Chapter 3 - East Tennessee Technology Park

East Tennessee Technology Park (ETTP) was originally 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 was changed to include the enrichment of uranium for nuclear reactor fuel elements and recycling of uranium recovered from spent fuel, and the name was changed to the "Oak Ridge Gaseous Diffusion Plant" (ORGDP). In the 1980s, a reduction in the demand for nuclear fuel resulted in the shutdown of the enrichment process, and production ceased. The emphasis of the mission then changed to environmental management and restoration operations, and the name was changed to the "East Tennessee Technology Park."

Environmental management and remediation operations consist of operations such as waste management, the cleanup of outdoor storage and disposal areas, the demolition and/or cleanup of facilities, land restoration, and environmental monitoring. Proper disposal of huge quantities of waste that were generated over the course of production operations is also a major task. Beginning in the 1990s, reindustrialization (the conversion of underused government facilities for use by the private sector) also became a major mission at ETTP. Reindustrialization allows private industry to lease underused facilities, thus providing both jobs and a new use for facilities that otherwise would have to be demolished. State and federally mandated effluent monitoring and environmental surveillance at ETTP involve the collection and analysis of samples of air, water, soil, sediment, and vegetation from ETTP and the surrounding area. Monitoring results are used to assess exposures to members of the public and the environment, to assess the performance of treatment systems, to help identify areas of concern, to plan remediation efforts, and to evaluate the efficacy of remediation efforts. In 2016, there was 100% compliance with permit standards for emissions/discharges from ETTP operations.

On November 10, 2015, the US Department of Energy (DOE) and the US Department of Interior signed a memorandum of agreement (MOA) establishing the Manhattan Project National Historic Park. The MOA defines the respective roles and responsibilities of the departments in administering the park and includes provisions for enhanced public access, management, interpretation, and historic preservation. The K-25 Building Site, formerly the K-25 Gaseous Diffusion Building, is within the boundary of the newly established National Park. As part of the activities to establish the park, DOE released the K-25 Virtual Museum, which is a website that details the history of the K-25 Gaseous Diffusion Plant through narrative and photographs and can be found at http://www.k-25virtualmuseum.org/.

3.1 Description of Site and Operations

Construction of the K-25 Site (Fig. 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 1 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 the Oak Ridge Gaseous Diffusion Plant (ORGDP).

After military production of highly enriched uranium (HEU) was concluded in 1964, the two original process buildings were shut down. For the next 20 years, the plant's primary missions were 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.

Fig. 3.1. East Tennessee Technology Park.

By 1985, the demand for enriched uranium had 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 East Tennessee Technology Park (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 2016.

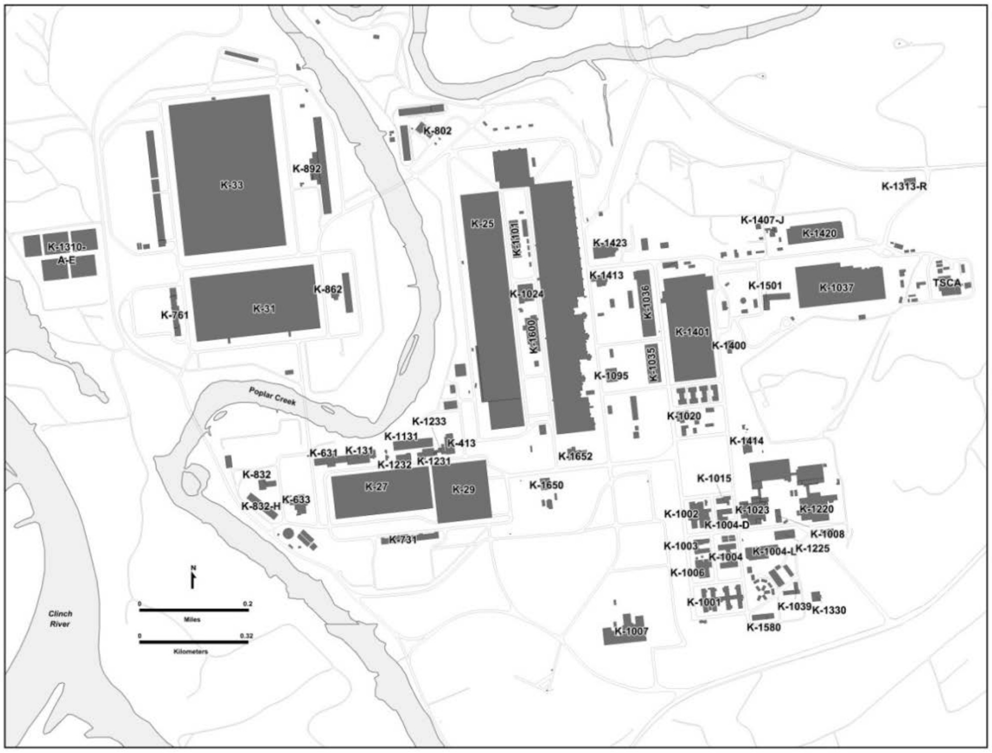

Fig. 3.2. East Tennessee Technology Park before the start of decontamination and decommissioning activities in 1991.

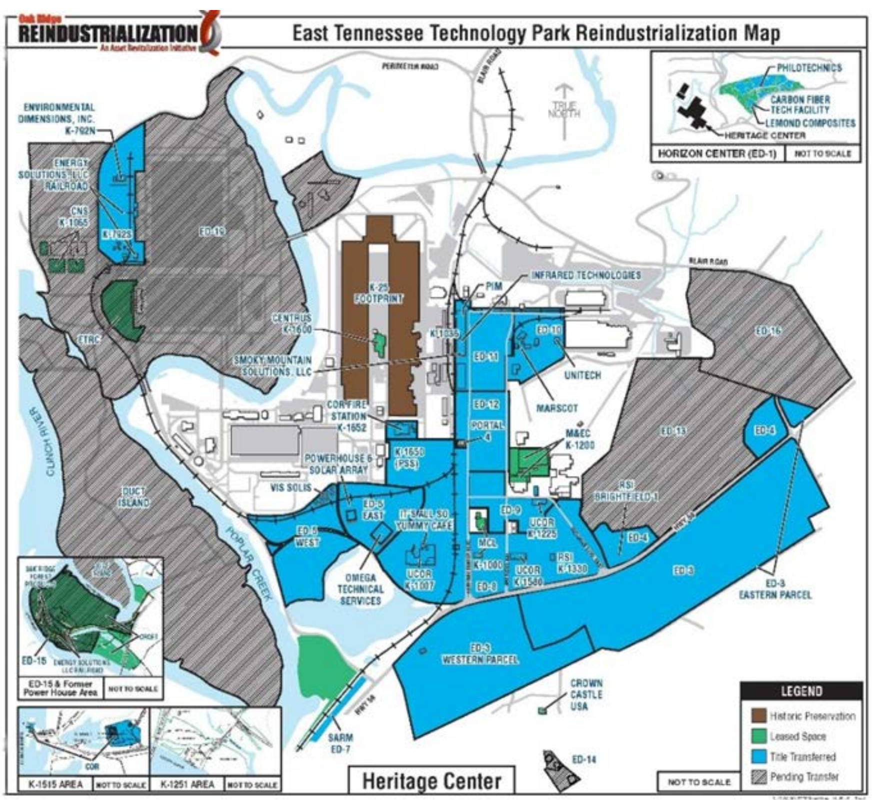

Fig. 3.3. East Tennessee Technology Park in 2016, showing progress in reindustrialization.

The ETTP mission is to reindustrialize and reuse site assets through leasing and/or transferring excess or underutilized land and facilities and through 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 (COR). 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 private business and industrial park. The facilities may then be subleased or sold, with the goal of stimulating private industry and recruiting business 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.

URS | CH2M Oak Ridge LLC (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. Unless otherwise noted, information on non-DOE entities located on the ETTP site is not provided in this document.

3.2 Environmental Management System

The UCOR Environmental Management System (EMS) is integrated with the UCOR Integrated Safety Management System (ISMS). UCOR's EMS is based on a graded approach for a closure and remediation contract and reflects the elements and framework contained in International Organization for Standardization (ISO) Standard 14001:2004 (ISO 2004), *Environmental management systems—Requirements with guidance for use*. UCOR is committed to incorporating sound environmental management, protection, and sustainability practices in all 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, "Our commitment 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.

Management Commitment—Integrate responsible environmental practices into project operations.

Environmental Compliance and Protection (EC&P)—Comply with all environmental regulations and standards.

Sustainable Environmental Stewardship—Minimize the effects of our operations on the environment through a combination of source reduction, recycling, and reuse; sound waste management practices; and P2.

Partnership/Stakeholder Involvement—Maintain partnerships through effective two-way communications with our customers and other stakeholders.

3.2.1 Environmental Stewardship Scorecard

The Environmental Stewardship Scorecard is used to track and measure site-level EMS performance. During 2016, UCOR received "green scores" for EMS performance. As an example, Fig. 3.4 presents information on UCOR's 2016 P2 recycling activities related to solid waste reduction at ETTP. UCOR recycles office and mixed paper, cardboard, phone books, newspapers, magazines, aluminum cans, antifreeze, engine oils, batteries (lead acid, universal waste, and alkaline), universal waste bulbs, plastic bottles, all types of #1 and #2 plastics, and surplus electronic assets, such as computers (CPUs and laptops) and monitors (CRTs and LCDs). Other recycling opportunities include unique structural steel, stainless-steel structural members, transformers, and electrical breakers.

UCOR's exceptional electronics stewardship earned it an award in 2016 from the Green Electronics Council for its use of Electronic Product Environmental Assessment Tool (EPEAT) methods. At the two-star level—one for computers and displays, and one for imaging equipment. EPEAT purchasers earn a star for each product category for which they have a policy in place and purchase EPEAT-registered electronics. EPEAT is a free and trusted source of environmental product ratings that help purchasers select high-performance electronics that meet their organizations' IT and sustainability goals. Manufacturers register products based on the devices' ability to meet various criteria developed and agreed upon by diverse stakeholders to address the full life cycle of an electronic product.

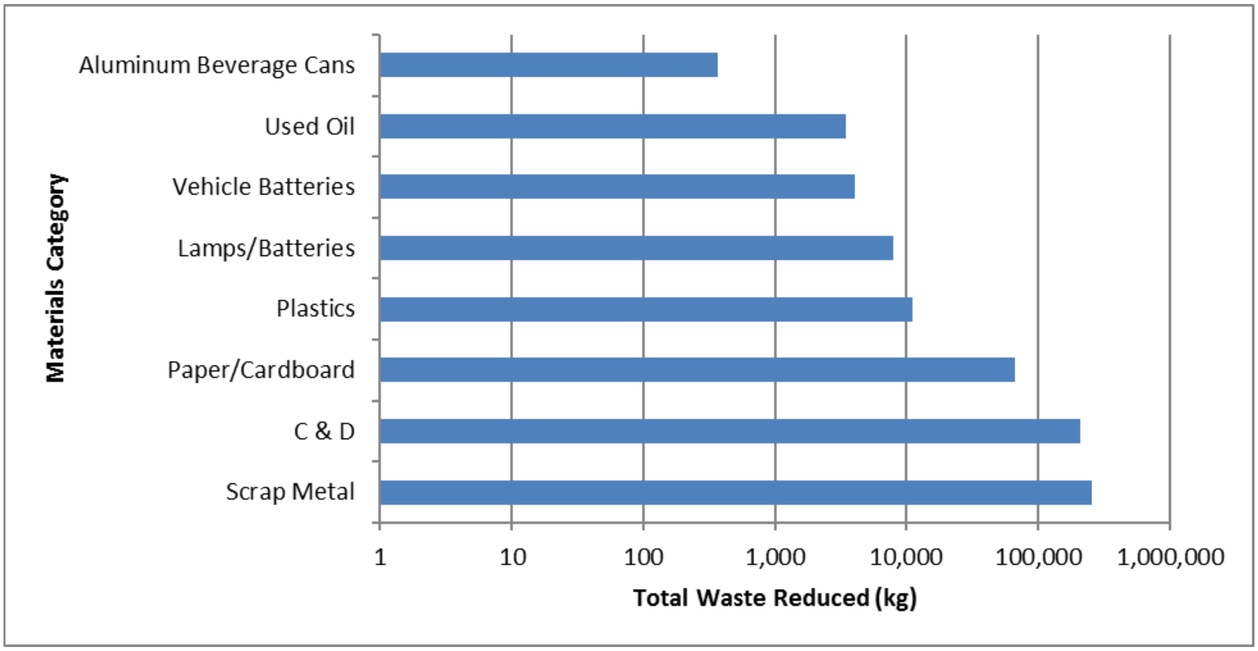

Fig. 3.4. Pollution prevention recycling activities related to solid waste reduction at East Tennessee Technology Park in Calendar Year 2016.

Additionally, UCOR internally recognized six projects for their pollution prevention/waste minimization (P2/WMin) accomplishments in 2016. ETTP also strives to continually find new avenues for waste diversion. In 2016, a significant improvement in the diversion of scrap metal was made. In the course of demolition and environmental cleanup, one challenge has been the ability to divert large volumes of construction and demolition debris from disposal in landfills due to radiological contamination. However, despite the radiological challenge, a substantial amount of scrap metal located inside of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)-designated areas is still eligible for recycling because it is not radiologically contaminated. For the nonradiological areas, a second challenge was identified due to the CERCLA Offsite Rule that requires all disposal and recycle facilities receiving CERCLA waste be reviewed and approved by the US Environmental Protection Agency (EPA) for acceptability. UCOR conducted a nationwide search for scrap metal recyclers that EPA had determined to be acceptable with the CERCLA Offsite Rule requirements all the way through the required smelter/foundry process step; however, none were located. Therefore, the only available option for disposal of the noncontaminated CERCLA scrap metal was land disposal.

In 2016, UCOR worked with EPA and the Tennessee Department of Environment and Conservation (TDEC) to develop a CERCLA screening process that allows noncontaminated scrap metal from CERCLA areas to be 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 unprecedented agreement allowed approximately 361,776 lb [164 metric tons [MT]) of scrap metal to be recycled in fiscal year (FY) 2016 in lieu of land disposal and provides a path forward for additional waste diversion for the duration of the contract.

Some of the scrap metal that has been screened for recycling is listed below:

- The ETTP power transmission and distribution systems and associated equipment/components, including electrical wire, cable, conductors, service equipment, lighting housing, metal conduit, switches, grounding equipment and associated bolts, nuts, clamps, etc. Legacy, nonenergized electrical power transmission and distribution system and associated equipment and components are considered industrial process equipment and constitute bulk metal that is ubiquitous at the site. This resulted in approximately 43,000 lb (19.5 MT) of scrap metal that was recycled.
- The K-1234 propane storage tank, a 30,000-gal metal storage tank, was purged with nitrogen, disconnected from the distribution lines, and taken out of service. A total of 51,750 lb (23.47 MT) was recycled by an offsite vendor as scrap metal.
- Numerous items at the Molten Salt Reactor Experiment (MSRE) Building 7505 at ORNL, consisting of large salt transfer casks, salt transfer cans, salt can transportation cages and heat exchanger covers deemed excess, and unused equipment with an estimated weight of 250,000 lb (114 MT). The material is stainless steel, lead, and carbon steel. The material, which consisted of equipment that was never used or placed in a radiological area, was recycled.
- Approximately 7,500 lb (3.4 MT) of scrap metal from the 6556 Trailer Complex at ORNL consisting of piping, conduit and sheet metal from roofing over walkways and utility disconnects to the trailers. The material, which had never been in a radiological area, was screened and recycled.
- A total of 9,526 lb (4.32 MT) of scrap metal located in Building 7503 at ORNL. It consisted of a stainless steel tool pig that was built for use during the uranium deposit removal project at the MSRE but never used and never put into a radiological area of any kind. It was recycled.

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

- Provides funds from the recycling payments that can support the Oak Ridge cleanup program. Receipts from these shipments resulted in approximately $18,000 that was available to go back into the program.
- Conserves valuable landfill space. In total, the scrap metal recycled from these five shipments saved over 200 yd^3 of valuable landfill space at an estimated cost savings of approximately $43,000, which takes into consideration 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, Oak Ridge National Laboratory (ORNL), and Y-12 National Security Complex (Y-12).

In the area of alternative energy, Restoration Services, Inc. (RSI), in concert with UCOR, continued operation of ETTP's first solar farm on the east end of the plant property. Brightfield 1 (Fig. 3.5), as it is known, 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.

Fig. 3.5. Brightfield 1 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 (CORED) using a TVA Generation Partners contract. The completed project was commissioned in April 2012 and is part of RSI's Brownfields to Brightfields (B2B) initiative that works to develop restricted use properties into solar farms. Brightfield 1 energy production in its first year was 110% more than projected, with no downtime due to maintenance issues. In Calendar Year (CY) 2016, Brightfield 1 produced 256,060 kWh of energy.

In addition, through the cooperative efforts of DOE, UCOR, RSI, Vis Solis, Inc., CROET, and the COR, a second solar farm—the Powerhouse 6 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 boosters development at ETTP. This project provides numerous benefits to the environment and the community at large, and includes 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 MT of carbon dioxide).
- Provides brownfield reuse/redevelopment at ETTP.
- Supports the COR renewable energy goals.
- Supports the TVA renewable energy initiative.
- Offers community economic development jobs and property tax income to the COR.
- Demonstrates benefits of ETTP reindustrialization.
- Supports DOE renewable energy goals.

- Demonstrates collaborative success between DOE and a public utility for renewable energy development.

UCOR also continued to use green products whenever possible and evaluated large quantity purchases for less toxic alternatives. In addition, UCOR maintained its extensive recycling program, which helps provide employment to beneficiaries of local charities who are employed by the local recycling facility for the county.

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, management assessments conducted by functional or project organizations, and routine field walkdowns conducted by a variety of functional and project personnel. Management and independent assessments are performed in accordance with *Management Assessment*, PROC-PQ-1420, and *Independent Assessment*, PROC-PQ-1401. Assessments are scheduled on the UCOR Quality Assurance System (QAS) in accordance with PROC-PQ-1420. 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).

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 environment, safety, and health (ES&H) goals. UCOR works continuously to improve 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 incorporating environmental protection and the elements of an enabling EMS into the daily conduct of business; fostering a spirit of cooperation with federal, state, and local regulatory agencies; and using appropriate waste management, treatment, storage, and disposal methods.

The environmental performance objectives are to achieve zero unpermitted discharges to the environment; comply with all conditions of environmental permits, laws, regulations, and DOE orders; integrate EMS and environmental considerations as part of ISMS; and, to the extent practicable, reduce waste generation, prevent pollution, maximize recycle and reuse potential, and encourage environmentally preferable procurement of materials with recycled and biobased content.

UCOR has established a set of core, corporate 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 (O) 436.1, *Departmental Sustainability* (DOE 2011a), and include the following:

- Comply with all environmental regulations, permits, and regulatory agreements.

- Reduce or eliminate the acquisition, use, storage, generation, and/or release of toxic, hazardous, and radioactive materials; waste; and greenhouse gas emissions through acquisition of environmentally preferable products, conduct of operations, waste shipment, and P2/WMin and sustainable practices.
- Reduce degradation and depletion of environmental resources and potential impact of climate change through post-consumer material recycling, energy, fuel, and water conservation efforts, use or promotion of renewable energy, and transfer for reuse valuable real estate assets.

3.2.5 Implementation and Operations

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 management assessments also provide a measure of how well EMS attributes are integrated into work activities through ISMS. UCOR has embodied its program for EC&P of natural resources in a companywide EM and protection policy. The policy is UCOR's fundamental commitment to incorporating sound EM practices into all work processes and activities.

3.2.6 Pollution Prevention/Waste Minimization

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 or other wastes generated 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 more 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. Some recent examples include:

- The UCOR IT organization implemented:
  - A Xerox contract that increased EPEAT-certified imaging equipment from 10% to 100%, reduced the number of onsite devices from 180 to 140 machines, and resulted in $130,000 of savings and $556,000 over the term of the contract.
  - A digital signature program for all UCOR documents using the Homeland Security Presidential Directive-12 (HSPD-12) badges that meets standards for authentication and can save thousands of dollars in paper savings.
- The UCOR CERCLA Decision Document Group and EC&P negotiating with regulators a screening process that allowed 361,776 lb of uncontaminated scrap metal to be recycled, with more expected.
- The UCOR Finance and Accounting organization migrated transactions from paper to electronic, saving 100,000 sheets of paper and $1,500 in expenses per year.
- The UCOR D&D organization along with the Power Integration Group, Supply Chain Management, and Reindustrialization:
  - Rerouted K-27 roof drains during D&D activities that avoided treating 5 million gallons of water and saved $203,000.
  - Transferred five racks of Dielecktrol® capacitor units to a local municipality for reuse, saving landfill space and $4,200 in avoided disposal costs.

- The Nuclear and High Hazard Organization (N&HHO):
  - Excessed $459,000 of unneeded materials.
  - Disposed of contaminated B-25 boxes as waste containers, saving $12,000.
  - Transitioned paper logs to electronic logbooks, saving $8,900 over the next 5 years.
- The UCOR Property Management and Shipping and Receiving organizations:
  - Recycled 400 ink cartridges and 90 new ink cartridges, saving valuable landfill space and $400 in cost avoidance.

Total savings associated with these projects were in excess of $1.2M and in many cases, valuable landfill space and virgin materials were conserved. The internal awards will be evaluated for possible nomination in national-level awards (e.g., DOE Headquarters annual award program).

3.2.7 Competence, Training, and Awareness

The UCOR training and qualification process ensures that needed skills for the workforce are identified and developed. The process also documents knowledge, experience, abilities, and competencies of the workforce for key positions requiring qualification. This process is described in PROC-TC-0702, *Training Program*. Completion and documentation of training, including required reading, are managed by the Local Education Administration Requirements Network (LEARN).

3.2.8 Communication

UCOR communicates externally regarding environmental aspects through the UCOR public website, which includes a link to its environmental policy statement, POL-UCOR-007; a list of environmental aspects; and a link to the *Integrated Safety Management System Description*, PPD-EH-1400. 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., ASER and the annual cleanup progress report (UCOR 2015a)]. UCOR participates in a number of public meetings related to environmental activities at the site [e.g., Oak Ridge Site Specific Advisory Board (ORSSAB) meetings, which include community stakeholders, permit review public meetings, and CERCLA decision document public meetings]. 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 Do-Act-Check, it provides a framework by which work incorporates 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 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 2017, UCOR-4127/R5). The EMS program is audited by a third party triennially by EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* (CEQ 2007), for conformance to the ISO 14001:2004 standard, with the most recent having been conducted in 2015. The results of the audit were, zero findings, two observations, and four proficiencies.

3.2.10 Management Review

Senior management review of EMS is performed at several layers and frequencies. A formal review/presentation with UCOR senior management that addresses the requirement elements contained in this section is conducted at least once per year. At least two of the senior managers are present for management reviews. The ISMS description is updated annually to address improvements and lessons learned and to update objectives and targets as necessary and signed by the UCOR president and project manager. The environmental policy is also reviewed during the management review annually and revised as necessary.

3.3 Compliance Programs and Status

During 2016, ETTP operations were conducted in compliance with contractual and regulatory environmental requirements, and there were no National Pollutant Discharge Elimination System (NPDES) permits or Clean Air Act (CAA) noncompliances. Figure 3.6 shows the trend of NPDES compliance at ETTP since 1999. The following sections provide more detail on each compliance program and the environmental remediation (ER)-related activities in 2016.

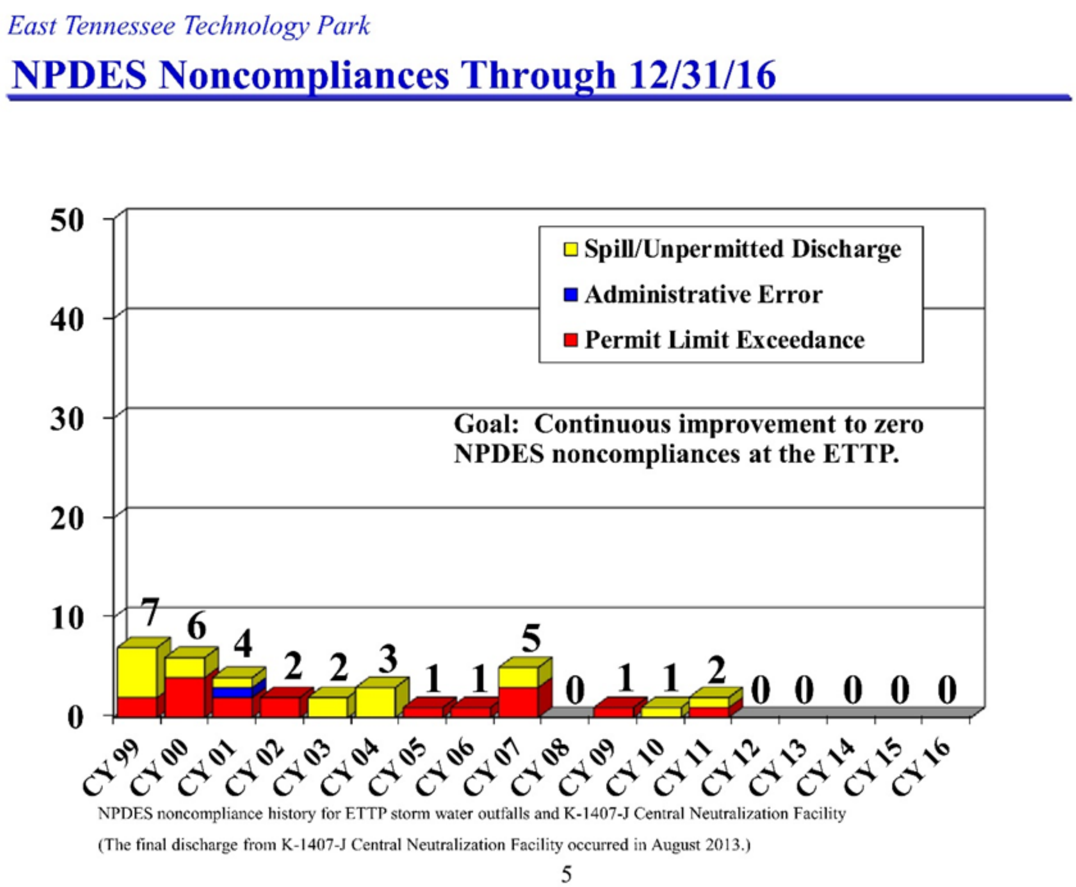

Fig. 3.6. East Tennessee Technology Park (ETTP) National Pollutant Discharge Elimination System (NPDES) permit compliance since 1999.

3.3.1 Environmental Permits

Table 3.1 contains a list of environmental permits that were in effect at ETTP in 2016.

3.3.2 Notices of Violation and Penalties

ETTP received no environmental violations in 2016.

3.3.3 Audits and Oversight

Table 3.2 presents a summary of environmental audits and oversight visits conducted at ETTP in 2016.

One CAA regulatory inspection was performed in 2016. An unannounced inspection of the UCOR asbestos compliance program was performed by TDEC Division of Solid Waste Management on August 24 and 25, 2016. The focus of the inspection was compliance with the applicable recordkeeping requirements. No regulatory violations or concerns were noted by TDEC during the inspection.

Table 3.1. East Tennessee Technology Park environmental permits, 2016

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	State permit to operate an air contaminant source—internal combustion engine–powered emergency generators and fire water pump	069346P	03-03-2015 Amended 11-22-2016	10-01-2024	DOE[a]	UCOR	UCOR
CWA	NPDES permit for storm water discharges	TN0002950	2-01-15	3-31-2020	DOE	UCOR	UCOR
CWA	State operating permit—waste transportation project; Blair Road and Portal 6 sewage pump and haul permit	SOP-05068	07-01-14	02-28-2019	DOE	TFE	TFE
CWA	State operating permit—ETTP holding tank/haul system for domestic wastewater	SOP-99033	07-01-15	06-30-2020	UCOR	UCOR	UCOR
UST	Authorized/certified USTs at K-1414 Garage	Customer ID 30166 Facility ID 073008	03-20-89	Ongoing	DOE	UCOR	UCOR
RCRA	ETTP container storage and treatment units	TNHW-165	09-15-15	09-15-2025	DOE	UCOR	UCOR
RCRA	Hazardous waste corrective action document (encompasses entire ORR)	TNHW-164	09-15-15	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)
NPDES = National Pollutant Discharge Elimination System
ORR = Oak Ridge Reservation
RCRA = Resource Conservation and Recovery Act
SOP = state operating permit
TFE = Technical and Field Engineering, Inc.
UCOR = URS | CH2M Oak Ridge LLC
UST = underground storage tank

Table 3.2. Regulatory oversight, assessments, inspections, and site visits at East Tennessee Technology Park, 2016

Date	Reviewer	Subject	Issues
March 7	TDEC	Annual RCRA Compliance Inspection	0
August 2	TDEC	RCRA Facility Closure Inspection	0
August 24-25	TDEC	Asbestos Accreditation Inspection	0
December 7	TDEC	RCRA Facility Closure Inspection	0
December 14	TDEC	Underground Storage Tank Inspection	0

RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment & Conservation

3.3.4 National Environmental Policy Act/National Historic Preservation 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. Many of the current operations at ETTP are conducted under CERCLA. NEPA reviews are part of the CERCLA planning process to ensure that NEPA values are incorporated into CERCLA projects and documentation.

During 2016, ETTP continued to operate under site-level, site-specific procedures that provide requirements for project reviews and NEPA compliance. These procedures call for a review of each proposed project, activity, or facility to determine the potential for impacts to the environment. To streamline the NEPA review and documentation process, DOE Oak Ridge Office (ORO) has approved generic categorical exclusion (CX) determinations that cover certain proposed activities (i.e., maintenance activities, facilities upgrades, personnel safety enhancements). A CX is one of a category of actions defined in 40 Code of Federal Regulations (CFR) Part 1508.4 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. UCOR activities on Oak Ridge Reservation (ORR) are in full compliance with NEPA requirements, and procedures for implementing NEPA requirements have been fully developed and implemented. At ETTP, a checklist incorporating NEPA and EMS requirements has been developed as an aid for project planners. For routine, recurring activities, DOE generic CX determinations are used. During 2016, no new CX determinations for activities at ETTP were issued by DOE.

Compliance with the National Historic Preservation Act (NHPA) at ETTP 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). At ETTP, there were 135 facilities eligible for inclusion on the National Register of Historic Places (NRHP), a National Park Service (NPS) program to identify, evaluate, and protect historic and archeological resources in the US, as well as numerous facilities that were not eligible for inclusion on NRHP. To date, more than 800 facilities have been demolished. Artifacts of historical and/or cultural significance are identified before demolition and are catalogued in a database to aid in the historic interpretation of ETTP.

