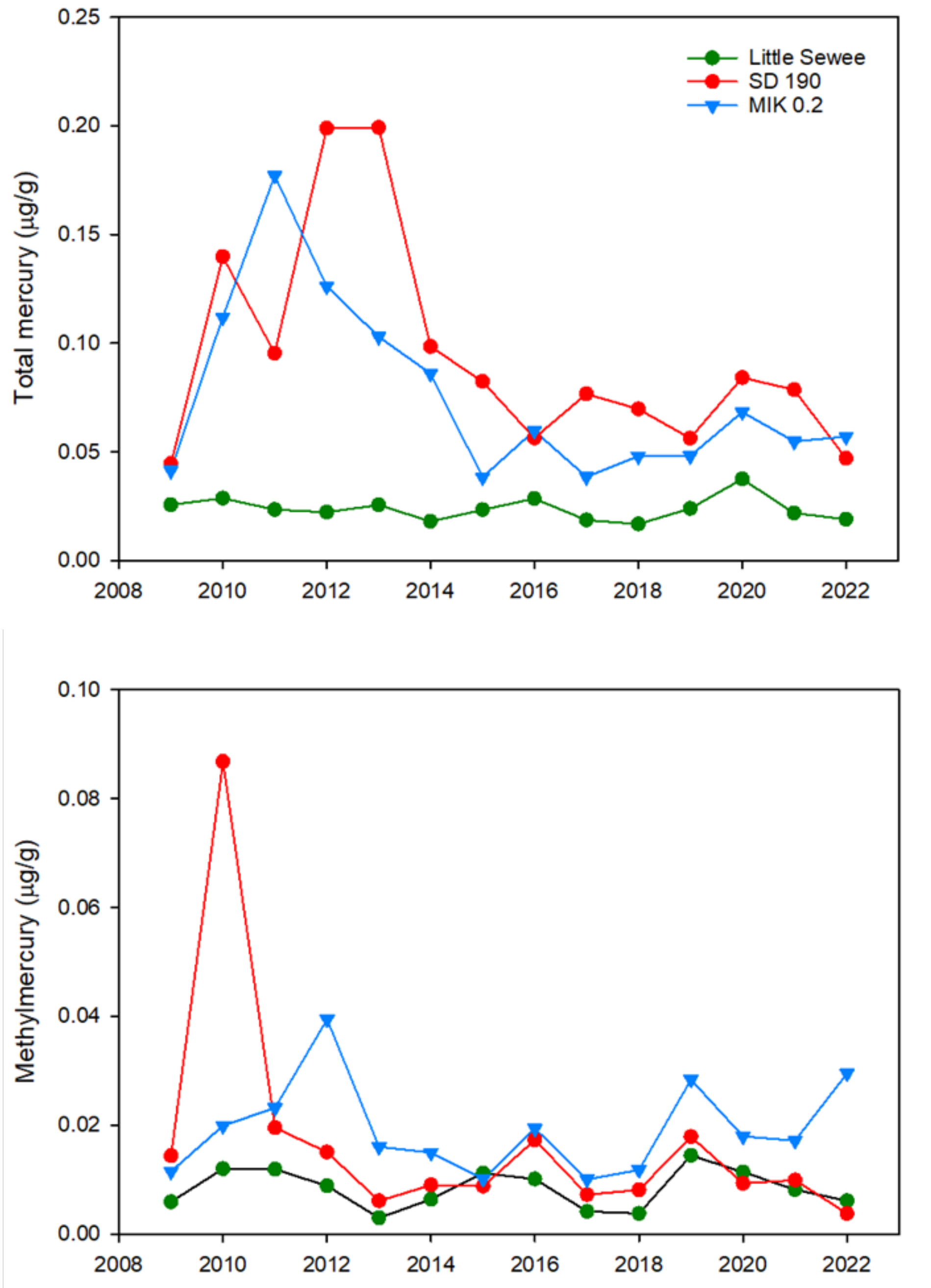


Notes:

1. *N = 2 composites of 10 clams each per year.*
2. *Shown in yellow are data for clams collected from the reference site, Little Sewee Creek (Meigs County, Tenn.).*
3. *Total PCBs is defined as the sum of Aroclors 1248, 1254, and 1260.*

Acronyms: *MIK = Mitchell Branch kilometer PCB = polychlorinated biphenyl*

Figure 3.27. Mean total PCB (Top: µg/g, wet wt; 1993–2022) and mercury (Bottom: µg/g wet wt; 2009–2022) concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch



Notes:

1. *N = 2 composites of 10 clams each per year.*
2. *Shown in yellow are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tennessee)*

Acronyms: *MIK = Mitchell Branch kilometer* *SD = storm drain*

Figure 3.28. Total (top panel) and methylmercury (bottom panel) concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch (µg/g wet wt; 2009–2022)

Figure 3.29 shows long-term monitoring results in redbreast sunfish (*Lepomis auritus*) at MIK 0.2. Average PCB concentrations in fish collected at MIK 0.2 in 2022 (0.71 ± 0.1 µg/g) were higher than those seen in 2021 (0.59 ± 0.4 µg/g) but remained comparable to concentrations seen at this site in recent years. Although there is not a regulatory limit for PCBs in fish, the level most often used in practice to issue fish consumption advisories in the state of Tennessee, as previously stated, is 1 µg/g. In 2022, the mean PCB concentration in sunfish fillets collected from MIK 0.2 was below this limit. While the observed fish tissue concentrations in Mitchell Branch are lower than they have historically been, they are still two to three orders of magnitude higher than concentrations seen in the same species at the Hinds Creek reference site in Anderson County.

Total mercury has been monitored more sporadically in redbreast sunfish fillets at MIK 0.2. Figure 3.29 shows long-term trends in Hg_T concentrations (µg/g) in these fish. A rapid increase in fillet Hg_T concentrations was observed in the early 1990s and concentrations have generally remained elevated, with mean concentrations exceeding the AWQC (0.3 µg/g) in most years. Similar to the PCB concentrations in fish from this site, Hg_T concentrations at MIK 0.2 have been oscillating around the EPA's recommended AWQC for the past several years. Mean mercury concentrations in redbreast at this site remained just above the mercury tissue criterion, averaging 0.33 + 0.06 µg/g in 2022.

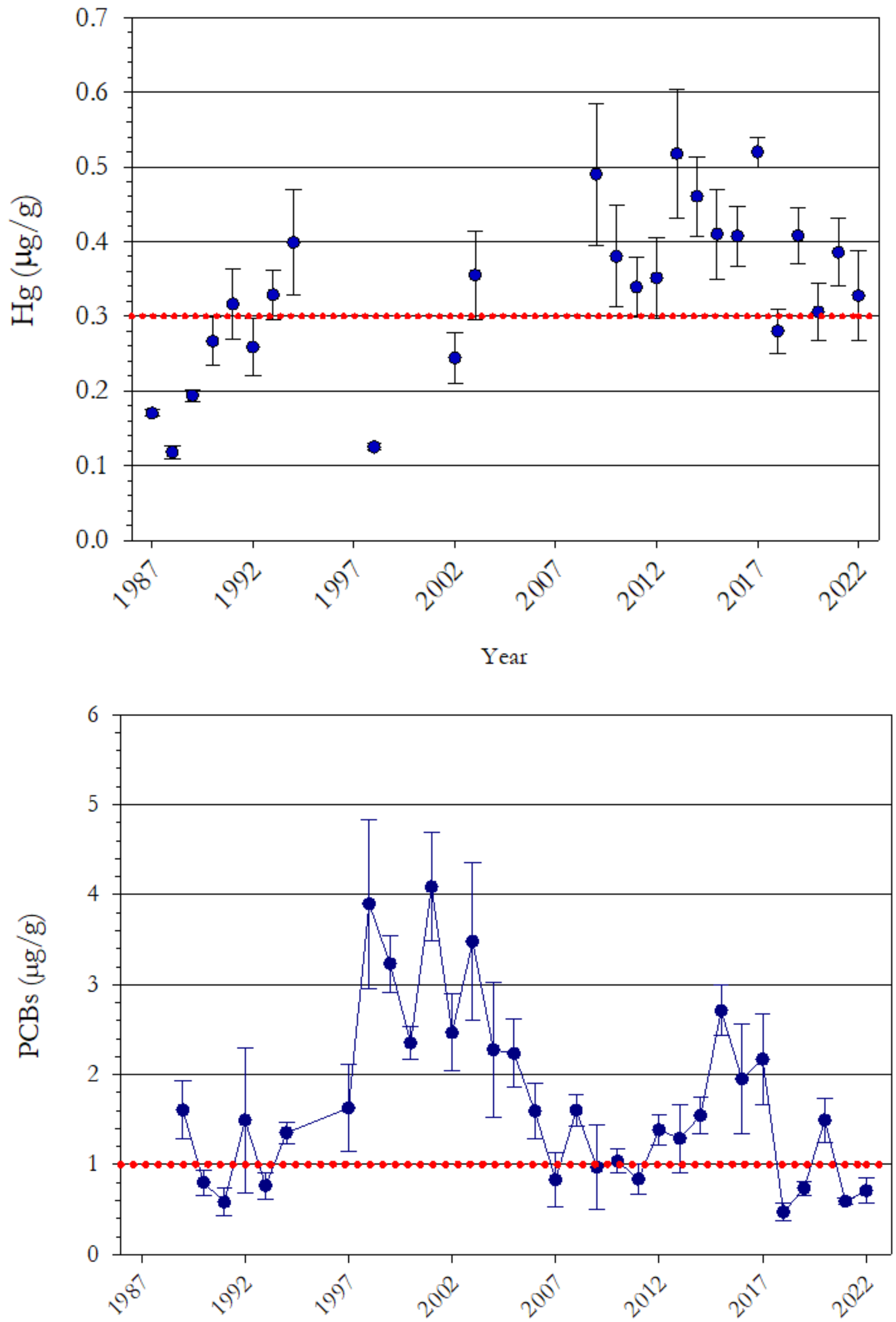
3.7.1.2. 1007-P1 Pond

Over the past decade, mean aqueous PCB concentrations in the K-1007-P1 Pond have fluctuated significantly but have generally been lower than concentrations seen before 2009 remediation activities (e.g., 36 ng/L in 2022 compared with 161 ng/L in 2007; Figure 3.30). Concentrations in 2022 were slightly higher than in 2021, but, still were also comparable to the lowest recorded average PCB concentration since remediation (26 ng/L in 2015). As hydrophobic contaminants, PCBs tend to be particle associated and are positively correlated with TSS. The fluctuations in PCB and TSS concentrations in water in the K-1007-P1 Pond could be related to fluctuations in aquatic plant coverage, which can affect sediment stability. The aqueous PCB concentrations measured in the K-1007-P1 Pond are above concentrations seen at the First Creek reference site (0.76 ng/L in 2022) and are above the state of Tennessee water quality criterion for the protection of fish and wildlife (14 ng/L).

PCB concentrations in clams placed at lower and upper SD-100 locations have fluctuated significantly since remediation actions in 2009, and were on an overall decreasing trajectory until the significant increases seen in 2017 and 2018 (Figure 3.31). Concentrations in clams deployed in upper and lower SD100 in 2022 were higher than the increased levels in 2017-2018. Both upper and lower SD100 concentrations remained elevated with respect to the reference site. PCB concentrations in clams placed at the K-1007-P1 outfall were also higher since the increase in 2017, but have been steadily falling since then, and in 2022, were comparable to concentrations seen just after remediation actions in this pond (Figure 3.31).

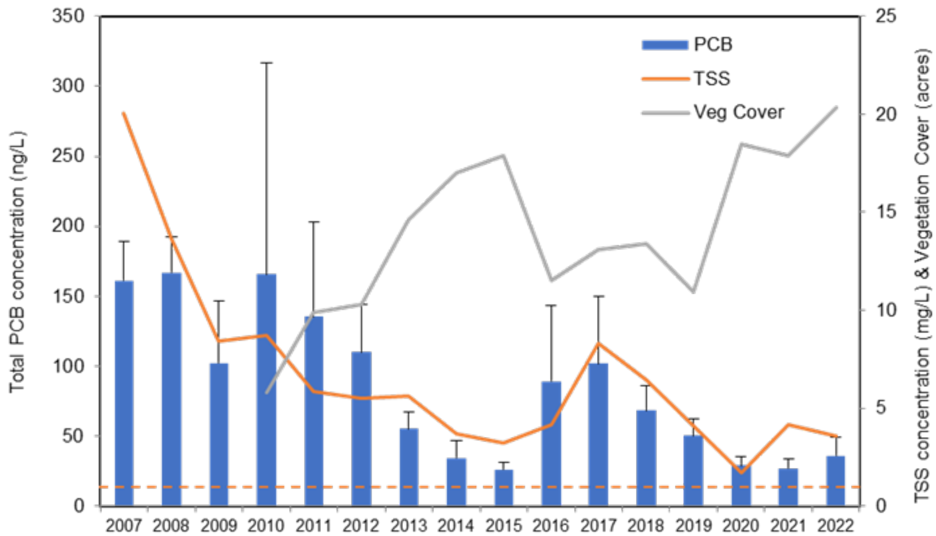
Similar trends have been observed in fish tissue PCB concentrations in the K-1007-P1 Pond (Figure 3.32). Since 2009, the target species for bioaccumulation monitoring in the K-1007-P1 Pond has been bluegill sunfish (*Lepomis macrochirus*). As in previous years, fillets from 20 individual bluegill and 6 whole body composites (10 bluegill per composite) from the K-1007-P1 Pond were analyzed for PCBs in 2022 to assess the ecological and human health risks associated with PCB contamination in this pond.

