5. Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) is the largest US Department of Energy (DOE) science and energy laboratory, conducting basic and applied research to deliver transformative solutions to compelling problems in energy and security.

Diverse capabilities at ORNL span a broad range of scientific and engineering disciplines, enabling the exploration of fundamental science challenges and the research needed to accelerate the delivery of solutions to the marketplace. ORNL supports DOE's national missions of scientific discovery, clean energy, and security through four major areas:

- **Neutrons**—The Spallation Neutron Source and the High Flux Isotope Reactor, two of the world's leading neutron sources, are operated at ORNL, enabling scientists and engineers to gain new insights into materials and biological systems.
- **Computing**—ORNL programs accelerate scientific discovery through modeling and simulation on powerful supercomputers and advance data-intensive science and US leadership in high-performance computing.
- **Materials**—Basic research and applied research are integrated at ORNL to develop advanced materials for energy applications.
- **Nuclear**—ORNL programs advance the scientific basis for 21st century nuclear fission and fusion technologies and systems and produce isotopes for research, industry, and medicine.

ORNL is managed by UT-Battelle, LLC, a partnership between the University of Tennessee and Battelle Memorial Institute. Other DOE contractors conducting activities at ORNL in 2015 included Wastren Advantage; North Wind Solutions, LLC; URS | CH2M Oak Ridge LLC; and Isotek Systems LLC. During 2015 activities of these contractors were conducted to comply with contractual and regulatory environmental requirements.

Because of differing permit-reporting requirements and instrument capabilities, various units of measurement are used in this report. The information found in "Units of Measure and Conversion Factors" is intended to help readers convert numeric values presented here as needed for specific calculations and comparisons.

5.1 Description of Site, Missions, and Operations

Oak Ridge National Laboratory (ORNL), which is managed for the US Department of Energy (DOE) by UT-Battelle, LLC, a partnership of the University of Tennessee and Battelle Memorial Institute, lies in the southwest corner of the DOE Oak Ridge Reservation (ORR) (Fig. 5.1) and includes facilities in two valleys (Bethel and Melton) and on Chestnut Ridge. ORNL was established in 1943 as part of the secret Manhattan Project to pioneer a method for producing and separating plutonium. During the 1950s and 1960s, and with the creation of DOE in the 1970s, ORNL became an international center for the study of nuclear energy and related research in the physical and life sciences. By the turn of the century, the laboratory supported the nation with a peacetime science and technology mission that was just as important as, but very different from, the work carried out in the days of the Manhattan Project.

Fig. 5.1. Location of Oak Ridge National Laboratory (ORNL) within the Oak Ridge Reservation and its relationship to other local US Department of Energy facilities.

[ETTP: East Tennessee Technology Park; ORISE: Oak Ridge Institute for Science and Education; Y-12: Y-12 National Security Complex.]

In March 2007, Isotek assumed responsibility for the Building 3019 Complex at ORNL, where the national repository of ^{233}U has been kept since 1962. A letter from the deputy secretary of energy, dated November 24, 2010, directed the conduct of an “alternatives analysis” to determine whether there were more efficient methods available for ^{233}U disposition. In April 2011, the deputy secretary of energy endorsed the recommendations in the *Final Draft ^{233}U Alternatives Analysis Phase I Report* (DOE 2011). The Phase I recommendations included the following: (1) proceed with a direct disposition campaign involving the transfer of Zero Power Reactor (ZPR) plate canisters to the National Nuclear Security Administration (NNSA) for future reuse and disposal of Consolidated Edison Uranium Solidification Project (CEUSP) material canisters at the Nevada National Security Site (NNSS) and (2) conduct a Phase II alternatives analysis to determine the best approach for processing the remaining 50% of the inventory. In December 2011, Isotek initiated transfer of the ZPR plate canisters to the NNSA Critical Safety Program located at the Device Assembly Facility at NNSS. Isotek completed transfer of the ZPR plate canisters in June 2012. In 2013 and 2014, Isotek continued to plan and prepare for future disposition of the remaining ^{233}U inventory. Disposal of the CEUSP material canisters began in 2015.

UT-Battelle provides air and water quality monitoring support for the Building 3019 complex and results are included in the UT-Battelle air and water monitoring discussions in this chapter.

UCOR is the DOE ORR “cleanup contractor.” The scope of UCOR activities at ORNL includes long-term surveillance, maintenance, and management of inactive waste disposal sites, structures, and buildings such as former reactors and isotope production facilities. Other activities include groundwater monitoring, transuranic (TRU) waste storage, and operation of the liquid low-level waste-processing facility.

For most of 2015, the TWPC was managed by Wastren Advantage, Inc., for DOE. On December 11, 2015, North Wind Solutions, LLC (NWSol) became the prime contractor for TWPC, which is located on the western boundary of ORNL on about 26 acres of land adjacent to the Melton Valley Storage Tanks along

State Route 95. TWPC's mission is to receive TRU wastes for processing, treatment, repackaging, and shipment to designated facilities for final disposal. TWPC consists of the waste-processing facility, the personnel building, and numerous support buildings and storage areas. TWPC began processing supernatant liquid from the Melton Valley Storage Tanks in 2002, contact-handled (CH) debris waste in December 2005 and remotely handled (RH) debris waste in May 2008. Based on the definition of TRU waste, some waste being managed as TRU is later determined to be low-level radioactive waste (LLW) or mixed LLW. UT-Battelle provides water quality monitoring for operations at the TWPC, and results are included in water monitoring discussions in this chapter. Air monitoring data from TWPC is provided to UT-Battelle for inclusion in the ORR National Emission Standards for Hazardous Air Pollutants for Radionuclides (Rad-NESHAPs) annual report, and is incorporated into air monitoring discussions in this chapter.

UT-Battelle manages several facilities located off the main ORNL campus for DOE. The Hardin Valley Campus (HVC) is home to the National Transportation Research Center (NTRC) User Facility and the Manufacturing Demonstration Facility (MDF). HVC is located on a 6-acre site owned by Pellissippi Investors, LLC, and is leased to UT-Battelle and the University of Tennessee. More than 85 industry partners work at the HVC to shape America's mobility future; more than 58 cooperative research and development (R&D) agreements are in place.

NTRC is DOE's only user facility dedicated to transportation and serves as the gateway to UT-Battelle's comprehensive capabilities for transportation R&D. Research focuses on fuels and lubricants, engines, emissions, electric drive technologies, lightweight and power-train materials, vehicle systems integration, energy storage and fuel cell technologies, vehicle cyber security, and intelligent transportation systems. Transportation staff have been members of teams that have won 20 R&D 100 awards.

MDF focuses on advanced manufacturing research, including additive manufacturing and carbon fiber composites. The facility also hosts local high school students who are building and analyzing robots in conjunction with FIRST Robotics, a program to inspire students to pursue education and career opportunities in science, technology, engineering, and mathematics.

In 2015, HVC received more than 6,600 visitors. The replica Shelby Cobra whose body and chassis were 3D-printed at MDF was a highlight during a visit from President Obama and Vice President Biden in January (Fig. 5.2). Also in 2015, MDF researchers unveiled the world's largest 3D-printed house and a 3D-printed utility vehicle.

Fig. 5.2. Dr. Lonnie Love discussing the 3D-printed Shelby Cobra with President Obama and Vice President Biden during a visit to the Hardin Valley Campus in January 2015. *[Photo by Techmer.]*

The Carbon Fiber Technology Facility (CFTF), a 42,000 ft^2 innovative technology facility located in the Horizon Center Business Park, in Oak Ridge, Tennessee, offers a flexible, highly instrumented carbon fiber line for demonstrating the scalability of advanced carbon fiber technology and for producing market-development volumes of prototypical carbon fibers (Fig. 5.3). CFTF is the world's most capable open-access facility for the scale-up emerging carbon fiber technology. The cost of carbon fiber material remains relatively high, prohibiting widespread adoption of carbon fiber–containing composite materials in the automotive manufacturing industry, which requires lower commodity pricing. The lower-cost carbon fiber produced at ORNL meets the performance criteria prescribed by some automotive manufacturers for carbon fiber materials for use in high-volume vehicle applications.

Fig. 5.3. Production of lower-cost carbon fiber at the Carbon Fiber Technology Facility.
[Photo by Jason Richards.]

UT-Battelle also manages several buildings and trailers located at the Y-12 National Security Complex (Y-12); the American Museum of Science and Energy; and in the city of Oak Ridge.

5.2 Environmental Management Systems

An important priority for DOE contractors performing management and operations activities at ORNL is the demonstration of environmental excellence through high-level policies that clearly state expectations for continual improvement, pollution prevention, and compliance with regulations and other requirements.

In accordance with DOE O 436.1, *Departmental Sustainability* (DOE 2011a), UT-Battelle, WAI/NWSol, UCOR, and Isotek have implemented Environmental Management Systems (EMSs), modeled after International Organization for Standardization (ISO) 14001:2004 (ISO 2004), to measure, manage, and control environmental impacts. An EMS is a continuing cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals. In September 2015 the revised ISO 14001:2015 standard was issued. The standard allows for a 3-year implementation period, but UT-Battelle plans to re-register to the new standard in 2016.

UT-Battelle's EMS was initially registered to the ISO 14001 standard by a third-party registrar in 2004 and was re-registered in July 2013 by National Sanitation Foundation, International Strategic Registrations, Ltd. (NSF-ISR). No nonconformities were identified during the most recent surveillance audit. Detailed information on the UT-Battelle EMS is provided in Sections 5.2.1 through 5.2.1.6. The Wastren Advantage, Inc./North Wind Solutions, LLC (WAI/NWSol) EMS for activities at TWPC was registered to the ISO 14001:2004 standard by the NSF-ISR in May 2008. NSF-ISR conducted a surveillance audit for the WAI/NWSol EMS program in April 2015; no nonconformities or issues were identified, and several significant practices were noted. Section 5.2.2 describes the WAI/NWsol EMS and associated implementation activities. In June 2009, DOE conducted an external validation audit and concluded "that Isotek has implemented an Environmental Management System (EMS) that is consistent with the requirements of DOE O 450.lA, *Environmental Protection Program*" (DOE 2008). Validation audits were again conducted by DOE in May 2012 and August 2015. Both audits concluded that Isotek's EMS for the U-233 Disposition Project conforms to the ISO 14001:2004 standard. Section 5.2.3 describes the Isotek EMS and associated implementation activities. (The UCOR EMS is discussed in Chapter 3.)

5.2.1 UT-Battelle Environmental Management System

The UT-Battelle EMS is a fully integrated set of environmental management services for UT-Battelle activities and facilities. Services include pollution prevention, waste management, effluent management, regulatory review, reporting, permitting, and other environmental management programs. Through the UT-Battelle Standards-Based Management System (SBMS), the EMS establishes environmental policy and translates environmental laws, applicable DOE orders, and other requirements into laboratory-wide subject area documents (procedures and guidelines). SBMS information is based on an evaluation of external requirements (i.e., DOE directives and federal, state, and local laws), corporate policies, and best management practices that have been determined applicable to UT-Battelle operations and processes. Through environmental protection officers, environmental compliance representatives, and waste services representatives (WSRs), the UT-Battelle EMS assists the line organizations in identifying and addressing environmental issues in accordance with SBMS requirements.

5.2.1.1 Integration with the Integrated Safety Management System

The UT-Battelle EMS and Integrated Safety Management System (ISMS) are integrated to provide a unified strategy for the management of resources, the control and attenuation of risks, and the establishment and achievement of the organization's environmental safety and health (ES&H) goals. Guided by the ISMS and EMS, UT-Battelle strives for continual improvement through "plan-do-check-act" cycles. Under the ISMS, the term "safety" also encompasses ES&H, including pollution prevention, waste minimization, and resource conservation. Therefore, the guiding principles and core functions in the ISMS apply both to the protection of the environment and to safety. Figure 5.4 depicts the relationship between the EMS and the ISMS.

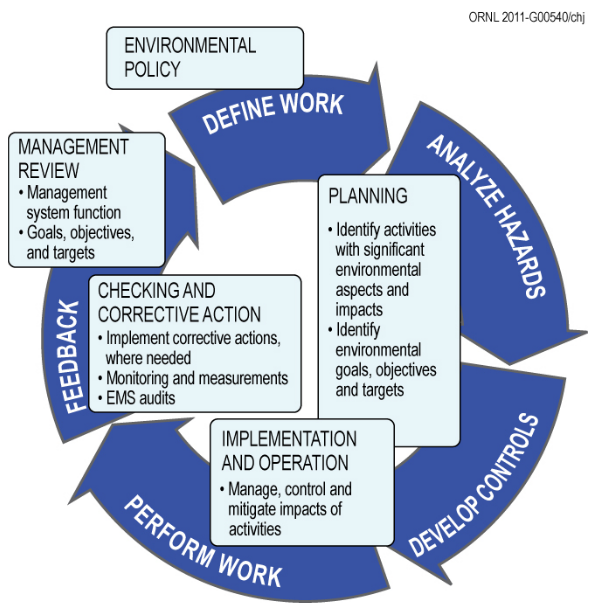

Fig. 5.4. The relationship between the UT-Battelle Environmental Management System and the Integrated Safety Management System.

The UT-Battelle EMS is consistent with the ISMS and includes the following elements:

- environmental policy;
- planning;
- legal and other requirements;
- objectives, targets, and programs;
- implementation and operation;
- resources, roles, responsibility, and authority;
- competence, training, and awareness;
- communication;
- documentation;
- control of documents;
- operational control;
- emergency preparedness and response;
- checking;
- monitoring and measurement;
- evaluation of compliance;
- nonconformity, corrective action, and preventative action;
- control of records;
- internal audit; and
- management review.

5.2.1.2 UT-Battelle Policy for Oak Ridge National Laboratory

The UT-Battelle environmental policy statements (Fig. 5.5) are part of the UT-Battelle Policy for ORNL, which is the highest-level statement of how UT-Battelle conducts business. By clearly stating expectations, the policy provides the framework for setting and reviewing environmental objectives and targets.

ORNL 2015-G00406/chj

Environmental Policy

- Provide and continually improve research, services, products, and management systems of the highest quality consistent with the needs, expectations, risk tolerance, and resources of our customers.
- Provide a safe and healthy workplace by developing and implementing work processes and equipment that abate hazards, operating in a manner that protects and restores the environment, and integrating sustainability (including pollution prevention) into planning and decision-making.
- Comply with applicable requirements for performing work and work-related activities on and off site, including requirements in the ORNL's Standards-Based Management System.
- Systematically integrate environmental, safety, health, quality, and physical and cyber security principles into management and work practices at all levels.
- Communicate appropriate environmental management system information to staff, subcontractors, customers, and other stakeholders.

Fig. 5.5. UT-Battelle environmental policy statements.

5.2.1.3 Planning

5.2.1.3.1 UT-Battelle Environmental Aspects

Environmental aspects are elements of an organization's activities, products, or services that can interact with the environment. Environmental aspects associated with UT-Battelle activities, products, and services have been identified at both the project and activity level. Activities that are relative to any of these aspects are carefully controlled to minimize or eliminate impacts to the environment. The following aspects have been identified as potentially having significant environmental impacts:

- hazardous waste generation;
- radioactive waste generation;
- mixed waste generation;
- energy use/intensity;
- greenhouse gas (GHG) emissions;
- permitted air emissions;
- regulated liquid discharges;
- storage, use, or transportation of chemicals; and
- storage, use, or transportation of radioactive materials.

5.2.1.3.2 UT-Battelle Legal and Other Requirements

Legal and other requirements that apply to the environmental aspects identified by UT-Battelle include federal, state, and local laws and regulations; environmental permits; applicable DOE orders; UT-Battelle contract clauses; waste acceptance criteria; and voluntary requirements such as ISO 14001:2004. UT-Battelle has established procedures to ensure that all applicable requirements are reviewed and that changes and updates are communicated to staff and incorporated into work-planning activities. UT-Battelle's environmental compliance status is discussed in Section 5.3.

5.2.1.3.3 UT-Battelle Objectives and Targets

To improve environmental performance, UT-Battelle has established and implemented objectives, targets, and performance indicators for appropriate functions and activities. In all cases, the objectives, targets, and performance indicators are consistent with the UT-Battelle Policy for ORNL and are supportive of the laboratory mission, and where practical, they are measurable. These objectives and targets are entered into a commitment tracking system and are tracked to completion.

5.2.1.3.4 UT-Battelle Programs

UT-Battelle has established an organizational structure to ensure that environmental stewardship practices are integrated into all facets of UT-Battelle's missions at ORNL. This includes programs led by experts in environmental protection and compliance, energy and resource conservation, pollution prevention, and waste management to ensure that laboratory activities are conducted in accordance with the environmental policy outlined in Fig. 5.5. Information on UT-Battelle's 2015 compliance status, activities, and accomplishments is presented in Section 5.3.

The environmental protection staff provide critical support services in the following areas:

- waste management,
- National Environmental Policy Act (NEPA) compliance,

- air quality compliance,
- water quality compliance,
- US Department of Agriculture (USDA) compliance,
- transportation safety,
- environmental sampling and data evaluation, and
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) interface.

The UT-Battelle staff also include experts who provide critical waste management, transportation, and disposition support services to research, operations, and support divisions:

- pollution prevention staff who manage recycling programs, work with staff to reduce waste generation, and promote sustainable acquisition;

- radiological engineering staff who provide radiological characterization support to generators and WSRs, develop tools to help ensure compliance with facility safety and transportation, and provide packaging support;

- waste acceptance and disposition staff who review and approve waste characterization methods, accept waste from generator areas into Transportation and Waste Management Division storage areas, review waste disposal paperwork to ensure compliance with the disposal facility's waste acceptance criteria, and certify waste packages;

- WSRs who provide technical support to waste generators to properly manage waste by assisting in identifying, characterizing, packaging, and certifying wastes for disposal;

- the waste-handling team, which performs waste-packing operations and conducts inspections of waste items, areas, and containers;

- the waste acceptance and disposition team, which coordinates off-site disposition of UT-Battelle's newly generated waste;

- the transportation management team, which ensures that both the on-site and off-site packaging and transportation activities are performed in an efficient and compliant manner; and

- the hazardous material spill response team, which is the first line of response to hazardous materials spills at ORNL and controls and contains spills until the situation is stabilized.

5.2.1.4 UT-Battelle Sustainable Campus Initiative

The Sustainable Campus Initiative is an ORNL-wide effort that builds upon the laboratory's strength as a premier science and technology organization in integrating energy efficiency, cutting-edge technologies, and operational and business processes to achieve sustainability. The ultimate goal is to achieve benchmark sustainability in campus operation and in the research, development, and deployment of key technologies by 2025.

Table 5.1 summarizes FY 2015 performance and planned actions to achieve future sustainability goals. Detailed information can be found in *The Site Sustainability Plan for the Oak Ridge National Laboratory* (ORNL 2015) (http://sustainability-ornl.org/Documents/2015%20SSP%2011-24-15.pdf).

