Y-12 is a one-of-a-kind manufacturing complex that plays an important role in United States national security. Through Life Extension Program activities, Y-12 produces refurbished, replaced, and upgraded weapons components to modernize the enduring stockpile.

4

The Y-12 National Security Complex

Y-12, a premier manufacturing facility managed and operated by Consolidated Nuclear Security, LLC (CNS) for the National Nuclear Security Administration (NNSA), plays a vital role in the DOE Nuclear Security Enterprise. Drawing on more than 75 years of manufacturing excellence, Y-12 helps ensure a safe and reliable United States nuclear weapons deterrent.

Y-12 has three primary missions—maintain the safety, security, and effectiveness of the U.S. nuclear weapons stockpile; reduce the global threat posed by nuclear proliferation and terrorism; and provide feedstock to fuel the U.S. Nuclear Navy.

Today's environment requires Y-12 to have a new level of flexibility and versatility; therefore, while continuing its key role, Y-12 has evolved to become the resource that the nation looks to for support in protecting America's future by developing innovative solutions in manufacturing technologies, prototyping, safeguards and security, technical computing, and environmental stewardship.

4.1. Description of Site and Operations

4.1.1. Mission

Charged with maintaining the safety, security, and effectiveness of the US nuclear weapons stockpile, Y-12 is a one-of-a-kind manufacturing facility that has a core mission to ensure a safe, secure, and reliable nuclear deterrent. Every weapon in the nuclear stockpile has components manufactured, maintained, or ultimately dismantled by Y-12. Through Life Extension Program activities, Y-12 produces refurbished, replaced, and/or upgraded weapons components to modernize the enduring stockpile. As the nation reduces the size of its arsenal, Y-12 has a central role in decommissioning weapons systems and providing weapons material for nonexplosive, peaceful uses.

Y-12 secures and stores highly enriched uranium, and makes uranium available for non-weapon uses (e.g., in research reactors that produce cancer-fighting medical isotopes and for other research reactor purposes). Y-12 also processes highly enriched uranium from weapons removed from the nuclear weapons stockpile for use by the Naval Reactors Program to fuel nuclear-powered submarines and aircraft carriers.

Located within the city limits of Oak Ridge, Tennessee, the site covers more than 3,024 acres including 810 acres in the Bear Creek Valley, stretching 2.5 mi (4.0 km) in length down the valley and nearly 1.5 mi (2.4 km) in width across it. Additional NNSA-related facilities located off-site include the Central Training Facility, Alternate Emergency Operations Center, Oak Ridge Enhanced Technology and Training Center, Uranium Processing Facility (UPF) project laydown storage and offices, Y-12 Material Acquisition and Control Facilities, John M. Googin Technology Development Facility, Test and Demonstration Facility, Commerce Park Office Complex, and Union Valley Sample Preparation Facility.

4.1.2. Modernization

Y-12 directly supports four NNSA capabilities—uranium, lithium, weapons assembly and disassembly, and safe and secure storage of strategic materials. The Y-12 strategic vision is driven by the overarching objectives that, by 2040, Y-12 will be capable of reliably fabricating any component, building any weapon, and qualifying any system on any day, as well as executing a digital transformation strategy that enables smart, real-time, data-driven operations. Today, Y-12 is not well suited to deliver this type of responsive capability. Following the end of the Cold War, operations were scaled back, and many once-reliable processes have since atrophied.

The ability to deliver a nuclear weapon without reusing components from legacy weapons or relying heavily on aging infrastructure does not exist. Additionally, Y-12 faces a unique need to reestablish capabilities and two material streams—binary and special materials—associated with the NNSA mission. Accelerated planning and improvements to site infrastructure, including the following, are key to reestablishing these capabilities:

- New production facilities
- New capability and operational support facilities
- Capability bridging until new facilities are in place

Planning for the future site ensures that Y-12 will continue to provide the infrastructure needed to support the primary capabilities and materials missions with new facilities and associated technologies. In addition to new and revitalized facilities, the security posture will be strengthened by a reduced protected area footprint and revitalized security infrastructure and systems. The envisioned future Y-12 site includes the following elements:

- Major supply chains, including uranium (enriched uranium, depleted uranium, and low enriched uranium) and lithium, are reestablished and/or transformed.
- The UPF, Lithium Processing Facility (LPF), Enriched Uranium Manufacturing Center, Assembly and Disassembly Center, and Depleted Uranium Manufacturing Capability are constructed.
- The security posture is sustained and improved through recapitalized and transformed footprint and security systems.
- The Mercury Treatment Facility and Environmental Management Disposal Facility are constructed, enabling approximately 2.8 million gross square feet (gsf) of excess facility demolition and legacy environmental threats to be remediated.
- Public tours of Y-12 historic facilities and participation in the Manhattan Project National Historic Park are implemented, to the extent possible.

Sixty-five percent of Y-12's facility footprint is more than 60 years old and accounts for 18 percent of Y-12's buildings, as shown in

Figure 4.1. To address this situation, Y-12 has been consolidating operations, modernizing facilities and infrastructure, and reducing the legacy footprint. These actions support NNSA overall transformation planning.

Through continued infrastructure projects, new construction, and the disposition of excess facilities, Y-12 continues to become more responsive and sustainable.

Replacement and revitalization are key elements to modernizing Y-12. A significant number of facilities are at or beyond design life. Currently, construction activities include the UPF, LPF, and the West End Protected Area Reduction project.

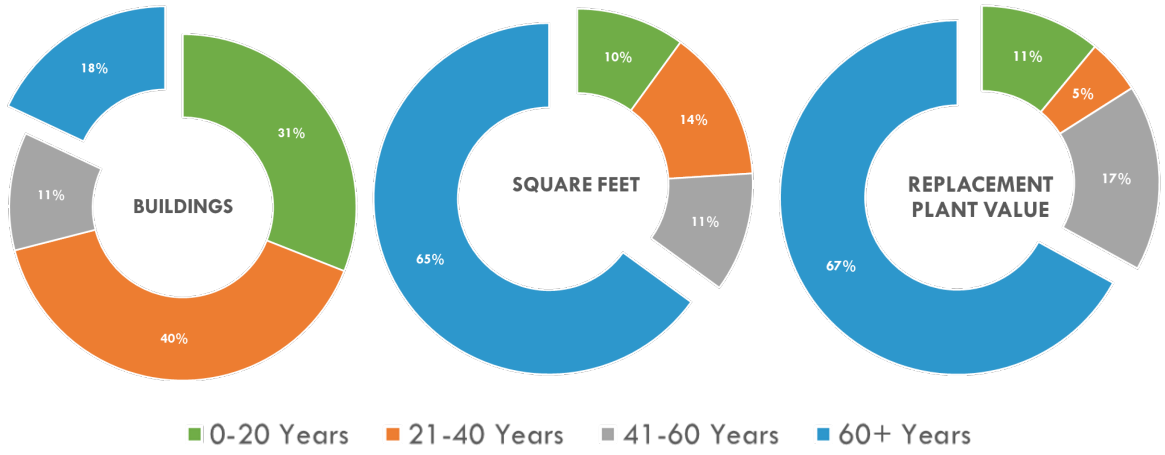


Figure 4.1. Age of facilities at Y-12 as of 2023

4.1.3. Production Operations

Y-12's core manufacturing and processing operations are housed in decades-old buildings near or past the end of their expected life spans. The UPF, which is an integral part of Y-12's transformation, is being constructed as one of two main facilities in which enriched uranium will be stored and processed in a more centralized area.

The major production capabilities and associated facilities at Y-12 include the following:

- **Enriched uranium.** Buildings 9212, 9215, and UPF
- **Depleted uranium.** Buildings 9215, 9201-05N, 9201-05W, 9996, and 9998
- **Lithium.** Buildings 9204-02, 9202, and LPF
- **General manufacturing and fabrication.** Building 9201-01
- **Assembly and disassembly.** Building 9204-02E
- **Special materials.** Buildings 9225-03 (2025) and 9990-03
- **Storage:** Buildings 9720-82, 9720-05, 9720-26, 9720-32, 9720-33, 9720-59, and 9811-01

The following planned major construction activities are replacing key production operations currently in aging, oversized facilities. Dates of the construction activities are tentative and subject to change.

- Building 9212 functions are to be replaced by the UPF in 2028, with some Building 9212 processes relocated to Buildings 9215 and 9204-2E.
- Building 9215 enriched uranium functions are to be replaced by the Enriched Uranium Manufacturing Center by 2050.
- Building 9204-02E functions are to be replaced by the Assembly and Disassembly Center by 2055.
- Building 9204-02 lithium functions are to be replaced by the LPF by 2031.
- Depleted uranium fabricating and manufacturing functions from the Building 9215 Complex, Building 9201-05N, and Building 9201-05W are to be replaced by phased line item construction, with the first phase—the Depleted Uranium Complex—by 2035.
- General manufacturing and fabrication functions from Building 9201-01 are to be replaced by the General Manufacturing Capability by 2043.

4.1.4. Support Facilities

Organization and facilities that support operations ensure Y-12 mission-critical work is completed. The primary missions of the operations support infrastructure are to protect vital national security assets and people and enable site missions. Operations support includes the following:

- Security
- Emergency Services
- Development
- Analytical Chemistry
- General Storage and Warehousing
- Cybersecurity and Information Technology
- Global Security and Strategic Partnerships
- Waste Management
- Sustainability and Stewardship
- Oak Ridge Enhanced Technology and Training Center

The following planned major construction activities are replacing key operations support facilities:

- Complete the West End Protected Area Reduction project, including a new Entry Control Facility, by 2025.
- Relocate bench-scale laboratory development functions from Buildings 9202 and 9203 to the off-site John M. Googin Technology Development Facility, located at 103 Palladium Way, by 2027. Construct a phased line item construction development campus, with the first phase—the Applied Technologies Laboratory—by 2037.
- Implement the Security Infrastructure Revitalization Program to upgrade and replace the legacy Perimeter Intrusion Detection and Assessment System.
- Explore new construction for replacement facilities to support Analytical Chemistry operations, including phased campus construction, beginning in 2026, and a future line item construction project—the Analytical Chemistry Laboratory—in 2033.
- Construct the Oak Ridge Institute for Global Nuclear Security at the new Oak Ridge Enhanced Technology and Training Center campus.
- Construct a new maintenance complex through phased line item construction, with the first phase to replace the 78-year-old Building 9201-03 and other aging maintenance facilities.
- Construct a new waste management complex to replace the aging West End Treatment Facilities.
- Implement a digital transformation and cybersecurity strategy.

- Construct a new security complex to accommodate growing requirements.

4.1.5. Excess Facility Disposition

Currently, there are 70 excess facilities at Y-12, with another 59 buildings and trailers to be excessed within the next 10 years. The major excess process-contaminated facilities, including Building 9201-05, Building 9204-04, and Building 9206, will be transitioned to the DOE Office of Environmental Management (EM) for disposition. The smaller, process-contaminated, ancillary facilities associated with Buildings 9201-05, 9204-04, and 9206; Building 9212-associated facilities; and the Building 9401-03 Complex (Steam Plant) are planned to be dispositioned by NNSA.

Process-contaminated facilities contain radiological and/or chemical contamination resulting from mission operations during the Manhattan Project or Cold War eras. Excess process-contaminated facilities are expected to be sufficiently managed until facility conditions meet criteria for transition to EM. Excess non-process-contaminated facilities are generally expected to be demolished by NNSA; however, some excess non-process-contaminated facilities may be demolished by EM depending on their complexity and/or proximity to process-contaminated facilities.

The Mercury Treatment Facility and the Environmental Management Disposal Facility will be constructed before any mercury-contaminated facilities can be demolished. Surveillance and maintenance activities, along with utility reroutes, unneeded material cleanout, and fluid and oil disposition, continue while these new facilities are being built.

4.2. Environmental Management System

DOE Order 436.1A, *Departmental Sustainability* (DOE 2023a), requires federal facilities to use a certified or conforming environmental management system (EMS) as a management framework to implement programs that meet sustainability goals and support the fulfillment of environmental compliance obligations.

The DOE Order also requires that EMSs, covering all site activities, are certified to or conform to the International Organization for Standardization's (ISO) 14001, *Environmental management systems—Requirements with guidance for use* (ISO 2015).

In September 2021, the Y-12 EMS was declared to be in conformance with ISO 14001. The audit team from The University of Tennessee Center for Industrial Services noted in the report that the Y-12 management and operating contract requires conforming to the 2004 version of the standard. The team audited the site to the 2015 version of the standard in anticipation that the requirement will change with the next Y-12 contract.

The EMS applies to site activities and operations managed by CNS as described in Section 4.1. By design, the "plan-do-check-act" approach of the ISO 14001 standard improves environmental performance, which supports Y-12's overall mission effectiveness.

The Y-12 EMS has two areas of focus—environmental compliance and environmental sustainability. Environmental compliance consists of regulatory compliance and monitoring programs that implement federal, state, and local requirements, agreements, and permits. Environmental sustainability promotes and integrates initiatives such as energy and natural resource conservation, air pollutant emission minimization, waste minimization, and the use of sustainable products and services.

4.2.1. Integrating with Integrated Safety Management System

Y-12's Integrated Safety Management System (ISMS) is the basis for planning and implementing environment, safety, and health (ES&H) programs and systems that provide the necessary structure for any work activity that could affect the public, workers, or the environment. Elements of the ISO 14001 EMS are incorporated in ISMS to achieve environmental compliance, pollution

prevention, waste minimization, resource conservation, and sustainability. Both ISMS and EMS are based on an internationally recognized cycle of continual improvement, commonly known as the "plan-do-check-act cycle," as depicted in Figure 4.2, which shows the relationship between ISMS and the integrated EMS.

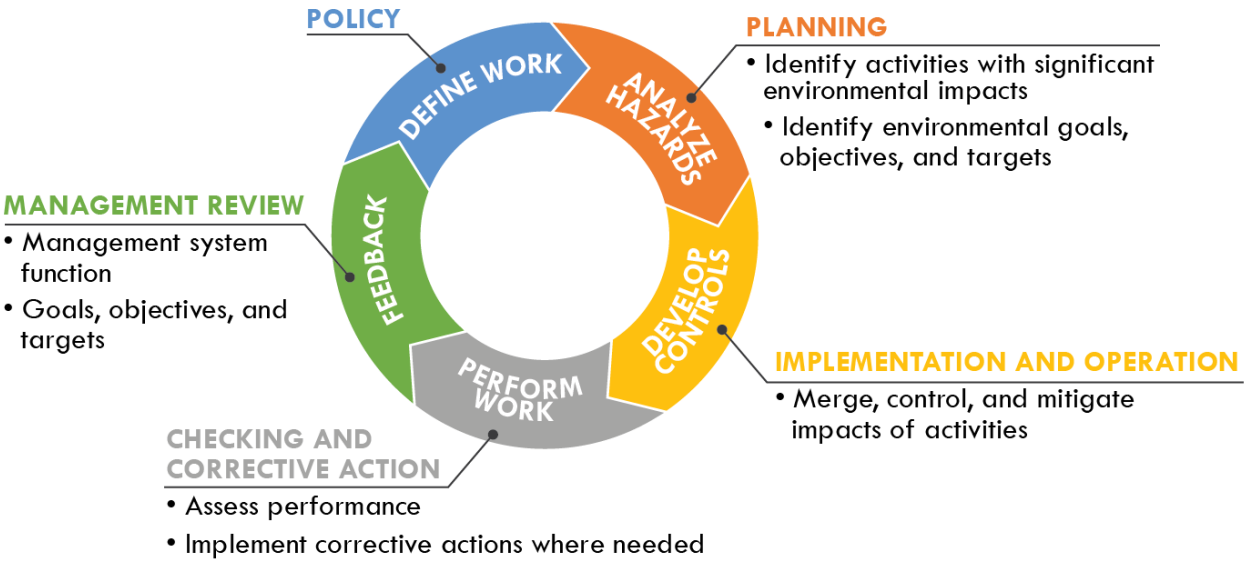


Figure 4.2. The "plan-do-check-act" cycle of continual improvement

4.2.2. Policy

Y-12's environmental policy and commitment to providing sound environmental stewardship practices through the implementation of an EMS have been defined, are endorsed by senior management, and have been made available to the public via company-sponsored forums and public documents. Y-12's ES&H policy is provided in Figure 4.3.

In addition to Y-12's ES&H policy, CNS has issued an environmental policy that is a significant component of its corporate ISMS and contributes to sustaining safe and secure operations. The Y-12 ES&H policy and the CNS environmental policy are incorporated into mandatory training for every employee and subcontractor. The policies are available for viewing on both Y-12's external and internal websites. Y-12 personnel are made aware of the commitments stated in the policies and how they relate to work activities. Communication of Y-12's environmental policy and other EMS training and awareness activities foster a greater understanding of environmental issues and empowers employees to contribute to improving Y-12's environmental footprint.

4.2.3. Planning

The following sections describe planning activities conducted as part of the Y-12 EMS.

4.2.3.1. Y-12 Environmental Aspects

Environmental aspects may be thought of as potential environmental hazards associated with a facility operation, maintenance job, or work activity. Environmental aspects and their impacts (i.e., potential risks to and effects on the environment) are evaluated to ensure that the significant aspects of Y-12 activities that are identified continue to reflect stakeholder concerns and changes in regulatory requirements. The EMS ensures that environmental aspects are systematically identified, monitored, and controlled to mitigate or eliminate potential impacts to the environment.

The analysis identified the following as significant environmental aspects in 2023:

- Storm water (runoff from roofs and outdoor storage areas)
- Groundwater
- Surface water (process water and dike emissions to creek)
- Wastewater (sanitary sewer and process water treated and disposed)
- Radiological waste
- Hazardous or mixed waste
- Excess facilities and unneeded materials and chemicals
- Aging infrastructure and equipment
- Legacy contamination and disturbance

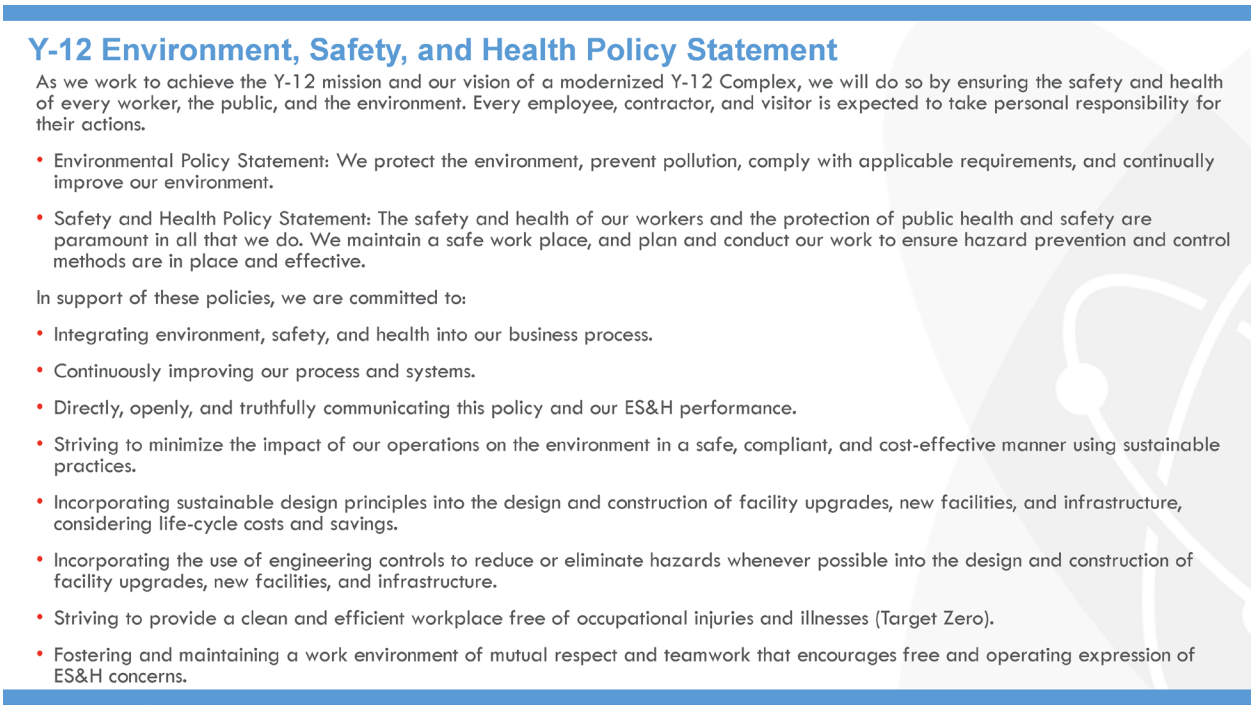


Figure 4.3. Y-12's environment, safety, and health policy

4.2.3.2. Legal and Other Requirements

To implement the compliance commitments of the ES&H policy and to meet legal requirements, systems are in place to review changes in federal, state, or local environmental regulations and to communicate those changes to affected staff. The environmental compliance status is discussed in Section 4.3.

4.2.3.3. Objectives, Targets, and Environmental Action Plans

Y-12 pursues sustainability initiatives by establishing and maintaining environmental commitments, goals, targets, and action plans. Goals and commitments are established annually and consider the site's significant environmental aspects. They are consistent with Y-12's mission, budget guidance, ES&H work scope, and DOE sustainability goals. Targets and action plans are established for broad objectives to pursue improvement in environmental performance in five areas: clean air; energy efficiency; hazardous materials; stewardship of land and water resources; and waste reduction, recycling, and buying green. Highlights of the 2023 environmental achievements are presented in Section 4.2.6.1.

4.2.3.4. Programs

NNSA has developed and funded several programs to integrate environmental stewardship into all facets of Y-12 missions. The programs also address the requirements in DOE orders for protecting various environmental media, reducing pollution, conserving resources, and helping to promote compliance with all applicable environmental regulatory requirements and permits.

Environmental Compliance

Y-12's Environmental Compliance Department provides environmental technical support services and oversees line organizations to ensure that site operations are conducted in a manner that is protective of workers, the public, and the environment; in compliance with applicable standards, DOE orders, environmental laws, and regulations; and consistent with CNS environmental policy and Y-12 site procedures. The department serves as the interpretive authority for environmental compliance requirements and as the primary point of contact between Y-12 and external environmental compliance regulatory agencies such as the City of Oak Ridge, the Tennessee Department of Environment and Conservation (TDEC), and the EPA. Environmental Compliance staff members administer compliance programs aligned with the major environmental legislation that affects Y-12 activities. Compliance status and results of monitoring and measurements conducted for these compliance programs are presented in this document.

The organization also maintains and ensures implementation of the Y-12 EMS and spearheads initiatives to address environmental concerns, to continually improve environmental performance, and to exceed compliance requirements.

Waste Management

The Y-12 Waste Management Program supports the full life cycle of all waste streams within the site. While ensuring compliance with federal and state regulations, DOE orders, Waste Acceptance Criteria, and Y-12 procedures and policies, the program provides services for day-to-day solid and liquid waste operations, including collection and transport, storage, on-site treatment operations, and shipment to off-site treatment and disposal. The program also provides technical support to Y-12 Operations for waste planning, characterizing, packaging, tracking, reporting, and managing waste treatment and disposal subcontracts.

Sustainability and Stewardship

The Sustainability and Stewardship Program has two major missions. The first is to establish and maintain programs and services to support sustainable material management operations. These sustainable operations include pollution prevention and recycling programs, excess materials programs, the PrYde Program for facility cleanliness, generator services programs, sanitary

waste and landfill coordination, and Destruction and Recycle Facility operations.

Y-12 has implemented continuous improvement activities, such as an Items Available for Reuse section on the site Property Accountability Tracking System and a central telephone number (574-JUNK) to provide employees with easy access to information and assistance related to the proper methods for disposing excess materials.

The second mission is managing stewardship practices—the programs that address legacy issues and assist in preventing development of new problematic issues. Stewardship programs include Clean Sweep, Unneeded Materials and Chemicals, and Targeted Excess Materials.

The Clean Sweep Program provides turnkey services to material generators, including segregation, staging, and materials pickup for excess, recycle, or disposal. "Sustain" areas have been established across the site to improve housekeeping through efficient material disposition. Customers place unneeded items into the transition portion of each Sustain area, and Clean Sweep Program personnel take care of the rest.

Unneeded materials at Y-12 are not automatically assumed to be wastes requiring disposal. Y-12 uses a systematic disposition evaluation process. The first step in the process is to determine if the items can be reused at Y-12. Items that cannot be used at Y-12 are evaluated for use at other DOE facilities or government agencies. Items are then evaluated for potential sale; recycle; or, as a last resort, disposal as waste.

Combining these programs under a single umbrella improves overall compliance with Executive Orders, DOE orders, federal and state regulations, and NNSA expectations, as well as eliminates duplication of efforts, while providing an overall improved appearance at Y-12.

Additionally, implementing these programs supports EMS objectives to disposition unneeded materials and chemicals; continually improves recycle programs by adding new recycle streams as applicable; improves sustainable acquisition (i.e., promotes the purchase of products made with recycled content and bio-based products); meets sustainable design requirements; and adheres to pollution prevention reporting requirements.

Energy Management

The Y-12 Energy Management Program incorporates energy efficient technologies across the site and positions Y-12 to meet NNSA energy requirement needs and reduction requirements as set forth by DOE. The program identifies improvements in energy efficiency in facilities, coordinates energy-related efforts across the site, is involved with energy savings and performance contracts, and promotes employee awareness of energy conservation programs and opportunities.

4.2.4. Implementing and Operating

The following sections describe activities conducted as part of the Y-12 EMS to establish, implement, and maintain good environmental practices and procedures.

4.2.4.1. Roles, Responsibility, and Authority

Safe, secure, efficient, and environmentally responsible operation of Y-12 requires the commitment of all personnel. Environmental and Waste Management technical support personnel assist line organizations with identifying and carrying out their environmental responsibilities. Additionally, the Environmental Officer Program helps to communicate environmental regulatory requirements and promotes EMS as a tool to drive continual environmental improvement. Environmental officers coordinate their organizations' efforts to maintain environmental regulatory compliance and promote other improvement activities.

4.2.4.2. Community and Community Involvement

NNSA and CNS are committed to keeping the community informed on operations, environmental concerns, safety, and emergency preparedness. CNS is a member of Oak Ridge and East Tennessee economic development and

business development agencies including the East Tennessee Economic Council, the Oak Ridge Chamber of Commerce, and the Anderson County Chamber of Commerce. CNS is also engaged in Anderson County and Oak Ridge's Leadership programs through its support of the Center for Leadership and Community Development.

Local charities receive donations from funds generated from the sale of aluminum beverage cans through the Employee Aluminum Can Recycling Program. Since the program began, more than $96,200 has been donated to local charities that were nominated by Y-12 employees and voted on by an employee committee.

Y-12 continues to promote sustainable behaviors for environmental improvements at the site and within the community. A United way coat and toiletries drive is held to provide coats and other needed items for the homeless who are served by the Volunteer Ministry Center. These activities reflect Y-12 employees' commitment to reduce landfill waste and to support community outreach.

4.2.4.3. Environmental Justice

CNS endorses and implements the core value of environmental justice through charitable and educational outreach to disadvantaged communities that are located in the counties that surround the Y-12 site. These counties include Anderson, Blount, Knox, Morgan, Roane, Hamblen, and Loudon.

In 2023, the CNS Community Investment Fund awarded grants totaling $180,000 to 24 nonprofits across East Tennessee. The fund is managed by the East Tennessee Foundation and directed by a committee of Y-12 volunteer employees. The fund passed the $1 million mark in grant distributions in 2022.

CNS is also a major supporter of United Way of Anderson County and the United Way of Greater Knoxville, with corporate and employee contributions totaling hundreds of thousands of dollars.

CNS continued its efforts to build relationships with K-12 teachers, community colleges, and technical schools. CNS provided volunteers for classroom outreach and community service projects and also provided leaders who served on local committees, nonprofit boards, and area business and professional organizations. CNS continued to fund educational scholarships to residents of the Scarboro community, located in Oak Ridge. Introduce a Girl to Engineering hosted hundreds of young girls toward an engineering career with in-person events early in 2023.

Additional organizations that CNS supports through charitable and educational outreach include the following:

- Aid to Distressed Families of Appalachian Counties
- American Museum of Science and Energy
- Angel Tree
- Big Brothers Big Sisters
- Casting for Recovery
- Children's Museum of Oak Ridge
- Covenant Health
- East Tennessee Children's Hospital
- Emory Valley Center
- Free Medical Clinic
- Helen Ross McNabb Center
- Junior Achievement
- Oak Ridge Breakfast Rotary Club Foundation
- Leukemia & Lymphoma Society
- March of Dimes
- McNabb Center
- Methodist Medical Center of Oak Ridge

4.2.4.4. Emergency Preparedness and Response

Local, state, and federal emergency response organizations are involved in Y-12's emergency drill and exercise program. The annual drill and exercise schedule is coordinated with all organizations to ensure maximum possible participation. At a minimum, the Tennessee

Emergency Management Agency (TEMA) Operations Office and the DOE Headquarters Watch Office participate in all Y-12 emergency response exercises.

The exercises, performance drills, and training drills conducted at Y-12 during FY 2023 focused on topics such as responding to a severe weather event with a chemical release and a change in the site's Security Condition. Building evacuation and accountability drills were also conducted.

4.2.5. Checking

The following sections describe Y-12 EMS activities to review, assess, and monitor operations to maintain environmentally safe and compliant practices and continually improve environmental performance.

4.2.5.1. Monitoring and Measuring

Y-12 maintains procedures to monitor overall environmental performance and measure key characteristics of its operations and activities that can have a significant environmental impact. Environmental effluent and surveillance monitoring programs are well established, and results of 2023 program activities are described throughout this chapter. Progress in achieving environmental goals is reported as a monthly metric on PerformanceTrack, the senior management web portal that consolidates and maintains Y 12 site-level performance. Progress is reviewed in periodic meetings with senior management and the NNSA Production Office (NPO) [Note: NPO was replaced by the new Y-12 Field Office (YFO) in April 2024].

4.2.5.2. Environmental Management System Assessments

To periodically verify that the EMS is operating as intended, assessments are conducted as part of the Y-12 internal assessment program. The assessments are designed to ensure that nonconformities with ISO 14001 are identified and addressed.

The Environmental Assessment Program conducts several types of assessments, each type serving a distinct but complementary purpose. Assessments range from informal observations of specific activities to rigorous audits of site-level programs.

To self-declare conformance to ISO 14001 in accordance with instructions issued by the Federal Environmental Executive and to adhere to requirements in DOE Order 436.1a, the EMS must be audited at least every 3 years by a qualified party outside of the control or scope of the EMS. In 2021, an audit team from The University of Tennessee Center for Industrial Services found that the Y-12 EMS fully conformed, and no issues were identified. The next external verification audit is scheduled for summer 2024.

4.2.6. Performance

This section discusses EMS objectives, targets, other plans, initiatives, and successes that work together to accomplish DOE goals, reduce environmental impacts and risks, and improve effectiveness in overall mission. To report performance, Y-12 uses the Federal Automotive Statistical Tool, which collects fleet inventory and fuel use, and the DOE Sustainability Dashboard, which collects data on metering requirements, water use, renewable energy generation and purchases, greenhouse gas (GHG) generation, and sustainable buildings. Pollution prevention waste reduction and recycling data, sustainable acquisition product purchases, electronic stewardship, and best practices data are also collected in this dashboard system.

Y-12 was given an EMS scorecard rating of "green" for FY 2023, indicating full and effective implementation of EMS requirements after submitting its annual compliance report via the DOE EMS Site Information Database.

4.2.6.1. Environmental Management System Objectives and Targets

At the end of 2023, Y-12 had achieved nine of 12 targets that had been established; the remaining targets were carried into future years. Highlights include the following, with additional details and successes presented in other sections of this report:

- **Clean air.** Y-12 completed a project to seal the Stack 11 basin and identified improved mission operations and improvements to air emissions.
- **Energy efficiency.** Y-12 completed chiller plant improvements in three locations after obtaining a utility energy service contract and funding approval.
- **Hazardous materials.** A project to disposition and ship legacy mixed waste according to the site treatment plan continued with five items shipped in FY 2023 to meet plan milestones. Unneeded materials and equipment were dispositioned from Building 9998 and two tanker trailers in FY 2023. Y-12 improved waste characterization processes and implemented real-time radiography to improve control and management of low-level radioactive waste.
- **Land, water, and natural resources.** Y-12 upgraded sanitary sewer networks in two areas as part of a project to protect the sanitary sewer lines from infill and infiltration. Y-12 also completed tank assessments on six aboveground inactive tanks and dikes in FY 2023.

4.2.6.2. Sustainability and Stewardship

Numerous efforts, including increased use of environmentally friendly products and processes and reductions in waste and emissions, have reduced Y-12's impact on the environment. These efforts have been recognized by NNSA, the community, and other stakeholders. Pollution prevention efforts at Y 12 have not only benefited the environment but have also resulted in cost avoidances (Figure 4.4).

In FY 2023, Y-12 implemented 105 pollution prevention initiatives (Figure 4.5), with a reduction of more than 17.8 million lb of waste and projected cost avoidances of more than $3.4 million.

Pollution Prevention and Source Reduction

Across Y-12, sustainable initiatives reduce the impact of pollution on the environment and to increase operational efficiency. Many of these sustainable initiatives have pollution prevention benefits or targets eliminating the source of pollution, including the 2023 activities highlighted in this section.

Sustainable Acquisition—Environmentally Preferable Purchasing

Sustainable products, including recycled content materials, are purchased for use across the site. In 2023, Y-12 bought more than $11.98 million of materials with recycled content.

Solid Waste Reduction

Y-12 reduces the amount of solid waste generated, often by diverting waste through source reduction, reuse, and recycling. In 2023, Y-12 diverted 56.8 percent of municipal and 32 percent of construction and demolition waste from landfill disposal through reuse and recycle. More than 4.1 million lb of municipal materials from landfill disposal were diverted through source reduction, reuse, and recycling, and more than 13.2 million lb of construction and demolition materials were diverted from landfill disposal.

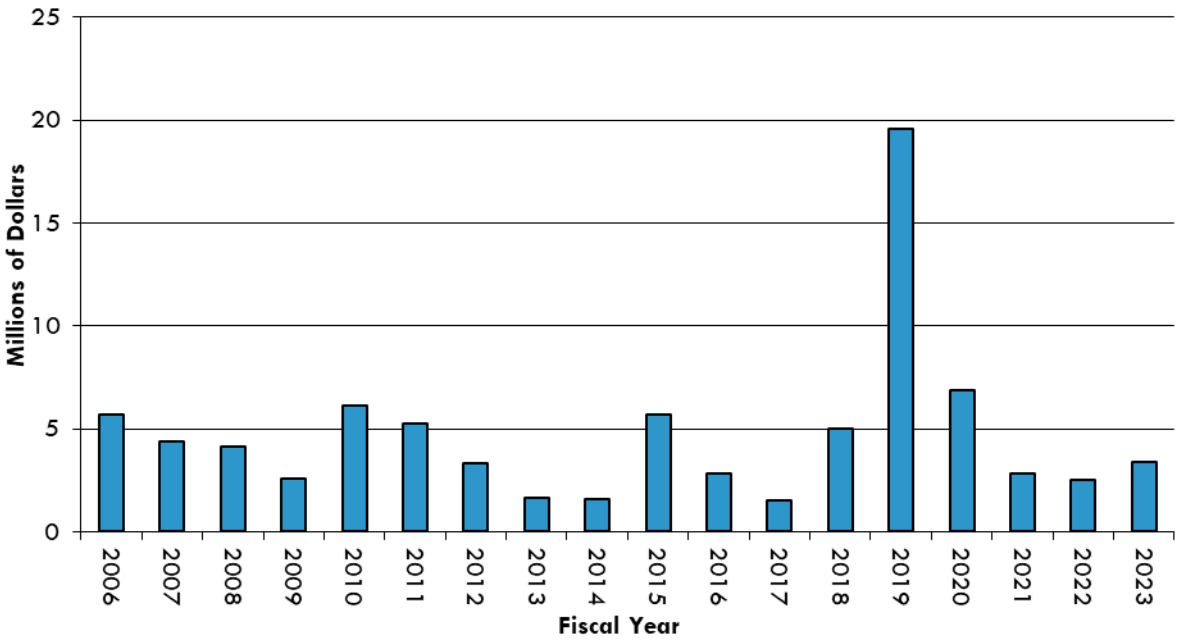


Figure 4.4. Cost avoidances from Y-12 pollution prevention activities, 2006–2023

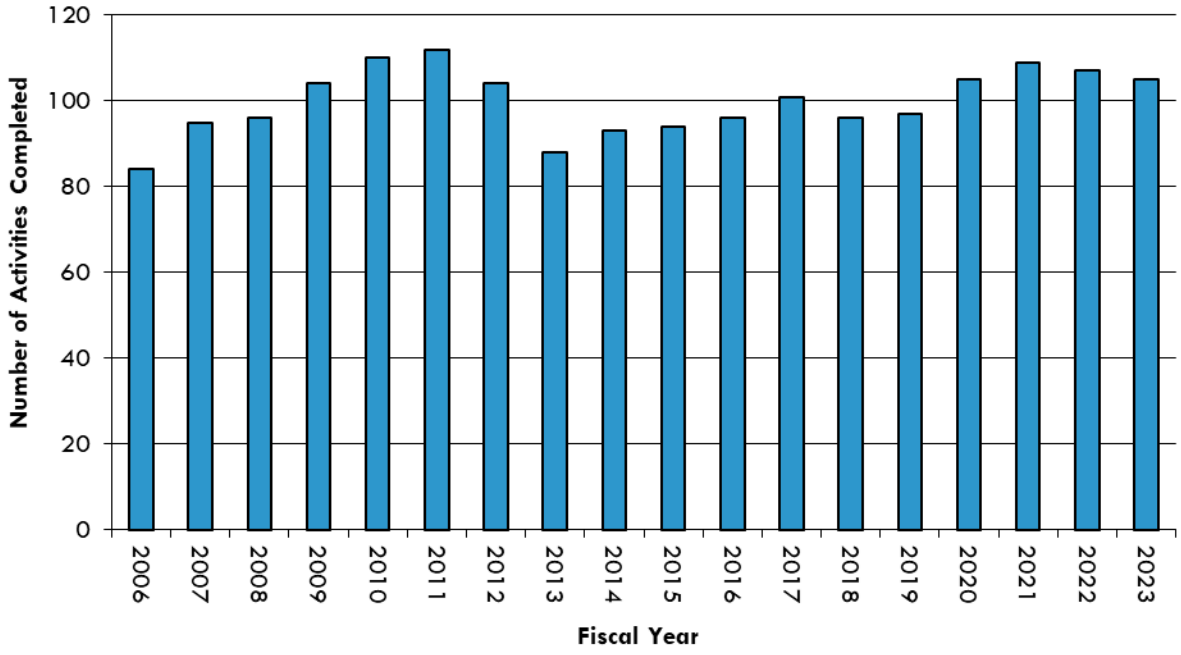


Figure 4.5. Y-12 pollution prevention initiatives, 2006–2023

Hazardous Chemical Minimization

The Generator Services group provides material disposition management services for waste generators at Y-12, including technical support to assist generators with determining whether the materials can be recycled, excessed, or reused. The Generator Services group can be used by any organization or generator at Y-12. During FY 2023, Generator Services personnel reused, or disseminated to other Y-12 organizations for reuse, more than 800 lb of various excess materials and chemicals. The Legacy Facilities group continued to produce hypochlorous acid, a safe, environmentally friendly, sustainable, and effective disinfectant. Producing hypochlorous acid on-site has reduced the need to purchase commercial disinfectants. Refillable containers are used to reduce the associated packaging waste materials from disinfectants.