While PCB concentrations in fish and in caged clams at K-1007-P1 Holding Pond have been fluctuating for the past few years, in 2022 biota concentrations decreased such that both fillets and whole-body concentrations in bluegill were below the targets for this pond. Mean PCB concentrations in bluegill fillets in the K-1007-P1



Notes:
1. 1989–2022 N = 6 fish per year.
2. Shown in red is the fish advisory level for PCBs (1 µg/g) and mercury concentration (0.3 µg/g).
Acronyms:
Hg = mercury MIK = Mitchell Branch kilometer PCB = polychlorinated biphenyl

Figure 3.29. Mean PCB (top panel) and mercury (bottom panel) concentrations (µg/g, wet wt) in redbreast sunfish fillets in Mitchell Branch (MIK 0.2), 1989–2022

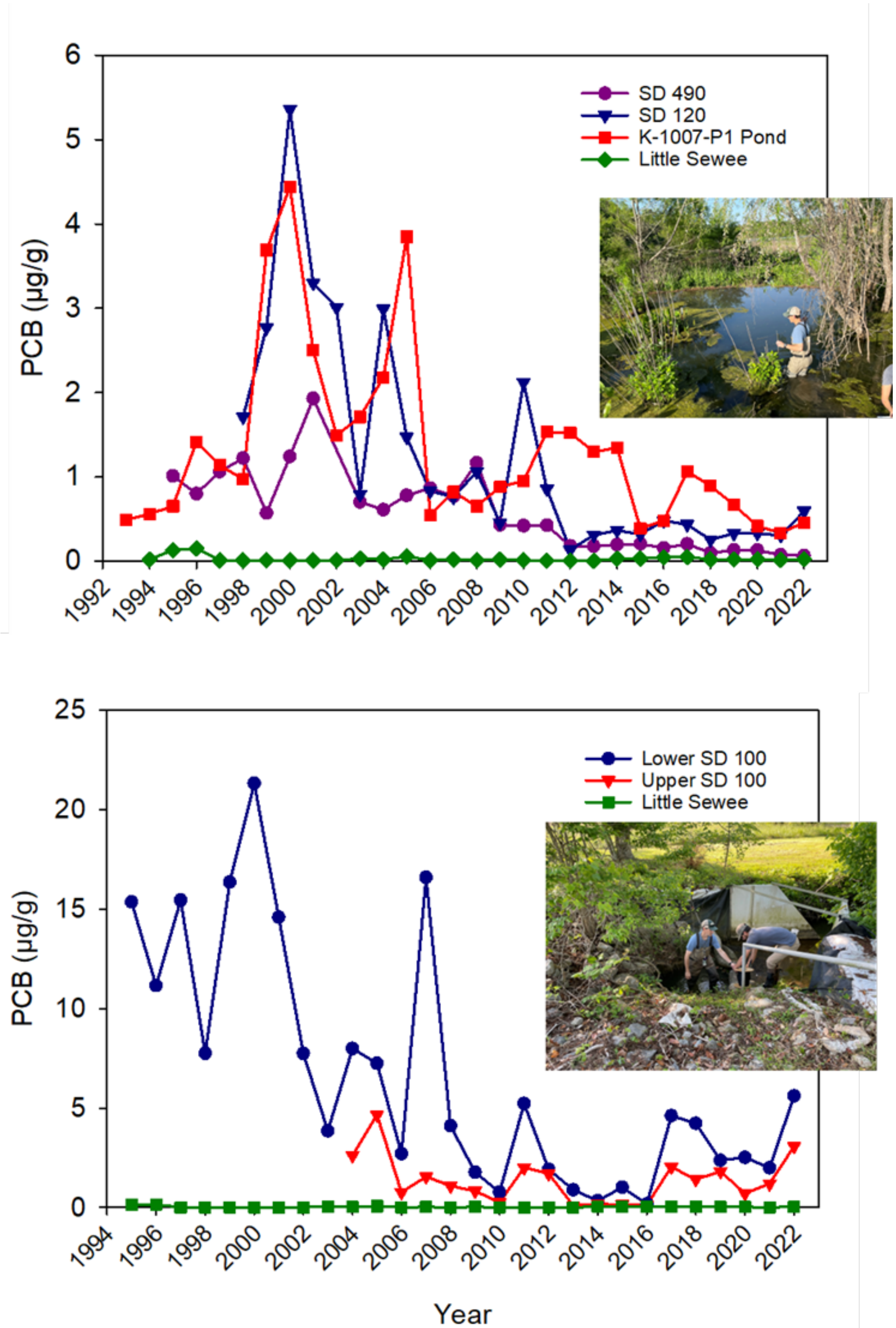


Notes:

1. *Means for PCBs in water and TSS are based on results across all collections made each year.*
2. *Note that mean concentrations of PCBs in water from First Creek were <0.3 ng/L in all years.*

Acronyms: *PCB = polychlorinated biphenyl   ITSS = total suspended solids*

Figure 3.30. Mean aqueous total PCB concentrations, total suspended solids, and vegetation cover in the K-1007-P1 Pond, 2007–2022

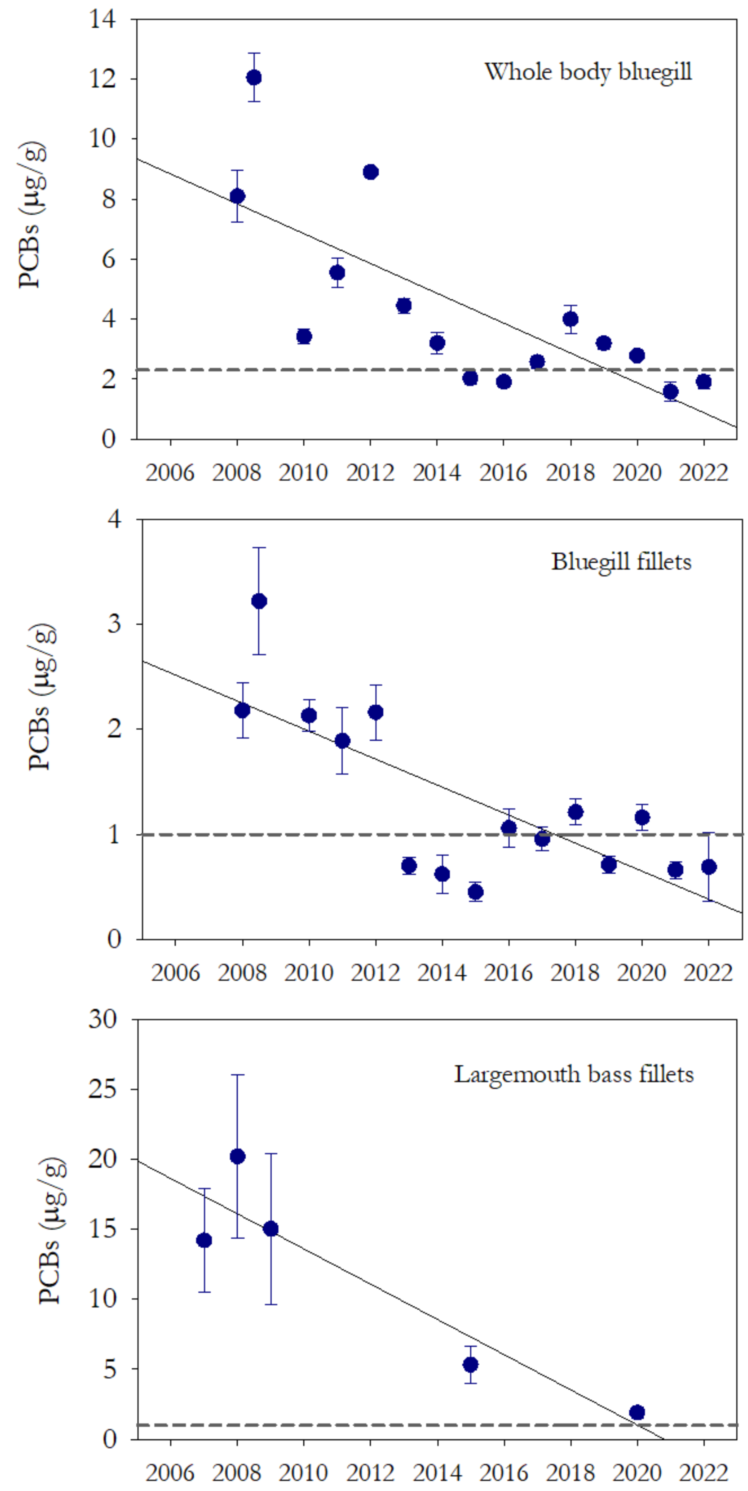


Notes:

1. *N = 2 clam composite samples per site/year.*
2. *Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.*
3. *Photos: Upper graph shows the SD-490 location; lower graph photo shows placement of clam cages in the Upper SD-100 location.*

Acronyms: *PCB = polychlorinated biphenyl SD = storm drain*

Figure 3.31. Mean total PCB concentrations (µg/g, wet wt) in caged clams placed at K-1007-P1 outfalls compared with reference stream clams (Little Sewee Creek), 1993–2022



Notes:

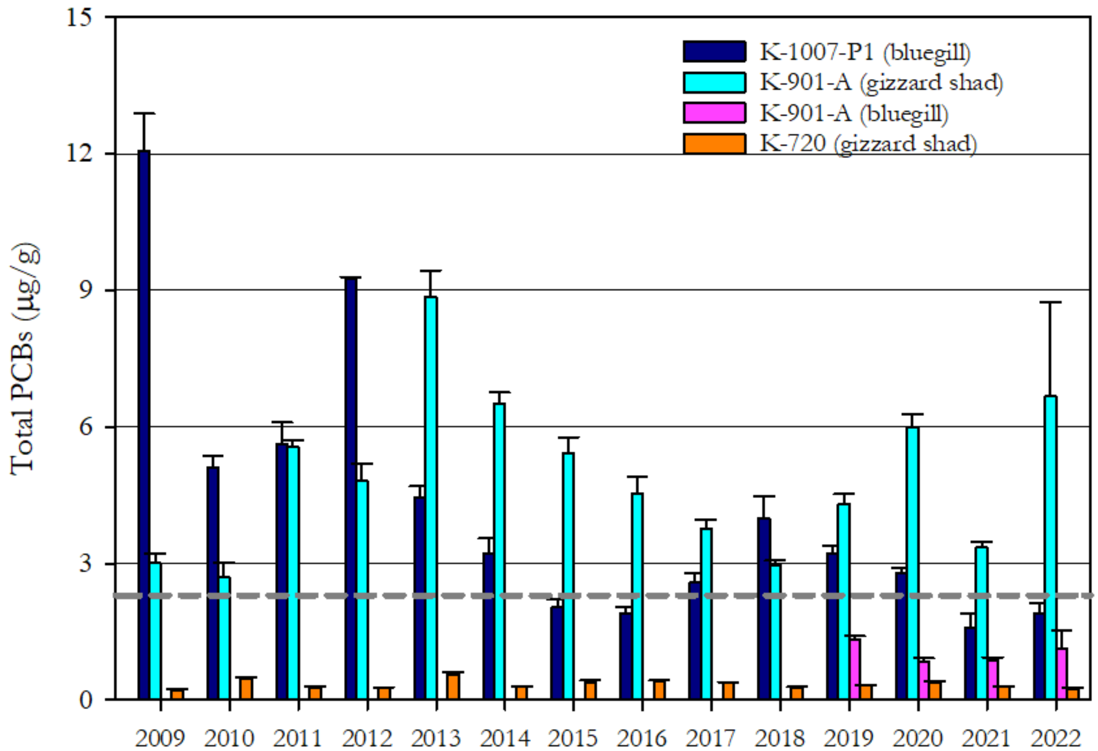
1. *For largemouth bass, N = 6 fish per site/year. For bluegill sunfish, N = 20 for fillets and N = 6 composites of 10 whole body fish.*
2. *The target for fillet (1 µg/g) and whole-body concentrations (2.3 µg/g) is shown with the gray dotted lines.*

Acronym: *PCB = polychlorinated biphenyl*

Figure 3.32. Mean PCB concentrations (µg/g, wet wt) in fish from the K-1007-P1 Pond, 2007–2022

Pond increased slightly from 0.66 µg/g in 2021 to 0.69 µg/g in 2022, remaining below the remediation goal for this pond (1 µg/g total PCBs in fillets). Mean concentrations in whole-body bluegill increased from 1.58 µg/g in 2021 to 1.91 µg/g in 2022, also remaining below the remediation target for whole body fish in this pond (2.3 µg/g in whole-body composites). (Figures 3.32 and 3.33; Table 3.8).

The interannual fluctuations in PCB concentrations could be due to water quality changes that have taken place in this pond, e.g., higher TSS, PCB inputs, and fluctuations in vegetation cover (Figures 3.32 and 3.33).