Table 5.1. Table of UT-Battelle Attainment of DOE Sustainability Goalsa

SSPP Goal #	DOE Goal	Performance Status through FY 2015	Planned Actions & Contribution
1.1	50% Scope 1 & 2 GHG reduction by FY 2025 from a FY 2008 baseline (2015 target: 19%).	**Scope 1** estimate is 65,388 $MTCO_2e$, a decrease of 27% from FY 2008. **Scope 2** estimate is 330,465 $MTCO_2e$, an increase of 33% from FY 2008 after purchased RECs. **Scope 1 & 2** combined estimate is 395,853 $MTCO_2e$, an increase of 17% from the baseline year of FY 2008.	**Scope 1** reductions are on target due to ECM efforts, ESPC implementation, the new steam plant system, and SF_6 process reductions. **Scope 2** reductions represent a substantial challenge due to growth in electricity demands for mission-critical facilities (HEMSFs). REC purchases and innovative technologies will be used to meet the goal by the target year.
1.2	25% Scope 3 GHG reduction by FY 2025 from a FY 2008 baseline (2015 target: 6%).	Scope 3 estimate is 44,440 $MTCO_2e$. Overall Scope 3 emissions have increased by 8%. Increased electricity consumption and a 33% increase in T&D losses limits the overall performance. A new electricity sub-station was commissioned on site in FY 2015.	Continuing focus on employee engagement areas such as responsible business travel (videoconferencing when possible), employee commutes, and telework programs will ensure progress toward Scope 3 reductions. T&D losses will grow along with purchased electricity. As with Scope 2, REC purchases will also produce credits to offset Scope 3 emissions by the target year.
2.1	25% energy intensity (Btu/GSF) reduction by FY 2025 from a FY 2015 baseline in goal subject buildings (2.5% reduction per year).	FY 2015 objective was to establish the energy intensity baseline. ORNL has calculated the new baseline at 265,326 Btu/GSF.	Ongoing process of energy audits will identify additional energy conservation projects to achieve the annual 2.5% reduction and the new FY 2025 goal of 25%.
2.2	EISA Section 432 energy and water evaluations.	Over 3.9% evaluated during this third year of the current four-year cycle.	Continue pace of 25% or more through current cycle (end of FY 2016). Leverage knowledge from previous cycles to conduct focused evaluations.
2.3	Meter all buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate.	The ORNL updated Metering Plan has been completed.	Continued implementation of metering plan will allow progress toward building level metering of all commodities.
2.4	At least 15% (by building count or GSF) of existing buildings greater than 5,000 GSF to be compliant with the revised Guiding Principles for HPSB by FY 2025, with progress to 100% thereafter.	ORNL has established an HPSB inventory of 25 buildings, exceeding the 15% goal.	Efforts will continue toward expanding the existing HPSB inventory.

Table 5.1 (continued)

SSPP Goal #	DOE Goal	Performance Status through FY 2015	Planned Actions & Contribution
2.5	Efforts to increase regional and local planning coordination and involvement.	Progress documented in Section 2.5 of the *Site Sustainability Plan.*	Continued participation in local and regional transportation and sustainability organizations.
2.6a	Net Zero Buildings: Percentage of the site's existing buildings (>5,000 GSF) intended to be energy, waste, or water net-zero buildings by FY 2025.	Progress documented in Section 2.6a of the *Site Sustainability Plan.*	See details in Section 2.6a of the *Site Sustainability Plan.*
2.6b	Net Zero Buildings: Percentage of new buildings (>5,000 GSF) entering the planning process designed to achieve energy net-zero beginning in FY 2020.	Progress documented in (Section 2.6b of the *Site Sustainability Plan*).	See details in Section 2.6b of the *Site Sustainability Plan.*
2.7	Data Center Efficiency. Establish a power usage effectiveness target in the range of 1.2 to 1.4 for new data centers and less than 1.5 for existing data centers.	In FY 2015 ORNL Data Centers experienced a portfolio average PUE of 1.28, exceeding the goal of 1.5.	Continue to optimize systems to meet or exceed goals. Engineering staff have identified several areas in which to pursue additional energy savings.
3.1	"Clean Energy" requires that the percentage of an agency's total electric and thermal energy accounted for by renewable and alternative energy shall be not less than: 10% in FY 2016–2017, working towards 25% by FY 2025.	The purchase of RECs for the Renewable Energy Target results in achieving a benchmark of 8% of the Clean Energy Target, as it readies to meet the targets in future years.	Purchase additional RECs, beyond the Renewable Energy Target, to meet and/or exceed the Clean Energy interim target of 10% in FY 2016.
3.2	"Renewable Electric Energy" requires that renewable electric energy account for not less than 10% of a total agency electric consumption in FY16–17, working towards 30% of total agency electric consumption by FY 2025.	ORNL has purchased RECs to supplement on-site renewable energy generation to achieve 11.2% of electrical energy to be from renewable resources, exceeding the interim 7.5% goal.	Purchase sufficient RECs to offset the on-site renewable energy generation and the TVA Southeastern Pilot Program RECs to meet and/or exceed the interim goal in FY 2016.
4.1	36% potable water intensity (Gal/GSF) reduction by FY 2025 from a FY 2007 baseline (2015 target: 16%).	Water use intensity measured 132 gal/GSF in FY 2015 (a reduction of 25% to date, exceeding the interim goal).	Continue to evaluate water conservation opportunities and to identify and repair leaks on an aging distribution system.
4.2	30% water consumption (gal) reduction of industrial, landscaping, and agricultural water by FY 2025 from a FY 2010 baseline (2015 target: 10%).	No ILA water use at ORNL.	No ILA water use at ORNL.

Table 5.1 (continued)

SSPP Goal #	DOE Goal	Performance Status through FY 2015	Planned Actions & Contribution
5.1	20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter. (2015 target: 20%).	In FY 2015 ORNL achieved a 57% reduction in cumulative petroleum consumption relative to the FY 2005 baseline, exceeding the DOE target.	Continue to use alternative fuel and continue to educate drivers about the importance of using alternative fuels in flex fuel vehicles to meet new Executive Order (EO) 13693.
5.2	10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter. (2015 target: 10%).	In FY 2015 ORNL achieved a 227% increase in cumulative alternative fuel consumption relative to the FY 2005 baseline, exceeding the DOE target of 160%.	Continue to use alternative fuel. Continue to ensure that biodiesel quality is maintained.
5.3	30% reduction in fleet-wide per-mile GHG emissions reduction by FY 2025 from a FY 2014 baseline. (2015 target: N/A; 2017 target: 4%).	Determine the 2014 GHG baseline for ORNL using final guidance and data to be provided by DOE (FEMP).	ORNL plans to support the GHG emission initiative through purchasing PHEVs.
5.4	75% of light duty vehicle acquisitions must consist of alternative fuel vehicles (AFV). (2015 target: 75%).	100% of the light duty vehicles purchased in FY 2015 were AFVs.	Continue to purchase AFVs from General Services Administration schedules as funds and approvals are provided.
5.5	50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025. (2015 target: N/A).	Not applicable for FY 2015. Note: ORNL has purchased 3 PHEVs and has EV charging infrastructure in place on campus and satellite locations (44 charging stations).	Prepare for new FY 2025 targets and other new EO and DOE directives
6.1	Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in 95% of applicable contracts.	100% of all applicable contracts in FY 2015 contained terms and conditions that invoke requirements for sustainable acquisitions.	As indicated in EO 13693, three FAR clauses will be added to the standard Commercial Items Terms and Conditions contracts beginning in January, 2016.
7.1	Divert at least 50% of nonhazardous solid waste, excluding construction and demolition debris.	A 49% diversion rate was achieved in FY 2015. While less than the target, this represents a significant improvement in the past year.	Continue mitigation measures and process improvements to close the gap for this goal in FY 2016 and beyond.
7.2	Divert at least 50% of construction and demolition materials and debris.	ORNL's diversion rate for construction and demolition debris for FY 2015 is 88%, exceeding the target.	Continue process improvements. Additional focus will be placed on segregation of waste.

Table 5.1 (continued)

SSPP Goal #	DOE Goal	Performance Status through FY 2015	Planned Actions & Contribution
8.1	Annual targets for performance contracting to be implemented in FY 2017 and annually thereafter as part of the planning of section 14 of EO 13693.	Progress documented in Section 8.1 of the *Site Sustainability Plan*.	Existing ESPC in place with JCI through FY 2031.
9.1	Purchases—95% of eligible acquisitions each year are EPEAT-registered products.	Exceeded the 95% goal in FY 2015.	Continue with guided procurement to assure compliance. Closely monitor nonstandard requests for electronic requisitions.
9.2	Power management—100% of eligible PCs, laptops, and monitors have power management enabled.	100% of eligible computers, monitors, and laptops are being actively power managed.	Continue to actively ensure all eligible computing equipment is power managed.
9.3	Automatic duplexing—100% of eligible computers and imaging equipment have automatic duplexing enabled.	Successful implementation of program to ensure all new print services include automatic duplexing set as default.	Update print management documents and strategy with respect to the DOE *Sustainable Print Management Guide* once the guide is finalized.
9.4	End of Life—100% of used electronics are reused or recycled using environmentally sound disposition options each year.	100% of dispositioned electronics equipment is reused or recycled using CFL and R2 certified reuse/recycle practices.	Continue to dispose of electronics equipment using CFL and R2 certified reuse/recycle practices.
10.1	Update policies to incentivize planning for and addressing the impacts of climate change.	See details in Section 10.1 of the *Site Sustainability Plan.*	CCR Team continues to review, update, and implement policies as needed.
10.2	Update emergency response procedures and protocols to account for projected climate change, including extreme weather events.	See details in Section 10.2 of the *Site Sustainability Plan.*	CCR Team working directly with subject matter experts to ensure that procedures and protocols are reviewed and updated as needed.
10.3	Ensure that workforce protocols and policies reflect projected human health and safety impacts of climate change.	See details in Section 10.3 of the *Site Sustainability Plan.*	CCR Team working directly with subject matter experts to ensure that procedures and protocols are reviewed and updated as needed.
10.4	Ensure that site/lab management demonstrates commitment to adaptation efforts through internal communications and policies.	See details in Section 10.4 of the of the *Site Sustainability Plan.*	ORNL management continues to be engaged and to communicate policy updates.
10.5	Ensure that site/lab climate adaptation and resilience policies and programs reflect best available current climate change science, updated as necessary.	See details in Section 10.5 of the *Site Sustainability Plan.*	Ongoing process for the CCR Team and subject matter experts

Table 5.1 (continued)

[a] *Source*: Adapted from the executive summary table in *Site Sustainability Plan with FY 2015 Performance Data*, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 2015 (http://sustainability-ornl.org/Documents/2015%20SSP%2011-24-15.pdf).

Acronyms:

AFV	alternative fuel vehicle
Btu	British thermal unit
C&D	construction and demolition
CCR	Climate Change Resiliency (team)
CFL	Computers for Learning
CO_2e	carbon dioxide equivalent
DOE	US Department of Energy
ECM	energy conservation measure
EISA	Energy Independence and Security Act
EPEAT	Electronic Product Environmental Assessment Tool
ESPC	Energy Savings Performance Contract
EV	electric vehicle
FAR	federal acquisition regulation
FEMP	Federal Energy Management Program
FY	fiscal year
GAL	gallon
GHG	greenhouse gas
GP	guiding principle
GSA	General Services Administration
GSF	gross square feet
HEMSF	high-energy, mission-specific facility
HPSB	High Performance Sustainable Buildings
ILA	industrial, landscaping, and agricultural
JCI	Johnson Controls, Inc.
LEED	Leadership in Energy and Environmental Design
MWh	megawatt-hour
$MTCO_2e$	metric ton carbon dioxide equivalent
ORNL	Oak Ridge National Laboratory
PC	personal computer
PHEV	plug-in hybrid electric vehicle
PUE	power usage effectiveness
R2	responsible recycling
REC	renewable energy credit (also, renewable energy certificate)
SSPP	Strategic Sustainability Performance Plan (DOE)
T&D	transmission and distribution
TVA	Tennessee Valley Authority

5.2.1.4.1 Pollution Prevention and Waste Reduction

UT-Battelle implemented 35 new pollution prevention projects at ORNL during 2015, eliminating more than 5.5 million kg of waste. In total, these projects and ongoing reuse/recycle projects led to cost savings/avoidance of more than $3.2 million. Source reduction actions pursued in 2015 included moving toward paperless work processes; resource-efficient computing; and recycling efforts for paper, scrap metal, lead, ballasts, drums, electronics, and construction and demolition (C&D) debris. Fig 5.6 summarizes recycling results for 2015.

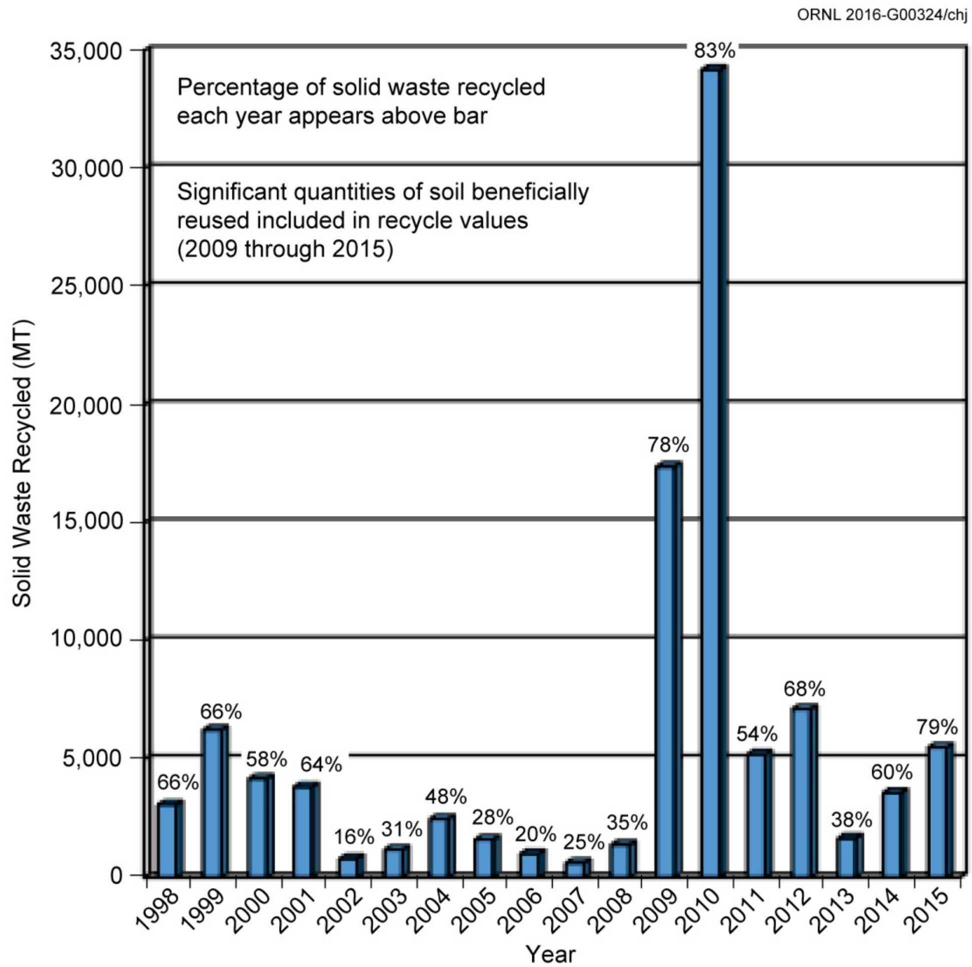

Fig. 5.6. Solid waste recycled at Oak Ridge National Laboratory as a result of recycling programs through 2015.

Oak Ridge National Laboratory Pollution Prevention/Sustainability Awards

- 2014 Clean Cities Coalition Davy Crockett Volunteer Leadership Award—awarded from DOE Clean Cities program in 2015 to recognize ORNL as a leader in alternative fuel use in the southeast and for alternative fuel use, sustainable transportation research, and public engagement among national labs.
- DOE 2015 DOE Earth Day Photo Contest—sustainability category winner for “Pull Horse Tilling—Sustainable Farming.”

- 2015 Sustainable Transportation Award—ORNL's on-site electric vehicle charging project cited by Tennessee Department of Environment and Conservation (TDEC) in conjunction with Clean Air Month at the 2015 inaugural Sustainable Transportation Awards.

- *R&D Magazine* R&D 100 Awards:

  - Top R&D technology product of the year in the Process/Prototype category awarded to UT-Battelle and Cincinnati Incorporated for the Big Area Additive Manufacturing System (a large-scale additive manufacturing system) (Fig. 5.7). The team also earned the *R&D Magazine's* 2015 Editor's Choice Award.

  - Award to researchers from ORNL and United Protective Technologies for development of a multifunctional superhydrophobic transparent glass coating.

  - Award received by a team of UT-Battelle researchers for development of a porous graphene desalination membrane.

Fig. 5.7. In 2015, UT-Battelle and Cincinnati Incorporated won an R&D 100 Award for the Big Area Additive Manufacturing System. *[Photo by Carlos Jones].*

5.2.1.4.2 Storm Water Management and the Energy Independence and Security Act of 2007

Section 438 of the Energy Independence and Security Act of 2007 (EISA 2007) stipulates the following: "The sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow."

For the purposes of this provision, "development or redevelopment is defined as "any action that results in the alteration of the landscape during construction of buildings or other infrastructure such as parking lots, roads, etc. (e.g., grading, removal of vegetation, soil compaction) such that the changes affect runoff volumes, rates, temperature, and duration of flow. Examples of projects that would fall under 'redevelopment' include structures or other infrastructure that are being reconstructed or replaced and the landscape is altered. Typical patching or resurfacing of parking lots or other travel areas would not fall under this requirement" (EISA 2007).

Strategic plans for demolition and renovation of old facilities and construction of new facilities at ORNL incorporate green infrastructure and low-impact development (GI/LID) practices to infiltrate, evapotranspire, and/or harvest and use storm water on site to the maximum extent feasible. GI/LID approaches and technologies have been used to mimic the natural hydrologic cycle processes of infiltration, evapotranspiration, and use. GI/LID practices that have been incorporated at ORNL include the following.

- trees and tree boxes,
- rain gardens,
- vegetated swales,
- pocket wetlands,
- infiltration planters,
- porous and permeable pavements,
- vegetated median strips,
- reforestation and revegetation,
- protection of riparian buffers and floodplains,
- retention ponds, and
- water reuse (e.g., tanks in restrooms to collect water for reuse in irrigation).

At ORNL, a three-step approach is used to evaluate and satisfy the requirements of EISA Section 438. Evaluation occurs

1. within the project boundaries. If the necessary volume of runoff cannot be infiltrated or retained on-site, then

2. on land immediately adjacent to the project boundaries. If the necessary volume of runoff cannot be infiltrated or retained on land immediately adjacent to the project boundaries, then

3. within the same valley or ridge area (e.g., within Bethel Valley if the project is within Bethel Valley; within Melton Valley if the project is within Melton Valley).

In addition to GI/LID practices, the projects may remove impervious areas and reestablish pervious areas to allow infiltration or evapotranspiration to occur.

5.2.1.5 Emergency Preparedness and Response

The UT-Battelle Emergency Management Program supplies the resources and capabilities to provide emergency preparedness services and, in the event of an accident, emergency response services. Emergency preparedness personnel perform hazard surveys and hazard assessments to identify potential emergency situations. Procedures and plans have been developed to prepare for and respond to a wide variety of potential emergency situations. Training is provided to ensure appropriate response and performance during emergency events. Frequent exercises and drills are scheduled to ensure the effective performance of the procedures and plans. An environmental subject matter expert is a member of the emergency response team and participates in drills and exercises to ensure that environmental requirements are met and that environmental impacts from the event (and the response) are mitigated.

5.2.1.6 Checking

5.2.1.6.1 Monitoring and Measurement

UT-Battelle has developed monitoring and measurement processes for each operation or activity that can have a significant adverse effect on the environment. Several SBMS subject areas include requirements for managers to establish performance objectives, indicators, and targets; conduct performance assessments to collect data and monitor progress; and evaluate the data to identify strengths and weaknesses in performance and areas for improvement.