Recycling

Y-12 has a well-established recycling program. The site continues to identify new material streams and expand the types of materials that can be recycled by finding new markets and outlets for the materials. As shown in Figure 4.6, more than 5.8 million lb of materials were diverted from landfills and into viable recycle processes during 2023. Currently, recycled materials range from office-related items to operations-related materials, such as scrap metal, tires, and batteries. Y-12 adds at least one new recycle stream to the Recycle Program each year to continue to increase the waste diversion rate. The Recycle Program was expanded in FY 2023 to include painted pallets to broaden waste diversion efforts.

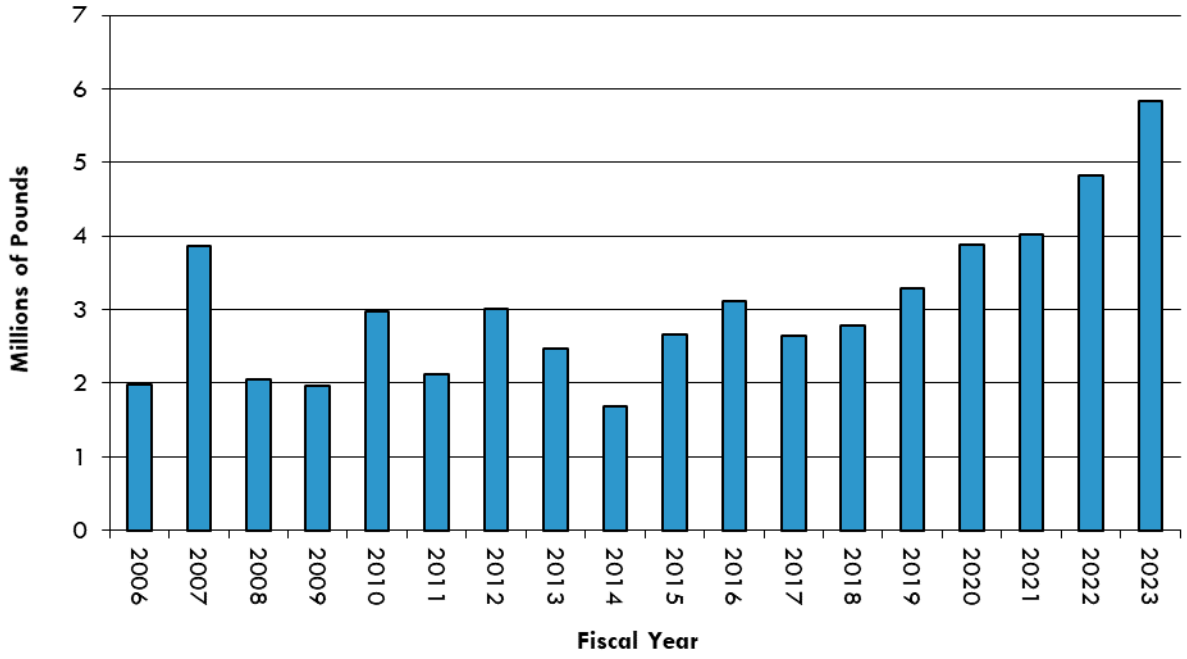
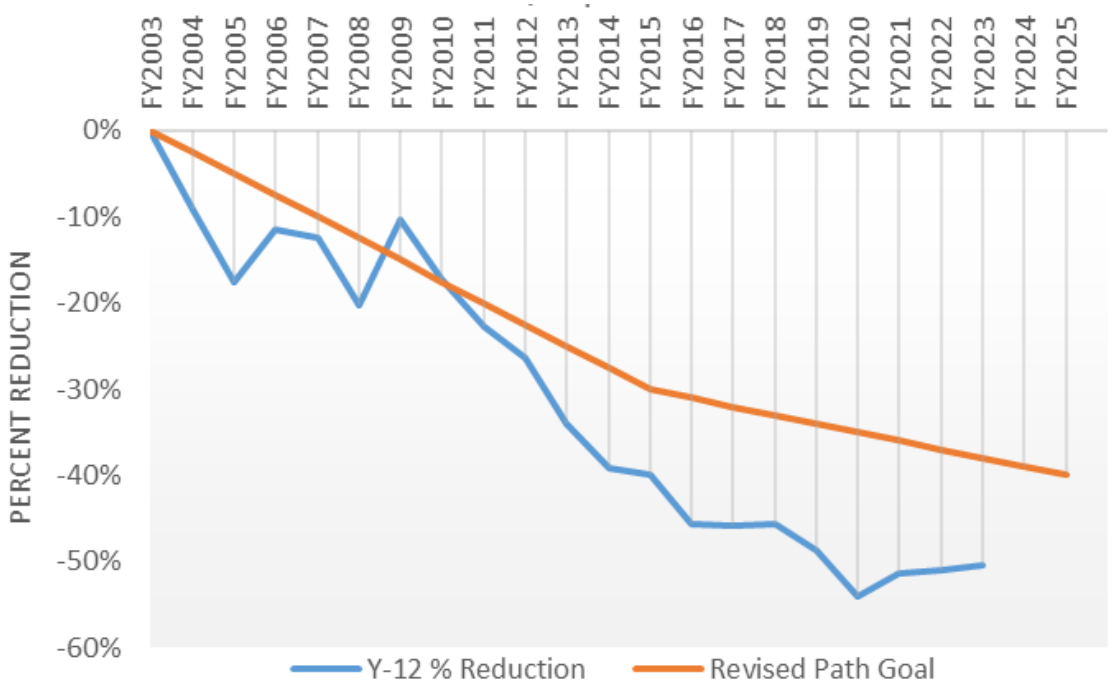


Figure 4.6. Y-12 recycling results, 2006–2023

4.2.6.3. Energy Management

The Energy Sustainability organization performs energy management activities. Energy usage and intensity, Energy Independence and Security Act of 2007 (EISA, EISA 2007) benchmarking and evaluations, facility metering and monitoring in accordance with the Energy Act of 2020 (EA 2020), and non-fleet vehicles and equipment are components of energy management reporting activities.

Y-12 exceeded the goal of a 30 percent energy intensity (Btu/gsf) reduction in goal-subject buildings by FY 2015 (from a FY 2003 baseline and 1 percent year-to-year reduction thereafter). During FY 2023, energy intensity was 207,645 Btu/gsf, a little over a half of a percentage above the prior year's 205,343 Btu/gsf. After the COVID-19 pandemic, rates have been rising slightly, especially compared to pandemic years 2020 and 2021, as the site's maximum teleworking policy expired and the site's population increased with newly hired employees. Continuing and new construction projects also contribute to the slightly increased energy intensity. Compared to the FY 2003 baseline year, Y-12 has seen an overall energy intensity reduction of 50.38 percent. Energy intensity through 2023 is shown in Figure 4.7.



Acronym: *FY = fiscal year*

Figure 4.7. Y-12 energy intensity (Btu per gross square foot) versus 2003 baseline goal

4.2.6.4. Sustainable Goals and Performance

DOE is required to meet sustainability goals mandated by statute and related Executive Orders, including goals for GHG emissions, energy and water use, fleet optimization, green buildings, and renewable energy. In 2023, the DOE Sustainability Performance Office used its web-based sustainability dashboard to collect and consolidate data from all DOE sites. The dashboard focuses on specific DOE sustainability goals, and site sustainability plans are completed within the dashboard. These goals, along with the current Y-12 performance ratings, are listed in Table 4.1.

Table 4.1. Sustainability goals and performance, 2023

DOE Goal	Current Status
Energy Management	
Reduce energy use intensity (Btu per gross square foot) in goal-subject buildings.	Goal Met: Y-12 exceeded the goal of meeting a 30 percent energy intensity reduction in goal-subject buildings by FY 2015 from an FY 2003 baseline and 1 percent year-to-year reduction thereafter. While energy reductions were met this year, as Y-12 site population increases every year and the site transforms to meet increased scope in the outyears, energy reductions compared to baseline will not be possible.
EISA Section 432 continuous (4-year cycle) energy and water evaluations.	Goal Met: Y-12 conducts EISA evaluations on a continuous 4-year cycle.
Meter individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate.	Goal Not Met: Y-12 meters all utilities; however, not all appropriate buildings are currently metered. Efforts are underway to fully implement sitewide metering.
Achieve a net-zero emissions building portfolio by 2045 through building electrification and other efforts.	Goal Not Met: Y-12 does not have a complete net-zero emissions portfolio at this time. Initial efforts are underway to begin net-zero planning for the site.
Water Management	
Reduce potable water use intensity (gal per gross square foot).	Goal Met: Y-12 exceeded the goal of reducing water intensity by 36% by FY 2025 relative to FY 2007.
Reduce non-potable freshwater consumption (gal) for industrial, landscaping, and agricultural.	Goal Not Applicable. Y-12 does not use industrial, landscaping, or agricultural water.
Waste Management	
Reduce nonhazardous solid waste sent to treatment and disposal facilities.	Goal Met: 56.5% (1,880.3 metric tons/3,329.8 metric tons) of nonhazardous waste diverted from the landfill.
Reduce construction and demolition materials and debris sent to treatment and disposal facilities by 50%.	Goal Not Met: 32% (2,164.9 metric tons/28,888 metric tons) of construction and demolition materials were diverted from the landfill in FY 2023.
Fleet Management	
Reduce petroleum consumption.	Goal Not Met: Y-12 did not meet the interim target of 20% reduction in fleet petroleum consumption. There was an 11.6% increase from the FY 2005 baseline.
Increase alternative fuel consumption.	Goal Not Applicable: Y-12 does not have access to alternative fuels.
Achieve 100 percent zero-emission vehicle acquisitions by 2035, including 100 percent zero-emission light-duty vehicle acquisitions by 2027.	Goal Not Met: Y-12 ordered 42 vehicles with zero-emission capabilities when available in FY 2023. While 100 percent zero-emission vehicle acquisitions have not been met, Y-12 is working toward the goals for 2035 and 2037.
Clean & Renewable Energy	
Achieve 100 percent carbon pollution-free electricity on a net annual basis by 2030, including 50 percent 24/7 carbon pollution-free electricity.	Goal Not Met: Y-12 has not fully achieved these goals but is working on a decarbonization plan.
Increase consumption of clean and renewable non-electric thermal energy.	Goal Not Met: Y-12 had a 5.4% decrease in natural gas use for FY 2023.

Table 4.1. Sustainability goals and performance, 2023 (continued)

DOE Goal	Current Status
Sustainable Buildings	
Increase the number of owned buildings that are compliant with the Guiding Principles for Sustainable Buildings.	Goal Met: Two buildings were certified as High Performance and Sustainable Buildings in FY 2023.
Acquisition & Procurement	
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring all sustainability clauses are included as appropriate.	Goal Met: All eligible contracts after Oct. 1, 2013, contain the sustainable acquisition requirements. The CNS Sustainable Acquisition Program is working with Contracts and Procurement to review the current $150,000 contract threshold for sustainable acquisition requirements to be included in subcontract languages so that future appropriate contracts will have the requirements to purchase sustainably.
Investments: Improvement Measures, Workforce, & Community	
Implement life-cycle cost-effective efficiency and conservation measures with appropriated funds and/or performance contracts.	Goal Met: Y-12 supported performance contracts issued by NNSA. These contracts have been instrumental in achieving energy, water, building modernization, and infrastructure goals at Y-12.
Electronic Stewardship & Data Centers	
Promote electronics stewardship from acquisition, to operations, to end of life.	Goal Not Met: Y-12 did not meet the goal of purchasing 95% of eligible electronics as Electronic Product Environmental Assessment Tool registered products. Current performance for FY 2023 is at 89.5%. Y-12 power manages all mission-critical electronics, and current automatic duplexing is at 91.2%. Y-12's electronics recycling vendor maintained Responsible Recycling certification; therefore, all FY 2023 shipments were made to a certified recycler. Electronics that were not recycled were those that could not be radiologically cleared for release. Therefore, 100% of eligible electronics were recycled to a Responsible Recycling certified recycler or were donated for reuse.
Increase energy and water efficiency in high performance computing and data centers.	Goal Not Met: While data centers have been consolidated at Y-12, which has saved energy and water, they are not fully metered. Current power usage effectiveness is estimated to be 2.4. As the site moves to modernized data centers, the overall energy and water efficiencies will continue to increase.
Adaptation & Resilience	
Implement climate adaptation and resilience measures.	Goal Met: Y-12 issued a severe event emergency response plan that addresses severe natural phenomena events, extended loss of power events, and events that result in the loss of mutual aid. Additionally, the site updated its vulnerability assessment and resilience plan, along with identified resilience solutions, which include increasing on-site renewable energy generation; solar powered equipment; new facilities; roof repairs and replacement; chiller upgrades; and heating, ventilation, and air conditioning system repairs and replacements.

Table 4.1. Sustainability goals and performance, 2023 (continued)

DOE Goal	Current Status
Multiple Categories	
Reduce Scope 1 and 2 greenhouse gas emissions.	Goal Met: Site Scope 1 and 2 emissions were reduced by 62.6% from the FY 2008 baseline. Most of this can be attributed to infrastructure improvements through energy savings performance contract projects.
Reduce Scope 3 greenhouse gas emissions.	Goal Not Met: Site Scope 3 emissions increased by 13.1% from FY 2022 (43,493.2 $MtCO_2e$) to FY 2023 (49,186.7 $MtCO_2e$). Overall Scope 3 emissions have increased by 54.2% since the FY 2008 baseline (31,894.5 $MtCO_2e$). The increase in Scope 3 emissions in FY 2023 is primarily due to the site's expiration of the teleworking policy and an increase in the on-site population.

Acronyms:
CNS = Consolidated Nuclear Security
EISA = Energy Independence and Security Act
FY = fiscal year
NNSA = National Nuclear Security Administration

4.2.6.5. Water Management

The current DOE water intensity goal is a 20 percent reduction from a FY 2007 baseline by FY 2015 and year to-year reductions of 0.5 percent thereafter. In FY 2023, Y-12's water intensity rating was 66.80 gal/ft^2, which is an 8.005 percent decrease from the previous year and a 68.27 percent reduction from the 2007 baseline. During the pandemic years (FYs 2020 and 2021), water intensity decreased significantly, as on-site personnel and processes were reduced and is not representative of Y-12's water intensity trend. An overview of water intensity performance is shown in Figure 4.8.

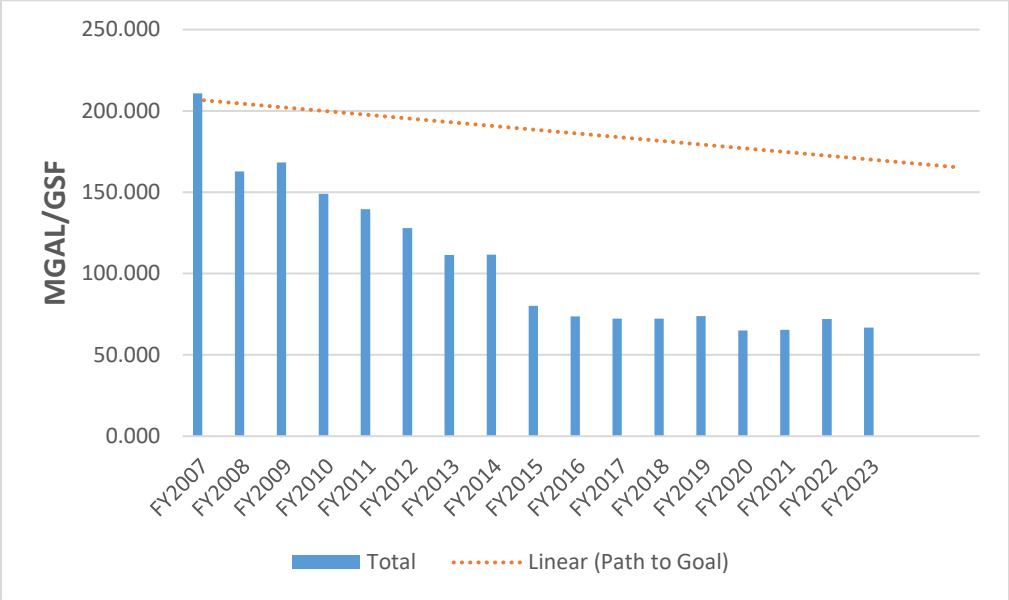
The following actions have contributed to the overall reduction in potable water use:

- Steam trap repairs and improvements
- Condensate return installations, repairs, and reroutes
- Replacement of once-through air handling units
- Low-flow fixture installation
- Chiller replacements
- Cooling tower replacements
- Steam replacements to natural gas when possible

Internal EISA audits are conducted on covered facilities on a 4-year rotating schedule. Additionally, Y-12 completed the FY 2022 water assessment of the site, which identified a number of water conservation projects that could be implemented should funding be allocated. These projects include domestic plumbing retrofits, kitchen equipment upgrades, process system upgrades, cooling tower upgrades, and steam plant upgrades.

Continued reductions in water usage will be incorporated into ongoing facility repairs and renovations as funding becomes available. These efforts include the following:

- Upgrading toilets and urinals to low-flow, hands-free units
- Installing flow restrictors on faucets and shower heads
- Repairing condenser loop connections so all condenser water is returned to the cooling towers
- Replacing existing once-through water-cooled air conditioning system with air-cooled equivalents
- Installing advanced potable water meters



Acronyms:
FY = fiscal year
GSF = gross square feet
Mgal = millions of gallons

Figure 4.8. Water intensity graph from baseline 2007 through FY 2023

4.2.6.6. Fleet Management

There are 638 vehicles in the Y-12 fleet, including 124 agency-owned units, 502 leased from General Services Administration (GSA), and 12 commercially leased special purpose vehicles. The inventory consists of sedans; light-duty trucks, vans, and sport utility vehicles; medium-duty trucks, vans, and sport utility vehicles; and heavy-duty trucks such as road tractors, dump trucks, box trucks, flatbeds, wreckers, and service trucks.

During 2023, Y-12 exchanged 42 older GSA-leased vehicles with new units and dispositioned 10 older E-tagged vehicles through Y-12 Property Sales. The new GSA replacements were ordered with alternative fuel or zero-emission capabilities when available, and these new vehicles have better fuel consumption and GHG emission figures than the older vehicles, which ranged from 7 to 12 years of age.

Vehicle availability (replacements as well as additions) was again a struggle during FY 2023, as only 34% of the GSA vehicle replacement order was actually filled. Normally, the majority of replacement orders placed with GSA in the November timeframe would be delivered by September, but manufacturer shortages and cancellations had a major impact in the actual vehicle delivery cycle during FY 2023. Additional vehicles will be required in the near future to support Y-12 construction projects.

The Y-12 taxi service and UPF bus service were major modes of transportation for the more than 6,500 employees. This service also helps reduce the number of overall vehicles needed, fuel consumption, and GHG emissions. The taxi service is an important asset to the overall transportation needs of the Y-12 workforce.

The Y-12 vehicle fleet achieved a 98.3 percent vehicle utilization rate for FY 2023 compared to 97.3 percent in FY 2022. Of those 11 vehicles that failed the utilization rate, eight achieved

80 percent or greater utilization scores. Vehicle reassignments were made multiple times throughout the year to help meet utilization goals.

FY 2023 fuel consumption at Y-12 (diesel and gasoline) decreased by 6.8 percent compared with FY 2022, while miles traveled for those same vehicles was down by 2.6 percent compared to the previous year.

Y-12 continues to use a mobile fuel tanker to dispense gasoline and diesel for vehicles because the site lacks a new fuel station, although plans are in place to build one just southwest of the existing Y-12 garage at the east end of the plant. Y-12 does not use alternative fuel (E85) because it is not available in the area. Because of this, an Epact 701 waiver (5 miles or 15 minutes away) was granted to Y-12.

4.2.6.7. Electronic Stewardship

Y-12 has various electronic stewardship activities, including virtualizing servers, creating virtual desktop infrastructure, procuring energy efficient computing equipment, reusing and recycling computing equipment, replacing aging computing equipment with more energy efficient equipment, and reconfiguring data centers to achieve more energy efficient operations. More than 89 percent of the desktop computers, laptops, monitors, and thin clients purchased or leased during FY 2023 were registered Electronic Product Environmental Assessment Tool products. Y-12's standard desktop configuration specifies the procurement of Electronic Product Environmental Assessment Tool registered and Energy Star-qualified products.

4.2.6.8. Greenhouse Gases

Compared to the FY 2008 baseline, Y-12 Scope 1 (on-site fuel burning) and Scope 2 (purchased electricity) GHG emissions have been reduced. Emission reductions can be attributed primarily to decreased Scope 1 emissions due to more efficient steam generation and decreased Scope 2 emissions due to energy efficiency projects.

Purchased electricity is by far the biggest contributor to Y-12's GHG footprint. Energy reduction initiatives involving production facilities and utility infrastructure have been completed through energy savings performance contract projects.

4.2.6.9. Storm Water Management and the Energy Independence and Security Act

Section 438 of the EISA requires federal agencies reduce storm water runoff from development and redevelopment projects to protect water resources. Y-12 complies with these requirements by using a variety of storm water management practices, often referred to as green infrastructure or low impact development practices. Several green infrastructure initiatives have been implemented to reduce the size and number of impervious surfaces through sustainable vegetative practices and porous pavements. During 2022, the Emergency Operation Center and Fire Station projects contributed to the overall prevention of storm water runoff by installing bioretention infiltration areas on the project sites. No new green storm water management practices were initiated in 2023.

4.3. Compliance Status

During 2023, Y-12 operations were conducted to comply with contractual and regulatory environmental requirements. Table 4.2 presents a summary of environmental audits conducted at Y-12 in 2023. The following sections summarize the major environmental programs and activities at the site and provide an overview of the compliance status for the year.

4.3.1. Environmental Permits

Table 4.3 lists environmental permits in force at Y-12.

Table 4.2. Summary of external regulatory audits and reviews, 2023

Date	Reviewer	Subject
February 23	TDEC	Quarterly ORR Landfill Inspection ILF-V, ILF-IV, and CDL-VII
March 6	COR	Sanitary Sewer Inspection
March 7	TDEC	Annual RCRA Hazardous Waste Compliance Inspection (ORR Landfill)
March 24	TDEC	Air Quality Inspection
May 11	TDEC	ILF-V Area 5 Construction Inspection
May 30	TDEC	ILF-V Area 5 Construction Inspection
May 31	TDEC	Quarterly ORR Landfill Inspection ILF-II, ILF-V, and CDL-VII
June 29	TDEC	Quarterly ORR Landfill Inspection ILF-IV
July 10	TDEC	ILF-V Area 5 Construction Inspection
August 2	COR	Sanitary Sewer Inspection
August 21	TDEC	ILF-V Area 5 Construction Inspection
August 29	TDEC	ILF-V Area 5 Construction Inspection
August 31	TDEC	Quarterly ORR Landfill Inspection of ILF-V and CDL-VII; Second Semi-Annual Inspection of Closed ILF-II
September 6	TDEC	NPDES Compliance Evaluation Inspection
September 7	TDEC	Quarterly ORR Landfill Inspection ILF-IV
September 5	TDEC	ILF-V Area 5 Construction Inspection
November 22	TDEC	Quarterly ORR Landfill Inspection of ILF-IV, V, and CDL-VII

Acronyms:
COR = City of Oak Ridge
ORR = Oak Ridge Reservation
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation

Table 4.3. Y-12 environmental permits, 2023

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Title V Major Source Operating Permit	571832	12/01/17	11/30/22[a]	DOE	DOE	CNS
CWA	Industrial and Commercial User Wastewater Discharge (Sanitary Sewer) Permit	1-91	07/20/21	03/31/26	DOE	DOE	CNS
CWA	NPDES Permit	TN0002968	08/05/22	09/30/27[b]	DOE	DOE	CNS
CWA	UPF General Storm Water Permit Y-12 (41.7 ha/103 acres)	TNR 134022	10/27/11	09/30/26	DOE	CNS	CNS
CWA	UPF NPDES General Permit for Construction Storm Water	TNR135568	08/06/18	09/30/26	DOE	BNI	BNI
CWA	Central Training Facility Berm Reinvestment Project NPDES Construction General Permit	TNR 135924	10/01/19	09/30/26	DOE	DOE	CNS
CWA	UCOR ILF-II General Storm Water Permit Y-12 (8.2 acres)	TNR 136478	08/03/21	Upon Notice of Termination	DOE	UCOR	UCOR
CWA	Y-12 Outfall 014 Repair Aquatic Resource Alteration Permit	NR1903.116	06/21/19	04/05/25	DOE	DOE	CNS
CWA	Central Training Facility Berm Aquatic Resource Alteration Permit	NR1903.096	05/15/19	04/05/25	DOE	DOE	CNS
CWA	Security Infrastructure Revitalization Program NPDES General Construction Permit	TNR 136604	11/30/21	Upon Notice of Termination	DOE	DOE	CNS
CWA	No Discharge Portal 20 Pump and Haul Permit	SOP-17014	06/24/22	06/30/27	DOE	DOE	CNS
CWA	No Discharge Portal 23 Pump and Haul Permit	SOP-17015	06/20/22	07/30/27	DOE	DOE	CNS
CWA	No Discharge Portal 19 Pump and Haul Permit	SOP-13031	07/01/23	06/30/28	DOE	DOE	CNS
CWA	No Discharge Environmental Management Waste Management Facility Pump and Haul Permit	SOP-01043	09/01/22	08/31/27	DOE	UCOR	UCOR
CWA	Oak Ridge Institute for Global Nuclear Security Aquatic Resource Alteration Permit	NR2003.249	01/14/21	Upon Notice of Termination	DOE	DOE	CNS
CWA	Oak Ridge Institute for Global Nuclear Security NPDES General Construction Permit	TNR136307	04/26/21	09/30/26	DOE	DOE	CNS
CWA	Y-12 National Security Complex LPF Permit	TNR13724	07/21/23	Upon Notice of Termination	DOE	DOE	CNS
CWA	West End Protected Area Reduction NPDES General Construction Permit	TNR136382	04/26/21	09/30/26	DOE	DOE	CNS

Table 4.3. Y-12 environmental permits, 2023 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	Monitoring Station 8 and Outfalls 051 and 099 Access Improvements Aquatic Resource Alteration Permit	NR2103.288	11/08/21	04/07/25	DOE	DOE	CNS
RCRA	Hazardous Waste Transporter Permit	TN3890090001	12/05/22	01/31/24	DOE	DOE	CNS
RCRA	Hazardous Waste Corrective Action Permit	TNHW-164	09/15/15	09/15/25	DOE	DOE, NNSA, and all ORR co-operators of hazardous waste permits	UCOR
RCRA	Hazardous Waste Container Storage Units	TNHW-184	03/05/21	03/05/31	DOE	DOE/CNS	CNS/LATS co-operator
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-191	09/21/23	09/21/33[c]	DOE	DOE/CNS	CNS co-operator
Solid Waste	Industrial Landfill IV (operating, Class II)	IDL-01-000-0075	Permitted in 1988. Most recent modification approved 06/20/19	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Industrial Landfill V (operating, Class II)	IDL-01-000-0083	Permitted in 1993. Most recent modification approved 08/04/22	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill (overfilled, Class IV subject to CERCLA Record of Decision)	DML-01-000-0012	Initial permit 01/15/86	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill VI (post-closure care and maintenance)	DML-01-000-0036	Permit terminated by TDEC 03/15/07	N/A	DOE	DOE/UCOR	UCOR

Table 4.3. Y-12 environmental permits, 2023 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
Solid Waste	Construction and Demolition Landfill VII (operating, Class IV)	DML-01-000-0045	Permitted in 1993. Most recent modification approved 08/31/22	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Centralized Industrial Landfill II (post-closure care and maintenance)	IDL-01-000-0189	Most recent modification approved 05/08/92	N/A	DOE	DOE/UCOR	UCOR
Safe Drinking Water Act	Underground Injection Control Class V Injection Well Permit	Permit by Rule, TDEC Rule 0400-45-06 and -00041	N/A	N/A	DOE	DOE	CNS

[a] *The Title V air permit renewal is still in the review process by TDEC.*

[b] *Some aspects of the current NPDES permit are currently under appeal by NNSA.*

Acronyms:

BNI = Bechtel National Inc.
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CNS = Consolidated Nuclear Security, LLC
CWA = Clean Water Act
LATS = LATA-Atkins Technical Services, LLC
LPF = Lithium Processing Facility
N/A = not applicable
NNSA = National Nuclear Security Administration
NPDES = National Pollutant Discharge Elimination System
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation
UPF = Uranium Processing Facility

4.3.2. National Environmental Policy Act

As federal agencies, DOE and NNSA comply with National Environmental Policy Act (NEPA) requirements as outlined in 10 CFR 1021, *National Environmental Policy Act Implementing Procedures*. NEPA requires reviews of all federal actions to identify any environmental or public consequences associated with that action. NEPA does not require that certain decisions be made or activities be rejected—it just makes sure that federal agencies evaluate environmental and related social and economic impacts in the decision-making process. This evaluation helps Y-12 and NNSA stay in compliance with many federal and state laws, regulations, and permits. Many of the NEPA documents for Y-12 can be found on the Y-12 publicly accessible website at www.y12.doe.gov.

The broadest and most complex NEPA document for Y-12 is DOE/EIS-0387, *Final Site-Wide Environmental Impact Statement (EIS) for the Y-12 National Security Complex* (DOE 2011a). This document takes into account the myriad activities planned for Y-12 in the foreseeable future. As changes in plans are identified or additional information becomes available, the sitewide document is updated with various supplement analyses. Following the 2011 sitewide EIS, supplement analyses were issued in 2016, 2018, and 2020 (NNSA 2016, NNSA 2018, NNSA 2020). NNSA plans to pursue a contract for a new supplement analysis in 2024.

NEPA environmental assessments are prepared for larger projects that may not have been covered in the EIS or supplement analysis.

The lowest level of NEPA documentation is a Categorical Exclusion (CX). These documents are used for smaller projects that have fewer environmental impacts and less cost than the types of activities covered by an EIS or environmental assessment.

There were 50 CX reviews in 2023, with 10 of those being federal CX documents requiring approval by the NNSA NEPA Compliance Officer. Some of these CX documents were for new projects, and others may be revisions to older project documents based on new information or small changes in project scope.

The EIS, supplement analyses, environmental assessments, and federal CXs documents are available at the Y-12 publicly accessible website on the Environment, Safety, and Health page under the About tab. Table 4.4 lists the 10 federal CX documents developed during 2023.

Table 4.4. National Nuclear Security Administration-approved Categorical Exclusions for 2023

Date issued	Title
2/2/2023	NEPA 5043 – Elza Switchyard Disposition
4/4/2023	NEPA 5056 – CRADA for CENTRUS UF6 Conversion Concept Development
4/11/2023	NEPA 5060 – Building 9983 Demolitions
5/24/2023	NEPA 4909 – Test and Demonstration Facility
8/24/2023	NEPA 5075 – Building 9713-14 Disposition
8/28/2023	Safety, Health, and Environmental Improvements for FY 2024 and FY 2025
8/30/2023	NEPA 5022 – Modular Salvage Operations
11/20/2023	NEPA 4818 Rev. 3 – Building 9215, DCM – Bottom Loading Furnaces
11/20/2023	NEPA 5079 – Building 9706-02 Complex Disposition
12/4/2023	NEPA 5087 – West End Production Change House

Acronyms:
CRADA = cooperative research and development agreement
DCM = Direct Chip Melt
NEPA = National Environmental Policy Act

4.3.3. National Historic Preservation Act

In accordance with the National Historic Preservation Act (NHPA, NHPA 1966), Y-12 is committed to identifying, preserving, enhancing, and protecting its cultural resources. Compliance activities in 2023 included completing Section 106 reviews of ongoing and new projects, coordinating with the Tennessee State Historic Preservation Office (SHPO) to update the cultural resource survey, and collecting and storing historic artifacts.

Y-12 is on approximately 3,500 acres within the northern portion of the 33,316 acres of the ORR. Archaeological surveys in 1992 and 1999 determined that the potential for preserved prehistoric or historic archaeological sites is virtually nonexistent due to the previous amount of disturbance during Manhattan Project-era and later construction. Y-12 continues to conduct archaeological surveys as necessary to comply with NHPA, although no surveys were needed during the 2023 time period.

The Y-12 guiding document for its historic preservation program, Y/TS-1983, *Y-12 National Security Complex National Historic Preservation Act Historic Preservation Plan* (BWXT 2003), is reviewed every 5 years to maintain its effectiveness. During the last review, it was determined that this document and the programmatic agreement needed to be updated to accurately reflect changes at Y-12 since the documents were completed in 2003.

Y-12 is updating its Section 110/cultural resource survey, which evaluates all site facilities constructed through 1992 to determine their eligibility for the National Register of Historic Places and inclusion within the redrawn boundaries of the Y-12 Historic District. This cultural resource survey is being developed in consultation with SHPO and will inform the strategies for the updated preservation plan and programmatic agreement. The proposed survey includes a total of 273 surveyed properties out of 352 extant properties at Y-12, including 119 properties assessed in the previous survey and 195 properties constructed after 1958, which is the end of the period of significance for the previous survey completed in 1999. The new proposed period of significance extends to 1992 to include Y-12's role in the Manhattan Project (1943-1945/1946), post-World War II (1945/1946-1950), the Cold War (1950-1992), and Peacetime Research and Development (1950-1992).

The NHPA program works through the NEPA process to ensure that the proper level of environmental review is performed before an irreversible commitment of resources is made. In 2023, 66 proposed projects were evaluated to determine whether any historic properties eligible for inclusion in the National Register of Historic Places would be adversely impacted. The SHPO was consulted twice for actions being taken toward minor heating and air modifications at Building 9731, the Manhattan Project-era facility included in the Manhattan Project National Historical Park. The SHPO agreed that the proposed modifications will have minimum adverse impact to the historical characteristics to the facility and will ultimately contribute to the future use and preservation of the facility.

4.3.4. Clean Air Compliance Status

The state of Tennessee issues permits as the primary means to impose clean air requirements that are applicable to Y-12. New projects are governed by construction permits and modifications to the Title V operating air permit, and eventually the requirements are incorporated into the sitewide Title V operating permit. Y-12 is currently governed by Title V Major Source Operating Permit 571832.

The permit requires recordkeeping and annual and semiannual reports. More than 2,000 data points are obtained and reported each year. All reporting requirements were met during 2023, and there were no exceedances during the reporting period.