Consultation for the development of a Memorandum of Agreement (MOA) for D&D of the K-25 and K-27 buildings started in 2001; the document, approved in 2003, required a third-party analysis of the preservation and interpretive strategies for those two buildings. In 2005, DOE, the Tennessee State Historic Preservation Office (SHPO), and the Advisory Council on Historic Preservation (ACHP) entered into an MOA that included the retention of the north end tower (also known as north wing and north end) of the K-25 building and Portal 4 (K-1028-45), among other features, as the "best and most cost-effective mitigation to permanently commemorate, interpret, and preserve the significance" of ETTP. Another series of consultation meetings ensued in 2009 and DOE advised that prohibitive costs and safety considerations precluded fulfillment of three stipulations in the 2005 MOA, including the preservation of the north end tower. The parties offered a wide array of potential mitigation measures and, in the absence of consensus on how best to commemorate Building K-25, DOE, SHPO, and ACHP entered into a bridge MOA until the parties could reach a final agreement. After completing an evaluation of the structural integrity of the K-25 building and interpretative approaches for the site, DOE distributed a preferred mitigation plan to the consulting parties in October 2011. The DOE final mitigation plan, which addressed comments submitted by consulting parties in November 2011, permitted demolition of the entire K-25 building and called for, among other mitigation measures, the designation of a commemorative area around the building's perimeter from which future surface development would largely be restricted; the retention, if possible, of the entire concrete slab or the demarcation of the building's footprint; the construction of a viewing tower and structure for equipment display; and the development of a history center within the ETTP Fire Station. A final MOA was signed in August 2012, finalizing the aspects set forth in the mitigation plan. During 2013, a request for proposal was issued for a "Professional Design Team and Museum Professional," as specified in the MOA. Nine firms were prequalified, and the selection and awards were executed April 1, 2014. The procurement process for the K-25 "virtual museum" web design firm was also begun in 2013 and awarded September 2, 2014.

On December 14, 2014, Congress authorized the establishment of the Manhattan Project Historical Park to commemorate the history of the Manhattan Project. It will comprise the three major sites: Los Alamos, New Mexico; Oak Ridge, Tennessee; and Hanford, Washington, which were dedicated to accomplishing the Manhattan Project mission.

The *Memorandum of Agreement Between the United States Department of the Interior and the United States Department of Energy for the Manhattan Project Historic National Park* was signed by the US Department of Interior and DOE on November 10, 2015 (DOE 2015d,), creating the new Manhattan Project Historic National Park. The K-25 Virtual Museum website (K-25 Virtual Museum) was launched in conjunction with the signing of the MOA.

The Museum Preliminary Design Report, was completed and provided to the Consulting Parties in July 2016. The Consulting Parties reviewed the report and plans and provided comments. The Final Design Plan will be completed and sent to the consulting parties for review in 2017.

3.3.5 Clean Air Act Compliance Status

The 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 (NAAQS), State Implementation Plans (SIPs), New Source Performance Standards (NSPSs), 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 2016. The ETTP ambient air monitoring program, permitted source operations tracking, and record keeping provided documentation fully supporting a 100% compliance rate.

3.3.6 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 CWA was EPA establishment of limits on specific pollutants allowed to be discharged in US waters by municipal sewage treatment plants (STPs) 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 2016, ETTP discharged to the waters of the state of Tennessee under the individual NPDES permit TN0002950, which regulates storm water discharges.

3.3.7 National Pollutant Discharge Elimination System Permit Noncompliances

In 2016, compliance with ETTP NPDES storm water permit TN0002950 was determined by more than 150 laboratory analyses, field measurements, and flow estimates. The NPDES permit compliance rate for all discharge points for 2016 was 100%.

3.3.8 Safe Drinking Water Act Compliance Status

Since October 1, 2014, all water at the ETTP site is supplied by the COR drinking water plant, located north of the DOE Y-12 Complex in Oak Ridge, Tennessee.

3.3.9 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. This amount includes hazardous waste generated under permitted activities (including repackaging or treatment residuals). At the end of 2016, ETTP had three generator accumulation areas for hazardous or mixed waste.

In addition, ETTP is permitted to store and treat hazardous and mixed waste under Resource Conservation and Recovery Act (RCRA) Part B Permit TNHW-165. Hazardous waste may be treated and stored at permitted locations in Building K-1423 and at the K-1065 complex. This hazardous waste permit was reissued on September 15, 2015, as a replacement for TNHW-117. The hazardous waste corrective action document, TNHW-164, which covers the ORR CERCLA areas of concern and solid waste management units was also reissued on September 15, 2015, as a replacement for TNHW-121.

In CY 2016, ETTP prepared and submitted to the TDEC Division of Solid Waste Management the CY 2015 annual report of hazardous waste activities. This report identifies the type and amount of hazardous waste that was generated, shipped offsite, or is currently in storage.

3.3.10 Resource Conservation and Recovery Act Underground Storage Tanks

Underground storage tanks (USTs) containing petroleum and hazardous substances are regulated under RCRA Subtitle I (40 CFR Part 280). EPA granted TDEC authority to regulate USTs containing petroleum under TDEC Rule 0400-18-01, *Underground Storage Tank Program*; however, EPA still regulates hazardous substance USTs. During 2016, operations of USTs at ETTP were in complete regulatory compliance.

3.3.11 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 (SARA). Under CERCLA, a site is investigated and remediated if it poses significant risk to health or the environment. The EPA National Priorities List (NPL) 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 NPL and numerous CERCLA decision documents are approved for ETTP site cleanup actions.

3.3.12 East Tennessee Technology Park RCRA-CERCLA Coordination

The *Federal Facility Agreement for the Oak Ridge Reservation* (FFA, DOE 2015a, DOE/OR-1014) is intended to coordinate the corrective action processes of RCRA required under the Hazardous and Solid Waste Amendments permit with CERCLA response actions.

3.3.13 Toxic Substances Control Act Compliance Status—Polychlorinated Biphenyls

On April 3, 1990, DOE notified EPA headquarters (as required by 40 CFR Part 761.205) that ETTP is a generator with onsite storage, a transporter, and an approved disposer of polychlorinated biphenyl (PCB) wastes. ETTP is no longer a disposer of PCBs since the Toxic Substances Control Act (TSCA) Incinerator's hazardous waste management permit TNHW-015 was terminated on September 21, 2012.

PCB waste generation, transportation, disposal, and storage at ETTP is regulated under EPA ID number TN0890090004. In 2016, ETTP operated eight PCB waste storage areas in ETTP generator buildings, and when longer term storage of PCB/radioactive wastes were necessary, RCRA-permitted storage buildings were used. These facilities were operated under 40 CFR 761.65(b)(2)(iii), which allows PCB storage permitted by the state authorized under section 3006 of RCRA to manage hazardous waste in containers, and spills of PCBs are cleaned up in accordance with subpart G of this part. During 2016, 3 of the 8 PCB waste storage areas went through RCRA closure and were closed in September 2016, with 5 remaining open at the end of the year. ETTP operated one long-term PCB waste storage area at ETTP where nonradioactive PCB waste was stored in a facility that was not a RCRA-permitted storage facility. The continued use of authorized PCBs in electrical systems and/or equipment (e.g., transformers, capacitors, rectifiers) is regulated at ETTP. At this time, no PCB-contaminated electrical equipment is in service at ETTP. Most TSCA-regulated equipment at ETTP has been disposed of. However, some ETTP facilities continue to use or store nonelectrical PCB-contaminated equipment for future reuse.

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 ORO and EPA Region 4 consummated a major compliance agreement known as the *Oak Ridge Reservation Polychlorinated Biphenyl Federal Facilities Compliance Agreement* (DOE 2012, ORR-PCB-FFCA), which became effective December 16, 1996, and was last revised on May 23, 2012, to revision 5. The modification in 2012 incorporated institutional controls at the TSCA Incinerator where limited areas of contamination remain in place at the facility after the facility closure actions were completed. The institutional controls will remain in place until future PCB cleanup actions, which will be addressed during CERCLA demolition actions.

The 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) each year per 40 CFR 761.180(a). 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 onsite for a minimum of 3 years.

3.3.14 Emergency Planning and Community Right-to-Know Act Compliance Status

The Emergency Planning and Community Right-to-Know Act (EPCRA) that is also identified as Title III of SARA require that facilities report inventories 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, and the state emergency response commission, and the local fire department. ETTP complied with these requirements in 2016 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 2016.

3.3.14.1 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 2016, 12 were located at ETTP. These chemicals were nickel metal, lead metal (including large lead acid batteries), sodium metal, diesel fuel, sulfuric acid (including large lead acid batteries), Chemical Specialties Ultrapoles, creosote-treated wood, unleaded gasoline, Sakrete™ Type S or N mortar mix, CCA Type C pressure-treated wood, Flexterra® FGM erosion control agent, and sodium chloride.

3.3.14.2 Toxic Chemical Release Reporting (EPCRA Section 313)

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 2016, the only chemicals that met the reporting requirements were diisocyanates associated with foaming activity to stabilize deposits in pipes undergoing remediation actions.

3.4 Quality Assurance Program

3.4.1 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 independently of 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 2016, 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 (RICE) for emergency use. TDEC issued an operating permit (069346P) covering six RICE units on March 3, 2015. The permit covered four RICE emergency generators and two RICE emergency firewater booster pumps. Three generators are diesel fueled and one is natural gas fueled. The two booster pumps are diesel fueled. During this reporting period one of the booster pumps was permanently removed from service. A request for an administrative amendment of the operating permit was submitted to TDEC. The operating permit as amended on November 22, 2016, covers the five remaining RICE through October 1, 2024.

Compliance for all units is demonstrated by following specified maintenance schedules, limiting hours of operations for non-emergencies to 100 h per year, and record keeping. Regulations exempt any operating hours of these units during nonscheduled (emergency) power outages. 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 impacting asbestos-containing materials (ACMs) are fully compliant with 40 CFR 61, Subpart M. This includes using approved engineering controls and work practices, inspections, and monitoring for proper removal and waste disposal of ACMs. ETTP has numerous buildings and equipment that contain ACMs. Major demolition activities during 2016 involved the abatement of significant quantities of ACMs that were subject to the requirements of 40 CFR 61, Subpart M. Most demolition and ACM abatement activities are governed under CERCLA. Under this act, notifications of asbestos demolition or renovations, as specified in 40 CFR 61.145(b), are incorporated into CERCLA document regulatory notifications. All other non-CERCLA planned demolition or renovation activities were individually reviewed for applicability of the TDEC notification requirements of the rule. During 2016, four Notification of Demolition and/or Asbestos Renovation submittals to TDEC were submitted for non-CERCLA ETTP activities. Three notices involved both asbestos abatement and demolition, and the fourth was for demolition only. 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 2016, 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 ACMs occurred at ETTP during 2016.

Stratospheric Ozone Protection

The management of ODSs at ETTP is subject to regulations in 40 CFR Part 82, Subpart F, Recycling and Emissions Reduction; 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 onsite ODS inventory at ETTP.

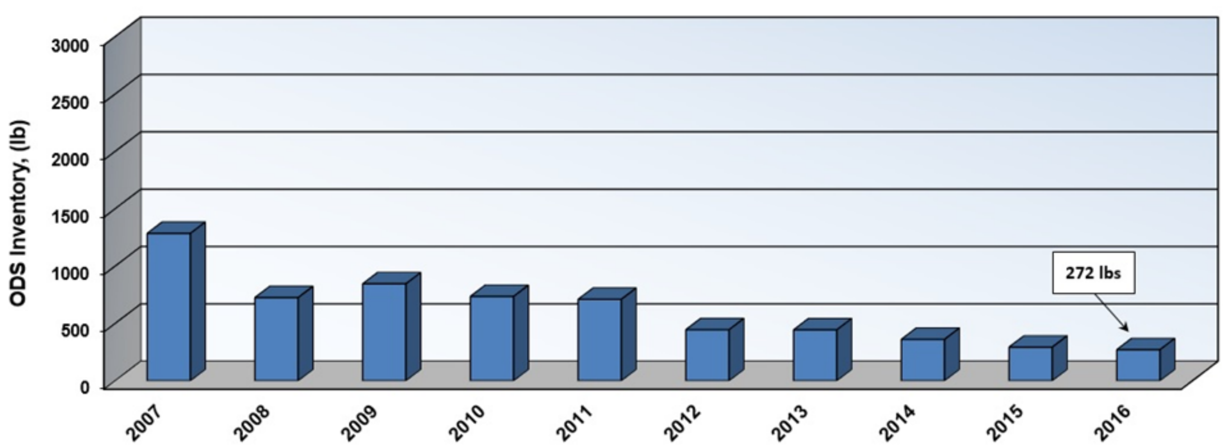

Fig. 3.7. East Tennessee Technology Park total on-site ozone-depleting substances inventory, 10-year history.

3.5.1.2 Fugitive Particulate Emissions

ETTP has been the location of major building demolition activities 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, 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 61, National Emission Standards for Hazardous Air Pollutants (Rad-NESHAP). 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 (ED) 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. ETTP Rad-NESHAP sources that operated during 2016—the K-1407 Chromium Water Treatment System (CWTS) Volatile Organic Compound (VOC) Air Stripper and K-2500-H Segmentation Shops B, C, and D—are 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. Figure 3.8 provides a historical dose trend for the most impacted onsite member of the public if they were located at the sampling locations. During 2016, there was a small dose increase that was coincidental to the demolition and debris removal of the last gaseous diffusion building. The highest annual dose impact as measured at the ambient air station K12 was only 0.07 mrem. The major dose contributor at K12 was ^{99}Tc. The results are based on actual ambient air sampling in a location conservatively representative of the onsite location.

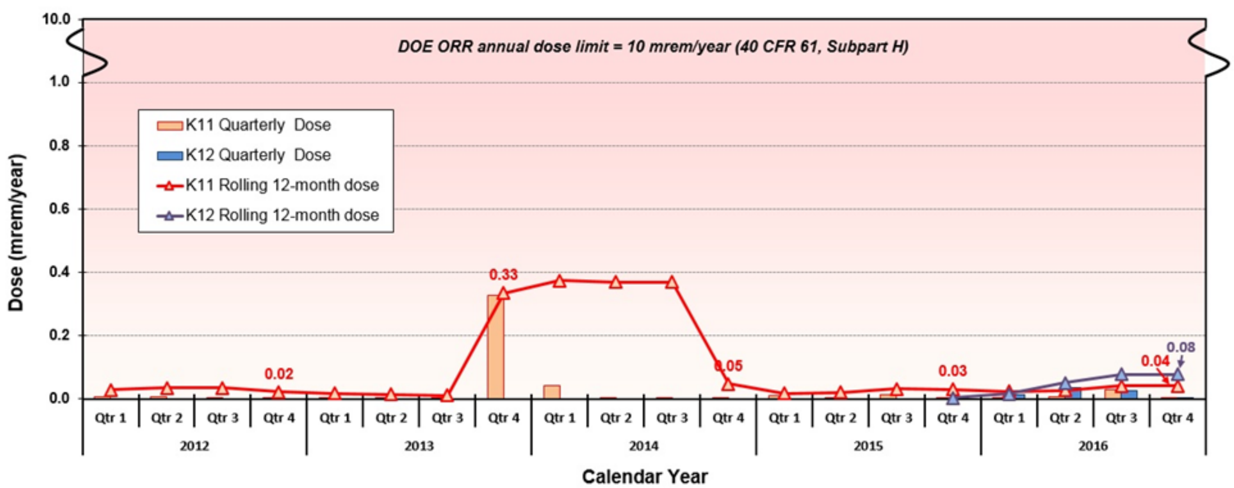

Fig. 3.8. East Tennessee Technology Park Ambient Air stations K11 and K12 radionuclide monitoring results: 5-year rolling 12-month dose history up through 2016. *(DOE = US Department of Energy and ORR = Oak Ridge Reservation)*

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 2015b, UCOR-4257). The plan satisfies the QA requirements in 40 CFR Part 61, Method 114, 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*. 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 2005a).

3.5.1.5 Greenhouse Gas Emissions

The EPA rule for mandatory reporting of Greenhouse Gases (GHGs) (also referred to as the "Greenhouse Gas Reporting Program") was enacted October 30, 2009, under 40 CFR Part 98. According to the rule in general, the stationary source emissions threshold for reporting is 25,000 MT or more of GHGs per year, reported as metric tons of CO_2 equivalent (CO_2e) 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 2016 review was performed of ETTP processes and equipment categorically identified under 40 CFR 98.2 whose emissions must be included as part of a facility annual GHG report starting with the CY 2010 reporting period. Based on total GHG emissions from all ETTP stationary sources during 2016, 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 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 small comfort heating systems, hot water systems, and power generators. Figure 3.9 shows the 5-year trend up through 2016 of ETTP total GHG stationary emissions. For the 2016 CY, GHG emissions totaled only 107 MT, which is less than 1% of the 25,000 MT per year threshold for reporting.

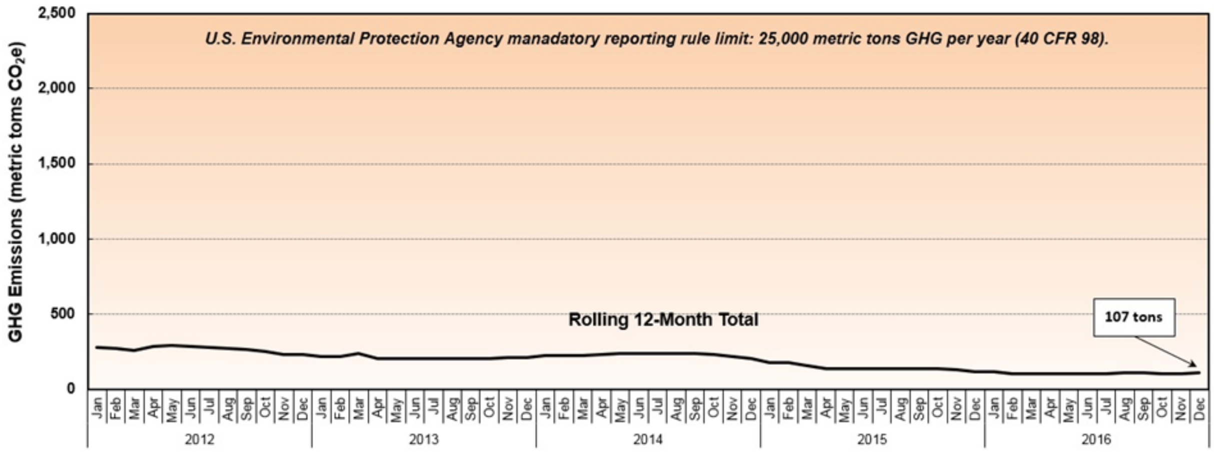

Fig. 3.9. East Tennessee Technology Park stationary source greenhouse gas (GHG) emissions tracking history. *(in carbon dioxide equivalent [CO2e]; CFR = Code of Federal Regulations)*

Executive Order (EO) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, was signed by President Barak Obama on October 5, 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 Scope 1 and Scope 2 reduction target of 28%, as compared to the 2008 baseline year.

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

The information reported here includes GHG emissions from the industrial landfills at Y-12 that are managed by UCOR. The landfills are not part of the contiguous ETTP site; however, DOE requested that UCOR 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 3.10 shows the trend toward meeting both the 28% total Scope 1 and 2 GHG emissions reduction target by FY 2020 and the 40% goal by FY 2025.

With respect to EO 13514, emissions for FY 2016 Scope 1 and 2 including the landfills totaled 19,138 MT CO_2e, roughly 49% below the FY 2020 target level of 37,478 MT CO_2e and a 63% reduction to date compared to the FY 2008 baseline year level of 52,053 MT. When compared to the EO 13693 target, FY 2016 data show that the targeted 40% reduction has already been achieved by comparing the FY 2016 total of 19,138 MT to the 40% target level of 31,232 MT.

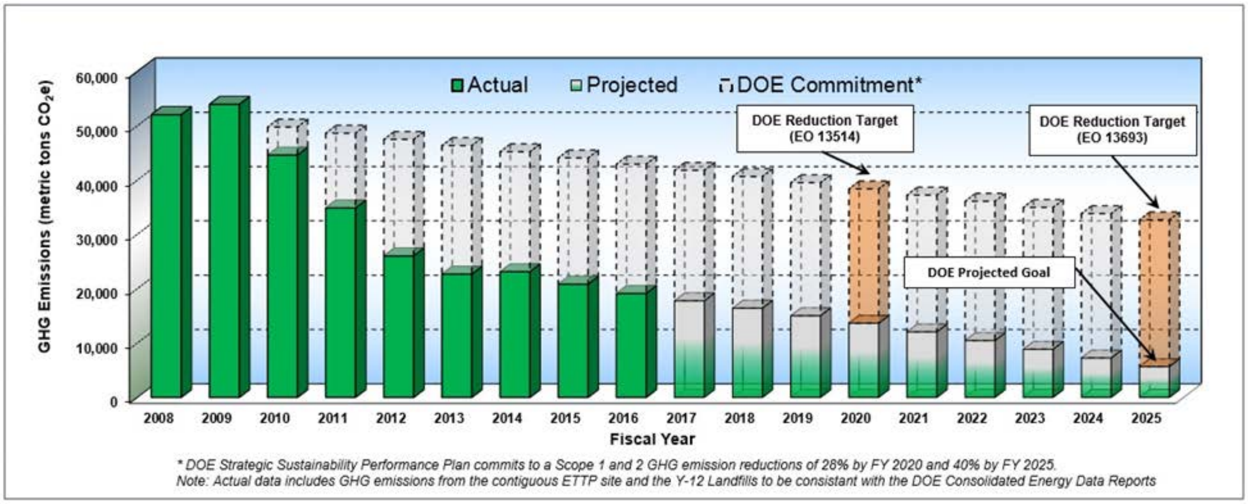

Fig. 3.10. East Tennessee Technology Park (ETTP) greenhouse gas (GHG) emissions trend and targeted reduction commitment. *(in metric tons carbon dioxide equivalent [CO2e])*

Figure 3.11 shows the relative distribution and amounts of all ETTP FY 2016 GHG emissions for Scopes 1, 2, and 3 including the landfills. 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 onsite combustion of fuels (stationary and mobile sources), lower consumption of electricity, and a smaller workforce. The total amount of GHG emissions for FY 2016 was 24,252 tons, as compared to the 25,884 tons (originally reported as 25,867 tons, but revised after publication to 25,884 tons when additional data became available) for FY 2015.

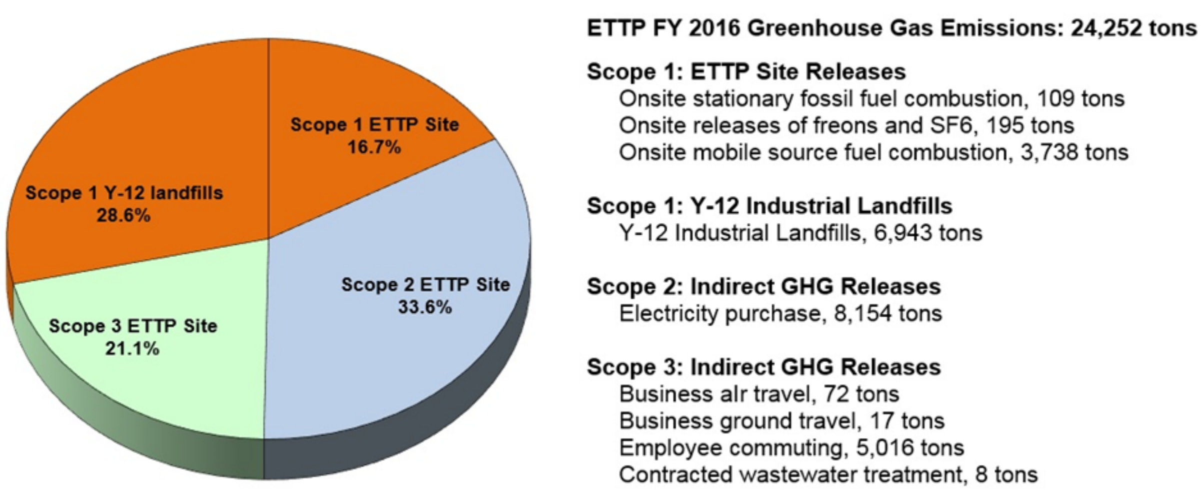

Fig. 3.11. FY 2016 East Tennessee Technology Park (ETTP) greenhouse gas (GHG) emissions by scope, as defined in Executive Order 13514. (Y-12 = Y-12 National Security Complex and SF6 = sulfur hexafluoride)

3.5.1.6 Source-Specific Criteria Pollutants

ETTP operations included one functioning minor stationary source with a potential to emit any form of criteria air pollutant in the CWTS. This unit is equipped with an air stripper to remove VOCs from the effluent stream. All process data records and the calculated potential maximum VOC emission rates for the CWTS air stripper were below levels that would require permitting. The calculated VOC annual emissions during 2016 for CWTS were only 0.011 ton/year as compared to an emission limit of 5 tons/year. The annual potential emissions for this facility would be well below the 5 ton/year limit assuming it operated at the maximum hourly emission rate continuously for the entire year.

Federal regulations amended in January of 2013 require permitting for existing and new stationary emergency generators powered by reciprocating internal combustion engines (i.e., emergency or e-RICE). Compliance actions specified by these amendments do not apply to e-RICE covered under CERCLA projects. TDEC originally issued an amended construction permit for six onsite units with an effective date of August 22, 2013. TDEC issued an operating permit for the six e-RICE units with an effective date of March 3, 2015. 2016 operations included four emergency generator engines (K-1007, K-1039, K-1095, and K-1652), and the remaining two units were fire water booster pump engines (K-802 and K-1310-RW). K-802 was permanently removed from service during 2016. A request to amend the operating permit was submitted to TDEC that requested removing the K-802 unit. TDEC issued an amended permit with an effective date of November 22, 2016. The expiration date of the amended permit is October 1, 2024.

Regulations limit e-RICE nonemergency and maintenance operations to 100 h of operations per 12-month rolling total (i.e., 100 h of running the engines for testing and maintenance purposes per year). Additionally, nonemergency operations are limited to 50 h of the 100-h annual limit. The current permit specifies conditions that must be met to demonstrate compliance. These requirements include performing scheduled maintenance, record keeping, and tracking the runtimes of each of the five permitted units. Copies of all maintenance activities are provided for permit compliance review, and the runtimes are entered into spreadsheets to track against annual limits. Table 3.3 provides the number of hours of operations for each unit, up through December 31, 2016.

Table 3.3. East Tennessee Technology Park UCOR emergency reciprocating internal combustion engine air permit compliance demonstration, 2016

e-RICE Unit	Permit limits: Total hours/year = 100 Nonemergency hours/year = 50			
	PM Testing (hours/year)	Nonemergency (hours/year)	Total (hours/year)	Emergency (hours/year)
K-802[a]	1.5	2.1	3.6	0.0
K-1007	6.4	17.2	23.6	11.5
K-1039	5.5	11.8	17.3	14.8
K-1095	6.9	0.1	7.0	1.4
K-1310-RW	4.0	20.8	24.8	0.9
K-1407[b]	3.5	9.6	13.1	12.0
K-1652	6.5	0.7	7.2	5.6

[a]K-802 fire water booster pump unit permanently removed from service on April 15, 2016. Removed from permit effective November 22, 2016.

[b]K-1407 e-RICE operating under CERCLA and exempt from TDEC air emission permitting.

Acronyms
e-RICE = emergency reciprocating internal combustion engine
PM = particulate matter
TDEC = Tennessee Department of Environment and Conservation
UCOR = URS | CH2M Oak Ridge LLC

ETTP operations released airborne pollutants from a variety of minor pollutant-emitting sources, such as stacks, 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.

3.5.1.7 Hazardous Air Pollutants (Nonradionuclide)

Unplanned releases of hazardous air pollutants (HAPs) are regulated through the risk management planning regulations under 40 CFR Part 68. 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 (HMIS) chemical inventories at ETTP with the risk management plan (RMP) threshold quantities listed in 40 CFR 68.130 was conducted. This is an ongoing action that documents the potential applicability for maintaining and distributing an RMP and to ensure 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, Sect. 112(r), "Prevention of Accidental Releases." The results of this review indicated that all RMP-listed chemicals were less than 1% of their specific trigger thresholds. Therefore, activities at ETTP are not subject to the rule. Procedures are in place 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 of air contaminant emissions from ETTP operations on ambient air quality.

The sampling stations in the ETTP area are designated as base, supplemental, or ORR perimeter air monitoring (PAM) stations. Figure 3.12 shows the locations of all ambient air sampling stations in and around ETTP that were active during the 2016 reporting period. Figure 3.13 shows an example of a typical ETTP air monitoring station.

The base program consists of two locations using high-volume, ambient air samplers. Supplemental locations are typically temporary, project-specific stations. Historically, the project-specific samplers are the same high-volume systems used for the base program. All base, supplemental, and PAM samplers operate continuously with exposed filters collected weekly. The radiological monitoring results for samples collected at the two ETTP area PAM stations were provided by UT-Battelle, LLC (UT-Battelle) staff and are included in the ETTP network for comparative purposes.

The analytical parameters were chosen with regard to existing and proposed regulations and with respect to activities at ETTP. A principle reason for supplemental stations K11 and K12 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 onsite members of the public. K12 remained a key sampling location regarding the potential dose impact on the most exposed individual (MEI), who is a member of the public during the demolition of K-27, which was the last gaseous diffusion building on the ETTP site.

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 emissions controls, a survey of all onsite tenants is reviewed every 6 months through a request for the most recent ETTP reindustrialization map.

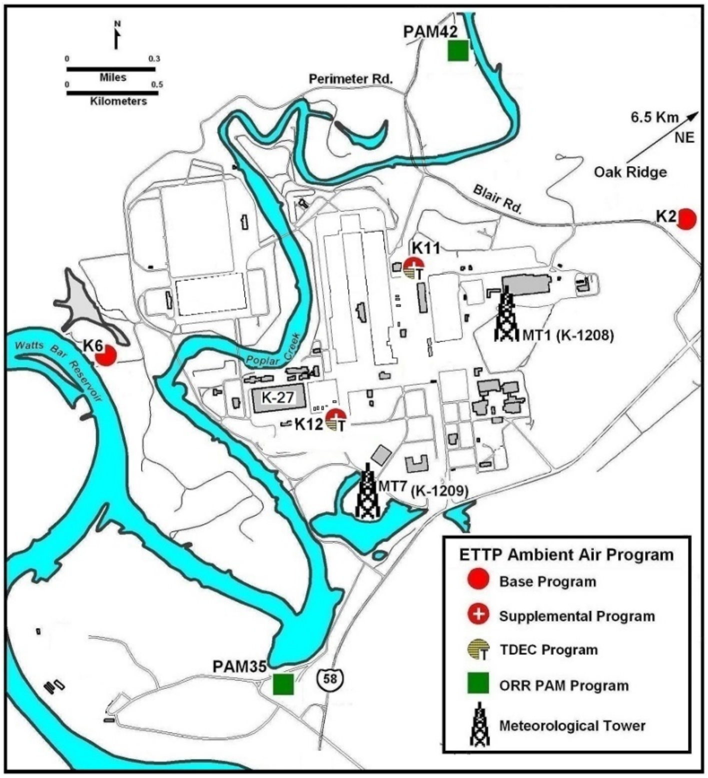

Fig. 3.12. East Tennessee Technology Park ambient air monitoring station locations.
(ETTP = East Tennessee Technology Park, MT = meteorological tower, ORR = Oak Ridge Reservation, PAM = perimeter air monitoring, TDEC = Tennessee Department of Environment & Conservation, and TSCAI = Toxic Substances Control Act Incinerator)

Fig. 3.13. East Tennessee Technology Park ambient air monitoring station.

All base and supplemental stations collected continuous samples for radiological and selected metals analyses during 2016. Inorganic analytical techniques were used to test samples for chromium (Cr) and lead (Pb). Radiological analyses of samples from the ETTP stations test for the isotopes ^{99}technetium (^{99}Tc), ^{234}uranium (^{234}U), ^{235}uranium (^{235}U), and ^{238}uranium (^{238}U); ORR station sampling results for ^{234}U, ^{235}U, and ^{238}U provided by UT-Battelle are included with the ETTP results.