Notes:
1. *Total PCBs are defined as the sum of Aroclors 1248, 1254, and 1260.*
2. *The dotted line signifies the target PCB concentration of 2.3 µg/g in whole body fish.*

Acronym: *PCB = polychlorinated biphenyl*

Figure 3.33. Mean (+1 standard error) total PCB concentrations (µg/g, wet wt) in whole body fish from K1007-P1 Pond, K-901-A Holding Pond, and K-720 Slough, 2009–2022

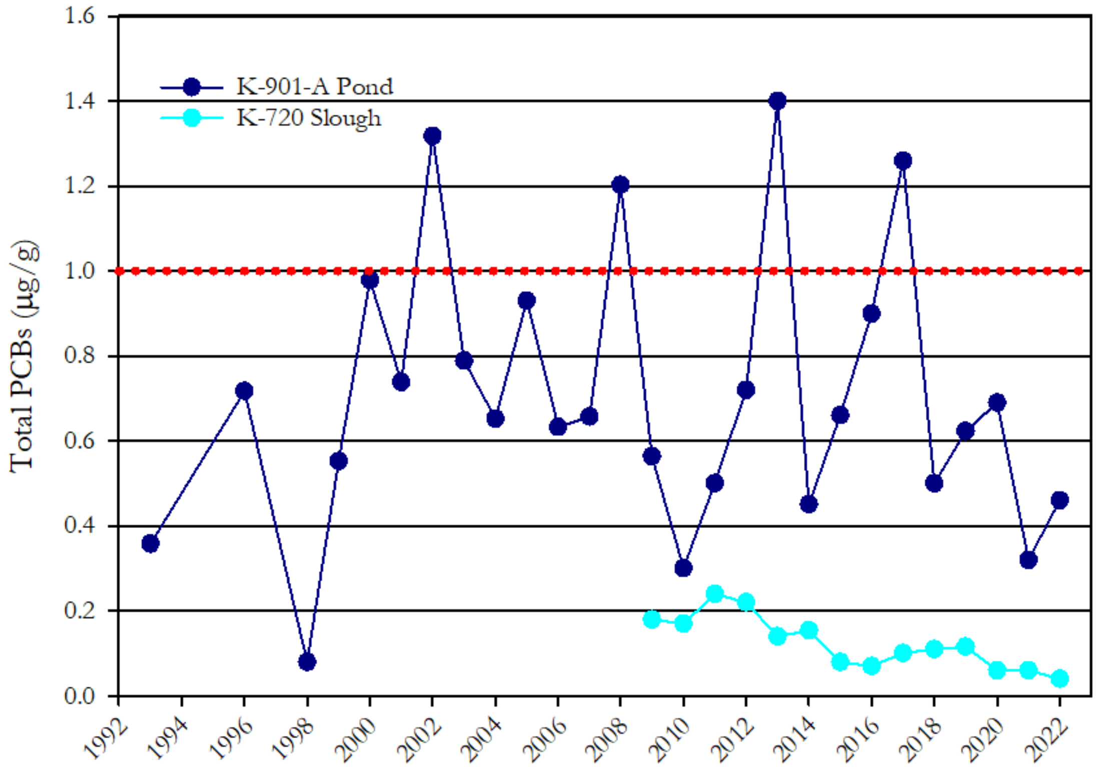
Table 3.8. Average concentrations of total PCBs in fillets and whole-body composites of fish collected in 2022 near the East Tennessee Technology Park

Site	Species	Sample type	Sample size (n)	Total PCBs (mean ± SE)	Range of PCB values	No. > target (PCBs)/n
K-1007-P1 Pond	Bluegill	Fillets	20	0.69 ± 0.33	0.30–1.37	3/20
		Whole-body composites	6	1.91 ± 0.23	1.65–2.30	0/6
K-901-A Pond	Largemouth bass	Fillets	17	0.46 ± 0.26	0.16–1.24	1/17
	Common carp	Fillets	3	1.89 ± 2.31	0.24-5.16	1/3
	Bluegill	Fillets	20	0.42 ± 0.25	0.09–1.00	0/20
		Whole-body composites	6	1.14 ± 0.39	0.64–1.78	0/6
	Gizzard shad	Whole-body composites	6	6.67 ± 2.06	3.78–9.50	6/6
K-720 Slough	Largemouth bass	Fillets	12	0.04 ± 0.02	0.02–0.10	0/12
	Common carp	Fillets	6	0.20 ± 0.10	0.07–0.36	0/6
	Smallmouth buffalo	Fillets	2	0.52 ± 0.30	0.31-0.73	0/2
	Gizzard shad	Whole-body composites	6	0.24 ± 0.03	0.20–0.29	0/6
CRM 11.0	Bluegill	Whole-body composites	6	0.06 ± 0.01	0.05–0.07	0/6
	Gizzard shad	Whole-body composites	6	0.12 ± 0.03	0.09–0.16	0/6
PCM 1.0	Bluegill	Whole-body composites	6	0.12 ± 0.01	0.10–0.13	0/6
	Gizzard shad	Whole-body composites	6	0.34 ± 0.06	0.25–0.46	0/6

Notes:

1. *Average concentrations = µg/g, wet wt.*
2. *Total PCBs = Aroclors 1248, 1254, and 1260.*
3. *Values are mean concentrations (µg/g) ± 1 SE.*
4. *Each whole-body composite sample is composed of 10 individual fish.*
5. *Also shown are the ranges of values observed for PCBs and the number of fish whose fillet PCB concentrations exceeded 1 µg/g out of the total number of fish (or composites) sampled (n). (1 µg/g total PCBs in fish fillets and 2.3 µg/g in whole-body composites*

Acronyms and abbreviations:
CRM = Clinch River mile
PCB = polychlorinated biphenyl
SE = standard error
n = sample size number
No. = number
PCM = Poplar Creek mile



Notes:

1. *Mean PCBs (± 1 SE) in largemouth bass fillets, 1993-2022 (µg/g).*
2. *N = 6 fish per year, when possible.*
3. *The dotted red line shows the advisory level for PCBs in fish fillets (1 µg/g).*

Acronyms:

PCB = polychlorinated biphenyl

SE = standard error

Figure 3.34. Mean total PCB concentrations in largemouth bass from the K-901-A Pond and the K-720 Slough

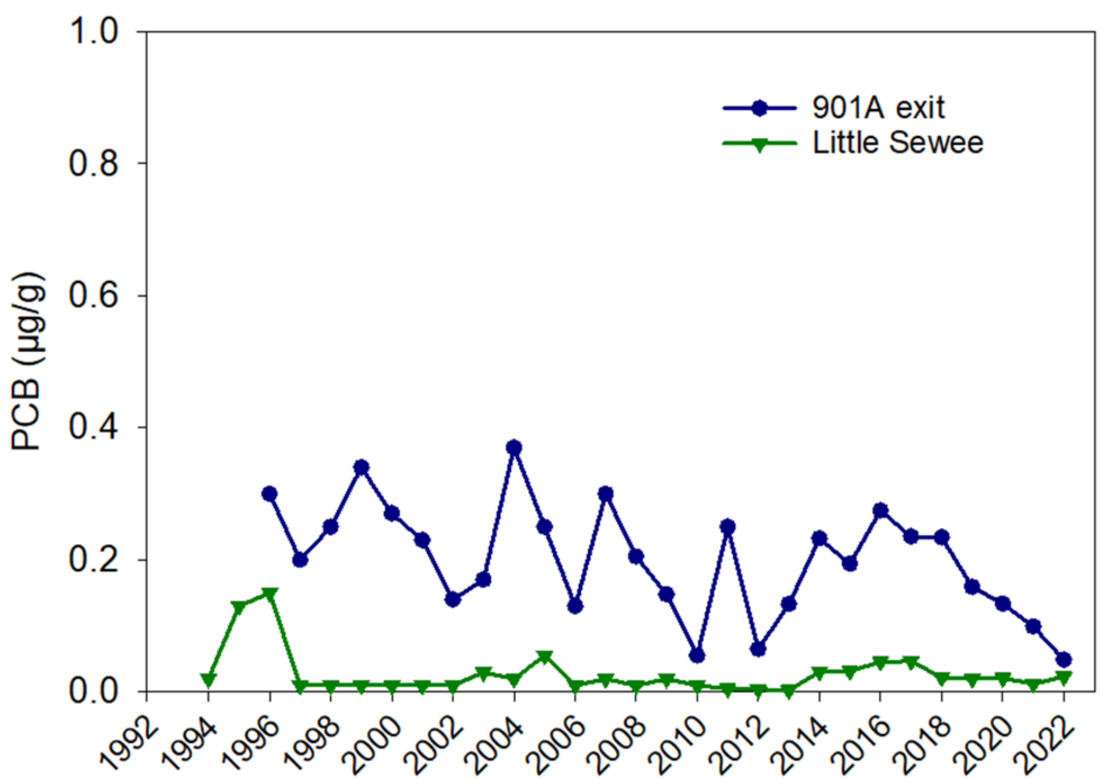
3.7.1.3. K-901-A Pond

The target fish species for analysis of PCBs in the K-901-A Holding Pond were gizzard shad (*Dorosoma cepedianum*) and largemouth bass (*Micropterus salmoides*).

At the K-901-A Holding Pond, mean PCB concentrations in largemouth bass collected in 2022 (0.46 µg/g) were similar to concentrations seen in 2021 (0.32 µg/g) and were below the target concentration set for the K-1007-P1 Pond of 1 µg/g total PCBs (Figure 3.34). Whole body gizzard shad from the K-901-A Holding Pond, collected as a measure of potential ecological risk to terrestrial wildlife, were substantially higher in concentration (6.65 µg/g) than the fillets of bass and carp, remaining above the target concentration set for the K-1007-P1 Holding Pond for whole body fish (2.3 µg/g) (Figure 3.33). However, mean PCB concentrations in whole-body bluegill (1.14 µg/g) were lower than concentrations in this same species collected from the K-1007-P1 Pond, were below the target concentration for whole-body fish in the K-1007-P1 Pond (2.3 µg/g) (Figure 3.33). PCB concentrations in clams deployed in the K-901-A Pond were similar to those deployed in the K-1007-P1 Pond and were lower in 2022 (0.05 µg/g) than in 2021 (0.10 µg/g; Figure 3.35).

3.7.1.4. K-720 Slough

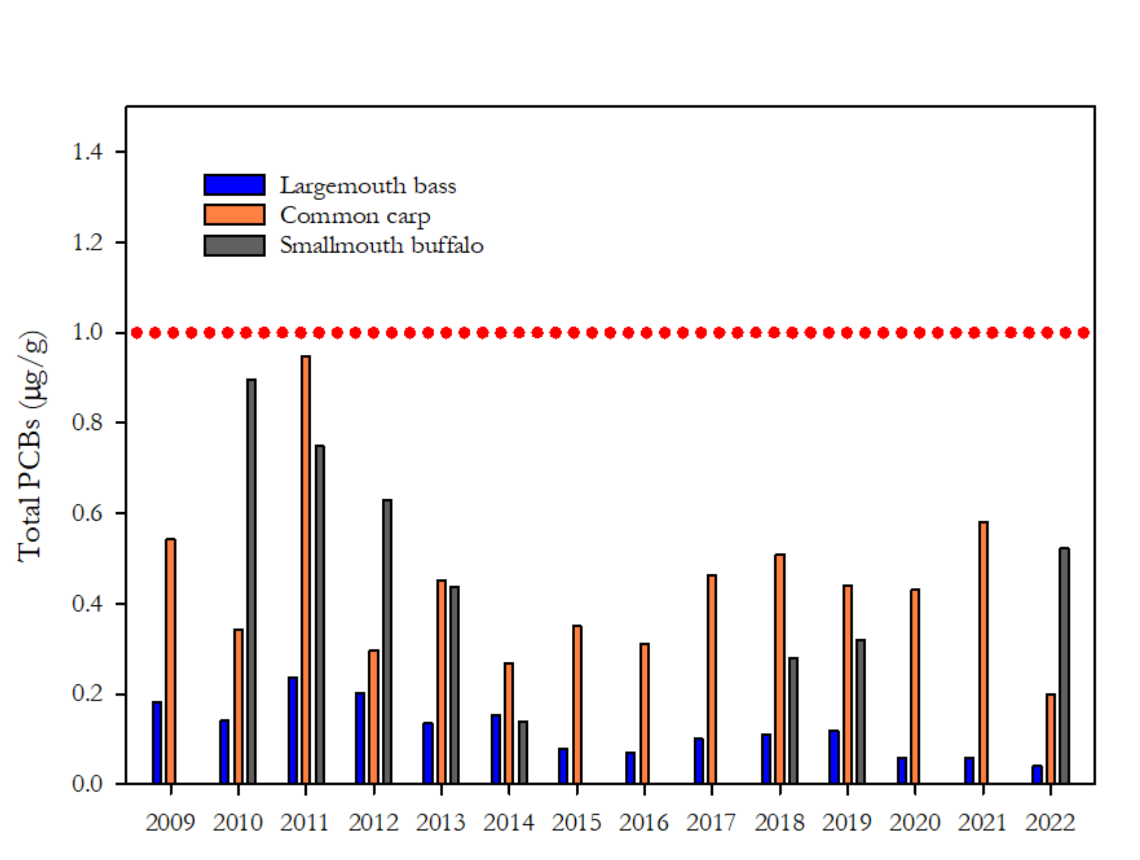
Routine bioaccumulation monitoring in the K-720 Slough began in 2009 (Figure 3.36). Although the target species for fish fillet monitoring in this slough is largemouth bass, as in the K-901-A Pond it has been difficult to collect a full sample of 20 fish of this species; to complete the collection, common carp also are collected for a total of 20 fish. Figure 3.36 shows the temporal trends in fish fillet concentrations in the slough. In 2022, PCB concentrations in both fish species monitored were below the state advisory limit of 1 µg/g. In all cases PCB levels in fish collected from the K-720 Slough were significantly lower than in the K-901-A Holding Pond for the same species (Table 3.8). PCB concentrations in largemouth bass collected from the K-720 Slough were significantly lower than those in the other monitored ponds, averaging 0.04 µg/g in 2022. Concentrations in carp collected from the slough were higher than concentrations in bass, averaging 0.20 µg/g. Total PCBs in whole body gizzard shad from the K-720 Slough were similar to those seen in recent years and were lower than those seen in whole body fish collected from the other monitored ponds, averaging 0.24 µg/g in 2022.