5.2.1.6.2 Environmental Management System Assessments

UT-Battelle uses several methods to evaluate compliance with legal and other environmental requirements. Most of the compliance evaluation activities are implemented through the EMS or are a part of line-organization assessment activities. If a nonconformance were identified, the ORNL issues-management process requires that any regulatory or management system nonconformance be reviewed for cause and that corrective and/or preventive actions be developed. These actions are then implemented and tracked to completion.

Environmental assessments that cover both legal and other requirements are performed periodically. Additionally, management system owners are required to assess management system performance and address issues identified from customer feedback, staff suggestions, and other assessment activities.

UT-Battelle also uses the results from numerous external compliance inspections conducted by regulators to verify compliance with requirements. In addition to regulatory compliance assessments, there are internal and external EMS assessments performed annually to ensure that the UT-Battelle EMS continues to conform to ISO requirements. An internal audit and an external surveillance audit conducted in 2015 verified that the EMS continued to conform to ISO 14001:2004. In addition to verifying conformance, these management system assessments also identify continual improvement opportunities.

5.2.2 Environmental Management System for the Transuranic Waste Processing Center

NSF-ISR registered the WAI/NWSol EMS for activities at TWPC to the ISO 14001:2004 Standard in May 2008 and is integrated with ISMS to provide a unified strategy for the management of resources, the control and reduction of risks, and the establishment and achievement of the organization's ES&H goals. EMS and ISMS are incorporated into the *Integrated Safety Management System Description* (BJC 2009) and in a "plan-do-check-act" cycle is used for continual improvement in both. NSF-ISR conducted a recertification audit in April 2014 and a surveillance audit in April 2015. No nonconformances or issues were identified, and several significant practices were noted.

The NWSol EMS incorporates applicable environmental laws, DOE orders, and other requirements (i.e., DOE directives and federal, state, and local laws) through NWSol's regulatory management plan (NWSol 2015), which dictates how the various requirements are incorporated into subject area documents (procedures and guidelines). The EMS assists NWSol line organizations in identifying and addressing environmental issues.

Environmental aspects are elements of an organization's activities, products, or services that can interact with the environment. NWSol has identified environmental aspects associated with TWPC activities, products, and services at both the project and activity level and has identified waste management activities, air emissions, storm water contamination, pollution prevention, habitat alteration, and energy consumption as potentially having significant environmental impacts. Activities that are relative to any of those aspects are carefully controlled to minimize or eliminate impacts to the environment.

NWSol has established and implemented objectives and measurable performance indicators for the targets associated with the identified significant impacts.

The pollution prevention programs at TWPC involve waste reduction efforts and implementation of sustainable practices that reduce the environmental impacts of the activities conducted at TWPC. The NWSol EMS establishes annual goals and targets to reduce the impact of TWPC's environmental aspects.

NWSol has a well-established recycling program at TWPC and continues to identify new material-recycling streams and to expand the types of materials included in the program. Currently, recycle streams at TWPC range from office materials such as paper, aluminum cans, plastic drinking bottles, Styrofoam cups, alkaline batteries, and toner cartridges to operations-oriented materials such as scrap metal, cardboard, construction debris, and batteries. NWSol has established a "single stream" recycling program that allows the mixing of multiple types of recyclables that increases the population of recyclable items and improves compliance. A construction debris recycling program began in September 2011 and has resulted in about 172 tons being diverted from the landfill to date.

"Environmentally preferable purchasing" is a term used to describe an organization's policy to reduce packaging and to purchase products made with recycled material or biobased materials and other environmentally friendly products. NWSol ensures that environmentally preferable products are purchased by incorporating the green procurement requirements in NWSol procurement procedures.

Several methods are used by NWSol to evaluate compliance with legal and other requirements. Most of these compliance evaluation activities are implemented by internal and external environmental and management assessment activities and routine reporting and reviews. NWSol also uses the results from numerous external compliance inspections conducted by regulators and contractors to verify compliance with requirements.

5.2.3 Environmental Management System for Isotek

Isotek has developed and implemented an EMS for the U-233 Disposition Project that reflects the elements and framework found in the ISO14001:2004 standard and that satisfies the applicable requirements of DOE O 450.1A, *Environmental Protection Program* (DOE 2008). The scope of the Isotek EMS is to achieve and demonstrate environmental excellence by identifying, assessing, and controlling the impact of Isotek activities and facilities on the environment. The EMS is designed to ensure compliance with environmental laws, regulations, and other applicable requirements and to improve effectiveness and efficiency, reduce costs, and earn and retain regulator and community trust. The Isotek EMS and ISMS are fully integrated.

Project procedures provide a systematic approach to integrating environmental considerations into all aspects of Isotek's activities at ORNL. The Isotek EMS includes a procedure for identifying environmental aspects associated with the U-233 Disposition Project and for determining whether those aspects can have significant environmental impacts. Isotek has identified radiological air emissions as the only environmental aspect of its operations that has potentially significant environmental impacts and has developed an environmental management plan with measurable objectives and targets to address that aspect. Isotek reviews environmental aspects, potential impacts, objectives, targets, and environmental management plans at least annually and updates them as necessary.

The U-233 Disposition Project has a well-established recycling program that is implemented at all Isotek facilities and includes Buildings 3017 and 3019 at ORNL and an off-site administrative office in Oak Ridge. The materials currently recycled by Isotek include paper, cardboard, aluminum cans, plastic bottles, inkjet and toner cartridges, lamps, batteries, scrap metal, circuit boards, aerosol cans, and used oil.

To evaluate compliance with legal and other requirements, Isotek conducts an EMS audit every 3 years, annual management assessments, and periodic surveillances. Compliance with requirements is also evaluated through inspections performed by regulatory agencies. The results of the compliance evaluations are used for continual improvement of the EMS.

5.3 Compliance Programs and Status

During 2015 UT-Battelle, UCOR, WAI/NWSol, and Isotek operations were conducted to comply with contractual and regulatory environmental requirements. A notice of violation (NOV) issued to UT-Battelle by TDEC was received on January 20, 2015, for failure to include two emergency generators in a timely manner in the ORNL site air permit. This was self-reported to TDEC on November 11, 2014 and the omission has since been corrected. The two generators are now included in a permit issued January 23, 2015.

Table 5.2 presents a summary of environmental audits conducted at ORNL in 2015.

The following discussions summarize the major environmental programs and activities carried out at ORNL during 2015 and provide an overview of the compliance status for the year.

Table 5.2. Summary of regulatory environmental audits, evaluations, inspections, and assessments conducted at Oak Ridge National Laboratory, 2015

Date	Reviewer	Subject	Issues
January 14	TDEC	Annual CAA Inspection for ORNL and CFTF	0
February 19	City of Oak Ridge	CFTF Wastewater Inspection	0
April 27 - 29	TDEC	Annual RCRA Inspection for ORNL (including TWPC)	1
April 29	1916-T2 Warehouse	1916-T2 Warehouse RCRA Inspection	0
August 3	City of Oak Ridge	CFTF Wastewater Inspection	0
October 21–22	TDEC	Annual CAA Inspection for ORNL and CFTF	0
October 28–29	City of Oak Ridge	CFTF Wastewater Inspection	0

Acronyms
CAA = Clean Air Act
CFTF = Carbon Fiber Technology Facility
ORNL = Oak Ridge National Laboratory
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation
TWPC = Transuranic Waste Processing Center

5.3.1 Environmental Permits

Table 5.3 contains a list of environmental permits that were in effect in 2015 at ORNL.

Table 5.3. Oak Ridge National Laboratory environmental permits, 2015

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Title V Major Source Operating Permit, ORNL	562765	08-16-11	08-15-16	DOE	UT-B	UT-B
CAA	Construction Permit, CFTF facility (located near ETTP) [a]	965013P	03-27-12	11-01-14[b]	DOE	UT-B	UT-B
CAA	Construction Permit, CFTF emergency generator	967180P	03/07/14	03-06-15 [b]	DOE	UT-B	UT-B
CAA	Construction Permit, Steam Plant boilers 7–9	969317F	01/07/15	01/06/16	DOE	UT-B	UT-B
CAA	Operating Permit, NTRC	0941-05[b]	10-23-12	Annually[b]	DOE	UT-B	UT-B
CAA	Operating Permit, WAI/NWSol	063331P	03-07-12	03-01-22	DOE	WAI/NWSol	WAI/NWSol
CAA	Operating Permit, WAI/NWSol emergency generator	068459P	04-14-14	10-01-23	DOE	WAI/NWSol	WAI/NWSol
CAA	Title V Major Source Operating Permit, ORNL	569768	09-18-15	09-17-20	DOE	UCOR	UCOR
CAA	Title V Major Source Operating Permit, Isotek	568276	10-06-14	10-05-19	DOE	Isotek	Isotek
CWA	ORNL NPDES Permit (ORNL sitewide wastewater discharge permit)	TN0002941	03-01-14	10-31-18	DOE	DOE	UT-B, UCOR, WAI/NWSol
CWA	Tennessee General NPDES Permit TNR10-0000, Storm Water Discharges from Construction Activities—Spallation Neutron Source	TNR139975	10-10-00	05-23-16	DOE	DOE	UT-B
CWA	Tennessee General NPDES Permit TNR10-0000, Storm Water Discharges from Construction Activities—7018 Renovations/Additions (2.81 acres)	TNR134552	08-05-14	05-23-16	DOE	DOE	UT-B
CWA	Industrial and Commercial User Waste Water Discharge Permit (CFTF)	1-12	10-15-12	03-31-15	UT-B	UT-B	UT-B
CWA	Tennessee General NPDES Permit TNR10-0000, Storm Water Discharges from Construction Activities—Pro2Serve National Security Engineering Center		10-06	NA	DOE	DOE	CROET
CWA	Tennessee Operating Permit, Holding Tank/Haul System for Domestic Wastewater	SOP-07014	06-01-12	04-30-17	UCOR	UCOR	UCOR
CWA	Tennessee Operating Permit (sewage)	SOP-02056	02-01-13	12-31-17	DOE	WAI/NWSol	WAI/NWSol
CWA	Tennessee General NPDES Permit TNR10-0000, Storm Water Discharges from Construction Activity—Site Expansion Project	TNR 133560	08-31-09	NA	DOE	WAI/NWSol	WAI/NWSol
CWA	ARAP for ORNL East Campus Pond Replacement	ARAP NR1403.060	05-06-14	06-30-15	DOE	UT-B	UT-B
RCRA	Hazardous Waste Transporter Permit	TN1890090003	01-12-15	01-31-16	DOE	DOE	UT-B, UCOR

Table 5.3 (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
RCRA	Hazardous Waste Corrective Action Permit	TNHW-121	09-28-04	09-28-14[c]	DOE	DOE/all[d]	DOE/all
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-134	09-26-08	09-26-18	DOE	DOE/UT-B	UT-B
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-145	02-03-10	02-03-20	DOE	DOE/ UCOR/ WAI/NWSol	UCOR/ WAI/NWSol

[a]Permit issued by Knox County Department of Air Quality Management.
[b]Continued construction/operation under an expired permit is allowed under air pollution control regulations when timely renewal or construction permit applications are submitted.
[c] On September 15, 2015, the ORR Hazardous Waste Corrective Action Permit TNHW-121 was reissued as TNHW-164.
[d]DOE and Oak Ridge Reservation contractors are co-operators of hazardous waste permits.

Acronyms

ARAP = Aquatic Resource Alteration Permit
CAA = Clean Air Act
CFTF = Carbon Fiber Technology Facility
CROET = Community Reuse Organization of East Tennessee
CWA = Clean Water Act
DOE = US Department of Energy
ETTP = East Tennessee Technology Park
Isotek = Isotek Systems LLC
NPDES = National Pollutant Discharge Elimination System
NTRC = National Transportation Research Center
NWSol=North Wind Solutions, LLC
ORNL = Oak Ridge National Laboratory
RCRA = Resource Conservation and Recovery Act
UCOR = URS | CH2M Oak Ridge LLC
UT-B = UT-Battelle, LLC
WAI = Wastren Advantage, Inc.

5.3.2 National Environmental Policy Act/National Historic Preservation Act

NEPA provides a means to evaluate the potential environmental impact of proposed federal activities and to examine alternatives to those actions. UT-Battelle, WAI/NWSol, and Isotek maintain compliance with NEPA through the use of site-level procedures and program descriptions that establish effective and responsive communications with program managers and project engineers to establish NEPA as a key consideration in the formative stages of project planning. Table 5.4 summarizes NEPA activities conducted at ORNL during 2015.

Table 5.4. National Environmental Policy Act activities, 2015

Types of NEPA documentation	Number of instances
Oak Ridge National Laboratory	
Approved under general actions or generic CX determinations[a]	86
Project-specific CX determinations[b]	3
Wastren Advantage, Inc./North Wind Solutions	
Approved under general actions[a] or generic CX determinations	1

[a]Projects that were reviewed and documented through the site NEPA compliance coordinator.
[b]Projects that were reviewed and approved through the DOE Site Office and NEPA compliance officer.

Acronyms
CX = categorical exclusion
NEPA = National Environmental Policy Act

During 2015, UT-Battelle and WAI/NWSol continued to operate under site-level procedures that provide requirements for project reviews and NEPA compliance. The procedures call for a review of each proposed project, activity, or facility to determine the potential for impacts to the environment. To streamline the NEPA review and documentation process, the DOE Oak Ridge Office has approved generic categorical exclusion (CX) determinations that cover proposed bench- and pilot-scale research activities and generic CXs that cover proposed nonresearch activities (e.g., maintenance activities, facilities upgrades, personnel safety enhancements). A CX is one of a category of actions defined in 40 CFR 1508.4 that does not individually or cumulatively have a significant effect on the human environment and for which neither an environmental assessment nor an environmental impact statement is normally required.

UT-Battelle uses SBMS as the delivery system to manage and control work at ORNL. NEPA is an integral part of SBMS, and a UT-Battelle NEPA coordinator works with principal investigators, environmental compliance representatives, and environmental protection officers within each UT-Battelle division to determine appropriate NEPA decisions.

Compliance with the National Historic Protection Act at ORNL is achieved and maintained in conjunction with NEPA compliance. The scope of proposed actions is reviewed in accordance with the ORR cultural resource management plan (Souza et al. 2001).

5.3.3 Clean Air Act Compliance Status

The Clean Air Act (CAA), passed in 1970 and amended in 1977 and 1990, forms the basis for the national air pollution control effort. This legislation established comprehensive federal and state regulations to limit air emissions. It includes four major regulatory programs: the national ambient air quality standards, state implementation plans, new source performance standards, and NESHAPs. Airborne discharges from DOE Oak Ridge facilities, both radioactive and nonradioactive, are subject to regulation by EPA and the TDEC Division of Air Pollution Control. The sitewide UT-Battelle Title V Major Source Operating Permit, renewed in 2011, was modified one time in 2015 to keep current with the latest UT-Battelle operating status. Three additional modification requests submitted to TDEC in 2015 will likely be finalized in conjunction with the next Title V permit renewal by TDEC. The renewal application is due in early 2016. The Title V Major Source Operating Permit for the 3039 stack, operated by UCOR, was renewed in 2015. To demonstrate compliance with the Title V Major Source Operating Permits, more than 1,500 data points are collected and reported every year. In addition, nitrogen oxides (NO_X), a family of poisonous, highly reactive gases and defined collectively as a criteria pollutant by the EPA (EPA 2016), is monitored continuously at one location. Samples are collected continuously from 9 major radionuclide sources and periodically from 15 minor radionuclide sources; and there are numerous other demonstrations of compliance with generally applicable air quality protection requirements (e.g., asbestos, stratospheric ozone). NTRC and CFTF are two off-site CAA-regulated facilities maintained and operated by UT-Battelle. A minor-source operating permit issued by Knox County Air Quality Management for NTRC was cancelled in 2015 because the source had been reclassified as insignificant and no longer needed a permit. A separate permit to be issued by Knox County for an emergency generator located at NTRC was pending at the end of 2015. The CFTF operates under two construction permits issued by TDEC. A permit application to convert them to a true minor operating air permit was submitted in 2015.

In summary, there was one UT-Battelle CAA violation and no Isotek, UCOR, or WAI/NWSol CAA violations or exceedances in 2015. The one violation was for failure to permit two emergency generators in a timely manner. The two generators were inadvertently omitted from an application submitted previously. The permit for the two generators was issued by TDEC on January 23, 2015. An NOV issued by TDEC in 2014 was amended in early 2015 to include an additional building that was demolished without prior notification to TDEC.. Section 5.4 provides detailed information on 2015 activities conducted by UT-Battelle in support of the CAA.

5.3.4 Clean Water Act Compliance Status

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

In 2015, compliance with the ORNL NPDES permit was determined by about 2,300 laboratory analyses and field measurements. The NPDES permit limit compliance rate for all discharge points for 2015 was greater than 99%, with four measurements exceeding numeric NPDES permit limits. The four effluent limit exceedances occurred at the ORNL STP in May 2015, when issues with STP sludge-management equipment occurred. Efforts to maintain sludge management included decreases in flow and aeration, which led to unfavorable conditions for nitrification and ammonia control within the system. As a result, the STP ammonia discharge limits were exceeded four times during that month. Corrective actions including sludge-management system improvements were completed before the end of May 2015, after which there were no further NPDES compliance issues at the STP. A nonconformance with a narrative (non-numeric) condition of ORNL's NPDES permit occurred in January 2015, when electrical power was temporarily lost at the Building 3625 Microscopy Laboratory. The electrical outage prevented a sanitary sewer collection system lift station from functioning properly, which led to an overflow of sanitary sewage and cooling water to the ground surface near Building 3625. A portion of the released water ultimately flowed into White Oak Creek (WOC). Following the incident, utility systems were reconfigured to prevent future recurrence. Section 5.5 contains detailed information on the monitoring programs and activities carried out in 2015 by UT-Battelle in support of CWA.

5.3.5 Safe Drinking Water Act Compliance Status

ORNL's water distribution system is designated as a "nontransient, noncommunity" water system by the TDEC Division of Water Supply. TDEC's Water Supply rules, Chapter 0400-45-01, Public Water Systems (TDEC 2012), sets limits for biological contaminants and for chemical activities and chemical contaminants. TDEC requires sampling for the following constituents for compliance with state and federal regulations:

- residual chlorine,
- bacteria (total coliform),
- disinfectant by-product (trihalomethanes and haloacetic acids), and
- lead and copper (required once every 3 years).

The City of Oak Ridge supplies potable water to the ORNL water distribution system and meets all regulatory requirements for drinking water. The water treatment plant, located on ORR, north of the Y-12 Complex, is owned and operated by the City of Oak Ridge.

In 2015, sampling results for ORNL's water system residual chlorine levels, lead and copper levels, bacterial constituents, and disinfectant by-products were all within acceptable limits. Sampling for lead and copper will not be required again until 2018.