Figures 3.14 and 3.15 illustrate the ambient air concentrations of chromium and lead for the past 5 years, based on quarterly composites of weekly continuous samples. All samples were analyzed by the inductively coupled plasma-mass spectrometer (ICP-MS) analytical technique. The results are compared with applicable air quality standards for each pollutant. The annualized levels of Cr and Pb during 2016 were well below the indicated annual standards. Stations K2 and K6 are in the prevailing topography of influenced upwind and downwind directions that are for identifying the impact to offsite members of the public. Stations K11 and K12 are located to provide a conservative measurement of the impact to onsite members of the public. Sampling results for Cr and Pb have periodically trended higher due to the proximity to major demolition sites, service roads for transporting debris, other demolition machinery, and railroad operations. Cr variations have been coincidental to activities associated with the removal of the gaseous diffusion building concrete pads. Pb variations are most likely due to the close proximity of the exhaust of diesel-burning equipment and vehicles.

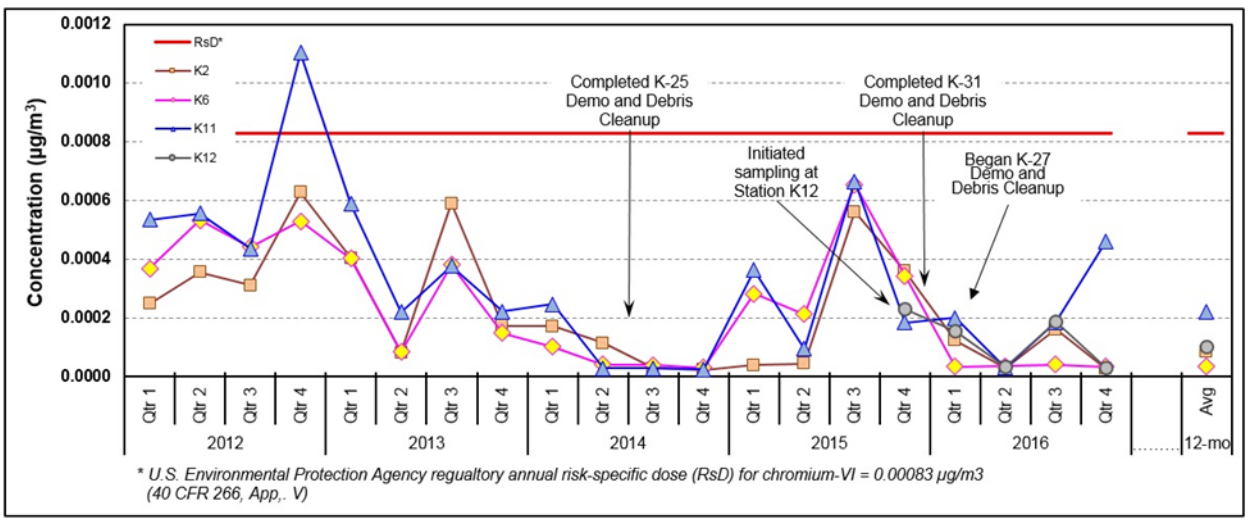

Fig. 3.14. Chromium monitoring results: 5-year history through December 2016. *(Demo = demolition)*

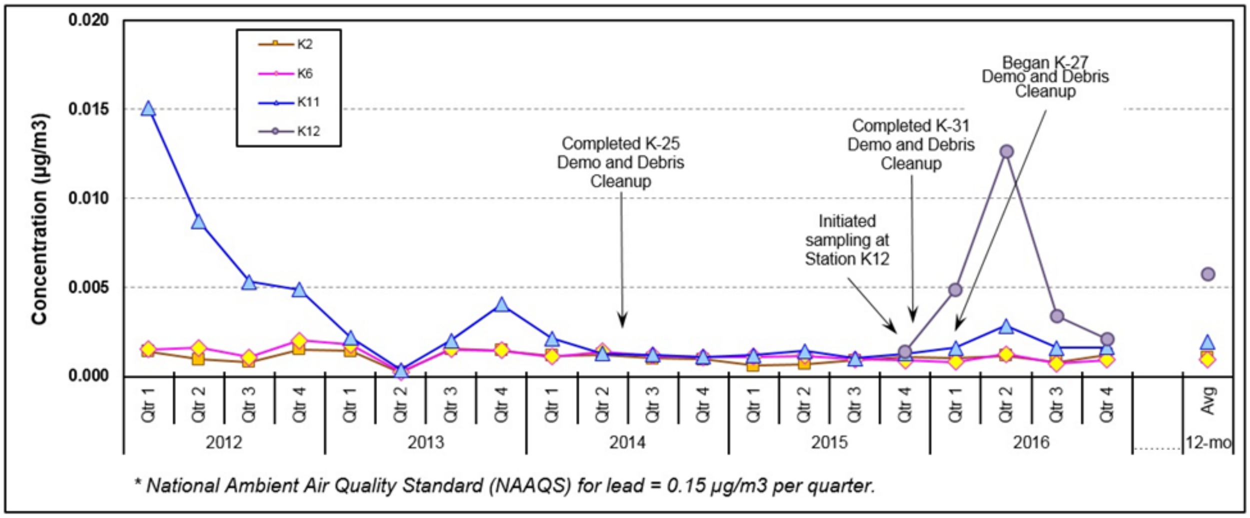

Fig. 3.15. Lead monitoring results: 5-year history through December 2016. *(Demo = demolition)*

Quarterly radiochemical analyses are performed on composite samples collected at all stations. The selected isotopes of interest were ^{99}Tc, ^{234}U, ^{235}U, and ^{238}U. The concentration and dose results for each of the nuclides are presented in Table 3.4 for the 2016 reporting period.

Table 3.4. Radionuclides in ambient air at East Tennessee Technology Park, January 2016 through December 2016

Station	Concentration (µCi/mL)				
	^{99}Tc	^{234}U	^{235}U	^{238}U	
K2[a]	1.78E-15	4.11E-18	6.92E-19	4.59E-20	
K6[a]	1.53E-15	4.22E-17	2.35E-18	3.46E-18	
K11[b]	2.27E-15	5.42E-17	4.93E-18	8.49E-18	
K12[b]	4.19E-15	1.55E-16	1.10E-17	2.76E-17	
	40 CFR 61, Effective Dose (mrem/year)				Total Dose
K2[a]	0.05	<0.001	<0.001	<0.001	0.05
K6[a]	0.04	0.005	<0.001	<0.001	0.05
K11[b]	0.03	0.003	<0.001	<0.001	0.03
K12[b]	0.05	0.009	0.001	0.001	0.07

[a]K2 and K6 results represent a residential exposure,

[b]K11 and K12 represent an onsite business exposure equivalent to ½ of a yearly exposure at this location.

The 2016 annual dose impact as listed in Table 3.4 show that Stations K2, K6, K11, and K12 have equivalent results. The doses associated with air monitoring stations K2 and K6 were approximately 0.05 mrem, and for air monitoring stations K11 and K12 the estimated doses were 0.03 mrem and 0.07 mrem, respectively. Stations K11 and K12 are near onsite businesses, therefore the estimated doses based upon residential exposures were divided by 2 to account for occupational exposures following approved procedures. This conservatively assumes that the onsite member of the public is at his or her workstation for half of the year. The isotopic details that were measured at the ambient air monitoring stations show that the most significant dose contributor was ^{99}Tc with the percent contribution ranging between 75.2% (K12) to 98.1% (K2). The remainder of the dose contribution was attributed to ^{234}U, ^{235}U, and ^{238}U. Data show that all measurements were well below the 10 mrem annual dose limit.

Figure 3.16 is a historical summary chart of dose calculation results. Each data point represents the accumulated dose over the previous four quarterly sampling periods. The highest potential dose impact over a 12-month rolling period for an individual over the most recent 5-year period and working in the vicinity of Station K11 would only be 0.37 mrem as compared to the annual limit of 10 mrem. For calendar year 2016, the dose impact was only 0.03 mrem. The onsite location of Station K12 was in close proximity to major demolition and debris removal activities that impacted radiologically contaminated materials. The dose at K12 was only 0.07 mrem. All data continue to show potential exposures are all well below the 10 mrem annual dose limit.

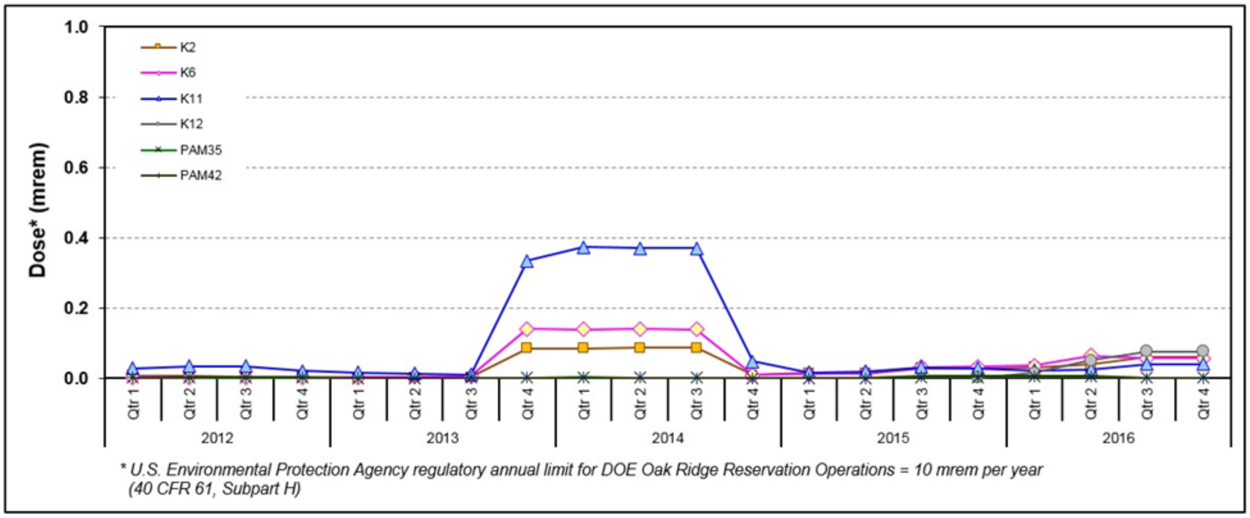

Fig. 3.16. Dose impact results: 5-year history through December 2016.

3.6 Water Quality Program

3.6.1 NPDES Permit Description

The latest ETTP NPDES permit became effective on April 1, 2015. It is scheduled to expire on March 31, 2020. As part of the requirements of the current ETTP NPDES permit, storm water outfalls will no longer be divided into two groups based on the types of flows being discharged through the outfalls. All outfalls will now be combined into a single group. A total of 27 representative outfalls will be monitored on an annual basis for oil and grease, total suspended solids (TSS), pH, and flow. Outfall 170 will be monitored quarterly for total chromium and hexavalent chromium. ETTP NPDES permit monitoring requirements for storm water outfalls are shown in Tables 3.5 and 3.6.

Table 3.5. Representative outfalls

(Outfalls 05A, 100, 142, 150, 170, 180, 190, 195, 198, 230, 280, 294, 334, 350, 430, 490, 510, 560, 660, 690, 694, 700, 710, 724, 890, 930, and 992)

Parameter	Qualifier	Value	Unit	Sample Type	Frequency	Statistical Base
Flow	Report	-	million gallons per day (MGD)	Estimate	Annual	Daily Maximum
Oil & Grease	Report	-	mg/L	Grab	Annual	Daily Maximum
Total Suspended Solids (TSS)	Report	-	mg/L	Grab	Annual	Daily Maximum
pH	≥ 6.0 and ≤ 9.0	-	SU	Grab	Annual	Daily Minimum and Daily Maximum

Table 3.6. Storm water Outfall 170 for chromium monitoring

Parameter	Qualifier	Unit	Sample Type	Frequency	Report
Chromium, hexavalent (as Cr)	Report	mg/L	Grab	Quarterly	Daily Maximum
Chromium, total (as Cr)	Report	mg/L	Grab	Quarterly	Daily Maximum

In addition to periodic monitoring requirements specified in the ETTP NPDES permit, several additional monitoring efforts have been included to support the CERCLA actions that are ongoing at ETTP. This monitoring will be conducted as part of the Storm Water Pollution Prevention (SWPP) Program and/or the ETTP Biological Monitoring and Abatement Program (BMAP).

1. Flux Monitoring

   For bioaccumulative pollutants such as mercury, a long-term monitoring of pollutant loadings (known as flux) will be conducted. This flux monitoring shall include the following:

   - Flow Monitoring

     Selected outfalls will include Outfalls 100, 170, 180, and 190, using field-installed flow meters to gauge flows for the following ranges of rain events at least once during the permit term at each outfall:

     - 0.1–0.5 in. rain event
     - 0.5–1.5 in. rain event
     - 1.5 in. or greater rain event

     These flows will be used to compare against flows generated using the Natural Resources Conservation Service (NRCS) Technical Report-55 (TR-55), the current flow modeling technique used at ETTP, to increase the accuracy of the TR-55 flow modeling process. Given that the flow monitoring will occur over a variety of rain events, and multiple field variables can pose problems in collecting usable data, this monitoring shall be completed any time during the permit period.

- Mercury Monitoring

  Mercury will be sampled at Outfalls 180 and 190 using the flow-weighted sampling technique. Specific sample collection guidelines will be included as part of upcoming SWPP Program Sampling and Analysis Plans (SAPs).

- Flux Calculation

  Flow monitoring results will be used to calibrate the variable inputs to the TR-55 flow model, which will then be used with the flow-paced mercury sampling results to determine mercury flux at the respective outfalls.

2. Remedial Activities, CERCLA, and Legacy Pollutant Monitoring

   - Storm water samples will be collected at locations that will be affected by RA activities prior to the initiation of these activities in order to determine the conditions present before remediation begins. In addition, storm water samples will be collected at potentially affected outfalls and storm water catch basins after remedial activities have been undertaken, and after they have been completed, to help gauge the effectiveness of the remediation efforts.
   - The results of the monitoring effort at the D&D sites, which are a subset of remedial activities, will be utilized in determining the effectiveness of BMPs in controlling offsite releases of legacy pollutants.
   - Periodic monitoring will be performed as part of the ETTP SWPP Program to monitor the continued effectiveness of the chromium collection system.

3. Permit Renewal Sampling

   - Sampling required for the completion of the NPDES permit application was initiated in fiscal year (FY) 2015 as part of the ETTP SWPP Program. The application for this permit renewal is required to be submitted to TDEC by October 1, 2019, to allow TDEC 180 days to review it prior to permit expiration on March 31, 2020. Additionally, DOE will require time to review the permit application before it is submitted to TDEC. Based on previous TDEC guidance, composite samples will be collected as time-weighted composites due to the short travel time for storm water runoff in the storm-drain piping system and to site conditions within the watersheds. Monitoring will be conducted to ensure all required samples are collected to complete the EPA Form 2E, Application Form 2E—*Facilities Which Do Not Discharge Process Wastewater*; and EPA Form 2F, *Application for Permit to Discharge Storm Water Discharges Associated with Industrial Activity*. The following sampling will be conducted:
     - Representative outfalls meeting the requirements to complete an EPA Form 2E will be sampled. Parameters that must be collected by grab sample, per analytical method or regulatory guidance will be collected as a grab sample only. All other required parameters will be collected as time-weighted composites only.
     - Representative outfalls will be sampled to ensure completion of EPA Form 2F, Sect. VII, Discharge Information, Parts A, B, and C, as follows:
       - Part A—Required parameters will be collected as required. Oil and grease, total nitrogen, total phosphorus, and pH will collected as grab samples per EPA guidance. Biochemical oxygen demand, chemical oxygen demand, and TSS will be collected as either grab samples or as time-weighted composites.

  - Part B—All facilities generating process wastewater at ETTP have been closed, and the respective NPDES permits have expired. Therefore, ETTP is no longer subject to any effluent guidelines, and there are no sampling requirements under Part B at any storm water outfall at ETTP.
  - Part C—Each representative storm water outfall will be sampled only for pollutants that could potentially be present based on the characteristics and uses of the drainage area for that outfall. The potential pollutants to be considered for monitoring are shown in Tables 2F-2, 2F-3, and 2F-4. Based upon historical site knowledge and analytical monitoring results, metals, mercury, and PCBs will be collected from all representative outfalls. In addition, each representative outfall will be evaluated, and VOCs, radionuclides, and other selected parameters will be collected from the representative outfalls as required. Part C parameters that must be collected by grab sample, per analytical method or regulatory guidance, will be collected as grab samples only. All other Part C parameters will be collected as time-weighted composites only.

4. Investigative Sampling
   - Investigative sampling will be performed as part of the ETTP SWPP Program. This will include sampling of storm drain networks for bioaccumulative parameters and investigations triggered by analytical results, CERCLA requirements, changes in site conditions, etc. (UCOR-4028/R5, *East Tennessee Technology Park Storm Water Pollution Prevention Program Sampling and Analysis Plan).*
   - Storm water sampling results will be reviewed and evaluated to provide feedback for the next round of investigative sampling, generate suggested modifications and improvements to storm water runoff controls, and provide input for CERCLA project cleanup decisions.

3.6.2 Storm Water Pollution Prevention Program

3.6.2.1 Radiologic Monitoring of Storm Water

ETTP conducts radiological monitoring of storm water discharges to determine compliance with applicable dose standards. ETTP also applies the as low as reasonably achievable (ALARA) process to minimize potential exposures to the public. Sampling for gross alpha and gross beta radioactivity, as well as specific radionuclides, is conducted as part of the ongoing SWPP Program sampling efforts. Analytical results are used to estimate the total discharge of each radionuclide from ETTP via the storm water discharge system.

As part of the ETTP SWPP SAP, storm water samples were collected from discharges that occurred after a storm event that (1) was greater than 0.1 in. in 24 h, and (2) occurred at least 72 h after a rain event greater than 0.1 in. in 24 h. No specified dry period was required before the samples were taken. A series of at least 3 manual grab samples of equal volume were collected during the first 60 min of a storm event discharge, and combined into a composite sample.

Table 3.7 contains information on the outfalls that were sampled for radiological discharges. Table 3.8 contains the results of this sampling effort. No radiological screening criteria were exceeded at these outfalls. Screening levels for individual radionuclides are established at 4% of the DCS values listed in DOE Standard 1196 (DOE 2011). Table 3.9 lists the cumulative activity levels of each of the major isotopes that were discharged from the overall ETTP water system in 2016.

Table 3.7. Storm water composite sampling for radiological discharges

Storm water outfall	Gross alpha/ gross beta (composite sample)	U isotopic (composite sample)	^{99}Tc (composite sample)
200	X	X	X
240	X	X	X

Table 3.8. Analytical results for radiological monitoring at ETTP storm water outfalls in 2016

Parameter	Screening Level	Outfall 200	Outfall 240
Alpha activity (pCi/L)	10	1.15 U	3.57 U
Beta activity (pCi/L)	30	2.49 U	4.77
^{99}Tc (pCi/L)	1760	3.31 U	3.89 U
$^{233/234}$U (pCi/L)	28	0.598	3.32
$^{235/236}$U (pCi/L)	29	–0.0191 U	0.162 U
^{238}U (pCi/L)	30	0.243 U	0.684

Table 3.9. Radionuclides released to offsite waters from the ETTP storm water system in 2016 (Ci)

Isotope	^{234}U	^{235}U	^{238}U	^{99}Tc
Activity level	0.0033	0.00034	0.0018	0.21

3.6.2.2 Post-Demolition Monitoring for the K-731 Switch House D&D

The K-732 Switchyard is a level, gravel-covered yard approximately four acres in size that is fenced on three sides. The K-732 Switchyard is bounded by the K-731 Switchhouse area to the north. The gravel layer covering the switchyard is approximately 18 in. thick. It was put into place as a containment measure for any spills. The switchyard was originally constructed in 1944 to provide electrical power to the K-27 Process Building. It later became the receiving point for TVA power at 161 kV and supplying 13.8 kV power to the ETTP site. The adjacent K-731 Switchhouse received power from the K-732 Switchyard via underground conduits. The switchyard contains a number of below-grade vaults and pits with conduits for electrical and communication cables. Use of the switchyard was phased out over the years and the yard was completely shut down in 2011. Electricity to ETTP is now provided by COR.

UCOR conducted the demolition of the K-731 Switchhouse, and the demolition of the K-732 Switchyard structures and equipment was contracted by DOE to CTI and Associates of Kansas City, Missouri. The projects included the recovery and recycling of metals and material assets.

Two sumps are located in the basement of the K-731 Switchhouse.

- Sump S-053 discharges to Sump S-054.
- Sump S-054 discharges to storm water Outfall 430.

An additional five sumps (Sumps S-055, S-056, S-057, S-058, and S-059) are located in the K-732 Switchyard.

- Sump S-055 collects water from Valve Vault 2 in the K-731 Switchyard.
- Sump S-056 collects water from Valve Vault 3 in the K-731 Switchyard.
- Sump S-057 collects water from Synchronous Condenser 101.
- Sump S-058 collects water from Synchronous Condenser 102.
- Sump S-059 collects water from Synchronous Condenser 103.

Five of these sumps discharge to Outfall 440. A portion of the south side of the switchyard discharges to storm water Outfall 440, as well. This discharge to Outfall 440 includes surface runoff from paved sections of the switchyard area as well as infiltration through the gravel portion of the switchyard area. The K-731/K-732 sumps and the drainage system from this area to Outfalls 430 and 440 are shown in Fig. 3.17.

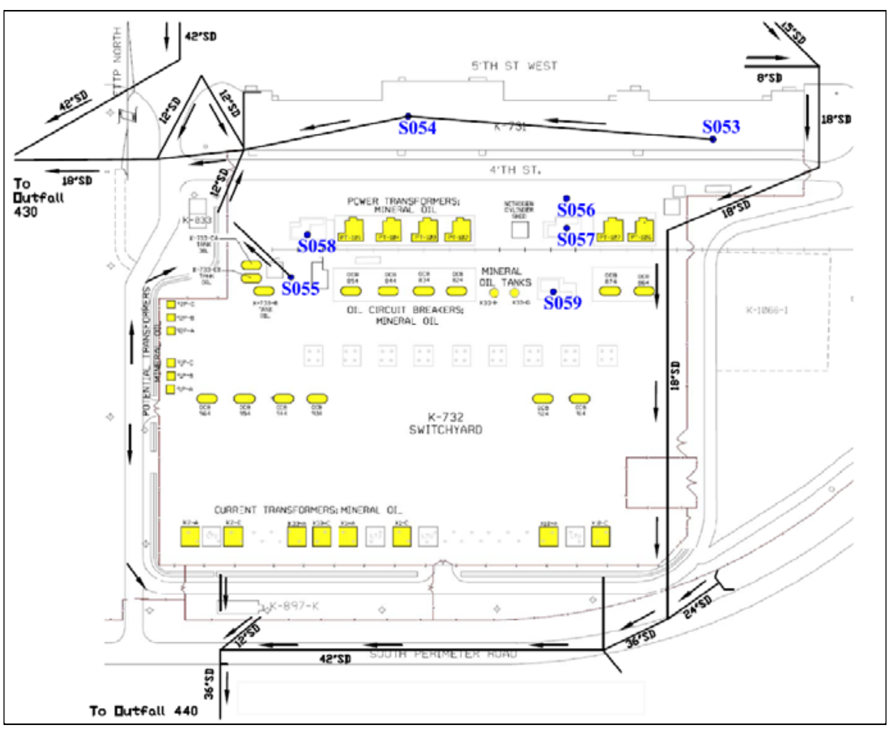

Fig. 3.17. K-731 Switchhouse and K-732 Switchyard draining system.

Outfall 430 was sampled on several occasions as part of the D&D of the K-27 building and the K-731 Switchhouse, since storm water runoff from both of these locations discharges through this outfall and portions of the D&D activities were being performed concurrently. Analytical data from samples of storm water from Outfall 430 are shown in Table 3.10.

On November 30, samples were collected from Outfall 440 to determine if water from Sumps S-055, S-056, S-057, S-058, and S-059, or from other portions of the K-732 Switchyard area, could be adversely affecting the discharge from the outfall. PCBs, metals, radiological parameters, and mercury were sampled in each of these sampling events. No results over screening levels were detected in samples collected from Outfall 440.

The K-732 Switchyard D&D required the electrical cables located in the basement of Building K-731 Switchhouse to be disconnected. Historically, the basement of Building K-731 has experienced water infiltration issues, and two sump pumps located in the east and west ends of the basement have transferred the water to the storm water system. In 2014, the sump pumps stopped operating, and the water accumulated in the basement at levels of up to 8 ft. In order to support the K-732 D&D efforts, and allow characterization of the basement under the *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2161&D2 [Zone 2 Record of Decision (ROD)], and to repair the sump pumps, approximately 1 million gallons of water were pumped from the basement and discharged to the Outfall 430 drainage network.

The water in the Building K-731 basement was sampled, and the results showed low levels of metals and radionuclides. However, the basement water was allowed to be pretreated and discharged to the storm drain system based on the following criteria:

- The water was below the sum of fractions (SOF) of the Derived Concentration Guide (DCG) listed in DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*
- The water is not a listed or characteristic hazardous waste.
- The untreated water met all TDEC ambient water quality criteria except for PCB-1260.
- The water met the TSCA concentrations for the unrestricted use of water, which allows discharge to the storm drain system.

The water from the basement of Building K-731 was discharged to Poplar Creek, an impaired stream for PCBs and mercury, via the ETTP storm water network at Outfall 430. Prior to discharge, the water was treated for PCBs and mercury to meet the TDEC ambient water quality criteria (AWQC) and antidegradation requirements as follows:

- The water was filtered using 25, 10, and 5 μm filters to remove suspended solids.
- The water was treated for PCBs and mercury using activated carbon columns (accepted Best Available Technology for PCB and mercury removal).
- The water was treated with a polishing filter using a 5 μm filter to capture fines from the carbon treatment unit.
- The effluent was treated to a level that will result in the surface water not exceeding 0.00064 ng/L for PCBs and 0.51 ng/L mercury.

Discharge of the water from the basement of K-731 was conducted in May and June 2016. None of the water that was discharged as part of this activity exceeded the stated discharge criteria.

Demolition of the K-731 Switchhouse was completed in the fourth quarter of CY 2016. Samples were collected from Outfalls 430 and 440 on December 12, 2016, as part of the ETTP SWPP Program sampling effort. These samples were collected after D&D activities at K-731were completed. No results over screening levels were detected in samples collected from either outfall.

3.6.2.3 D&D of the K-27 Building

Initial sampling was performed in CY 2015 at Outfalls 380 and 430 and in Poplar Creek near Outfall 460 to provide baseline data for conditions before demolition of the K-27 Building began in February 2016. During demolition activities, samples were collected at Outfalls 380 and 430 and at Poplar Creek near Outfall 460 after each rain event of 1 in. or more. The outfall sampling was weather dependent, and samples were collected any time storm water runoff was observable in the area where D&D activities were being conducted. The criteria for storm event sampling utilized for other SWPP Program sampling did not have to be met for this sampling effort.

Table 3.10 contains information on the locations and parameters that were sampled as part of the K-27 D&D monitoring effort.

Table 3.10. Storm water sampling to support D&D of the K-27 Building

Sampling location	Sampling frequency	pH	Gross alpha/beta	U Isotopic, ^{99}Tc	PCBs[a] (individual Aroclors® and total PCBs)	Metals[b]/ Mercury	Hexavalent chromium
Outfall 380	Prior to initiation of building demolition activities After each rain event of 1 in. or more in a 24-h period. Upon completion of D&D activities	X	X	X	X	X	X
Outfall 430	Prior to initiation of building demolition activities After each rain event of 1 in. or more in a 24-h period. Upon completion of D&D activities	X	X	X	X	X	X
Poplar Creek instream @ Outfall 460	Prior to initiation of building demolition activities After each rain event of 1 in. or more in a 24-h period. Upon completion of D&D activities	X	X	X	X	X	X

[a] PCB analysis includes: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268. Total PCBs will also be reported as part of the analytical data package.

[b] Metals analysis includes: Al, Ag, As, Ba, Be, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn.

Samples were collected on February 16, 2016, at Outfalls 380 and 430; and in Poplar Creek near Outfall 460, after a rain event of approximately 2.1 in. had occurred. Table 3.11 shows the parameters that exceeded screening criteria as part of this sampling event.

Samples were collected on April 1, 2016, at Outfalls 380 and 430 and in Poplar Creek near Outfall 460 after a rain event of approximately 1.55 in. had occurred. Table 3.11 shows the parameters that exceeded screening criteria as part of this sampling event.

Samples were collected on July 6, 2016, at Outfall 430 and in Poplar Creek near Outfall 460 after a rain event of approximately 1.12 in. had occurred. Outfall 380 did not flow during this storm event and could not be sampled. Table 3.11 shows the parameters that exceeded screening criteria as part of this sampling event.

Samples were collected on August 19, 2016, at Outfalls 380 and 430, and in Polar Creek near Outfall 460, after a rainfall of approximately 0.95 in. Table 3.11 shows the parameters that exceeded screening criteria as part of this sampling event.

Table 3.11. Results over screening levels for Building K-27 D&D monitoring

Sampling Location	Gross Alpha (pCi/L)	Thallium (µg/L)	Lead (µg/L)	Cadmium (µg/L)	PCB-1260 (µg/L)	Mercury (µg /L)	Hexavalent chromium (µg/L)	Selenium (µg/L)
Screening Level	10	7.5	1.8	Detectable	Detectable	25	8	3.8
OUTFALL 380								
2/16/16	36.9	0.457	11.2	0.169				
4/1/16	41.4	1.55	7.87					
7/6/16								
8/19/16	18.7		17.4					
11/30/16								
OUTFALL 430								
2/16/16			4.43					
4/1/16		0.463	3.88		0.0581			
7/6/16							12	
8/19/16							12	
11/30/16			5.09					
12/12/16								
INSTREAM POPLAR CREEK @ OUTFALL 460								
2/16/16			5.37	7.55		1120		
4/1/16			2.8	1.09		273		
7/6/16				6.4		72		
8/19/16				0.225		84.6		
11/30/16						244		9.05
12/12/16						335		

On November 30, 2016, and December 12, 2016, sampling was conducted after rainfalls of 4.4 in. and 0.96 in., respectively. Samples were collected at Outfalls 380 and 430, and in Poplar Creek near Outfall 460. However, due to low flows at Outfall 380, only samples for ^{99}Tc were collected at this location. Table 3.11 shows the results that exceeded screening criteria at the other two locations. While it is possible that the lead, thallium, gross alpha, and PCB-1260 screening level exceedances at Outfalls 380 and 430 may be related to the D&D of the K-27 Building, the mercury detected in instream samples collected in Poplar Creek may likely be more due to historical releases of mercury from upstream operations into East Fork Poplar Creek, which discharges into Poplar Creek north of ETTP.

3.6.2.4 D&D of the K-25 Building

To collect data for trend graphs in the Remediation Effectiveness Report (RER) and ASER, and to collect data that can be compared with information gathered by TDEC on an ongoing basis, a sample for ^{99}Tc will be collected at Outfall 190 each time a quarterly mercury sample is collected. The analytical data from this sample will assist in determining if ^{99}Tc-contaminated groundwater from the K-25 D&D project could be migrating to the Outfall 190 drainage area and then discharging into Mitchell Branch. Table 3.12 contains information on ^{99}Tc levels detected in discharges from Outfall 190 since the first quarter of CY 2015.

Table 3.12. Quarterly ^{99}Tc sampling at Outfall 190

Sampling location	^{99}Tc (pCi/L)* 3/19/15	^{99}Tc (pCi/L)* 5/11/15	^{99}Tc (pCi/L)* 8/3/15	^{99}Tc (pCi/L)* 11/2/15	^{99}Tc (pCi/L)* 1/12/16	^{99}Tc (pCi/L)* 4/19/16	^{99}Tc (pCi/L)* 7/11/16	^{99}Tc (pCi/L)* 10/17/16
Outfall 190	33.1	27.7	14.4	15.9	13.4	6.37 U	4.21 U	3.26 U

*^{99}Tc results are provided as a reference. They do not exceed screening criteria.