Ambient air monitoring, while not specifically required by any permit condition, is conducted at Y-12 to satisfy requirements in DOE Order 458.1, *Radiation Protection of the Public and the*

Environment (DOE 2011b), as a best management practice and to provide evidence of sufficient programmatic control of certain emissions. The monitoring conducted specifically for Y-12 (i.e., mercury monitoring) is supplemented by additional monitoring conducted for ORR and by both on- and off-site monitoring conducted by TDEC.

Section 4.4 provides additional information about Clean Air Act (CAA) activities conducted at Y-12.

4.3.5. Clean Water Act Compliance Status

During 2023, Y-12 continued compliance with the National Pollutant Discharge Elimination System (NPDES) water discharge permit limits. Data obtained as part of the NPDES program are provided in a monthly report to TDEC. The percentage of compliance with permit discharge limits for 2023 was almost 100 percent.

Approximately 4,100 data points were obtained from sampling required by the NPDES permit. Y-12's new NPDES permit was issued on August 5, 2022, and became effective on October 1, 2022. The new permit is currently under appeal in part, and settlement negotiations are ongoing.

4.3.6. Safe Drinking Water Act Compliance Status

The City of Oak Ridge supplies potable water to Y-12 and meets all federal, state, and local standards for drinking water. The water treatment plant, located north of Y-12, is operated by the City of Oak Ridge. Y-12 potable water distribution is operated by a state-certified distribution system operator. The distribution system is regulated by TDEC as a public water system, with public water distribution system identification number 0001068.

TDEC water resource regulation Chapter 0400-45-01, "Public Water Systems," (TDEC 2019), sets limits for biological contaminants, chemical activities, and chemical contaminants. Sampling for total coliform, chlorine residuals, lead, copper, and disinfectant byproducts is conducted by Y-12's Environmental Compliance organization, with oversight by a state-certified operator.

Y-12's potable water distribution system was last reviewed by TDEC in 2021 and received a sanitary survey score of 100 out of a possible 100 points and, thus, retained its approved status as a public water system in good standing with TDEC. All total coliform samples collected during 2021 were analyzed by the state of Tennessee laboratory, and all results were negative. The analytical results for disinfectant byproducts (total trihalomethanes and haloacetic acids) for Y-12's water distribution system were within allowable TDEC and Safe Drinking Water Act limits for the yearly average. Y-12's potable water system is sampled triennially for lead and copper. The system was last sampled in 2023. The results were below TDEC and Safe Drinking Water Act limits and met established requirements.

4.3.7. Resource Conservation and Recovery Act Compliance Status

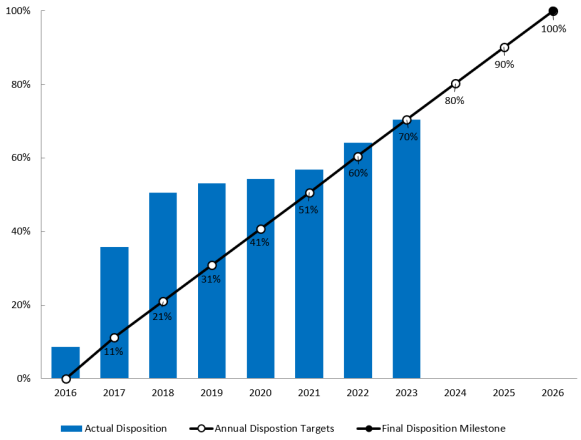
The Resource Conservation and Recovery Act (RCRA) regulates hazardous wastes that, if mismanaged, could present risks to human health or the environment. The regulations are designed to ensure that hazardous wastes are managed from the point of generation to final disposal. In Tennessee, EPA delegates the RCRA program to TDEC, but EPA retains an oversight role. Y-12 is considered a large quantity generator because it may generate more than 1,000 kg of hazardous waste in a month and because it has RCRA permits to store hazardous wastes for up to 1 year before shipping off-site to licensed treatment and disposal facilities. Y-12 also has a number of satellite accumulation areas and 90-day waste storage areas.

Mixed wastes are materials that are both hazardous (under RCRA guidelines) and radioactive. The Federal Facility Compliance Act requires that DOE work with local regulators to develop a site treatment plan to manage mixed waste (FFCA 1992). The plan has two purposes: to identify available treatment technologies and disposal facilities (federal or commercial) that can manage mixed waste produced at federal facilities and to develop a schedule for treating and disposing of the waste streams that cannot be

treated and disposed of in strict compliance with RCRA time limits.

The *Site Treatment Plan for Mixed Wastes on the US Department of Energy Oak Ridge Reservation* (TDEC 2023) is updated annually and submitted to TDEC for review. The plan documents the mixed waste inventory and describes efforts to seek new commercial treatment and disposal outlets for various waste streams. NNSA has developed a disposition schedule for the mixed waste in storage and will continue to maintain the plan, as a reporting mechanism, as progress is made.

Y-12 has developed disposition milestones to address its remaining inventory of legacy mixed waste. Disposition milestones for the final inventory are FYs 2016 through 2026, as shown in Figure 4.9. In FY 2023, Y-12 staff dispositioned 70 percent of the legacy mixed waste inventory listed in the ORR site treatment plan.



Note: *As part of the Oak Ridge Reservation Site Treatment Plan.*

Figure 4.9. Disposition of Y-12 legacy mixed waste inventory by fiscal year, 2016–2023

The quantity of hazardous and mixed wastes generated by Y-12 in 2023 decreased compared to the previous year, as shown in Figure 4.10. Y-12 is a state-permitted treatment, storage, and disposal facility. Under its permits, Y-12 received 5,064 kg of hazardous and mixed waste from off-site in 2023. The 5,064 kg of hazardous waste received at Y-12 was generated from CNS activities at the Union Valley Facility (UVF), Central Training Facility (CTF), and ETTP. Waste from all three facilities is shipped to Y-12, where it is aggregated to allow economical shipments to disposal facilities. The majority (97%) was generated as a result of analytical chemistry laboratory operations at UVF. It is typical for the majority of waste received to be from UVF; however, in 2023 there was a marked increase in waste from the facility due to some laboratory operations moving from Building 9995. In addition, there was a large cleanout activity that generated a number of expired and excess chemicals. Small amounts of hazardous waste were also generated from security activities at CTF and UPF project operations at ETTP.

In addition, 927,341 kg of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 10 million kg of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

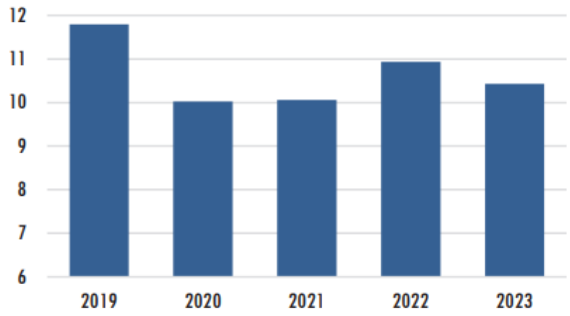


Figure 4.10. Y-12 hazardous waste generation (in million kg), 2019–2023

4.3.7.1. Resource Conservation and Recovery Act Underground Storage Tanks

TDEC regulates active petroleum underground storage tanks (USTs). Existing UST systems that remain in service must comply with performance requirements described in Chapter 0400-18-01, "Underground Storage Tank Program" (TDEC 2018).

The last two petroleum USTs at Y-12 were closed and removed from the East End Fuel Station in August 2012. No petroleum USTs remain at Y-12.

4.3.7.2. Resource Conservation and Recovery Act Subtitle D Solid Waste

ORR landfills operated by DOE EM are located within the Y-12 boundary. The facilities include two Class II operating industrial solid waste disposal landfills and one operating Class IV construction demolition landfill. The facilities are permitted by TDEC and accept solid waste from DOE operations on ORR. In addition, one Class IV facility (Spoil Area 1) is overfilled by 8,945 m^3 and has been the subject of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation and feasibility study. A CERCLA Record of Decision for Spoil Area 1 was signed in 1997 (DOE 1997b). One Class II facility (Landfill II) has been closed and is subject to post-closure care and maintenance.

Associated TDEC permit numbers are noted in Table 4.3. Additional information about the operation of these landfills is provided in Section 4.8.2.

4.3.8. Resource Conservation and Recovery Act–Comprehensive Environmental Response, Compensation, and Liability Act Coordination

The ORR Federal Facility Agreement (DOE 2023c) is used to coordinate the corrective action processes of RCRA required under the ORR Corrective Action TNHW-164, which was renewed for a 10-year period from September 15, 2015, through September 15, 2025. As required in TNHW-164, the annual update of solid waste management units and areas of concern was submitted to TDEC in January 2024 as an update of the previous year's activities.

4.3.9. Toxic Substances Control Act Compliance Status

Storage, handling, and use of polychlorinated biphenyls (PCBs) are regulated under the Toxic Substances Control Act (TSCA). Capacitors manufactured before 1970 believed to be oil-filled are handled as though they contain PCBs, even when that cannot be verified from manufacturer records. Certain equipment containing PCBs and PCB waste containers must be inventoried and labeled. The inventory is updated by July 1 of each year and was last submitted on June 22, 2023.

Given the widespread historical uses of PCBs at Y-12 and fissionable material requirements that must be met, EPA and DOE negotiated an agreement to assist ORR facilities in becoming compliant with TSCA regulations (DOE 2012). This agreement, known as the ORR PCB Federal Facility Compliance Agreement, addresses PCB compliance issues that are unique to these facilities. Y-12 operations involving TSCA-regulated materials were conducted in accordance with TSCA regulations and the agreement.

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

The Emergency Planning and Community Right-to-Know Act requires facilities to report inventories (i.e., Tier II report sent to state and local emergency responders) and releases (i.e., toxic release inventory report submitted to state and federal environmental agencies) of certain chemicals that exceed specified thresholds (EPCRA 1986). Y-12 submitted reports for reporting year 2023 in accordance with requirements under Sections 303, 311, 312, and 313 of the Act.

Y-12 had no unplanned release of a hazardous substance that required notification of the regulatory agencies. (Section 4.3.11 provides additional information.) Three substances were over the threshold during 2023. Inventories, locations, and associated hazards of over-threshold hazardous and extremely hazardous chemicals were submitted to TEMA and local emergency responders in the annual Tier II report required by Section 312. Data submittal was through the E-Plan web-based reporting system, as requested by TEMA. Some local emergency responders accepted data through the E-Plan system, but others require that electronic copies of the Tier II reports be submitted via email. Y-12 reported 44 chemicals that were over Section 312 inventory thresholds in 2023.

Y-12 operations are evaluated annually to determine the applicability for submittal of a toxic

release inventory report to TEMA and EPA in accordance with Section 313 requirements. The amounts of certain chemicals manufactured, processed, or otherwise used are calculated to identify those that exceed reporting thresholds. After threshold determinations are made, releases and off-site transfers are calculated for each chemical that exceeds a threshold. Submittal of the data to TEMA and EPA is made through the Toxics Release Inventory-Made Easy (abbreviated as TRI-ME) web-based reporting system operated by EPA. Seven chemicals were reported for 2023 on the Toxic Release Inventory report. Table 4.5 lists the reported chemicals for Y-12 and its associated Central Training Facility for 2022 and 2023.

4.3.11. Spill Prevention, Control, and Countermeasures

Section 311 of the Clean Water Act regulates the discharge of oils or petroleum products to waters of the United States and requires spill prevention, control, and countermeasure plans be developed and implemented to minimize the potential for oil discharges (CWA 1972). The major requirements for plans are contained in 40 Part 112. These regulations require that these plans be reviewed, evaluated, and amended at least once every 5 years, or earlier if significant changes occur. The rule includes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines. Specific facilities are required to prepare, amend, and implement spill prevention, control, and countermeasure plans.

Y/SUB/02-001091/8, *Spill Prevention, Control, and Countermeasure Plan for the U.S. Department of Energy Y-12 National Security Complex* (CNS 2022) was revised in October 2022 to update changing site infrastructure. This plan presents the requirements to be implemented by Y-12 to prevent spills of oil and the countermeasures to be invoked should a spill occur. In general, the first response of an individual discovering a spill is to call the Y-12 Operations Center. Spill response materials and equipment are stored near tanks, drum storage areas, and other strategic areas to facilitate spill response. All Y-12 personnel and subcontractors are required to have initial spill and emergency response training before they can work on the site.

4.3.12. Unplanned Releases

Y-12 has procedures for notifying off-site authorities of categorized events at Y-12. Off-site notifications are required for specified events according to federal statutes, DOE orders, and the Tennessee Oversight Agreement. As an example, certain observable oil sheens on East Fork Poplar Creek (EFPC) must be reported to the EPA National Response Center, among others. Spills of CERCLA reportable quantity limits must be reported to the EPA National Response Center, DOE, TEMA, and the Anderson County Local Emergency Planning Committee.

In addition, Y-12's Occurrence Reporting Program provides timely notification to the DOE community of events and site conditions that could adversely affect public or worker health and safety, the environment, national security, DOE safeguards and security interests, DOE facilities functions, or DOE's reputation.

Y-12 occurrences are categorized and reported through the Occurrence Reporting and Processing System, which provides NNSA and the DOE community with a readily accessible database of information about occurrences at DOE facilities, causes of those occurrences, and corrective actions to prevent recurrence of the events. DOE analyzes aggregate occurrence information for generic implications and operational improvements.

During 2023, there were no reportable releases to the environment, including no reportable radiological air emission releases for Y-12.

Table 4.5. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and chemicals manufactured, processed, or otherwise used for Y-12 and the Central Training Facility

Report	Chemical/ Compound	2022			2023			Comments
		Manufactured (lb)	Processed (lb)	Otherwise Used (lb)	Manufactured (lb)	Processed (lb)	Otherwise Used (lb)	
Y-12	Chromium/ Chromium Compounds	0	124,787	62,990	0	169,521	17,475	2023 increased amount recycled and metal processed; decreased UPF construction materials otherwise used.
Y-12	Cobalt	0	29,718	6,928	0	40,072	2,912	2023 increased amount recycled and decreased UPF construction materials otherwise used.
Y-12	Copper	0	153,166	49,010	0	250,743	13,880	2023 increased amount recycled and decreased UPF construction materials otherwise used.
Y-12	Lead/Lead Compounds	0	66,122	8,389	0	91,984	35,435	2023 increased amount recycled and decreased construction materials otherwise used. CTF lead counts for ammunition are not included in the Y-12 report but in a standalone report for 2023. UCOR otherwise used and shipments increased for 2023.
Y-12	Manganese	0	84,755	21,514	0	117,437	9,172	2023 increased amount of recycled and metal processed; decreased UPF construction materials otherwise used.
Y-12	Methanol[a]	0	0	31,768	0	0	6,372	Not reportable under threshold for 2023. Building 9767-4 no longer in use for the brine system.
Y-12	Nickel	0	299,380	74,812	0	409,514	26,664	2023 increased amount recycled and metal processed and decreased UPF construction materials otherwise used.
CTF	Lead/Lead Compounds	0	0	1,094	0	0	1,109	2023 CTF is reported separately from Y-12 because the facility is not adjacent or adjoining the Y-12 site.

a Not reported during 2023

Acronyms:

CTF = Central Training Facility

UPF = Uranium Processing Facility

4.3.13. Audits and Oversight

In 2023, Y-12 was inspected by federal, state, or local regulators on four occasions, as listed in Table 4.2.

Personnel from the TDEC Division of Water Resources conducted an NPDES compliance evaluation inspection on September 6, 2023. The inspection included outfalls, records, and the on-site laboratory. No issues were identified.

As part of the City of Oak Ridge's pretreatment program, city personnel collect samples from the Y-12 monitoring station to conduct compliance monitoring, as required by the pretreatment regulations. City personnel also conduct compliance inspections twice yearly. No issues were identified in 2023.

Personnel from the TDEC Division of Solid Waste Management conducted an unannounced RCRA hazardous waste compliance inspection of Y-12 on March 6–7, 2023. The inspections covered waste storage areas and records reviews. Two issues were identified: storage of three bags of spent aerosol cans for more than one year and one aerosol can puncturing device that was not closed securely. Immediate corrective actions were taken where possible. The issues and their causes are being reviewed to prevent recurrence.

Personnel from the TDEC Division of Air Pollution Control conducted an air quality inspection on March 24, 2023. The inspection covered 13 air emission sources, including some emergency generators, and inspections of the facilities. Title V air permit records were also reviewed. No issues were identified.

4.3.14. Radiological Release of Property

Releasing property from Y-12 is conducted in accordance with approved procedures that comply with DOE Order 458.1. Property consists of real property (i.e., land and structures) and personal property (i.e., property of any type except real property) (DOE 2011b).

At Y-12, there are three paths for releasing property to the public based on the potential for radiological contamination:

- Survey and release property potentially contaminated on the surface (Section 4.3.14.1).
- Evaluate materials with a potential to be contaminated in volume (Section 4.3.14.2).
- Evaluate using process knowledge (surface and volumetric) (Section 4.3.14.3).

Table 4.6 summarizes some examples of the property released in 2023 and their amounts. Y-12 recycled more than 5.8 million lb of materials off-site for reuse, including computers, electronic office equipment, used oil, scrap metal, tires, batteries, lamps, and pallets.

The paths discussed in Sections 4.3.14.1 and 4.3.14.2 use pre-approved authorized limits as outlined in DOE Order 458.1. The basis of these standards is to limit the dose to any member of the public to a maximum of 1.0 mrem (0.01 mSv) per year total effective dose from clearing materials from regulatory control. These authorized limits are applicable to the release of personal property only (including recycled material). No real property was released from Y-12 in 2023.

Table 4.6. Summary of materials released in 2023

Category	Amount released
Real property (land and structures)	None
Computer equipment recycle:	60,749 lb
– Computers	
– Monitors	
– Printers	
– Mainframes	
Recycling examples:	
– Used oils	18,887 gal
– Used tires	6,080 lb
– Scrap metal	3,189,754 lb
– Lead acid batteries	92,621 lb
Public and negotiated sales:	
– Brass	21,417 lb
– Miscellaneous furniture	7,200 lb
– Vehicles and miscellaneous equipment/materials	152,024 lb
External transfers	N/A

Note: *External transfers include vehicles, miscellaneous equipment, and materials transferred to various federal, state, and local agencies for reuse during FY 2023. Y-12 transferred property with an acquisition value of approximately $1,072,462; however, the weight of the transferred items in pounds was unable to be quantified.*

4.3.14.1. Property Potentially Contaminated on the Surface

Property that is potentially contaminated on the surface is completely surveyed, unless it can be released based on process knowledge or through a survey plan that provides survey instructions, along with technical justification (process knowledge) for the plan, based on NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (NRC 2000) and NUREG-1575, Supplement 1, *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual* (NRC 2009). Table 4.7 lists the surface contamination limits used at Y-12 to determine whether materials and equipment (M&E) are suitable for release to the public.

Y-12 uses an administrative limit for average and maximum activity of 240 dpm/100 cm^2 for radionuclides in Group 3 and 2,400 dpm/100 cm^2 for radionuclides in Group 4 (Table 4.7). Y-12 also uses an administrative limit for removable activity of 240 dpm/100 cm^2 for radionuclides in Group 3 (Table 4.7). Using the more-restrictive administrative limits ensures that M&E do not enter into commerce exceeding the definition of contamination for high-toxicity alpha emitters and for beta and gamma emitters, respectively, found in 49 CFR 173, *Shippers—General Requirements for Shipments and Packaging*.

4.3.14.2. Property Potentially Contaminated in Volume

Materials, such as activated materials, smelted-contaminated metals, liquids, and powders, are subject to volumetric contamination (i.e., radioactivity per unit volume or per unit mass) and are treated separately from surface-contaminated objects. Materials that may be subject to volumetric contamination are evaluated for release by one of the following three methods:

- **Unopened, sealed containers.** Material is in an original manufacturer's sealed, unopened container. A seal can be visible (e.g., lock tabs, heat shrink) or unseen (e.g., unbroken fluorescent bulbs, sealed capacitors), as long as the container remains unopened.
- **Process knowledge.** If contamination being able to enter a system is unlikely, then process knowledge is documented and used as the basis for release. Often, this is accompanied by confirmatory surveys.
- **Analytical.** The material is sampled, and the results are evaluated against the preapproved authorized limits in DOE Order 458.1. If preapproved authorized limits have not been obtained, then analytical results are evaluated against measurement method critical levels or background levels from materials that have not been impacted by Y-12 activities. If results meet defined criteria, then they are documented, and the material is released.

Table 4.7. DOE Order 458.1 preapproved authorized limits for surface contamination[a,b]

Radionuclide[c]	Average[d,e]	Maximum[d,e]	Removable[f]
Group 1: Transuranics, ^{125}I, ^{129}I, ^{227}Ac, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	100	300	20
Group 2: Th-natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	1,000	3,000	200
Group 3: U-Natural, ^{235}U, ^{238}U, associated decay products, alpha emitters	5,000	15,000	1,000
Group 4: Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission), except ^{90}Sr and others noted above[g]	5,000	15,000	1,000
Tritium (applicable to surface and subsurface)[h]	N/A	N/A	10,000

[a] *The values in this table (except for tritium) apply to radioactive material deposited on but not incorporated into the interior or matrix of the property. No generic concentration guidelines have been approved for release of material that has been contaminated in depth, such as activated material or smelted-contaminated metals (e.g., radioactivity per unit volume or per unit mass). Authorized limits for residual radioactive material in volume must be approved separately.*

[b] *As used in this table, disintegrations per minute means the rate of emission by radioactive material, as determined by counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.*

[c] *Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.*

[d] *Measurements of average contamination should not be averaged over an area of more than 1 m^2. Where scanning surveys are not sufficient to detect levels in the table, static counting must be used to measure surface activity. Representative sampling (static counts on the areas) may be used to demonstrate by analyses the static counting data. The maximum contamination level applies to an area of not more than 100 cm^2.*

[e] *The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.*

[f] *The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination of objects on surfaces of less than 100 cm^2 is determined, the activity per unit area should be based on the actual area, and the entire surface should be wiped. Wiping techniques to measure removable contamination levels are unnecessary if direct scan surveys indicate the total residual surface contamination levels are within the limits for removable contamination.*

[g] *This category of radionuclides includes mixed fission products, including ^{90}Sr that is present in them. It does not apply to ^{90}Sr that has been separated from other fission products or mixtures where ^{90}Sr has been enriched.*

[h] *Measurement should be conducted by a standard smear measurement but using a damp swipe or material that will readily absorb tritium, such as polystyrene foam. Property recently exposed or decontaminated should have measurements (smears) at regular time intervals to prevent a buildup of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in Group 4 do not apply to tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure nonremovable fractions and residual tritium in mass will not cause exposures that exceed DOE dose limits and constraints.*

Acronyms:

N/A = not applicable

Y-12 was granted approval to use the DOE Order 458.1 preapproved authorized limits for volumetric contamination on July 20, 2021, which is documented in NPO letter COR-NP0-60 ESH-7.20.2021-919599, "Approval to Use Pre-Approved Authorized Limits for the Release and Clearance of Volumetric Radioactivity of Personal Property" (NNSA 2021). Table 4.8 lists these volumetric contamination limits for various groups of radionuclides. When multiple radionuclides exist in a single sample, a sum of fractions is used to verify that material meets the specified limits.

4.3.14.3. Process Knowledge

Process knowledge is used to release property from Y-12 without monitoring or analytical data and to implement a graded approach (less than 100 percent monitoring) for monitoring of some M&E (Classes II and III, NRC 2009). A conservative approach (nearly 100 percent monitoring) is used to release older M&E for which a complete and accurate history is difficult to compile and verify (Class I, NRC 2009). The process knowledge evaluation processes are outlined in Y-12 procedures.

The following are examples of M&E released without monitoring based on process knowledge; however, this does not preclude conducting verification monitoring before sale:

- All M&E from rad-free zones
- Pallets generated from noncontaminated areas
- Pallets that are returned to shipping during the same delivery trip
- Lamps from noncontaminated areas
- Drinking water filters
- M&E approved for release by radiological engineering technical review
- Portable restrooms used in noncontaminated areas
- Documents, mail, diskettes, compact disks, and other office media
- Personal M&E
- Paper, plastic products, water bottles, aluminum beverage cans, and toner cartridges
- Office trash, housekeeping materials, and associated waste
- Breakroom, cafeteria, and medical wastes
- Medical and bioassay samples generated in noncontaminated areas
- Subcontractor, vendor, and privately owned vehicles, tools, and equipment used in noncontaminated areas
- M&E that are administratively released
- M&E that were delivered to stores in error and that have not been distributed to other Y-12 locations
- New computer equipment distributed from the Central Computing Facility
- Subcontractor, vendor, and privately owned vehicles, tools, and equipment that have not been used for excavation activities
- New cardboard
- Consumer glass containers

Table 4.8. DOE Order 458.1 preapproved authorized limits for volumetric contamination[a]

Radionuclide groups[b]	SI units, volume (Bq/g)[f]	Conventional units, volume (pCi/g)[f]
Group 0 Special Case: ^{129}I[c]	0.01	0.3
Group 1 High-energy gamma, radium, thorium, transuranics, and mobile beta-gamma emitters: ^{22}Na, ^{46}Sc, ^{54}Mn, ^{56}Co, ^{60}Co, ^{65}Zn, ^{94}Nb, ^{106}Ru,^{110m}Ag, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu,^{182}Ta, ^{207}Bi, ^{210}Po, ^{210}Pb, ^{226}Ra, ^{228}Ra, ^{228}Th,^{229}Th, ^{230}Th, ^{232}Th, ^{232}U, ^{238}Pu, ^{239}Pu, ^{240}Pu,^{242}Pu, ^{244}Pu, ^{241}Am, ^{243}Am, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, ^{249}Cf, ^{251}Cf, ^{254}Es, and associated decay chains[d], and others[b]	0.1	3
Group 2 Uranium and selected beta-gamma emitters: ^{14}C, ^{36}Cl, ^{59}Fe, ^{57}Co, ^{58}Co, ^{75}Se, ^{85}Sr, ^{90}Sr, ^{95}Zr, ^{99}Tc, ^{105}Ag, ^{109}Cd, ^{113}Sn, ^{124}Sb, ^{123m}Te, ^{139}Ce, ^{140}Ba, ^{155}Eu, ^{160}Tb, ^{181}Hf, ^{185}Os, ^{190}Ir, ^{192}Ir, ^{204}Tl, ^{206}Bi, ^{233}U, ^{234}U, ^{235}U, ^{238}U, natural uranium[e], ^{237}Np, ^{236}Pu, ^{243}Cm, ^{244}Cm, ^{248}Cf, ^{250}Cf, ^{252}Cf, ^{254}Cf, and associated decay chains[d], and others[b]	1	30
Group 3 General beta-gamma emitters: ^{7}Be,^{74}As, ^{93m}Nb, ^{93}Mo, ^{93}Zr, ^{97}Tc, ^{103}Ru, ^{114m}In, ^{125}Sn,^{127m}Te, ^{129m}Te, ^{131}I, ^{131}Ba, ^{144}Ce, ^{153}Gd, ^{181}W, ^{203}Hg, ^{202}Tl, ^{225}Ra, ^{230}Pa, ^{233}Pa, ^{236}U, ^{241}Pu, ^{242}Cm, and others[b]	10	300
Group 4 Low-energy beta-gamma emitters: ^{3}H, ^{35}S, ^{45}Ca, ^{51}Cr, ^{53}Mn, ^{59}Ni, ^{63}Ni, ^{86}Rb, ^{91}Y, ^{97m}Tc, ^{115m}Cd, ^{115m}In, ^{125}I, ^{135}Cs, ^{141}Ce, ^{147}Nd, ^{170}Tm, ^{191}Os, ^{237}Pu, ^{249}Bk, ^{253}Cf, and others[b]	100	3,000
Group 5 Low-energy beta emitters: ^{55}Fe, ^{73}As, ^{89}Sr, ^{125m}Te, ^{147}Pm, ^{151}Sm, ^{171}Tm, ^{185}W, and others[b]	1,000	30,000

[a] *The screening levels for clearance have been rounded to one significant figure and are assigned for volume radioactivity.*

[b] *To determine the specific group for radionuclides not shown, a comparison of the screening factors, by exposure scenario, listed in Tables B. 1, C.1, and D.1 of NCRP Report No. 123I (NCRP 1996) for the radionuclides in question and the radionuclides in the general groups above will be performed and a determination of the proper group made, as described in ANSI/HPS N13.12-2013, Annex A.*

[c] *Because of potential ground-water concerns, the volume radioactivity values for ^{129}I when disposal to landfills or direct disposal to soil is anticipated is assigned to Group 0.*

[d] *For decay chains, the screening levels represent the total activity (i.e., the activity of the parent plus the activity of all progeny) present.*

[e] *The natural uranium screening levels for clearance shall be lowered from Group 2 to Group 1 if decay-chain progeny are present (i.e., uranium ore versus process or separated uranium, for example, in the form of yellowcake). The natural uranium activity equals the activity from uranium isotopes (48.9% from ^{238}U, plus 48.9% from ^{234}U, plus 2.2% from ^{235}U). This approach is consistent with summing radionuclide fractions discussed in ANSI/HPS N13.12-2013, Section 4.4.*

[f] *Each individual limit applies to the particular radionuclides, but must be summarized and the Sum of Fractions must be ≤ 1.*

Notes:

1. *COR-NP0-60 ESH-7.20.2021-919599, NNSA Production Office Approval to Use Pre-Approved Authorized Limits for the Release and Clearance of Volumetric Radioactivity of Personal Property*

4.4. Air Quality Program

Sections of Y-12's Title V Permit 571832 contain requirements that are generally applicable to most industrial sites. Examples include requirements associated with control of asbestos, stratospheric ozone-depleting chemicals, and fugitive emissions.

The Title V permit contains specific requirements directly applicable to individual sources of air emissions at Y-12. Major requirements in that section include 40 CFR 61, *National Emission Standards for Hazardous Air Pollutants*, (NESHAP) and numerous requirements associated with emissions of criteria pollutants and other nonradiological hazardous air pollutants. In addition, a number of sources that are exempt from permitting requirements under state rules but subject to listing on the Title V permit application are documented, and information about them is available upon request from the Y-12 Clean Air Program.

4.4.1. Construction and Operating Permits

The following Title V permitting actions were submitted and approved in 2023:

- An insignificant activity exemption was completed for the part cleaning station-sanding operation in Building 9204-2.
- An operational flexibility request was made to add a new Bridgeport mill machine to the electrorefining processing operations in Building 9998.
- An insignificant activity exemption was completed for the Dismantlement glovebox operation in Building 9204-2E.

Demonstrating compliance with air permits conditions is a significant effort at Y-12. Key compliance elements are maintaining and operating control devices, monitoring, recordkeeping, and reporting.

High-efficiency particulate air filters and scrubbers are control devices used throughout Y-12. In-place testing to verify the integrity of the filters is routinely performed. Scrubbers are operated and maintained in accordance with source-specific procedures. Monitoring tasks consist of continuous stack sampling, onetime stack sampling, and operation of control devices. The radiological stack monitoring systems on numerous sources throughout Y-12 are part of continuous stack sampling efforts.

The Y-12 sitewide permit requires annual and semiannual reports, including the following:

- Annual ORR radiological NESHAP report, which includes specific information regarding Y-12 radiological emissions.
- Annual Title V compliance certification report, which indicates compliance status with all conditions of the permit.
- Title V semiannual report, which covers a 6-month period for some specific emission sources and consists of monitoring and recordkeeping requirements for the sources.
- Boiler maximum available control technology report for the Y-12 Steam Plant, which requires the boilers to be tuned annually.

Table 4.9 lists the actual emissions versus allowable emissions for the Y-12 Steam Plant.

Table 4.9. Actual versus allowable air emissions from the Y-12 Steam Plant, 2023

Emissions (tons/yr)[a]			
Pollutant	**Actual**	**Allowable**	**Percentage of allowable**
Particulate	2.74	41.0	6.7
Sulfur dioxide	0.22	39.0	0.6
Nitrogen oxides[b]	11.54	81.0	14.2
VOCs[b]	2.66	9.4	28.3
Carbon monoxide[b]	30.29	139.0	21.8

[a] *1 ton = 907.2 kg.*

[b] *When no applicable standard or enforceable permit condition exists for a pollutant, the allowable emissions are based on the maximum actual emissions calculation, as defined in TDEC Rule 1200-3-26-.02(2)(d)3 (maximum design capacity for 8,760 h/yr) (TDEC 2024a). Both actual and allowable emissions were calculated based on the latest EPA compilation of air pollutant emission factors (EPA 1995, 1998).*

Note: *The emissions are based on fuel usage data for January through December 2023. The VOC emissions include VOC hazard air pollutant emissions.*

Acronym:

TDEC = Tennessee Department of Environment and Conservation *VOC = volatile organic compound*

4.4.1.1. Generally Applicable Permit Requirements

Y-12, like many industrial sites, has a number of generally applicable requirements, such as those pertaining to managing and controlling asbestos, ozone-depleting substances, and fugitive particulate emissions.

Asbestos Control

Y-12 also has a number of general requirements applicable to removing and disposing of asbestos-containing materials, including monitoring, notifying TDEC of demolitions and renovations, and prescribed work practices for abating and disposing of asbestos materials. There was no reportable release of asbestos in 2023. There were three notifications of asbestos demolitions and renovations. Asbestos, ozone-depleting substances, and fugitive particulate emissions are notable examples.

Stratospheric Ozone Protection and Hydrofluorocarbon Phasedown

As required by the 1990 CAA Amendment Title VI, *Stratospheric Ozone Protection,* and in accordance with 40 CFR 82, *Protection of Stratospheric Ozone,* actions have been implemented to comply with the prohibition against intentionally releasing ozone-depleting substances during maintenance activities performed on refrigeration equipment. EPA enacted major revisions to the stratospheric ozone rules in 2017, including regulating non-ozone-depleting substance substitutes as part of 40 CFR 82, Subpart F. These revisions were effective January 1, 2018, for disposal of small appliances and January 1, 2019, for the leak rate provisions for large appliances. There were no appliances at Y-12 that leaked refrigerant in 2023 to trigger this reporting.

On October 1, 2021, EPA began implementing the hydrofluorocarbon phasedown requirements of the American Innovation and Manufacturing Act of 2020, which seeks to reduce hydrofluorocarbon consumption and production to 15 percent of a 2011–2013 baseline by 2036 (AIM 2020). Sitewide use of hydrofluorocarbons is being evaluated to understand future effects of Act phasedowns.

Fugitive Particulate Emissions

As modernization reduction efforts increase at Y-12, there is a mature project planning process to review, recommend, and implement appropriate work practices and controls to minimize fugitive

dust emissions. The following precautions are used to prevent particulate matter from becoming airborne:

- Where possible, water or chemicals are used to control dust when demolishing existing buildings or structures, performing construction operations, grading roads, or clearing land.
- Asphalt, water, or suitable chemicals are applied on dirt roads, material stockpiles, and other surfaces that can create airborne dusts.
- Hoods, fans, and fabric filters are installed and used to enclose and vent dusty materials.

4.4.1.2. National Emission Standards for Hazardous Air Pollutants for Radionuclides

The release of radiological contaminants, primarily uranium, into the atmosphere at Y-12 occurs almost exclusively as a result of plant production, maintenance, and waste management activities. The major radionuclide emissions contributing to the dose from Y-12 are ^{234}U, ^{235}U, ^{236}U, and ^{238}U, which are emitted as particulates (Figure 4.11). The particle size and solubility class of the emissions are based on review of the operations and processes served by the exhaust systems to determine the quantity of uranium handled in the operation or process, the physical form of the uranium, and the nature of the operation or process. The following four categories of processes or operations are considered when calculating the total uranium emissions:

- Those that exhaust through monitored stacks
- Unmonitored processes for which calculations are performed according to Appendix D of 40 CFR 61
- Processes or operations exhausting through laboratory hoods, also involving 40 CFR 61, Appendix D, calculations
- Emissions from room ventilation exhausts (calculated using radiological control monitoring data from the work area)

Continuous sampling systems are used to monitor emissions from a number of process exhaust stacks at Y-12. In addition, a probe cleaning program is in place, and the results from the cleaning at each source are incorporated into the respective emission point source terms. In 2023, 24 process exhaust stacks were continuously monitored, 23 of which were major sources, and the remaining stack was a minor source. The sampling systems on the stacks have been approved by EPA Region 4.

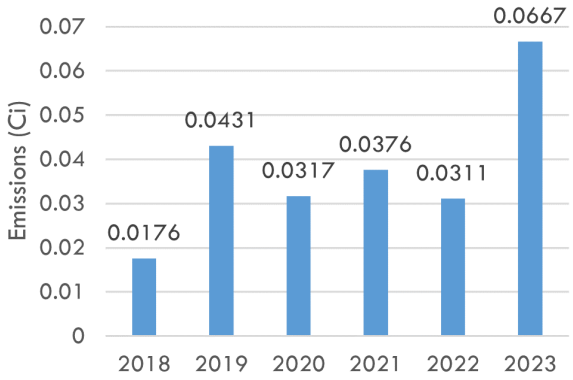


Figure 4.11. Total curies of uranium discharged from Y-12 to the atmosphere, 2018–2023

During 2023, unmonitored uranium emissions occurred from 46 points associated with on-site unmonitored processes and laboratories. Emission estimates for the processes and laboratory stacks were made using inventory data with emission factors provided in 40 CFR 61, Appendix D. The Y-12 source term includes an estimate of these emissions.