5.3.6 Resource Conservation and Recovery Act Compliance Status

The Hazardous Waste Program under RCRA establishes a system for regulating hazardous wastes from the initial point of generation through final disposal. In Tennessee, TDEC has been delegated authority by EPA to implement the Hazardous Waste Program; EPA retains an oversight role. In 2015, DOE and its contractors at ORNL were jointly regulated as a "large-quantity generator of hazardous waste" under EPA ID TN1890090003 because, collectively, they generated more than 1,000 kg of hazardous/mixed wastes in at least one calendar month during 2015. Mixed wastes are both hazardous (under RCRA regulations) and radioactive. Hazardous/mixed wastes are accumulated in satellite accumulation areas or in less-than-90-day accumulation areas and are stored and/or treated in RCRA-permitted units. In addition, hazardous/mixed wastes are shipped off site for treatment and disposal. The RCRA units operate under three permits at ORNL, TNHW-145, TNHW-134, and TNHW-164, as shown in Table 5.5. In 2015, UT-Battelle and UCOR were permitted to transport hazardous wastes under an EPA ID number issued for ORNL activities. On September 15, 2015, the ORR Hazardous Waste Corrective Action Permit TNHW-121 was reissued as TNHW-164. TNHW-164 is a set of conditions pertaining to the current status of all solid waste management units (SWMUs) and areas of concern (AOCs) at ETTP, ORNL, and the Y-12

National Security Complex. The corrective action conditions require that the SWMUs and AOCs be investigated and, as necessary, remediated.

Table 5.5. Oak Ridge National Laboratory Resource Conservation and Recovery Act operating permits, 2015

Permit number	Storage and treatment units/description
	Oak Ridge National Laboratory
TNHW-134	Building 7651 Container Storage Unit Building 7652 Container Storage Unit Building 7653 Container Storage Unit Building 7654 Container Storage Unit Portable Unit 2 Storage and Treatment Unit
TNHW-145	Portable Unit 1 Storage Unit and Treatment Unit Building 7572 Container Storage Unit Building 7574 Container Storage Unit Building 7823 Container Storage Unit Building 7855 Container Storage Unit Building 7860A Container Storage Unit Building 7879 Container Storage Unit Building 7883 Container Storage Unit TWPC-1 (Contact-Handled Storage Area) Container Storage Unit TWPC-2 (Second Floor WPB) Container Storage Unit TWPC-3 (Drum Aging Criteria) Container Storage Unit TWPC-4 (First Floor WPB) Container Storage Unit TWPC-5 (Container Storage Area) Container Storage Unit TWPC-6 (Contact-Handled Marshaling Building) Container Storage Unit, Building 7880BB TWPC-7 (Drum-Venting Building) Container Storage Unit, Building 7880AA TWPC-8 (Multipurpose Building) Container Storage Unit, Building 7880QQ T-1[a] Macroencapsulation Treatment T-2[a] Amalgamation Treatment T-3[a] Solidification/Stabilization Treatment T-4[a] Groundwater Absorption Treatment T-5[a] Size Reduction T-5a Treatment T-6[a] Groundwater Filtration Treatment
	Oak Ridge Reservation
TNHW-121[b]	Hazardous Waste Corrective Action Permit

[a]Treatment operating units within TWPC facilities.
[b] On September 15, 2015, the ORR Hazardous Waste Corrective Action Permit TNHW-121 was reissued as TNHW-164.

Acronyms
TWPC = Transuranic Waste Processing Center
WPB = Waste Processing Building

Reporting is required for hazardous waste activities on 42 active waste streams at ORNL, some of which are mixed wastes. The quantity of hazardous/mixed waste generated at ORNL in 2015 was 661,044 kg, with mixed wastewater accounting for 556,428 kg. Excluding the wastewater, 2015 hazardous waste generation decreased by about 2.5%. This reduction is attributed to a decrease in macroencapsulation of hazardous waste. ORNL generators treated 4,395 kg of hazardous/mixed waste by elementary neutralization, silver recovery, and deactivation. Ninety-four kg of hazardous/mixed radioactive waste was received from East Tennessee Technology Park and 228 kg waste was received from UT-Battelle generators at the Y-12 National Security Complex, all of which was stored at ORNL and subsequently shipped off site for treatment and disposal. The quantity of hazardous/mixed waste treated in RCRA-permitted treatment facilities at ORNL in 2015 was 1,406 kg. This included waste treated by macroencapsulation, size reduction, and stabilization/solidification. In addition, 556,428 kg of mixed waste was treated at an on-site wastewater treatment facility. The amount of hazardous/mixed waste shipped off site to commercial treatment, storage, and disposal facilities decreased about 4.5% to 108,151 kg in 2015.

In April 2015, TDEC conducted an annual RCRA inspection of ORNL generator areas; battery collection areas; RCRA-permitted treatment, storage, and disposal facilities; and RCRA records. During the inspection, all records and areas were found to be in compliance with RCRA regulations and the RCRA permits. One recommendation was made for making timely temporary repairs to the flooring in buildings where the flooring acts as part of the secondary containment system.

DOE and UT-Battelle operations at NTRC and CFTF were regulated as “conditionally exempt small-quantity generators” in 2015, meaning that less than 100 kg of hazardous waste per month was generated.

No hazardous/mixed wastes were generated, accumulated, or shipped by DOE or UT-Battelle at the DOE Office of Scientific and Technical Information, the 1916-T2 warehouse, or the 0800 Area in 2015. The 0800 Area is a location on ORR adjacent to ORNL that has been assigned EPA identification number TNR000019760.

5.3.7 Oak Ridge National Laboratory RCRA-CERCLA Coordination

The Federal Facility Agreement for the Oak Ridge Reservation (FFA) (DOE 2014a) is intended to coordinate the corrective action processes of RCRA required under the Hazardous and Solid Waste Amendments permit with CERCLA response actions. Annual updates for 2015 for ORNL’s SWMUs and AOCs were consolidated with updates for ETTP, the Y-12 Complex, and ORR and were reported to TDEC, DOE, and the EPA Region 4 in January 2016.

Periodic updates of proposed C&D activities and facilities at ORNL have been provided to managers and project personnel from the TDEC Remediation Division and EPA Region 4. A CERCLA screening process is used to identify proposed C&D projects and facilities that warrant CERCLA oversight. The goal is to ensure that modernization efforts do not adversely affect the effectiveness of previously completed CERCLA environmental remediation actions and that they do not adversely impact future CERCLA environmental remediation actions.

5.3.7.1 Resource Conservation and Recovery Act Underground Storage Tanks

Underground storage tanks (USTs) containing petroleum and hazardous substances are regulated under RCRA Subtitle I (40 CFR 280). TDEC has been granted authority by EPA to regulate USTs containing petroleum under TDEC Rule 400-18-01; however, hazardous-substance USTs are still regulated by EPA.

ORNL has four USTs registered with TDEC under Facility ID 0-730089. A summary of the USTs follows.

- Two are in service (petroleum) and meet the current UST standards.
- One (formerly storing petroleum) has been placed into a “temporary closure” status in accordance with the regulations pending permanent closure in the future.

- One is a wastewater treatment tank that is exempt from regulation.

5.3.8 Comprehensive Environmental Response, Compensation, and Liability Act Compliance Status

CERCLA, also known as Superfund, was passed in 1980 and was amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). Under CERCLA, a site is investigated and remediated if it poses significant risk to health or the environment. The EPA National Priorities List (NPL) is a comprehensive list of sites and facilities that have been found to pose a sufficient threat to human health and/or the environment to warrant cleanup under CERCLA.

In 1989, ORR was placed on the EPA NPL. In 1992, the ORR FFA among EPA, TDEC, and DOE became effective and established the framework and schedule for developing, implementing, and monitoring remedial actions (RAs) on ORR. The on-site CERCLA Environmental Management Waste Management Facility (EMWMF) is operated by UCOR for DOE. Located in Bear Creek Valley, EMWMF is used for disposal of waste resulting from CERCLA cleanup actions on ORR, including ORNL. EMWMF is an engineered landfill that accepts low-level radioactive, hazardous, asbestos, and polychlorinated biphenyl (PCB) wastes and combinations of the aforementioned wastes in accordance with specific waste acceptance criteria under an agreement with state and federal regulators.

5.3.9 Toxic Substances Control Act Compliance Status

PCB uses and waste are regulated under the Toxic Substance Control Act (TSCA). PCB waste generation, transportation, and storage at ORNL are regulated under EPA ID TN1890090003. In 2015, UT-Battelle operated 16 PCB waste storage areas. When longer-term storage was necessary, PCB/radioactive wastes were stored in RCRA-permitted storage buildings at ORNL. Two PCB waste storage areas were operated at UT-Battelle facilities at the Y-12 Complex. The continued use of authorized PCBs in electrical systems and/or equipment (e.g., transformers, capacitors, rectifiers) is regulated at ORNL. Most of the equipment at ORNL that required regulation under TSCA has been disposed of. However, some of the ORNL facilities at the Y-12 Complex continue to use (or store for future reuse) PCB equipment.

Because of the age of many of the ORNL facilities and the varied uses for PCBs in gaskets, grease, building construction, and equipment, DOE self-disclosed unauthorized use of PCBs to EPA in the late 1980s. As a result, DOE and ORNL contractors negotiated a compliance agreement with EPA (see Chapter 2) to address the compliance issues related to these unauthorized uses and to allow for continued use pending decontamination or disposal. As a result of that agreement, DOE continues to notify EPA when additional unauthorized uses of PCBs, such as PCBs in paint, adhesives, electrical wiring, or floor tile, are found at ORNL.

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

The Emergency Planning and Community Right-to-Know Act (EPCRA) and Title III of SARA require that facilities report inventories and releases of certain chemicals that exceed specific release thresholds. The reports are submitted to the local emergency planning committee and the state emergency response commission. Table 5.6 describes the main elements of EPCRA. UT-Battelle complied with these requirements in 2015 through the submittal of reports under EPCRA Sections 302, 303, 311, 312, and 313. These reports contain information on all DOE prime contractors and their subcontractors who reported activities at the ORNL site.

ORNL had no releases of extremely hazardous substances, as defined by EPCRA, in 2015. Releases of toxic chemicals that were greater than the Section 313 designated reportable threshold quantities are discussed in Section 5.3.10.2.

Table 5.6. Main elements of the Emergency Planning and Community Right-to-Know Act

Title	Description
Sections 302 and 303, Planning Notification	Requires that local planning committee and state emergency response commission be notified of EPCRA-related planning
Section 304, Extremely Hazardous Substance Release Notification	Addresses reporting to state and local authorities of off-site releases
Sections 311–312, Material Safety Data Sheet/Chemical Inventory	Requires that either safety data sheets or lists of hazardous chemicals for which they are required be provided to state and local authorities for emergency planning. Requires that an inventory of hazardous chemicals maintained in quantities over thresholds be reported annually to EPA
Section 313, Toxic Chemical Release Reporting	Requires that releases of toxic chemicals be reported annually to EPA

Acronyms
EPA = US Environmental Protection Agency
EPCRA = Emergency Planning and Community Right-to-Know Act

5.3.10.1 Material Safety Data Sheet/Chemical Inventory (Section 312)

Inventories, locations, and associated hazards of hazardous chemicals and/or extremely hazardous substances were submitted in an annual report to the E-Plan – Emergency Response Information System as required by the State of Tennessee. In 2015, there were 17 hazardous chemicals and/or extremely hazardous substances at ORNL met EPCRA reporting criteria.

Private-sector lessees were not included in the 2015 submittals. Under the terms of their leases, lessees must evaluate their own inventories of hazardous and extremely hazardous chemicals and must submit information as required by the regulations.

5.3.10.2 Toxic Chemical Release Reporting (EPCRA Section 313)

DOE submits annual toxic release inventory reports to EPA and TDEC on or before July 1 of each year. The reports cover the previous calendar year and address releases of certain toxic chemicals to air, water, and land and waste management, recycling, and pollution prevention activities. Threshold determinations and reports for each of the ORR facilities are made separately. Operations involving toxic release inventory chemicals were compared with regulatory thresholds to determine which chemicals exceeded the reporting thresholds based on amounts manufactured, processed, or otherwise used at each facility. After threshold determinations were made, releases and other waste management activities were calculated for each chemical that exceeded one or more of the thresholds.

For CY 2015, ORNL reported on the “otherwise use” of nitric acid and the “manufacture” of nitrate compounds in quantities greater than the designated reportable threshold quantities. Most of the nitric acid was used in wastewater treatment operations at the Process Waste Treatment Complex (PWTC). Nitrate compounds are coincidentally manufactured as by-products of neutralizing the nitric acid waste and as by-products of sewage treatment.

5.3.11 US Department of Agriculture/Tennessee Department of Agriculture

USDA, through Animal and Plant Health Inspection Services, issues permits for the import, transit, and controlled release of regulated animals, animal products, veterinary biologics, plants, plant products, pests, organisms, soil, and genetically engineered organisms. The Tennessee Department of Agriculture issues agreements and jointly regulates domestic soil. In 2015, UT-Battelle personnel had a combined 46 permits and agreements for the receipt, movement, or controlled release of regulated articles.

5.3.12 Wetlands

In May 2015, vegetation parameters were measured at the ORNL parking structure wetland approximately 4 years after mitigation that took place in 2011. The percentage of cover by species was measured for each plot. Information was also taken on any fauna present at the time of the survey. Five years of data, including the data collected during the year of mitigation, have shown excellent overall vegetation coverage, providing good quality habitat. Vegetation growing in the wetland in 2015 included both planted and volunteer plant species. There was a noted increase in black willow, sycamore, and green ash saplings. Climbing hempweed, an invasive, continues to infiltrate the west end of the wetland; however, the spread is being controlled by the UT-Battelle grounds crew. A good variety of fauna was noted in and around the wetland, including birds, frogs, and benthic macroinvertebrates.

Stream habitat assessments were conducted at both First Creek and WOC reaches using Habitat Assessment Data Sheets found in the Tennessee Mitigation Guidelines. Metrics evaluated at both sites included epifaunal substrate, embeddedness (e.g., the amount of silt between rocks), velocity/depth regime, sediment deposition, channel flow, frequency of riffles, bank stability, and vegetative cover (Fig. 5.8). Metrics evaluated were measured using rapid bioassessment protocols for use in wadeable streams and rivers (Barbour et al. 1999).

Fig. 5.8. First Creek Mitigation site in 2015. *[Photo by Neil Giffen]*

First Creek mitigation activities had already been completed before the first habitat assessment, which was conducted in 2011. The 2015 survey represented the fifth formal assessment of postmitigation conditions. Premitigation conditions for First Creek are discussed qualitatively based on information contained in previous reports (Ryon and Quarles 2008; Giffen, Ryon, and Jett 2011). The 2015 WOC habitat assessment was based on habitat conditions about 4 years after mitigation.

Riparian zone vegetation surveys were conducted by establishing 32.8 × 16.4 ft plots 32.8 ft apart (First Creek—east bank, WOC—north and south banks). Eleven plots were established at First Creek, and 13 plots were established at WOC. For each plot the following parameters were measured: trees (≥ 3 in. diam at breast height)—measured, shrub stems (< 3 in. diameter at breast height)—counted, percent groundcover, percent canopy cover, canopy height, and vegetation overhang (in centimeters) for each stream bank.

Fish and benthic community monitoring results were evaluated as an indicator of whether or not the stream sections were functioning as suitable habitat for instream organisms. Benthic macroinvertebrate community data were gathered at First Creek (July 9, 2015) and WOC (July 9, 2015) using an EPA-approved rapid qualitative assessment technique. At each site seven aquatic habitats were identified and sampled for aquatic macroinvertebrates, riffles, leaf packs, woody debris, rocks, root wads, aquatic vegetation, and instream sediment deposition. These habitats were located within 328 ft upstream and downstream of the sampling site established along each reach. Habitats missing from the site were not sampled. After all habitats were sampled, a tally of each insect family was completed to determine the number of families represented by Ephemeroptera, Plecoptera, and Trichoptera (EPT). Biological Monitoring and Abatement Plan (BMAP) fish survey data used for evaluation of First Creek were from fishes in close proximity to the subject reach. The fish community data used for evaluation of the WOC site were from data taken during routine BMAP surveys within the subject reach. The fish communities within the reaches were monitored using a multiple-pass removal estimate method (Ryon 2011). The sample sites were isolated by block nets, multiple passes were made using backpack or barge electrofishers, and all stunned fish were collected. Fish were identified by species, measured for length and weight, and returned to the site.

The results of habitat measurements conducted along the First Creek reach in 2015 showed that the creek continued to provide good overall habitat and that it remained in an unimpaired state. The relatively linear condition of the creek was evidence of past channelization with the development of the area. Relatively narrow riparian zones are a weakness of the site from the perspective of providing good quality habitat. However, riparian zones in this area are restricted by paved and landscaped areas because the creek runs through a developed area. Mitigation plantings on the east side of the creek have improved habitat quality in that area over original habitat conditions, which included large mowed turf grass areas and a high number of invasive plant species. The riparian zone on the west side is highly restricted because of the close proximity of landscaped and parking areas associated with a building complex. Cover is maintained to the maximum extent possible in that narrow zone. Invasive plants were not found to be a major concern, with only a slight increase from the previous year. Invasive plant management was conducted for winter creeper and Bradford pear in fall 2015.

Good plant survivorship was noted. The number of dead or dying plants was higher than in 2014 but similar to that recorded in 2013. In general, planted vegetation appears to be thriving, and regeneration is evident. Dense growths of shrubs previously existing on the site (e.g., silky dogwood, spicebush) provided significant cover along the creek banks, particularly along northern portions of the study area. Both percent canopy cover and ground cover increased. Plant species diversity showed a significant increase from the 2014 survey. Overall conditions at the site related to vegetation growth and success remain very good.

A moderately diverse benthic macroinvertebrate population was recorded at the First Creek site in 2015, with a slight increase since 2014. It included some less-tolerant taxa typically found in clear streams. The number of fish species increased slightly compared to 2014 for both downstream and upstream sampling locations for the October–December sampling period. For the March–May sampling period, number of fish species decreased slightly for the downstream sampling location and remained the same for the upstream sampling location in comparison with the number of species found in 2014. The frequency of riffles in the creek increased slightly since 2014.

An increase in plant species diversity was observed at the WOC reach, and plant survivorship remains good. However, of the mitigation plantings, a total of 52 dead or dying plants were noted along the stretch. A number of plants have volunteered into many of the areas to fill gaps that may have been left by the dead plants, but an area on the northwest end of the site has been identified as being in need of supplemental planting; plans will be made to address that area The percentage of groundcover slightly decreased and percent canopy cover increased since 2014. The percentage of invasive species increased fairly significantly from that recorded in 2014. However, the percentage for invasive winter creeper decreased from that recorded in 2014. This is believed to be due to concentrated efforts to control this species. The area will be evaluated for overall treatment of invasive plant species.

5.3.13 Radiological Clearance of Property at Oak Ridge National Laboratory

5.3.13.1 General Property Clearance Processes

DOE O 458.1, *Radiation Protection of the Public and the Environment* (DOE 2011b), established standards and requirements for operations of DOE and its contractors with respect to protection of members of the public and the environment against undue risk from radiation. In addition to discharges to the environment, the release of property containing residual radioactive material is a potential contributor to the dose received by the public, and DOE Order 458.1 established requirements for clearance of property from DOE control and for public notification of clearance of property.

At ORNL, UT-Battelle uses a graded approach for release of material and equipment for unrestricted public use. Material that may be released to the public has been categorized so that in some cases an administrative release can be accomplished without a radiological survey. Such material originates from nonradiological areas and includes items such as the following:

- documents, mail, diskettes, compact disks, and other office media;
- nonradioactive items or materials received that are immediately (within the same shift) determined to have been delivered in error or damaged;
- personal items or materials;
- paper, plastic products, aluminum beverage cans, toner cartridges, and other items released for recycling;
- office trash;
- housekeeping materials and associated waste;
- breakroom, cafeteria, and medical wastes;
- compressed gas cylinders and fire extinguishers;
- medical and bioassay samples; and
- other items with an approved release plan.