From this data, it does not appear that ^{99}Tc contaminated groundwater is discharging at significant levels to Mitchell Branch via Outfall 190.

3.6.2.5 Mercury Investigation Monitoring

ETTP conducted activities involving mercury, including use and handling of manometers, switches, mass spectrometers, mercury diffusion pumps, mercury traps, and laboratory operations. ETTP also processed and stored large quantities of mercury-bearing wastes from the onsite gaseous diffusion (GD) plant operations and support buildings, Oak Ridge National Laboratory (ORNL), and Y-12. Mercury from soils and spill cleanups was processed on site as well. Mercury recovery operations were conducted in a number of buildings, many of which were located in watersheds that discharged primarily to Mitchell Branch.

It was subsequently found that mercury levels exceeding the 51 ng/L AWQC at ETTP were identified in the Mitchell Branch watershed , as well as in a number of storm water outfalls, surface water locations, and groundwater monitoring wells at ETTP. Knowledge of known historical mercury processes at the facility has increased substantially during remedial action investigations. This has led to an ongoing storm water network investigation to more precisely detect and quantify the extent of any mercury contamination that may exist.

Factors considered as part of the mercury investigation include weather conditions (wet vs. dry), RA activities (before, during, and after demolition of ETTP facilities), and types of monitoring locations chosen for sampling (in-stream, outfall, ambient, catch basin). For the purpose of the investigation activities, a dry weather period was defined at least 72 h after a storm event of 0.1 in. or more. Wet weather conditions were defined as a storm event greater than 0.1 in. that occurs within a time period of 24 h or less and which occurs at least 72 h after any previous rainfall greater than 0.1 in. in 24 h. In addition, manual grab samples were defined as samples collected according to the guidelines specified in

Sects. 3.1.2 and 3.3.1 of EPA 833-B-92-001, *NPDES Storm Water Sampling Guidance Document,* and applicable procedures that have been developed by the sampling subcontractor, Restoration Services Inc (RSI).

ETTP Monitoring Programs

Several monitoring programs collected mercury data across ETTP at various locations during CY 2016. Samples were collected as specifically defined in the NPDES permit and as part of the SWPP Program. In addition, samples were also collected as part of the Environmental Monitoring Program (EMP) and in support of D&D activities.

As part of the previous NPDES permit compliance program, mercury was sampled on a quarterly basis at Outfalls 05A, 170, 180, and 190. These four locations were selected because information gathered as part of the permit application process indicated that mercury levels at these sites occasionally exceeded the AWQC level of 51 ng/L. Outfalls 170, 180, and 190 collect storm water from large areas on the north side of ETTP and discharge to Mitchell Branch. Outfall 05A is the discharge point for the former sewage treatment plant drainage basin into Poplar Creek on the east side of ETTP. The NPDES permit that took effect on April 1, 2015, no longer requires quarterly mercury monitoring. However, to continue collecting data for the analysis of trends in mercury discharges from these outfalls, quarterly mercury sampling will be conducted as part of the ETTP SWPP Program, as indicated in Table 3.13. Because mercury has not been detected at Outfall 170 at levels over the AWQC of 51 ng/L for several years, Outfall 170 will not be sampled as part of this SWPP Program effort. Data from this sampling effort will be used as part of the RER, and may provide information that can be used in upcoming CERCLA cleanup decisions.

Table 3.13. Mercury sampling at storm water outfalls sampled under previous NPDES permit

Sampling Location	Parameter	Measurement frequency	Sample type
Outfall 05A	Mercury	1/quarter	Grab
Outfall 180	Mercury	1/quarter	Grab
Outfall 190	Mercury	1/quarter	Grab

Table 3.14 contains analytical data from mercury sampling performed at Outfalls 170, 180, 190, and 05A during CYs 2015 and 2016. Samples collected during the first and second quarters of CY 2015 were collected as part of the requirements of the ETTP NPDES permit that was in effect at that time. Mercury samples collected since that time were taken as part of the requirements of the ETTP SWPP Program.

Table 3.14. Quarterly NPDES/SWPP Program mercury monitoring results—CY 2015 and 2016

Sampling location	1st Quarter CY 2015 (ng/L)	2nd Quarter CY 2015 (ng/L)	3rd Quarter CY 2015 (ng/L)	4th Quarter CY 2015 (ng/L)	1st Quarter CY 2016 (ng/L)	2nd Quarter CY 2016 (ng/L)	3rd Quarter CY 2016 (ngL)	4th Quarter CY 2016 (ng/L)
Outfall 170**	4.1	25.6	-----	-----	-----	-----	-----	-----
Outfall 180	**219**	**53.1**	50.8	**99.3**	27.1	31.3	**123**	**177**
Outfall 190	20.3	11.1	16.7	**55.6**	12.9 **(96.5)*****	35	16.4	17.6
Outfall 05A	**67.4**	**132**	**148**	**185**	**86.4**	**105**	**126**	**459**

*Results in **bold** exceed the AWQC for mercury (51 ng/L)

**Quarterly mercury samples were not collected at Outfall 170 after March 2015.

***Sample result was from a special flow-proportional sample collected as part of the mercury flux study.

Mercury levels at Outfalls 180, 190, and 05A continue to fluctuate over time, but frequently remain above the AWQC. This is likely due to the transport of mercury-contaminated sediments in these drainage networks by storm water flow. Data from this sampling effort will be used as part of the RER and may provide information for upcoming CERCLA cleanup decisions.

Figures 3.18 through 3.21 represent the mercury levels at the surface water K-1700 Weir and at storm water Outfalls 170, 180, 190, and 05A from CY 2010–present. The outfall sampling results are from quarterly sampling performed as part of the quarterly NPDES permit compliance/quarterly SWPP Program sampling, NPDES permit renewal sampling, D&D sampling, and other mercury sampling performed at these outfalls.

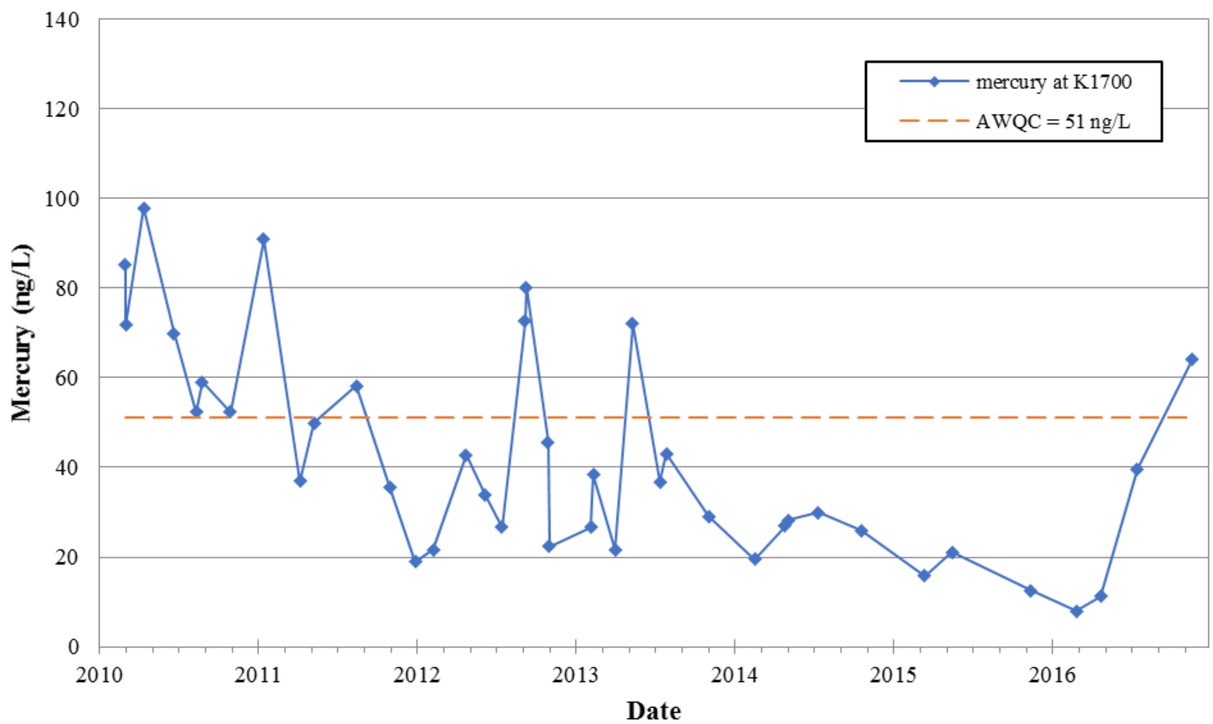

Fig. 3.18. Mercury concentrations at Surface Water Location K-1700

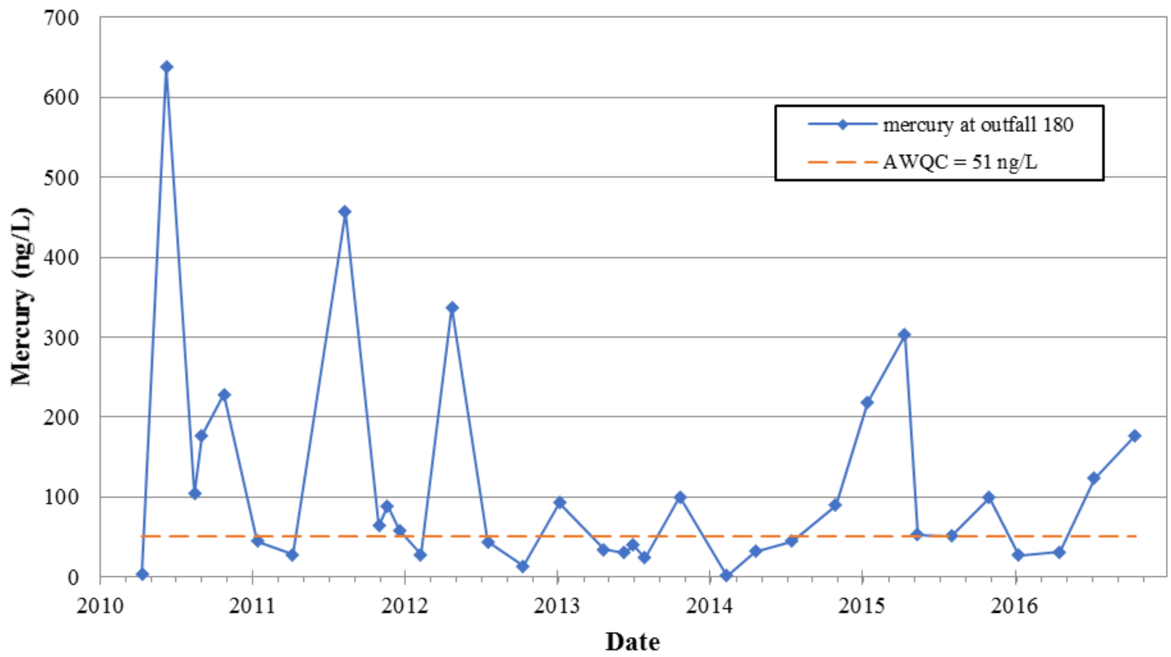

Fig. 3.19. Mercury concentrations at Outfall 180.

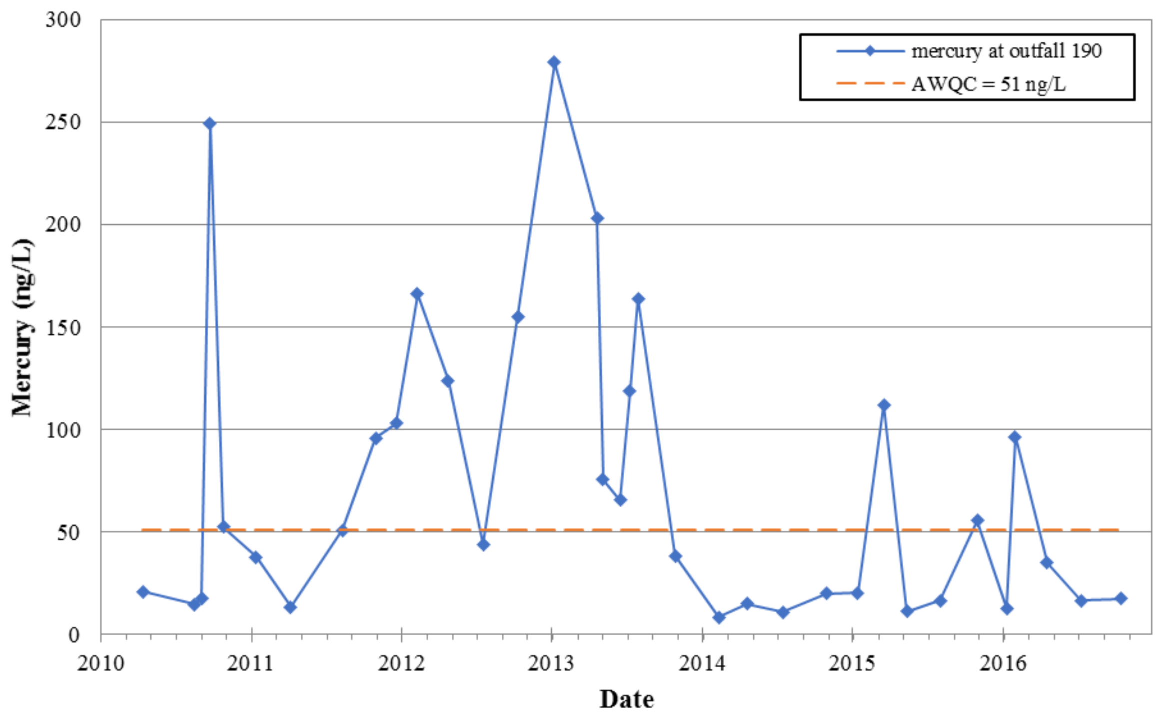

Fig. 3.20. Mercury concentrations at Outfall 190.

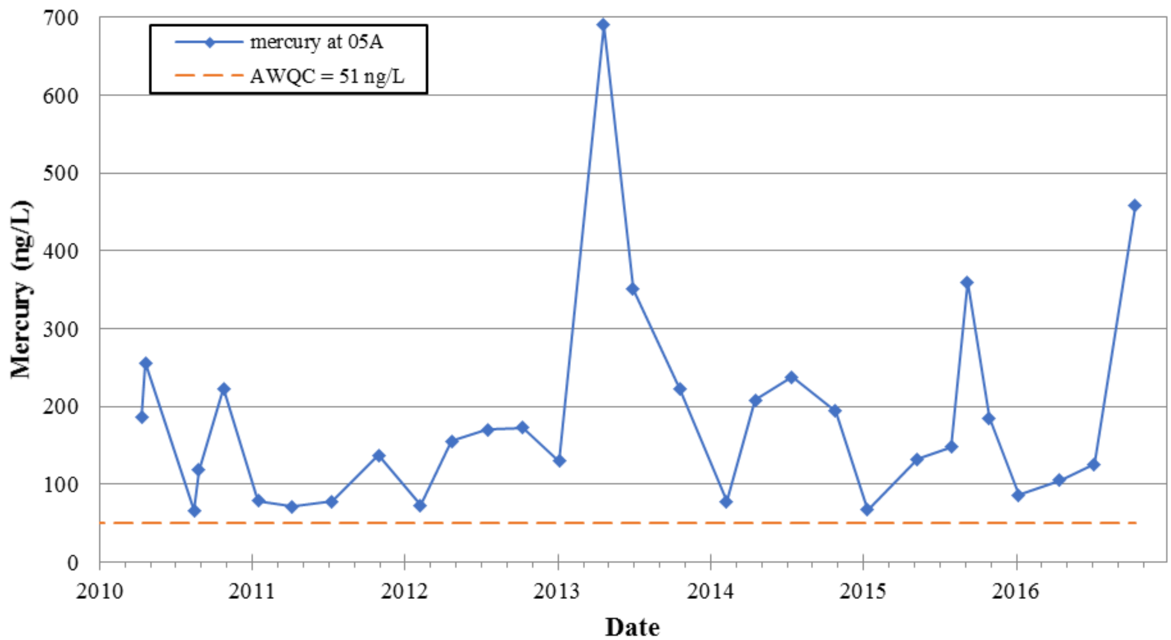

Fig. 3.21. Mercury concentrations at Outfall 05A.

NPDES Permit Renewal Sampling

Mercury has been sampled at several outfalls as part of the NPDES permit renewal process. None of the mercury results for these samples exceeded the AWQC of 51 ng/L with the exception of Outfall 230, which had a mercury level of 129 ng/L. The results of the NPDES permit renewal mercury sampling are in Table 3.15.

Table 3.15. NPDES permit renewal sampling-mercury results

Sampling location	Mercury (ng/L)
Outfall 230	**129**
Outfall 430	16.8
Outfall 490	14.9
Outfall 560	20
Outfall 724	7.27

3.6.2.6 PCB Monitoring at ETTP Storm Water Outfalls

An evaluation of PCB data collected as part of the ETTP SWPP Program from CY 2000 to CY 2015 was performed to identify locations where PCBs have been detected at ETTP storm water outfall locations. Several of the locations where PCBs were identified were sampled as part of the FY 2016 SWPP Program, as shown in Table 3.16. Table 3.17 indicates the analytical results from storm water outfall samples for PCBs collected as part of this sampling program.

Table 3.16. PCB samples collected as part of the FY 2016 SWPP Program

Location	Parameter[a]	Sample type
Outfall 150	Total PCBs and individual PCB Aroclors	Grab
Outfall 170	Total PCBs and individual PCB Aroclors	Grab
Outfall 180	Total PCBs and individual PCB Aroclors	Grab
Outfall 280	Total PCBs and individual PCB Aroclors	Grab
Outfall 510	Total PCBs and individual PCB Aroclors	Grab
Outfall 690	Total PCBs and individual PCB Aroclors	Grab

[a] PCB analysis includes: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268. Total PCBs will also be reported as part of the analytical data package.

Table 3.17. Analytical results from CY 2016 SWPP Program PCB sampling

Location	Parameter[a]	Date Sampled	Results Above Detection Limit
Outfall 150	Total PCBs and individual PCB Aroclors	2/23/2016	No PCBs detected
Outfall 170	Total PCBs and individual PCB Aroclors	2/23/2016	No PCBs detected
Outfall 180	Total PCBs and individual PCB Aroclors	2/23/2016	No PCBs detected
Outfall 280	Total PCBs and individual PCB Aroclors	11/30/2016	No PCBs detected
Outfall 510	Total PCBs and individual PCB Aroclors	2/23/2016	No PCBs detected
Outfall 690	Total PCBs and individual PCB Aroclors	2/23/2016	PCB-1254-0.0518 µg/L

As shown in Table 3.17, detectable quantities of PCBs were found in samples collected at Outfall 690. Additional sampling of the discharges from this outfall may be conducted as part of upcoming SWPP Program. Analytical data collected as part of the storm water monitoring effort will be utilized to provide information for evaluating cleanup decisions and to measure the effectiveness of RAs.

3.6.2.7 Chromium Water Treatment System and Plume Monitoring

In 2007, the release of hexavalent chromium into Mitchell Branch from storm water Outfall 170 and from seeps at the headwall of Outfall 170 resulted in levels of hexavalent chromium that exceeded State of Tennessee AWQC. Immediately below Outfall 170, hexavalent chromium levels were measured at levels as high as 0.78 mg/L, which exceeded the State of Tennessee hexavalent chromium water quality chronic criterion of 0.011 mg/L for the protection of fish and aquatic life. The levels of total chromium were at approximately the same value, indicating that the bulk of the release was almost entirely hexavalent chromium at the release point. The reason that the chromium was still in a hexavalent state is unknown, considering that hexavalent chromium has not been used in ETTP operations in over 30 years. On November 5, 2007, DOE notified EPA and TDEC of their intent to conduct a CERCLA time-critical removal action to install a grout barrier wall and groundwater collection system to intercept this discharge. This action reduced the level of hexavalent chromium in Mitchell Branch from 0.78 mg/L to levels consistently below the AWQC value of 0.011 mg/L. The time-critical removal action is documented in (DOE/OR/01-2598&D2), *Removal Action Report for the Long-Term Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee*.

In 2012, the treatment of the chromium collection system water was transitioned from the Central Neutralization Facility (CNF) to the CWTS. To monitor both the continued effectiveness of the collection system as well as the effectiveness of the new CWTS, periodic monitoring is performed as part of the ETTP SWPP Program. In CY 2016, samples were collected at monitoring well TP-289, the chromium collection system wells, Outfall 170, and Mitchell Branch kilometer (MIK) 0.79. Samples are collected at TP-289 to monitor the concentrations of chromium in the contaminated groundwater plume. Samples are collected from the chromium collection system wells to monitor the chromium in the water recovered by the groundwater collection system. Samples collected at Outfall 170 monitor the concentrations of the chromium and hexavalent chromium plume being discharged directly to Mitchell Branch. Samples are collected at MIK 0.79 to monitor chromium and hexavalent chromium concentrations in Mitchell Branch. Requirements for this sampling effort are listed in Table 3.18.

These locations are manually grab-sampled quarterly during alternating wet-and-dry weather conditions according to the guidelines specified in Sects. 3.1.2 and 3.3.1 of EPA 833-B-92-001 and applicable procedures developed by the sampling subcontractor. All guidelines in UCOR-4028/R5, *East Tennessee Technology Park Storm Water Pollution Prevention Program Sampling and Analysis Plan,* were also followed as part of this sampling effort. Figures 3.22 and 3.23 show the results of this monitoring.

Table 3.18. Monitoring requirements–Mitchell Branch subwatershed total and hexavalent chromium sampling locations

Sampling Location	Parameter	Measurement frequency	Sample type
MIK 0.79	Total chromium	1/quarter	Grab
MIK 0.79	Hexavalent chromium	1/quarter	Grab
Outfall 170	Total chromium	1/quarter	Grab
Outfall 170	Hexavalent chromium	1/quarter	Grab
Monitoring Well-289 (TP-289)	Total chromium	1/quarter	Grab
Monitoring Well-289 (TP-289)	Hexavalent chromium	1/quarter	Grab
Cr collection system wells (CWTS-INF)	Total chromium	1/quarter	Grab
Cr collection system wells (CWTS-INF)	Hexavalent chromium	1/quarter	Grab

NOTE: Total chromium and hexavalent chromium will be collected during varying weather conditions (for example, samples will be collected during wet weather conditions one quarter and during dry weather conditions the following quarter.)

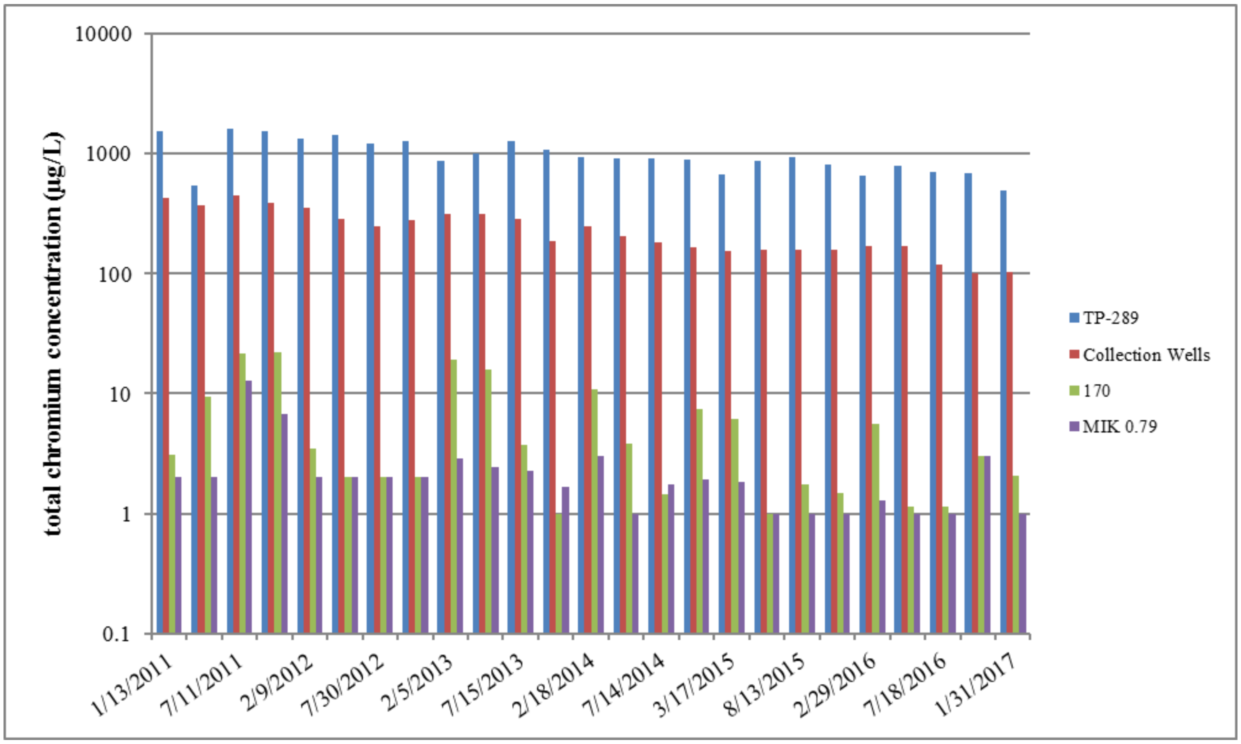

Fig. 3.22. Total chromium sample results for the chromium collection system.

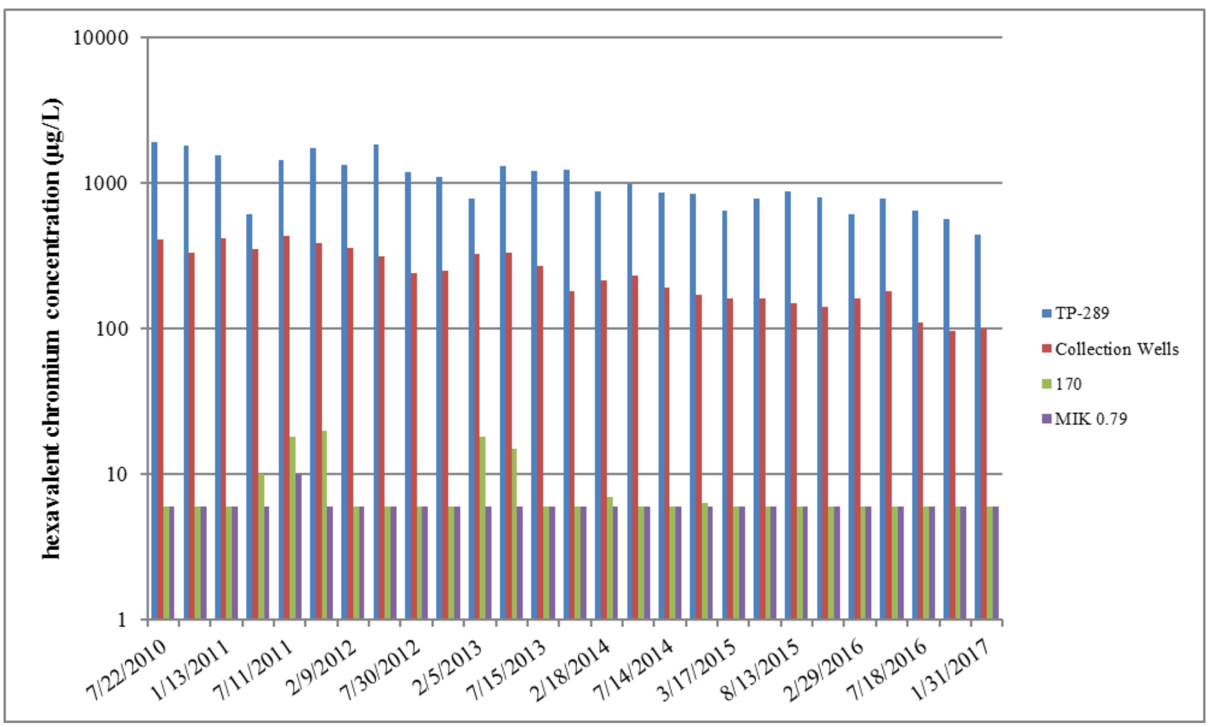

Fig. 3.23. Hexavalent chromium sample results for the chromium collection system.

The analytical data indicate that both total and hexavalent chromium levels may fluctuate slightly at TP-289 and the collection wells but are relatively consistent over the long term. Total chromium values at Outfall 170 and MIK 0.79 are slightly more variable. This is most likely due to the greater variability in flow rates at these two locations. Hexavalent chromium levels at Outfall 170 and MIK 0.79 have remained remarkably consistent since 2010, as shown in Fig. 3.23.

In October 2016, during a CERCLA project test of the CWTS, the pumps at the collection wells were turned off for a period of 48 hours. Samples were collected from several locations, including Outfall 170 and MIK 0.79, before and during the time the pumps were off. Samples were then collected 6 hours after the pumps were returned to service. The samples were analyzed for total and hexavalent chromium. Figures 3.24 and 3.25 show the results for hexavalent chromium at Outfall 170 and MIK 0.79 respectively. Prior to the test, hexavalent chromium levels were below the detection limit. When the pumps were turned off, levels of hexavalent chromium rose to 34 µg/L at storm water Outfall 170, and 29 µg/L at MIK 0.79. Six hours after the pumps were returned to service, levels of hexavalent chromium had returned to below the AWQC at Outfall 170. After 6 hours, the instream levels of hexavalent chromium at MIK 0.79 had dropped to approximately 15 µg/L. Additional sampling conducted four days after the test showed hexavalent chromium at MIK 0.79 had dropped to below detection levels. Levels of total chromium followed the same pattern.

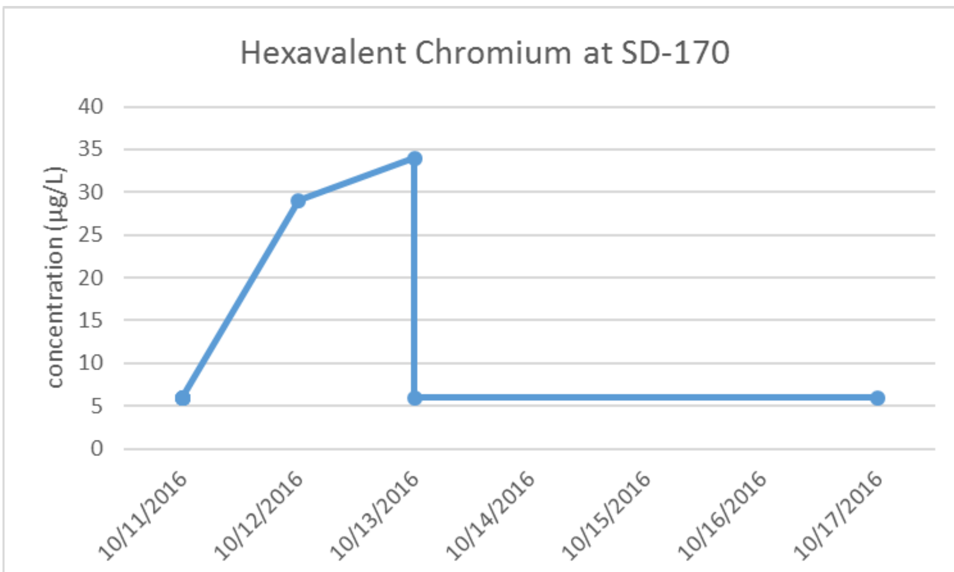

Fig. 3.24. Hexavalent chromium results at storm water Outfall 170 during the CERCLA Project test of CWTS.