Notes:
1. *Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.*
2. *N = 2 composites of 10 clams each per year.*
3. *Shown in green are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tenn.).*

Acronym:
PCB = polychlorinated biphenyl

Figure 3.35. Mean total PCB (µg/g, wet wt; 1993–2022) concentrations in the soft tissues of caged Asiatic clams deployed in the K-901-A Pond for a 4-week period



Notes:

1. *Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.*
2. *The target sample was 20 largemouth bass, but because these fish are not abundant in the slough, carp and smallmouth buffalo were collected to complete the sample size of 20 fish.*

Acronym:

PCB = polychlorinated biphenyl

Figure 3.36. Mean total PCB (µg/g, wet wt; 2009–2022) concentrations in the fillets of largemouth bass, common carp, and smallmouth buffalo collected from the K-720 Slough

3.7.2. Task 2: Instream Benthic Macroinvertebrate Communities

Benthic macroinvertebrate communities in Mitchell Branch are sampled using ORNL and TDEC protocols (Figures 3.37 and 3.38). Evaluation of long-term trends of macroinvertebrate communities in the stream make it possible to document the effectiveness of pollution abatement activities or remediation, efforts as well as to assess the potential consequences of unanticipated events as sitewide remediation continues (e.g., chromium release into Mitchell Branch).

Figure 3.37. Collecting an invertebrate sample using Oak Ridge National Laboratory Biological Monitoring and Abatement Program protocols

Figure 3.38. Sampling for benthic macroinvertebrates with TDEC protocols

3.7.2.1. Benthic Macroinvertebrates

The major objectives of the benthic macroinvertebrate task are: (1) to help assess the ecological condition of Mitchell Branch, and (2) to evaluate changes in stream ecology associated with changes in facilities operations and RAs within the Mitchell Branch watershed. To meet these objectives, the condition of the benthic macroinvertebrate community of Mitchell Branch has been monitored routinely since late 1986. This summary includes results of samples collected each April from 1987 to 2022 following ORNL BMAP quantitative sampling protocols and samples collected annually (August/September) with TDEC semi-quantitative sampling protocols for estimating the Tennessee Macroinvertebrate Biotic Index (TMI) and the Habitat Index (TDEC 2021). For both sets of protocols, four sites were assessed in Mitchell Branch—MIKs 0.4, 0.7, 0.8, and 1.4. MIK 1.4 serves as the primary reference site, but narrative Biotic Index results for TDEC protocols are based on reference conditions established by TDEC from a suite of reference sites in the same ecoregion as Mitchell Branch. Finally, also included in this summary is a comparison between the macroinvertebrate community structure at the four Mitchell Branch sites and five other reference sites on ORR. Most of these reference sites—spanning a range of stream sizes both smaller and larger than Mitchell Branch (based on watershed area)—have been monitored using ORNL protocols since the mid-1980s for other biological monitoring projects on ORR (ORNL BMAP and WRRP/Bear Creek Biological Monitoring Program) (Table 3.9). This summary provides information on how invertebrate community structure at Mitchell Branch sites, including MIK 1.4, compares with the community structure of a range of relatively unaffected reference sites on ORR.

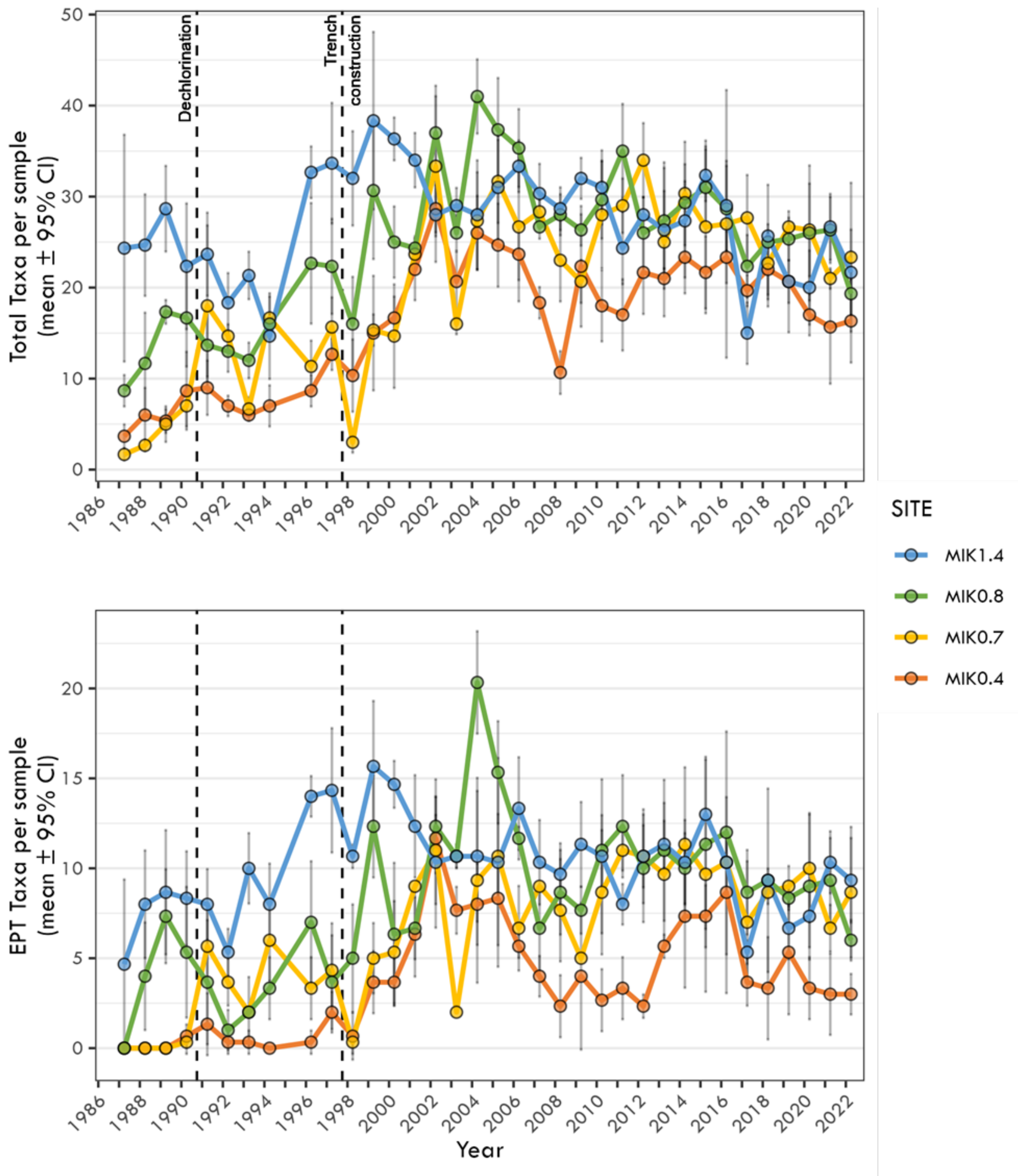
Table 3.9. Stream sites included in the comparison between Mitchell Branch and other reference sites on the Oak Ridge Reservation

Site	Location		Watershed area (km^2)	Program
	Latitude (N)	Longitude (W)		
Mitchell Branch				
MIK 0.4	35.93859	84.39040	1.554	ETTP BMAP
MIK 0.7	35.93786	84.38792	1.347	ETTP BMAP
MIK 0.8	35.93786	84.38682	1.269	ETTP BMAP
MIK 1.4 (reference)	35.93790	84.37662	0.311	ETTP BMAP
Other ORR reference sites				
First Creek (FCK 0.8)	35.92670	84.32355	0.596	ORNL BMAP
Fifth Creek (FFK 1.0)	35.93228	84.31746	0.596	ORNL BMAP
Gum Hollow Branch (GHK 2.9)	35.96385	84.31594	0.777	Bear Creek BMP/WRRP
Walker Branch (WBK 1.0)	35.95805	84.27953	1.010	ORNL BMAP
White Oak Creek (WCK 6.8)	35.94106	84.30145	2.072	ORNL BMAP

Acronyms:
BMAP = Biological Monitoring and Abatement Program
BMP = Biological Monitoring Program
ETTP = East Tennessee Technology Park
km^2 = square kilometers
MIK = Mitchell Branch kilometer
N = north
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation
W = west
WRRP = Water Resources Restoration Program

3.7.2.2. Mitchell Branch–ORNL and TDEC Protocols

Total taxa richness (i.e., the total number of taxa per sample) and Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness (i.e., the total number of pollution-intolerant EPT taxa [mayflies, stoneflies, and caddisflies] per sample) measured using ORNL protocols has varied over the measurement period (1987–2021) in all Mitchell Branch sites (Figure 3.39). Both total taxa richness and EPT taxa richness increased in MIKs 0.4, 0.7, and 0.8 from 1987 to the late 1990s, and then reached fairly consistent values, albeit with considerable year to year variation (Figure 3.39). Total taxa richness and EPT taxa richness have been fairly consistent throughout the measurement period in the reference site, MIK 1.4, though values have been lower in four of the past six years (Figure 3.39). In April 2022, total taxa richness and EPT taxa richness declined at MIK 1.4 and MIK 0.8 while both values improved at MIK 0.7. Due to this, total taxa richness was highest at MIK 0.7, while EPT taxa richness was highest at MIK 1.4, while both metrics were lowest at MIK 0.4 (Figure 3.39). The increase in EPT taxonomic richness at MIK 0.7 returned EPT taxa to values similar to those observed prior to 2020, whereas the decrease observed at MIK 0.8 represents a marked departure from the relatively stable values seen over the previous five years (Figure 3.39).



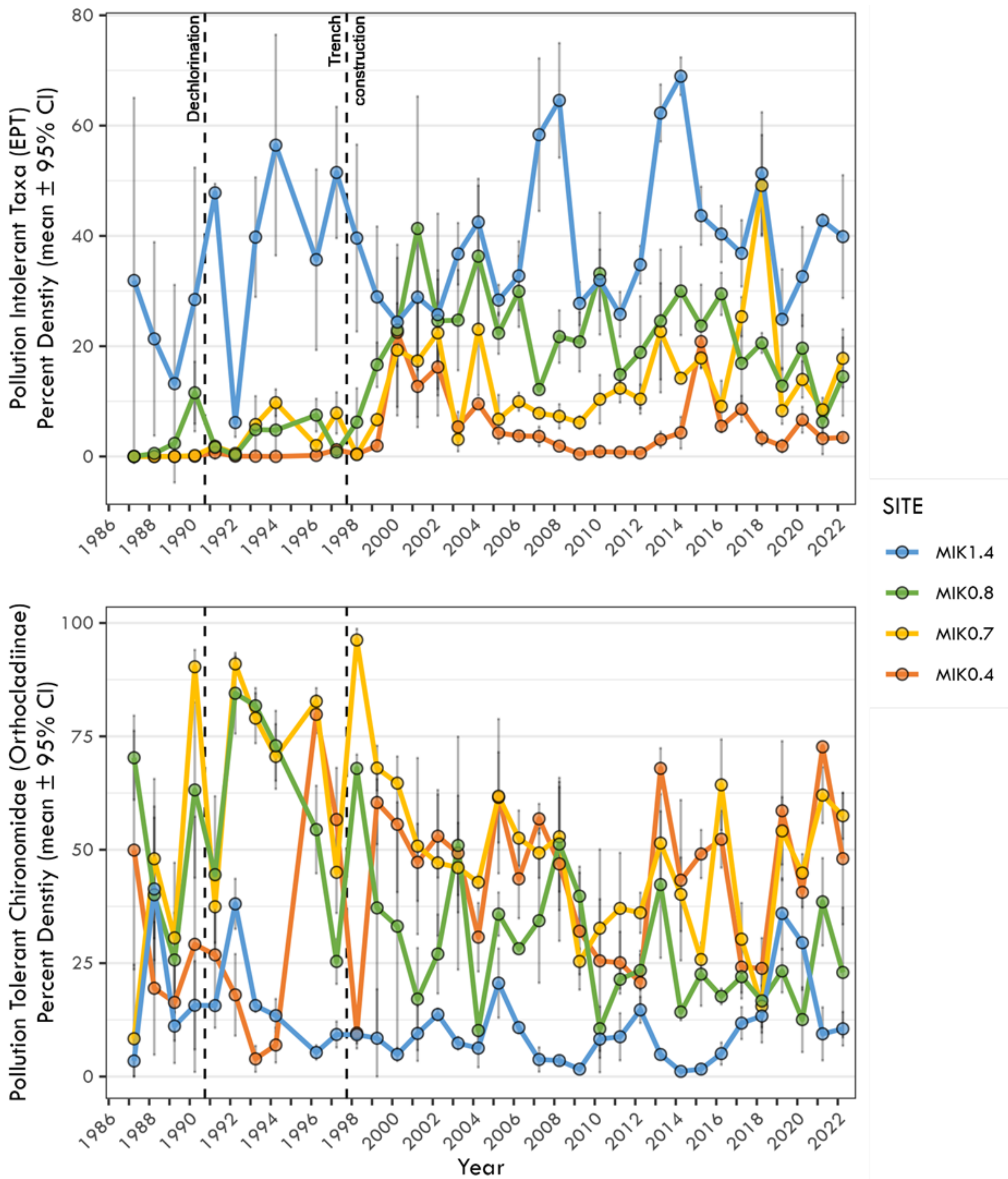
Note: *Samples were not collected in April 1995.*
Acronyms:
EPT = Ephemeroptera, Plecoptera, and Trichoptera *MIK = Mitchell Branch kilometer* *CI = confidence interval*