The Analytical Chemistry organization operates two main laboratories. One is located in Building 9995, and the other is located in a leased facility on Union Valley Road, about 0.3 mi east of Y-12 and outside the ORR boundary. In 2023, there were no radionuclide emission points (or sources) in the off-site laboratory facility.

Additionally, estimates from room ventilation systems are considered, using radiological control data on airborne radioactivity concentrations in the work areas. Where applicable, exhausts from any area where the monthly concentration average exceeds 10 percent of the derived air concentration, as defined in *Compliance Plan, National Emission Standards for Hazardous Air Pollutants for Airborne Radionuclides on the Oak*

Ridge Reservation, Oak Ridge, Tennessee (DOE 2020a), are included in the annual source term. Annual average concentrations and design ventilation rates are used to calculate the annual emission estimate for those areas. Five emission points from room ventilation exhausts were identified in 2023 where emissions exceeded 10 percent of the derived air concentration. All emission points fed to monitored stacks, and any radionuclide emissions were accounted for as noted for monitored emission points; therefore, they are not included in the total overall source term for Y-12.

The Y-12 Title V (Major Source) operating permit contains a sitewide, streamlined alternate emission limit for enriched uranium and depleted uranium process emission units. A particulate limit of 907 kg/yr was set for the sources for the purposes of paying fees. The compliance method requires the annual actual mass emission particulate emissions to be generated using the same monitoring methods required for radiological NESHAP compliance. An estimated 0.0667 Ci (35.1 kg) of uranium was released into the atmosphere in 2023 as a result of Y-12 process and operational activities.

The calculated radiation dose to the maximally exposed off-site individual from airborne radiological release points at Y-12 during 2023 was 0.5 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.2 percent of the roughly 300 mrem that the average individual receives from natural sources of radiation. Chapter 7 discusses how the airborne radionuclide dose was determined.

Lastly, the UPF is being designed and constructed to house some of the processes that are in existing production buildings. The UPF project was issued a construction air permit (967550P) in March 2014. With concurrence from TDEC Air Division, the UPF was included in the 2018 update of Y-12's Title V Operating Permit 571832 on February 18, 2019. The Title V air permit was administratively extended until a new permit is issued. The UPF project will be maintained on inactive status until operational readiness and startup.

4.4.1.3. Quality Assurance

Quality assurance (QA) activities for the radiological NESHAP program are documented in Y/TS 874, *Y-12 Plant Quality Assurance Project Plan for National Emission Standards for Hazardous Air Pollutants (NESHAP) Radionuclide Emission Measurements*, which satisfies the QA requirements in 40 CFR 61, Method 114, for ensuring that radionuclide air emission measurements from Y-12 are representative to 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 (CNS 2020a).

The requirements are also referenced in TDEC Regulation 0400-30-38, "Emission Standards for Hazardous Air Pollutants" (TDEC 2022a). The plan ensures the quality of Y-12 radionuclide emission measurements data from the continuous samplers and minor radionuclide release points. It specifies the procedures for managing activities affecting data quality. QA objectives for completeness, sensitivity, accuracy, and precision are discussed. Major programmatic elements addressed in the QA plan are the sampling and monitoring program, emissions characterization, analytical program, and minor source emission estimates.

4.4.1.4. Source-Specific Criteria Pollutants

Proper maintenance and operation of control devices, such as high-efficiency particulate air filters and scrubbers, helps control emissions of criteria pollutants. The primary source of criteria pollutants at Y-12 is the steam plant, where only natural gas and Number 2 fuel oil are permitted to be burned. Actual versus allowable emissions from the steam plant are listed in Table 4.9.

Particulate emissions from point sources result from many operations throughout Y-12. Compliance is demonstrated through several activities, including monitoring the operations of control devices, limiting process input materials, and using certified readers to conduct emission evaluations of visible stacks.

Use of solvent 140/142, methanol, and vertrel throughout Y-12 and volatile organic compounds (VOCs) from the steam plant are primary sources of VOC emissions. Material mass balances and engineering calculations are used to determine annual emissions. The calculated amounts of solvent 140/142 and methanol emitted for 2023 are 4,505.93 lb (2.25 tons) and 5,082 lb (2.54 tons), respectively.

4.4.1.5. Mandatory Reporting of Greenhouse Gas Emissions Under 40 CFR 98

40 CFR 98, *Mandatory Reporting of Greenhouse Gases*, establishes reporting requirements for owners and operators of certain facilities that directly emit GHGs and for certain fossil fuel suppliers and industrial GHG suppliers. The purpose of the rule is to collect accurate and timely data on GHG emissions that can be used to inform future policy decisions.

The rule requires reporting annual emissions of carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, perfluorochemicals, and other fluorinated gases (e.g., nitrogen trifluoride and hydrofluorinated ethers). These gases are often expressed in metric tons of carbon dioxide equivalent (CO_2e).

Y-12 is subject only to Subpart A general provisions and reporting from stationary fuel combustion sources covered in 40 CFR 98, Subpart C, "General Stationary Fuel Combustion." Currently, the rule does not require control of GHGs; rather, it requires only monitoring and reporting by sources emitting above the 25,000 CO_2e threshold level.

The Y-12 Steam Plant is subject to this rule. The steam plant has four boilers. The maximum heat input capacity of each boiler does not exceed 99 million Btu/h. Natural gas is the primary fuel source for the boilers; Number 2 fuel oil is a backup fuel source. Other limited, stationary combustion sources are metal-forming operations and production furnaces that use natural gas.

In Building 9212, a gas-fired furnace used for drying wet residues and burning solids in a recovery process has a maximum heat input of 700,000 Btu/h. In Building 9215, 10 natural gas torches, each at 300 standard ft^3/h, are used to preheat tooling associated with a forging and forming press. In Building 9204-02, natural gas is used to heat two electrolytic cells. The maximum rated heat input to the burners on each cell is 550,000 Btu/h.

All of the combustion units burning natural gas are served through the fuel supply and distribution system and are reported as combined emissions consistent with the provisions of 40 CFR 98.36(c)(3). The Tier 1 method was used to calculate GHGs from Y-12. The amount of natural gas supplied to the site, along with the fuel use logs, provides basic information required for calculating GHG emissions.

The emissions report is submitted electronically in the EPA-specified format. Each report is signed by a designated representative of the owner or operator, certifying under penalty of law that the report has been prepared in accordance with the requirements of the rule. The total amount of GHGs, subject to the mandatory reporting rule, emitted from Y-12, is shown in Table 4.10. The decrease in emissions from 2010 to 2017 is because coal is no longer burned since the natural gas-fired steam plant became operational. The slight increase in CO_2e emissions was because fuel oil was burned for a few days in December 2018. A slightly decrease in CO_2e emissions in 2023 was primarily due to no oil and less natural gas being burned in the steam plant boilers.

Table 4.10. Greenhouse gas emissions from stationary fuel combustion sources

Year	GHG emissions (metric tons CO_2e)
2010	97,610
2011	70,187
2012	63,177
2013	61,650
2014	58,509
2015	51,706
2016	50,671
2017	50,292
2018	51,010
2019	45,971
2020	46,126.8
2021	43,812.7
2022	43,224.2
2023	42,083.1

Acronyms:
CO_2e = CO_2 equivalent
GHG = greenhouse gas

4.4.1.6. Hazardous Air Pollutants (Nonradiological)

Beryllium emissions from machine shops are regulated under a state-issued permit and are subject to a limit of 10 g/24 h. Compliance is demonstrated through a onetime stack test and monitoring control device operations. Hydrogen fluoride is used at one emission source, and emissions are controlled through scrubber systems. The beryllium control devices and the scrubber systems were monitored during 2023 and found to be operating properly.

Methanol is released as fugitive emissions (e.g., pump and valve leaks) as part of the brine and methanol system. It is subject to state air permit requirements; however, due to the nature of its release (fugitive emissions only), no specific emission limits or mandated controls exist.

Mercury is a significant legacy contaminant at Y-12, and cleanup is being addressed by DOE EM. Like methanol emissions, mercury air emissions from legacy sources are fugitive in nature and, therefore, are not subject to specific air emission limits or controls. On-site monitoring of mercury is conducted as discussed in Section 4.4.2.1.

In 2007, EPA vacated a proposed Maximum Achievable Control Technology standard that was intended to minimize hazardous air pollutant emissions. At that time, a case-by-case Maximum Achievable Control Technology review was conducted as part of the construction-permitting process for the Y-12 replacement steam plant. The new natural gas-fired steam plant became operational on April 20, 2010, and coal is no longer combusted. Specific conditions aimed at minimizing hazardous air pollutant emissions from the new steam plant were incorporated into the operating permit issued on January 9, 2012, as discussed in Section 4.4.1. In addition, the boiler Maximum Achievable Control Technology standard was revised and reissued on January 31, 2013. TDEC issued a minor modification to the Title V air permit on October 29, 2014, which included the new boiler Maximum Achievable Control Technology requirements. The new requirements (work practice standards) include conducting annual tune-ups and a onetime energy assessment of the boilers to meet these requirements.

The steam plant has no numeric emission limit requirements. The new rule requires that a onetime energy assessment for the steam plant be completed on or after January 1, 2008. The new rule requires that tune-ups for the boilers must be completed 13 months from previous tune-ups. To comply with that requirement, an energy assessment for the Y-12 Steam Plant, performed by a qualified energy assessor, was completed in July 2013. Tune-ups for Boilers 1, 3, and 4 were completed on February 15, 2023. Boiler 2 was out of service in 2023.

Unplanned releases of hazardous air pollutants are regulated through risk management planning regulations. Y-12 personnel have determined no processes or facilities contain inventories of chemicals in quantities exceeding thresholds specified in rules pursuant to CAA, Title III, Section 112(r), "Accidental Release Prevention/Risk Management Plan Rule." Therefore, Y-12 is not subject to that rule.

Procedures are in place to review new processes and/or process changes against the rule thresholds.

EPA has created multiple national regulations to reduce air emissions from reciprocating internal combustion engines. Two federal air standards are applicable to these engines: 40 CFR 60, *Standards of Performance for New Stationary Sources*, Subpart IIII, and 40 CFR 63, *National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters*, Subpart DDDDD. The compression ignition engines and generators located at Y-12 are subject to these rules. EPA is concerned how reciprocating internal combustion engines are used and the emissions generated from these engines in the form of both hazardous air pollutants and criteria pollutants.

All previous stationary emergency engines and generators were listed in Y-12's Title V air permit application as insignificant activities. However, on January 16, 2013, EPA finalized revisions to standards to reduce air pollution from stationary engines that generate electricity and power equipment at sites of major sources of hazardous air pollutants. Regardless of engine size, the rules apply to any existing, new, or reconstructed stationary reciprocating internal combustion engine located at a major source of hazardous air pollutant emissions.

To comply with the rules, Y-12 prepared a significant permit modification to its Title V (Major Source) Operating Air Permit to add numerous stationary emergency-use engines and generators located throughout the site. The permit application was submitted to TDEC on May 6, 2013. TDEC downgraded the significant modification to a minor modification according to EPA's review and request. In a prior, updated permit application for renewal of Y-12's Title V (Major Source) Operating Air Permit dated March 9, 2011, Y-12 staff identified 40 CFR 60, Subpart IIII, "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines," as applicable to the stationary emergency-use engines located at Y-12.

TDEC issued Y-12 a minor permit modification to the Title V air permit on March 3, 2014, for the emergency engines and generators. Compliance for the engines and generators is determined through monthly operational records that are recorded through a nonresettable hour meter on each engine and generator. The number of hours spent for emergency operation, maintenance checks and readiness testing, and nonemergency operation must be documented. Each engine and generator must use only diesel fuel with low sulfur content (15 ppm) and an acetane index of 40. The vendor, Rogers Petroleum, supplied a onetime statement certifying that all diesel fuel will contain no more than 15 ppm of sulfur by weight and will either have a minimum acetane index of 40 or a maximum aromatic content of 35 volume percent.

Since the above rules were adopted into Tennessee Air Pollution Control regulations, the emergency engines and generators can be considered an insignificant activity if the potential to emit is below the significance thresholds (less than 5 tons/yr of each criteria pollutant and less than 1,000 lb/yr of any hazardous air pollutant evaluated at a 500 h/yr limit). There was also a change to the Tennessee Air Pollution Control regulations that allows for stationary engines to be eligible to be considered insignificant activities. Condition D14 of the Title V permit was amended to incorporate new language specifying stationary reciprocating internal combustion engines are eligible to be considered insignificant activities that must comply with any underlying applicable rules associated with a stationary internal combustion engine.

The emergency engines and generators are used to provide power for critical systems in the event of electrical power failures and outages at Y-12. The engines and generators operate exclusively as emergency engines and generators. Based upon historical usage of the emergency engines, generators, and fire water pumps, and EPA's 500-h default assumption (maximum hour usage), calculations verify and confirm that potential emissions from each stationary, emergency, internal combustion engine less than 645 hp qualifies, or should be reclassified, as an

insignificant activity because the potential to emit is well below the significance thresholds of less than 5 tons/yr of each regulated air pollutant that is not a hazardous air pollutant, and less than 1,000 lb/yr of any hazardous air pollutant, in accordance with Tennessee Air Pollution Control Regulation 1200-03-09-.04(5)(a)4(i) (TDEC 2022b). Approximately 95 percent of Y-12's stationary, emergency engines, generators, and fire water pumps are considered and/or are reclassified as an insignificant activity in accordance with the regulation. These engines are listed in Y-12's Title V air permit.

4.4.2. Ambient Air

To understand the ambient air monitoring in and around Y-12, data must be considered from monitoring conducted specifically for Y-12, ORR perimeter monitoring, and monitoring conducted by TDEC Division of Remediation, Oak Ridge, personnel.

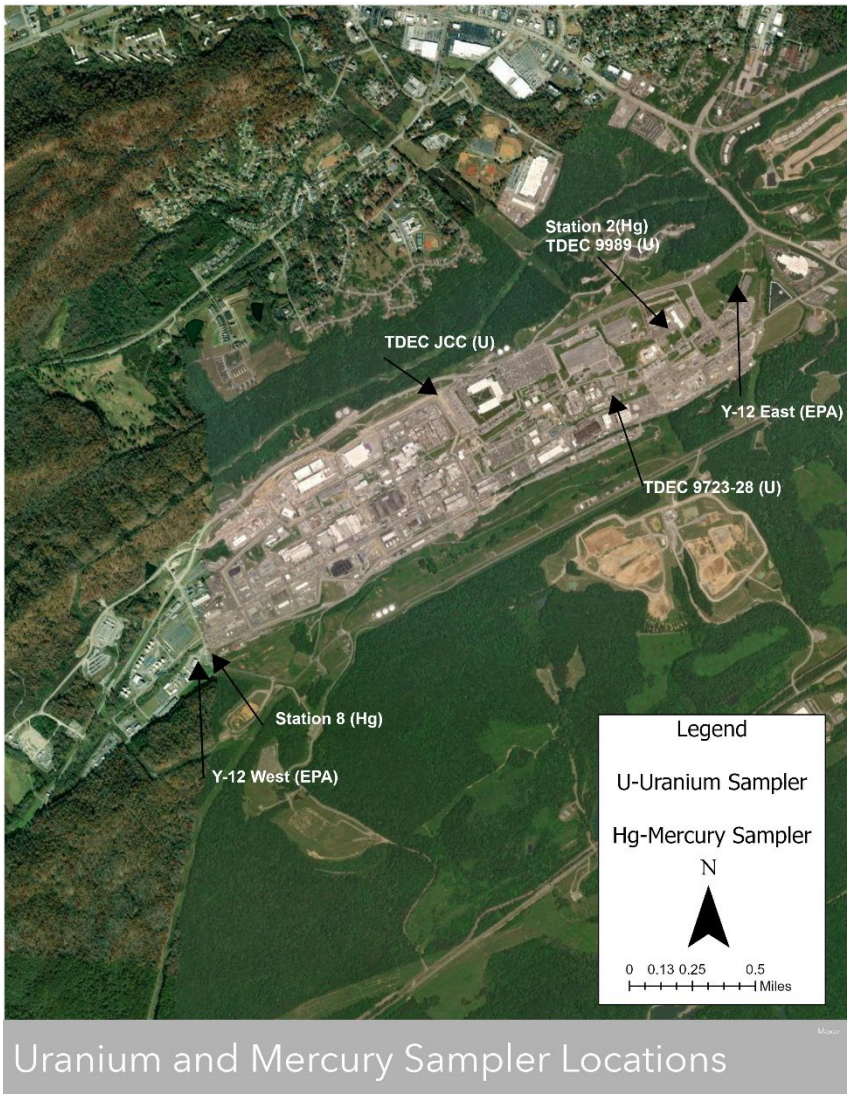
No federal regulations, state regulations, or DOE orders require ambient air monitoring within the Y-12 boundary; however, on-site ambient air monitoring for mercury and radionuclides is conducted as a best management practice. With the reduction of plant operations and improved emission and administrative controls, levels of measured pollutants have decreased significantly. In addition, major processes that emit enriched uranium and depleted uranium are equipped with stack samplers that have been approved by EPA to meet NESHAP requirements.

4.4.2.1. Mercury

The Y-12 Ambient Air Monitoring Program for mercury was established in 1986 as a best management practice. The objectives of the program have been to maintain a database of mercury concentrations in ambient air, to track long-term spatial and temporal trends in ambient mercury vapor, and to demonstrate protection of the environment and human health from releases of mercury to the atmosphere. There are two atmospheric mercury monitoring stations currently operating at Y-12—Ambient Air Station 2 (AAS2) and Ambient Air Station 8 (AAS8)—which are located near the east and west boundaries, respectively, as shown in Figure 4.12. AAS2 and AAS8 have monitored mercury in ambient air continuously since 1986, with the exception of short intervals of downtime because of electrical or equipment outages.

In addition to the Y-12 monitoring stations, two additional monitoring sites have been operated. A reference site (Rain Gauge 2) was developed on Chestnut Ridge in the Walker Branch Watershed for a 20-month period in 1988 and 1989 to establish a reference concentration, and a site was operated at New Hope Pond for a 25-month period from August 1987 to September 1989.

To determine mercury concentrations in ambient air, airborne mercury vapor is collected by pulling ambient air through a sampling train consisting of a Teflon filter and an iodinated-charcoal sampling trap. A flow-limiting orifice upstream of the sampling trap restricts airflow through the sampling train to about 1 L/min. Actual flows are measured bi-weekly with a calibrated Gilmont flowmeter in conjunction with changing the sampling trap. The charcoal in each trap is analyzed for total mercury using cold vapor atomic fluorescence spectrometry after acid digestion. The average concentration of mercury vapor in ambient air for each 14-day sampling period is then calculated by dividing the total mercury per trap by the volume of air pulled through the trap during the corresponding 14-day sampling period.



Acronyms:

AAS = Ambient Air Station *JCC = Jack Case Center*

RadNet = EPA radiation monitoring program with Y-12 sampling by TDEC

TDEC = Tennessee Department of Environment and Conservation

Figure 4.12. Locations of ambient air monitoring stations at Y-12

Average mercury concentration at the ambient air monitoring sites has declined significantly since the late 1980s. Recent average annual concentrations at the two boundary stations are comparable to concentrations measured in 1988 and 1989 at the Chestnut Ridge reference site (Table 4.11). Average mercury concentration at AAS2 for 2023 is 0.0031 µg/m^3 (N = 25), comparable to averages measured since 2003.

After an increase in average concentration at AAS8 for the period 2005 through 2007, possibly due to increased demolition and decommissioning work on the west end, the average concentration at AAS8 for 2023 was 0.0040 µg/m^3 (N = 25), similar to levels reported since 2008 and the early 2000s.

Table 4.11 summarizes the 2023 mercury results with data from 1986 through 1988 included for comparison. Figure 4.20 illustrates temporal

trends in mercury concentration for the two active mercury monitoring sites for the period since the inception of the program in 1986 through 2023 [parts (a) and (b)] and seasonal trends at AAS8 from 1994 through 2023 [part (c)]. The dashed line superimposed on the plots in Figure 4.13(a) and (b) is the EPA reference concentration of 0.3 μg/m^3 for chronic inhalation exposure. The large increase in mercury concentration at AAS8 observed in the late 1980s [part (b)] was thought to be related to disturbances of mercury-contaminated soils and sediments during Perimeter Intrusion Detection and Assessment System installation and storm drain restoration projects underway at that time within the West End Mercury Area. In Figure 4.13(c), a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through 2023.

Table 4.11. Summary of data for the Y-12 Ambient Air Monitoring Program for mercury, 2023

Ambient air monitoring stations	Mercury vapor concentration (μg/m^3)			
	2023 Minimum	2023 Maximum	2023 Average	1986–1988[a] Average
AAS2 (east end of the Y-12 Complex)	0.0011	0.0064	0.0031	0.010
AAS8 (west end of the Y-12 Complex)	0.0020	0.0074	0.0040	0.033
Reference site, Rain Gauge 2 (1988[b])	N/A	N/A	N/A	0.006
Reference site, Rain Gauge 2 (1989[c])	N/A	N/A	N/A	0.005

[a] *Period in late 1980s with elevated ambient air mercury levels; shown for comparison.*

[b] *Data for period from February 9 through December 31, 1988.*

[c] *Data for period from January 1 through October 31, 1989.*

The average mercury concentrations at the two mercury monitoring sites in 2023 were comparable to reference levels measured for the Chestnut Ridge reference site in 1988 and 1989. More importantly, measured concentrations continue to be well below current environmental and occupational health standards for inhalation exposure to mercury vapor as determined by the National Institute for Occupational Safety and Health, the American Conference of Governmental Industrial Hygienists, and the EPA.

4.4.2.2. Quality Control

A number of QA and quality control (QC) steps are taken to ensure the quality of the data for mercury in the Ambient Air Monitoring Program.

An hour meter records the actual operating hours between sample changes. This allows for correction of total flow in the event of power outages during the weekly sampling interval.

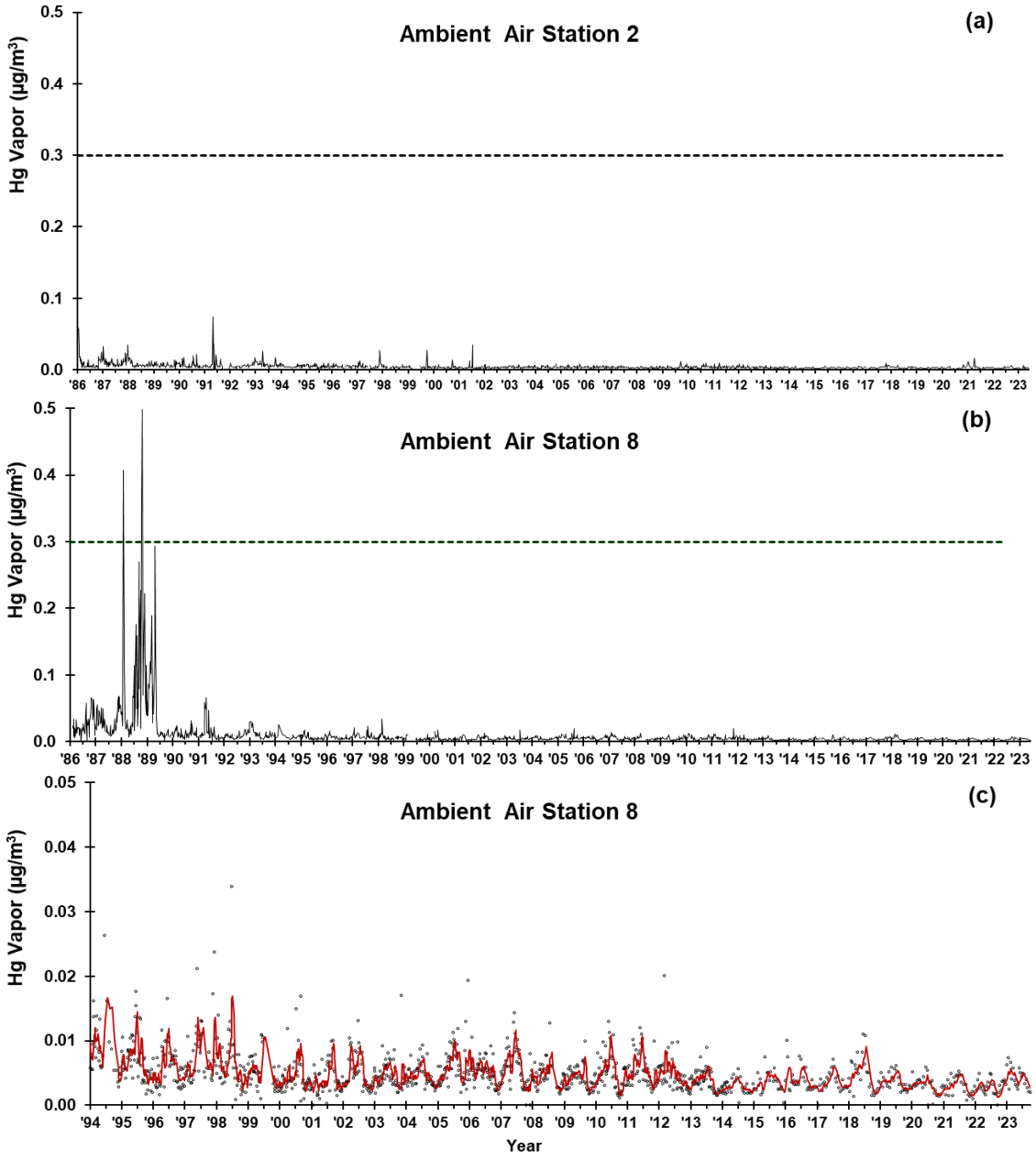
A Gilmont correlated flowmeter is used for measuring flows through the sampling train. Because these flowmeters have been discontinued, they are shipped back to the manufacturer annually for recalibration in accordance with standards set by the National Institute of Standards and Technology.

A minimum of 5 percent of the samples in each batch submitted to the analytical laboratory are blank samples. The blank sample traps are submitted "blind" to verify trap blank values and to serve as a field blank for diffusion of mercury vapor into used sample traps during storage before analysis.

To verify the absence of mercury breakthrough, 5 percent to 10 percent of the field samples have the front (upstream) and back segments of the charcoal sample trap analyzed separately. The absence of mercury above blank values on the back segment confirms the absence of breakthrough.

Chain-of-custody forms track the transfer of sample traps from the field technicians to the analytical laboratory.

A field performance evaluation is typically conducted annually by the project manager to ensure that proper procedures are followed by the sampling technicians. Due to scheduling conflicts, a field performance evaluation was not conducted during 2023. AAS2 was taken offline from Aug. 30, 2023, through Oct. 5, 2023, due to facility construction in the area. No samples were taken during this time.



Note: *The dashed line superimposed on the plots in (a) and (b) is the EPA reference concentration of 0.3 µg/m³ for chronic inhalation exposure. A monthly moving average has been superimposed in (c) over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through 2023. Note the different concentration scale on (c).*

Figure 4.13. Temporal trends in mercury vapor concentration for the boundary monitoring stations at Y-12 Complex, July 1986 to December 2023 [(a) and (b)] and January 1994 to December 2023, for Ambient Air Station 8 [(c)].

Analytical QA/QC requirements include the following:

- Use of prescreened and/or laboratory purified reagents
- Analysis of at least two method blanks per batch
- Analysis of standard reference materials
- Analysis of laboratory duplicates (one per 10 samples) (Any laboratory duplicates differing by more than 10 percent at five or more times the detection limit are to be rerun [third duplicate] to resolve the discrepancy.)
- Archival of all primary laboratory records for at least 1 year

4.4.2.3. Complementary Ambient Air Monitoring

Ambient air monitoring is conducted at multiple locations near ORR to measure radiological and other selected parameters. These monitors are operated in accordance with DOE orders. Their locations were selected so that areas of potentially high exposure to the public are monitored continuously for parameters of concern. This monitoring provides direct measurement of airborne concentrations of radionuclides and other hazardous air pollutants, allows facility personnel to determine the relative level of contaminants at the monitoring locations during an emergency, verifies that the contributions of fugitive and diffuse sources are insignificant, and serves as a check on dose-modeling calculations.

As part of the ORR network, an ambient air station located in Oak Ridge's Scarboro community (Station 46) measures off-site impacts of Y-12 operations. This station is located near the theoretical area of maximum public pollutant concentrations as calculated by air quality modeling. ORR network stations are also located at the east end of Y-12 (Station 40) and just south of the city in the Country Club Estates neighborhood (Station 37).

In addition to this monitoring, TDEC and EPA perform ambient air monitoring to characterize the region in general and to characterize and monitor DOE operations locally. Multiple high-volume samplers (Figure 4.12) are being used by TDEC's Fugitive Radiological Air sampling project to monitor air at Y-12. One is located at the west end of the plant, one is east of Building 9212, one is located on the south side of Building 9723-28 change house, and the fourth was placed at the east end of Y-12 at the Y-12 Mercury Monitoring Station 2 in September 2020.

TDEC also performs ambient air monitoring via the EPA RadNet Program at two Y-12 locations, one on the east end of the plant near the intersection of Scarboro Road and Bear Creek Road and on the west end of the plant near the intersection of Bear Creek Road and Old Bear Creek Road near Station 8.

Results from TDEC's air monitoring projects at Y-12 and other locations on the ORR are summarized in annual environmental monitoring reports issued by the TDEC Division of Remediation Oak Ridge Office, which are posted on its website **here**.

The state of Tennessee also operates a number of regional monitors to assess ambient concentrations of criteria pollutants such as sulfur dioxide, particulate (various forms), and ozone for comparison against ambient standards. The results are summarized and available through EPA and state reporting mechanisms.

4.5. Water Quality Program

Water quality is monitored at Y-12 to satisfy the NPDES permit and the Industrial Wastewater Discharge Permit. It is also monitored in real time to indicate potential adverse conditions that could be causing an impact on water quality in Upper EFPC.

4.5.1. National Pollutant Discharge Elimination System Permit and Compliance Monitoring

For 2023, the Y-12 NPDES permit (TN0002968) required sampling, analysis, and reporting for about 62 outfalls. Major outfalls are shown in Figure 4.14. The NPDES permit became effective October 1, 2022. (The permit is currently under

appeal in part. Y-12 is working with the regulators to resolve.) The number of outfalls changes as they are eliminated or consolidated or if permitted discharges are added. Currently, Y-12 has outfalls and monitoring points in EFPC, Bear Creek, and several tributaries on the south side of Chestnut Ridge, all of which eventually drain to the Clinch River.

Discharges to surface water allowed under the permit include storm drainage; cooling water; cooling tower blowdown; steam condensate; and treated process wastewaters, including effluents from wastewater treatment facilities. Groundwater inflow into sumps in building basements and infiltration to the storm drain system are also permitted for discharge to the creek. The monitoring data collected by sampling and analyzing permitted discharges are compared with NPDES limits where applicable for each parameter. Some parameters, defined as monitor only, have no specified limits.

The water quality of surface streams near Y-12 is affected by current and legacy operations. Discharges from Y-12 processes flow into EFPC before the water exits the site. EFPC eventually flows through the City of Oak Ridge to Poplar Creek and into Clinch River. Bear Creek water quality is affected by area source runoff and groundwater discharges. The NPDES permit requires regular monitoring and storm water characterization in Bear Creek and several of its tributaries.

Requirements of the permit for 2023 were satisfied, and monitoring of outfalls and instream locations indicated excellent compliance. Data obtained as part of the NPDES program, along with other events and observations, are provided in a monthly discharge monitoring report to TDEC. The percentage of compliance with permit discharge limits for 2023 was nearly 100 percent, as shown in Table 4.12.