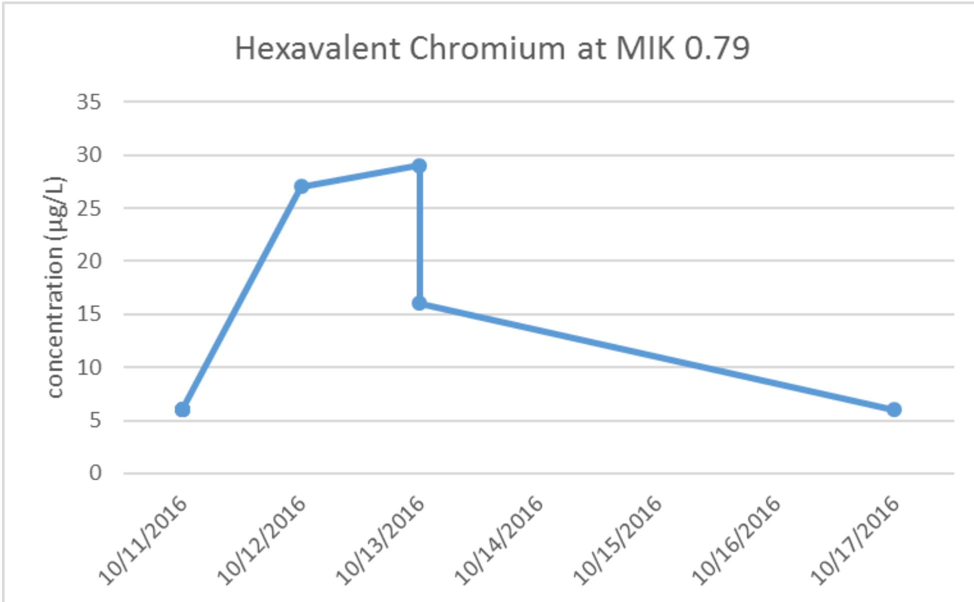

Fig. 3.25. Hexavalent chromium results at MIK 0.79 during the CERCLA Project test of CWTS.

Additional monitoring of the CWTS will be performed as indicated in UCOR-4259, *East Tennessee Technology Park Chromium Water Treatment System Sampling and Analysis Plan, Oak Ridge, Tennessee*. In addition to chromium treatment, the upgraded CWTS also has provisions for air stripping of the VOCs that are also found in the groundwater. The air stripper has demonstrated a removal efficiency of greater than 98% over the last several monitoring periods.

3.6.2.8 NPDES Permit Renewal Monitoring

Preparations are being made for the NPDES permit application that will be submitted to TDEC in CY 2019. The submittal schedule will include time for DOE to review the application before it is submitted to TDEC. Sampling required to complete the permit application continued as part of the CY 2016 SWPP Program SAP. Table 3.19 indicates the dates when samples were collected at representative outfalls during CY 2016.

Table 3.19. NPDES permit renewal sampling conducted in CY 2016

Outfall	Manual Grab Samples—Date Collected	Manual Grab or Grab-by-Compositor Samples—Date Collected	Composite Samples—Date Collected
230			5/11/2016
430			1/26/2016
490	2/1/2016	2/1/2016	2/1/2016
560		12/1/2016	8/18/2016
724	1/26/2016	1/26/2016	1/26/2016

Table 3.20 indicates results from these NPDES permit renewal sampling efforts performed in CY 2016 that exceeded screening levels.

Table 3.20. Analytical results exceeding screening levels for NPDES permit renewal sampling—CY 2016

Outfall	Copper	Lead	Zinc	Mercury	Gross Beta Activity
	Screening level 7 µg/L	Screening level 1.8 µg/L	Screening level 75 µg/L	Screening level 51 ng/L	Screening level 50 pCi/L
230	8.75	23.3	102	129	
430	12.6	33	130		
490					276
560	7.47	9.78	106		

When screening levels are exceeded, any of several actions may be implemented, including:

- An investigation is undertaken by EC&P personnel to determine the cause of the exceedance.
- Personnel from the EC&P Organization observe the storm water outfall(s) and drainage basins where the screening levels were exceeded to determine if best management practices (BMPs) or other corrective measures may be required.
- Corrective actions are implemented to ensure that an NPDES permit limit or other reference standard is not exceeded during subsequent sampling events.
- Additional monitoring is performed to determine if the release is ongoing.
- Evaluations through sampling at instream locations are conducted to confirm that no impacts are occurring in instream mixing zones.

Exceedance of screening levels at Outfalls 230 and 490 are likely related to D&D actions that were performed for the K-25 building. Exceedance of screening levels at Outfall 430 is likely related to D&D actions that were performed for the K-731 Switchhouse and/or the K-732 Switchyard. Exceedance of screening levels at Outfall 560 is likely related to D&D actions that were performed for the K-31 building. Additional best management practices (BMPs) were not determined to be necessary since D&D actions at the facilities listed have been completed and no instream mixing zone impacts were identified. Additional monitoring will be performed as part of future ETTP SWPP Program sampling efforts to determine if additional corrective actions may be required at these outfalls.

3.6.2.9 Flow Monitoring at Storm Water Outfalls Associated with NPDES Permit Requirements

Flux monitoring was conducted as part of the mercury investigation at ETTP. To properly monitor mercury flux, accurate flow estimates and mercury concentrations measured during storm events were needed. Flow monitoring was conducted at Outfalls 100, 170, 180, and 190 as part of the requirements of the ETTP NPDES permit. Outfall 170 was monitored first.

At each of these four storm drain locations, the ETTP NPDES permit required that flows for three ranges of rainfall events be monitored at least once during the permit term at each outfall. The rainfall events for which flow monitoring data was collected and evaluated are defined as follows:

- 0.1–0.5 in.-rain event
- 0.5–1.5 in.-rain event
- 1.5-in. or greater rain event

These measured flows were utilized to compare against modeled flows generated using the Natural Resources Conservation Service Technical Report 55 (TR-55), which was the model used at ETTP to estimate storm water discharge flows. These compared values were used to increase the accuracy of the TR-55 flow modeling process. Given that the flow monitoring occurred over a variety of rain events and multiple field variables could pose problems in collecting usable data, this monitoring was completed during the permit period.

3.6.2.10 Results of Flow Monitoring at Outfall 170

The calculated flows obtained at Outfall 170 with the TR-55 model do not appear to correspond well with the measured flows obtained by direct measurement using a rain gauge and flow meter. In many instances, the flow values calculated using TR-55 are a fraction of the flows measured by monitoring equipment. The only situations where the calculated flows and the measured flows were reasonably close occurred when there had been a long span of time between rain events and the baseflow had returned to a minimum level. It appears the TR-55 model does not consider that a rain event may affect the amount of discharge from an outfall for several days after an event. It may be that the model treats the rain event as discrete and short-term, without considering longer-term effects. This could explain the consistent low estimates of flow compared to the flow measurements collected by the automatic water sampling equipment (ISCO), which operates and records on a continuous basis. It would also explain why the TR-55 calculated flow and the measured flow are closest for a rain event that occurs after an extended dry period.

Flow data collected by the ISCO monitoring equipment indicate that rain events of as little as 0.2 in. may cause the discharge from Outfall 170 to overtop the V-notch weir if they occur over a short period of time. The Outfall 170 drainage system responds rather quickly to short-term, high-intensity rain events. Because of the size of the drainage area and due to the fact that approximately 30% of the area is impervious to storm water infiltration, even smaller rain events generate large quantities of runoff. It is believed that the V-notch weir at Outfall 170 can be utilized for flow measurement in storm events of up to approximately 0.5 in., as long as the rain event occurs over a long enough time period that the weir is not overtopped.

In the ETTP NPDES permit, TDEC states that only an annual estimate of the daily maximum flow is required at regulated outfalls. There is no accompanying description in the ETTP NPDES permit concerning the accuracy of the measurement. Therefore, flow measurements obtained at Outfall 170 using the TR-55 model meet the requirements of the NPDES permit as being a flow estimate. Additionally, no flux monitoring was required at Outfall 170 by the ETTP NPDES permit due to the historically low concentrations of bioaccumulative pollutants such as mercury and PCBs that are discharged from this outfall. Therefore, it is not believed at this time that additional flow monitoring capabilities are required at Outfall 170. In the future, if more accurate flow measurement is required, an H-flume or similar flow measurement device, may be required at this outfall.

3.6.2.11 Status of Additional Flow Monitoring Activities Associated with NPDES Permit Requirements

As part of the requirements of the ETTP NPDES permit that became effective in April 2015, flow monitoring will also be conducted at Outfalls 100, 180, and 190. An H-type flume was purchased and installed at Outfall 190 in late 2015. Flow data have been collected from the monitoring equipment at the Outfall 190 flume since December 2015. During much of this time period, a small oily sheen has been discharged from the Outfall 190 piping system, necessitating the use of an oil-absorbent boom at the end of the Outfall 190 pipe. It is possible that the boom may have disrupted the flow measurement equipment here; a data analysis will be conducted to determine if this has happened. In the meantime, collection of flow data at Outfall 190 will continue.

In addition, flow-paced composite mercury samples required by the ETTP NPDES permit have been collected at Outfall 190 for the 0.1–0.5 in. rain event and the 0.5–1.5 in. rain event, as specified in the ETTP NPDES permit. The results from these samples are shown in Table 3.21.

Table 3.21. Analytical results from flow-proportional composite sampling

Location	Parameter	Date Sampled	Rain Event Sampled	Results (ng/L)
Outfall 190	Mercury	2/2/16	0.1–0.5 in.	96.5
Outfall 190	Mercury	1/12/2017	0.5–1.5 in.	162

3.6.2.12 Significant Spill Events

Release of Unknown Material into Catch Basin Located Near Building K-131

On December 8, 2016, UCOR D&D personnel were downsizing an exterior tank on the north side of Bldg. K-131, the former function and original location of which are unknown. Heavy machinery was used to cut the tank into smaller pieces for disposal. During this operation, an unknown white solid material was released onto the paved area where the tank was located. This release occurred immediately before a rainfall event, and D&D personnel were not able to clean up the material before the rain began. Despite efforts to prevent the material from entering a nearby storm drain inlet, some of it entered an inlet connected to Outfall 382, which discharges to Poplar Creek. Because this material could have posed safety and health hazards, sampling of it was delayed until additional information could be gathered on the potential source of the released material and the tank.

On December 12, 2016, samples of the discharge from Outfall 382 were collected and analyzed for radiological parameters, metals, total ammonia nitrogen, semivolatile organic compounds (SVOCs), mercury, and total residual chlorine. No analytical results exceeded screening criteria. Further analysis indicated that the unknown material was most likely sodium sulfate. No threat to the environment occurred as a result of this spill, no impact to aquatic biota was observed, and discharge of this material from the tank appeared to be unrelated to mercury found in the discharge from Outfall 382.

Fire Water Line Break at Building K-1052

On December 1, 2016, a significant fire-water line break occurred near the M&EC Process/Storage Area at Bldg. K-1052. Chlorinated fire water, discharged as part of this event, flowed into a radiologically contaminated portion of Bldg. K-1052, as well as a radiologically contaminated portion of Bldg. K-1010 (M&EC Process Area). The K-1010 Process Area had been recently contaminated during the processing of a waste stream containing a significant amount of strontium-90 (^{90}Sr) and was being cleaned.

The water flowed back out of these buildings and into a nearby storm drain inlet that is connected to the storm water Outfall 100 drainage system. In addition, a substantial quantity of sediment was transported to the Outfall 100 drainage system as part of the line break. UCOR personnel valved off the leak shortly after it was noted. The area was stabilized until the line could be repaired. On December 7, 2016, UCOR personnel repaired the break and backfilled the affected area with gravel.

Due to the potential for transport of radiological contamination to the Outfall 100 drainage system and into the K-1007-P1 pond, sampling was conducted at Outfall 100 and the K-1007-B weir on December 2, 2016, for gross alpha/gross beta activity, isotopic uranium, ^{90}Sr, and gamma activity. The results from this sampling effort are shown in Table 3.22.

Table 3.22. Analytical results for Outfall 100 and K-1007-B Weir sampling conducted on December 2, 2016

Location	Gross Alpha Activity	Gross Beta Activity	^{137}Cs	^{90}Sr	$^{233/234}$U	$^{235/236}$U	^{238}U
	Screening level 10 pCi/L	Screening level 30 pCi/L	Screening level 120 pCi/L	Screening level 44 pCi/L	Screening level 28 pCi/L	Screening level 29 pCi/L	Screening level 30pCi/L
Outfall 100	7.41	**591**	2.4 U	**275**	1.39	0.217 U	0.879
K-1007-B Weir	-0.488 U	7.44	-0.228 U	0.059 U	0.642 U	0.0235 U	0.045 U

Results in **BOLD** indicate exceedance of screening criteria.

Water samples taken by UCOR personnel on December 2, 2016, at Outfall 100 did indicate increased levels of ^{90}Sr (275 pCi/L) as well as total beta (591 pCi/L). However, all other nuclides showed no significant increase in activity levels. The activity levels of ^{90}Sr were below the levels given in DOE Standard 1196. Gross alpha radiation activity levels in samples collected at the K-1007-B Weir were below the analytical detection limit, and gross beta radiation levels were below the internal screening levels established based upon the National Primary Drinking Water standards listed in 40 CFR 141.

On December 13, 2016, follow-up sampling for gross alpha/gross beta contamination was performed at Outfall 100 to determine if radiological contamination might still be present at the outfall as a result of this fire-water break. The results from this sampling event are shown in Table 3.23.

Table 3.23. Analytical results for Outfall 100 and K-1007-B Weir sampling conducted on December 13, 2016

Location	Gross Alpha Activity	Gross Beta Activity
	Screening level 10 pCi/L	Screening level 30 pCi/L
Outfall 100	4.22	7.49

Even though elevated levels of gross beta radiation and ^{90}Sr were detected after the initial spill, the levels of these contaminates had dissipated by the time the follow-up sampling was performed. Therefore, it is believed that no threat to the environment occurred as a result of this spill. No impact to aquatic biota in the K-1007-P1 pond was observed.

3.6.3 Surface Water Monitoring

During 2016, the ETTP EMP personnel conducted environmental surveillance activities at 12 surface water locations (Fig. 3.26) to monitor groundwater and storm water runoff 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]. As part of monitoring the ambient stream conditions, K-1700 and MIKs 0.45, 0.59, 0.71, and 1.4 were sampled and analyzed quarterly for radionuclides; and CRKs 16 and 23, K-716, and the K-702-A slough were sampled semiannually.

At MIKs 0.45, 0.59, and 0.71, quarterly monitoring is conducted for ^{99}Tc only. Results of radiological monitoring were compared with the DCS values in DOE Standard 1196 (DOE 2011). 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 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%) 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%). In 2016, the monitoring results yielded SOF values of less than 0.01 (1% of the allowable DCS) at all surface water surveillance locations at ETTP (Fig. 3.27).

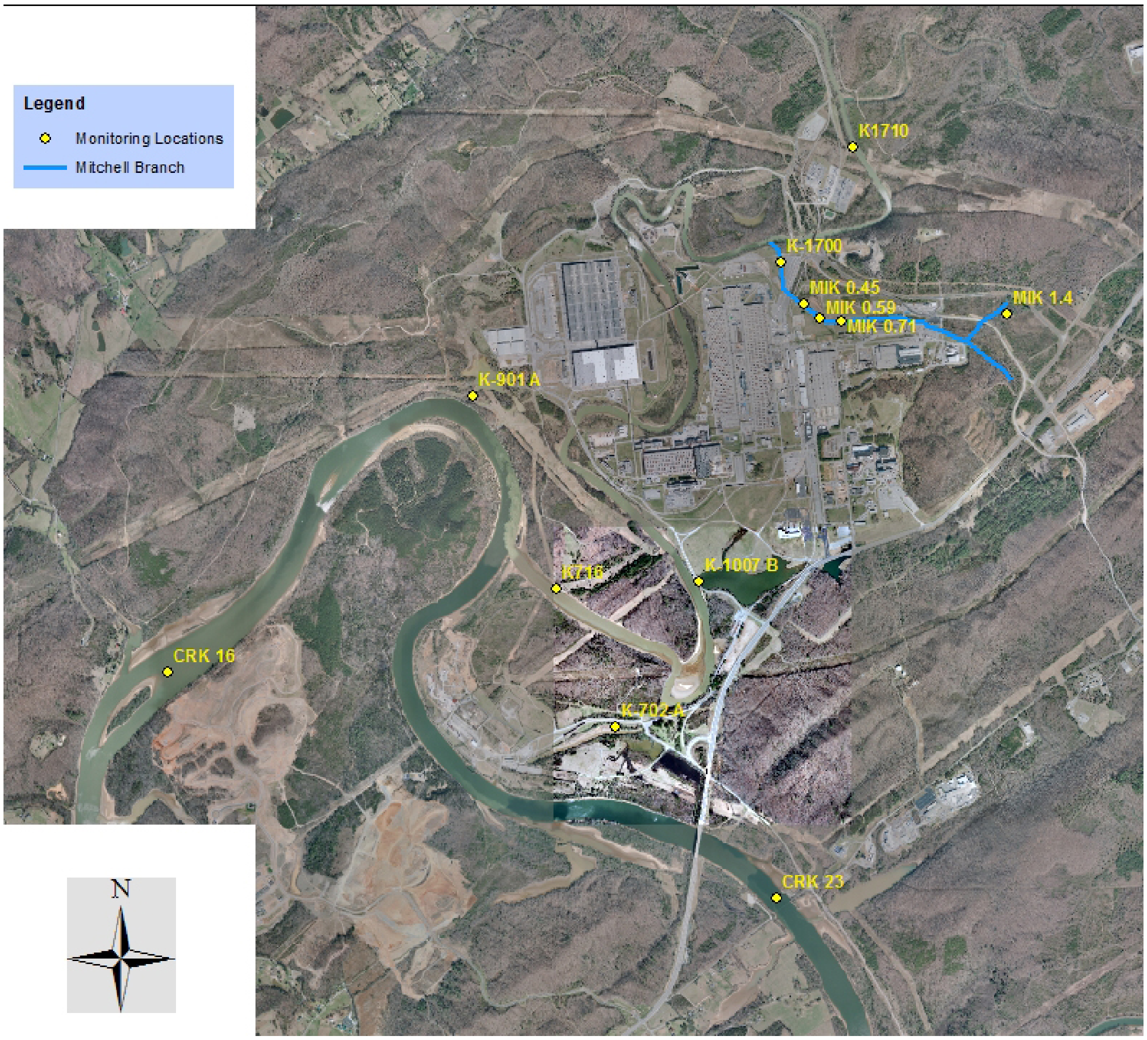

Fig. 3.26. East Tennessee Technology Park Environmental Monitoring Program surface water monitoring locations. *(CRK = Clinch River kilometer and MIK = Mitchell Branch kilometer)*

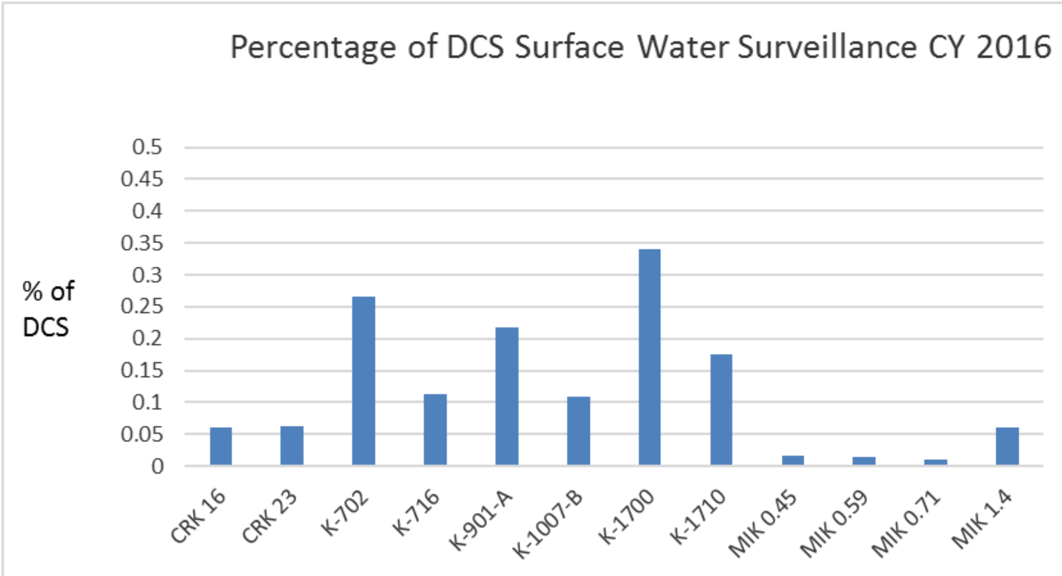

Fig. 3.27. Annual average percentage of derived concentration standards (DCSs) at surface water monitoring locations, 2016. *(CRK = Clinch River kilometer and MIK = Mitchell Branch kilometer)*

Depending on the monitoring location, water samples may be analyzed for pH, selected metals, and VOCs. In 2016, results for most of these parameters were well within the appropriate AWQC. There were nine exceptions in 2016. During the second quarter of 2016, there were 3 exceedances of the AWQC. At K-716, mercury was measured at 0.0534 µg/L, which exceeded the AWQC of 0.051 µg/L. K-716 monitors Poplar Creek, which typically contains elevated levels of mercury as a result of past discharges from Y-12, which is situated upstream from ETTP. At K-1700, zinc was measured at 380 µg/L, which exceeded the hardness-dependent AWQC of 203 µg/L. K-1700 monitors Mitchell Branch, which drains areas of naturally high levels of zinc in the soil. At MIK 1.4, lead was measured at 3.4 µg/L, which exceeded the AWQC of 2.1 µg/L. This level of lead is not typical at this location, and no operations were ongoing in the vicinity that might have caused the exceedance, so the cause of this exceedance remains unknown. During the third quarter, there were two failures to meet the minimum level of dissolved oxygen (5.0 mg/L). Dissolved oxygen levels were measured at 3.4 mg/L at K-901-A and at 4.1 mg/L at K-1007-B. Both of these readings were collected at times of elevated temperatures and very low flow due to the drought, conditions which favor high biological activity and the consequent depletion of dissolved oxygen. In the fourth quarter, elevated levels of mercury were detected at both K-1700 (0.0642 µg/L) and K-1710 (0.0561 µg/L). The drainage area monitored by K-1700 supported some minor mercury operations in the past, and such levels are not unprecedented here. K-1710 monitors Poplar Creek, which typically contains elevated levels of mercury as a result of past discharges from Y-12, which is situated upstream from ETTP. Elevated levels of zinc were also seen at K-1710 (680 µg/L). Soils in the northern portion of ETTP contain relatively high levels of naturally occurring zinc. The result reported for carbon tetrachloride at K-1700, 19 µg/L, exceeds the AWQC of 16 µg/L. This result is atypical for this location, where the concentrations of carbon tetrachloride are usually below the detection limit, and to date no cause of the exceedance has been identified. No obvious signs of distress (e.g., dead fish) were observed to be associated with any of these exceedances in 2016.

Figures 3.28 and 3.29 illustrate the concentrations of TCE (trichloroethene) and cis-1,2-dichloroethene (cis-1,2-DCE) from the K-1700 weir (which is used to monitor Mitchell Branch), the only surface water monitoring location where VOCs are regularly detected. 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. Although there had been a test of the CWTS in October 2016, in which the collection well pumps had been intentionally stopped, the test had been completed and the pumps restarted over a month before these samples were collected. The Sample Management Office has reviewed these data points and they did not discover any indication of a laboratory error. At this time the reason for these increases is unknown. It should be noted that even at the increased levels, the results are still well within the AWQC. Concentrations of TCE and total 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. Moreover, the standards for 1,2-DCE apply only to the "trans" form of 1,2-DCE; almost all of the 1,2-DCE is in the cis isomer. In addition, vinyl chloride has sometimes been detected in Mitchell Branch water (Fig. 3.30). 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; however, storm drain network monitoring generally has not detected these compounds in the storm water discharges. When detected, the concentrations are lower than in the stream. Therefore, 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 (Fig. 3.31). In 2016, hexavalent chromium levels in Mitchell Branch were all below the detection limit of 6 µg/L.

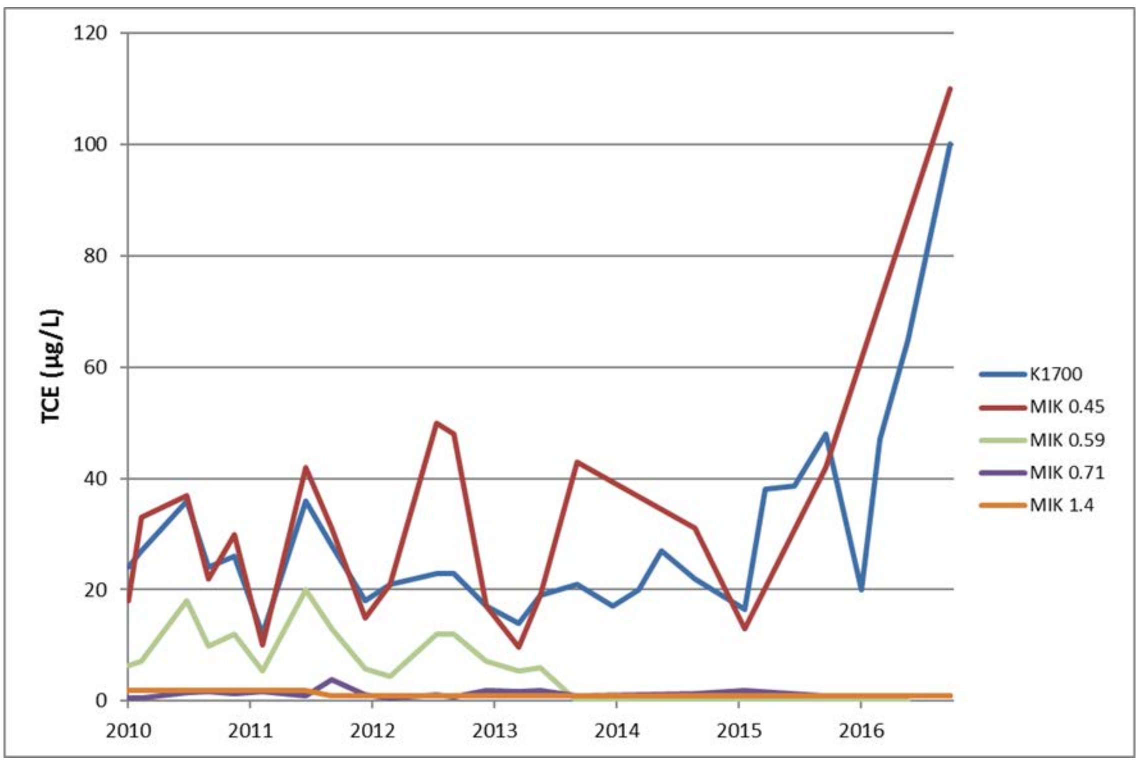

Fig. 3.28. Trichloroethene concentrations in Mitchell Branch. *(MIK = Mitchell Branch kilometer)*

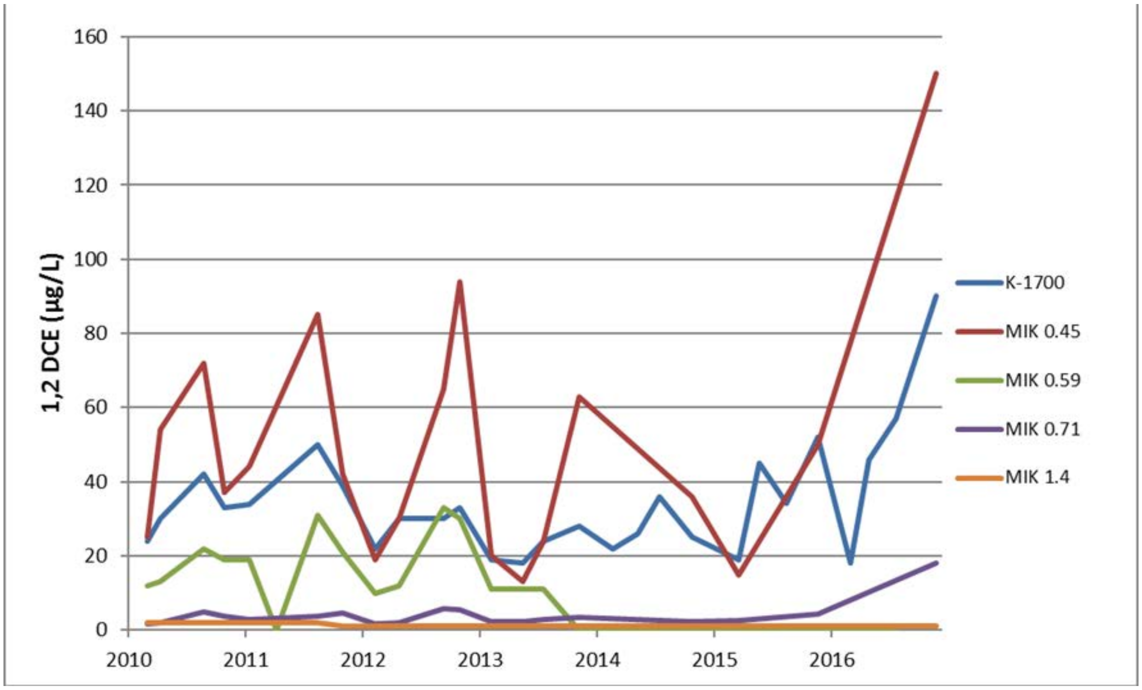

Fig. 3.29. Concentrations of cis-1,2-dichloroethene in Mitchell Branch. *(MlK = Mitchell Branch kilometer)*

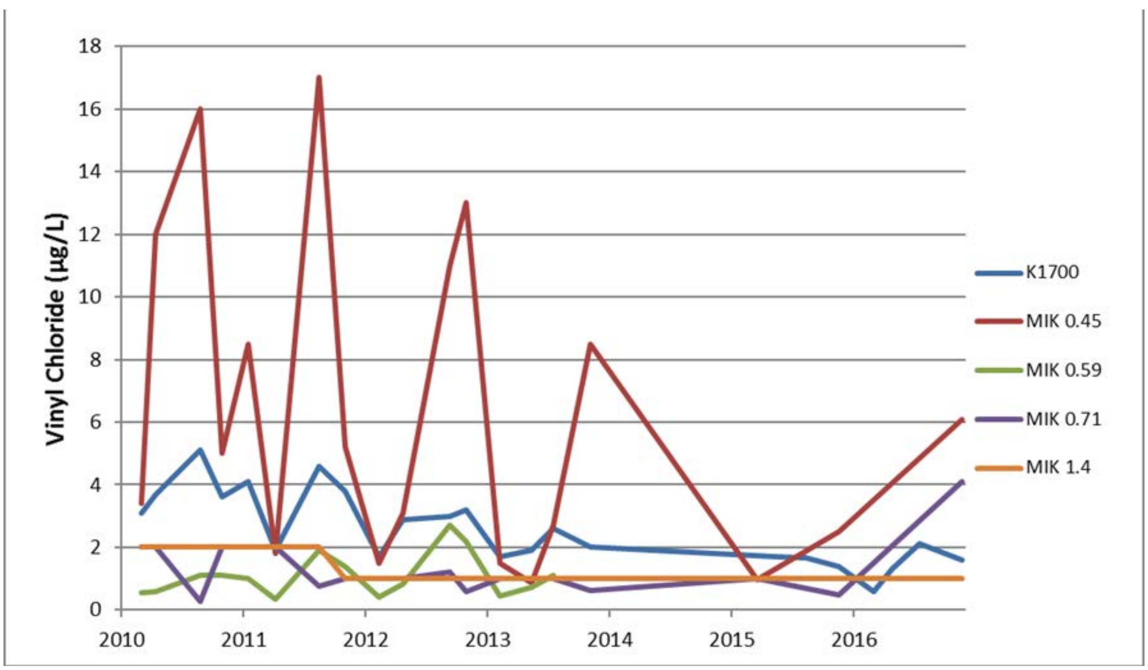

Fig. 3.30. Vinyl chloride concentrations in Mitchell Branch. *(MlK = Mitchell Branch kilometer)*

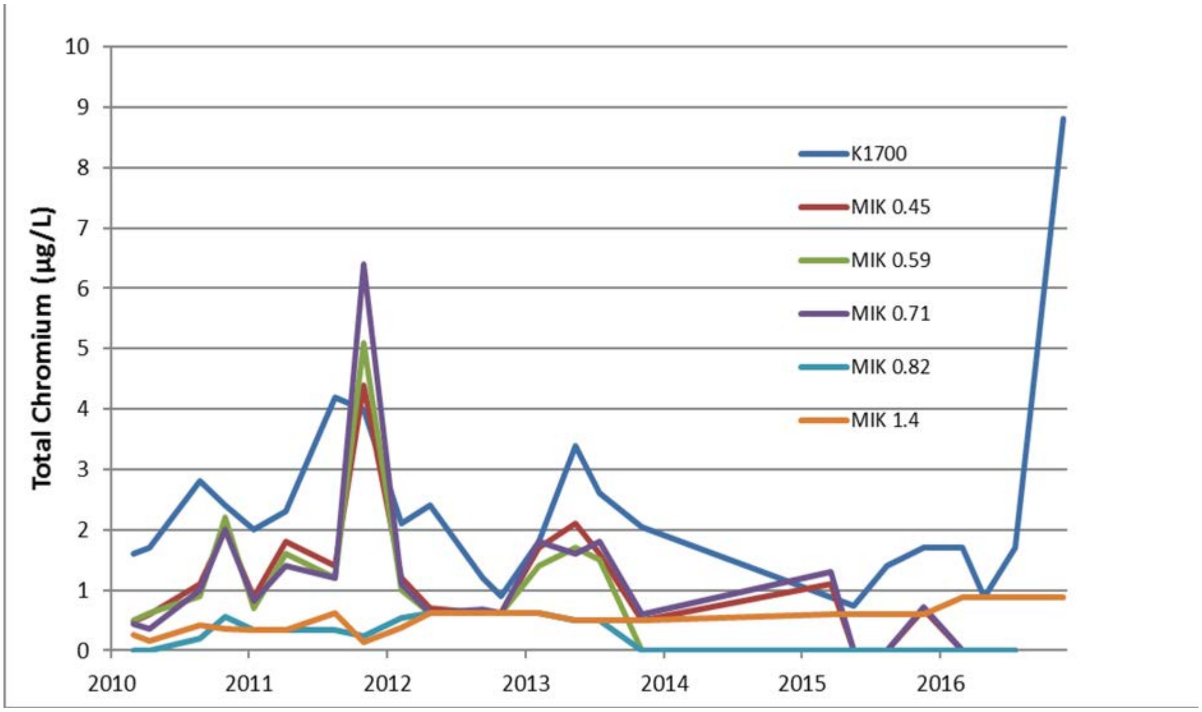

Fig. 3.31. Total chromium concentrations at K-1700. *(The AWQC for Cr(III), which is hardness-dependent, is 74 µg/L, based on a hardness of 100 mg/L. The AWQC for Cr(IV) is 11 µg/L. (AWQC = ambient water quality criterion, MIK = Mitchell Branch kilometer)*

3.6.4 Groundwater Monitoring

3.6.4.1 Groundwater Exit Pathways

Groundwater exit pathway monitoring sites are shown in Fig. 3.32. Groundwater monitoring results for the exit pathways are discussed below:

Mitchell Branch—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. Section 3.6.3 includes discussion of the detected concentrations of VOCs in Mitchell Branch.