Figure 3.39. Mean (± 95 percent confidence interval) total taxonomic richness (top) and richness of the pollution-intolerant taxa per sample (bottom) for Mitchell Branch sites, April 1987–2022

The percent density of the pollution-intolerant taxa (higher values are indicative of good condition) was highest at MIK 1.4, the reference site, and lowest at MIK 0.4 in April 2022, which is a pattern that has been observed in most years since monitoring began in 1987 (Figure 3.40). In 2022, as in most years, the percent density of pollution-tolerant taxa (lower values are indicative of good conditions) was lowest at the reference site, MIK 1.4. An exception to this pattern occurred during 2019 and 2020 when the percent density of pollution-tolerant taxa was higher at MIK 1.4 than MIK 0.8 but still lower than at MIK 0.4 and MIK 0.7 (Figure 3.40). In 2022, the percent of pollution-tolerant taxa at MIK 1.4 remained stable after a two-year period (2019 and 2020) that had the highest values seen since monitoring began and were only surpassed in 1988 and 1992 (Figure 3.40). Continued monitoring will determine if those higher values at MIK 1.4 reflect increased interannual variability or a stochastic deviation from long-term patterns.

Based on TDEC protocols (TDEC 2021), scores for the TMI in 2022 rated the invertebrate community at all sites as falling below biocriteria guidelines (Figure 3.41). TMI scores in 2022 declined (MIK 1.4, MIK 0.7), remained stable (MIK 0.4), or increased (MIK 0.8) compared to 2021 scores (Figure 3.41). In 2022, MIK 1.4 scores decreased for EPT taxa richness but remained stable for all other metrics (Table 3.10). MIK 0.8 improved for a percentage of clingers and a percentage of EPT taxa, while remaining stable for all other metrics. MIK 0.7 metrics decreased for a percentage of clingers. Both MIK 0.7 and MIK 0.8 received low scores for all metrics except a percentage of oligochates and chironmids, which was high across all sites in Mitchell Branch. As in 2021, the TMI score for MIK 0.7fell below MIK 0. MIK 0.4 received low scores for total taxa richness, EPT taxa richness, and percentage EPT, but received the highest scores possible for all other invertebrate metrics except the percentage of nutrient-tolerant taxa (Table 3.10). Since sampling using TDEC protocols began in 2008 in Mitchell Branch, TMI scores at have almost always rated the invertebrate community at MIK 1.4 as passing biocriteria guidelines, while MIK 0.4, MIK 0.7, and MIK 0.8 were generally rated as falling below biocriteria guidelines. (Figure 3.41).

Based on TDEC stream habitat protocols, habitat quality was above the ecoregion 67f guideline at all sites within Mitchell Branch (Figure 3.41). Habitat scores increased at MIK 0.4, MIK 0.8, and MIK 1.4 but decreased at MIK 0.7. In general, increases from the previous year were primarily seen in decreased sediment deposition and increased channel flow. Small riparian width, particularly on the left bank, remained an issue at all sites, except MIK 1.4.



Notes:

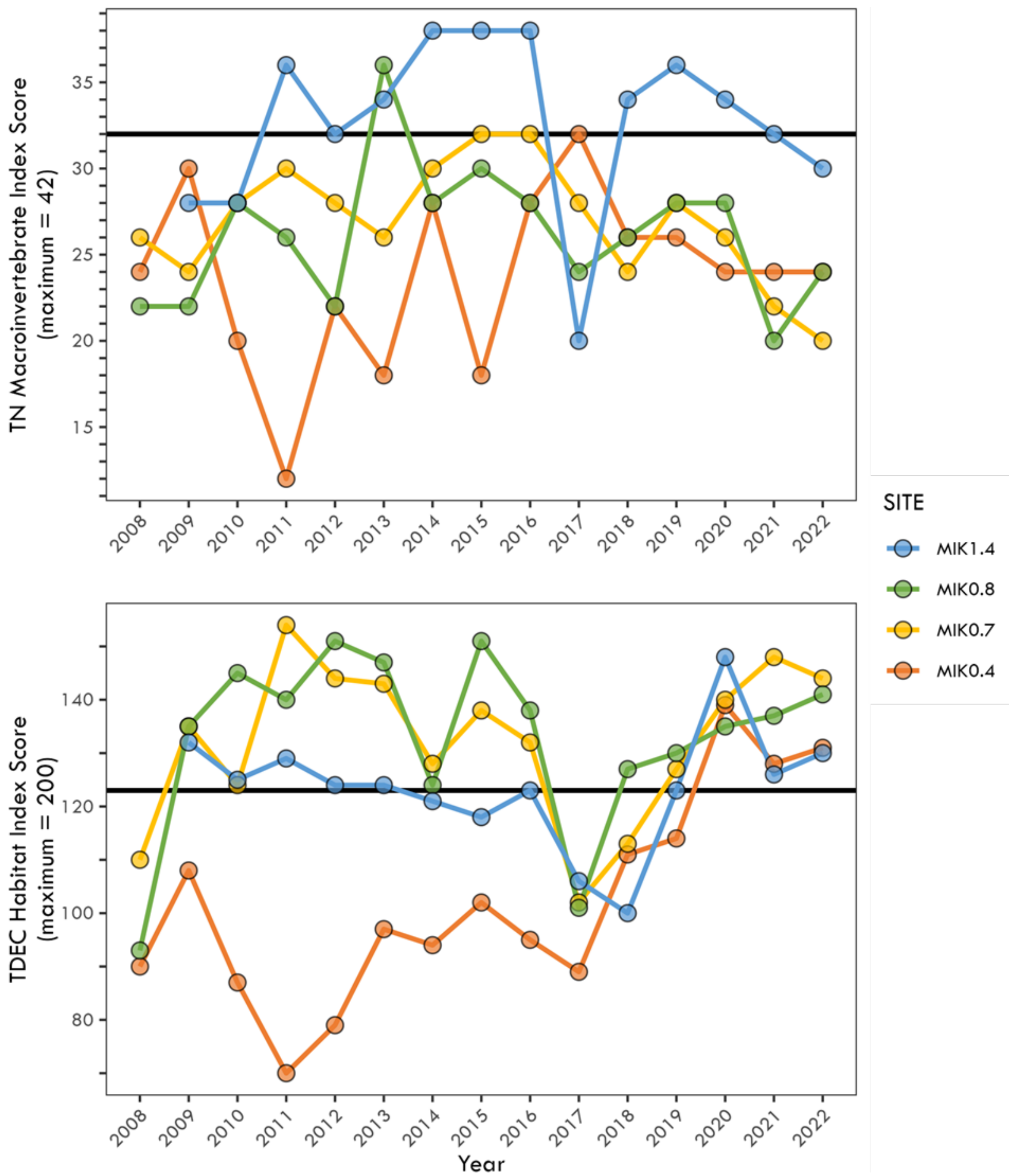
1. *Pollution-intolerant taxa, i.e., stoneflies, mayflies, and caddisflies or Ephemeroptera, Plecoptera, and Trichoptera taxa (top).*
2. *Percentages were based on total densities for each site.*
3. *Samples were not collected in April 1995.*

Acronyms:

MIK = Mitchell Branch kilometer *CI = confidence interval*

EPT = Ephemeroptera, Plecoptera, and Trichoptera (pollution-intolerant taxa)

Figure 3.40. Mean percent density of pollution-intolerant taxa and of the pollution-tolerant Orthocladiinae midge larvae (Chironomidae) at Mitchell Branch sites, April 1987–2022



Notes:

1. *Mitchell Branch site MIK 1.4 was not sampled with TDEC protocols in 2008.*
2. *The horizontal line on each graph shows the rating threshold for each index for ecoregion 67f; TDEC macroinvertebrate index threshold is 32; TDEC habitat index threshold is 123. Values above the thresholds are indicative of passing biocriteria or habitat guidelines.*

Figure 3.41. Temporal trends in the TDEC Macroinvertebrate Index (top) and Stream Habitat Index (bottom) scores for four Mitchell Branch sites, August 2008–2022

Table 3.10. Tennessee Macroinvertebrate Index metric values and scores and index scores for Mitchell Branch, August 16, 2022[a,b,c]

Site	Metric values							Metric scores							TMI[d]
	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	
MIK 0.4	20	2	0.8	11.6	4.6	73.6	43.4	2	0	0	6	6	6	4	24
MIK 0.7	18	4	13.8	3.6	5.5	48.5	57.7	2	2	0	6	4	4	2	20
MIK 0.8	19	5	17	14.4	5.8	66	61.7	2	2	2	6	4	6	2	24
MIK 1.4	26	7	32.2	17.4	4.2	44.3	41.7	4	2	4	6	6	4	4	30

[a] TMI metric calculations and scoring and index calculations are based on Tennessee Department of Environment and Conservation (TDEC) protocols for ecoregion 67f: TDEC 2021, Quality System Standard Operating Procedures for Macroinvertebrate Stream Surveys, TDEC Division of Water Resources, Nashville, Tennessee. Available ***here****.*

[b] Taxa rich = Taxa richness; EPT rich = Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies) taxa richness; %EPT = EPT abundance excluding Cheumatopsyche spp.; %OC = percent abundance of oligochaetes (worms) and chironomids (nonbiting midges); NCBI = North Carolina Biotic Index; %Cling = percent abundance of taxa that build fixed retreats or otherwise attach to substrate surfaces in flowing water excluding Cheumatopsyche spp; %TN Nuttol. = percent abundance of nutrient-tolerant organisms.

[c] MIK = Mitchell Branch kilometer.

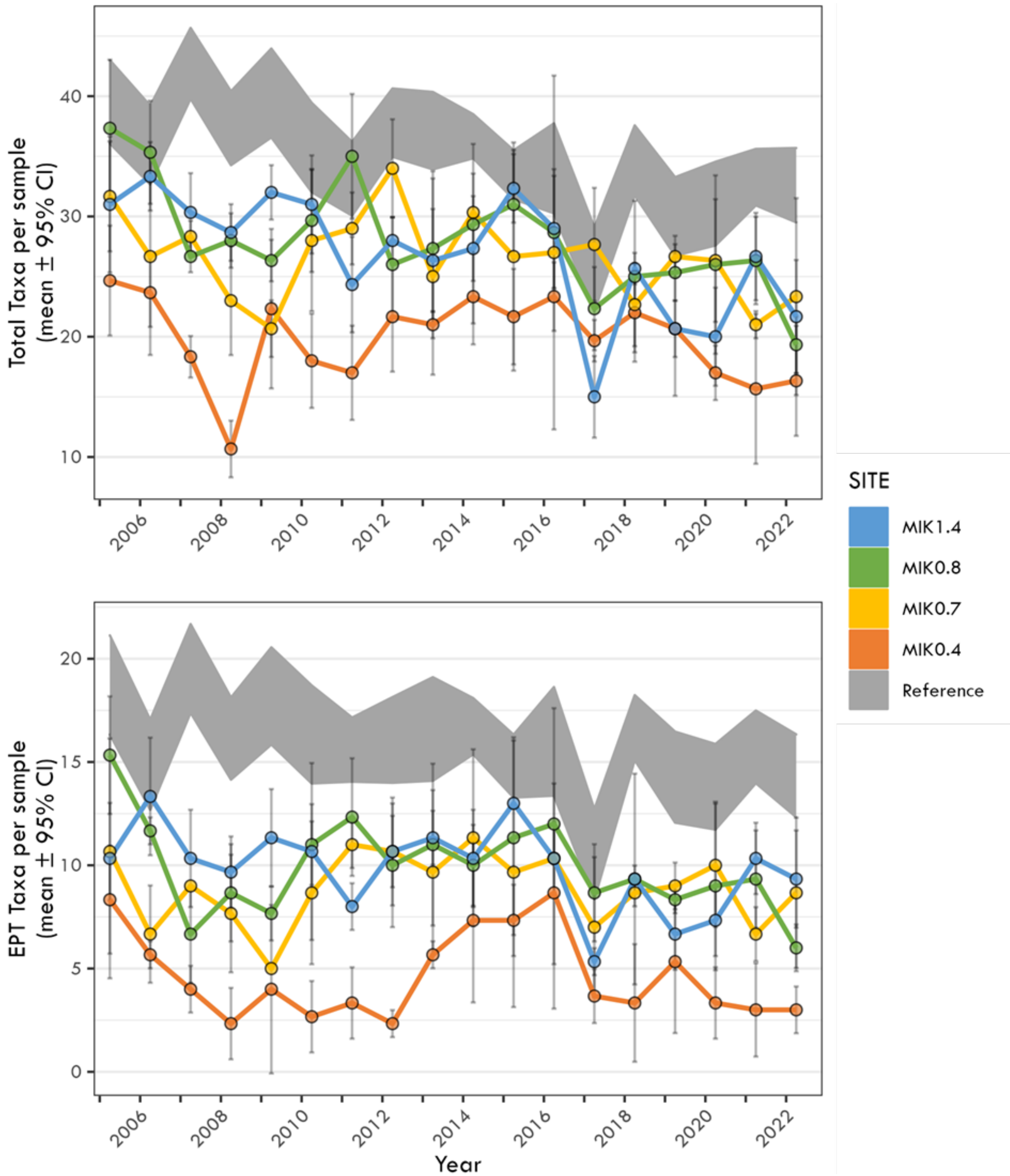
[d] TMI = Tennessee Macroinvertebrate Index score. TMI is the total index score, and higher index scores indicate higher-quality conditions. A score of ≥ 32 is considered to pass biocriteria guidelines.