Items originating from nonradiological areas within the site’s controlled areas not in the listed categories are surveyed before release to the public, or a process knowledge evaluation is conducted to ensure that the material has not been exposed to radioactive material or beams of radiation capable of creating radioactive material. In some cases both a radiological survey and a process knowledge evaluation are performed (e.g., a radiological survey is conducted on the outside of the item, and a process knowledge form is signed by the custodian for inaccessible surfaces). A similar approach is used for material released to state-permitted landfills on ORR. The only exception is for items that could be internally contaminated; those items are also sampled by laboratory analysis to ensure that landfill permit criteria are met.

When the process knowledge approach is used, the item’s custodian is required to sign a statement that specifies the history of the material and confirms that no radioactive material has passed through or contacted the item. This process knowledge certification is more stringent than what is allowed by DOE Order 458.1 (DOE 2011b) in that ORNL requires an individual to take personal responsibility and accountability for knowing the complete history of an item before it can be cleared using process knowledge alone. DOE Order 458.1 allows use of procedures for evaluating operational records and operating history to make process knowledge release decisions, but UT-Battelle has chosen to continue to require personal certification of the status of an item. This requirement ensures that each individual certifying the item is aware of the significance of this decision and encourages the individual to obtain a survey of the item if he or she is not 100% confident that the item can be certified as being free of contamination.

A survey and release plan may be developed to direct the radiological survey process for large recycling programs or clearance of bulk items with low contamination potential. For such projects, survey and release plans are developed based on guidance from the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (NRC 2000) or the *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual* (MARSAME) (NRC 2009). MARSSIM and MARSAME allow for statistically based survey protocols that typically require survey measurements for a representative portion of the items being released. The survey protocols are documented in separate survey and release plans, and the measurements from such surveys are documented in radiological release survey reports.

UT-Battelle continues to use the preapproved authorized limits for surface contamination established in Table IV-1 of DOE Order 5400.5 (cancelled in 2011) and the November 17, 1995, Pelletier memorandum (Pelletier 1995) for TRU alpha contamination. UT-Battelle also continues to follow the requirements of the scrap metal suspension. No scrap metal directly released from radiological areas is being recycled. In 2015, UT-Battelle cleared more than 15,000 items through the excess items and property sales processes. A summary of items requested for release through these processes (including donations, transfers, landfill, reutilization, and sales) is shown in Table 5.7.

Table 5.7. Excess items requested for release and/or recycling, calendar year 2015

	Process knowledge	Radiologically surveyed
Release request totals for calendar year 2015		
Computers-for-Learning	44	0
DOE donations	0	0
Other donations	912	196
LEDP (donations to colleges/universities)	28	6
DOE transfers	503	156
Other federal agency transfers	434	38
Landfill	0	0
Reuse at ORNL	510	66
Sales	11,005	2,116
Totals	13,436	2,578
Recycling request totals for calendar year 2015		
Cardboard (tons)	125.15	
Scrap metal (nonradiological areas) (tons)	794.33	
Used tires (each)	611	
Used batteries (pounds)	29,031	

Acronyms

DOE = US Department of Energy
LEDP = Laboratory Equipment Donation Program
ORNL = Oak Ridge National Laboratory
PCB = polychlorinated biphenyl

5.3.13.2 Authorized Limits Clearance Process for Spallation Neutron Source and High Flux Isotope Reactor Neutron Scattering Experiment Samples

The Spallation Neutron Source (SNS) and High Flux Isotope Reactor (HFIR) facilities provide unique neutron scattering experiment capabilities that allow researchers to explore the properties of various materials by exposing samples to well-characterized neutron beams. Because materials exposed to neutrons can become radioactive, a process has been developed to evaluate and clear samples for release to off-site facilities. DOE regulations and orders governing radiological release of material do not specifically cover items that may have radioactivity distributed throughout the volume of the material. To address sample clearance, activity-based limits were established using the authorized limits process defined in DOE O 458.1 and associated guidance. The sample clearance limits are based on an assessment of potential doses against a threshold of 1 mrem/year to an individual and evaluation of other potentially applicable requirements (e.g., US Nuclear Regulatory Commission licensing regulations). Implementation of the clearance limits involves use of unique instrument screening and sample activity prediction methods to provide an efficient and defensible process to release neutron scattering experiment samples to researchers without further DOE control.

The approved revised process for notification was continued in 2015. In 2015 ORNL cleared 101 samples from neutron scattering experiments using the SNS and HFIR sample authorized limits process.

5.4 Air Quality Program

5.4.1 Construction and Operating Permits

Permits issued by the State of Tennessee convey the clean air requirements that are applicable to ORNL. New projects are governed by construction permits until the projects are converted to operating status. The sitewide Title V Major Source Operating Permits include requirements that are generally applicable to large operations such as national laboratories (e.g., asbestos and stratospheric ozone) as well as specific requirements directly applicable to individual air emission sources. Source-specific requirements include Rad-NESHAPs (see Section 5.4.3), requirements applicable to sources of ambient air criteria pollutants, and requirements applicable to sources of other hazardous air pollutants (HAPs) (nonradiological). In September 2011 the State of Tennessee issued Title V Major Source Operating Permit 562765 to DOE and UT-Battelle operations at ORNL. This permit was modified in 2013 and 2014 to reflect current operations. In January 2015, TDEC issued a construction permit for 3 new duel fuel fired boilers. DOE and UT-Battelle also maintained a valid minor source operating permit with the Knox County Air Quality Management Division for NTRC facilities located in Knox County.

In 2012 UT-Battelle applied for and received construction permit number 965103P for the construction of CFTF, located off-site at the Horizon Center Business Park in Oak Ridge, Tennessee. The initial start-up of CFTF occurred in March 2013. In accordance with provisions of the construction permit an emissions test was performed in July 2013 and confirmed that the hydrogen cyanide (HCN) mass emission rate was 0.0024 lb/h, far less than the maximum hourly emission rate of 0.05 lb/h established in the permit. The test results were provided to TDEC, and DOE–UT-Battelle applied for a Title V Major Source Operating Permit for CFTF in 2014. However, based on conversations with TDEC Division of Air Pollution Control, UT-Battelle has determined that potential HCN emissions will be below the major source threshold for Title V facilities, and UT-Battelle applied for True Minor Source Operating Permit for CFTF in April 2015. As a True Minor Facility, potential emissions of HCN are determined to less than 2 tons per year as opposed to Major Source Threshold of 10 tons per year. Potential emissions do not take into account the thermal oxidizer control efficiency rated at 99%. A construction permit was also obtained in 2013 for the CFTF emergency generator. The True Minor Source Operating Permit for the facility and its emergency generator is anticipated to be issued in 2016.

DOE WAI /NWSol has two Title V Major Source Operating Permits for one emission source and two emergency generators at TWPC. DOE Isotek has a Title V Major Source Operating Permit for the Radiochemical Development Facility (Building 3019 complex). During 2015, no permit limits were exceeded. UCOR also has a Title V Major Source Operating Permit for the 3039 stack and the 3608 air stripper. No permit limits were exceeded for these sources in 2015.

5.4.2 National Emission Standards for Hazardous Air Pollutants—Asbestos

Numerous facilities, structures, facility components, and various pieces of equipment at ORNL contain asbestos-containing material (ACM). UT-Battelle's Asbestos Management Program manages the compliance of work activities involving the removal and disposal of ACM, which include notifications to TDEC for all demolition activities and required renovation activities, approval of asbestos work authorization requests, current use of engineering controls and work practices, inspections, air monitoring, and waste tracking of asbestos-contaminated waste material. During 2015, there were no deviations or releases of reportable quantities of ACM.

5.4.3 Oak Ridge National Laboratory Radiological Airborne Effluent Monitoring

Radioactive airborne discharges at ORNL consist primarily of ventilation air from radioactively contaminated or potentially contaminated areas, vents from tanks and processes, and ventilation for hot cell operations and reactor facilities. (See Appendix E, Table E.1, for a list of radionuclides and associated radioactive half-lives.) The airborne emissions are treated and then filtered with high-efficiency particulate air filters and/or charcoal filters before discharge. Radiological airborne emissions from ORNL consist of solid particulates, adsorbable gases (e.g., iodine), tritium, and nonadsorbable gases (e.g., noble gases).

The major radiological emission point sources for ORNL consist of the following seven stacks. Six are located in Bethel and Melton Valleys and one, the SNS Central Exhaust Facility stack, is located on Chestnut Ridge (Fig. 5.9).

- 2026 Radioactive Materials Analytical Laboratory
- 3020 Radiochemical Development Facility
- 3039 central off-gas and scrubber system, which includes the 3500 cell ventilation system, isotope solid-state ventilation system, 3025 area cell ventilation system, 3042 ventilation system, and 3092 central off-gas system
- 7503 Molten Salt Reactor Experiment Facility
- 7880 TWPC
- 7911 Melton Valley complex, which includes HFIR and the Radiochemical Engineering Development Center
- 8915 SNS Central Exhaust Facility stack

In 2015 there were 14 minor point/group sources, and emission calculations/estimates were made for each of them.

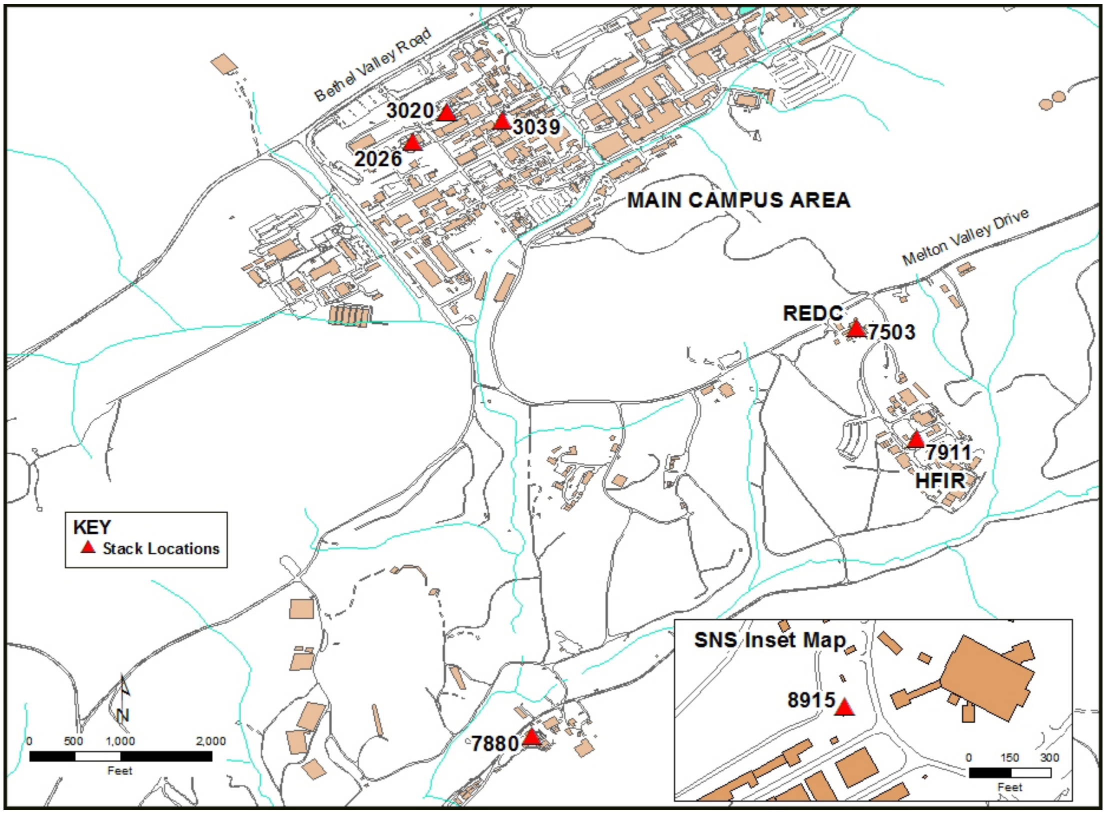

Fig. 5.9. Locations of major radiological emission points at Oak Ridge National Laboratory. *(HFIR = High Flux Isotope Reactor, REDC = Radiochemical Engineering Development Center, and SNS = Spallation Neutron Source.)*

5.4.3.1 Sample Collection and Analytical Procedure

Four of the major point sources (stacks 2026, 3020, 3039, and 7503) are equipped with in-stack source-sampling systems that comply with criteria in the American National Standards Institute (ANSI) standard ANSI N 13.1-1969R (ANSI 1969). The sampling systems generally consist of a multipoint in-stack sampling probe, a sample transport line, a particulate filter, activated charcoal cartridges, a silica gel cartridge (if required), flow-measurement and totalizing instruments, a sampling pump, and a return line to the stack. The 7911 (Melton Valley complex) and 7880 (TWPC) stacks are equipped with in-stack source-sampling systems that comply with criteria in the ANSI–Health Physics Society standard ANSI/HPS N13.1-1999 (ANSI 1999).

The 7911 sampling system has the same components as the ANSI 1969 sampling systems but uses a stainless-steel-shrouded probe instead of a multipoint in-stack sampling probe. The sampling system also consists of a high-purity germanium detector with an analog-to-digital converter) and ORTEC GammaVision software, which allows for continuous isotopic identification and quantification of radioactive noble gases (e.g., ^{41}Ar) in the effluent stream. The 7880 sampling system consists of a stainless-steel-shrouded probe, an in-line filter-cartridge holder placed at the probe to minimize line losses, a particulate filter, a sample transport line, a rotary vane vacuum pump, and a return line to the stack. The sample probes from both the ANSI 1969 and ANSI 1999 stack sampling systems are removed, inspected, and cleaned annually. The 8915 (SNS Central Exhaust Facility) stack is equipped with an in-stack radiation detector that complies with criteria in ANSI/HPS N13.1-1999. The detector monitors radioactive gases flowing through the exhaust stack and provides a continual readout of detected activity using a scintillator probe. The detector is calibrated to correlate with isotopic emissions.

Velocity profiles are performed quarterly at major and some minor sources; the criteria in EPA Method 2 (EPA 2010) are followed. The profiles provide accurate stack flow data for subsequent emission-rate calculations. An annual leak-check program is carried out to verify the integrity of the sample transport system. For the 7880 stack, an annual comparison between the effluent flow rate totalizer and EPA Method 2 is performed. The stack effluent-flow-rate monitoring system response is checked quarterly with the manufacturer's instrument test procedures. The stack sampler rotameter is calibrated at least quarterly in comparison with a secondary (transfer) standard. Only a certified secondary standard is used for all rotameter tests.

In addition to the major sources, ORNL has a number of minor sources that have the potential to emit radionuclides to the atmosphere. A minor source is defined as any ventilation system or component such as a vent, laboratory hood, room exhaust, or stack that does not meet the approved regulatory criteria for a major source but that is located in or vents from a radiological control area as defined by Radiological Support Services of the UT-Battelle Nuclear and Radiological Protection Division. Various methods are used to determine the emissions from the various minor sources. Methods used for minor source-emission calculations comply with EPA criteria. The minor sources are evaluated on a 1- to 5-year basis. Emissions, major and minor, are compiled annually to determine the overall ORNL source term and associated dose.

The charcoal cartridges, particulate filters, and silica-gel traps are collected weekly to biweekly. The use of charcoal cartridges is a standard method for capturing and quantifying radioactive iodine in airborne emissions. Gamma spectrometric analysis of the charcoal samples quantifies the adsorbable gases. Analyses are performed weekly to biweekly. Particulate filters are held for 8 days before a weekly gross alpha and gross beta analysis to minimize the contribution from short-lived isotopes such as ^{220}Rn and its daughter products. At stack 7911, a weekly gamma scan is conducted to better detect short-lived gamma isotopes. The filters are then composited quarterly or semiannually and are analyzed for alpha-, beta-, and gamma-emitting isotopes. At stack 7880, the filters are composited monthly and analyzed for alpha-, beta-, and gamma-emitting isotopes. The sampling system on stack 7880 requires no other type of radionuclide collection media. Compositing provides a better opportunity for quantification of the low-concentration isotopes. Silica-gel traps are used to capture water vapor that may contain tritium. Analysis is performed weekly to biweekly. At the end of the year, the sample probes for all of the stacks are rinsed, except for the 8915 and 7880 probes, and the rinsate is collected and submitted for isotopic analysis identical to that performed on the particulate filters. A probe-cleaning program has been determined unnecessary for 8915 because the sample probe is a scintillator probe used to detect radiation and not to extract a sample of stack exhaust emissions. It is not anticipated that contaminant deposits would collect on the scintillator probe. A probe-cleaning program for 7880 has established that rinse analysis historically showed no detectable contamination. Therefore, the frequency of probe rinse collection and analysis is no more often than every 3 years unless there is an increase in particulate emissions, an increase in detectable radionuclides in the sample media, or process modifications.

The data from the charcoal cartridges, silica gel, probe wash, and filter composites are compiled to give the annual emissions for each major source and some minor sources.

5.4.3.2 Results

Annual radioactive airborne emissions for ORNL in 2015 are presented in Table 5.8. All data presented were determined to be statistically different from zero at the 95% confidence level. Any number not statistically different from zero was not included in the emission calculation. Because measuring a radionuclide requires counting random radioactive emissions from a sample, the same result may not be obtained if the sample is analyzed repeatedly. This deviation is referred to as the "counting uncertainty." Statistical significance at the 95% confidence level means that there is a 5% chance that the results could be erroneous.

Historical trends for tritium (^{3}H) and ^{131}I are presented in Figs. 5.10 and 5.11. For 2015, tritium emissions totaled about 450.2 Ci (Fig. 5.10), a decrease from 2014 but in line with 2013 emissions; ^{131}I emissions totaled 0.09 Ci (Fig. 5.11), a slight decrease but in line with emissions from the past 3 years. For 2015, the isotopes that contributed 10% or more to the off-site dose at ORNL were ^{234}U, ^{11}C, and ^{238}Pu, with dose contributions of approximately 26%, 25%, and 12%, respectively. Emissions of ^{234} U and ^{238}Pu are associated with a number of sources at ORNL, including 4000 and the Melton Valley area laboratory hoods. Carbon-11 emissions result from SNS operations and research activities. For 2015, ^{234}U emissions totaled 0.029 Ci; ^{11}C emissions totaled 21,900 Ci, almost double that of 2014; and ^{238}Pu emissions totaled 9.08E-04 Ci. Emissions of ^{138}Cs totaled 255 Ci, which was double that of 2014 and ^{41}Ar emissions remained in the same range as 2014, totaling 317 Ci (Fig. 5.12).

The calculated radiation dose to the maximally exposed individual (MEI) from all radiological airborne release points at ORR during 2015 was 0.4 mrem. The dose contribution to the MEI from all ORNL radiological airborne release points was 98.4% of the ORR dose. This dose is well below the NESHAPs standard of 10 mrem and is less than 0.1% of the roughly 300 mrem that the average individual receives from natural sources of radiation. (See Section 7.1.2 for an explanation of how the airborne radionuclide dose was determined.)