Wells BRW-083 and UNW-107, located near the mouth of Mitchell Branch, have been monitored since 1994. Table 3.24 shows the history and concentrations of detected VOCs in groundwater. 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. During FY 2016, no chlorinated VOCs were detected in either BRW-083 or UNW-107.

K-1064 Peninsula area—Wells BRW-003 and BRW-017 monitor groundwater at the K-1064 Peninsula burn area. Metals and VOCs are monitored at the site. Metals detected in groundwater at the site include antimony and arsenic. Antimony was detected at very low, estimated concentration in both wells. Well BRW-003 had an antimony detection of 0.11 µg/L (J) in the September sample and well BRW-017 had 0.1 µg/L in the March sample with a nondetect result in September. Arsenic

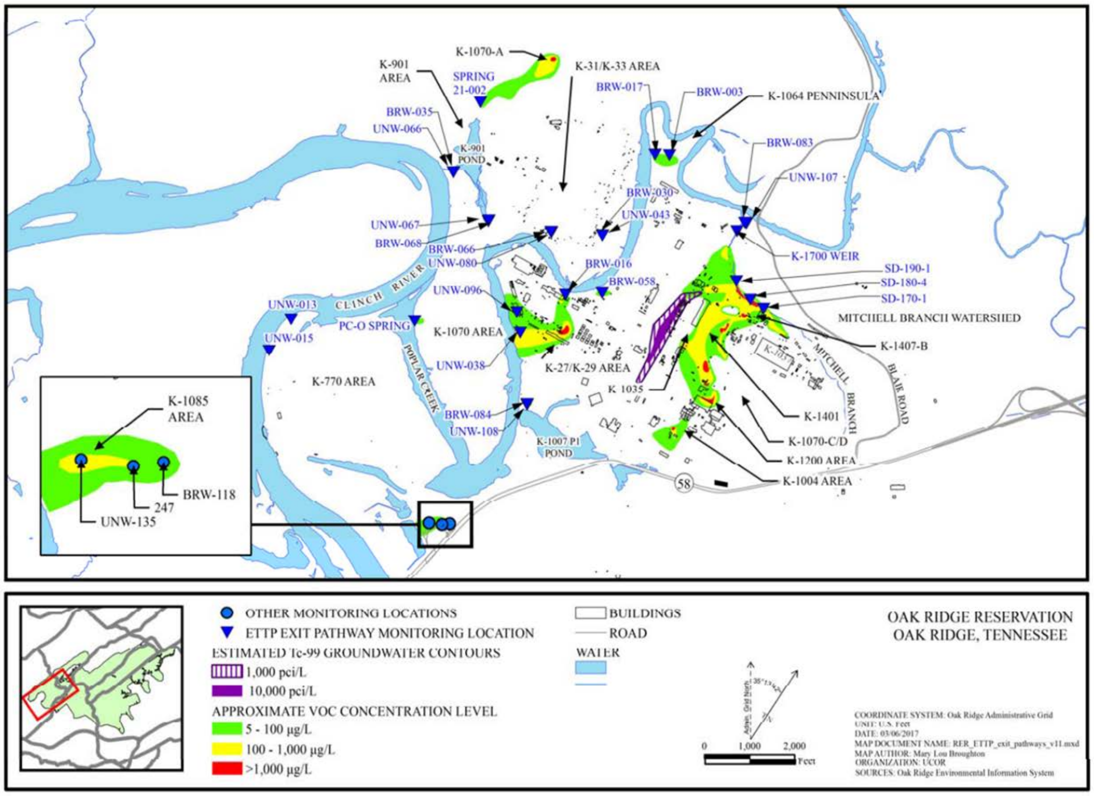

Fig. 3.32. ETTP exit pathways monitoring locations.

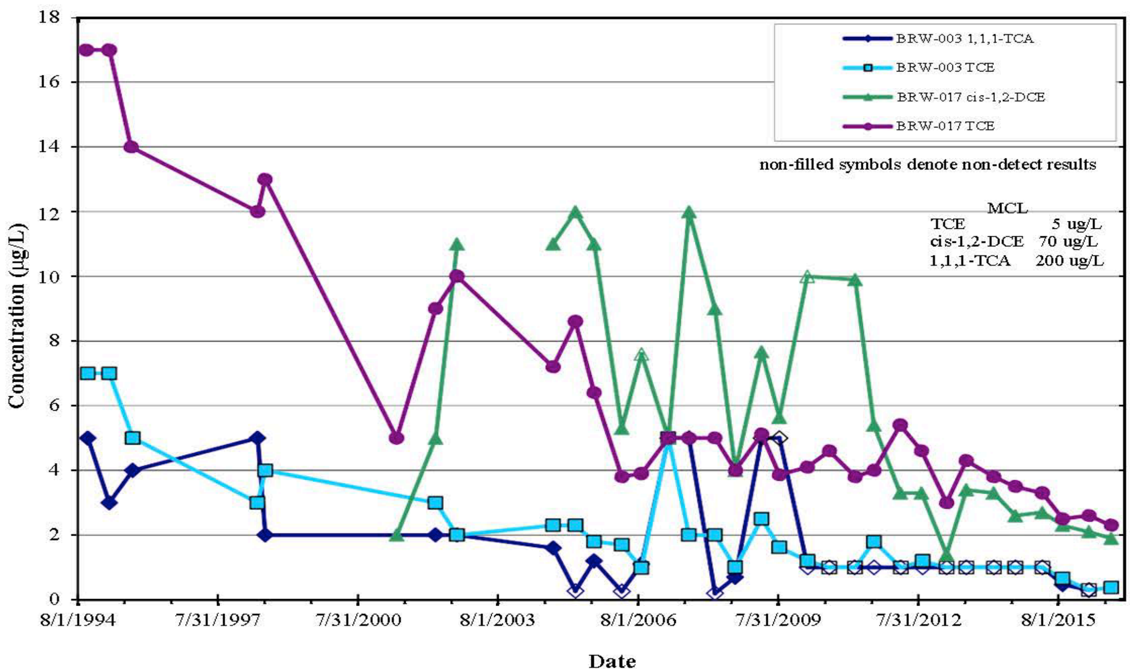

Fig. 3.33. **VOC concentrations in groundwater at K-1064 Peninsula area.**

was also detected in both wells with maximum concentrations of 0.015 mg/L in well BRW-003 in September and 0.016 mg/L in well BRW-017 in March. Figure 3.33 shows the history of significant VOC detections in groundwater from FY 1994 through FY 2016. 1,1,1-TCA was detected at 0.65 µg/L (J) in well BRW-003 in the September sample and was not detected in the March sample. Cis-1,2-DCE was detected in well BRW-017 at 2.1 and 1.9 µg/L in March and September, respectively. TCE concentrations have declined in both wells over the monitoring period. TCE was present at concentrations less than the MCL during FY 2016 at both wells. In well BRW-017, TCE was detected at concentrations of 2.6 and 2.3 µg/L in March and September, respectively. At well BRW-003, TCE was detected at 0.38 µg/L (J) in the September sample and was not detected in the March sample.

K-31/K-33 area—Groundwater is monitored in 4 wells (BRW-066, BRW-030, UNW-080, and UNW-043) that lie between the K-31/K-33 area and Poplar Creek. VOCs are not COCs in this area; however, leaks of recirculated cooling water in the past have left residual subsurface chromium contamination. Chromium concentrations in the unconsolidated zone wells (UNW-043 and UNW-080) have exceeded the 1 mg/L MCL screening concentration in the past while levels have been much lower in the bedrock wells. Figure 3.34 shows the history of chromium detection in wells UNW-043 and UNW-080. Groundwater at well UNW-043 exhibits the highest residual chromium concentrations of any in the area. Chromium concentrations in well UNW-043 correlate with the turbidity of samples. The acidification of unfiltered samples that contain suspended solids often causes detection of high metals content because the addition of acid preservative releases metals that are adsorbed to the solid particles at the normal groundwater pH.

During FY 2006, an investigation was conducted to determine if groundwater in the vicinity of the K-31/K-33 buildings contained residual hexavalent chromium from recirculated cooling water leaks. The data indicated the chromium in groundwater near the leak sites was essentially all the less toxic trivalent species. During FY 2008 through FY 2016, field-filtered (i.e., dissolved) and unfiltered samples were collected from UNW-043. Chromium concentrations in the field-filtered samples are consistently much less than the MCL and during FY 2016 the chromium concentration in filtered aliquots were 0.017 mg/L and 0.0056 mg/L in March and August, respectively. During FY 2016, both field-filtered and unfiltered samples were collected for chromium analysis from wells BRW-066, UNW-030 and UNW-080. All results in samples from UNW-030 and UNW-080 were less than the MCL. Chromium was below the detection limit in all samples from well BRW-066 during FY 2016.

K-27/K-29 area—Several exit pathway wells are monitored in the K-27/K-29 area. Figure 3.35 provides concentrations of detected VOCs in wells both north and south of K-27 and K-29 through FY 2016. The source of VOC contamination in well BRW-058 is not suspected to be from K-27/K-29 area operations, but is more likely associated with groundwater contamination that originates in the K-25 area. At well BRW-058, VC continues to slightly exceed the MCL while cis-1,2-DCE remains at concentrations slightly lower than the MCL. The presence of cis-1,2-DCE and VC in well BRW-058 is an indication that some natural attenuation is occurring in the source area. The VOC concentrations in well BRW-016 continue to gradually decrease and cis-1,2-DCE, which does not exceed its MCL, is the only detectable VOC in the well. At BRW-016, cis-1,2-DCE levels show a decreasing trend and VC has decreased to < 1 µg/L which is less than the MCL. TCE levels in well UNW-038 exhibit a long-term decreasing trend, with seasonal fluctuations (higher during the wet season and lower during the dry season) between about 10–20 times the MCL.

Table 3.24. VOCs detected in groundwater in the Mitchell Branch Exit Pathway

Well	Date	cis-1,2-DCE	PCE	TCE	VC
BRW-083	8/29/2002	ND	**5**	**28**	ND
	3/16/2004	0.69	2.2	**9.9**	ND
	8/26/2004	2	4.7	**20**	ND
	3/14/2007	5	**9**	**28**	ND
	3/20/2008	ND	ND	ND	ND
	8/21/2008	ND	ND	ND	ND
	3/12/2009	ND	ND	1.31 J	ND
	8/3/2009	ND	2.66	**14.2**	ND
	3/3/2010	ND	ND	ND	ND
	8/30/2010	3.6	**5.1**	**18**	ND
	3/15/2011	2.8	**6.7**	**22**	ND
	8/10/2011	ND	ND	ND	ND
	3/1/2012	ND	ND	ND	ND
	8/16/2012	ND	ND	ND	ND
	8/6/2013	ND	ND	ND	ND
	3/13/2013	ND	ND	ND	ND
	3/13/2014	ND	ND	ND	ND
	8/7/2014	ND	ND	ND	ND
	3/30/2015	ND	ND	ND	ND
	8/20/2015	ND	ND	ND	ND
	3/8/2016	ND	ND	ND	ND
	8/31/2016	ND	ND	ND	ND
UNW-107	8/3/1998	ND	ND	3	ND
	8/26/2004	4.7	ND	3.6	ND
	8/21/2006	3.4	**14**	2	1.2
	3/13/2007	25	2 J	**23**	2[a]
	8/21/2007	17	ND	**30**	0.3 J
	3/5/2008	ND	ND	ND	ND
	8/18/2008	ND	ND	ND	ND
	3/12/2009	ND	ND	ND	ND
	7/30/2009	ND	ND	ND	ND
	3/4/2010	ND	ND	ND	ND
	7/28/2010	ND	ND	ND	ND
	3/16/2011	ND	ND	ND	ND
	8/11/2011	ND	ND	ND	ND
	3/20/2012	ND	ND	ND	ND
	9/12/2012	ND	ND	ND	ND
	8/8/2013	ND	ND	ND	ND
	3/20/2013	ND	ND	ND	ND

Table 3.24. VOCs detected in groundwater in the Mitchell Branch Exit Pathway (cont.)

Well	Date	cis-1,2-DCE	PCE	TCE	VC
UNW-107	3/18/2014	ND	ND	ND	ND
	8/20/2014	ND	ND	ND	ND
	3/16/2015	ND	ND	ND	ND
	8/25/2015	ND	ND	0.53 J	ND
	3/9/2016	ND	ND	ND	ND
	8/30/2016	ND	ND	ND	ND

[a]Detection occurred in a field replicate. Constituent not detected in regular sample.
Bold table entries exceed SDWA MCL screening values (PCE, TCE = 5 µg/L, cis-1,2-DCE = 70 µg/L, VC = 2 µg/L) All concentrations µg/L.
DCE = dichloroethene
J = estimated value
MCL = maximum contaminant level
ND = Not Detected
PCE = tetrachloroethene
SDWA = Safe Drinking Water Act TCE = trichloroethene
VC = vinyl chloride
VOC = volatile organic compound

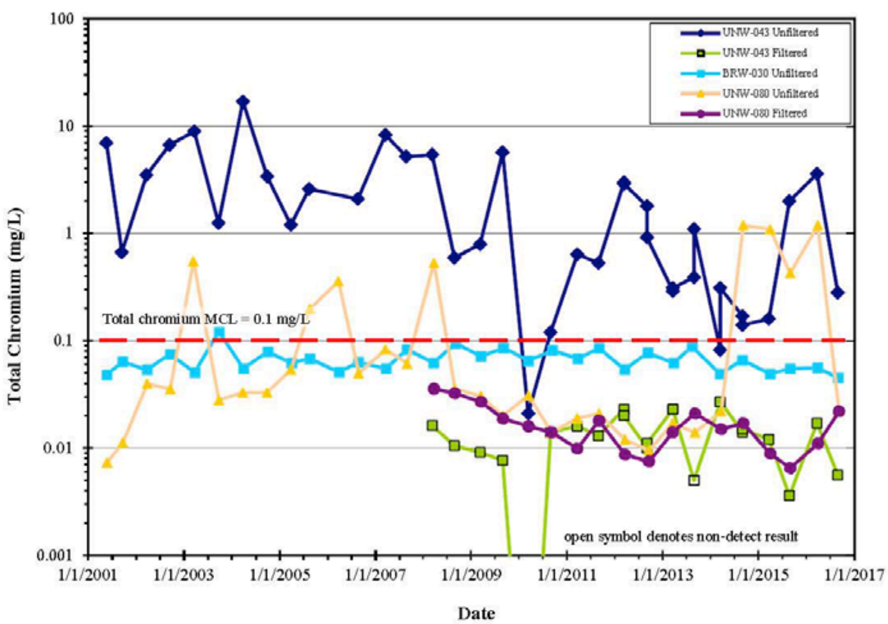

Fig. 3.34. Chromium concentrations in groundwater in the K-31/K-33 area.

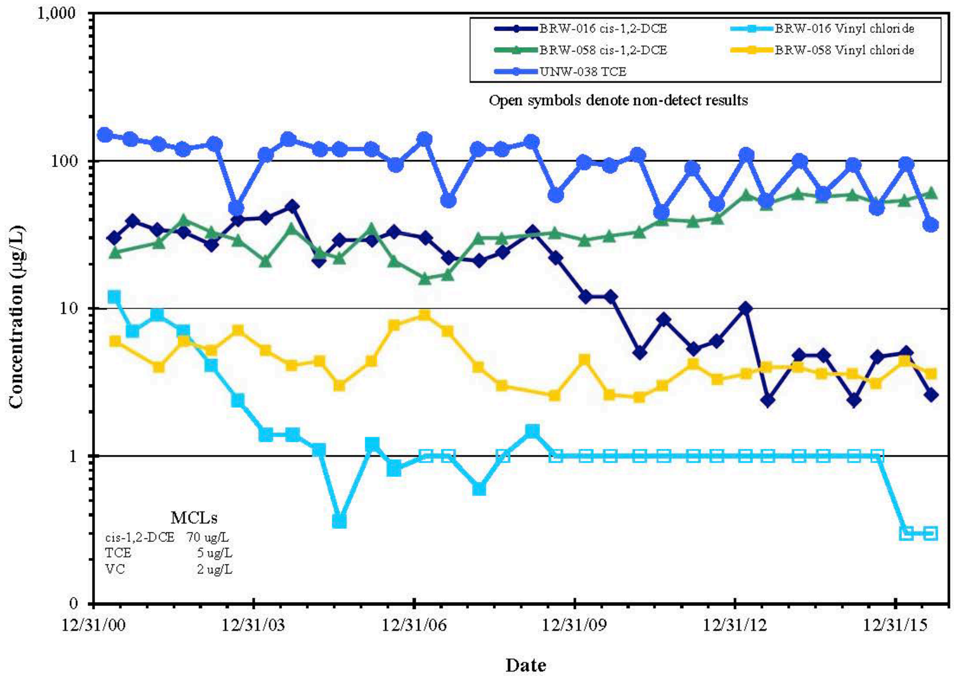

Fig. 3.35. Detected VOC concentrations in groundwater exit pathway wells near K-27 and K-29.

K-1007-P1 Holding Pond area—Wells BRW-084 and UNW-108 are exit pathway monitoring locations at the northern edge of the K-1007-P1 Holding Pond (Fig. 3.32). These wells were monitored intermittently from 1994 through 1998 and semiannually from FY 2001 through FY 2016. The first detections of VOCs in these wells occurred during FY 2006 with detection of low (approximately 10 µg/L or less) concentrations of TCE and cis-1,2-DCE. The source area for these VOCs is not known. During FY 2016, no VOCs were detected in either well. Metals continue to be detected and are associated with the presence of turbidity in the samples. Data from filtered samples indicate very low, apparently dissolved concentrations of antimony (0.22 µg/L (J) in well BRW-084 in August, and 0.11 µg/L (J) in well UNW-108 in August) and selenium (1.2 µg/L [J] in BRW-084 in March) were detected in FY 2016. Potential sources of these metals in this area are unknown and the detected concentrations are far below any criterion level.

K-901-A Holding Pond area—Exit pathway groundwater in the K-901-A Holding Pond area (Fig. 3.36) is monitored by four wells (BRW-035, BRW-068, UNW-066, and UNW-067) and two springs (21-002 and PC-0). Very low concentrations (< 5 µg/L) of VOCs are occasionally detected in wells adjacent to the K-901-A Holding Pond. However, these contaminants are not persistent in groundwater west and south of the pond. VOCs detected in the K-901-A Holding Pond exit pathway wells during FY 2016 include cis-1,2-DCE at 0.46 µg/L (J) and TCE at 0.31 µg/L (J) in the March sample from well BRW-035, and TCE at 0.48 J µg/L in the March sample from well UNW-066. At well BRW-035 alpha and beta activity levels have remained fairly consistent over the past several years with nondetect concentrations of alpha and beta levels between 10–15 pCi/L. Similarly, well BRW-068 has experienced fairly stable, low-to-nondetect concentrations of alpha and < 10 pCi/L of beta activity. In the past 2 years at well UNW-066, the alpha activity has exceeded the 15 pCi/L screening level in three of four samples, with a value of 62.5 pCi/L in August 2016. Likewise, the beta activity levels in well UNW-066 have exceeded the 50-pCi/L screening level in three of four samples collected during FY 2015–2016. During August 2016, the beta activity was 79.9 pCi/L. In well UNW-067, the alpha and beta activity screening levels were not exceeded during FY 2016. Technetium-99 was analyzed in samples from wells UNW-066 and UNW-067 during FY 2016. Low concentrations of ^{99}Tc were detected in samples from both wells. In well UNW-066, the ^{99}Tc level was 8.81 pCi/L in March and, in well UNW-067, the level was 6.03 pCi/L in September.

TCE is the most significant groundwater contaminant detected in the springs, and the historic TCE concentrations are shown in Fig. 3.52. Spring PC-0 was added to the sampling program in 2004. During April through 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 the PC-0 spring is presumed to be disposed waste at the former Construction Spoil Area (K-1070-F) located on Duct Island. The TCE concentrations in PC-0 spring have varied between nondetectable levels and 26 µg/L and have decreased from their highest measured value in 2006 to concentrations less than or several times the drinking water standard. During FY 2016, cis-1,2-DCE was detected at estimated low concentrations < 1 µg/L in PC-0 samples collected in November 2015 and in March and September 2016.

Although TCE is the principal contaminant detected at spring 21-002, 1,1-DCE, carbon tetrachloride, chloroform, and PCE were present at concentrations less than 5 µg/L. The TCE concentration at spring 21-002 tends to vary between > 5 µg/L and 25 µg/L, and this variation appears to be related to variability in rainfall which affects groundwater discharge from the K-1070-A VOC plume. During FY 2016, the TCE detected concentrations ranged from a high of 24 µg/L in November 2015, to a low of 5.4 µg/L in March 2016. Alpha activity was detected at 3.13 pCi/L and 4.09 pCi/L in November and March samples, respectively; and detected beta activities were 20.8 pCi/L and 9.08 pCi/L in November and May samples, respectively. Technetium-99 detections ranged from 2.71 pCi/L to 19.9 pCi/L, much lower than the 900-pCi/L MCL-DC. Uranium-234, ^{235}U, and ^{238}U were detected at < 1 pCi/L.

The 10-895 spring discharges groundwater from beneath Black Oak Ridge along Poplar Creek, near Blair Road. Black Oak Ridge is located behind the ETTP site. The source of TCE has not been confirmed. Although the Contractors Spoil Area is the closest upgradient waste disposal site, it is possible that contaminants from the more distant K-1070-A site could migrate via karst groundwater flow pathways to the spring. TCE concentrations measured in samples from spring 10-895 are shown on Fig. 3.36. The highest TCE concentration measured was 5.6 µg/L. Cis-1,2-DCE was detected at 0.34 µg/L (J) in the September sample.

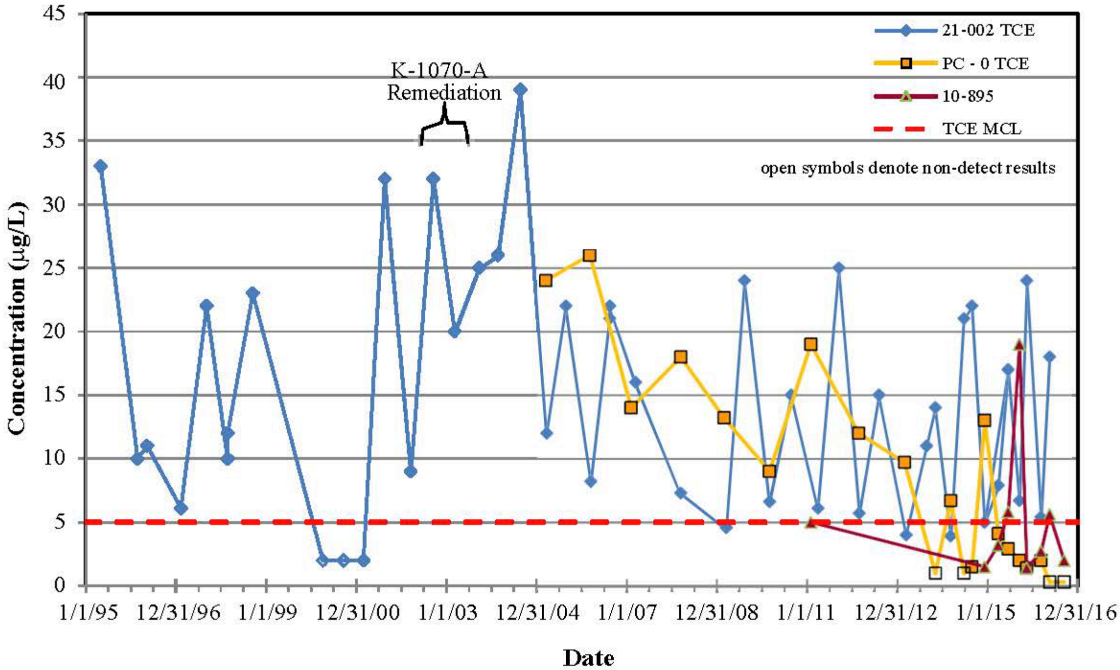

Fig. 3.36. TCE concentrations in selected ETTP area springs.

K-770 area—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 Clinch River (Fig. 3.32). Measured alpha and beta activity levels were below screening levels during FY 2016, with the exception that beta activity in the September 2016 sample from well UNW-013 had 50.8 pCi/L (50 pCi/L is the beta activity screening level). Figure 3. 37 shows the history of measured alpha and beta activity in this area. Historic analytical results indicate that the alpha activity is largely attributable to uranium isotopes, and well UNW-013 historically contained ^{99}Tc that is a strong beta-emitting radionuclide responsible for the elevated beta activity in that well. Much lower alpha and beta activity levels have been measured in well UNW-015 since sampling was resumed in FY 2013 following an interruption in sampling during site remediation activities.

K-1085 Drum Burial/Old Firehouse Burn area—In October 2000, the TDOT encountered three buried drums adjacent to State Route 58 (locally known as Highway 58) during a road-widening project. This discovery triggered a CERCLA Removal Action to identify buried waste at the site and to excavate and dispose of the waste at the Environmental Management Waste Management Facility (EMWMF). Approximately 77 m^3 of mixed RCRA, TSCA, and low-level waste (LLW) was excavated from five separate locations at the 12,000 ft^2 site. In 2005, the area was further characterized, and in 2008, an additional 300 yd^3 of soil were removed for disposal. During 2010−2011, four groundwater monitoring wells were installed at the site. One bedrock well (BRW-118) was installed at the downslope edge of the excavation area to monitor contaminants in the bedrock groundwater zone, which might indicate the presence of DNAPLs beneath the site. Three unconsolidated zone wells were installed radial to the excavation site in directions of potential groundwater movement. Initial sampling of all four wells showed the presence of VOC contamination in two of the wells, BRW-118 and UNW-135, and in a surface seep location (247). Wells BRW-118 and UNW-135 are sampled semiannually to provide contaminant trend data. Figure 3.38 shows the VOC monitoring results from BRW-118 and UNW-135. In well BRW-118 PCE and TCE both exceed their 5 µg/L MCL screening levels and both exhibit seasonal fluctuations. The detected concentrations of cis-1,2-DCE, carbon tetrachloride, and chloroform in well BRW-118, are all less than MCL screening levels. At well UNW-135, TCE continually exceeds its 5 mg/L MCL screening level, although cis-1,2-DCE concentrations dipped below its 70 µg/L MCL screening level between March 2014 and March 2016, with the most recent point reaching 85 µg/L. The measured VOC concentrations at the site are indicative of dissolved phase contamination in the groundwater. Concentration trends at the K-1085 site are generally decreasing although concentrations fluctuate based on seasonal influences.