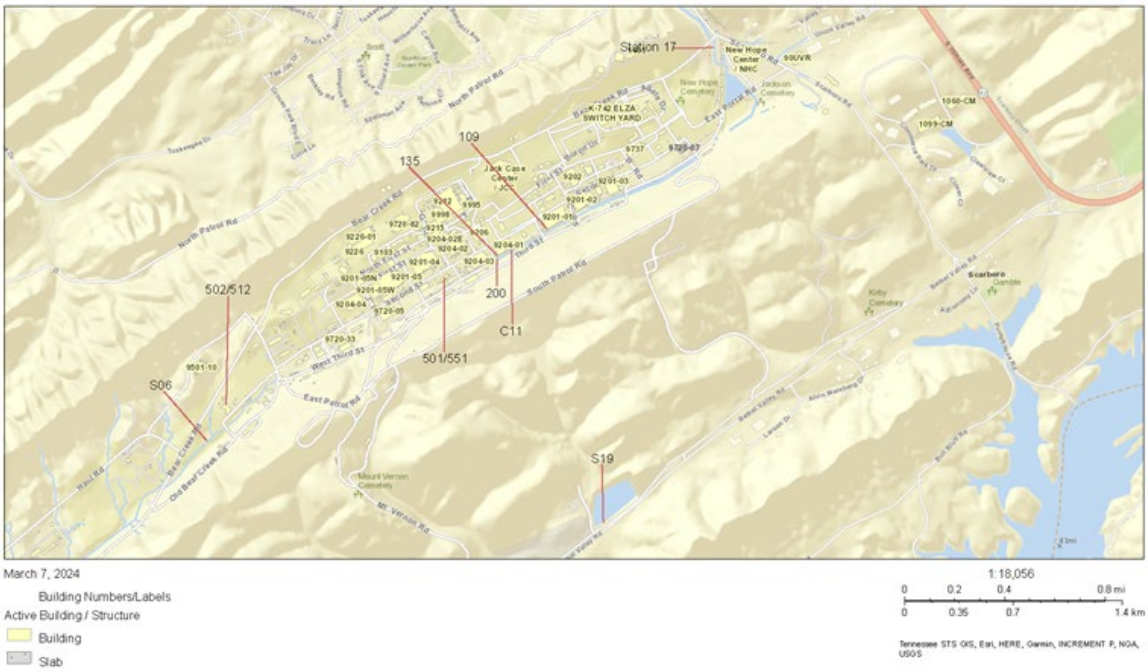


Figure 4.14. Major Y-12 National Pollutant Discharge Elimination System outfalls and monitoring locations

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2023

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Outfall 200 (North/South pipes)						
pH, standard units			*a*	9.0	100	12
Temperature, deg C				30.5	92	12
Hexane extractables			10	15	100	12
Cyanide			0.0052	0.022	92	12
Cadmium			0.0043	0.0118	100	12
Silver				0.0081	100	12
Selenium			0.0031	0.02	100	12
PCB, Total				0.00000064	100	13
Total residual chlorine			0.011	0.019	100	12
Ammonia (as N) Summer			1.01	2.02	100	6
Ammonia (as N) Winter			1.92	3.84	100	6
IC_{25} Ceriodaphnia			50% Minimum		100	*5*
IC_{25} Pimephales			50% Minimum		100	*5*
Outfall 501 (Central Pollution Control)						
pH, standard units			*a*	9.0	*b*	0
Total suspended solids			31.0	40.0	*b*	0
Total toxic organic				2.13	*b*	0
Hexane extractables			10	15	*b*	0
Cadmium	0.16	0.4	0.07	0.15	*b*	0
Chromium	1.0	1.7	0.5	1.0	*b*	0
Copper	1.2	2.0	0.5	1.0	*b*	0
Lead	0.26	0.4	0.1	0.2	*b*	0
Nickel	1.4	2.4	2.38	3.98	*b*	0
Nitrate/Nitrite				100	*b*	0
Silver	0.14	0.26	0.05	0.05	*b*	0
Zinc	0.9	1.6	1.48	2.0	*b*	0
Cyanide	0.4	0.72	0.65	1.2	*b*	0
PCB				0.001	*b*	0
Outfall 502 (West End Treatment Facility)						
pH, standard units			*a*	9.0	100	1
Total suspended solids		31		40	100	1
Total toxic organic				2.13	100	1
Hexane extractables			10	15	100	1
Cadmium		0.4		0.15	100	1
Chromium		1.7		1.0	100	1
Copper		2.0		1.0	100	1

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2023 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Lead		0.4		0.2	100	1
Nickel		2.4		3.98	100	1
Nitrate/Nitrite				100	100	1
Silver		0.26		0.05	100	1
Zinc		0.9		1.48	100	1
Cyanide		0.72		1.20	100	1
PCB				0.001	100	1
Outfall 512 (Groundwater Treatment Facility)						
pH, standard units			α	9.0	100	12
PCB				0.001	100	1
Outfall 551						
pH, standard units			α	9.0	100	51
Mercury			0.002	0.004	100	51
Non-Process Outfalls (Dry Weather Sampling) (014, 021, 034, 042,047, 048, 067, 071, 088, 099, 109, 135)						
Temperature				30.5	100	28
pH, standard units			α	9.0	100	28
Ammonia (as N) Summer			1.01	2.02	100	2
Ammonia (as N) Winter			1.92	3.84	100	2
Total Residual Chlorine				0.019	100	24
Outfall 200 (North/South pipes) Wet Weather Flow						
pH, standard units			α	9.0	100	1
Temperature, deg C				30.5	92	1
Ammonia (as N) Summer				2.02	100	1
Ammonia (as N) Winter				3.84	100	0
Cyanide				0.022	100	1
Cadmium				0.0118	100	1
Copper				0.064	100	1
Lead				0.6265	100	1
Nickel				1.705	100	1
Silver				0.0081	100	1
Zinc				0.641	100	1
Selenium				0.02	100	1
Outfall C11 (Instream EFPC) Wet Weather						
Temperature				30.5	100	1
pH			α	9.0	100	1
Ammonia (as N) Summer				2.02	100	1
Ammonia (as N) Winter				3.84	100	0
Cyanide				0.022	100	1

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2023 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Cadmium				0.0118	100	1
Copper				0.064	100	1
Lead				0.6265	100	1
Nickel				1.705	100	1
Silver				0.0081	100	1
Zinc				0.641	100	1
Selenium				0.020	100	1
Outfall C03 (Instream EFPC) Wet Weather						
Temperature				30.5	100	1
pH			a	9.0	100	1
Ammonia (as N) Summer				2.02	100	1
Ammonia (as N) Winter				3.84	100	0
Cyanide				0.022	100	1
Cadmium				0.0118	100	1
Copper				0.064	100	1
Lead				0.6265	100	1
Nickel				1.705	100	1
Silver				0.0081	100	1
Zinc				0.641	100	1
Selenium				0.020	100	1
Outfall EFP (Station 17) Wet Weather						
Temperature				30.5	100	1
pH			a	9.0	100	1
Ammonia (as N) Summer				2.02	100	1
Ammonia (as N) Winter				3.84	100	0
Cyanide				0.022	100	1
Cadmium				0.0118	100	1
Copper				0.064	100	1
Lead				0.6265	100	1
Nickel				1.705	100	1
Silver				0.0081	100	1
Zinc				0.641	100	1
Selenium				0.020	100	1
Outfall S06 Wet Weather						
Temperature				30.5	100	1
pH			a	9.0	100	1
Ammonia (as N) Summer				2.02	100	1
Ammonia (as N) Winter				3.84	100	0
Cyanide				0.022	100	1

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2023 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Cadmium				0.0188	100	1
Copper				0.103	100	1
Lead				1.063	100	1
Nickel				2.604	100	1
Silver				0.0191	100	1
Zinc				0.979	100	1
Selenium				0.020	100	1
Outfall S24 Wet Weather						
Temperature				30.5	100	1
pH			a	9.0	100	1
Ammonia (as N) Summer				2.02	100	1
Ammonia (as N) Winter				3.84	100	0
Cyanide				0.022	100	1
Cadmium				0.0188	100	1
Copper				0.103	100	1
Lead				1.063	100	1
Nickel				2.604	100	1
Silver				0.0191	100	1
Zinc				0.979	100	1
Selenium				0.020	100	1
Outfall S06 Dry Weather						
Temperature				30.5	100	1
pH			a	9.0	100	1
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1
Cadmium				0.0188	100	1
Copper				0.103	100	1
Lead				1.063	100	1
Nickel				2.604	100	1
Silver				0.0191	100	1
Zinc				0.979	100	1
Selenium				0.020	100	1
Outfall S24 Dry Weather						
Temperature				30.5	100	1
pH			a	9.0	100	1
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2023 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Cadmium				0.0188	100	1
Copper				0.103	100	1
Lead				1.063	100	1
Nickel				2.604	100	1
Silver				0.0191	100	1
Zinc				0.979	100	1
Selenium				0.020	100	1
Outfall C11 (Instream EFPC) Dry Weather						
Temperature				30.5	100	4
pH			a	9.0	100	4
Ammonia (as N) Summer			1.01	2.02	100	2
Ammonia (as N) Winter			1.92	3.84	100	2
Cyanide			0.0052	0.022	100	4
Cadmium			0.0043	0.0118	100	4
Copper			0.0407	0.064	100	4
Lead			0.0244	0.6265	100	4
Nickel			0.189	1.705	100	4
Silver				0.0081	100	4
Zinc			0.646	0.641	100	4
Selenium			0.0031	0.020	100	4
Total Residual Chlorine			0.011	0.019	100	4
Outfall C03 (Instream EFPC) Dry Weather						
Temperature				30.5	100	4
pH			a	9.0	100	4
Ammonia (as N) Summer			1.01	2.02	100	2
Ammonia (as N) Winter			1.92	3.84	100	2
Cyanide			0.0052	0.022	100	4
Cadmium			0.0043	0.0118	100	4
Copper			0.0407	0.064	100	4
Lead			0.0244	0.6265	100	4
Nickel			0.189	1.705	100	4
Silver				0.0081	100	4
Zinc			0.646	0.641	100	4
Selenium			0.0031	0.020	100	4
Total Residual Chlorine			0.011	0.019	100	4
Outfall EFP (Station 17) Dry Weather						
Temperature				30.5	100	4
pH			a	9.0	100	4
Ammonia (as N) Summer			1.01	2.02	100	2

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2023 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Ammonia (as N) Winter			1.92	3.84	100	2
Cyanide			0.0052	0.022	100	4
Cadmium			0.0043	0.0118	100	4
Copper			0.0407	0.064	100	4
Lead			0.0244	0.6265	100	4
Nickel			0.189	1.705	100	4
Silver				0.0081	100	4
Zinc			0.646	0.641	100	4
Selenium			0.0031	0.020	100	4
Total Residual Chlorine			0.011	0.019	100	4

[a] *Not applicable.*

[b] *No discharge.*

Acronyms:

IC_{25} = 25-percent inhibition concentration

PCB = polychlorinated biphenyl

4.5.2. Radiological Monitoring Plan and Results

Y-12 has a radiological monitoring plan to address compliance with DOE orders that was provided to TDEC as a matter of comity under NPDES Permit TN0002968. Y-12 submitted results from the radiological monitoring plan quarterly as an addendum to the NPDES discharge monitoring report. There were no discharge limits set by the NPDES permit for radionuclides; the requirement is to monitor and report. In October 2022, the new NPDES permit became effective, and the requirement for a radiological monitoring plan was removed. The radiological monitoring plan was developed based on an analysis of operational history, expected chemical and physical relationships, and historical monitoring results.

Under the existing plan, effluent monitoring is conducted at four types of locations: treatment facilities, other point source and area source discharges, instream locations, and storm water runoff from production area roofs. Operational history and past monitoring results provide a basis for parameters routinely monitored under the plan (Table 4.13). Y/TS-1704, *Radiological Monitoring Plan for the Oak Ridge Y-12 National Security Complex: Surface Water* was revised and issued in 2020 (CNS 2020b). This revision added Outfall 109 and roof runoff from production areas.

Radiological monitoring during storm water events is part of the storm water monitoring program. Uranium is monitored at three major EFPC storm water outfalls, two instream monitoring locations, and an outfall on Bear Creek. In addition, the monthly 7-d composite sample for radiological parameters taken at Station 17 on EFPC likely includes rain events.

Radiological monitoring plan locations sampled in 2023 are noted on Figure 4.15. Table 4.14 identifies the monitored locations, the frequency of monitoring, and the sum of the percentages of the derived concentration standards for radionuclides measured in 2023. Radiological data were well below the allowable derived concentration standards.

Table 4.13. Radiological parameters monitored at Y-12

Parameters	Specific isotopes	Rationale for monitoring
Uranium isotopes	^{238}U, ^{235}U, ^{234}U, total U, weight % ^{235}U	These parameters reflect the major activity (uranium processing) throughout the history of Y-12 and are the dominant detectable radiological parameters in surface water.
Fission and activation products	^{90}Sr, ^{99}Tc, ^{137}Cs	These parameters reflect a minor activity at Y-12 (processing recycled uranium from reactor fuel elements from the early 1960s to the late 1980s) and will continue to be monitored as tracers for beta and gamma radionuclides, although their concentrations in surface water are low.
	^{3}H	Tritium is not expected to be high in fuel elements because tritium is produced primarily as an activation product in reactor coolants. Tritium is highly mobile and is detected in groundwater samples associated with the S-3 Site.
Transuranium isotopes	^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$	These parameters are related to recycle uranium processing. Monitoring has continued because of their half-lives and presence in groundwater.
Other isotopes of interest	^{232}Th, ^{230}Th, ^{228}Th, ^{226}Ra, ^{228}Ra	These parameters reflect historical thorium processing and natural radionuclides necessary to characterize background radioisotopes.

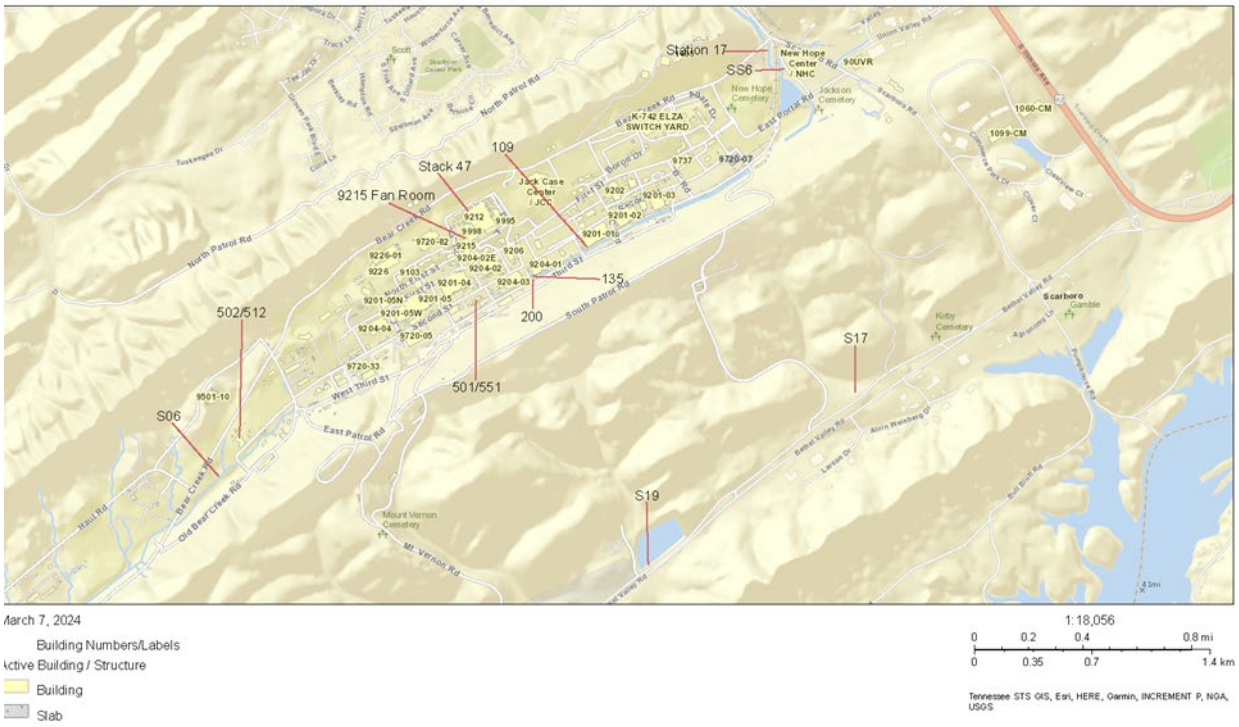


Figure 4.15. Radiological sampling locations at Y-12

Table 4.14. Summary of Y-12's radiological monitoring plan sample requirements and results, 2023

Location	Sample	Sample type	Sum of derived
Y-12 wastewater treatment facilities			
Central Pollution Control Facility	1/batch	Composite during batch operation	No flow
West End Treatment Facility	1/batch	24-h composite	0.07
Groundwater Treatment Facility	4/yr	24-h composite	2.7
Central Mercury Treatment Facility	4/yr	24-h composite	2.2
Other Y-12 point and area source discharges			
Outfall 109	4/yr	24 h composite	0.35
Outfall 135	4/yr	24-h composite	0.39
Kerr Hollow Quarry	1/yr	24-h composite	1.7
Y-12 instream locations			
Outfall S24	1/yr	7-d composite	4.6
East Fork Poplar Creek, complex exit (east)	1/month	7-d composite	1.8
North/south pipes	1/month	24-h composite	2.2
Y-12 Production roof runoff			
9215 Fan Room	4/yr	Grab during rain	18
Stack 47	4/yr	Grab during rain	34

In 2023, the total mass of uranium and associated curies released from Y-12 at the easternmost monitoring station—Station 17 on Upper EFPC—was 118 kg or 0.092 Ci, as shown in Table 4.15.

Table 4.15. Uranium release from Y-12 to the off-site environment as liquid effluent

Year	Quantity released	
	Ci[a]	kg
Station 17		
2014	0.061	90
2015	0.068	116
2016	0.045	88
2017	0.080	154
2018	0.084	205
2019	0.079	203
2020	0.082	173
2021	0.063	139
2022	0.071	167
2023	0.092	118

[a] *1 Ci = 3.7E+10 Bq.*

Figure 4.16 illustrates a 6-year trend of these releases. The total release is calculated by multiplying the average concentration (g/L) by the average flow (million gal/d). Converting units and multiplying by 365 d/yr yields the calculated discharge.

Y-12 is permitted to discharge domestic wastewater to the City of Oak Ridge's publicly owned treatment works. Radiological monitoring of the sanitary sewer system discharge is conducted and reported to the city, although no city-established radiological limits exist. Alpha and beta levels are measured weekly, and subsequent uranium analyses are performed if the alpha or beta levels are above prescribed levels. Potential sources of radionuclides discharging to the sanitary sewer have been identified in previous studies at Y-12 as part of an initiative to meet goals to keep levels as low as reasonably achievable. Results of radiological monitoring were reported to the City of Oak Ridge in quarterly monitoring reports.

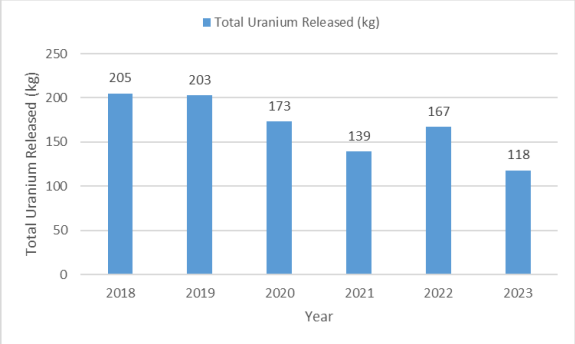


Figure 4.16. Y-12 uranium releases to East Fork Poplar Creek, 2018–2023

4.5.3. Storm Water Pollution Prevention

Y-12 has implemented a storm water pollution prevention program in alignment with the requirements of NPDES Permit TN0002968. program focuses primarily on storm water pollution prevention and continual improvement. It protects the quality of storm water runoff through identifying and properly managing outdoor storm water pollutant sources, implementing best management practices, sampling storm water and interpreting data to evaluate efficacy of pollutant controls, and conducting routine storm water inspections and surveillances.

For the Y-12 NPDES permit, storm water monitoring is performed at category outfalls and wet weather locations. These are described as follows:

- **Category 1 Storm Water Outfalls.** Annual monitoring of pH at Outfalls 002, 003, 004, 006, 007, 008, 009, 010, 011, 017, S17, S18, 019, 020, 033, 041, 044, 045, 046, 054, 057, 058, 062, 063, 064, 086, 087, 110, 114, 125, 126, 134.
- **Category 2 Storm Water Outfalls.** Annual monitoring of pH and total residual chlorine at Outfalls 034, 042, 071, 083, 088, 099, 113.
- **Sector AA Outfalls.** Annual monitoring of pH, nitrite plus nitrate (as N), total iron, total zinc, total aluminum, total mercury, and flow at Outfalls 014, 016, 047, 048, 067, 102, 135.
- **Other Wet Weather.** Annual monitoring as prescribed in the permit tables at Outfalls 200 and S30; Instream EFPC Locations C03, C11, EFP (Station 17); Instream Bear Creek Locations S06 and S24; and Instream Monitoring Station S19.

Y-12 completed the storm water sampling scheduled for sampling year 2023. All stormwater samples were collected as required in the current NPDES permit. The results were compared to the applicable permit table alert values and daily maximum benchmark values. The 2023 sampling year ran from October 2022 to the end of September 2023.

The following are the results for the stormwater sampling conducted in 2023:

- **Category 1 Storm Water Outfalls.** All water sample results were within the typical NPDES permit range for pH of 6.0 and 9.0 standard units.
- **Category 2 Storm Water Outfalls.** All water sample results were within the typical NPDES permit range for pH of 6.0 and 9.0 standard units and were less than 0.05 mg/L for total residual chlorine.
- **Sector AA Storm Water Outfalls.** None of the results exceeded the applicable surface water daily maximum benchmarks as described in the permit.
- **Other Wet Weather Samples.** None of the results exceeded the applicable surface water daily maximum benchmarks or alerts as described in the permit.

An area of concern continues to be on-site construction activities; however, site surveillances continue to identify issues, and they are addressed before they cause an impact to storm water runoff. In addition, overall, the housekeeping and general conditions that could impact storm water continue to improve. Based upon the results of the storm water sampling and site surveillances, the Y-12 stormwater pollution prevention program is effective at protecting the surface waters at Y-12 from storm water pollution. Y-12 will continue to seek opportunities for additional improvement to stormwater protections.

4.5.4. Ambient Surface Water Quality

A network of real-time monitors located at instream locations along Upper EFPC is used to monitor key indicators of water quality. The Surface Water Hydrological Information Support System is available for real-time water quality measurements, such as pH, temperature, dissolved oxygen, conductivity, and chlorine. The locations are shown in Figure 4.17. The system is used to indicate potential adverse conditions that could be causing an impact on water quality in Upper EFPC. It is operated as a best management practice.

Additional sampling of springs and tributaries is conducted in accordance with Y-12's Groundwater Protection Program to monitor trends throughout the three hydrogeologic regimes, as discussed in Section 4.6.

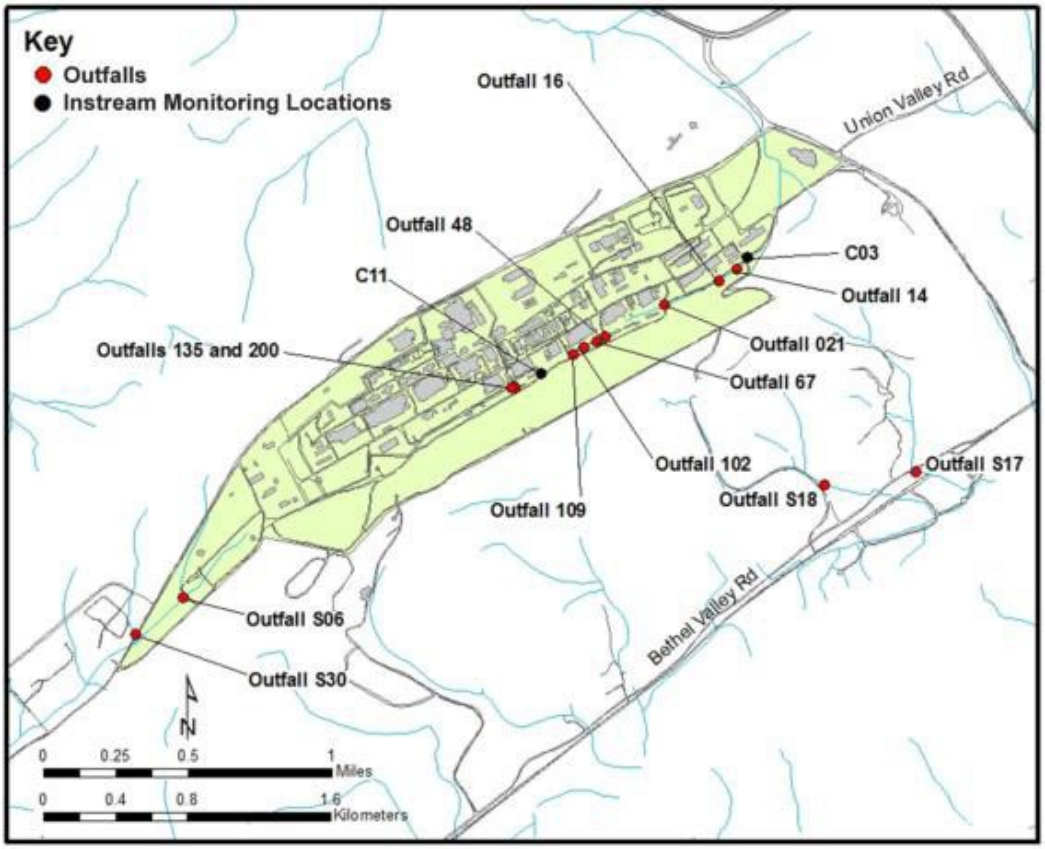


Figure 4.17. Y-12 storm water monitoring locations along East Fork Poplar Creek

4.5.5. Industrial Wastewater Discharge Permit

Industrial and Commercial User Wastewater Discharge Permit 1-91 defines requirements for discharging wastewaters to the sanitary sewer system as well as prohibitions for certain types of wastewaters. It prescribes requirements for monitoring certain parameters at the East End Sanitary Sewer Monitoring Station. The permit sets limits for most parameters.

Samples for gross-alpha and gross-beta are taken in a weekly 24-h composite sample. The sample is analyzed for uranium if the alpha or beta values exceed certain levels. Other parameters, including oil and grease, solids, and biological oxygen demand, are monitored on a monthly basis. Metals and organic parameters are monitored once per quarter. Results of compliance sampling are reported quarterly. Flow is measured continuously at the monitoring station.

As part of the City of Oak Ridge's pretreatment program, city personnel use the east end monitoring station (also known as SS6) to conduct compliance monitoring as required by the pretreatment regulations. City personnel also conduct compliance inspections twice a year.

Monitoring results from 2023 are listed in Table 4.16. Three permit limits were exceeded, all of which were of the 2,100-gal/min instantaneous flow limit. To reduce storm water inflow and infiltration, a project is evaluating approximately 15,000 linear feet of the Y-12 sewage collection system via smoke tests and video inspection. The project also performs needed repairs identified during the evaluation, including manhole relining, pipe bursting, and installing cured-in-place piping. Repair work was completed in the B-449, C-409A, and B408A networks. Flow data evaluation indicates this project has reduced inflow and infiltration.

Table 4.16. Discharge point SS6 monitoring results, 2023

Effluent parameter	Number of samples	Average value	Daily maximum (gal/min)[a]	Monthly average (effluent limit)[a]	Number of limit exceedances
Max flow rate (gal/min)	Continuous	N/A	2,100	N/A	3
Flow (average kgpd) January through March	90	475	N/A	500[b]	0
Flow (average kgpd) April through June	91	375	N/A	500[b]	0
Flow (average kgpd) July through September	92	330	N/A	500[b]	0
Flow (average kgpd) October through December	92	347	N/A	500[b]	0
pH (standard units)	16	7.8	N/A	9 and 6[c]	0
Biochemical oxygen demand	13	53.2	N/A	300	0
Kjeldhal nitrogen	14	30.7	N/A	45	0
Phenols—total recoverable	13	<0.031	N/A	0.15	0
Oil and grease	13	<7.8	N/A	25	0
Suspended solids	13	75.5	N/A	200	0
Cyanide	13	<0.0027	N/A	0.006	0
Arsenic	6	<0.0012	N/A	0.01	0
Cadmium	6	<0.0005	N/A	0.0033	0
Chromium, hexavalent	4	0.005	N/A	0.053	0
Copper	6	0.0283	N/A	0.14	0
Iron	6	0.7527	N/A	10	0
Lead	6	<0.0025	N/A	0.049	0
Mercury	13	0.0019[d]	N/A	0.035[d]	0
Nickel	6	<0.005	N/A	0.021	0
Silver	6	0.0013	N/A	0.05	0
Zinc	6	0.1712	N/A	0.35	0
Molybdenum	6	0.0173	N/A	0.05[e]	N/A
Selenium	6	<0.0025	N/A	0.01[e]	N/A
Toluene	5	0.005	N/A	0.005[e]	N/A
Ammonia	6	24.2	N/A	0.10[e]	N/A
Methanol	5	0.98	N/A	1.0[e]	N/A
Benzene	5	0.005	N/A	0.005[e]	N/A

Table 4.16. Discharge point SS6 monitoring results, 2023 (continued)

Effluent parameter	Number of samples	Average value	Daily maximum (gal/min)[a]	Monthly average (effluent limit)[a]	Number of limit exceedances
1,1,1-Trichloroethane	5	0.005	N/A	0.005[e]	N/A
Ethylbenzene	5	0.005	N/A	0.005[e]	N/A
Carbon tetrachloride	5	0.005	N/A	0.005[e]	N/A
Chloroform	5	0.0052	N/A	0.005[e]	N/A
Tetrachloroethene	5	0.0038	N/A	0.005[e]	N/A
Trichloroethene	5	0.005	N/A	0.005[e]	N/A
trans-1,2-Dichloroethene	5	0.005	N/A	0.005[e]	N/A
Methylene chloride	5	0.0044	N/A	0.005[e]	N/A

[a] *Industrial and commercial user wastewater permit limits.*

[b] *Average daily flow allowed in gal/d.*

[c] *Maximum and minimum value.*

[d] *Units are lb/d.*

[e] *This parameter does not have a permit limit. This value is the required detection limit. All units are mg/L unless noted otherwise.*

Acronyms: *kgpd = thousand gallons per day N/A = not applicable*

4.5.6. Quality Assurance and Quality Control

The Environmental Monitoring Management Information System is used to manage surface water monitoring data at Y-12. It uses standard sample definitions to ensure that samples are taken at the correct location at a specified frequency using the correct sampling protocol.

Field sampling QA encompasses many practices that minimize error and evaluate sampling performance. Some key quality practices include the following:

- Using standard operating procedures for sample collection and analysis
- Using chain-of-custody and sample identification, customized chain-of-custody documents, and sample labels provided by the Environmental Monitoring Management Information System
- Standardizing, calibrating, and verifying instruments
- Training sample technicians
- Preserving, handling, and decontaminating samples
- Using QC samples, such as field and trip blanks, duplicates, and equipment rinses

Surface water data are entered directly by the analytical laboratory into the Laboratory Information Management System on the day of approval. The Environmental Monitoring Management Information System routinely accesses the Laboratory Information Management System electronically to capture pertinent data. Generally, the system will store data in the form of concentrations.

A number of electronic data management tools automatically flag data points and allow monitoring and trending of data over time. Field information on all routine samples taken for surface water monitoring is entered in the Environmental Monitoring Management Information System, which also retrieves data nightly from the analytical laboratory. The system then performs numerous data checks, including comparing individual results against any applicable screening criteria, regulatory thresholds, compliance limits, best management practices, or other water quality indicators, and then produces required reports.

4.5.7. Biomonitoring Program

The NPDES permit for Y-12 (TN0002968, Part III, Section E) contains chronic toxicity testing requirements. These requirements specify that chronic toxicity testing (a 3-Brood *Ceriodaphnia dubia* survival and reproduction test and a 7-day fathead minnow larval survival and growth test) is required to determine whether the effluent is contributing chronic toxicity to the receiving water. The permit changed the permit limit and requires quarterly testing of Outfall 200. Chronic toxicity testing is performed using 100 percent effluent and the dilution series shown in Table 4.17.

Table 4.18 summarizes the results of the 2023 outfall biomonitoring tests in terms of the 25-percent inhibition concentration (IC_{25}), which is the concentration (i.e., a percentage of full-strength effluent diluted with laboratory control water) of each outfall effluent that causes a 25-percent reduction in the survival or reproduction of water fleas (*Ceriodaphnia dubia*) or the survival or growth of fathead minnow (*Pimephales promelas*) larvae (with respect to these same endpoints for these animals measured in control laboratory water). The lower the value of the IC_{25}, the more toxic the effluent. According to the NPDES permit, toxicity is demonstrated if the IC_{25} is less than or equal to the permit limit. The permit limit is 50-percent whole effluent for Outfall 200.

Table 4.17. Serial dilutions for whole effluent toxicity testing, as a percent of effluent Serial dilutions for whole effluent toxicity testing, as a percent of effluent

Outfall 200	Control	0.25 x Permit limit	0.50 x Permit limit	Permit limit	(100+Permit limit)/2	100% Effluent
	0	12.5	25	50	75	100

Notes:

1. *Under permit effective Oct. 1, 2022.*
2. *The effluent water is diluted with control laboratory water.*

Table 4.18. Biomonitoring program summary information for Outfall 200, 2023

Water collection dates	Test type	Test organism	End point	Metric[a]	IC_{25}[b] (%)
3/15/23–3/22/23	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
			Reproduction	IC_{25}	>100%
		Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
			Growth	IC_{25}	>100%
5/3/23–5/10/23	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
			Reproduction	IC_{25}	>100%
		Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
			Growth	IC_{25}	>100%
8/9/23–8/16/23	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
			Reproduction	IC_{25}	>100%
		Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
			Growth	IC_{25}	>100%
11/1/23–11/8/23	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
			Reproduction	IC_{25}	>100%
		Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
			Growth	IC_{25}	>100%

[a] *IC_{25} is summarized for the discharge monitoring location (Outfall 200).*

[b] *IC_{25} as a percentage of full-strength effluent from Outfall 200 diluted with laboratory control water. IC_{25} is the concentration that causes a 25-percent reduction in water fleas (Ceriodaphnia dubia) survival or reproduction or fathead minnow (Pimephales promelas) survival or growth.*

4.5.8. Biological Monitoring and Abatement Program

The NPDES permit issued for Y-12 mandates a biological monitoring and abatement program to demonstrate that the effluent limitations established for the facility protect the classified uses of the receiving stream—EFPC. The 2023 program sampling efforts follow the NPDES-required *Y-12 National Security Complex Biological Monitoring and Abatement Program Plan* (ORNL 2013).

Y-12's program, which has been monitoring the ecological health of EFPC since 1985, consists of three major tasks that reflect complementary approaches to evaluating the effects of Y-12 discharges on the aquatic integrity of EFPC—bioaccumulation studies, benthic macroinvertebrate community surveys, and fish community monitoring. Data collected on contaminant bioaccumulation and the composition and abundance of communities of aquatic organisms directly evaluate the effectiveness of abatement and remedial measures in improving ecological conditions in the stream.

Monitoring is conducted at seven primary EFPC sites (Figure 4.18), although sites may be excluded or added depending on the specific objectives of the various tasks. The primary sampling sites include the following:

- Upper EFPC at EFPC kilometers (EFKs) 24.4 and 23.4, located upstream and downstream of Lake Reality, respectively
- EFKs 18.7 and 18.2, located off ORR and below an area of intensive commercial and light industrial development, respectively
- EFKs 13.8 and 13.0, located upstream and downstream of the Oak Ridge Wastewater Treatment Facility, respectively
- EFK 6.3, located about 1.4 km downstream of the ORR boundary

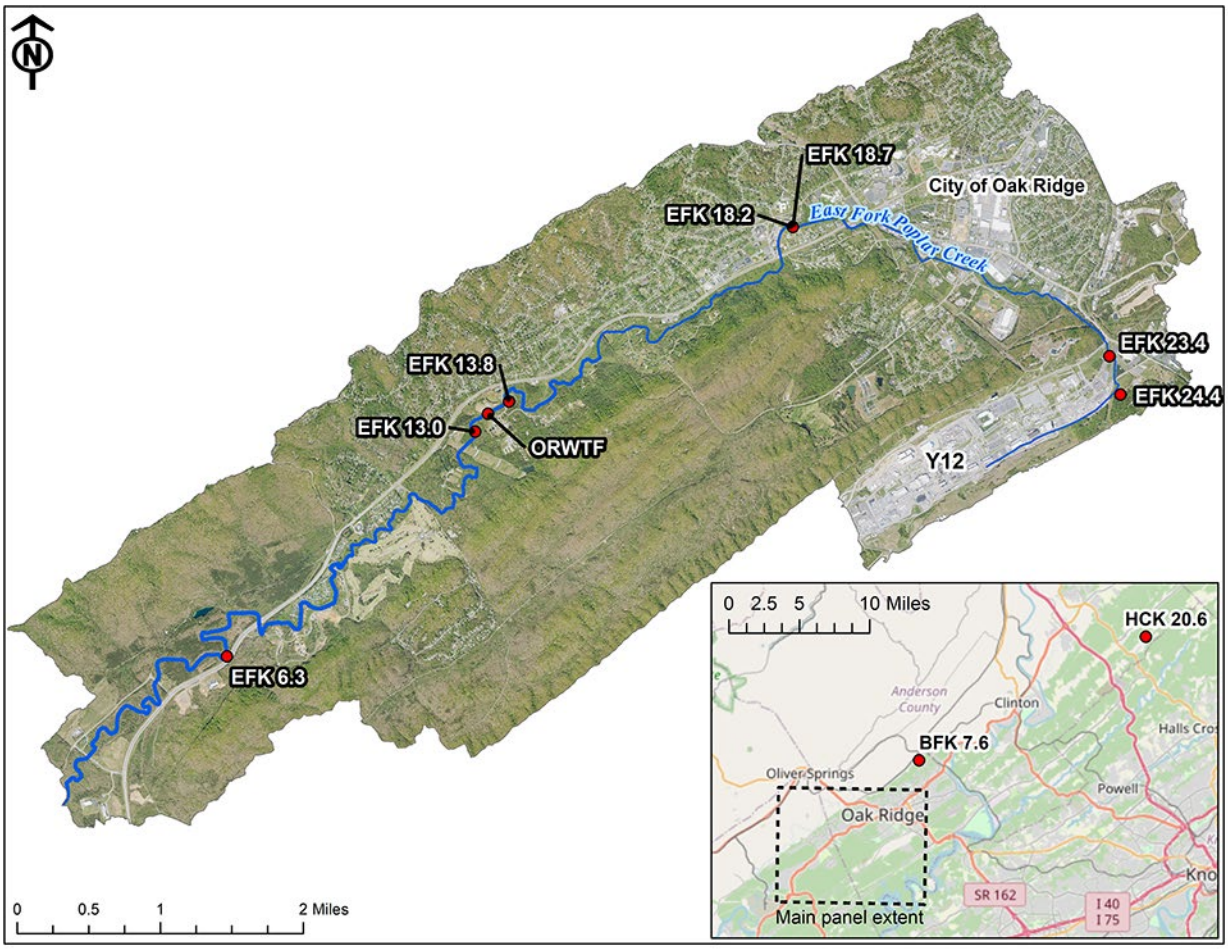
Brushy Fork at Brushy Fork kilometer 7.6 had been used as a reference stream for the fish and macroinvertebrate community tasks; however, the site may be replaced because of limitations in site access and degraded ecological conditions at the site. Hinds Creek at Hinds Creek kilometer 20.6 is also used as a reference for the macroinvertebrate and fish community monitoring task.

Generally, the number of invertebrate and fish species in EFPC has increased over the last three decades (primarily in the upstream sites), demonstrating that the overall ecological health of the stream continues to improve. However, the richness of pollution-intolerant invertebrate taxa at some sites in EFPC has declined since the end of flow augmentation in 2014. Further, the pace of improvement in Upper EFPC near Y-12 has slowed in recent years, and fish and invertebrate communities continue to have fewer species than the corresponding communities in reference streams.

4.5.8.1. Bioaccumulation Studies

Historically, mercury and PCB concentrations in fish from EFPC have been elevated relative to fish in uncontaminated reference streams. Fish in EFPC are monitored regularly for mercury and PCBs to assess spatial and temporal trends in bioaccumulation associated with ongoing remedial activities and Y-12 operations.

As part of this monitoring effort, redbreast sunfish (*Lepomis auritus*) and/or rock bass (*Ambloplites rupestris*) are collected from five sites throughout the length of EFPC and are analyzed twice a year for tissue concentrations of mercury (Figure 4.19) and annually for PCBs (Figure 4.20). Mercury concentrations remained higher in fish from EFPC in 2023 than in fish from reference streams. Elevated mercury concentrations in fish from the upper reach of EFPC indicate that Y-12 remains a continuing source of mercury to fish in the stream.



Note: *BFK 7.6 and HCK 20.6 are reference sites.*

Acronyms:

BFK = Brushy Fork kilometer
EFK = East Fork Poplar Creek kilometer
Y12 = Y-12 National Security Complex
HCK = Hinds Creek kilometer
ORWTF = Oak Ridge Wastewater Treatment Facility

Figure 4.18. Biological monitoring sites in East Fork Poplar Creek relative to Y-12

Figure 4.19 shows temporal trends for mercury concentrations in water collected from EFK 23.4 (Station 17) and in fish collected just upstream of this monitoring station at EFK 24.4. Waterborne mercury concentrations in the upper reach of EFPC have decreased substantially over the years in response to various remedial actions.