Table 5.8. Radiological airborne emissions from all sources at ORNL, 2015 (Ci)[a]

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{225}Ac	M	particulate								1.35E-04	1.35E-04
^{226}Ac	M	particulate								8.50E-06	8.50E-06
^{227}Ac	M	particulate								2.89E-07	2.89E-07
^{228}Ac	M	particulate								2.34E-05	2.34E-05
^{110m}Ag	M	particulate								5.68E-05	5.68E-05
^{110m}Ag	S	particulate					2.09E-06				2.09E-06
^{111}Ag	M	particulate								1.05E-03	1.05E-03
^{241}Am	M	particulate	5.02E-08	1.78E-07				4.12E-08		9.71E-06	9.98E-06
^{241}Am	F	particulate			3.22E-07	2.50E-08	1.25E-06			1.95E-07	1.79E-06
^{243}Am	M	particulate								6.92E-09	6.92E-09
^{41}Ar	B	unspecified						2.31E+02	8.59E+01		3.17E+02
^{131}Ba	M	particulate								1.23E-04	1.23E-04
^{137m}Ba	B	unspecified								1.16E-12	1.16E-12
^{139}Ba	M	particulate						3.20E-01			3.20E-01
^{140}Ba	M	particulate						3.71E-04		3.43E-04	7.14E-04
^{140}Ba	S	particulate					2.82E-05				2.82E-05
^{7}Be	M	particulate	1.96E-07	9.30E-08				3.65E-07		3.08E-06	3.74E-06
^{7}Be	S	particulate			4.71E-06		1.93E-05			5.22E-07	2.45E-05
^{211}Bi	B	unspecified								1.21E-08	1.21E-08
^{212}Bi	M	particulate								2.00E-07	2.00E-07
^{214}Bi	M	particulate								1.23E-13	1.23E-13
^{249}Bk	M	particulate								7.00E-11	7.00E-11
^{11}C	G	dioxide							2.19E+04		2.19E+04
^{14}C	M	particulate								1.03E-12	1.03E-12
^{45}Ca	M	particulate								1.40E-09	1.40E-09
^{47}Ca	M	particulate								1.57E-10	1.57E-10

Table 5.8 (continued)

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{115}Cd	M	particulate									
^{139}Ce	M	particulate								3.76E-06	3.76E-06
^{141}Ce	M	particulate						8.04E-07		2.06E-04	2.07E-04
^{144}Ce	M	particulate								4.86E-05	4.86E-05
^{252}Cf	M	particulate						1.52E-09		1.73E-08	1.88E-08
^{36}Cl	M	particulate								5.50E-15	5.50E-15
^{242}Cm	M	particulate								8.00E-14	8.00E-14
^{243}Cm	M	particulate	6.95E-08					4.22E-10		2.85E-12	6.99E-08
^{243}Cm	F	particulate				1.25E-08	7.29E-07			1.19E-07	8.61E-07
^{244}Cm	M	particulate	6.95E-08					4.22E-10		3.76E-06	3.83E-06
^{244}Cm	F	particulate				1.25E-08	7.29E-07			1.19E-07	8.61E-07
^{245}Cm	M	particulate								2.97E-10	2.97E-10
^{246}Cm	M	particulate								5.95E-15	5.95E-15
^{247}Cm	M	particulate								6.84E-14	6.84E-14
^{248}Cm	M	particulate								1.11E-13	1.11E-13
^{57}Co	M	particulate								1.26E-13	1.26E-13
^{58}Co	M	particulate								1.77E-12	1.77E-12
^{60}Co	M	particulate								2.65E-05	2.65E-05
^{60}Co	S	particulate					2.71E-06				2.71E-06
^{51}Cr	M	particulate								2.03E-04	2.03E-04
^{132}Cs	F	particulate								7.64E-05	7.64E-05
^{134}Cs	F	particulate								1.81E-06	1.81E-06
^{134}Cs	S	particulate					1.95E-06				1.95E-06
^{136}Cs	F	particulate								2.26E-04	2.26E-04
^{137}Cs	F	particulate	9.97E-06	1.45E-06				5.35E-06		4.84E-04	5.01E-04
^{137}Cs	S	particulate			3.43E-05	3.36E-08	2.18E-06			4.90E-04	5.27E-04
^{138}Cs	F	particulate						2.55E+02			2.55E+02

Table 5.8 (continued)

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{64}Cu	M	particulate								8.17E-07	8.17E-07
^{66}Cu	B	unspecified								1.93E-13	1.93E-13
^{67}Cu	M	particulate								3.72E-09	3.72E-09
^{152}Eu	M	particulate								2.57E-04	2.57E-04
^{154}Eu	M	particulate								4.86E-05	4.86E-05
^{155}Eu	M	particulate								5.09E-06	5.09E-06
^{55}Fe	M	particulate								3.86E-06	3.86E-06
^{59}Fe	M	particulate								9.41E-07	9.41E-07
^{72}Ga	M	particulate								2.08E-12	2.08E-12
^{153}Gd	M	particulate								2.96E-10	2.96E-10
^{71}Ge	M	particulate								2.46E-09	2.46E-09
^{3}H	V	vapor	3.50E-02		3.85E+00	8.25E-01		1.10E+02	3.35E+02	5.16E-01	4.50E+02
^{175}Hf	M	particulate								1.42E-08	1.42E-08
^{178m}Hf	M	particulate								4.01E-11	4.01E-11
^{181}Hf	M	particulate								3.21E-07	3.21E-07
^{203}Hg	M	inorganic								6.12E-14	6.12E-14
^{166m}Ho	M	particulate								1.20E-04	1.20E-04
^{124}I	V	vapor								3.59E-16	3.59E-16
^{125}I	F	particulate								3.28E-05	3.28E-05
^{125}I	V	vapor								5.62E-10	5.62E-10
^{126}I	V	vapor								4.11E-10	4.11E-10
^{129}I	F	particulate								1.83E-05	1.83E-05
^{129}I	V	vapor					5.48E-06			8.94E-13	5.48E-06
^{130}I	V	vapor								2.28E-32	2.28E-32
^{131}I	F	particulate						9.15E-02		1.90E-04	9.17E-02
^{131}I	V	vapor			3.54E-06		1.71E-05			4.28E-07	2.11E-05
^{132}I	F	particulate						5.34E-01			5.34E-01

Table 5.8 (continued)

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{133}I	V	vapor			6.01E-05					1.73E-35	6.01E-05
^{133}I	F	particulate						3.82E-01			3.82E-01
^{134}I	F	particulate						6.00E-01			6.00E-01
^{135}I	F	particulate						1.03E+00			1.03E+00
^{114m}In	M	particulate								4.50E-13	4.50E-13
^{192}Ir	M	particulate								1.27E-11	1.27E-11
^{40}K	M	particulate								7.99E-05	7.99E-05
^{79}Kr	B	unspecified								1.60E-29	1.60E-29
^{81}Kr	B	unspecified								3.49E-15	3.49E-15
^{85}Kr	B	unspecified						6.40E+02		3.52E-07	6.40E+02
^{85m}Kr	B	unspecified						3.27E+00			3.27E+00
^{87}Kr	B	unspecified						2.41E+01			2.41E+01
^{88}Kr	B	unspecified						3.67E+01	1.63E+02		2.00E+02
^{89}Kr	B	unspecified						2.47E+01			2.47E+01
^{140}La	M	particulate						5.50E-02		4.46E-05	5.50E-02
^{140}La	S	particulate					1.26E-05				1.26E-05
^{172}Lu	M	particulate								3.61E-12	3.61E-12
^{177}Lu	M	particulate								9.28E-11	9.28E-11
^{177m}Lu	M	particulate								2.20E-12	2.20E-12
^{27}Mg	B	unspecified								1.09E-33	1.09E-33
^{54}Mn	M	particulate								1.94E-07	1.94E-07
^{54}Mn	S	particulate					2.22E-06				2.22E-06
^{56}Mn	M	particulate								2.00E-18	2.00E-18
^{93}Mo	M	particulate								3.88E-10	3.88E-10
^{99}Mo	M	particulate								9.36E-04	9.36E-04
^{13}N	B	unspecified							4.70E+02		4.70E+02
^{22}Na	M	particulate								7.54E-11	7.54E-11

Table 5.8 (continued)

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{24}Na	M	particulate								1.21E-07	1.21E-07
^{91}Nb	B	unspecified								5.30E-11	5.30E-11
^{91m}Nb	B	unspecified								1.20E-11	1.20E-11
^{93m}Nb	M	particulate								2.49E-10	2.49E-10
^{94}Nb	M	particulate								1.46E-12	1.46E-12
^{95}Nb	M	particulate								1.08E-04	1.08E-04
^{95m}Nb	M	particulate								1.50E-15	1.50E-15
^{96}Nb	M	particulate								8.55E-12	8.55E-12
^{147}Nd	M	particulate								2.73E-05	2.73E-05
^{59}Ni	M	particulate								5.36E-11	5.36E-11
^{63}Ni	M	particulate								1.77E-03	1.77E-03
^{65}Ni	M	particulate								3.33E-21	3.33E-21
^{66}Ni	M	particulate								1.92E-13	1.92E-13
^{237}Np	M	particulate								8.80E-04	8.80E-04
^{239}Np	M	particulate								2.02E-09	2.02E-09
^{191}Os	M	particulate								1.86E-12	1.86E-12
^{32}P	M	particulate								2.66E-09	2.66E-09
^{33}P	M	particulate								9.77E-17	9.77E-17
^{228}Pa	M	particulate								4.40E-05	4.40E-05
^{229}Pa	B	unspecified								1.20E-04	1.20E-04
^{230}Pa	M	particulate								1.17E-04	1.17E-04
^{231}Pa	M	particulate								3.54E-10	3.54E-10
^{232}Pa	M	particulate								2.49E-04	2.49E-04
^{233}Pa	M	particulate								2.90E-04	2.90E-04
^{210}Pb	M	particulate								2.53E-11	2.53E-11
^{211}Pb	M	particulate								4.26E-08	4.26E-08
^{212}Pb	M	particulate	3.67E-01	4.41E-01				1.84E-02		1.08E-05	8.26E-01

Table 5.8 (continued)

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{212}Pb	S	particulate			7.27E-01	1.17E-01				1.87E-02	8.63E-01
^{214}Pb	M	particulate								2.50E-13	2.50E-13
^{147}Pm	M	particulate								1.50E-12	1.50E-12
^{148m}Pm	M	particulate								9.41E-07	9.41E-07
^{144}Pr	M	particulate								3.79E-12	3.79E-12
^{144m}Pr	B	unspecified								4.54E-14	4.54E-14
^{238}Pu	M	particulate	6.66E-09	2.17E-08						9.05E-04	9.05E-04
^{238}Pu	F	particulate					1.87E-06			5.07E-07	2.38E-06
^{239}Pu	M	particulate	2.03E-08	3.47E-07				1.58E-08		1.44E-07	5.27E-07
^{239}Pu	F	particulate			4.85E-07	7.60E-09	8.17E-07			3.21E-07	1.63E-06
^{240}Pu	M	particulate	2.03E-08					1.58E-08		3.65E-08	7.25E-08
^{240}Pu	F	particulate			4.85E-07	7.60E-09	8.17E-07			3.21E-07	1.63E-06
^{241}Pu	M	particulate								1.72E-11	1.72E-11
^{242}Pu	M	particulate								4.54E-09	4.54E-09
^{223}Ra	M	particulate								1.63E-05	1.63E-05
^{224}Ra	M	particulate								4.14E-04	4.14E-04
^{225}Ra	M	particulate								2.88E-05	2.88E-05
^{226}Ra	M	particulate								4.51E-08	4.51E-08
^{228}Ra	M	particulate								2.34E-05	2.34E-05
^{186}Re	M	particulate								3.58E-10	3.58E-10
^{188}Re	M	particulate								6.91E-04	6.91E-04
^{189}Re	M	particulate								3.04E-11	3.04E-11
^{103m}Rh	M	particulate								1.27E-14	1.27E-14
^{106}Rh	B	unspecified								1.29E-12	1.29E-12
^{219}Rn	B	unspecified								2.49E-08	2.49E-08
^{220}Rn	B	unspecified								2.00E-07	2.00E-07
^{103}Ru	M	particulate								3.43E-04	3.43E-04

Table 5.8 (continued)

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{103}Ru	S	particulate					2.73E-06				2.73E-06
^{106}Ru	M	particulate								4.33E-05	4.33E-05
^{35}S	M	particulate								5.00E-08	5.00E-08
^{120m}Sb	M	particulate								3.77E-05	3.77E-05
^{122}Sb	M	particulate								1.71E-10	1.71E-10
^{124}Sb	M	particulate								7.67E-05	7.67E-05
^{125}Sb	M	particulate								3.71E-06	3.71E-06
^{126}Sb	M	particulate								9.32E-05	9.32E-05
^{127}Sb	M	particulate								8.91E-05	8.91E-05
^{44}Sc	M	particulate								1.96E-22	1.96E-22
^{46}Sc	M	particulate								1.36E-08	1.36E-08
^{47}Sc	M	particulate								2.78E-08	2.78E-08
^{48}Sc	M	particulate								2.17E-08	2.17E-08
^{75}Se	F	particulate								1.02E-10	1.02E-10
^{75}Se	S	particulate			5.42E-02		1.53E-06				5.42E-02
^{31}Si	M	particulate								1.15E-23	1.15E-23
^{145}Sm	M	particulate								2.91E-10	2.91E-10
^{151}Sm	M	particulate								1.99E-15	1.99E-15
^{113}Sn	M	particulate								9.02E-10	9.02E-10
^{117m}Sn	M	particulate								5.25E-05	5.25E-05
^{119m}Sn	M	particulate								2.12E-10	2.12E-10
^{121}Sn	M	particulate								3.39E-10	3.39E-10
^{121m}Sn	M	particulate								4.24E-12	4.24E-12
^{123}Sn	M	particulate								1.74E-15	1.74E-15
^{125}Sn	M	particulate								1.20E-04	1.20E-04
^{85}Sr	M	particulate								2.00E-10	2.00E-10
^{89}Sr	M	particulate	6.30E-08	5.15E-07				7.35E-06		3.14E-04	3.22E-04

Table 5.8 (continued)

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{89}Sr	S	particulate			5.85E-06	3.44E-08				1.09E-04	1.15E-04
^{90}Sr	M	particulate	6.30E-08	5.15E-07				7.35E-06		4.16E-04	4.24E-04
^{90}Sr	S	particulate			5.85E-06	3.44E-08	8.87E-06			1.09E-04	1.24E-04
^{182}Ta	M	particulate								2.49E-08	2.49E-08
^{183}Ta	M	particulate								2.97E-06	2.97E-06
^{184}Ta	M	particulate								4.08E-14	4.08E-14
^{160}Tb	M	particulate								5.40E-10	5.40E-10
^{99}Tc	M	particulate								8.17E-07	8.17E-07
^{99}Tc	S	particulate					9.75E-06			6.37E-05	7.35E-05
^{123m}Te	M	particulate								3.42E-06	3.42E-06
^{125m}Te	M	particulate								1.09E-12	1.09E-12
^{127}Te	M	particulate								2.89E-15	2.89E-15
^{127m}Te	M	particulate								2.95E-15	2.95E-15
^{129m}Te	M	particulate								4.60E-05	4.60E-05
^{132}Te	M	particulate								9.89E-05	9.89E-05
^{227}Th	S	particulate								4.20E-04	4.20E-04
^{228}Th	S	particulate	6.54E-09	5.41E-09	6.61E-09	1.30E-09		1.23E-08		2.64E-05	2.64E-05
^{229}Th	S	particulate								2.29E-08	2.29E-08
^{230}Th	S	particulate	8.83E-10	2.79E-09				6.61E-09		7.13E-08	8.16E-08
^{230}Th	F	particulate			1.09E-08	5.92E-10				3.37E-09	1.49E-08
^{231}Th	S	particulate								4.82E-04	4.82E-04
^{232}Th	S	particulate	3.81E-10	2.45E-09				5.43E-09		1.01E-03	1.01E-03
^{232}Th	F	particulate			7.47E-09	4.91E-10				1.47E-09	9.43E-09
^{234}Th	S	particulate								1.08E-11	1.08E-11
^{45}Ti	M	particulate								1.08E-24	1.08E-24
^{208}Tl	B	unspecified								3.20E-06	3.20E-06
^{232}U	M	particulate								2.00E-07	2.00E-07

Table 5.8 (continued)

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{233}U	M	particulate	2.59E-08					1.02E-07		1.30E-04	1.30E-04
^{233}U	S	particulate			2.85E-07	2.98E-08	9.19E-07			1.32E-05	1.44E-05
^{234}U	M	particulate	2.59E-08	3.60E-07				1.02E-07		2.93E-02	2.93E-02
^{234}U	S	particulate			2.85E-07	2.98E-08	9.19E-07			1.32E-05	1.44E-05
^{235}U	M	particulate	5.42E-09	1.70E-07				4.83E-08		7.35E-03	7.35E-03
^{235}U	S	particulate			2.63E-07	1.76E-08	1.50E-06			1.96E-06	3.74E-06
^{236}U	M	particulate								1.29E-04	1.29E-04
^{236}U	S	particulate								3.24E-06	3.24E-06
^{238}U	M	particulate	3.71E-09	1.30E-07				4.46E-08		8.90E-03	8.90E-03
^{238}U	S	particulate			1.82E-07	1.06E-08	1.26E-06			1.18E-06	2.63E-06
^{49}V	M	particulate								9.82E-10	9.82E-10
^{181}W	M	particulate								1.27E-11	1.27E-11
^{185}W	M	particulate								5.02E-09	5.02E-09
^{187}W	M	particulate								8.22E-03	8.22E-03
^{188}W	M	particulate								6.08E-04	6.08E-04
^{127}Xe	B	unspecified							1.57E+02	4.37E-11	1.57E+02
^{129m}Xe	B	unspecified								9.23E-11	9.23E-11
^{131m}Xe	B	unspecified						1.20E+02		6.02E-08	1.20E+02
^{133}Xe	B	unspecified						5.13E+00		5.66E-09	5.13E+00
^{133m}Xe	B	unspecified						2.05E+01		3.45E-16	2.05E+01
^{135}Xe	B	unspecified	7.15E-06					1.14E+01			1.14E+01
^{135m}Xe	B	unspecified						8.87E+00			8.87E+00
^{137}Xe	B	unspecified						3.84E+01			3.84E+01
^{138}Xe	B	unspecified						5.14E+01			5.14E+01
^{88}Y	M	particulate								3.06E-07	3.06E-07
^{88}Y	F	particulate					2.69E-06				2.69E-06
^{90}Y	M	particulate								5.17E-11	5.17E-11

Table 5.8 (continued)

Isotope	Inhalation form	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{91}Y	M	particulate								1.16E-13	1.16E-13
^{65}Zn	M	particulate								1.34E-05	1.34E-05
^{65}Zn	F	particulate					5.72E-06				5.72E-06
^{69}Zr	M	particulate								1.45E-09	1.45E-09
^{69m}Zr	M	particulate								4.52E-08	4.52E-08
^{93}Zr	M	particulate								2.19E-13	2.19E-13
^{95}Zr	M	particulate								1.48E-06	1.48E-06
^{95}Zr	S	particulate					4.56E-06				4.56E-06
Totals			**4.02E-01**	**4.41E-01**	**4.63E+00**	**9.42E-01**	**1.40E-04**	**1.58E+03**	**2.31E+04**	**6.05E-01**	**2.47E+04**

[a]Emissions given in curies (Ci). 1 Ci = 3.7E+10 Bq

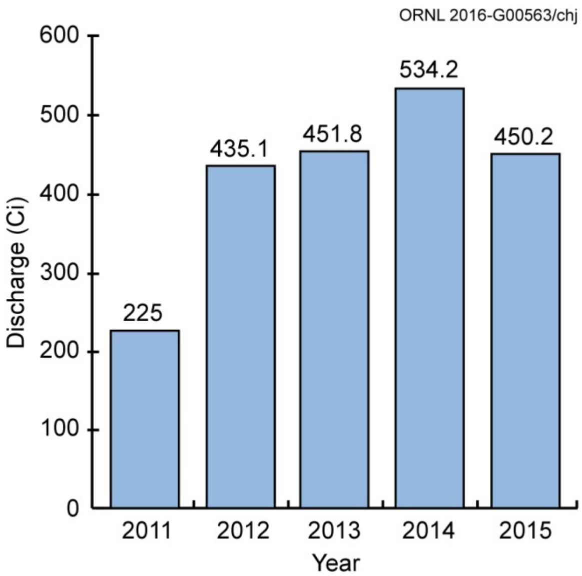

Fig. 5.10. Total curies of tritium discharged from Oak Ridge National Laboratory to the atmosphere, 2011–2015.