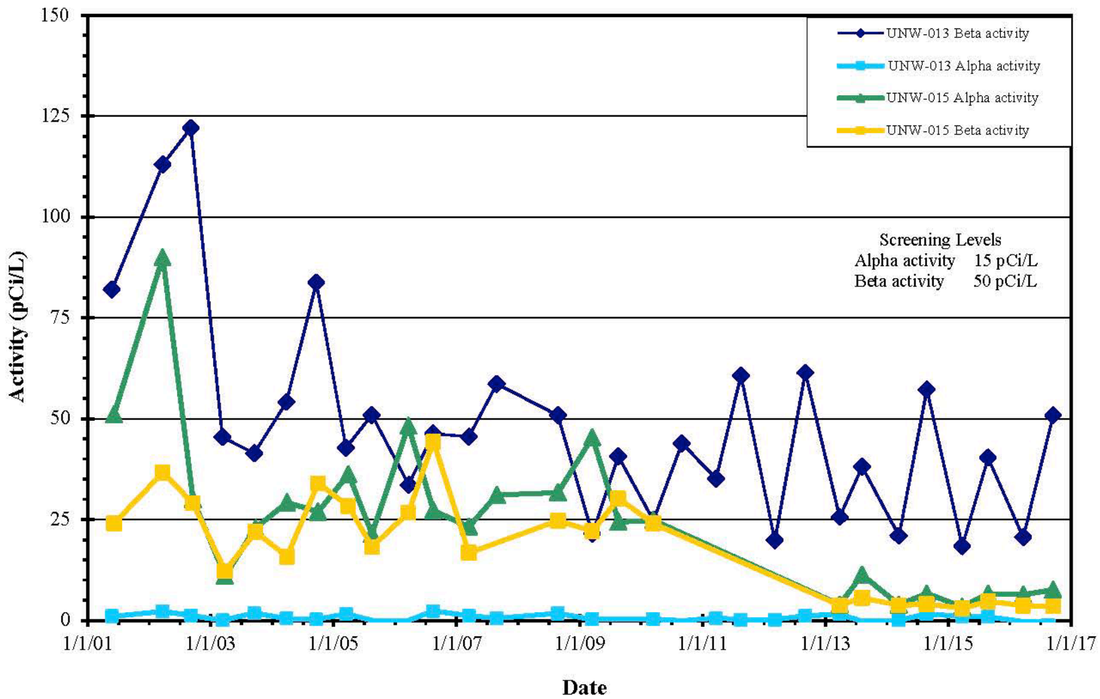

Fig. 3.37. History of measured alpha and beta activity in the K-770 area.

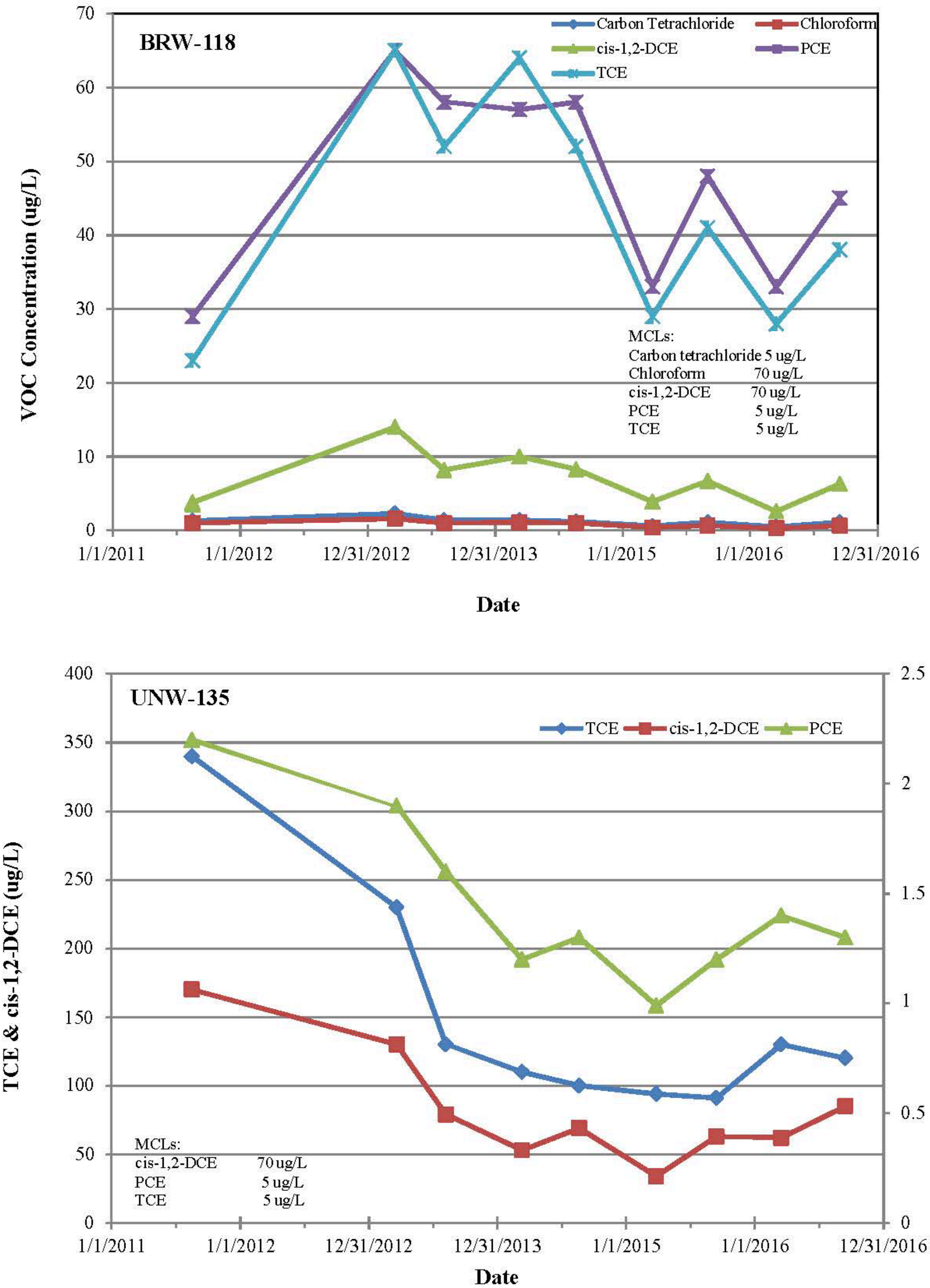

Fig. 3.38. VOC concentrations in groundwater at K-1085.

3.6.4.2 ^{99}Tc in ETTP Site Groundwater

Technetium-99 is a beta particle-emitting radionuclide. There is not a specific drinking water MCL for ^{99}Tc, but its MCL-DC concentration is 900 pCi/L. Technetium-99 has been a known groundwater contaminant at the ETTP site for many years. Past CERCLA investigations have sampled and analyzed for ^{99}Tc in groundwater. In the past, the highest ^{99}Tc activity levels (as high as 6,000+ pCi/L) have been observed beneath the K-1070-A burial ground, where concentrations at a couple of wells remain in the 200–500 pCi/L range. The area along Mitchell Branch near the former K-1407 Ponds has residual ^{99}Tc contaminated groundwater from the operational era of the ponds, and possibly from K-1420, with much lower activity levels (<100 pCi/L).

The environmental fate of some metal contaminants in groundwater is strongly dependent on the pH and redox state of the water. A summary review of the environmental behavior of ^{99}Tc in the environment was published by Pacific Northwest National Laboratory (PNNL; PNNL-15372) related to tank wastes at the Hanford Site in the state of Washington. Background information from that report is used in preparation of the following interpretation of potential ^{99}Tc mobility in groundwater at the ETTP site.

Under electrochemically oxidizing conditions, technetium forms the negatively charged pertechnetate ion (TcO_4^-) with technetium assuming a valence of 7^+. The pertechnetate ion is quite mobile in aqueous settings since negatively charged ions do not tend to adsorb to mineral surfaces in soil or rock, which inherently tend to have negatively-charged to neutrally-charged surfaces. Under electrochemically reducing conditions, the pertechnetate ion is not stable and technetium may assume a 4^+ valence. In the 4^+ valence state, technetium may form ionic combinations with oxygen and hydroxyl groups, which may be amorphous solids with lower solubilities than the pertechnetate ion. In the 4^+ valence, in the absence of complexing ligands, technetium may adsorb to mineral and organic matter surfaces, and may become bound in low solubility technetium oxyhydroxides. In the 4^+ valence, technetium may also form soluble complexes with carbonate/bicarbonate ions as well as sulfate. Thermodynamic and directly measured speciation and solubility relationships for technetium carbonate and sulfate complexes have not been established, although these complexes may be important to technetium mobility in reducing electrochemical environments.

In addition to standard physical chemical conditions, microbial processes are important as potential mediators that can lead to reduction of technetium from the highly soluble and mobile 7^+ valence in the pertechnetate ion to the 4^+ valence in the lower solubility forms. Microbial processes often occur in very localized regions in the subsurface where chemical conditions are favorable. This fact is evident in groundwater at the ETTP site where intrinsic microbial communities are known to slowly degrade chlorinated organic compounds in some areas but not in other areas. Factors that may favor microbial reduction of dissolved compounds include relatively slow groundwater movement, which limits influx of dissolved oxygen via groundwater recharge; presence of organic carbon that can serve as electron donor material; and presence of microbes capable of affecting the required molecular transformations.

During demolition of the K-25 east wing in the winter of 2013, fugitive dust suppression misting and rainfall carried ^{99}Tc off the work area. Contaminated runoff apparently percolated through soil and into subsurface utility lines and probably into backfill surrounding the buried utilities. Groundwater sampling for ^{99}Tc was increased in wells in the general vicinity of the east wing and where wells were available along potential groundwater transport pathways. During FY 2016, the third and final phase of subsurface investigation work was completed. The investigation included additional shallow piezometer installation and sampling along the abandoned electrical duct bank to the north of the ^{99}Tc source area and installation of two bedrock wells and one additional unconsolidated well in locations downgradient from the source area.

The scope of investigations focused on understanding the role of site subsurface infrastructure in migration of ^{99}Tc away from the K-25 east wing source area and the involvement of groundwater. The investigations primarily used push technology to sample soil along and beneath portions of SDs, sanitary sewer pipes, and the abandoned electrical ductbank that formerly carried electrical cables along the east side of the K-25 building. Temporary polyvinyl chloride (PVC) piezometers were installed in each of the Phase 1 and 2 boreholes to allow observation of groundwater levels and to provide groundwater samples for ^{99}Tc and/or VOC analyses. The Phase 3 investigation included seven push probe sample locations and installation of two permanent bedrock monitoring wells and one unconsolidated zone well.

The investigations determined that although ^{99}Tc entered and traveled through the sanitary sewer and the SD that discharges to the K-1007-P1 Holding Pond, the amount of ^{99}Tc transport in backfill outside those pipes was minimal. The investigation found that ^{99}Tc transport through the abandoned underground electrical ductbank was an important transport pathway along the east side of the K-25 building as far south as ductbank manhole row 21. RAs conducted in Zone 1 included plugging the ductbank manholes with cement grout from row 21 to the south and west to the former steam plant located near the Clinch River in the K-770 area. To minimize the remaining available transport flow path, 38 additional manholes in Zone 2 were grouted starting with manhole row 22, moving northward all the way through the demolition area and beyond. Since chlorinated VOCs are the most common groundwater contaminant at ETTP, groundwater at all locations was sampled and analyzed for these contaminants. VOCs were found to not be significant contaminants in any of the groundwater. Twenty-one of the groundwater investigation locations installed in the RmSE are retained for long term monitoring and to support future CERCLA groundwater decisions at ETTP. During FY 2016, groundwater was analyzed for ^{99}Tc in samples from 68 wells across the ETTP area. The highest concentrations remain centered along the eastern side of the K-25 Building. An *Addendum to the Technetium-99 Removal Site Evaluation at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2663&D1/A2) was issued in August 2016, providing documentation of the investigation and results.

3.6.4.3 Technetium-99 sampling investigation

The conclusion of the *Technetium-99 Removal Site Evaluation at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2663&D1) indicated the measured levels of Tc-99 in site surface water releases were in compliance with applicable regulatory requirements and DOE Orders in prior years and do not pose a threat to human health and the environment. The discussion that follows describes the sewage sampling that continued in FY 2016.

3.6.4.4 Sanitary sewer

The Tc-99 sampling for FY 2016 continued to show declining trends:

- Concentrations at the Rarity Ridge Lift Station #1 ranged from a high of 85 pCi/L to a low of 6 pCi/L.
- Concentrations at the Rarity Ridge Effluent Weir ranged from a high of 90 pCi/L to a low of 25 pCi/L.
- Concentrations at the Rarity Ridge Biological Treatment Aeration Basins ranged from a high of 7,690 pCi/L to a low of 3,350 pCi/L.
- Concentrations at the Rarity Ridge Digester ranged from a high of 171,000 pCi/L to a low of 68,200 pCi/L.

- During FY 2016, five tanker shipments of approximately 5,000 gal per tanker of digester sludge were pumped and shipped off-site for treatment as LLW.

The ^{99}Tc sewage treatment network influent concentrations and STP effluent discharges in FY 2016 were both in compliance with DOE Order 458.1 and state of Tennessee annual SOF criteria.

3.7 Biological Monitoring

The ETTP BMAP consists of two tasks designed to evaluate the effects of ETTP historical 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 3.39 shows the major water bodies at ETTP and Fig. 3.40 shows the BMAP monitoring locations along Mitchell Branch.

3.7.1 Bioaccumulation Studies

The bioaccumulation task includes monitoring of caged Asiatic clams (*Corbicula fluminea*; Fig. 3.41) placed at selected locations around ETTP, and the collection and analysis of fish from Mitchell Branch and three major ponds on the site. Both clams and fish from uncontaminated offsite locations are also analyzed as points of reference. While historically the primary contaminant of concern (COC) for the bioaccumulation task at ETTP has been PCBs, in recent years mercury has been added to the list of legacy COCs at selected locations.

In 2016, the clams were deployed for four weeks. They were then analyzed for PCBs (as Aroclors; Fig. 3.42) and, at all but one of the sites, for total and methylmercury (Fig. 3.43). In general, there is significant variability in PCB concentrations in the clams from year to year, although there are some overall trends of note. In 2016, the greatest concentrations of PCBs were found in the clams from storm water Outfall 190 and downstream of that location in Mitchell Branch, as has been seen in recent years. The concentrations of PCBs in the clams from the K-1007-P1 pond were significantly lower in the 2015 and 2016 samples than in the 2013 and 2014 samples.

Clams from the Mitchell Branch watershed, the K-901-A and K-1007-P1 ponds, and two oil separators (K-897-J and K-897-K) were analyzed for mercury (both total mercury and methylmercury) in 2016. The highest mean total mercury concentrations were found in the clams from storm water Outfall 180 (0.136 µg/g). Clams from the section of Mitchell Branch between K-1700 and Outfall 190 also had elevated concentrations, ranging from a low of 0.03 µg/g to a high of 0.08 µg/g. At other sites, mercury concentrations in clams ranged from at or near reference values to fourfold higher (e.g., from 0.019 µg/g to 0.078 µg/g). Clams were also analyzed for methylmercury, which typically makes up a small fraction of the total mercury in clams. Methylmercury concentrations in clams deployed in 2016 ranged from a low of 0.005 µg/g in the clams from K-897-K to a high of 0.020 µg/g in the clams from MIK 0.2. In most instances, the methylmercury concentrations were only slightly elevated with respect to concentrations seen in the clams from the reference locations (an average of 0.011 µg/g).

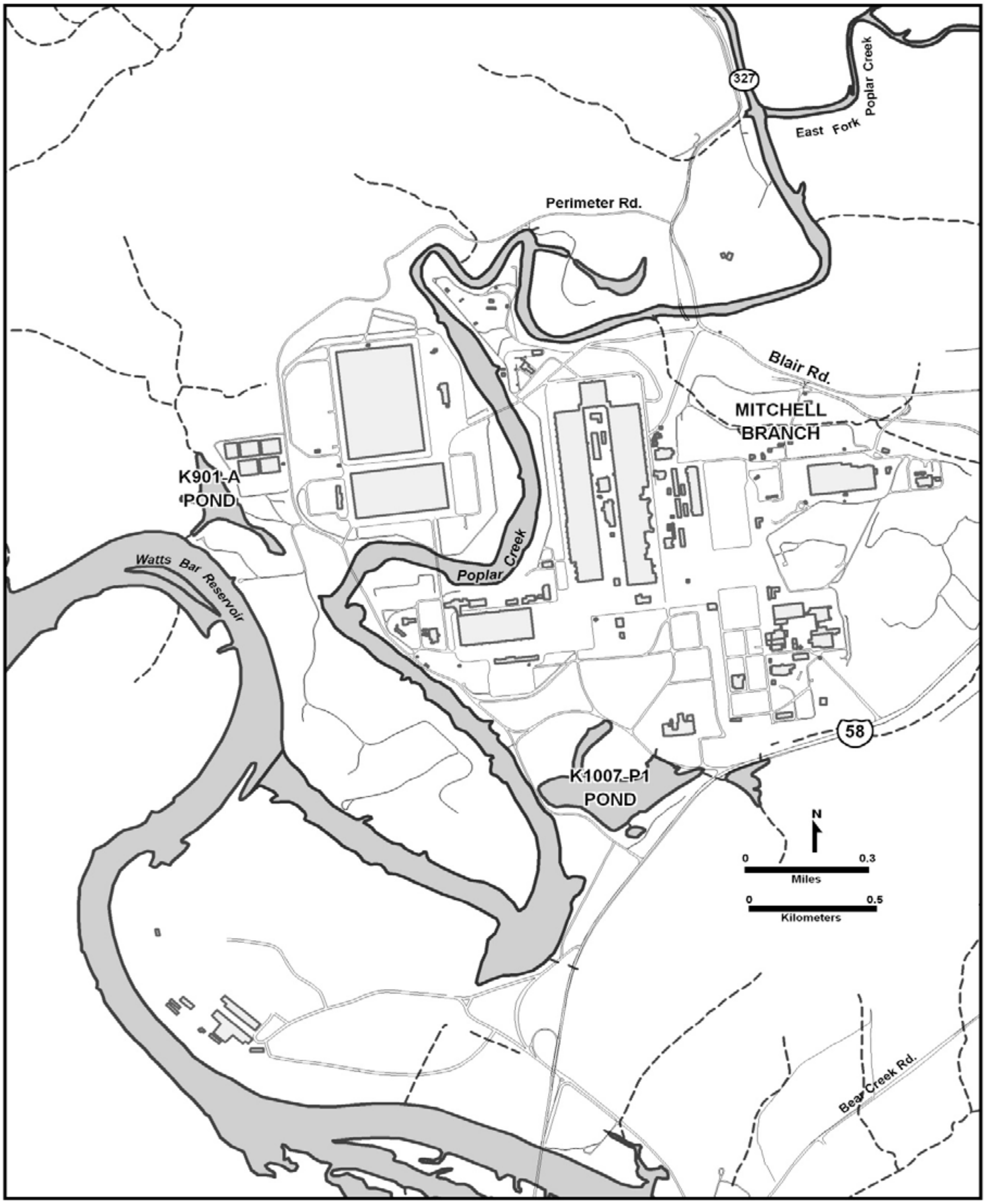

Fig. 3.39. Water bodies at the East Tennessee Technology Park.

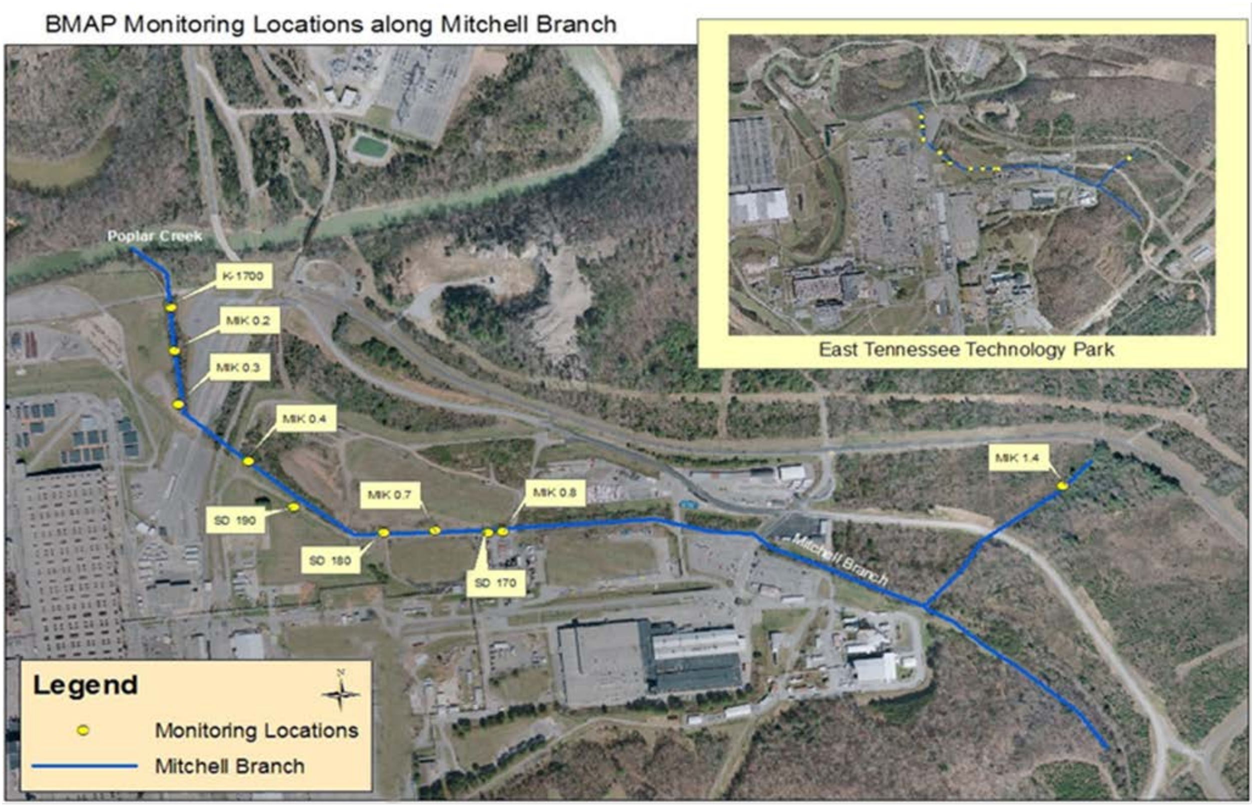

Fig. 3.40. Major storm water outfalls and biological monitoring locations on Mitchell Branch.
(BMAP = Biological Monitoring and Abatement Program, MIK = Mitchell Branch kilometer, and SD = storm water outfall/storm drain)

Bioaccumulation monitoring in the K-1007-P1 pond, K-901-A pond, K-720 slough, and Mitchell Branch involves sampling fish (Fig 3.44) and analyzing the tissues for PCB concentrations (Fig. 3.45). Typically, fillets of game fish are used as a monitoring tool to assess human health risks, while whole-body composites of forage fish are used to assess ecological risks associated with exposure to PCBs. Target species vary from site to site, depending upon the habitat. The target species for bioaccumulation monitoring in 2016 in the K-1007-P1 pond was bluegill sunfish (*Lepomis macrochirus*) (Fig. 3.46). In Mitchell Branch, the target species was the redbreast sunfish (*Lepomis auritus*). In the K-901-A pond and the K-720 slough, the target species were the gizzard shad (*Dorosoma cepedianum*) and largemouth bass (*Micropterus salmoides*). As there were not enough largemouth bass, carp (*Cyprinus carpio*) were also collected.

Whole body samples (six composites of 10 bluegill) and fillets from 20 individual bluegills were analyzed for PCBs to assess the ecological and human health risks associated with PCB contamination in the K-1007-P1 pond. Whole body bluegill composites from the K-1007-P1 pond averaged 1.91 µg/g total PCBs, down slightly from 2.03 µg/g in 2015. Fillets averaged 1.06 µg/g total PCBs, slightly higher than concentrations seen in 2015 (0.45 µg/g). Average PCB concentrations in sunfish fillets collected in Mitchell Branch were 1.95 µg/g, slightly lower than the levels seen in 2015 (2.71 µg/g). The concentrations observed in fillets of largemouth bass from the K-901-A pond (0.90 µg/g) increased slightly from the concentrations seen in the 2015 monitoring, 0.66 µg/g. Fillets of carp from the K-901-A pond averaged 1.43 µg/g. Gizzard shad whole body composite samples from K-901-A pond (4.52 µg/g) decreased slightly from the concentrations seen in the 2015 monitoring (5.41 µg/g). Levels of PCBs in bass, gizzard shad, and carp from the K-720 slough (0.07 µg/g, 0.40 µg/g, and 0.31 µg/g, respectively) were considerably lower than for the same species from the K-901-A pond.

ORNL 2010-G00934/chj

Fig. 3.41. Asiatic clam (*Corbicula fluminea*).

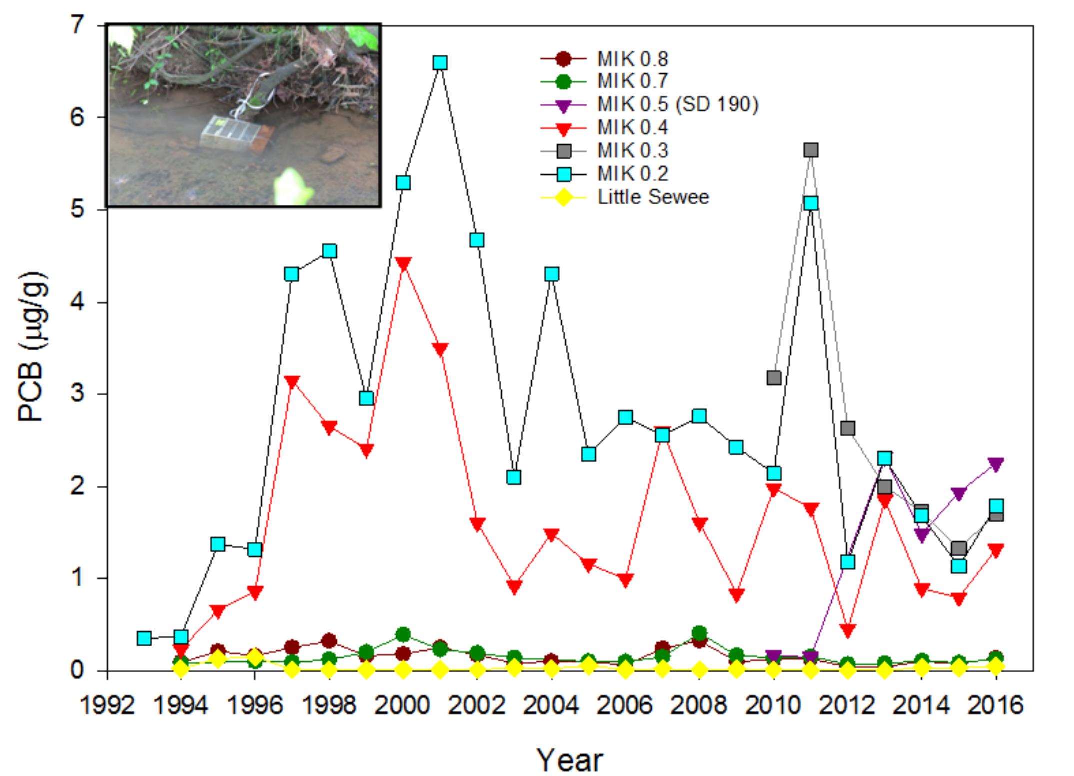

Fig. 3.42. Mean total polychlorinated biphenyl (PCB) (µg/g, wet wt; 1993–2016) concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch. *N = 2 composites of 10 clams each per year. Shown in yellow are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tennessee). Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260. (MIK = Mitchell Branch kilometer)*

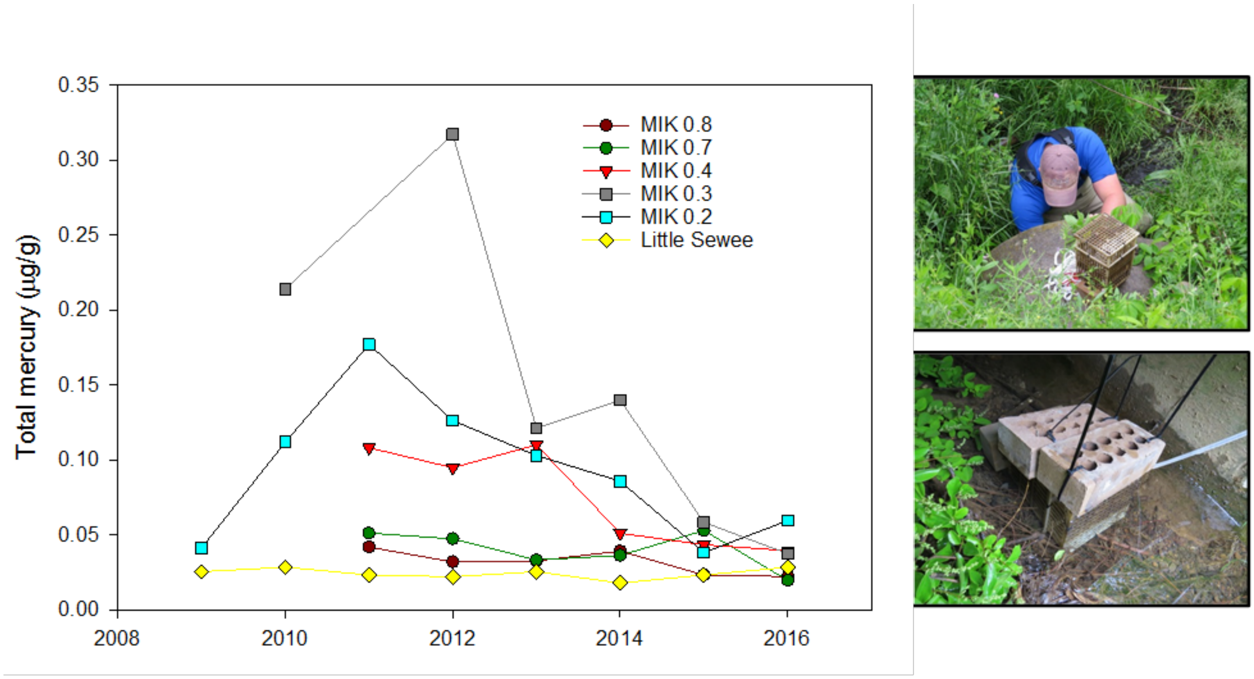

Fig. 3.43. Mean total mercury (µg/g wet wt; 2009–2016) concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch. *N = 2 composites of 10 clams each per year. Shown in yellow are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tennessee). (MIK = Mitchell Branch kilometer)*

Fig. 3.44. Fish bioaccumulation sampling at K-1007-P1 pond.

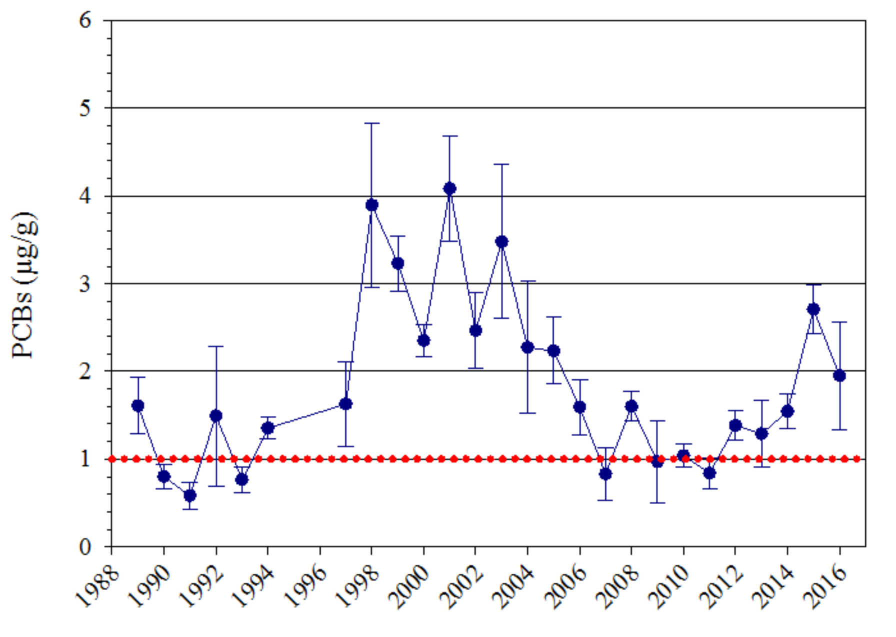

Fig. 3.45. Mean (+/- standard error) polychlorinated biphenyl (PCB) concentrations (µg/g, wet wt) in redbreast sunfish fillets in Mitchell Branch (MIK 0.2).