Significant fluctuations in aqueous mercury concentrations (thought to be the result of storm drain relining and cleanout) have been seen at EFK 23.4 since 2009. In July 2018, aqueous mercury concentrations spiked as a result of a onetime flux of mercury that occurred during construction and demolition activities at the west end of Y-12. The elevated mercury concentrations were associated with toxicity and a fish kill (ORNL 2019, 2022).

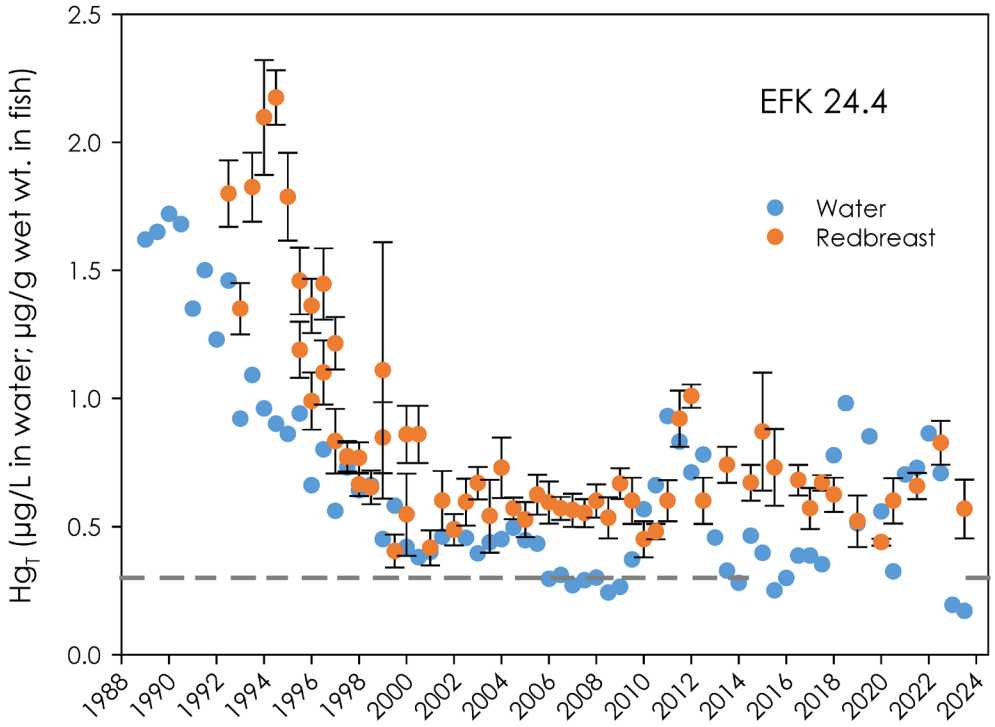
Aqueous mercury and fish concentrations at Station 17 decreased significantly in 2023, and mean mercury concentrations in fish collected at EFK 24.4 increased slightly (0.56 μg/g) but remained above the EPA-recommended ambient water quality criterion for mercury (0.3 μg/g mercury as methylmercury in fish fillet).

The relationship between aqueous total mercury concentrations and fish tissue concentrations is complex. Aqueous mercury concentrations vary

by orders of magnitude throughout the various watersheds across ORR, but fish tissue concentrations tend not to vary greatly (twofold to threefold). Multiple investigations are being conducted to better understand mercury bioaccumulation dynamics in EFPC and to better predict how remedial changes may impact mercury concentrations in fish in the future.

The mean total PCB concentration in sunfish fillets at EFK 23.4 was 0.26 µg/g in FY 2023, slightly higher than concentrations seen in FY 2022 (0.17 µg/g) (Figure 4.20). Regulatory guidance and human health risk levels vary widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. The Tennessee water quality criterion for both individual Aroclors and total PCBs is 0.00064 µg/L under the recreation designated-use classification and is the target for PCB-focused total maximum daily loads, including for local reservoirs, such as Melton Hill, Watts Bar, and Fort Loudoun (TDEC 2010a, 2010b, 2010c).

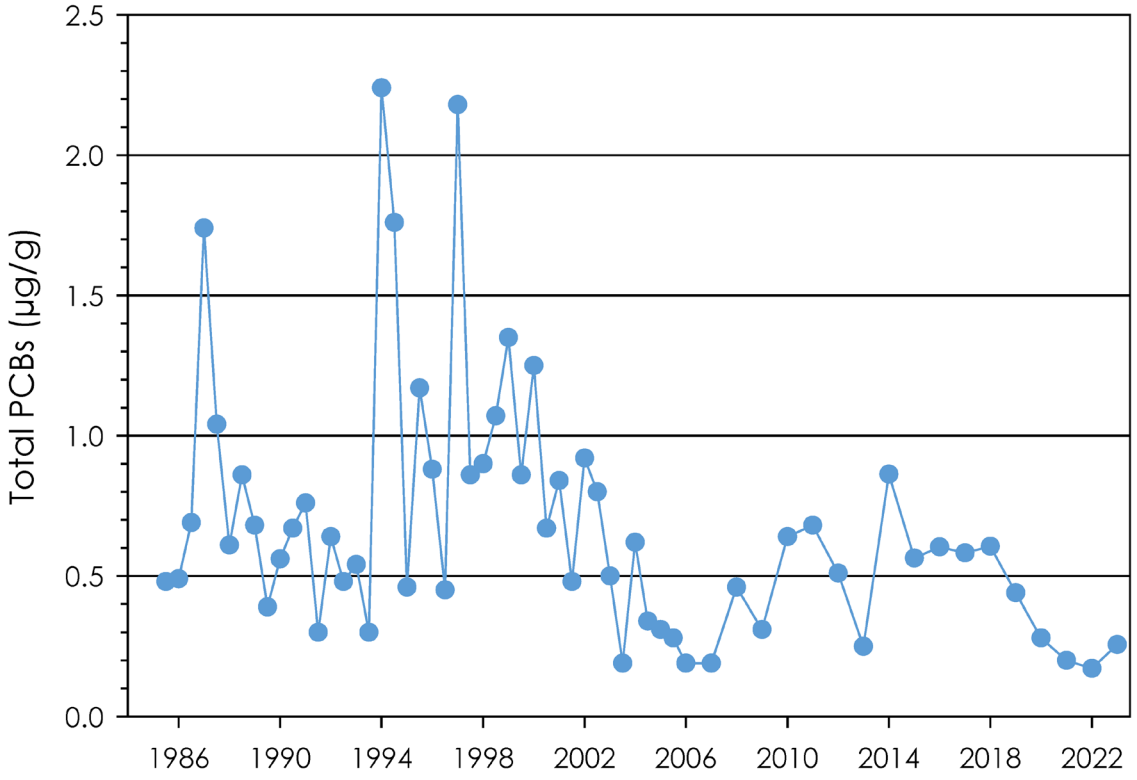
In the state of Tennessee, assessments of impairment for water body segments, as well as public fishing advisories, are based on fish tissue concentrations. Historically, the US Food and Drug Administration threshold limit of 2-µg/g PCBs in fish fillets was used for advisories. For many years, an approximate range of 0.8 to 1 µg/g was used, depending on the data available and factors such as the fish species and size. Most recently, the water quality criterion has been used to calculate the fish tissue concentration triggering impairment and a total maximum daily load (TDEC 2024b). This concentration is 0.02-µg/g PCBs in fish fillets (TDEC 2010a, 2010b, 2010c). The mean fish PCB concentration in Upper EFPC, is well above this concentration.



Notes:

1. *Dashed gray line represents the ambient water quality criterion for methylmercury in fish fillets (0.3 µg/g).*
2. *Water: At East Fork Poplar Creek kilometer 23.4.*
3. *Fish: At East Fork Poplar Creek kilometer 24.4.*

Figure 4.19. Semiannual average mercury concentration in muscle fillets of redbreast sunfish and water from East Fork Poplar Creek, 1988–2023



Note: *At East Fork Poplar Creek kilometer 23.4.*

Acronym:

PCB = polychlorinated biphenyl

Figure 4.20. Annual mean concentrations of polychlorinated biphenyls in rock bass muscle fillets, 1986–2023

4.5.8.2. Benthic Invertebrate Surveys

Monitoring the benthic macroinvertebrate community continued in the spring of 2023 at three sites in EFPC and at one reference stream (Hinds Creek). There have been long-term changes in the macroinvertebrate community at EFPC sites since monitoring began in 1986 (Figure 4.21).

Total taxa richness (number of taxa and sample) increased at EFK 24.4 from 1986 until the mid-2000s and then remained steady for approximately 14 years (Figure 4.21). After flow management ended in 2014, total taxa richness decreased at EFK 24.4 and has remained at these lower values since that time, with the exception of an increase in 2021 to a value similar to that measured before 2014, before decreasing again in 2022.

Total taxa richness at EFK 23.4 steadily increased since monitoring began, and values also decreased after flow management ceased (Figure 4.21). In 2023, total taxa richness remained similar to 2022 values at EFK 23.4, which are comparable to values observed from 2015 to 2019.

Total taxa richness at EFK 13.8 and the reference sites has been fairly consistent over the entire monitoring period, although the value at EFK 13.8 declined in 2023 and was the lowest observed since 2009 (Figure 4.21).

Total taxa richness at EFK 24.4 has consistently been lower than at the reference sites throughout the monitoring period, while total taxa richness at EFK 13.8 has generally fallen within or above the 95-percent confidence interval of reference site values, especially in the past decade (Figure 4.21). Total taxa richness at EFK 23.4 was lower than the 95-percent confidence interval of the reference sites from 1986 to 2009, but since then total taxa

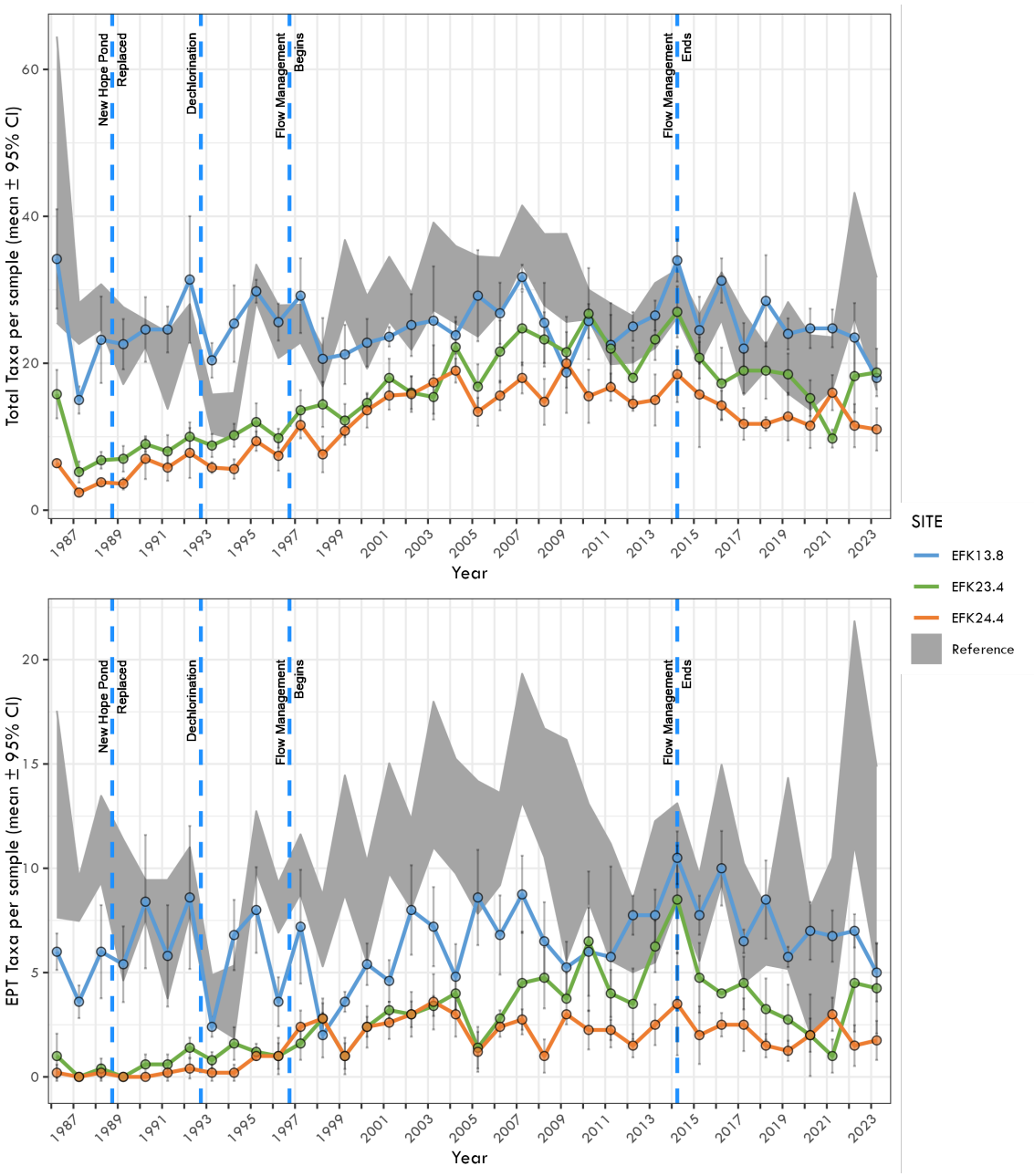
richness has mostly been within the 95-percent confidence interval of the reference sites (Figure 4.21).

Temporal patterns in the number of pollution-intolerant taxa (Ephemeroptera, Plecoptera, and Trichoptera [EPT] taxa richness) were similar to those observed for total taxa richness (Figure 4.21). EPT taxa richness at EFK 24.4 was very low (less than 1 EPT taxa and sample) from 1986 until 1994 and then increased slightly (greater than 1 but less than 5 taxa per sample) until 2014. Since 2014, EPT taxa richness has generally been slightly lower, with values in 2023 remaining similar to 2022 (Figure 4.21).

EPT taxa richness at EFK 23.4 steadily increased since 1986 but decreased after flow management ended (Figure 4.21). In 2023, EPT taxa richness at EFK 23.4 remained similar to values observed in 2022 and comparable to those observed from 2017 to 2019 following the lowest values observed in recent years in 2021 (Figure 4.21). EPT taxa richness at EFKs 24.4 and 23.4 has typically been lower than the 95-percent confidence interval of EPT taxa richness at the reference streams, indicative of degraded conditions.

The number of pollution-intolerant taxa at EFK 13.8 has remained fairly steady during the monitoring period, although with large interannual variation. EPT taxa richness values at EFK 13.8 have been within the reference site confidence limits since 2012, with the exception of 2022, which was below the confidence limits (Figure 4.21).

The implications of ending flow management in 2014 on invertebrate communities in EFPC are still uncertain. After flow augmentation ceased, EPT taxa richness at EFK 23.4 has consistently declined until 2022 (Figure 4.21). EPT taxa richness at EFK 24.4 has also shown a slight decrease since flow augmentation ended, with some recovery evident in 2020 and 2021, though this recovery was erased in 2022 (Figure 4.21). The effects of ending flow augmentation on Lower EFPC (EFK 13.8) do not seem as evident, which makes sense as flow augmentation contributed a smaller percentage of total discharge at downstream sites. The long-term effects of ending flow management on the invertebrate community in EFPC will become more evident as conditions stabilize and additional data become available.



Notes:

1. *Top: Total taxonomic richness (mean number of taxa per sample with 95 percent confidence interval).*
2. *Bottom: Taxonomic richness of the pollution-intolerant taxa (Ephemeroptera, Plecoptera, and Trichoptera [EPT]) (i.e., mean number of EPT taxa per sample with 95 percent confidence interval).*
3. *The timing of various activities within the watershed is shown with vertical blue lines.*
4. *Reference streams are Brushy Fork and Hinds Creek; however, Brushy Fork was not sampled in 2022 or 2023 due tolack of access to the survey site.*

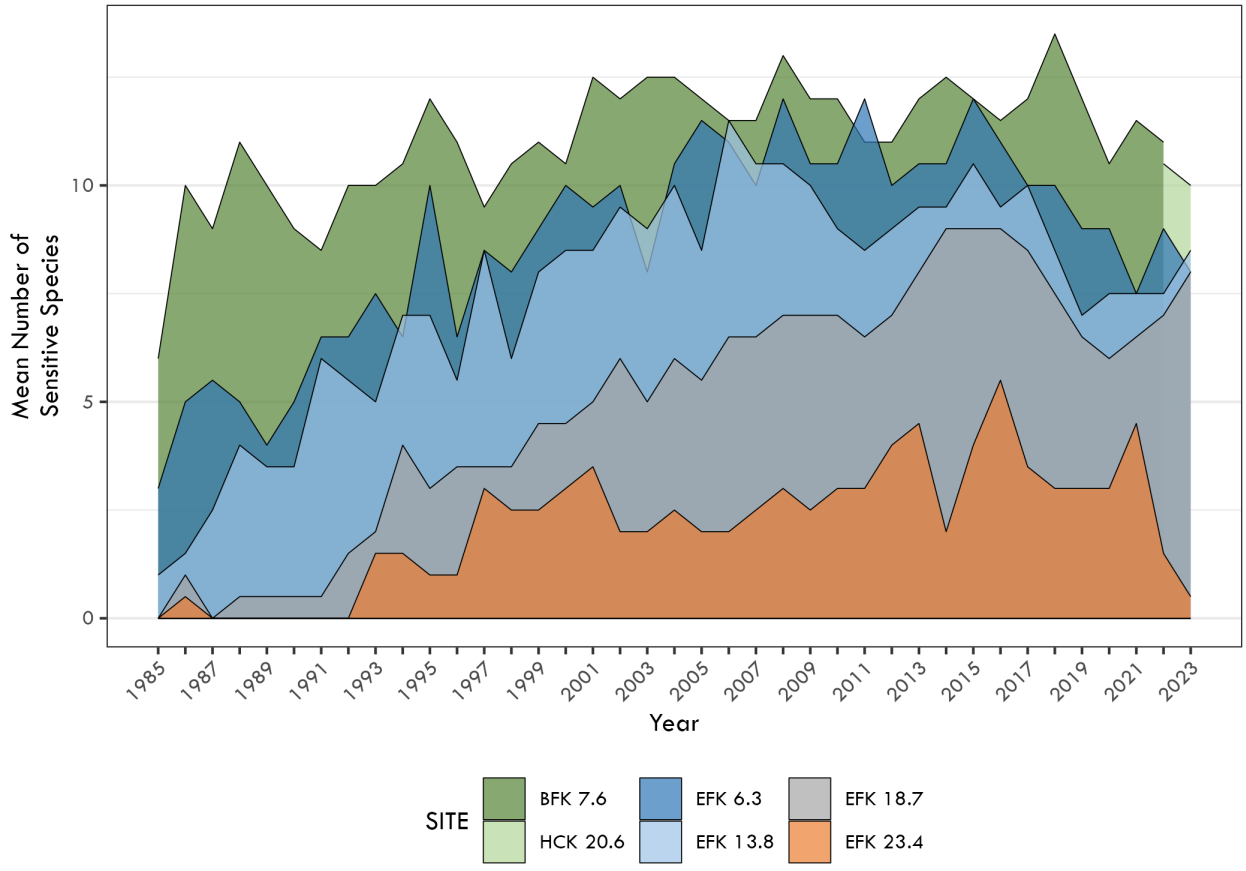
Acronyms:

EFK = East Fork Poplar Creek kilometer *EPT = Ephemeroptera, Plecoptera, and Trichoptera*

Figure 4.21. Benthic macroinvertebrate communities in three sites along East Fork Poplar Creek and the 95 percent confidence interval for two nearby reference streams

4.5.8.3. Fish Community Monitoring

Fish communities were monitored in the spring and fall of 2023 at sites along EFPC and at Hinds Creek, a comparable local reference stream. In the past three decades, overall species richness, density, biomass, and number of pollution-sensitive fish species improved at all sampling locations below Lake Reality. Some seasonal conditions, such as flooding and drought, can cause minor fluctuations in values but rarely cause long-term impacts on larger systems such as EFPC. However, some species of fish are considered sensitive, require very specific habitat conditions to survive, and can only tolerate a narrow range of environmental disturbance. The mean number of sensitive species at four sites in EFPC and the reference streams is shown in Figure 4.22, dramatically highlighting major improvements in the fish community in the middle to lower sections (EFKs 6.3 and 13.8) of the stream. However, the EFPC fish community continues to lag behind reference stream communities (Brushy Fork kilometer 7.6 and Hinds Creek kilometer 20.6) in the most important metrics of fish diversity and community structure, especially at the monitoring sites closest to Y-12 (EFKs 23.4 and 24.4).



Notes:

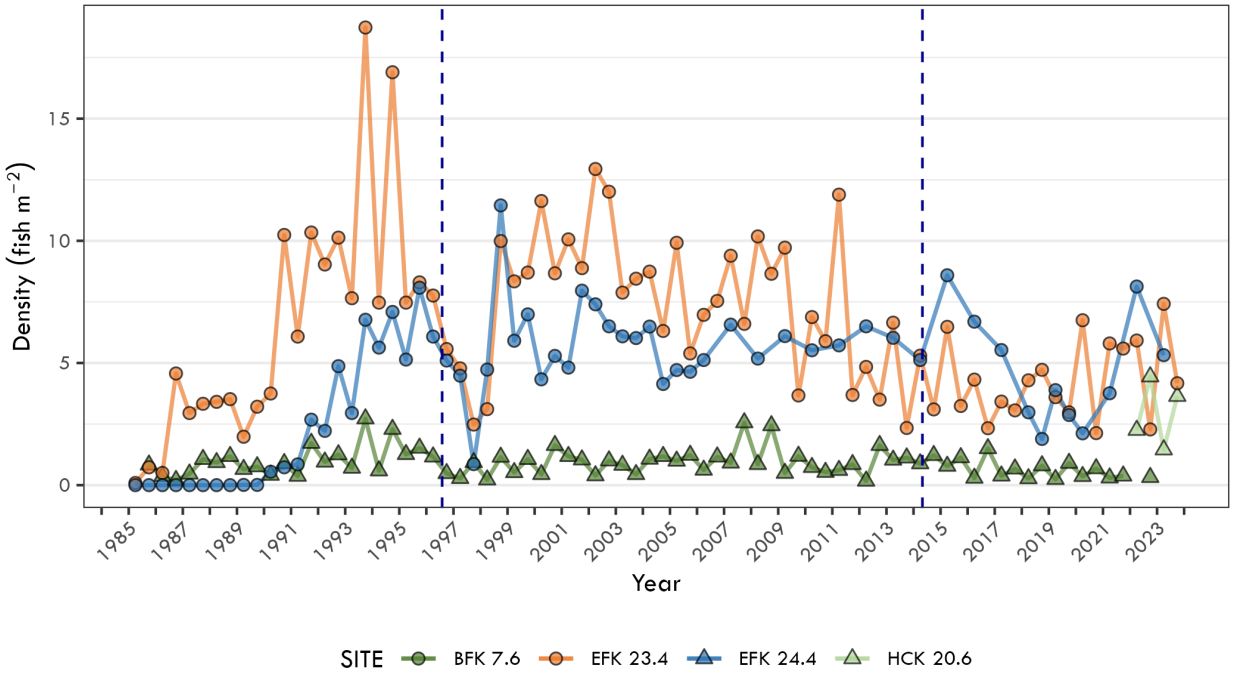
1. *Mean sensitive species richness refers to the number of species.*
2. *Reference sites are Brushy Fork kilometer 7.6 and Hinds Creek kilometer 20.6.*

Acronyms:

BFK = Brushy Fork kilometer EFK = East Fork Poplar Creek kilometer HCK = Hinds Creek kilometer

Figure 4.22. Comparison of mean sensitive fish species richness collected from East Fork Poplar Creek and reference sites, 1985–2023

Fish communities in Upper EFPC continued to fluctuate in density during 2023. Reduced stream flows associated with the termination of flow augmentation from Melton Hill in April 2014 and occasional unexpected fish kills are likely factors driving the decrease in fish densities in these upper sites (Figure 4.23). Despite this, fish diversity remained relatively consistent at these sites. Very high densities are not always a positive indicator of fish health, and the most abundant species within these sites continue to be those that are considered tolerant. Continued monitoring will provide additional insight into these variabilities.



Notes:

1. *Access to the Brushy Fork site (BFK 7.6) was restricted in spring 2022 and 2023, and no samples were collected. A comparable reference site was sampled beginning in spring 2022.*
2. *The interval of time between the dashed lines represents the period of flow management in East Fork Poplar Creek.*
3. *Fish density refers to the number of fish per m^2.*
4. *Reference sites are Brushy Fork (BFK 7.6) and Hinds Creek (HCK 20.6).*

Acronyms:

BFK = Brushy Fork kilometer EFK = East Fork Poplar Creek kilometer HCK = Hinds Creek kilometer

Figure 4.23. Fish density for two sites in Upper East Fork Poplar Creek and reference sites, 1985–2023

4.6. Groundwater at the Y-12 National Security Complex

Groundwater is monitored to comply with federal, state, and local requirements and to determine the environmental impact from legacy and current operations. There are approximately 190 known or potential sources of contamination identified in the Federal Facility Agreement for Y-12 (DOE 2023c). Groundwater monitoring provides information on the nature and extent of contamination, which is used to identify actions needed to protect the worker, public, and environment. Figure 4.24 depicts major source areas where groundwater is monitored.

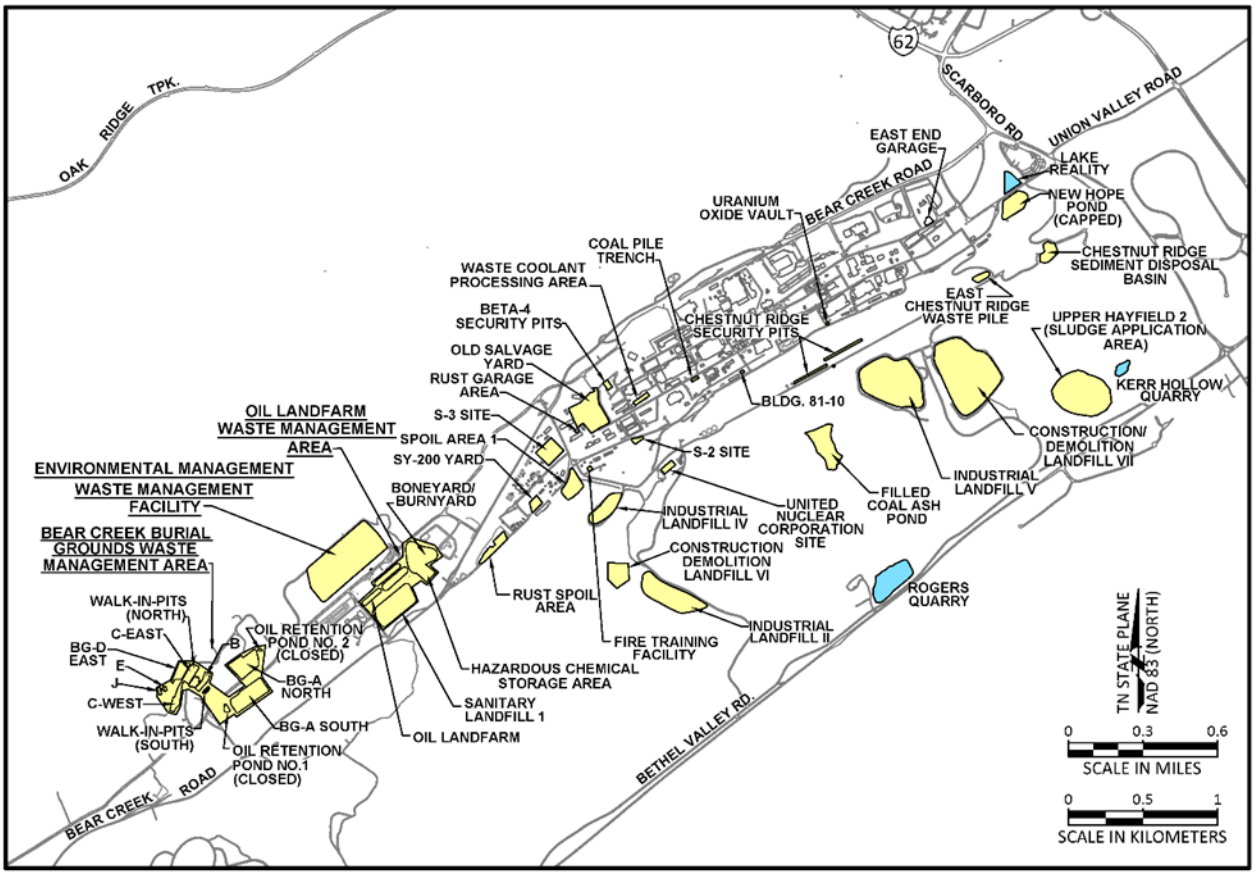


Figure 4.24. Known or potential contaminant source areas where groundwater is monitored at Y-12

4.6.1. Hydrogeologic Setting

Y-12 is divided into three hydrogeologic regimes—Bear Creek, Upper EFPC, and Chestnut Ridge (Figure 4.25). Most of the Bear Creek and Upper EFPC regimes are underlain by shale, siltstone, and sandstone bedrock, which act as an aquitard. An aquitard can contain water but does not readily yield that water to pumping wells. However, the southern portion of the Bear Creek and Upper EFPC regimes is underlain by the Maynardville Limestone, which is part of the Knox aquifer. (An aquifer more readily yields water to pumping wells.) The Chestnut Ridge regime is almost entirely underlain by the Knox aquifer.

In general, groundwater flow in the water table interval follows the topography; therefore, it flows off areas of higher elevation into the valleys and then flows parallel to the valley, along geologic strike (Figure 4.26). Shallow flow in the Bear Creek and Upper EFPC regimes diverges from a topographic and groundwater divide located near the western end of Y-12. In the Chestnut Ridge regime, a groundwater divide nearly coincides with the crest of the ridge. On Chestnut Ridge, shallow groundwater flow tends to be toward either flank of the ridge, with discharge primarily to surface streams and springs in Bethel Valley to the south and Bear Creek Valley to the north.

In Bear Creek Valley, groundwater in the intermediate and deep intervals moves through fractures in the aquitard, converging on and then moving through fractures and solution conduits in the Maynardville Limestone (Figure 4.25). Karst development in the Maynardville Limestone has a significant impact on groundwater flow in the water table and intermediate intervals. Groundwater flow rates in Bear Creek Valley vary; they are slow within the deep interval of the fractured non-carbonate rock (less than 10 ft/yr) but can be quite rapid within solution conduits in the Maynardville Limestone (10 to 5,000 ft/d).

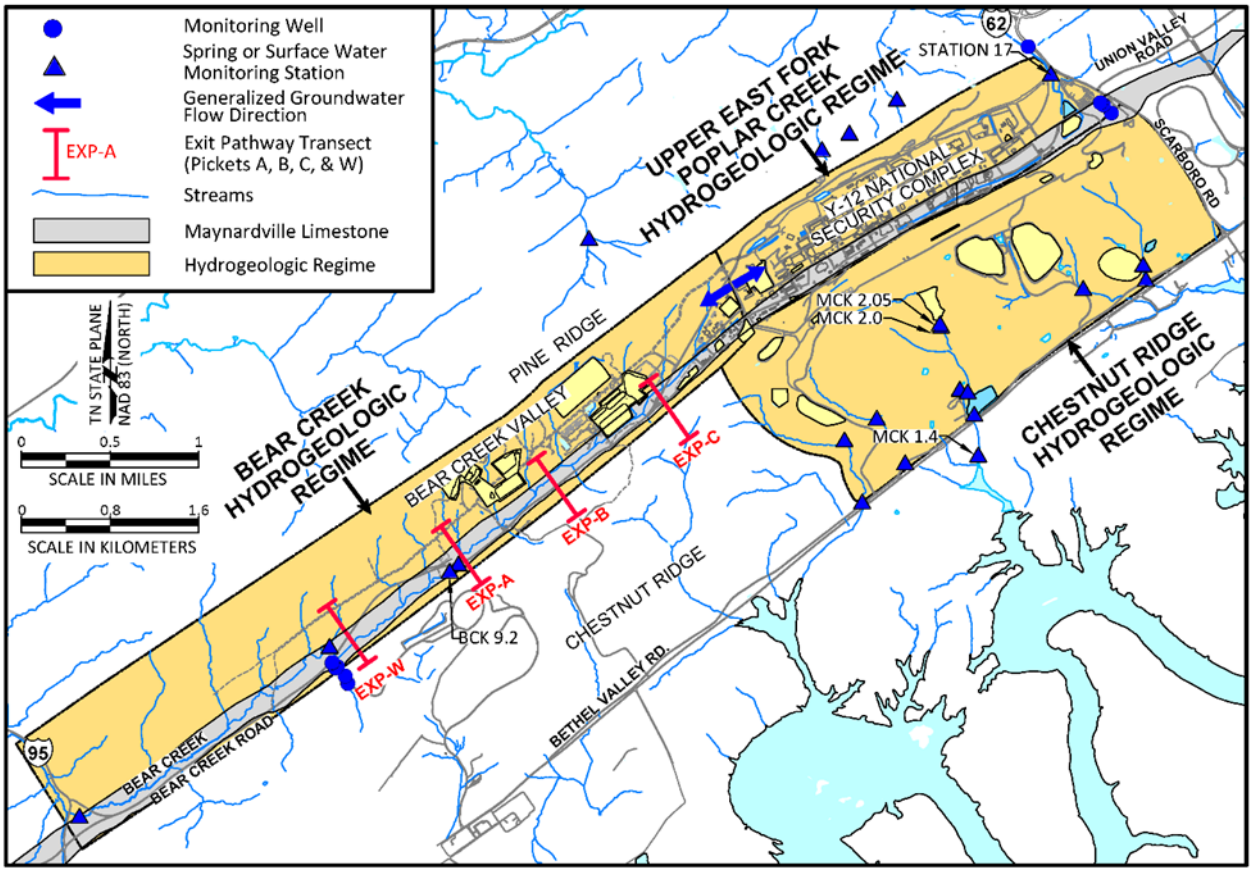


Figure 4.25. Hydrogeologic regimes, flow directions, perimeter/exit pathway locations, and position of Maynardville Limestone at Y-12

Contaminants are transported, along with flowing groundwater, through the pore spaces, fractures, or solution conduits of the hydrogeologic system. Strike-parallel transport of some contaminants can even occur within the aquitard units for significant distances, where they discharge to surface water tributaries or underground utility and storm water distribution systems in Y-12's industrial area. For example, elevated levels of nitrate (a contaminant from legacy waste disposals) within the fractured bedrock of the aquitard are known to extend east and west from the S-3 site for thousands of feet. Extensive VOC contamination from multiple sources is observed in both the Bear Creek and Upper EFPC regimes and to a lesser extent in the Chestnut Ridge regime. VOCs (e.g., petroleum products, coolants, and solvents) in groundwater within the fractured bedrock of the aquitard units can remain close to source areas for long durations. This is because they tend to adsorb to the bedrock matrix, diffuse into pore spaces within the matrix, and very slowly diffuse back out of the matrix when concentration gradients change before migrating to exit pathways, where more rapid transport occurs for longer distances.

Groundwater flow in the Chestnut Ridge regime is through fractures and solution conduits in the Knox aquifer. Discharge points for intermediate and deep flow are not well-known. However, following the crest of the Chestnut Ridge, water table elevations decrease from west to east, demonstrating an overall easterly trend in groundwater flow.