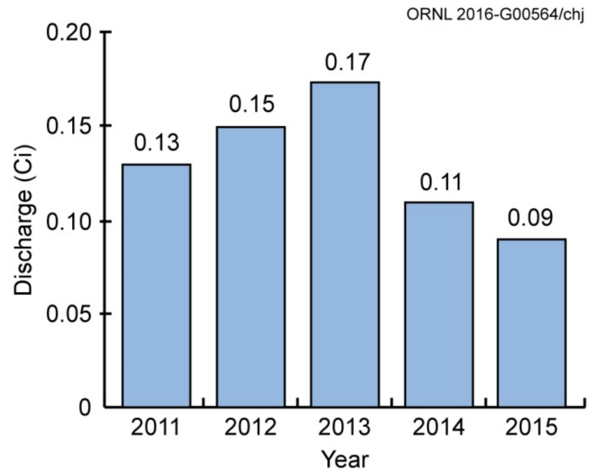

Fig. 5.11. Total curies of 131I discharged from Oak Ridge National Laboratory to the atmosphere, 2011–2015.

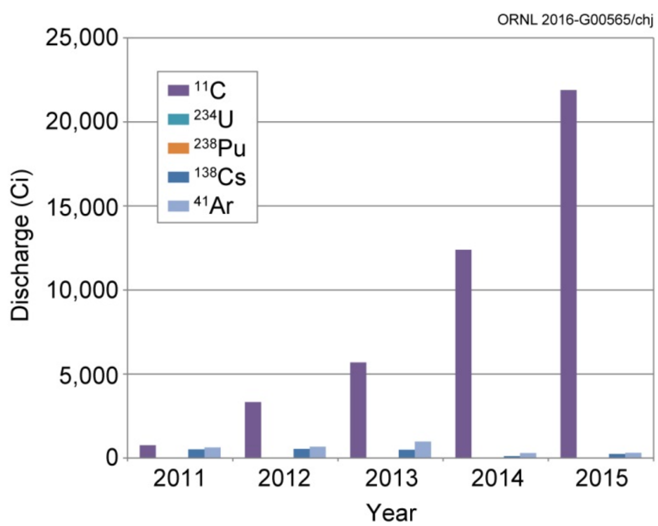

Fig. 5.12. Total discharges of ^{41}Ar, ^{11}C, ^{138}Cs, ^{238}Pu, and ^{234}U from Oak Ridge National Laboratory to the atmosphere, 2011–2015.

5.4.4 Stratospheric Ozone Protection

As required by the CAA Title VI Amendments of 1990, actions have been implemented to comply with the prohibition against intentionally releasing ozone-depleting substances (ODSs) during maintenance activities performed on refrigeration equipment. In addition, service requirements for refrigeration systems (including motor vehicle air conditioners), technician certification requirements, and labeling requirements have been implemented. ORNL has implemented a plan to phase out the use of all Class I

ODSs. (Class I includes the fully halogenated CFCs, halons, and the ODSs that are the most threatening to the ozone layer.) All critical applications of Class I ODSs have been eliminated, replaced, or retrofitted with other materials. Work is progressing as funding becomes available for noncritical applications.

5.4.5 Ambient Air

The ORNL ambient air monitoring network consists of three stations located in areas most likely to show the impacts of airborne emissions from ORNL (Fig. 5.13). During 2015 sampling was conducted at each station to quantify levels of tritium; uranium; and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.9).

The sampling system consists of a low-volume air sampler for particulate collection in a 47 mm glass-fiber filter. The filters are collected biweekly, composited annually, then submitted to an analytical laboratory for analysis. A silica-gel column is used for collection of tritium as tritiated water. Samples are typically collected biweekly or weekly, depending on ambient humidity levels, and composited quarterly for tritium analysis.

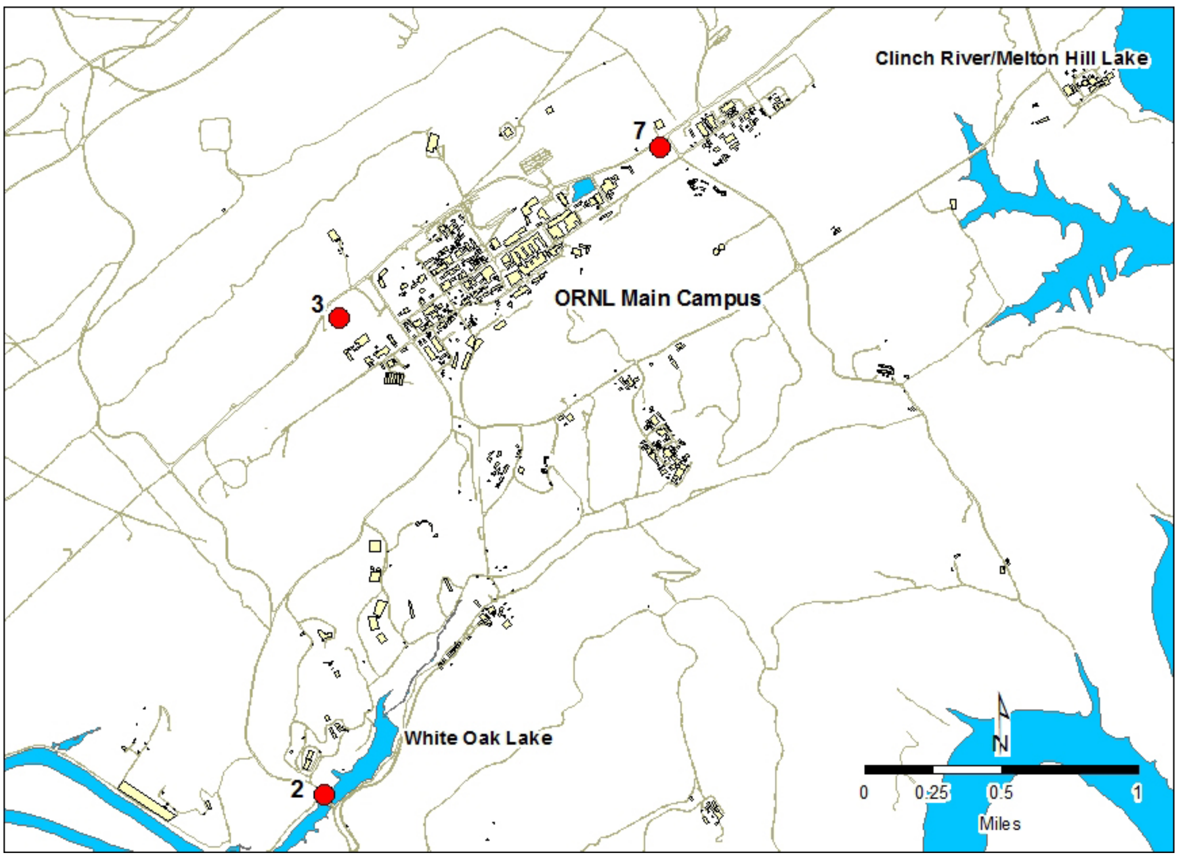

Fig. 5.13. Locations of ambient air monitoring stations at Oak Ridge National Laboratory.

Table 5.9. Radionuclide concentrations (pCi/mL)a measured at Oak Ridge National Laboratory perimeter air monitoring stations, 2015

Parameter	Number detected/ sampled	Concentration		
		Average	Minimum	Maximum
		Station 2		
Alpha	1/1	9.18E-09	*b*	*b*
^{7}Be	1/1	1.73E-08	*b*	*b*
Beta	1/1	1.83E-08	*b*	*b*
^{40}K	0/1	-1.24E-09	*b*	*b*
^{234}U	1/1	4.26E-12	*b*	*b*
^{235}U	0/1	1.11E-13	*b*	*b*
^{238}U	1/1	3.91E-12	*b*	*b*
Total U	1/1	8.29E-12	*b*	*b*
		Station 3		
Alpha	1/1	7.79E-09	*b*	*b*
^{7}Be	1/1	1.93E-08	*b*	*b*
Beta	1/1	1.61E-08	*b*	*b*
^{40}K	0/1	-2.03E-09	*b*	*b*
^{234}U	1/1	6.03E-12	*b*	*b*
^{235}U	0/1	4.21E-14	*b*	*b*
^{238}U	1/1	4.38E-12	*b*	*b*
Total U	1/1	1.04E-11	*b*	*b*
		Station 7		
Alpha	1/1	1.02E-08	*b*	*b*
^{7}Be	1/1	1.97E-08	*b*	*b*
Beta	1/1	1.77E-08	*b*	*b*
^{40}K	0/1	-1.34E-09	*b*	*b*
^{234}U	1/1	5.21E-12	*b*	*b*
^{235}U	1/1	1.37E-12	*b*	*b*
^{238}U	1/1	5.99E-12	*b*	*b*
Total U	1/1	1.26E-12	*b*	*b*

[a] 1 pCi = 3.7×10^{-2} Bq.
[b] Not applicable.

5.4.5.1 Results

The ORNL perimeter air monitoring stations are designed to provide data for collectively assessing the specific impact of ORNL operations on local air quality. Sampling data from these stations (Table 5.9) are compared with derived concentration standards (DCSs) for air established by DOE as guidelines for controlling exposure to members of the public. During 2015, average radionuclide concentrations measured for the ORNL network were less than 1% of the applicable DCSs in all cases.

5.5 Oak Ridge National Laboratory Water Quality Program

NPDES permit TN 0002941, issued to DOE for the ORNL site, was renewed by the State of Tennessee in 2014 and includes requirements for discharging wastewaters from the two ORNL on-site wastewater treatment facilities and for the development and implementation of a water quality protection plan (WQPP). The permit calls for a WQPP to "establish better linkages between water quality monitoring and detecting and abating water quality and ecological impact." Rather than prescribing rigid monitoring schedules, the ORNL WQPP is flexible, allows an annual assessment of all outfalls, and focuses on significant findings. The WQPP goals are to meet the requirements of the NPDES permit, improve the quality of aquatic resources on the ORNL site, prevent further impacts to aquatic resources from current activities, identify the stressors that contribute to impairment of aquatic resources, use available resources efficiently, and communicate outcomes with decision makers and stakeholders.

The ORNL WQPP was developed by UT-Battelle and was approved by TDEC in 2008, and the WQPP monitoring was initiated in 2009. The WQPP incorporated several control plans that were required under the previous NPDES permit, including a BMAP, a chlorine control strategy, a storm water pollution prevention plan, a non-storm-water best management practices plan, and an NPDES radiological monitoring plan. The WQPP has been reviewed and revised annually and submitted to TDEC for review and comment.

To prioritize the stressors and/or contaminant sources that may be of greatest concern to water quality and to define conceptual models that would guide any special investigations, the WQPP strategy was defined using EPA's *Stressor Identification Guidance Document* (EPA 2000). Figure 5.14 summarizes this process. The process involves three major steps for identifying the cause of any impairment:

1. list candidate causes of impairment (based on historical data and a working conceptual model),
2. analyze the evidence (using both case study and outside data), and
3. characterize the causes.

The first two steps of the stressor identification process were initiated in 2009, focusing first on mercury impairment (Fig. 5.15) and then on PCBs because mercury and PCB concentrations in fish from WOC are at or near human health risk thresholds [e.g., EPA ambient water quality criteria (AWQCs) and TDEC fish advisory limits]. Some of the major sources of mercury to biota in the WOC watershed are known, providing a good basis from which to define an appropriate conceptual model for mercury contamination in WOC. A list of potential causes of PCB contamination was also developed.

After potential causes were listed and the available evidence on mercury and PCB contamination in the WOC watershed was analyzed, it was clear that additional investigation was needed to characterize the causes. Special investigations were designed to identify specific source areas and to revise the conceptual model of the major causes of contamination in the WOC watershed.

At the end of each year, monitoring and investigation data collected under the ORNL WQPP are analyzed, interpreted, reported, and compared with past results in the WQPP annual report. This information provides a solid, overall assessment of the status of ORNL's receiving-stream watersheds and the impact of ongoing efforts to protect and restore those watersheds and will guide efforts to improve the water quality in the watershed.

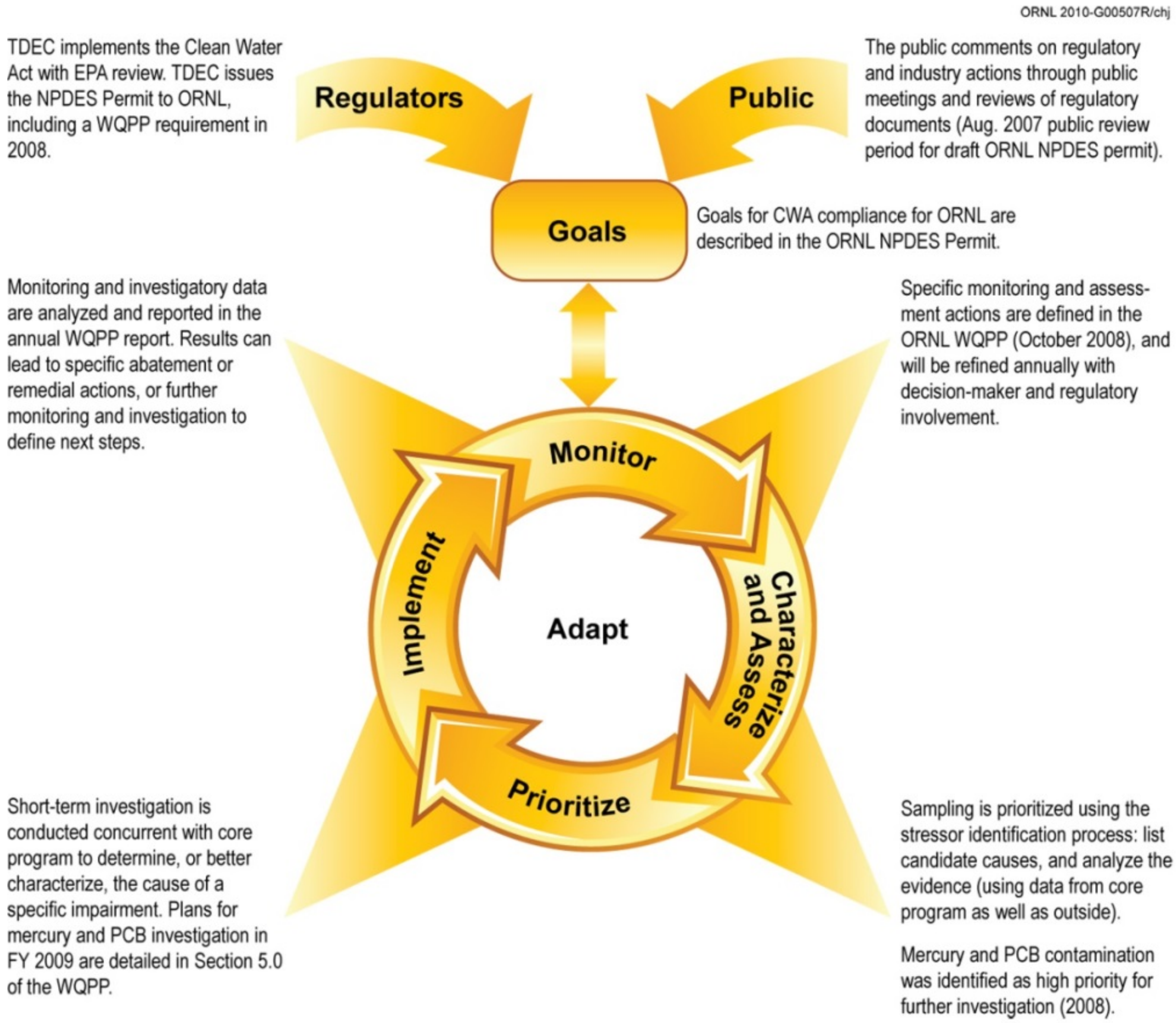

Fig. 5.14. Diagram of the adaptive management framework with step-wise planning specific to the Oak Ridge National Laboratory Water Quality Protection Plan (WQPP). *[Adapted from the US Environmental Protection Agency (EPA) stressor guidance document (EPA 2000). Acronyms: CWA = Clean Water Act, NPDES = National Pollutant Discharge Elimination System, ORNL = Oak Ridge National Laboratory, PCB = polychlorinated biphenyl, TDEC = Tennessee Department of Environment and Conservation.]*

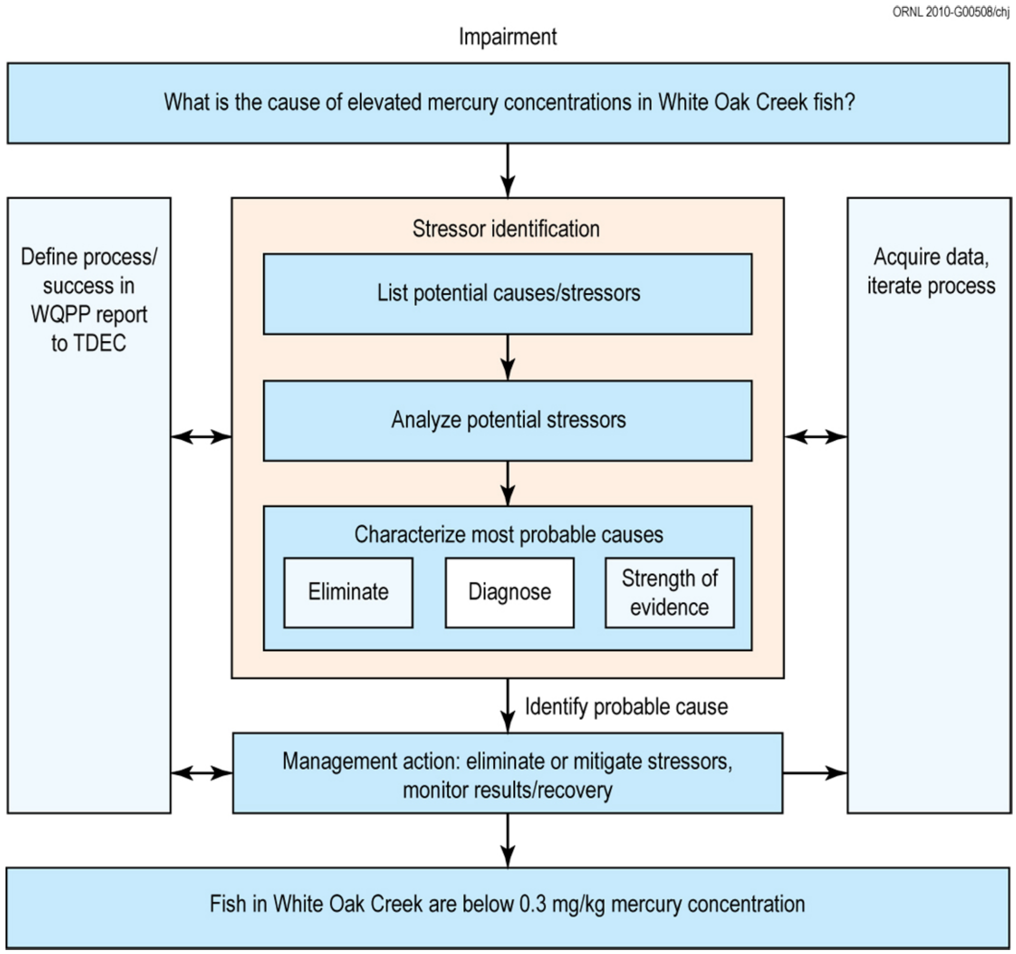

Fig. 5.15. Application of stressor identification guidance to address mercury impairment in the White Oak Creek watershed. *[Modified from Figure 1-1 in the US Environmental Protection Agency stressor guidance document (EPA 2000). TDEC = Tennessee Department of Environment and Conservation, WQPP = water quality protection plan.]*

5.5.1 Treatment Facility Discharges

Two on-site wastewater treatment systems were operated at ORNL in 2015 to provide appropriate treatment of the various R&D, operational, and domestic wastewaters generated by site staff and activities. Both were permitted to discharge treated wastewater and were monitored under NPDES Permit TN0002941, issued to DOE for the ORNL site by TDEC. These are the ORNL STP (outfall X01) and the ORNL PWTC (outfall X12). The ORNL NPDES permit requirements include monitoring the two ORNL wastewater treatment facility effluents for conventional, water-quality-based, and radiological constituents and for effluent toxicity, with numeric parameter-specific compliance limits established by TDEC as determined to be necessary. The ORNL NPDES permit was last renewed by TDEC in March 2014. The results of field measurements and laboratory analyses to assess compliance for the parameters required by the NPDES permit and rates of compliance with numeric limits established in the permit are provided in Table 5.10. ORNL wastewater treatment facilities achieved 99% compliance with permit limits and conditions in 2015. On infrequent occasions, the plant has gone into partial-treatment mode (disinfection) when the influent-handling capacity was exceeded due to heavy rain storms. A project to upgrade the ORNL STP is in design, including increased influent-handling capacity. The project is planned to be completed in 2016.