1989–2016, N = 6 fish per year. Shown in red is the fish advisory level for PCBs (1 µg/g).

Fig. 3.46. Bluegill sunfish (Lepomis macrochirus).

In addition to being analyzed for PCBs, selected species collected from several locations were analyzed for total mercury (Fig. 3.47). Previous studies have shown that methylmercury accounts for more than 95% of the total mercury in fish, so a separate analysis for methylmercury was not conducted. The EPA's recommended limit for mercury in fish fillets is 0.3 µg/g. The mean mercury concentration in sunfish fillets collected at MIK 0.2 was 0.41 µg/g in 2016, the same as in 2015. Average mercury concentrations in fish in Mitchell Branch in recent years have ranged between 0.3 µg/g and 0.5 µg/g, with about 10–20% variability within the annual collection. Fillets of sunfish from the reference site, Hinds Creek, averaged 0.07 µg/g of mercury in 2016.

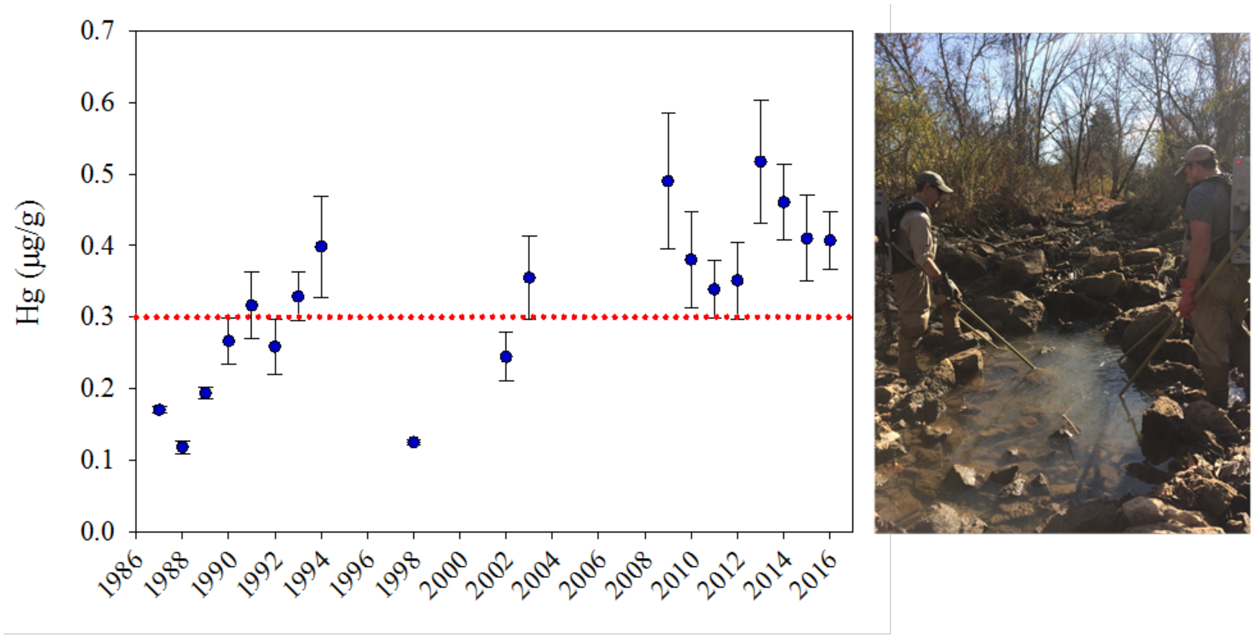

Fig. 3.47. Mean total mercury (Hg) concentrations (µg/g, wet wt) in redbreast sunfish fillets in Mitchell Branch (MIK 0.2). *1989–2016, N = 6 fish per year. Shown in red is the fish advisory level mercury (0.3 µg/g). The photograph shows fish electrofishing activities in lower Mitchell Branch.*

3.7.2 Instream Monitoring of Biological Communities

In April 2016, the benthic macroinvertebrate community at four Mitchell Branch locations (MIKs 0.4, 0.7, 0.8, and 1.4) was sampled using standard quantitative techniques (Fig. 3.48). MIK 1.4 was the reference location. Results of monitoring in 2016 using the ORNL protocols show little change at the three uppermost locations (MIKs 1.4, 0.8, and 0.7). The number of pollution-intolerant species is highest at MIK 1.4 (Fig. 3.49). Pollution-tolerant species make up a higher percentage of the total number of individuals at MIK 0.7. Otherwise, except for the period from 2010–2012, trends in change at MIK 0.4 have generally mirrored those at MIKs 0.7 and 0.8. In recent years, the benthic macroinvertebrate community at MIK 0.7 and MIK 0.8 has shown no major persistent change in trends of either the mean number of taxa (taxonomic richness of all taxa) or the mean number of pollution-intolerant taxa (i.e., the taxonomic richness of the *Ephemeroptera*, *Plecoptera*, and *Trichoptera* [EPT]— mayflies, stoneflies, and caddisflies). These results show that the benthic community at MIK 0.4 continues to be negatively impacted while the results for MIKs 0.7 and 0.8 suggest that the macroinvertebrate community at those sites is affected to a lesser degree.

Since August 2008, TDEC protocols, which assess both community and habitat characteristics, have also been used at the MIK 0.4, 0.7, and 0.8 monitoring locations. Beginning in August 2009, the use of TDEC protocols was expanded to include MIK 1.4 as well (Fig. 3.50). The 2016 biotic index indicated that the communities at MIKs 0.7, 0.8, and 1.4 were nonimpaired, and the community at MIK 0.4 was slightly impaired. The habitat assessment (which primarily considers the physical aspects of the stream to determine its suitability to support biological communities) in 2016 indicated habitat impairment at MIKs 0.4, 0.7, and 1.4, while the habitat at MIK 0.8 was rated as unimpaired. Overall, results using TDEC's semiquantitative protocols and ORNL's quantitative protocols since 2008 have been in general agreement that the macroinvertebrate community at MIK 0.4 scores from slightly to moderately impaired, and the communities at MIKs 0.7 and 0.8 score from slightly impaired to unimpaired. Habitat assessments show evidence of some impairment at all sites.

Fig. 3.48. Benthic macroinvertebrate sampling in Mitchell Branch.

Fish communities in MIKs 0.4 and 0.7 and at local reference sites were sampled in 2016. In Mitchell Branch, species richness (number of species; Fig. 3.54), density (fish/m²; Fig. 3.52), and biomass were assessed for comparison with area reference streams. Results for 2016 showed changes within the normal range of variation for species richness. However, most of the species found during the community studies sampling tend to be more tolerant of less than optimal conditions. At the most downstream site (MIK 0.4), species richness (Fig. 3.54) increased from 2015, with a slight decrease in both density and biomass. MIK 0.7 had an increase in species richness and biomass, and a decrease in density. Overall, variations in these three parameters are typical of streams that have been severely impacted and are still recovering. While the condition of the fish communities over the last several years has been relatively stable, they have yet to reach conditions typical of less impacted streams in the area; and the stream is still dominated by more tolerant fish species.

Similar to stream sampling, the K-1007-P1 pond is sampled annually to assess the diversity and density of resident fish populations. The pond is isolated from Poplar Creek by a weir grate at the outfall, preventing migration of fish into or out of the pond. Remediation efforts in 2007 focused on creating a fish community dominated by short-lived sunfish. Before remediation activities, the fish community contained high densities of predatory fish, as well as grazers, which fed on phytoplankton. In 2016, the fish community was comprised primarily of sunfish (> 65%) and gizzard shad (22.4%), with largemouth bass and other species comprising small percentages. These numbers continue to vary from year to year, indicating that the population has not reached a state of balance yet, but they do continue to indicate a movement towards the goal of a sunfish-dominated community.

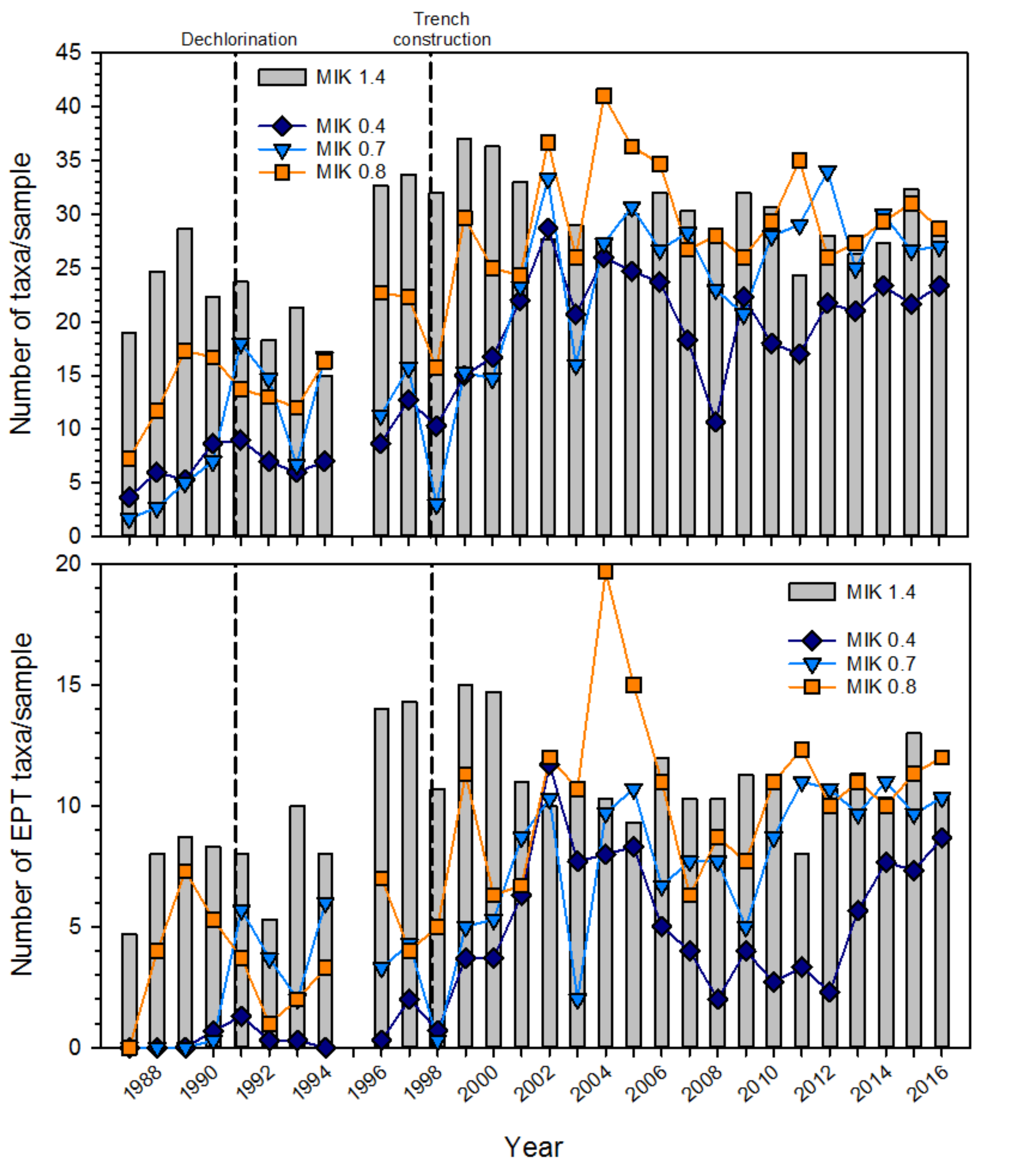

Fig. 3.49. Mean taxonomic richness in Mitchell Branch, 1987–2016 *(a) number of all taxa, and (b) number of pollution-intolerant Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies, or EPT) taxa per sample. Samples were not collected in April 1995, as indicated by the gap in the lines. (MIK = Mitchell Branch kilometer)*

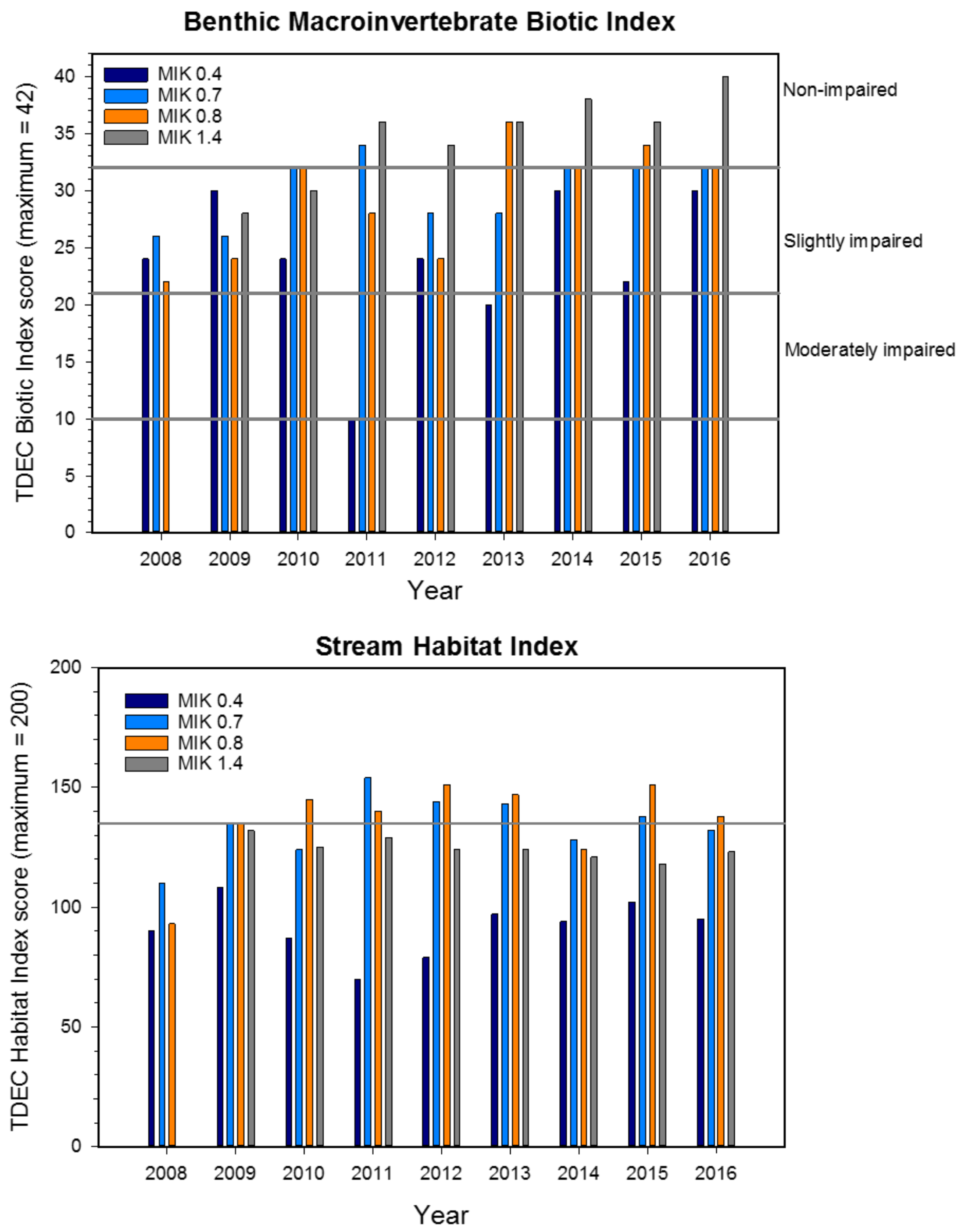

Fig. 3.50. Temporal trends in Tennessee Department of Environment and Conservation (TDEC) Benthic Macroinvertebrate Biotic Index (a) and Stream Habitat Index (b) scores for Mitchell Branch, August 2008–2016. *Horizontal lines in both graphs show the lower thresholds for narrative index ratings; respective narrative ratings for each threshold are shown on the right side of each graph. (MIK = Mitchell Branch kilometer)*

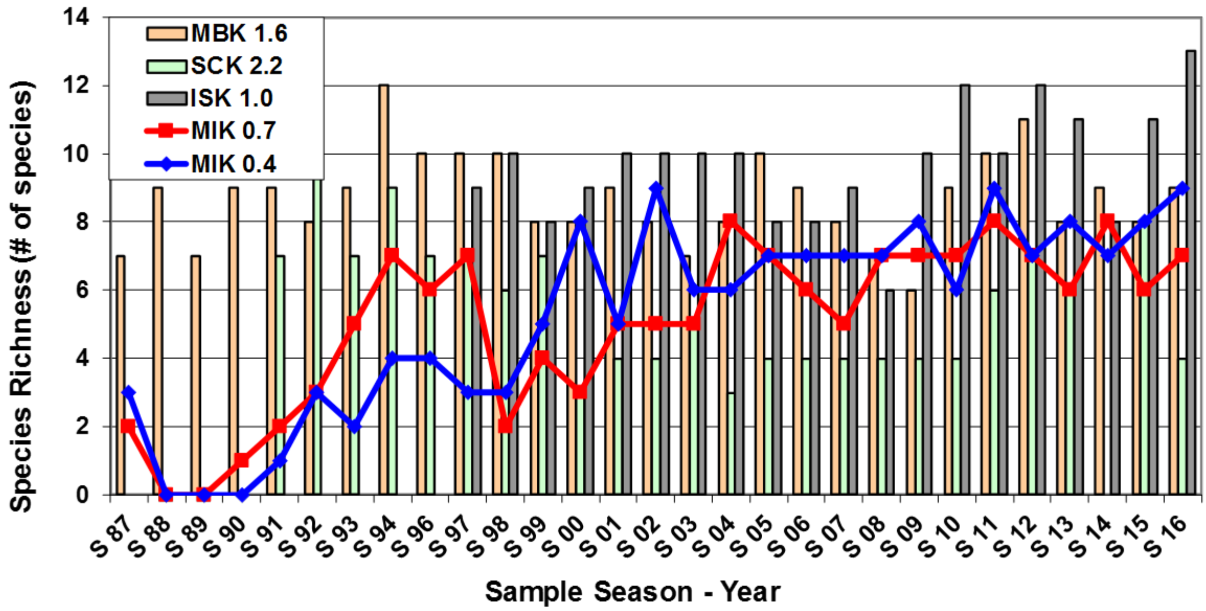

Fig. 3.51. Species richness for fish communities at sites in Mitchell Branch and in reference streams. *(ISK = Ish Creek kilometer, MBK = Mill Branch kilometer, MIK = Mitchell Branch kilometer, SCK = Scarboro Creek kilometer)*

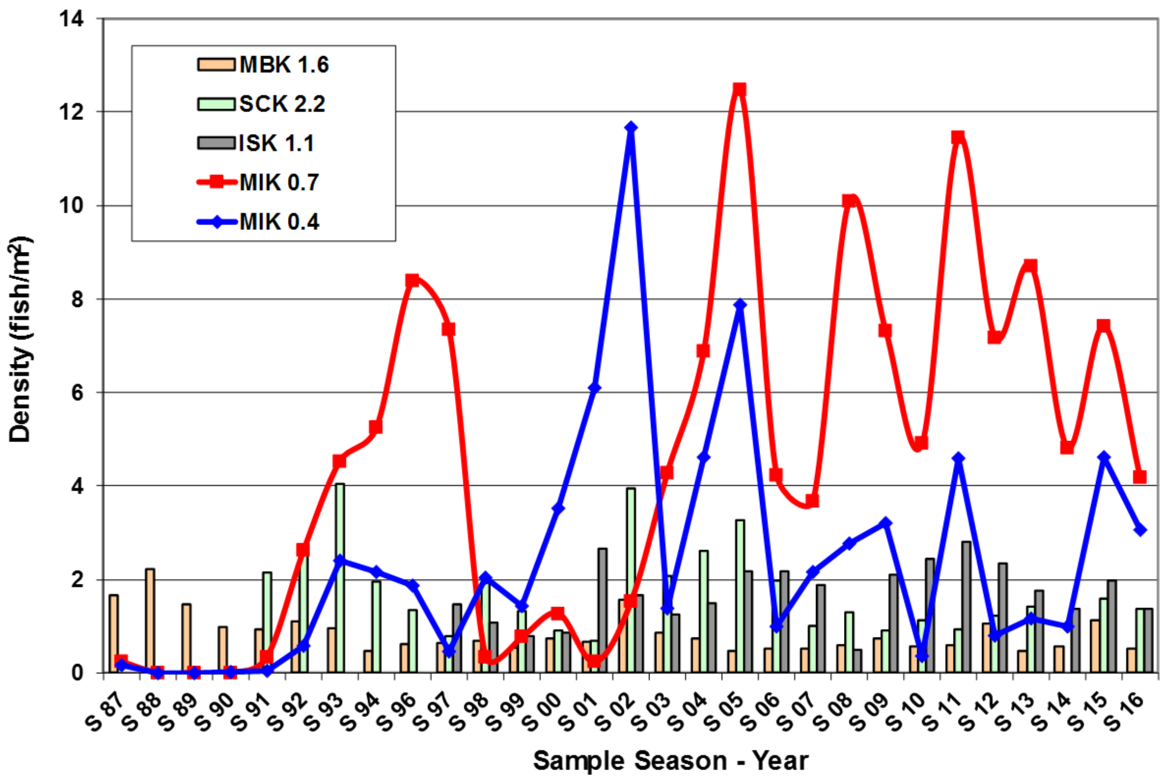

Fig. 3.52. Density for fish communities at sites in Mitchell Branch, and in reference streams. *(ISK = Ish Creek kilometer, MBK = Mill Branch kilometer, MIK = Mitchell Branch kilometer, SCK = Scarboro Creek kilometer)*

3.8 Environmental Management and Waste Management Activities

Waste Management Activities

Restoration of the environment, D&D of facilities, and management of legacy wastes constitute the major operations at ETTP.

CWTS is a small water treatment unit for chromium-contaminated groundwater that sits within the existing CNF footprint. CWTS came online in late 2012, and handles purge water from groundwater monitoring, as well as the chromium collection system water. Effluent from CWTS discharges into the Clinch River through an existing CNF discharge line. Section 3.6.2.7 provides a more detailed discussion of CWTS operations.

3.8.1 Environmental Remediation Activities

EM continued remediation activities to reduce ETTP soil contamination in 2016. In FY 2016 the groundwater treatability study that will help determine the effectiveness of different treatment technologies that will assist in identifying and selecting the ETTP's final groundwater remedy continued. The 2016 effort included characterization to support the design of a pilot scale *in situ* thermal treatment study in the K-1401 area. The work plan was updated and approved by regulators and planning was initiated. Sitewide groundwater and surface water data are being evaluated in conjunction with the treatability study activities that support the preparation of CERCLA documentation leading to a final sitewide ROD.

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 exposure units (EUs) that vary in size.

3.8.1.1 Zone 1

The interim Zone 1 ROD, which documents the cleanup method for the site, required EM to remediate soil to a depth of 10 ft (suitable for the protection of an industrial work force) and remove sources of groundwater contamination. As part of this interim ROD, an evaluation of the K-1065 former waste storage area was conducted and the determination was made that no further cleanup is required in this area. This outcome makes the area available for industrial use.

3.8.1.2 Zone 2

The Zone 2 ROD divides the zone into seven geographic areas and 44 EUs that range in size from 6 to 38 acres.

In FY 2016, UCOR completed remediation of EU Zone 2-28 and the confirmation sampling. EPA and TDEC approved concurrence forms documenting the completion. The area is in the former administrative section of ETTP and generally housed offices and laboratories. The area has now been recommended for unrestricted industrial use.

The Building K-25 and K-31 footprint areas were also characterized. It was determined that the K-25 footprint will require remediation, but that the K-31 footprint will require no further action. The K-25 footprint has been dedicated for historical commemoration and interpretation activities. The characterization data are being used to evaluate potential end states that can preserve the building slab.

The remainder of Zone 2 is still being characterized. EU Zones 2-28 and 2-41 were remediated. This remediation action resulted in the disposal of 5,850 yds^3 of soil and debris at EMWMF and the Nevada National Security Site. No further remedial actions will be required at these two areas.

3.8.1.3 Technetium-99 GW Investigation

Elevated levels of ^{99}Tc, a slowly decaying isotope, were observed in groundwater, storm water, and sanitary sewage during the demolition of the K-25 building. In 2016, the shallow groundwater investigation near the K-25 Building slab was completed. It was determined that the migration of ^{99}Tc outside of sanitary sewer and storm drain lines in subsurface utility corridors has been limited. However, 21 locations will be retained for future groundwater monitoring.

3.8.1.4 Building K-27 Demolition

Demolition of the K-27 building in 2016 marked the first time in the world that all of a former enrichment complex's process buildings were successfully removed. UCOR completed the demolition nine months ahead of schedule and $2.8 million under budget.

3.8.1.5 Building K-731 Demolition

In addition to completing the Bldg. K-27 demolition, demolition of buildings that supported the gaseous diffusion operations also were conducted in 2016.

Demolition began on the K-731 Switch House. The three-floor building was built in 1944 to provide electrical power to the K-27 process building, and was later enlarged to also provide electrical power to the K-29 process building.

3.8.1.6 Building K-1037 Deactivation Begins

The deactivation of K-1037 began in 2016. Deactivation is the initial step that prepares the facility for eventual demolition. The facility is one of the highest remaining cleanup priorities at ETTP.

K-1037 was originally a warehouse that was later converted into a facility that produced the porous barrier material used in the gaseous diffusion process to separate the ^{235}U from the ^{238}U isotopes. Currently, the facility contains the barrier material from the sites former enrichment operations.

Work conducted in 2016 included asbestos abatement, universal hazardous waste disposal, chemical removal, and radiologic surveys. All electrical and mechanical hazardous energy sources were also removed. Temporary power to support facility deactivation activities was installed. Demolition is expected to begin in 2018.

3.8.1.7 Poplar Creek Deactivation Underway

The deactivation of the 27 Poplar Creek facilities was underway in 2016, with approximately 40% of the deactivation completed by the end of FY 2016. These facilities provided a variety of supporting operations at the site and include storage buildings, water pumping houses, and sandblasting and painting activities. The deactivation process includes disconnecting utilities to these facilities, removing certain components, and performing other steps necessary to prepare the buildings for demolition.

Deactivation and demolition of the tie lines in the Poplar Creek area was also well underway and was approximately 45% complete by the end of FY 2016. The tie lines connected the K-27 and K-31 gaseous diffusion buildings and carried enriched uranium from one building to another as the uranium moved through the enrichment process. Workers inject foam into these lines to stabilize any remaining contaminants so they will meet the criteria necessary for disposal at EMWMF.

3.8.1.8 Converters Removed

The last of approximately 5,000 converters were removed from the ETTP and shipped to the Nevada National Security Site for disposition in 2016. The converters were part of the gaseous diffusion process used to enrich uranium.

3.8.1.9 Commemoration of the K-25 Site

Historic preservation of the K-25 Site continued in FY 2016 with the launch of the K-25 Virtual Museum, which is now available online at www.K-25virtualmuseum.org. The virtual museum shares oral histories from the site's former workers, and it recounts the history of the world's first gaseous diffusion plant and the hundreds of facilities and structures at ETTP.

Congress appropriated approximately $6 million for K-25 historic preservation activities. This funding is being used for the conceptual design of the Equipment Building, Viewing Tower, K-25 History Center, Wayside Exhibits, and K-25 slab delineation.

3.8.2 Reindustrialization

As cleanup has progressed extensively at ETTP, more large parcels are becoming available for transfer (Fig. 3.53). The completion of K-31 demolition allows for the first parcel of over 200 contiguous acres that can be developed for a large-scale, industrial project at Heritage Center Industrial Park. This area has been approved for transfer by the EPA and TDEC. Transfer of the land is expected to take place in 2017. This will be the second largest transfer in the history of the program. Additionally, a large area of 170 acres at the southeast corner of ETTP has been approved for transfer to Metropolitan Knoxville Airport Authority for a potential airport project. The general aviation airport runway will accommodate small corporate jets, private airplanes, and EMS aircraft. DOE completed an Environmental Assessment to support the property transfer and potential construction and operation of the airport. In 2016, DOE received EPA and TDEC approval on documentation for future property transfers of large industrial parcels at the former Powerhouse area and Duct Island, both located at the western end of the site. DOE also submitted documentation to EPA and TDEC for their approval for transfer of three large warehouse facilities at K-1065.

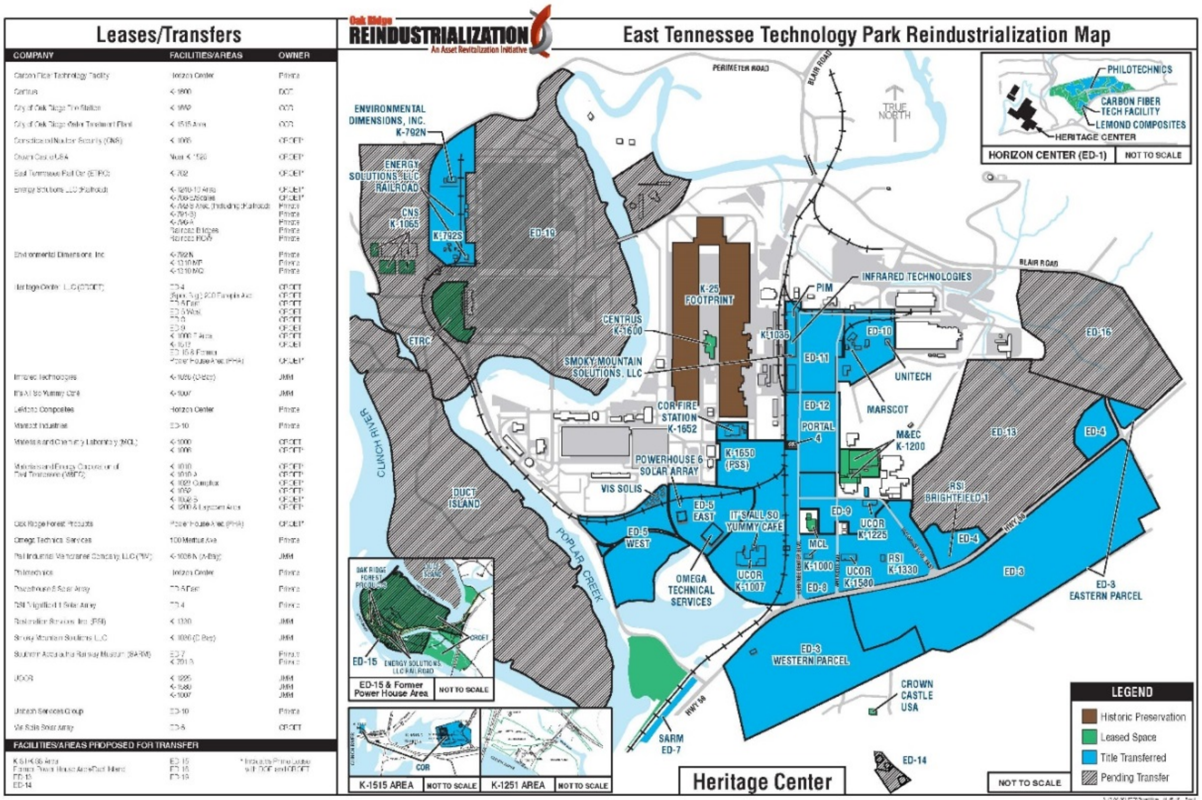

Fig. 3.53. East Tennessee Technology Park reindustrialization status, 2016.

3.9 References

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