3.7.2.3. Comparison between Mitchell Branch and Other Reference Sites on ORR

In Figure 3.42, the benthic macroinvertebrate communities in Mitchell Branch are compared to ORR reference streams over a 17-year period. Mean values for total taxa richness and taxa richness of pollution-intolerant (EPT) taxa for Mitchell Branch are shown in Figure 3.42, and percent density of the pollution-intolerant and pollution-tolerant taxa are shown in Figure 3.43. Also shown in gray shading in Figures 3.42 and 3.43 is the 95 percent confidence interval for the five reference sites on ORR—First Creek kilometer 0.8, Fifth Creek kilometer 1.0, White Oak Creek kilometer 6.8, Walker Branch kilometer 1.0, and Gum Hollow Branch kilometer 2.9.

In 2022, total taxa richness and taxa richness of pollution-intolerant taxa at Mitchell Branch sites, including MIK 1.4, were less than both the 95 percent confidence interval for the five reference sites (Figure 3.42). This trend was observed since these comparisons began in 2005, with some exceptions (e.g., 2011, 2017). In contrast to richness metrics, the mean percent densities of pollution-intolerant and pollution-tolerant taxa at MIK 1.4 were not often outside of the 95 percent confidence interval for the reference sites (Figure 3.43). The percent density of pollution-tolerant taxa at MIK 1.4 increased slightly in 2022, but fell within the 95 percent confidence interval for reference sites for the first time since 2017 (Figure 3.43). Since 2005, the mean percent density of pollution-intolerant taxa at MIK 0.7 and MIK 0.8 have largely remained below the reference 95 percent confidence interval, while the percent density of pollution-tolerant taxa at these sites were higher than the reference 95 percent confidence interval. MIK 0.4 has remained well outside the 95 percent confidence intervals for reference sites since 2005 (Figure 3.43).

These results from the comparison of Mitchell Branch sites with the reference sites, combined with the long-term results for all Mitchell Branch sites discussed above, suggest that from the standpoint of reference sites, MIK 1.4 falls near the lower distribution of expected reference conditions on ORR. Factors potentially contributing to excursions of invertebrate community metrics outside of the 95 percent confidence interval for other reference sites include the somewhat smaller size of MIK 1.4 compared with the other reference sites (based on watershed area, Table 3.10), which may limit the range of invertebrate species that can colonize and thrive at the site, and habitat characteristics that have typically contributed to the lower-quality habitat at the site, such as low flow and poor substrate quality (seen earlier in Figures 3.40 and 3.41). These results also support the contention that sites downstream of MIK 1.4 continue to exhibit evidence of mild to moderate degradation.

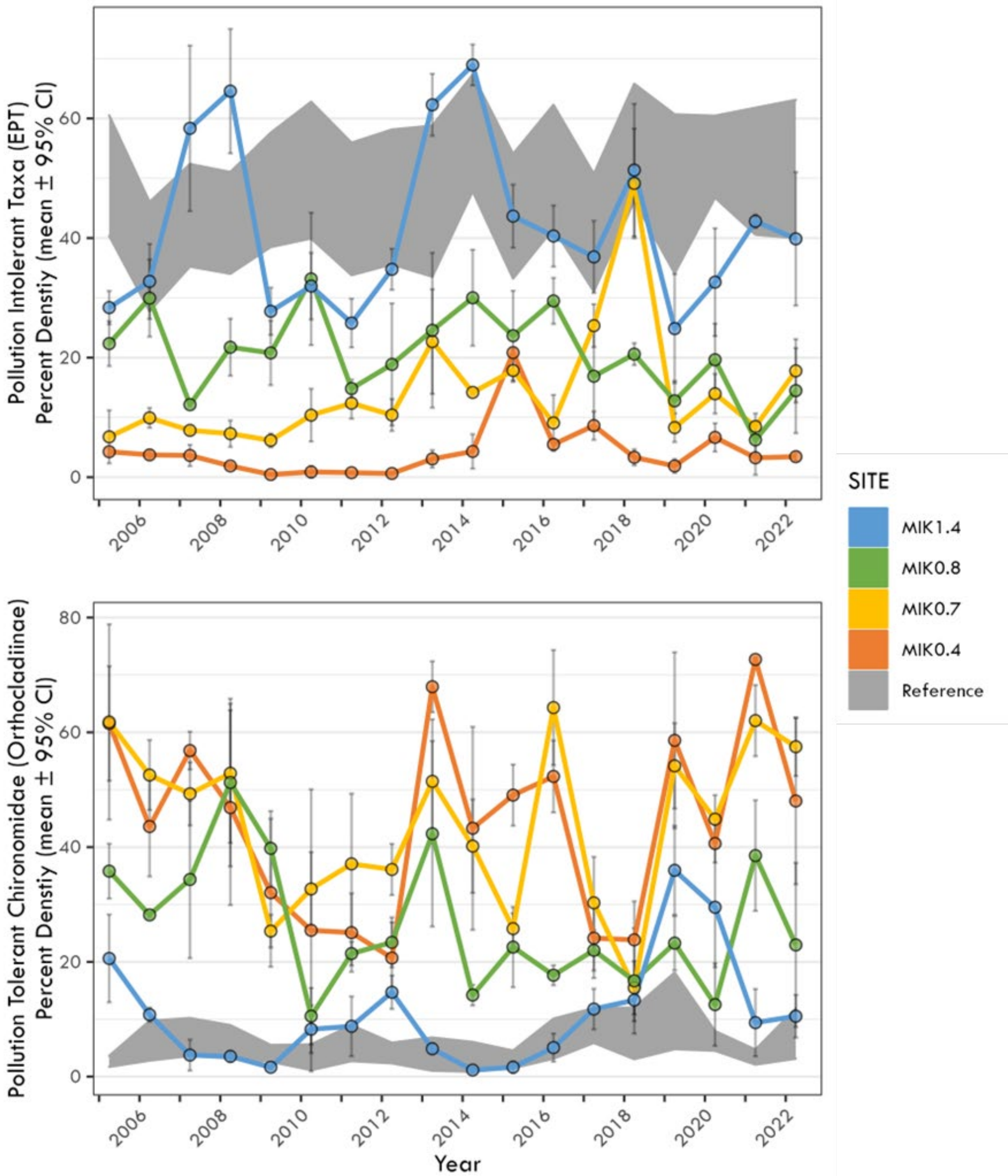


Note: *The gray shading on each graph shows the 95% confidence interval of values at five additional reference stream sites on ORR from 2005 to 2022.*

Acronyms:

CI = confidence interval
EPT = Ephemeroptera, Plecoptera, and Trichoptera
MIK = Mitchell Branch kilometer
MIK 1.4 = reference site
ORR = Oak Ridge Reservation

Figure 3.42. Mean total taxonomic richness (top) and pollution-intolerant taxa per sample (bottom) for the benthic macroinvertebrate community at Mitchell Branch and the 95% confidence interval for ORR reference sites, April 2005–2022



Notes:

1. *Pollution-intolerant taxa, i.e., stoneflies, mayflies, and caddisflies or Ephemeroptera, Plecoptera, and Trichoptera taxa (top).*
2. *Pollution-tolerant Orthocladiinae midge larvae (bottom).*
3. *Percentages were based on total densities for each site.*
4. *The gray shading on each graph shows the 95% confidence interval for values at five additional reference sites on ORR from 2005 to 2022.*

Acronyms:

CI = confidence interval MIK 1.4 = reference site EPT = Ephemeroptera, Plecoptera, and Trichoptera
ORR = Oak Ridge Reservation MIK = Mitchell Branch kilometer

Figure 3.43. Mean percent density of pollution-intolerant taxa (top) and pollution-tolerant Chironomidae (bottom) in Mitchell Branch the 95% confidence interval for ORR reference sites, April 2005–2022

3.7.3. Task 3: Fish Community

Fish population and community studies are used to evaluate the biotic integrity (or general ecological health) of Mitchell Branch. The fish community is sampled quantitatively at two sites in Mitchell Branch, MIK 0.4 (downstream of SD-190) and MIK 0.7 (downstream of SD-170) and at local reference streams each spring.

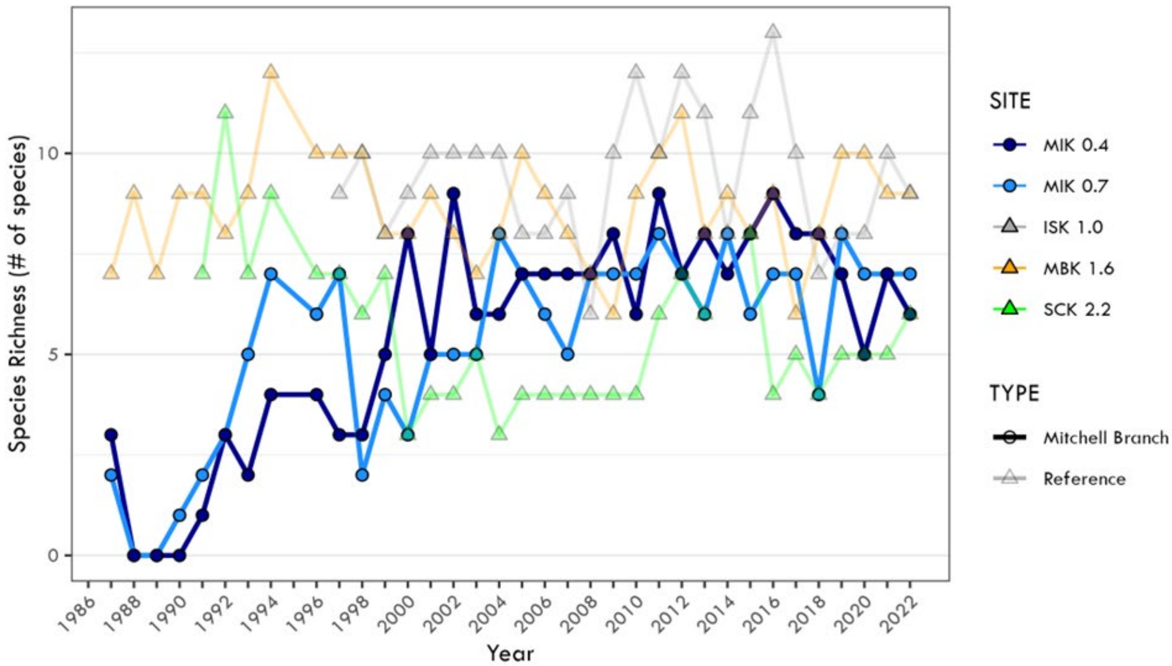
Mitchell Branch Fish Community

Historically, the fish community in Mitchell Branch was most severely affected in the late 1980s and early 1990s. After some recovery in the mid-1990s, Mitchell Branch was affected negatively again in 1998 in association with a remedial activity that replaced a large section of stream bottom with a liner and interlocking rock substrate (Figure 3.44). In recent years, this reach of stream appears to be developing more natural habitat, including a more robust riparian plant community and some instream riffle/pool sequences as substrate is slowly beginning to throughout the reach (Figure 3.45). This has added to the complexity of the habitat available for fishes to colonize. Since 2000, the fish community has had relatively stable species diversity but rather large variations in fish density and biomass, which are often reflective of unstable, impaired streams. Streams that experience high density and biomass of tolerant fish species are often indicative of either high nutrient influences on a fish community (i.e., more algal growth means more food at the base of the food chain) or poor instream habitat—and often a combination of both. Of the two sites sampled for fish community, MIK 0.7 has experienced the greatest fluctuations in these community parameters. This is likely due to the modified stream channel and riparian areas and poor instream habitat associated with the remediation work in this reach. Similar conditions are seen in other area streams on ORR, including sections of East Fork Poplar Creek where tolerant species dominate the concrete- and bedrock-lined channel, which supports little riparian protection. In addition, extremely low precipitation amounts, which often occur in the summer, result in very low flows in many area streams. Small first and second order streams without springs or groundwater influence are most severely affected by these conditions. This may partially explain the decreased density and biomass numbers observed in some years and the apparent return of higher values in following years.