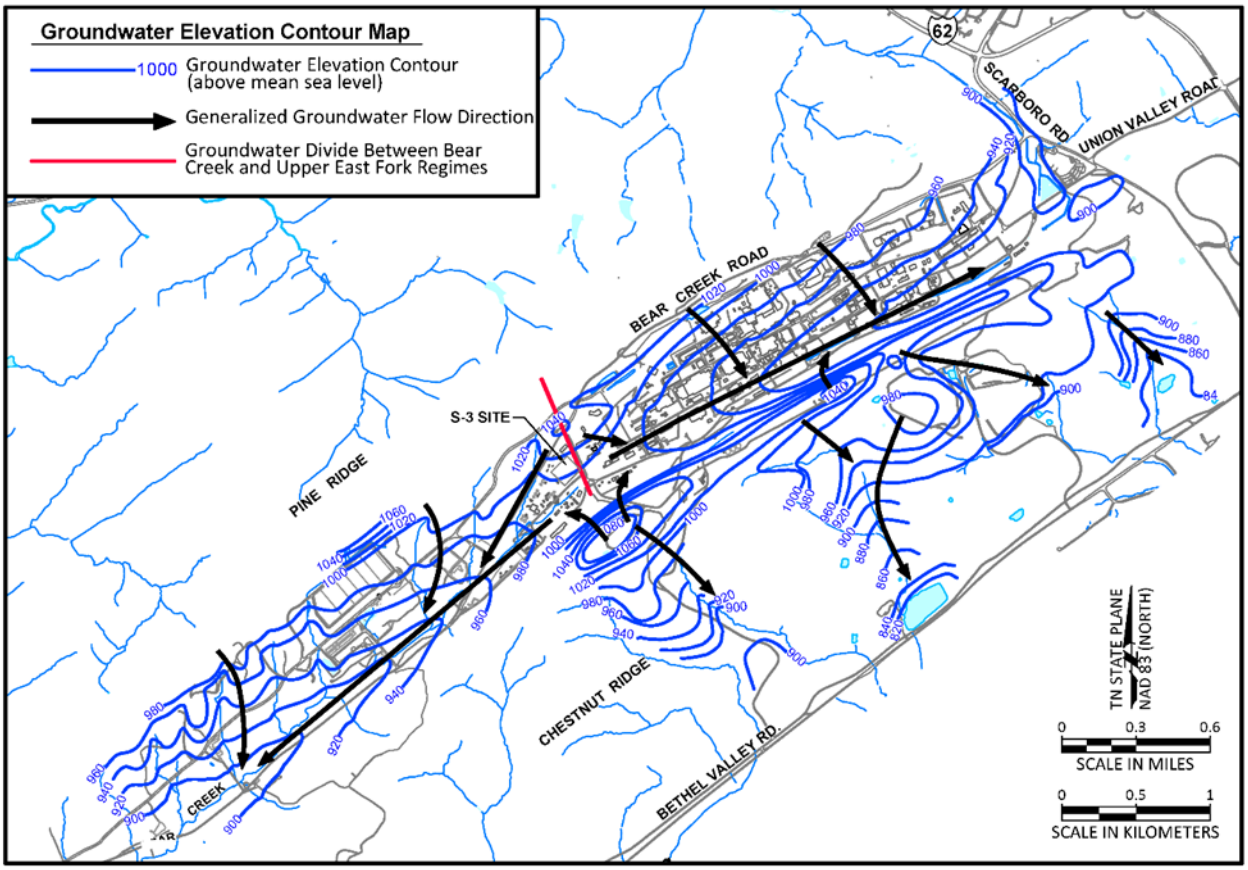


Figure 4.26. Groundwater elevation contours and flow directions at Y-12

4.6.2. Groundwater Monitoring

Groundwater monitoring in 2023 was performed as part of Y-12's Groundwater Protection Program, DOE EM programs such as the Water Resources Restoration Program, and other projects. Compliance requirements were met by monitoring 210 wells and 61 surface water locations and springs (Table 4.19). (Locations sampled for research projects are not included in the wells and locations monitored for compliance requirements.)

Specific wells of interest, based on 2023 data, are discussed later in this section. Figure 4.25 shows the locations of perimeter/exit pathway stations that are routinely monitored.

Table 4.19. Summary of groundwater monitoring at the Y-12 National Security Complex, 2023

	Restoration[a]	Waste management[b]	Surveillance[c]	Other[d]	Total
Purpose for which monitoring was performed					
Number of active wells	62	33	115	77	287
Number of other monitoring stations (e.g., springs, seeps, and surface water)	36	10	15	3	64
Number of samples taken[e]	282	282	145	82	791
Number of analyses performed	11,423	9,746	17,182	1,944	40,295
Percentage of analyses that are non-detects	63.0	87.8	69.4	NA	72.2
Ranges of results for positive detections, VOCs (µg/L)[f]					
Chloroethenes	0.15-1800	2.77-5.9	0.8-44000	NA	
Chloroethanes	0.13-250	59.7-66.2	1-1300	NA	
Chloromethanes	0.2-1400	0.51-1.25	1-670	NA	
Petroleum hydrocarbons	0.18-7300	ND	1-490	NA	
Uranium (mg/L)	0.00003-0.35	0.000078-0.014	0.000516-0.333	NA	
Nitrates (mg/L)	0.048-4200	ND-1.44	0.0452-11300	NA	
Ranges of results for positive detections, radiological parameters (pCi/L)[g]					
Gross-alpha activity	0.68-370	1.25-7.08	0-140	NA	
Gross-beta activity	0.63-3800	2.88-25.6	0-420	NA	

[a] *Monitoring to comply with CERCLA requirements.*

[b] *Solid waste landfill detection monitoring and CERCLA landfill detection monitoring.*

[c] *DOE Order surveillance monitoring.*

[d] *Research-related groundwater monitoring associated with activities of the DOE Oak Ridge Field Research Center and Ecosystems and Networks Integrated with Genes and Molecular Assemblies.*

[e] *The number of unfiltered samples, excluding duplicates, determined for unique location/date combinations.*

[f] *These ranges reflect concentrations of individual contaminants (not summed VOC concentrations):*

- *Chloroethenes—includes tetrachloroethene; trichloroethene; 1,2-dichloroethene (cis- and trans-); 1,1-dichloroethene; and vinyl chloride.*
- *Chloroethanes—includes 1,1,1-trichloroethane; 1,2-dichloroethane; and 1,1-dichloroethane.*
- *Chloromethanes—includes carbon tetrachloride, chloroform, and methylene chloride.*
- *Petroleum hydrocarbon—includes benzene, toluene, ethylbenzene, and xylene.*

[g] $pCi = 3.7 \times 10^{-2}\ Bq$

Acronyms:

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act

NA = not analyzed

Water quality results of groundwater monitoring activities are presented in the 2023 groundwater monitoring report (CNS 2024). The groundwater sampling technicians shown in Figure 4.27 are taking water quality samples from a well in the East Fork regime.

Monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FYs 2023 and 2024 Water Resources Restoration Program sampling and analysis plans (UCOR 2022, 2023b respectively) and the annual CERCLA remediation effectiveness reports (DOE 2023b, 2024).

Thirty-five monitoring wells were installed near the S-3 site by the Ecosystems and Networks Integrated with Genes and Molecular Assemblies research group in 2023. Three monitoring wells were installed by the Y-12 Groundwater Protection Program. Twenty-one monitoring wells were plugged and abandoned by the DOE Water Resources Restoration Program in 2023. Eight of these monitoring wells were located around Building 9201-02, which will be demolished. The remaining were located around the future Environmental Management Disposal Facility site.

Figure 4.27. Groundwater monitoring well sampling in the Upper East Fork regime at Y-12

4.6.3. Groundwater Quality

Historical monitoring shows that four primary contaminants adversely affect groundwater quality at Y-12: nitrate, VOCs, metals, and radionuclides. Of those, VOCs are the most widespread. Uranium and ^{99}Tc are the radionuclides of greatest concern. Trace metals (e.g., arsenic, barium, cadmium, chromium, and mercury), the least extensive groundwater contaminants, generally occur close to source areas because of their high adsorption characteristics. Data show that plumes from multiple source units have mixed with one another and that contaminants are not always easily associated with a single source.

4.6.3.1. Upper East Fork Poplar Creek Hydrogeologic Regime

Among the three hydrogeologic regimes, the Upper EFPC regime contains most of the known and potential sources of contamination. Contaminants from the S-3 site (nitrate and ^{99}Tc) and VOCs from multiple source areas are observed in groundwater in the western portion of the Upper EFPC regime, whereas groundwater in the eastern portion of the regime is predominantly contaminated with VOCs.

Plume Delineation

Sources of contaminants monitored during 2023 include the S-2 site, Fire Training Facility, S-3 site, Waste Coolant Processing Facility, former petroleum USTs, New Hope Pond, Old Salvage Yard, and process/production buildings throughout Y-12.

The S-3 site is near the hydrologic divide that separates the Upper EFPC regime from the Bear Creek regime and has contributed groundwater contamination to both regimes. Contaminant plumes in both regimes (shown in orange shading on Figures 4.28, 4.30, 4.31, and 4.32) are elongated as a result of preferential transport of contaminants parallel to strike (parallel to the valley axis) in both the Knox aquifer and the fractured bedrock of the aquitard.

The plumes depicted reflect the average concentrations and radioactivity in groundwater between 2013 and 2017. The circular icons presented on the plume maps (Figures 4.28, 4.30, 4.31, and 4.32) represent 2023 monitoring results for the Upper EFPC regime (discussed in this section), the Bear Creek regime (discussed in Section 4.6.3.2), and the Chestnut Ridge regime (discussed in Section 4.6.3.3).

Nitrate

Nitrate is highly soluble and moves easily with groundwater. In the central and western portions of Upper EFPC, nitrate concentrations exceed the 10-mg/L drinking water standard. (A list of the national drinking water standards is presented in Appendix C.) The two primary sources of nitrate contamination are the S-2 and S-3 sites. In the past, these were ponds that received large quantities of nitric acid wastes. In 2023, there was a maximum nitrate concentration of 9,360 mg/L in well GW-275. This well is located approximately 396 m (1,300 ft) east of the S-3 site and is screened in the shallow-intermediate bedrock interval about 19 m (63 ft) below ground surface (Figure 4.28).

Increasing concentration trends are indicated by the nitrate data for wells 55-2A, 55-2B, 55-2C, and GW-275 in the East Fork regime (Figure 4.29). Considering the mobility of nitrate, the increasing trends suggest increased flux of nitrate via some of the fracture flowpaths in the Nolichucky Shale east of the S-3 site. This is consistent with both the heterogeneous transport characteristics of the groundwater flow system as well as described in the conceptual model for contaminant transport from the S-3 site, whereby the center of mass of the nitrate (and other intermixed contaminants) plume in the Nolichucky Shale east of the site continues to slowly move eastward via permeable flowpaths (e.g., bedding plane fractures) that parallel geologic strike (DOE 1998).

The nitrate trends for wells 55-2A, 55-2B, and 55-2C appear to be fairly stable since 2010, and the nitrate trend at well GW-275 appears to be stable or decreasing since 2017, which demonstrates the continued eastward strike-parallel migration of the nitrate plume. Nitrate trends in the groundwater at well clusters reflect conditions at different depth intervals at the same location. Whereas wells 55-2A, 55-2B, and 55-2C show similar nitrate trends, divergent nitrate trends occur at wells GW-274 and GW-275 (decreasing and increasing). The decreasing trend at well GW-274 likely reflects higher groundwater flow (flushing) in the shallow groundwater system (Figure 4.29).

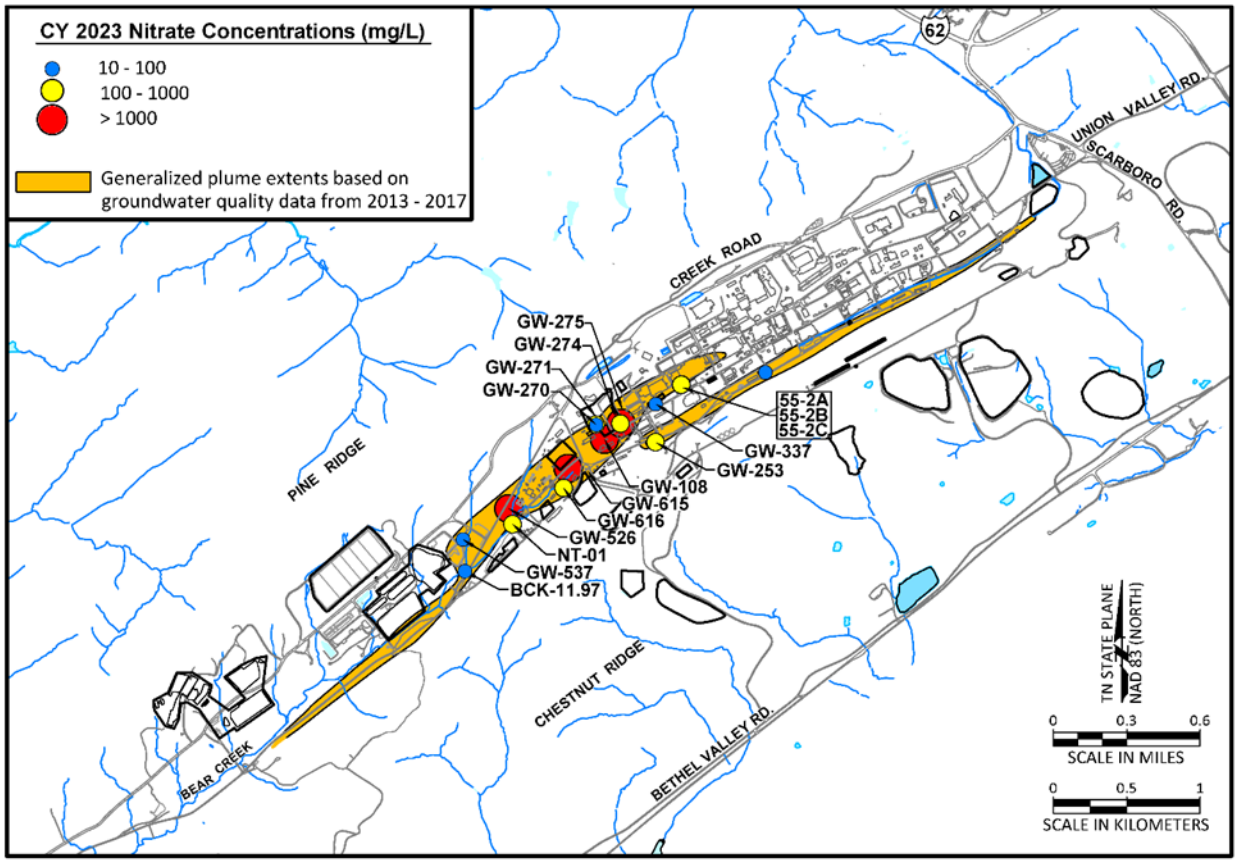


Figure 4.28. Nitrate in groundwater at Y-12, 2023

Trace Metals

In 2023, barium, beryllium, cadmium, chromium, copper, nickel, thallium, and uranium exceeded primary drinking water standards in groundwater in the Upper EFPC regime. Uranium was found predominately downgradient of the S-2 and S-3 sites, and upgradient of the New Hope Pond site. Trace metal concentrations above standards occur adjacent to source areas because of their low solubility and high adsorption to the clay-rich soils and bedrock.

VOCs

VOCs, the most widespread contaminants in the Upper EFPC regime, consist of chlorinated and petroleum hydrocarbons. In 2023, the highest summed concentration of dissolved chlorinated hydrocarbons (52,296 µg/L) was again observed at well 55-3B in the western portion of Y-12, adjacent to currently inactive manufacturing facilities. The highest dissolved concentration of petroleum hydrocarbons was again seen at well GW-658 (14,310 µg/L) at the closed East End Garage.

Most monitoring results are consistent with data from previous years because a dissolved plume of legacy VOCs in the bedrock zone extends eastward from the S-3 site over the entire length of the regime (Figure 4.30). Additional sources are the Waste Coolant Processing Facility, fuel facilities (Rust Garage and East End Garage), and other waste disposal and production areas.

Chloroethene compounds (tetrachloroethene [PCE], trichloroethene [TCE], dichloroethene [DCE], and vinyl chloride) tend to dominate the VOC plume in the western and central portions of the Upper East Fork regime. However, PCE is almost ubiquitous throughout, indicating many source areas. Chloromethane compounds (carbon tetrachloride, chloroform, and methylene chloride) are the predominant VOCs in the eastern portion of the regime.

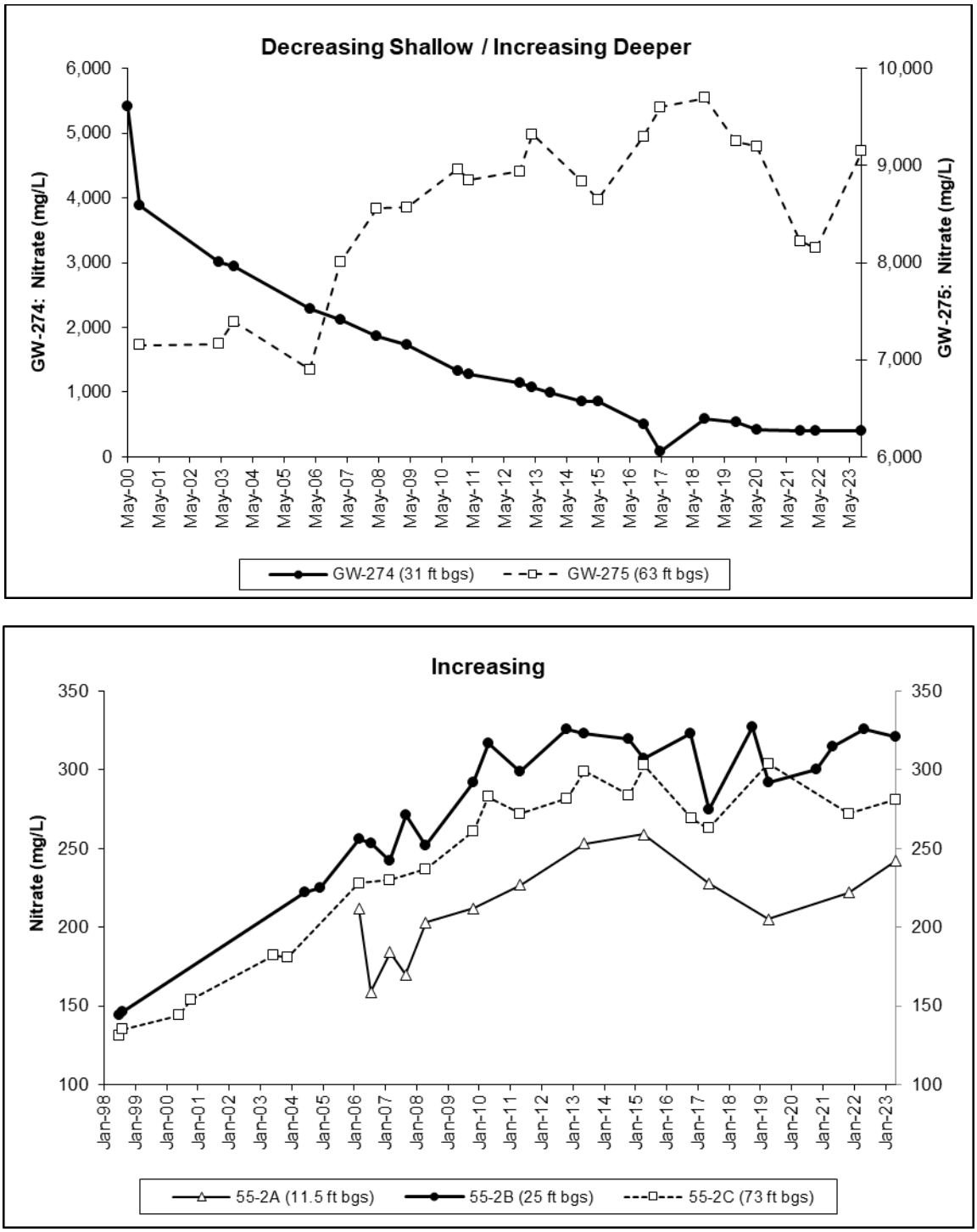


Figure 4.29. Nitrate concentration trends in surveillance monitoring wells GW-274/GW-275 and 55-2A/55-2B/55-2C in the East Fork regime

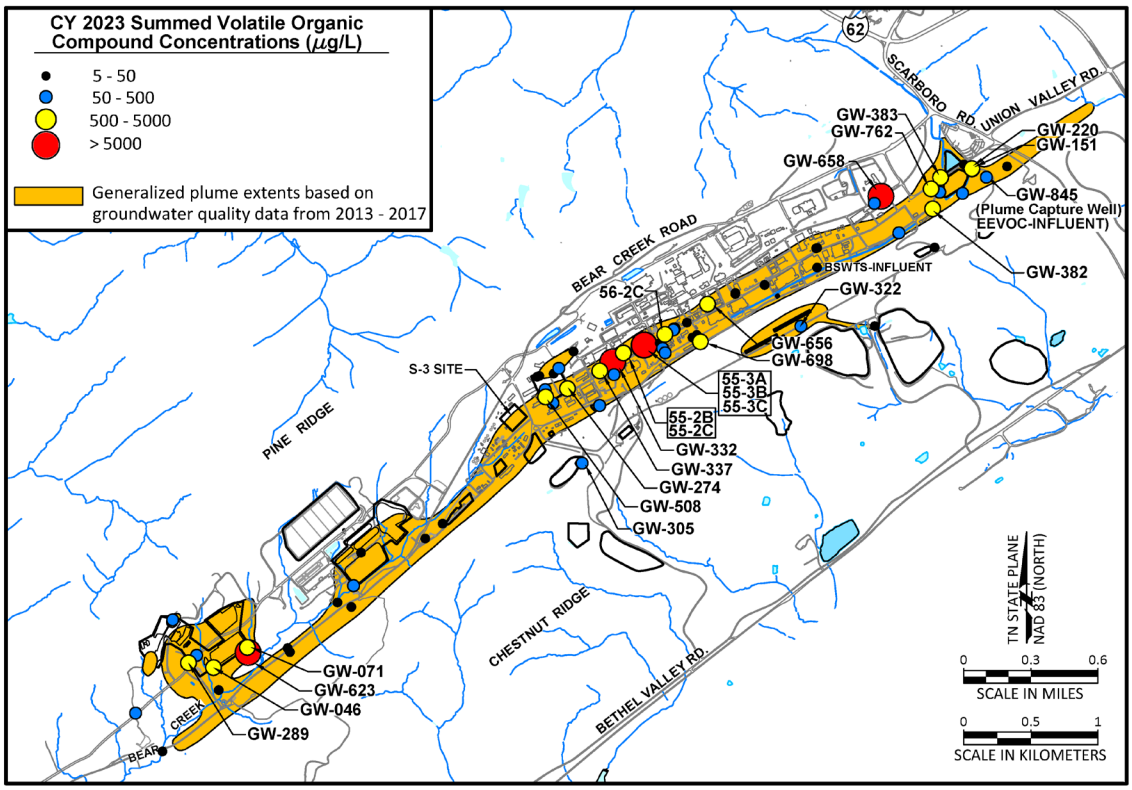


Figure 4.30. Summed volatile organic compounds in groundwater at Y-12, 2023

Variability in concentration trends of chlorinated and petroleum VOCs is seen within the Upper EFPC regime. Increasing trends have been observed in wells associated with the Rust Garage, Old Salvage Yard, and S-3 site, as well as some legacy sources at production/process facilities in central areas. While data from most monitoring wells have remained relatively constant since the late 1980s/early 1990s, some wells show trends in recovery from legacy contamination, especially where petroleum hydrocarbons are the predominant contaminant. For example, while GW-658 has the highest dissolved concentration of petroleum hydrocarbons in the regime, the concentration is an order of magnitude lower than measured in the same well in 1992 and 1993 (>100,000 mg/L).

Radionuclides

The primary alpha-emitting radionuclides found in the Upper EFPC regime during 2023 are isotopes of uranium. Exceedances of the drinking water standard for gross-alpha (15 pCi/L) have been observed near the S-3 site, Old Salvage Yard, and other western source areas; in the central areas near production facilities and the Uranium Oxide Vault; and in the east end near the former oil skimmer basin at the former inlet to New Hope Pond, which was capped in 1988. In 2023, the maximum occurrence of gross-alpha activity in groundwater in the Upper EFPC regime was 370 pCi/L, again at well GW-154 near the former oil skimmer basin as shown in Figure 4.31.

The primary beta-emitting radionuclides observed in the Upper EFPC regime are ^{99}Tc and isotopes of uranium. Historically, elevated gross-beta activity in groundwater shows a pattern similar to that observed for gross-alpha activity as shown in Figure 4.32.

Technetium-99 is the primary contaminant exceeding the gross-beta screening level of 50 pCi/L; the source is the S-3 site. The highest gross-beta activity in groundwater was observed during 2023 from well GW-108 (3,800 pCi/L), down from a maximum gross-beta (21,300 pCi/L) in 2008 in the same well.

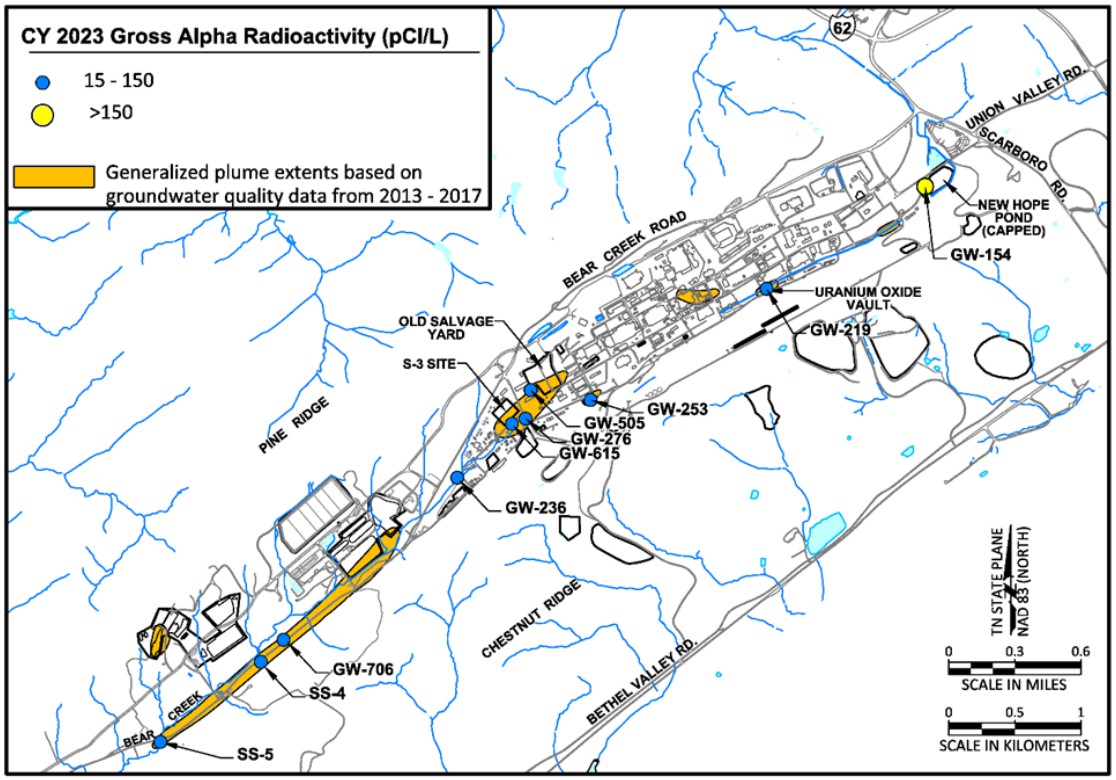


Figure 4.31. Gross-alpha activity in groundwater at Y-12, 2023

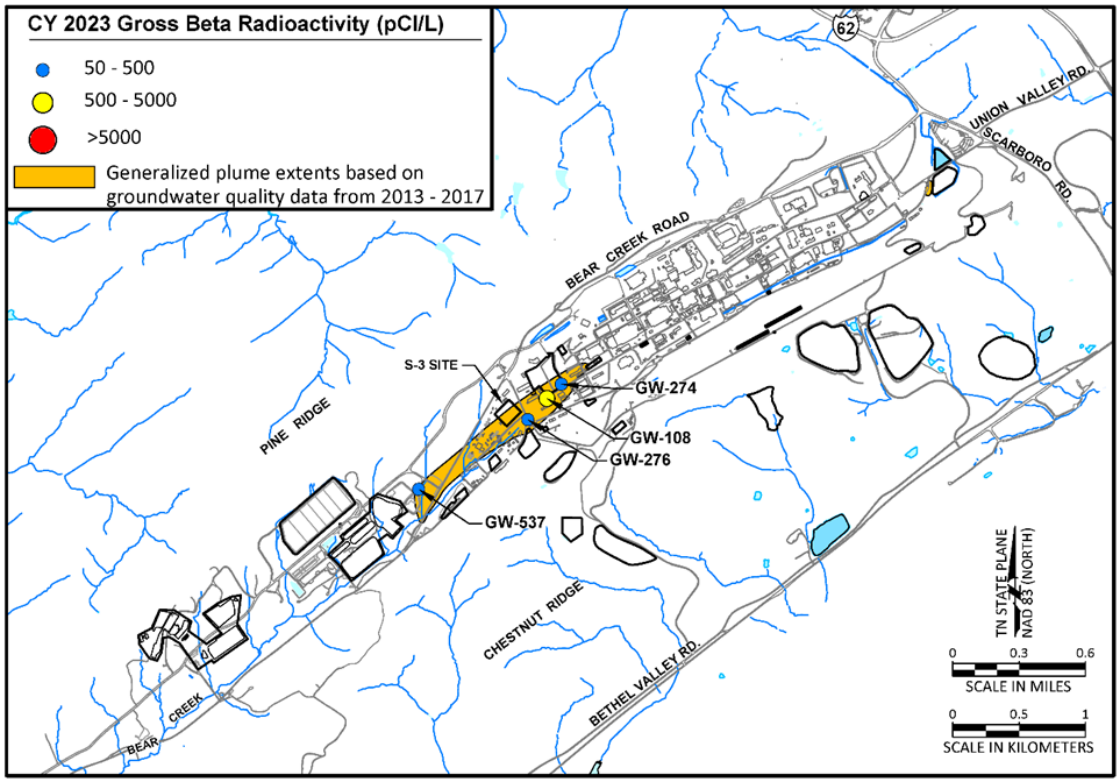


Figure 4.32. Gross-beta activity in groundwater at Y-12, 2023

Exit Pathway and Perimeter Monitoring

In the Upper EFPC regime, VOCs have been observed at depths of up to 500 ft below ground surface. The deep fractures and solution channels in the Maynardville Limestone (the primary exit pathway) appear to be well connected and facilitate contaminant migration into Union Valley off-site to the east of Y-12.

Because of off-site migration of contaminants, a plume capture system (the East End VOC Treatment System) was constructed in and around well GW-845 (shown on Figure 4.30) and began continuous operation in October 2000. Groundwater is pumped from the Maynardville Limestone at about 95 L/min (25 gal/min), passes through a treatment system to remove the VOCs, and then discharges to Upper EFPC. The effectiveness of this system is reported annually in remediation effectiveness reports published by DOE EM (DOE 2023b, 2024).

Monitoring wells near the plume capture system continue to show an encouraging response. The trends near the East End VOC plume show that contaminants in shallow-intermediate wells located perpendicular to strike across lithologic units from the plume capture system installed in GW-845 may be mobilized by the system. However, no downgradient detection of these compounds is apparent; therefore, migration is limited. An example is observed in the Westbay system installed in well GW-722. This multiport well, located downgradient from the East End VOC Treatment System, allows sampling of several vertically discrete zones within the Maynardville Limestone. Monitoring results from GW-722 indicate reductions in VOCs due to the plume capture system, derived from summed VOC levels above 1,000 µg/L before the treatment system was installed to below 50 µg/L in the last 4 years.

Five zones in well GW-722 were sampled in 2023, with four zones showing summed VOCs greater than 5 µg/L. Four zones exceeded the drinking water standard for carbon tetrachloride, with the highest concentration (15 µg/L) measured at zone 722-17 (385 ft below ground surface). Zone 722-20 (333 ft below ground surface) also exceeded the drinking water standard for PCE at 5.1 µg/L.

In addition to the deep system in the eastern portion of the Upper EFPC regime, VOCs have also been observed in shallow groundwater where it flows north-northeast (mimicking the flow of the creek) east of the New Hope Pond site and Lake Reality. In this area, GW-832 has been installed in a distribution channel underdrain associated with former New Hope Pond. During 2023, the summed concentrations of VOCs at the New Hope Pond distribution channel underdrain remained low (15.6-17.7 µg/L).

Upper EFPC flows north, exiting Y-12 through a gap in Pine Ridge. As mentioned previously, shallow groundwater mimics the creek and also moves through this exit pathway. GW-816 in this pathway gap was monitored in 2023, and no groundwater contaminants were observed above primary drinking water standards.

Perimeter sampling locations continue to be monitored north and northwest of Y-12 to evaluate possible contaminant transport, even though those locations are considered unlikely contaminant exit pathways. One of the stations monitored is a tributary that drains the north slope of Pine Ridge and discharges into the adjacent Scarboro community. Another location monitors an upper reach of Mill Branch, which discharges into the residential areas along Wiltshire Drive. The remaining location monitors Gum Hollow Branch as it flows adjacent to the Country Club Estates community. There were no indications that contaminants were being discharged from ORR into those communities.

Union Valley Monitoring

Groundwater monitoring data obtained in the early 1990s provided the first indication that VOCs were being transported off the ORR through the deep Maynardville Limestone exit pathway. The Upper EFPC remedial investigation (DOE 1998) discussed the nature and extent of VOC contamination in Union Valley.

In 2023, monitoring locations in Union Valley continued to show overall decreasing or low concentration stable trends. Vinyl chloride at

2.6 µg/L (above the maximum contaminant level of 2 µg/L) was detected at monitoring well GW-230, located in the University of Tennessee Arboretum (approximately 3,500 ft east of the ORR boundary). A groundwater flow divide west of GW-230, coincident with Scarboro Creek, Illinois Avenue, and a gap in Chestnut Ridge, probably restricts transport of VOCs from the ORR further east (MMES 1995). This would indicate that the VOCs observed in the well are from a source other than Y-12.

Under the terms of an interim Record of Decision, restrictions on potential future groundwater use have been established and maintained. Additionally, the previously discussed plume capture system (well GW-845) was installed to mitigate groundwater migration contaminated with VOCs into Union Valley (DOE 1997b).

In July 2006, the Agency for Toxic Substances and Diseases Registry—the principal federal public health agency charged with evaluating the human health effects of exposure to hazardous substances in the environment—published *Public Health Assessment: Evaluation of Potential Exposures to Contaminated Off-Site Groundwater from the Oak Ridge Reservation*, in which groundwater contamination across the ORR was evaluated (ATSDR 2006). In the report, it was acknowledged that groundwater contamination exists throughout the ORR, but the authors concluded there is no public health hazard from exposure to contaminated groundwater originating on the ORR. At that time, the Y-12 East End VOC groundwater contaminant plume was acknowledged as the only confirmed, off-site, contaminant plume migrating across the ORR boundary. The report recognized that institutional and administrative controls established in the Record of Decision do not provide for reduction in toxicity, mobility, or volume of contaminants of concern, but it concluded the controls protect public health to the extent that they limit or prevent community exposure to contaminated groundwater in Union Valley.

4.6.3.2. Bear Creek Hydrogeologic Regime

Located west of Y-12 in Bear Creek Valley, the Bear Creek regime is bounded to the north by Pine Ridge and to the south by Chestnut Ridge. The regime encompasses the portion of Bear Creek Valley extending from the west end of Y 12 to State Highway 95.

Plume Delineation

The primary contaminants in the Bear Creek regime are nitrate, trace metals, VOCs, and radionuclides. The S-3 site is a source of all four contaminants. The Bear Creek Burial Grounds and Oil Landfarm waste management areas are sources of uranium, other trace metals, and VOCs. Chlorinated hydrocarbons and PCBs have been observed in groundwater as deep as 82 m (270 ft) below the Bear Creek Burial Grounds (MMES 1990).

Contaminant plume boundaries are constrained by the bedrock formations (particularly the Nolichucky Shale) that underlie the waste disposal areas in the Bear Creek regime. This fractured aquitard unit is north of and adjacent to the exit pathway unit, the Maynardville Limestone. The elongated shape of the plumes in the Bear Creek regime is the result of preferential transport of the contaminants parallel to strike (parallel to the valley axis).

The plumes in the Bear Creek regime (Figures 4.28, 4.30, 4.31, and 4.32) represent the average concentrations and radioactivity between 2013 and 2017. The circular icons presented on the figures represent 2023 monitoring results.

Nitrate

Data from 2023 indicate nitrate in groundwater continues to exceed the drinking water standard (10 mg/L) in an area that extends west from the S-3 site. The highest nitrate concentration (11,300 mg/L) was observed at well GW-615 adjacent to the S-3 site at a depth of 245 ft below ground surface. Historically, elevated concentrations of nitrate (>1,000 mg/L) have been detected at greater depths (>700 ft below ground surface) near the S-3 site.

In 2023, concentrations of nitrate appear to be lower in the Bear Creek Regime. In past years, it has been reported that concentrations exceeding the drinking water standard were detected in

groundwater as far as 2,438 m (8,000 ft) west of the S-3 site, from spring location SS-4. However, these concentrations are now slightly lower than the drinking water standard of 10 mg/L (8 mg/L). In 2023, monitoring well GW-537 located 762 m (2,500 ft) from the S-3 site showed elevated concentrations above the drinking water standard (74.8 mg/L).

Natural attenuation processes have reduced nitrate levels in the shallow groundwater downgradient of the site. Despite the slightly elevated nitrate result for aquitard well GW-537 in 2023, the overall decreasing trend in nitrate indicates more efficient natural attenuation of nitrate in the shallow flow system, including seasonal discharge of nitrate-contaminated groundwater to the surface drainage network in Bear Creek Valley, compared to the substantially slower attenuation of nitrate in less permeable groundwater flow/contaminant transport pathways deeper in the bedrock.

Under the conceptual model for contaminant transport in the valley, elevated nitrate concentrations in the shallow groundwater from well GW-537 (1,285 in 1992 and 8.44 mg/L in 2020) were sustained by nitrate-contaminated groundwater upwelling from deeper flowpaths in the Nolichucky Shale (DOE 1997b).