Figure 3.44. Construction of lined section of Mitchell Branch, MIK 0.7, in 1998

Figure 3.45. More recent habitat conditions at Mitchell Branch in 2022

At both MIK 0.4 and MIK 0.7, the 2022 sample of fish community parameters indicated continued variation. Species richness (number of species) at the lower site decreased slightly while richness at the upper site remained stable compared to 2021 values (Figure 3.46). Both sites have species



Acronyms:

ISK = Ish Creek
MBK = Mill Branch kilometer
MIK = Mitchell Branch kilometer
SCK = Scarboro Creek

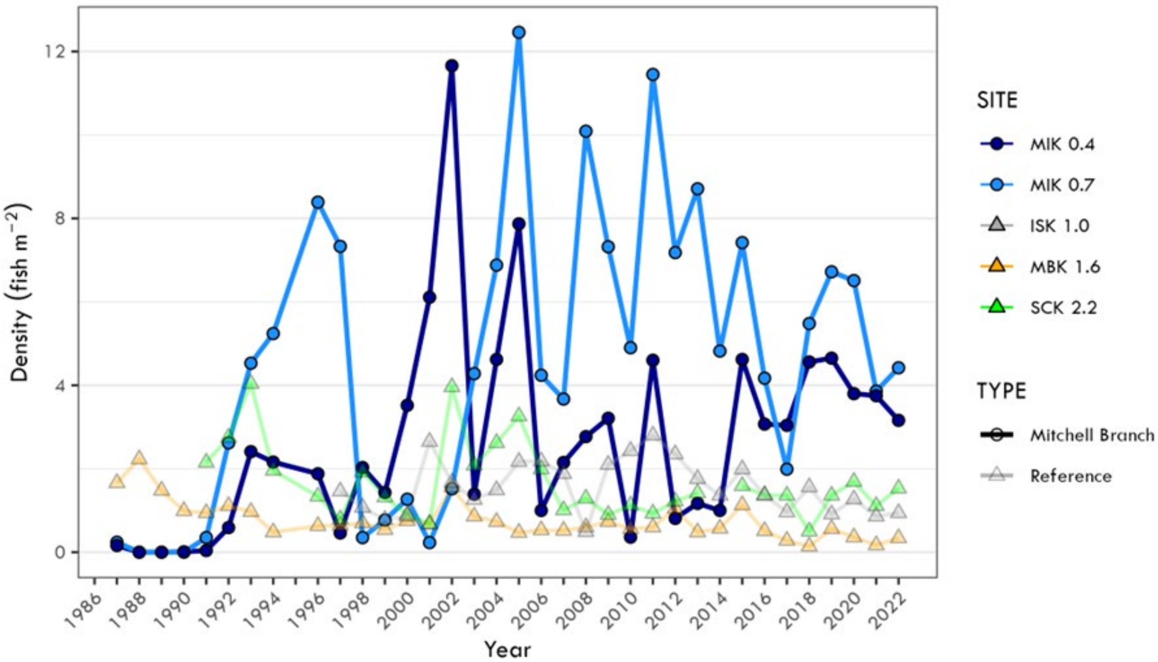
Figure 3.46. Species richness for the fish communities at sites in Mitchell Branch and in reference streams Mill Branch, Scarboro Creek, and Ish Creek, 1987–2022

richness comparable with similar sized reference streams. Density (number of fish) at both sites still remains well above reference conditions (Figure 3.47). Biomass (weight) also remains elevated at both sites (Figure 3.48). Both the lower Mitchell Branch site and the upper site had reduced diversity and density of sensitive fish species in 2022 compared to reference sites.

Over the last decade, there has been a slight uptick in the occurrence of sensitive fish species at both sampled sites in Mitchell Branch, which can be attributed to the regular presence of fish such as banded sculpin (*Cottus carolinae*) that appear to be a resident species in Mitchell Branch, and also occasional occurrences of other more sensitive fish. In 2022, no new species were observed in the two sites and the resident banded sculpin were very limited. However, new species of darters, suckers, and sunfish continue to show up within Mitchell Branch, and some represent unique sensitive species in this reach of stream.

In general, the Mitchell Branch fish communities at MIK 0.4 and MIK 0.7 continue to lack diverse resident species that are sensitive to stress or that have specialized feeding or reproductive requirements, such as darters or suckers that occur consistently at higher frequencies in the reference streams. Like the benthic communities, fish community monitoring provides an integrated response to *all* of the various water chemistry and habitat influences in a stream. Identifying the major stressor influences on the community (i.e., causal analysis) would require additional investigatory strategies coupled with the monitoring data.

During routine bioaccumulation sampling, several species of fish are collected regularly at MIK 0.2 that are infrequently observed in the Mitchell Branch fish community monitoring activities at the upstream sites. These included four pollution-sensitive species: black redhorse (*Moxostoma duquesnei*), snubnose darter, greenside darter



Acronyms:

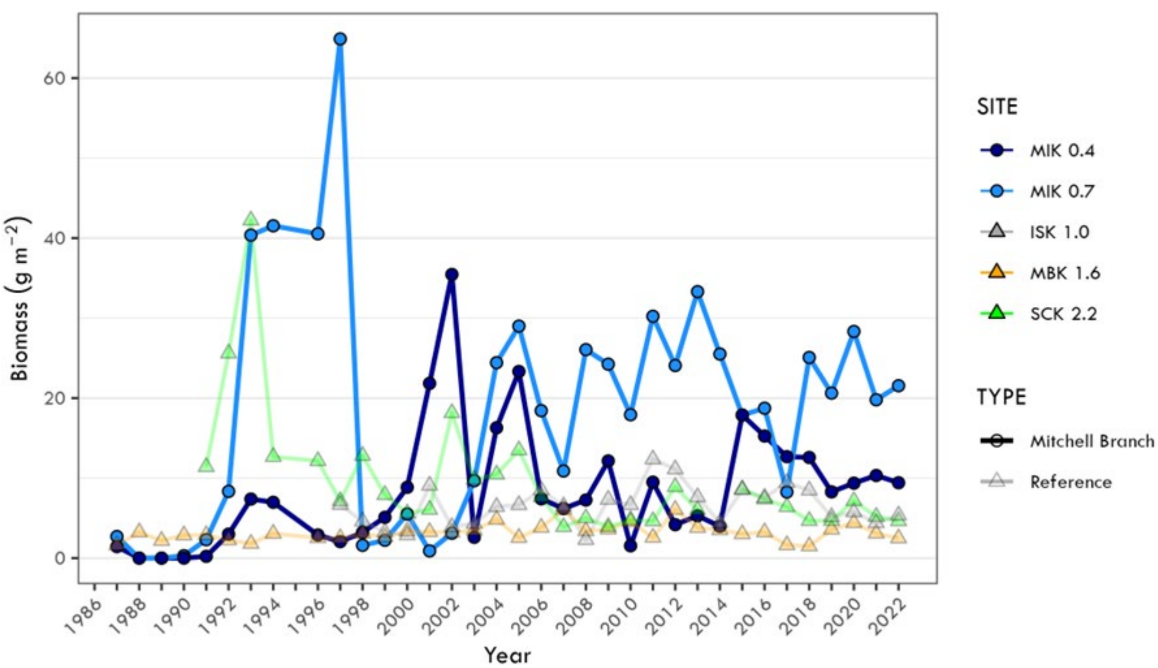
ISK = Ish Creek

MBK = Mill Branch kilometer

MIK = Mitchell Branch kilometer

SCK = Scarboro Creek

Figure 3.47. Density for the fish communities at sites in Mitchell Branch and in reference streams Mill Branch, Scarboro Creek, and Ish Creek, 1987–2022



Acronyms:

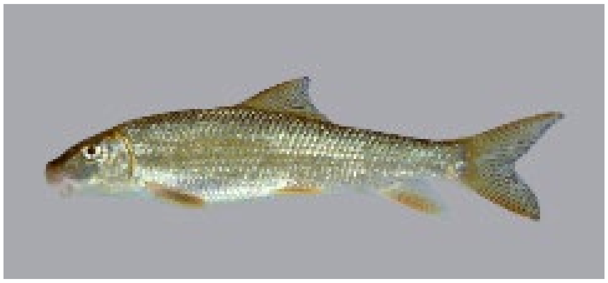
ISK = Ish Creek

MBK = Mill Branch kilometer

MIK = Mitchell Branch kilometer

SCK = Scarboro Creek

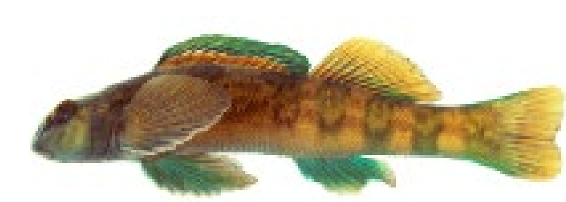
Figure 3.48. Biomass for the fish communities at sites in Mitchell Branch and in reference streams Mill Branch, Scarboro Creek, and Ish Creek, 1987–2022



Black redhorse *(Moxostoma duquesnei)*

Snubnose darter *(Etheostoma simoterum)*

Northern hogsucker *(Hypentelium nigricans)*



Greenside darter *(Etheostoma blennioides)*

Photos: Chris Bryant

Figure 3.49. Sensitive fish species observed in lower Mitchell Branch

(*Etheostoma blennioides*), and northern hogsucker (*Hypentelium nigricans*) (clockwise, Figure 3.49). Future monitoring will help determine if these species are becoming established farther upstream in Mitchell Branch or are merely seasonal migrants to the stream's lower section, which is easily accessible from the much larger Poplar Creek.

K-1007-P1 Pond Fish Community

The fish communities in the K-1007-P1 Pond are assessed annually. This sampling is conducted to evaluate the effectiveness of remediation efforts implemented in 2009 and is aimed at reducing the PCBs available for transfer out of the pond via natural routes (i.e., trophic transfer). The RAs included capping contaminated sediment with fill dirt, planting native aquatic vegetation to stabilize sediment, and removing potentially contaminated fish from the pond. Fish initially were removed from the pond using a piscicide (Rotenone), and uncontaminated native fish were stocked in the pond with the goal of establishing a sunfish-dominated community. Sunfish have a shorter lifespan than many other species of fish, especially higher trophic level fish, and they have a prey source that is generally varied but consistently lower on the aquatic food chain compared with species such as largemouth bass, thus reducing the likelihood that contaminants would biomagnify within the system.

Despite efforts to remove all unwanted fish from the pond, an unexpected breach in the weir separating the K-1007-P1 Pond from the adjacent Poplar Creek in May 2010 allowed numerous fish to enter the pond during high waters. These unwanted fish constituted several species that were unfavorable to the pond action—including: (1) nonnative species and (2) species with life history traits that undermined the remediation efforts, such as being long-lived and having feeding habits that disturb potentially contaminated sediments. Continued work to remove these unwanted fish has been productive, and only limited numbers of the most long-lived species, such as common carp (*Cyprinus carpio*) and smallmouth buffalo (*Ictiobus bubalus*), are encountered in annual monitoring.

Two additional species that returned to the pond after the weir breach were gizzard shad (*Dorosoma cepedianum*) and largemouth bass

(*Micropterus salmoides*). Gizzard shad feed on phytoplankton and zooplankton in natural environments such as larger reservoirs, but in smaller ponds such as P1, they often turn to feeding on algal growth at the surface of the pond sediment, which can disturb soils and potentially resuspend contaminants in the pond substrate. Largemouth bass tend to be a long-lived species and are a top predator in aquatic environments, making them particularly susceptible to bioaccumulation. They also are a game fish highly prized by many anglers as well as a common table fare. These two species also have been targeted for removal during continued remediation efforts and fish surveys.

Overall, the K-1007-P1 Pond fish community surveys conducted in February 2022 revealed the presence of 12 species of fish. An observation of particular importance from previous surveys is the abundance of sunfish species (bluegill, redear sunfish, and warmouth), which constitute approximately 93 percent of the total fish population (Figure 3.50). Bluegill, the most prevalent of these species, were historically the dominant sunfish species in the pond, and they are the desired bioindicator fish species to have in the remediated pond. Although largemouth bass continue to persist in the pond, their abundance remains relatively low. Despite removal efforts, their presence is likely to continue, given the habitat conditions currently in the pond (i.e., abundant prey sources and open water). Gizzard shad (*Dorosoma cepedianum*) continue to be present in the pond and are suspected of reproducing some years. Although they constituted a much larger portion of the fish population in 2020 than in previous years, they have been almost absent in subsequent sampling. Their abundance has had some minor fluctuations each year but in general has remained relatively low compared with earlier years.

3.8. Environmental Management and Waste Management Activities

Remediation activities were underway across ETTP in 2022. Wastes were generated during these operations and were handled in accordance with the applicable regulations.

3.8.1. Waste Management Activities

Most of the waste generated during FY 2022 cleanup activities in Oak Ridge went to disposal facilities on the Oak Ridge Reservation—namely, the EMWMF and the Oak Ridge Reservation Landfills (ORRL). These facilities are owned by DOE and operated/maintained by UCOR. They have been vital to cleanup progress and success, Enabling OREM to accomplish more cleanup by avoiding costly and unnecessary cross-country shipments.

EMWMF only receives low-level radioactive and hazardous waste meeting specific criteria. The waste is mostly soil and building debris. In FY 2022, EMWMF received 7,172 waste shipments from cleanup projects at ETTP, ORNL, and Y-12, plus 643 clean fill shipments for the enhanced operational cover expansion and constructing access roads and dump ramps. The EMWMF landfill has a design capacity of 2.331 million yd^3 and is now over 82 percent filled.

EMWMF generated 17.28 million gal of wastewater in FY 2022. Approximately 3.30 million gal of leachate (water that enters the leachate collection system) was transported by tanker to the ORNL Liquid and Gaseous Waste Operations for treatment and release. Approximately 13.98 million gal of contact water (water that contacts waste but does not enter the leachate collection system) was released to Bear Creek after laboratory analysis verified it met all regulatory limits and discharge standards.

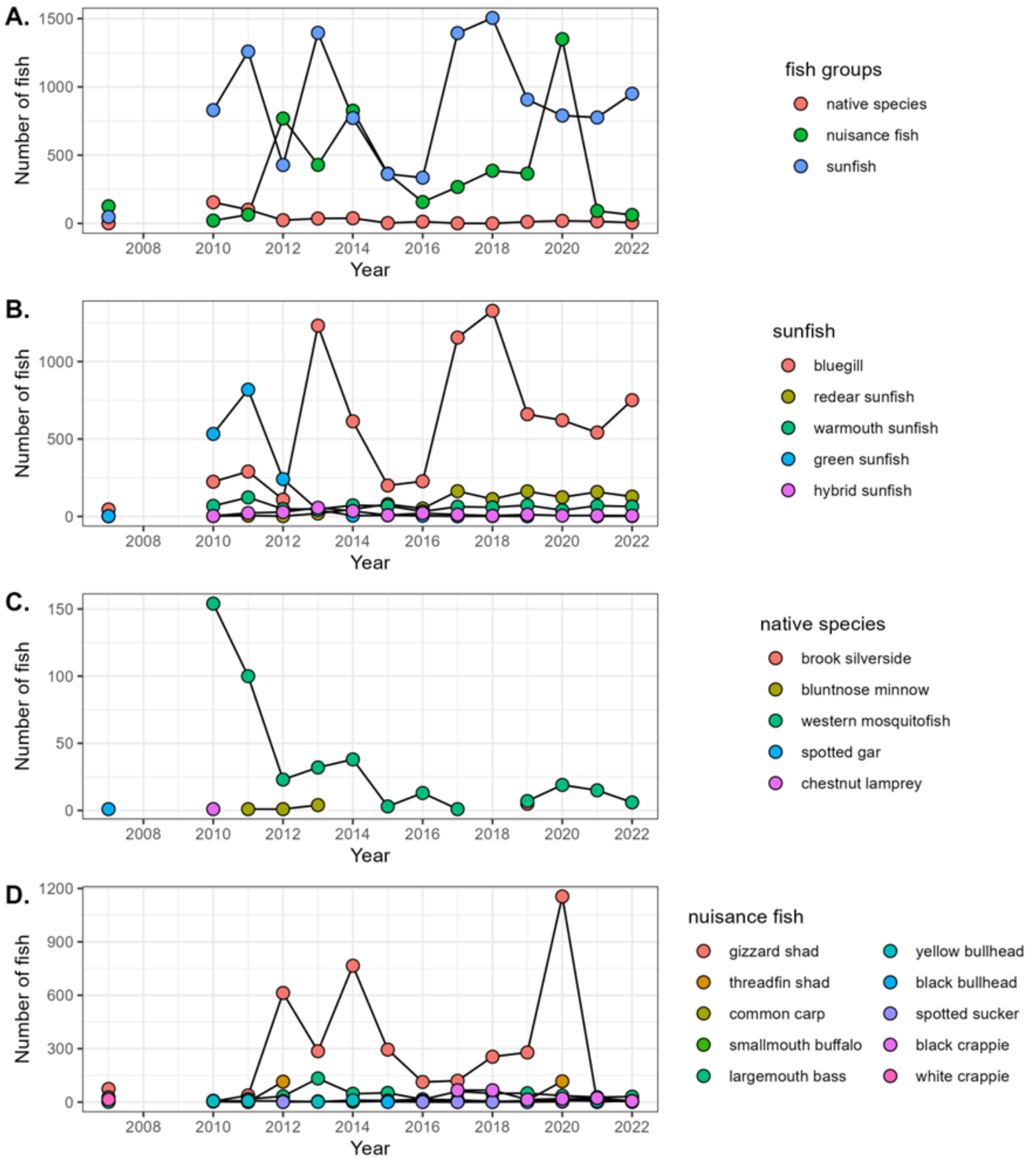


Figure 3.50. Changes in the K-1007-P1 Pond fish community from 2007–2022

ORRL accepts sanitary/industrial waste and construction/demolition debris. In FY 2022, these three active landfills received 11,146 waste shipments, totaling 155,034 yd^3 of waste.

ORRL also manages non-regulated leachate. In FY 2022, ORRL compliantly discharged 4.1 million gal of leachate from the three active landfills to the Y-12 sanitary sewer system.

Work continued with regulatory agencies on seep mitigations for Sanitary Landfill II (a closed landfill) and active Landfill VII. Repairs at Landfill VII included developing and implementing a minor modification approved by the regulators that allowed landfill operations to remove approximately 456,000 gal of leachate trapped inside of Landfill VII for an extended period of time. This water was transferred to the Landfill V leachate facility for discharge.

In FY 2022, ORRL continued improvements for all sediment and erosion controls. These measures included upgrading drainage features, which significantly reduces the amount of sediment released from these landfills. TDEC inspections in FY 2022 noted excellent sediment and erosion controls with no areas of concern or violations. Workers removed approximately 60,000 yd^3 of soil and made major preparations for the Landfill V (Area 5) expansion.

EMWMF will reach capacity before OREM completes its cleanup at Y-12 and ORNL. Planning continued in FY 2022 for another disposal facility, the Environmental Management Disposal Facility (EMDF), to provide the capacity required to complete Oak Ridge's cleanup mission.

The EMDF ROD was signed on September 30, 2022. This major milestone for the project allows OREM to begin site preparation activities and finalize the facility's design. OREM continues to work with EPA and TDEC on follow-on regulatory documents related to the project. Planning for the groundwater field demonstration that will augment the existing site characterization is in progress, including finalizing the demonstration design. Planning for early site preparation activities to reroute roads and provide utilities to the future EMDF site is in progress. FFS for Water Management for the Disposal of CERCLA Waste was approved on September 6, 2022 (DOE 2022a). This approval followed the dispute resolution for radiological discharge limits. The FFS provides an evaluation of landfill wastewater treatment alternatives, and its approval was a prerequisite for the EMDF ROD signature by the Federal Facility Agreement parties.

OREM continued to monitor 31 groundwater wells at the selected site for the disposal facility, measuring and recording water levels and groundwater characteristic data for the entire year.

The Transuranic (TRU) Waste Processing Center (TWPC) continued processing and shipping TRU, mixed low-level waste (MLLW), and low-level waste in FY 2022. In 2022, the TWPC portion of the RCRA Hazardous Waste Permit (TNHW-145) was transferred from North Wind Solutions, LLC to UCOR. The facility has completed processing of 98 percent and shipment of 83 percent of its contact-handled TRU waste and 70 percent of its remote-handled TRU waste.

TWPC's operational focus in FY 2022 was on processing the legacy Nuclear Fuel Services waste (12.4 cubic meters [m^3]) and TRU waste processing by-product wastes (46 m^3). TWPC completed limited processing operations for 1.9 m^3 of MLLW macro-encapsulation. TWPC continued critical actions associated with readiness preparation to commission new waste processing capabilities at TWPC for high activity oxide and wastes requiring new infrastructure, which encompasses over 75 percent of the remaining 39 m^3 of the TRU legacy waste inventory on the Site Treatment Plan for Mixed Wastes on the DOE Oak Ridge Reservation. TWPC continued certification and shipment of 59.3 m^3 of TRU waste to the Waste Isolation Pilot Plant, 58.5 m^3 MLLW to treatment and disposal, and 2.7 m^3 of hazardous waste to treatment and disposal, eliminating 475 containers of the stored inventory.

3.8.2. Environmental Remediation Activities

During 2020, the final major cleanup project was completed. The ultimate goal of the remediation work is to make parcels of land available for a general aviation airport, conservation areas, and private-sector development that can economically benefit the region. Highlights of this effort are given below. For details, please see the *2022 Cleanup Progress—Annual Report to the Oak Ridge Regional Community* (UCOR 2023, OREM-23-7632).

3.8.2.1. Soil Remediation

UCOR's soil remediation efforts at ETTP are helping to prepare the site for future commercial industrial use. The site is divided into two cleanup regions: Zone 1, a 1,400-acre area outside the main plant area, and Zone 2, the 800-acre area that comprises the main plant area. The areas in these zones are divided into EUs that vary in size from 6 to 38 acres. Remediation efforts are designed to protect groundwater, wildlife, and the future workforce. Remediation activities include removal of facilities, excavation of soil, and land use covenants. In FY 2022, OREM excavated and removed soil with radiological contaminants from several small areas in EU-13, an area near Poplar Creek that once housed many of the gaseous diffusion and uranium hexafluoride enrichment support facilities. Workers also removed the K-1131 ash pit and surrounding soils in that area.

Remediation was also underway within EU-21, an area that is located in the middle of the K-25 footprint, which is part of the Manhattan Project National Historical Park. Characterization sampling was performed as part of the overall cleanup of the ETTP site. Based on results of model calculations, workers are set to excavate 108,000 yd^3 of soil to eliminate risks to groundwater.

Excavations to remediate the potential risk to groundwater began in April 2021 and are ongoing. To support the treatment of water that could accumulate within the excavation areas, a treatment system was designed to remove contaminants from the water prior to discharge to the Clinch River.

Other RA accomplishments in FY 2022 include the following:

- Completed soil RA activities within the footprint of the former K-1303, Mercury Distillation Facility; site restoration activities included placing clean fill and hydroseeding the area to stabilize the site
- Completed the concrete slab/associated plenum and soil RA surrounding the former K-1302, Fluorine Storage and Distribution Facility; site restoration activities included placing soil fill with final site stabilization pending
- Completed the concrete slab RA of the former K-1301, Fluorine Production Facility; site restoration activities included placing and compacting gravel across the area's footprint

3.8.2.2. Groundwater Protection

ETTP completed several soil RAs in FY 2022 that help protect groundwater. Workers on these projects removed approximately 20,000 yd^3 of soil and concrete.

The EU-25 RA centered on the slab, foundation, and underlying soil of the former K-1413 Building. Constructed in the 1950s, the building was operated until the early 1980s for a range of chemical waste processing activities. Included with the building were three neutralization pits ranging from 2,500 to 21,000 gal. Extensive contamination in the concrete and soil was removed during the action. Over 13,000 yd^3 of concrete and soil were removed from the site.

The EU-35 RA was conducted on the site of the former K-1407-K Building. This facility contained six 500-gal tanks and a system used for mixing chemical solutions. Four of the tanks were used to convert dry chemicals into solutions; two tanks were used to hold rinse water. Concrete and soil in the footprint of the former building were found to contain methylene chloride and PCE that exceed site groundwater screening levels. Approximately

800 yd^3 of soil and concrete was removed from the area.

The EU-42 area is the site of the former K-1004-J Building, a laboratory that was part of the now-demolished Centrifuge Complex. Remediation was performed on the former slab and soils remaining after demolition. Research conducted in the former facility resulted in discharges to drain lines and neutralization pits that contaminated the concrete and soil in the area with radioactive isotopes. RAs in this EU removed more than 6,200 yd^3 of concrete and soil.

OREM is also working to develop RODs to address groundwater cleanup at the site. RODs document the cleanup approach that will be used. The RODs will be for the K-31/33 Area, Main Plant Area, and Zone 1.

3.8.3. Reindustrialization

OREM continued to see significant momentum in the Reindustrialization Program at ETTP. The former government-owned uranium enrichment complex is being turned into a multiuse industrial park that includes national historic preservation and conservation and greenspace areas. To date, OREM has successfully transferred almost 1,300 acres at ETTP for beneficial reuse and is working to complete transfer of the remaining acreage at the site.

During FY 2022, the Reindustrialization team advanced the regulatory review of seven land transfer packages. This includes areas such as the former Powerhouse area, the Centrifuge area, and the K-1037 and TSCA Incinerator area. OREM and UCOR continued to partner with CROET to identify remaining available property, coordinate schedules, and support new businesses as they set up operations.

FY 2022 saw an increase in economic development with four new companies acquiring land. An estimated 1,500 jobs will be added in the coming years with an investment of nearly $500 million. Their expertise ranges from an advanced nuclear demonstration project to nuclear fuel fabrication facilities and a glass fiber recycling facility. Oak Ridge is quickly becoming an area known for next-generation nuclear and clean energy industries.

The national historical preservation activities continued with the completion of the building design for the K-25 Viewing Platform. This new facility will be adjacent to the K-25 History Center and is positioned to overlook the former K-25 Building footprint.

Conservation/Greenspace

Enhancing the area's natural assets and creating more public recreation opportunities continued to be a major focus at ETTP. The Tennessee Wildlife Resources Agency and OREM collaboration resulted in the signing of an agreement in principle to plan to transfer almost 3,500 acres for greenspace and mixed-use recreational areas.

OREM and UCOR continued to share progress and lessons learned with the community and stakeholders through several meetings, workshops, and a virtual public event held in February 2022. These activities helped describe the remaining scope of work and provided an update on how the site is being transformed into a valuable community asset.

3.9. References

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