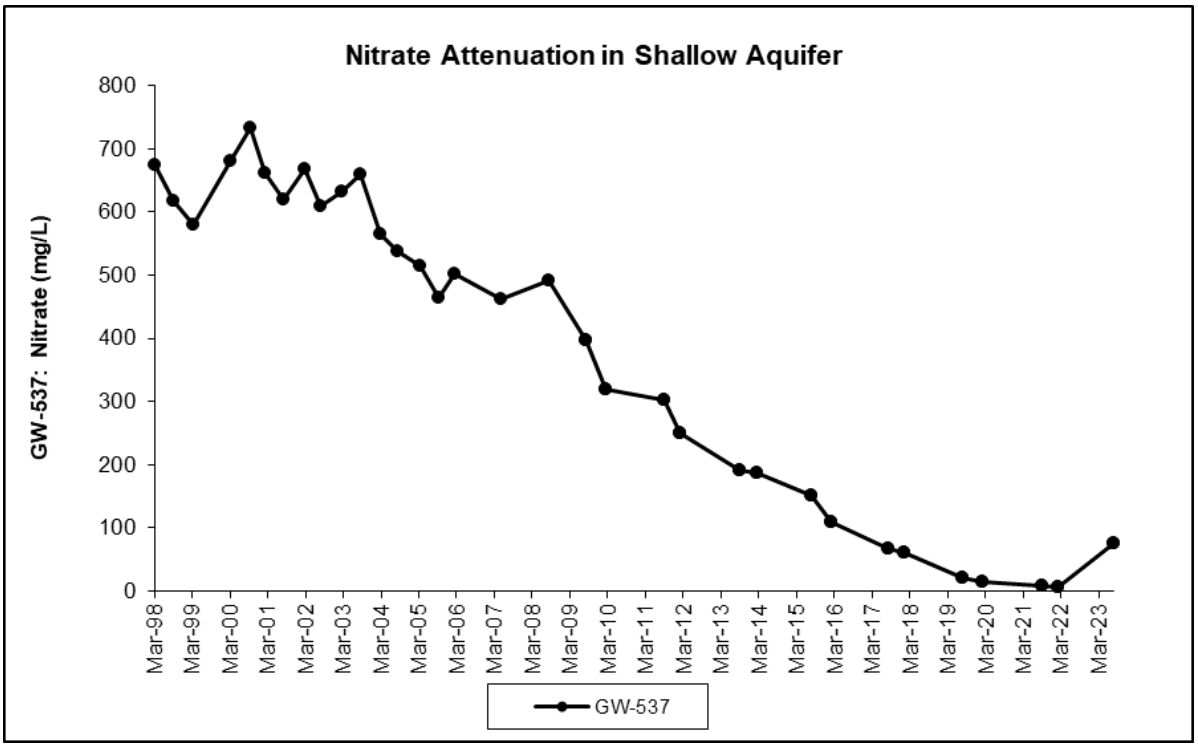


Figure 4.33. Nitrate trend in surveillance monitoring well GW-537, Bear Creek Regime, 1998–2023

Trace Metals

During 2023, arsenic, barium, cadmium, and uranium were identified as trace metal contaminants in the Bear Creek regime that exceeded primary drinking water standards. Elevated concentrations of many of the trace metals were observed at shallow depths near the S-3 site. Disposal of acidic liquid wastes at the site reduced the pH of the groundwater, which allows the metals to remain in solution longer and migrate further from the source area. In other areas of the Bear Creek regime, where natural geochemical conditions prevail, the trace metals may occur sporadically and in close association with source areas because conditions are typically not favorable for dissolution and migration.

The most prevalent trace metal contaminant is uranium. There has been a decrease in uranium in

Bear Creek since 1990, as shown in Table 4.20; however, uranium concentrations in the upper reaches of Bear Creek have been stable, indicating that this contaminant still presents an impact to surface water and groundwater.

Table 4.20. Nitrate and uranium concentrations in Bear Creek

Bear Creek Monitoring Station (Distance from S-3 site)	Contaminant	Average Concentration[a] (mg/L)			
		1990–1999	2000–2009	2010–2019	2020–2023
BCK[b]-11.84 to 11.97	Nitrate	91.9	75.2	43.4	26.25
(~0.5 miles downstream)	Uranium	1.61	0.124	0.183	0.166
BCK-09.20 to 09.47	Nitrate	12.4	11.3	4.8	2.7
(~2 miles downstream)	Uranium	0.096	0.115	0.061	0.052
BCK-04.55	Nitrate	3.8	2.5	0.96	2.56
(~5 miles downstream)	Uranium	0.033	0.028	0.018	0.016

[a] *Excludes results that do not meet data quality objectives.*

[b] *BCK = Bear Creek kilometer, measured upstream from the confluence with East Fork Poplar Creek.*

VOCs

VOCs are widespread in groundwater in the Bear Creek regime. The primary compounds are PCE; TCE; cis-1,2-DCE; vinyl chloride; and 1,1-dichoroethane. In most areas, they are dissolved in groundwater and can occur in bedrock at depths up to 92 m (300 ft) below ground surface. VOCs that occur in groundwater of the fractured bedrock aquitard units are found within about 305 m (1,000 ft) laterally of source areas.

The highest concentration observed in 2023 occurred in the Nolichucky Shale aquitard at the Bear Creek Burial Ground waste management area, with a maximum summed VOC concentration of 6,520 µg/L in well GW-623; trichloroethene (4,300 µg/L), tetrachloroethene (1,700 µg/L), and cis 1,2-dichloroethene (320 µg/L) comprised most of the summed total. The summed VOC concentrations of GW-623 show wide temporal concentration fluctuations that do not display any consistently increasing or decreasing long-term trend.

As illustrated by respective time-series plots for wells GW-229, GW-289, and GW-706 (Figure 4.34), the summed VOC concentrations either show wide temporal concentration fluctuations that do not display any consistently increasing or decreasing long-term trend, or exhibit a generally stable trend that suggests little corresponding change in the overall flux of dissolved VOCs via the groundwater flow/transport pathways intercepted by the well. The indeterminate long-term trends probably reflect the combined influence of the large volume of VOCs in the subsurface at source areas, low permeability of the groundwater flow/transport pathways monitored by the wells, and/or minimal natural attenuation of the VOCs during residence/transport in the subsurface.

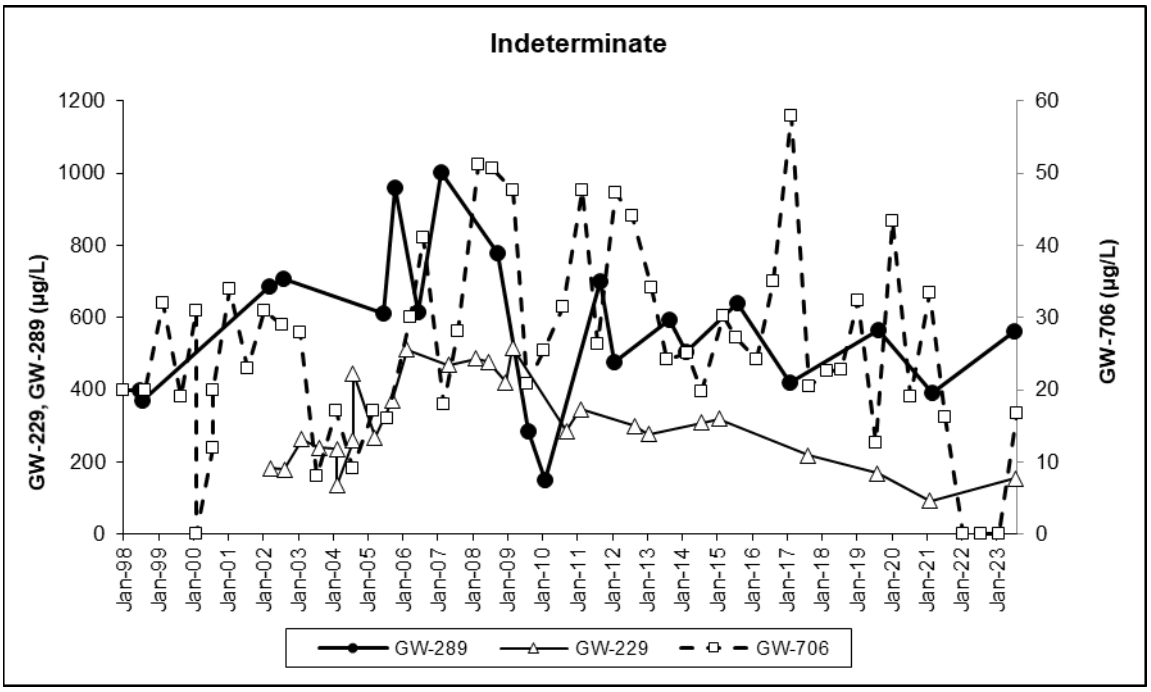


Figure 4.34. Indeterminate VOC trends in surveillance monitoring wells GW-229, GW-289, and GW-706

Radionuclides

As in the EFPC regime, the primary radionuclides identified in the Bear Creek regime are isotopes of uranium and ^{99}Tc. The extent of radionuclides in groundwater in the Bear Creek regime during 2023 was based primarily on measurements of gross-alpha and gross-beta activity. If the gross-alpha activity in a well exceeded 15 pCi/L (the drinking water standard for gross-alpha activity), then one or more of the alpha-emitting radionuclides (e.g., uranium) is assumed to be present and, at certain monitoring locations, is evaluated isotopically. A similar rationale is used for gross-beta activity that exceeds 50 pCi/L. Technetium-99, a more volatile radionuclide, is qualitatively screened by gross-beta activity analysis.

Groundwater in the Bear Creek regime with elevated gross-alpha activity occurs near the S-3 site and the Oil Landfarm waste management areas. In the bedrock interval, gross-alpha activity has exceeded 15 pCi/L in groundwater in the fractured bedrock of the aquitard units only near source areas (Figure 4.32).

In 2023, the highest gross-alpha activity observed in a monitoring well in the Bear Creek regime (100 pCi/L) was in GW-276, which is adjacent to the S-3 site (Figure 4.31).

In 2023, the highest gross-beta activity in groundwater in the Bear Creek regime was also at GW-276 at 100 pCi/L (Figure 4.32)

Exit Pathway and Perimeter Monitoring

Bear Creek, which flows over the Maynardville Limestone (the primary exit pathway for groundwater) in much of the Bear Creek regime, is the principal exit pathway for surface water. Studies have shown the surface water in Bear Creek, the springs along the valley floor, and the groundwater in the Maynardville Limestone are hydraulically connected. Surveys have identified gaining (groundwater discharging into surface waters) and losing (surface water discharging into a groundwater system) reaches of Bear Creek. The western exit pathway monitoring well transect (EXP-W) serves as the perimeter well location for the Bear Creek regime (Figure 4.25).

Exit pathway monitoring continues at four exit pathway transects (A, B, C, and W; Figure 4.25) also referred to as pickets, and selected springs and surface water stations. Data obtained during 2023 indicate groundwater is contaminated above

drinking water standards in the Maynardville Limestone as far as Picket W. The drinking water standard for gross-alpha was exceeded (24 pCi/L) in deep well GW-710. Historically, this well has presented elevated levels of gross-alpha activity. At 164.6 m (540 ft) below ground surface, the well is affected by deep brine water that likely contains naturally occurring radium and radon, which could account for the elevated gross-alpha activity. Concentration trends throughout the exit pathway continue to be generally stable to decreasing, as shown in Figure. 4.35.

In 2023, GW-713 in exit pathway transect W showed a trace concentration (0.33 µg/L) of TCE (below drinking water standards), thus indicating migration of contaminants potentially thousands of feet from likely sources areas to the east (e.g., Boneyard/Burnyard, the S-3 site, or Spoil Area 1). TCE is sporadically detected in GW-713 but has never been detected above drinking water standards.

Surface water samples collected in 2023 indicate water in Bear Creek contains many of the same compounds found in the groundwater. Uranium concentrations exceeding the drinking water standard have been observed in surface water west of the Burial Grounds as far as Picket W. This location is 4,724 m (15,500 ft) west of the S-3 site.

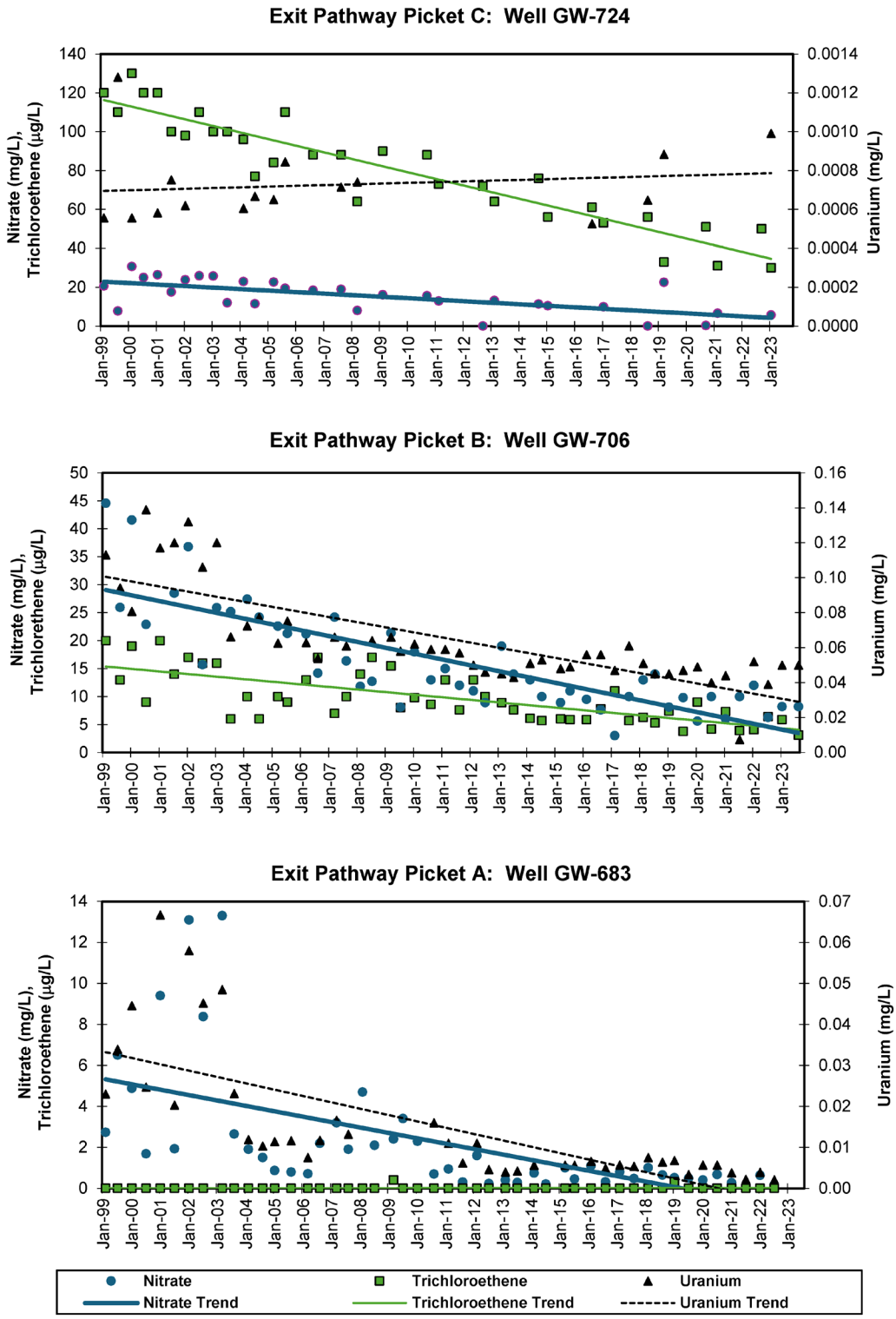
The concentrations in the creek generally decrease with distance downstream of the waste disposal sites (Table 4.20).

Exit pathway monitoring stations sampled in 2023 show that gross-alpha activity in the Maynardville Limestone exceeds the drinking water standard as far as 3,353 m (11,000 ft) west of the S-3 site at Spring SS-5 (19 pCi/L). The alpha activity at this spring recently shows a decreasing trend.

4.6.3.3. Chestnut Ridge Hydrogeologic Regime

The Chestnut Ridge hydrogeologic regime is flanked to the north by Bear Creek Valley and to the south by Bethel Valley Road (Figure 4.24). The regime encompasses the portion of Chestnut Ridge extending from Scarboro Road, east of the complex, to Dunaway Branch, located just west of Industrial Landfill II.

The Chestnut Ridge Security Pits area is the primary source of groundwater contamination in the regime. Contamination from the security pits is distinct and does not mingle with plumes from other sources.



Note: *Only nitrate and uranium results above the detection limit are plotted; non-detected trichloroethene results are plotted at zero.*

Figure 4.35. Concentrations of selected contaminants in exit pathway monitoring wells in the Bear Creek hydrogeologic regime, 2023

Plume Delineation

The extent of the VOC plume at the Chestnut Ridge Security Pits is reasonably well defined in the water table and shallow bedrock zones. With two possible exceptions, historical monitoring indicates the VOC plume from the Chestnut Ridge Security Pits has shown minimal migration in any direction (<305 m [<1,000 ft]).

Data obtained during 2022 indicate the western lateral extent of the VOC plume at the site has not changed significantly. VOC contaminants at a well about 458 m (1,500 ft) southeast and downgradient of the Chestnut Ridge Security Pits continue to show some migration of the eastern plume has occurred. Additionally, previously performed dye tracer test results and the intermittent detection of trace concentrations of VOCs (similar to those found in wells adjacent to the Chestnut Ridge Security Pits) at a natural spring about 2,745 m (9,000 ft) to the east and along geologic strike may suggest that Chestnut Ridge Security Pits contaminants have migrated further than the monitoring well network indicates. However, as in 2021 and 2022, no VOCs were detected at this spring in 2023.

The Chestnut Ridge Security Pits plume in the Chestnut Ridge regime (shown by orange shading on Figure 4.30) represents the average VOC concentrations between 2013 and 2017. The circular icons presented on the figure represent 2023 monitoring results.

Nitrate

Nitrate concentrations continue to be below the drinking water standard at all monitoring stations in the Chestnut Ridge regime in 2023.

Trace Metals

Concentrations of arsenic above drinking water standards have been observed in two surface water monitoring locations downstream from the Filled Coal Ash Pond, which is monitored under a CERCLA Record of Decision (DOE 1996b). Under the decision, migration of contaminated effluent from the Filled Coal Ash Pond is reduced by a constructed wetland area. In recent years, it became apparent the wetland efficiency was decreasing because, in part, of erosion channels forming around the wetland. During 2019, a maintenance activity was conducted at the site to improve the aquatic habitat for plant growth and to increase retention time for water within the wetland. The elevated arsenic levels were detected both upgradient (McCoy Branch kilometer [MCK] 2.05) and downgradient (MCK 2.0) of this wetland area. In 2023, the passive wetland treatment area continued to be effective in reducing arsenic.

VOCs

Overall, concentrations of VOCs in groundwater at the Chestnut Ridge Security Pits have decreased since 1988. Summed VOC concentrations were observed at monitoring well GW-322 (78 µg/L) during 2023.

At Industrial Landfill IV, VOCs have been observed in the groundwater since 1992. Well GW-305, located immediately to the southeast of the facility (Figure 4.30), exhibited increasing trends of summed VOCs from 1992 to 2014 but have stabilized, with the 2023 concentration at 71.45 µg/L. GW-305 was sampled in January and July 2023 with results for 1,1 DCE of 5.25 µg/L and 4.86 µg/L, respectively. (The drinking water standard for this compound is 5 ug/L.)

Radionuclides

In 2023, no gross-alpha (15 pCi/L) or gross-beta (50 pCi/L) above the drinking water standards were observed in the Chestnut Ridge hydrogeologic regime.

Exit Pathway and Perimeter Monitoring

Contaminant and groundwater flowpaths in the karst bedrock underlying the Chestnut Ridge regime have not been well characterized. Tracer studies have been conducted that show groundwater from Chestnut Ridge discharging into Scarboro Creek (approximately 9,000 ft from the Chestnut Ridge Security Pits) and other tributaries that feed into Melton Hill Lake. However, no springs or surface streams that represent discharge points for groundwater have been conclusively correlated to a waste management unit or operation at Y-12 that is a

known or potential groundwater contaminant source. Springs along Scarboro Creek are monitored for water quality, and trace concentrations of VOCs are intermittently detected. The detected VOCs are suspected to originate from the Chestnut Ridge Security Pits; however, this has not been confirmed. In 2023, two springs along Scarboro Creek were sampled with no detected concentrations of VOCs.

Monitoring natural groundwater exit pathways is a basic monitoring strategy in a karst regime, such as that of Chestnut Ridge. Perimeter springs and surface water tributaries were monitored to determine whether contaminants are exiting the downgradient (southern) side of the regime. Six springs and three surface water monitoring locations were sampled during 2023. No contaminants at any of these monitoring stations were detected at levels above primary drinking water standards.

4.6.4. Emerging Contaminants

Per- and polyfluoroalkyl substances (PFAS) are emerging contaminants that constitute a large family of fluorinated chemicals. The persistence and mobility of some PFAS, combined with decades of widespread use in industrial processes, certain types of firefighting foams, and consumer products, have resulted in their being present in environmental media at trace levels across the globe. It was not until the early 2010s that analytical methods to detect a limited number of PFAS became widely available and had detection limits in water low enough to be commensurate with levels of potential human health effects. Toxicological studies have raised concerns regarding the bioaccumulative nature and potential health concerns of some PFAS.

The following actions and activities were conducted at Y-12 during 2023 to address these emerging contaminants of concern:

- Y-12 continues to maintain compliance with the DOE requirements pertaining to PFAS storage, use, and disposal (DOE 2021a, DOE 2021b). No PFAS-containing aqueous film-forming foam (AFFF) was used for training purposes, and no new AFFF systems were installed in 2023. One waste storage building (Building 9720-09) has an active AFFF fire suppression system that is only approved for fire emergencies. This system undergoes periodic maintenance and post-maintenance testing, which generates AFFF wastes that contain PFAS. No new releases or spills of PFAS-containing AFFF occurred in 2023.
- Y-12 has a fire department and fire training facility. The Y-12 Fire Department has one firetruck with a foam induction system that uses a fluorine-free foam.
- Current and historic uses of 196 PFAS or PFAS-related substances are being tracked using the Y-12 Hazardous Material Information System. No PFAS substances were used in excess of the Emergency Planning and Community Right-to-Know Act Toxics Release Inventory reporting threshold during 2023.
- No production-related activities, equipment, or processes are known to have generated or released PFAS to the environment; however, several products and/or chemicals containing PFAS have been used in small quantities, primarily in the Analytical Chemistry laboratories and in the Development facilities.
- Y-12 personnel began to coordinate with the EPA and prepare for the Unregulated Contaminant Monitoring Rule 5 (EPA 2024) sampling efforts to begin in 2024. The Safe Drinking Water Act requires that, once every 5 years, the EPA issue a list of unregulated contaminants to be monitored by public water systems. The new rule requires that samples be collected for 30 chemical contaminants between 2023 and 2025 using standard analytical methods. Twenty-nine of these contaminants are PFAS. This action provides scientifically valid data on the national occurrence of these contaminants in drinking water to improve the agency's understanding of the frequency of detection and concentrations of PFAS in the nation's drinking water systems. The monitoring data on PFAS will help determine future regulations and other actions to protect public health.

- In accordance with the DOE *PFAS Strategic Roadmap: DOE's Commitments to Action 2022-2025* (DOE 2022), Y-12 participated in the 2023 site-specific status update survey. The results will be published in 2024.

4.7. Quality Assurance Program

Y-12's QA Program establishes a quality policy and requirements for the Y-12 site. Internal procedures detail the methods used to carry out work processes safely and securely and in accordance with established procedures. They also describe mechanisms in place to identify and correct findings and prevent recurrences.

Many factors can potentially affect the results of environmental data collection activities, including sampling personnel, methods, and procedures; field conditions; sample handling, preservation, and transport; personnel training; analytical methods; data reporting; and recordkeeping. QA programs are designed to minimize these sources of variability and control all phases of the monitoring process.

Field sampling QA encompasses many practices that minimize error and evaluate sampling performance. The following are some key quality practices:

- Using work control processes and standard operating procedures for sample collection and analysis
- Using chain-of-custody and sample identification procedures
- Standardizing, calibrating, and verifying instruments
- Training sample technicians and laboratory analysts
- Preserving, handling, and decontaminating samples
- Using QC samples, such as field and trip blanks, duplicates, and equipment rinses

The Y-12 Environmental Sampling Services organization is responsible for field sampling activities, sample preservation and handling, chain-of-custody, and field QC sample transport in accordance with Y-12 Environmental Compliance procedures. Environmental Sampling Services developed a standards and calibration program that conforms to ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories* (ISO 2017), and provides a process for uniform standardization, calibration, and verification of measurement and test equipment. The program ensures measurements are made using appropriate documented methods, traceable standards, appropriate measurement and test equipment of known accuracy, trained personnel, and technical best practices.

Analytical results may be affected by a large number of factors inherent to the measurement process. Laboratories that support Y-12 environmental monitoring programs use internal QA/QC programs to ensure early detection of problems that may arise from contamination, inadequate calibrations, calculation errors, or improper procedure performance. Internal laboratory QA/QC programs include routine calibrations of counting instruments; yield determinations; frequent use of check sources and background counts, replicate and spiked sample analyses, and matrix and reagent blanks; and maintenance of control charts to indicate analytical deficiencies. These activities are supported by using standard materials or reference materials (e.g., materials of known composition that are used to calibrate instruments, methods standardization, spike additions for recovery tests, and other practices). Certified standards traceable to the National Institute of Standards and Technology, DOE sources, or EPA are used, when available.

Y-12's Analytical Chemistry organization has an internal manual that describes program elements; customer-specific requirements; certification program requirements; federal, state, and local regulations; and waste acceptance criteria. As a government-owned, contractor-operated laboratory that performs work for DOE, the Analytical Chemistry laboratory operates in accordance with DOE Order 414.1D, *Quality Assurance* (DOE 2011c).

Other internal practices used to ensure laboratory results represent of actual conditions and include training and managing staff; maintaining adequacy of the laboratory environment; ensuring safety; controlling the storage, integrity, and identity of samples; maintaining recordkeeping; maintaining and calibrating instruments; and using technically validated and properly documented methods.

Y-12's Analytical Chemistry organization participated in Mixed Analyte Performance Evaluation Program studies conducted in 2023 for water and soil matrices for metals, organics, and radionuclides. The overall acceptability rating from both studies was 96.23 percent.

Verification and validation of environmental data are performed as components of the data collection process, which includes planning, sampling, analyzing, and performing data review. Some level of verification and validation of field and analytical data collected for environmental monitoring and restoration programs is necessary to ensure that data conform to applicable regulatory and contractual requirements. Validation of field and analytical data is a technical review performed to compare data with established quality criteria to ensure that data are adequate for the intended use. The extent of project data verification and validation activities is based on project-specific requirements.

For routine environmental effluent monitoring and surveillance monitoring, data verification activities may include processes to check whether data have been accurately transcribed and recorded, appropriate procedures have been followed, electronic and hard copy data show one-to-one correspondence, and data are consistent with expected trends. Typically, routine data verification actions alone are sufficient to document the validity and accuracy of environmental reports. For restoration projects, routine verification activities are more contractually oriented and include checks for data completeness, consistency, and compliance with a predetermined standard or contract.

Certain projects may require a more-thorough technical validation of the data, as mandated by the project's data quality objectives. Sampling and analyses conducted as part of a remedial investigation to support the CERCLA process may generate data that are needed to evaluate risk to human health and the environment, to document that no further remediation is necessary, or to support a multimillion-dollar construction activity and treatment alternative. In these cases, the data quality objectives of the project may mandate a thorough technical evaluation of the data against rigorous predetermined criteria.

The validation process may result in identifying data that do not meet predetermined QC criteria or in the ultimate rejection of data for their intended use. Typical criteria evaluated in the validation of contract laboratory program data include the percentage of surrogate recoveries, spike recoveries, method blanks, instrument tuning, instrument calibration, continuing calibration verifications, internal standard response, comparison of duplicate samples, and sample holding times.

A due diligence analysis is performed for facilities used for the treatment, storage, or disposal of radiological and hazardous waste to ensure that each facility is well operated and maintained; has minimal environmental issues and impacts; employs personnel who are properly trained, competent, and work safely; is in compliance with regulatory requirements; and is adequately insured against personal and environmental liabilities.

This evaluation includes a review of information on the facility's compliance history, design, operations, recordkeeping and reporting requirements, emergency response procedures, closure/post-closure plans, and insurance coverage, as well as any environmental issues, remediation, litigation or regulatory agency concerns related to the facility. Y-12 limits the number of facilities used and avoids or discontinues using facilities that present significant environmental and/or safety liability. This evaluation may rely on results of third-party accreditation assessments reported under the DOE Consolidated Audit Program.

Table 4.21 lists treatment, storage, and disposal facilities used in 2023 for the disposition of radiological and hazardous waste.

Table 4.21. Treatment, storage, and disposal facilities used to disposition radiological and hazardous waste, 2023

Facility Name	Location	Identification Number
Clean Harbors Cincinnati (Spring Grove) Facility	Cincinnati, Ohio	OHD000816629
Clean Harbors of Baltimore	Baltimore, Maryland	MDD980555189
Clean Harbors Baton Rouge	Baton Rouge	LAD010395127
Clean Harbors Cleveland Technical Services	Cleveland, Ohio	OHD000724153
Clean Harbors Deer Park Incineration Facility	La Porte, Texas	TXD055141378
Clean Harbors El Dorado Incineration Facility	Ed Dorado, Arkansas	ARD069748192
Clean Harbors Environmental Services	Kimball, Nebraska	NED981723513
Clean Harbors Grassy Mountain Landfill Facility	Clive, Utah	UTD991301748
Clean Harbors La Porte Technical Services	La Porte, Texas	TXD982290140
Clean Harbors Lone Mountain Facility	Waynoka, Oklahoma	OKD065438376
Clean Harbors Reidsville	Reidsville, North Carolina	NCD000648451
Diversified Scientific Services, Inc.	Kingston, Tennessee	TND982109142
Energy Solutions Bear Creek Processing Facility	Kingston, Tennessee	TND982157570
EnergySolutions Clive Disposal Facility	Grantsville, Utah	UTD982598898
Nevada National Security Site	Mercury, Nevada	NV3890090001
Perma-Fix of Florida, Inc.	Gainesville, Florida	FLD980711071
Safety-Kleen Systems	Smithfield, Kentucky	KYD053348108
Veolia ES Technical Solutions	Port Washington, Wisc.	WID988566543
Veolia ES Technical Solutions	Tallahassee, Florida	FL0000207449
Waste Control Specialists	Andrews, Texas	TXD988088464

4.8. Environmental Management and Waste Management Activities

The three sites on ORR have a rich history of research, innovation, and scientific discovery. Unfortunately, despite their vitally important missions, they are hindered by environmental legacies remaining from past operations. The contaminated portions of ORR are on the EPA National Priorities List, which includes hazardous waste sites across the nation that are to be cleaned up under CERCLA. Areas that require cleanup or further action on ORR have been clearly defined, and DOE EM is working to clean those areas under the Federal Facility Agreement with the EPA and TDEC. The *2023 Cleanup Progress: Annual Report on Oak Ridge Reservation Cleanup* (UCOR 2023a) provides detailed information on DOE EM cleanup activities.

4.8.1. Environmental Management Activities

At Y-12, DOE EM is working to address excess and contaminated facilities, remove mercury soil and groundwater contamination, and enable

modernization that allows NNSA to continue its crucial national security and nuclear nonproliferation responsibilities.

Biology Complex Site Transferred

EM's steady work removing old, contaminated structures is paving the way for new uses of land, including a site where NNSA recently hosted a groundbreaking ceremony for the new LPF.

The new 245,000-ft^2 facility will feature updated technology, increase processing capacity, and make the work environment safer for employees. Construction is forecasted to begin in mid-2025, with completion projected in the early 2030s.

Work Continues on the Mercury Treatment Facility

In 2023, progress continued on construction of the Outfall 200 Mercury Treatment Facility. The facility is the linchpin for DOE EM's cleanup strategy at Y-12. This vital piece of infrastructure will open the door for demolition of Y-12's large, deteriorated, mercury-contaminated facilities and subsequent soil remediation by providing a mechanism to limit potential mercury releases into the Upper EFPC.

At the headworks site, the first lift concrete walls are complete on both major structures—the storm flow pump station and the grit flow chamber. The second lift walls are being installed with rebar and formwork.

Backfill of the excavation is also in process. A total of 1,800 yards of concrete have been placed, with 200 tons of rebar installed. At the treatment site, work continues with construction of a 500,000-gal equalization tank. All underground piping has been installed and tested. Chemical storage tanks are stored on location, and the clarifier plates are installed. Painting of concrete surfaces and structural steel is progressing.

When operational, the facility will be able to treat 3,000 gal of water per minute and help DOE meet regulatory limits in compliance with EPA and state of Tennessee requirements.

Deactivation Continued on Processing Facilities

Deactivation activities continued at three large former uranium processing facilities throughout FY 2023. Those facilities—Building 9201-02, Building 9201-04, and Building 9204-01—were home to the historic calutron (mass spectrometer) racetracks used for separating isotopes of uranium.

- **Building 9201-02.** The three-story facility is approximately 320,000 gsf. In FY 2023, crews removed a variety of contaminants. Approximately 4,500 gal of water were drained from the facility's demineralized water system, and 280,000 lb of lead-shielding blocks were removed from the second floor of the facility. All deactivation activities were completed in the aboveground floors in 2023. In the basement, workers recovered 113 lb of elemental mercury. The building is set for demolition starting in 2024.
- **Building 9201-04.** During 2023, workers began preparing the four-story facility for deactivation. With 600,000 ft^2, the building one of Y-12's larger high-risk facilities, with elemental mercury contaminating much of the structure. After the electromagnetic separation process was abandoned, column exchange processing structures were added to the outside of the facility to perform a new method of processing, which required substantial quantities of mercury.
- As part of preparing for building deactivation, workers have been sampling asbestos-containing material, performing utility isolations to bring the building to cold and dark status, and characterizing more than 400 legacy drums.
- **Building 9204-01.** Next to Building 9201-02 is a two-story building with approximately 210,500 gsf. Most of the deactivation in the upper floors was completed in 2023, and the small amount remaining will be completed early in FY 2024. In the basement, crews worked to remove, treat, and discharge more than 1 million gal of water using a special water treatment skid system, which filters water through micron bag filters and carbon

vessels inside the unit to achieve the water quality standards needed for discharge. Once the water is removed, the basement can be accessed for deactivation in 2024.

Slab Removal at Demolished Lab Site

Workers have finished removing the slab at the former Criticality Experiment Laboratory at Y-12. DOE EM and UCOR demolished the structure in 2022. The Criticality Experiment Laboratory was constructed in 1949 and was used to conduct experiments and collect reactor physics data from 1950 to 1987. The facility was permanently shut down in 1992, with the exception of limited use for training exercises. The area is planned to be used as a storage/laydown area to support other Y-12 projects.

4.8.2. Waste Management Activities

Waste management is performed at multiple locations on the ORR for both solid and liquid wastes, including landfills and water treatment facilities.

4.8.2.1. CERCLA Waste Disposal

Most of the waste generated during FY 2023 cleanup activities in Oak Ridge went to disposal facilities on the ORR. The Environmental Management Waste Management Facility received 5,221 waste shipments, totaling 41,410 yd^3, from cleanup projects at ETTP, ORNL, and Y-12. This engineered landfill consists of six disposal cells that only accept low-level radioactive and hazardous waste meeting specific criteria. These wastes include soil, dried sludge and sediment, building debris, and personal protective equipment.

4.8.2.2. Solid Waste Disposal

DOE operates and maintains solid waste disposal facilities known as the ORR Landfills. In FY 2023, these three active landfills received 5,767 waste shipments, totaling 79,977 yd^3 of waste.

4.8.2.3. Wastewater Treatment

Safe and compliant treatment of more than 48.5 million gallons of wastewater and groundwater generated from both production and environmental cleanup activities was provided at various facilities during 2023:

- The West End Treatment Facility and the Central Pollution Control Facility processed approximately 267,715 gallons of wastewater, primarily in support of NNSA operational activities.
- The Big Springs Water Treatment System treated more than 31 million gallons of mercury-contaminated groundwater.
- The East End VOC Treatment System treated 12.9 million gallons of VOC-contaminated groundwater.
- The Liquid Storage Facility and Groundwater Treatment Facility treated more than 2.5 million gallons of leachate from burial grounds and well purge waters from remediation areas.
- The Central Mercury Treatment System treated approximately 1.4 million gallons of mercury-contaminated sump waters from Building 9201-04.

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