Table 5.10. National Pollutant Discharge Elimination System compliance at Oak Ridge National Laboratory, January through December 2015

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (lb/day)	Daily max. (lb/day)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
X01 (ORNL Sewage Treatment Plant)								
LC_{50} for *Ceriodaphnia* (%)					100	0	1	100
LC_{50} for fathead minnows (%)					100	0	1	100
Ammonia, as N (summer)	6.26	9.39	2.5	3.75		4[b]	26	84.62
Ammonia, as N (winter)	13.14	19.78	5.25	7.9		0	26	100
Carbonaceous biological oxygen demand	19.2	28.8	10	15		0	52	100
Dissolved oxygen					6	0	52	100
Escherichia coliform (col/100 mL)			941	126		0	52	100
Oil and grease				15		0	1	100
pH (standard units)				9	6	0	52	100
Total suspended solids	57.5	86.3	30	45		0	52	100
X12 (Process Waste Treatment Complex)								
LC_{50} for *Ceriodaphnia* (%)					100	0	1	100
LC_{50} for fathead minnows (%)					100	0	1	100
Arsenic, total				0.014		0	4	100
Chromium, total				0.44		0	4	100
Copper, total				0.11		0	4	100
Cyanide, total				0.046		0	2	100
Lead, total				0.69		0	4	100
Oil and grease				15		0	12	100
pH (standard units)				9.0	6.0	0	52	100
Temperature (°C)				30.5		0	52	100
Instream chlorine monitoring points								
Total residual oxidant			0.011	0.019		0	792	100

[a] Percentage compliance = 100 – [(number of noncompliances/number of samples) × 100].
[b] There were three measured effluent ammonia-limit exceedances, which resulted in a fourth, calculated exceedance of a monthly average limit in May 2015 at the STP Outfall X01. There were sludge management issues due to equipment reaching the end of its design life; these issues were resolved by the end of May 2015.

Abbreviated terms

LC_{50} = lethal concentration; the concentration (as a percentage of full-strength wastewater) that kills 50% of the test species in 48 h.
IC_{25} = inhibition concentration; the concentration (as a percentage of full-strength wastewater) that causes 25% reduction in survival, reproduction, or growth of the test organisms.
NPDES = National Pollutant Discharge Elimination System
ORNL = Oak Ridge National Laboratory

Toxicity testing provides an assessment of any harmful effects that could occur from the total combined constituents in discharges from ORNL wastewater treatment facilities. Effluents from the STP have been required to be tested for toxicity to aquatic species under the NPDES permit every year since 1986, and effluents from PWTC have been tested since it went into operation in 1990. Test species have been *Ceriodaphnia dubia* (*C. dubia*), an aquatic invertebrate, and fathead minnow (*Pimephales promelas*) larvae. They have been tested using EPA chronic and acute test protocols at frequencies ranging from one to four times per year. Test results have been excellent. PWTC effluent has always been shown to be nontoxic. The STP has shown isolated indications of effluent toxicity, none recent, but confirmatory tests conducted as required by the permit have shown that either the result of the routine test was an anomaly or that the condition of toxicity that existed at the time of the routine test was temporary and of short duration.

Toxicity test requirements under the current NPDES permit include testing the ORNL STP and PWTC once per year each, using two test species. In 2015, toxicity test results for the ORNL wastewater treatment facilities were once again favorable, with no indication of toxicity in any of the tests that were conducted (Table 5.10).

5.5.2 Residual Bromine and Chlorine Monitoring

Chlorine is added to drinking water as a disinfectant prior to consumption. Chlorine and bromine are added to cooling system water to prevent bacterial growth in the system. When waters are discharged to streams, residual chlorine and bromine can be toxic to fish and other aquatic life. The ORNL NPDES permit controls the discharge of chlorinated and brominated waters, reported as “total residual oxidant” (TRO), by limiting the TRO mass loading from outfalls and the instream TRO concentration. Outfalls with low potential to discharge chlorinated water are generally monitored semiannually; outfalls with known sources that are dechlorinated are monitored more frequently to ensure operational integrity of the dechlorinator. Instream locations are monitored bimonthly.

NPDES permit outfalls are monitored for TRO to ensure effective operation of cooling towers and dechlorination systems and maintenance of waterlines. When the permit action level of 1.2 g/day is exceeded at an outfall, the staff investigate and implement treatment and reduction measures. TRO is also monitored at instream points twice per month to verify that releases are not creating adverse conditions for fish and other aquatic life.

Twenty-two individual outfalls are checked for TRO either semiannually, quarterly, monthly, or bimonthly. Flow was detected 273 times in the outfalls. Table 5.11 lists instances in 2015 where TRO levels at outfalls were found to be in excess of the permit action level. One outfall tested, Outfall 267, was found once to be in excess of the permit action level of 1.2 g/day. A valve for supplied water was inadvertently diverted around a carbon prefilter in Building 3147 that is designed to remove residual chlorine and other contaminants from the incoming potable supply water. The residual chlorine in Outfall 267 was below detection after the valve was reopened.

Table 5.11. Outfalls exceeding total residual oxidant NPDES permit action level in 2015a

Sample date	Outfall	TRO concentration (mg/L)	Flow (gpm)	Load (g/day)	Receiving stream	Downstream integration point	Instream TRO point
2/5/2015	267	0.75	12	49.05	Fifth Creek	FFK 0.2	X19

[a] The National Pollutant Discharge Elimination System (NPDES) action level is 1.2 g/day.

Acronyms
FFK = Fifth Creek kilometer
TRO = total residual oxidant

5.5.3 Radiological Monitoring

At ORNL, monitoring of liquid effluents and selected instream locations for radioactivity is conducted under the WQPP. Table 5.12 details the analyses performed on samples collected in 2015 at two treatment facility outfalls, three instream monitoring locations, and 20 category outfalls (outfalls that are categorized into groups with similar effluent characteristics for the purposes of setting monitoring and reporting requirements in the site NPDES permit). Dry-weather discharges from category outfalls are primarily cooling water, groundwater, and condensate. Low levels of radioactivity can be discharged from category outfalls in areas where groundwater contamination exists and where contaminated groundwater enters category outfall collection systems from building and facility sumps, building footer drains, and direct infiltration. In 2015, dry-weather grab samples were collected at 15 of the 20 category outfalls targeted for sampling. Five category outfalls (205, 241, 265, 284, and 368) were not sampled because there was no discharge present during sampling attempts.

The ORNL STP outfall (outfall X01) and PWTC outfall (outfall X12) were monitored for radioactivity in 2015. Instream monitoring was also performed at X13 on Melton Branch, X14 on WOC, and X15 at White Oak Dam (WOD) (Fig. 5.16). At each treatment facility and instream monitoring location, monthly flow-proportional composite samples were collected using dedicated automatic water samplers.

DOE DCSs are radionuclide-specific concentration limits used to evaluate discharges of radioactivity from DOE facilities. DCSs were developed for evaluating effluent discharges and are not intended to be applied to instream values, but such comparisons can provide a useful frame of reference. Four percent of the DCS is roughly equivalent to the 4 mrem dose limit on which the EPA radionuclide drinking water standards are based and is a convenient comparison point. Although these comparisons are made, neither ORNL effluents nor ambient surface waters are direct sources of drinking water. The annual average concentration of at least one radionuclide exceeded 4% of the relevant DCS concentration in dry-weather discharges from NPDES outfalls 080, 085, 204, 207, 302, 304, X01, and X12 and at instream sampling locations on Melton Branch and at WOD (Fig. 5.17).

In 2015, average total radioactive strontium (^{89,90}Sr) concentrations at Outfalls 085, 207, and 304 exceeded the DCS for ^{90}Sr (it is reasonable to assume that ^{89,90}Sr activity is comparable to ^{90}Sr activity due to the relatively short half-life of ^{89}Sr—50.55 days). The concentrations of ^{89,90}Sr were 300%, 150%, and 820% of the DCS at outfalls 085, 207, and 304 respectively. Consequently, concentrations of radioactivity in discharges from each of these three outfalls were also greater than DCS levels on a sum-of-fractions basis (i.e., on the basis of the summation of DCS percentages of multiple radiological parameters); the sum-of-fractions were 330%, 160% and 830% respectively.

Table 5.12. Radiological monitoring conducted under the Oak Ridge National Laboratory Water Quality Protection Plan, 2015

Location	Frequency	Gross alpha/beta	Gamma scan	^{3}H	^{14}C	$^{89/90}$Sr	^{99}Tc	Isotopic uranium	Isotopic plutonium	^{241}Am	$^{243/244}$Cm
Outfall 001	Annual	X									
Outfall 080	Monthly	X	X	X		X				X [a]	X
Outfall 081	Annual	X									
Outfall 085	Quarterly	X	X	X		X		X [a]	X [a]	X [a]	X [a]
Outfall 203	Annual	X	X			X					
Outfall 204	Semiannual	X	X			X					
Outfall 205 [b]	Annual										
Outfall 207	Quarterly	X	X [a]			X [a]		X [a]	X [a]	X [a]	X [a]
Outfall 211	Annual	X									
Outfall 234	Annual	X									
Outfall 241 [b]	Quarterly										
Outfall 265 [b]	Annual										
Outfall 281	Quarterly	X		X							
Outfall 282	Quarterly	X									
Outfall 284 [b]	Annual										
Outfall 302	Monthly	X	X	X		X	X [a]	X [a]	X [a]	X [a]	X [a]
Outfall 304	Monthly	X	X	X		X	X [a]	X [a]	X [a]	X [a]	X [a]
Outfall 365	Semiannual	X									
Outfall 368 [b]	Annual										
Outfall 383	Annual	X		X							
STP (X01)	Monthly	X	X	X	X	X					
PWTC (X12)	Monthly	X	X	X		X	X [a]	X	X [a]	X [a]	X [a]
Melton Branch (X13)	Monthly	X	X	X		X					
WOC (X14)	Monthly	X	X	X		X					
WOD (X15)	Monthly	X	X	X		X					

[a] The Water Quality Protection Plan does not require this parameter for this location, and therefore it may have been monitored on a frequency less than indicated in the table. Additional analyses are sometimes performed on samples, the most common reason being that gross alpha and gross beta activities exceeded a screening criteria (as described in the May 2012 update to the Water Quality Protection Plan).

[b] The outfall was included in the monitoring plan, but samples were not collected because no discharge was present during sampling attempts.

Acronyms

PWTC = Process Waste Treatment Complex
STP = Sewage Treatment Plant
WOC = White Oak Creek
WOD = White Oak Dam

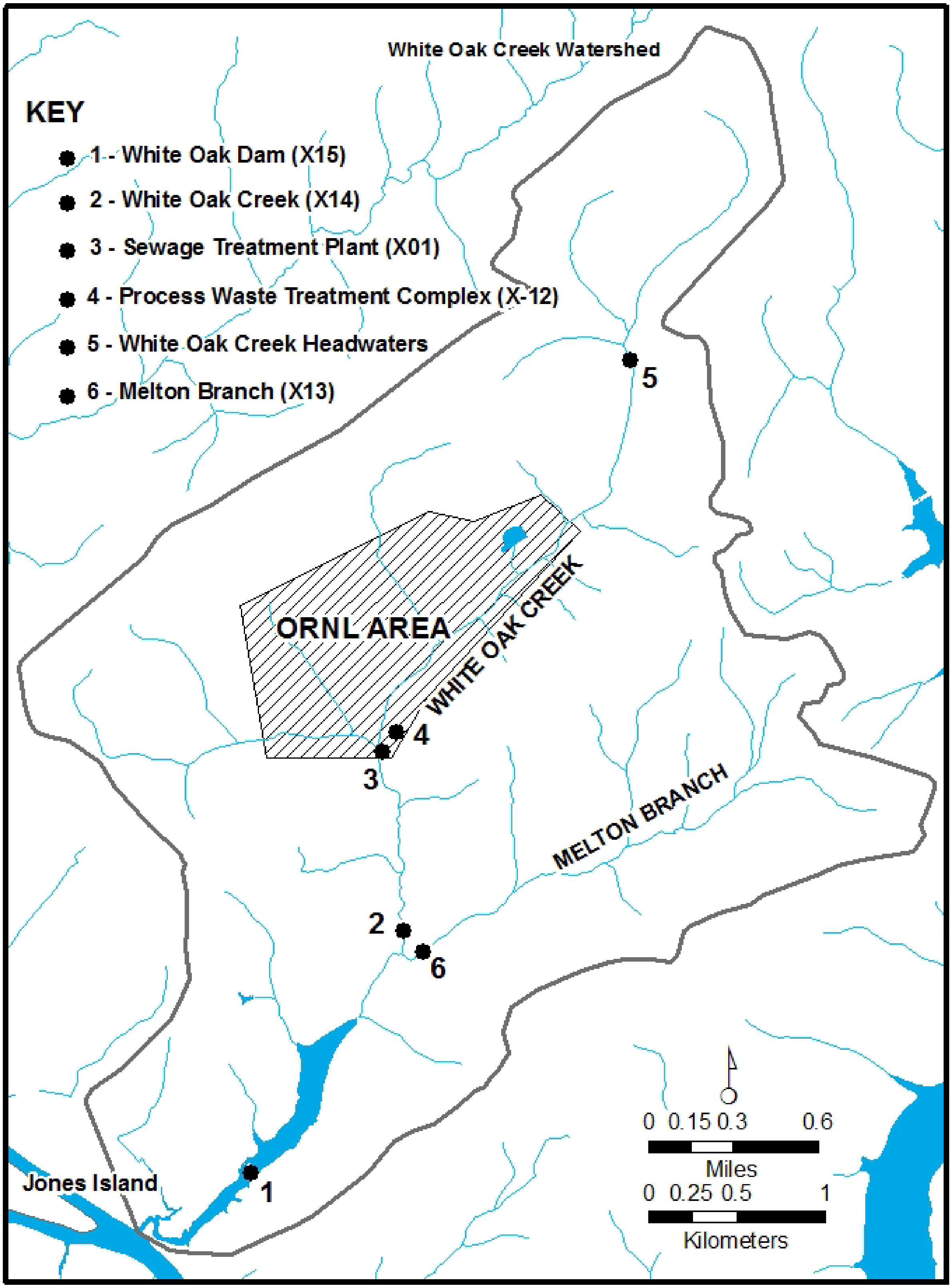

Fig. 5.16. Selected surface water, National Pollutant Discharge Elimination System, and reference sampling locations at Oak Ridge National Laboratory.

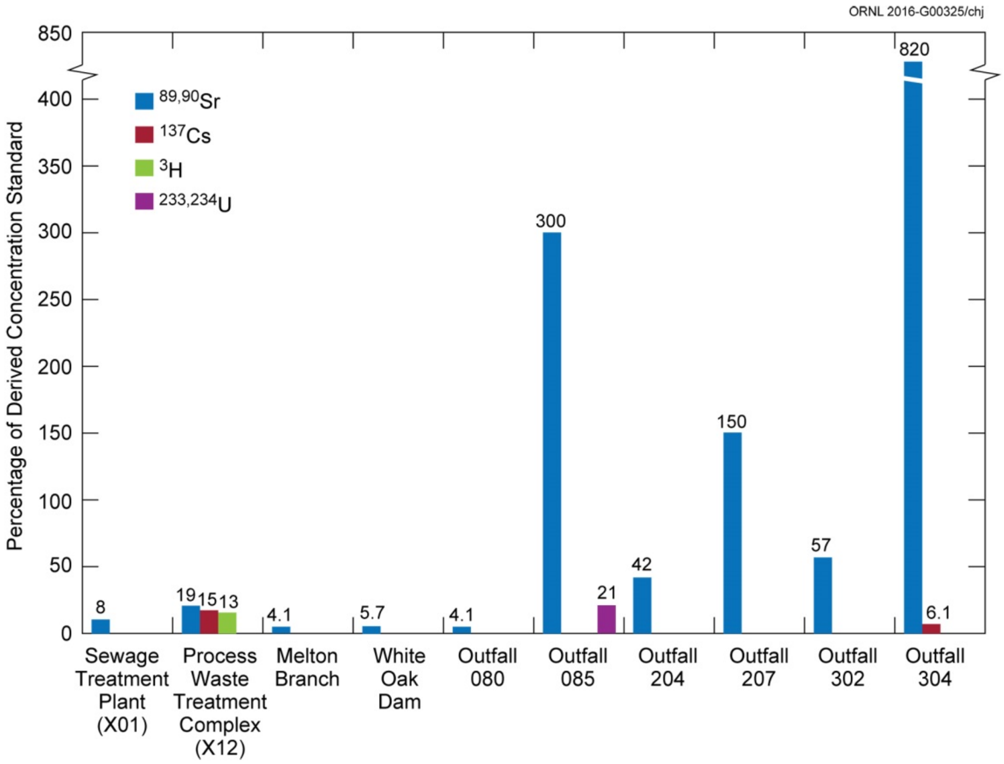

Fig. 5.17. Outfalls and instream locations at Oak Ridge National Laboratory with average radionuclide concentrations greater than 4% of the relevant derived concentration standards in 2015.

The increases in radioactivity concentrations at outfall 085 in 2015 are believed to be the result of existing underground contamination being mobilized by a water leak in Building 7830A. In the early morning hours of February 23, 2015, a pipe that is part of the fire suppression system in that building froze and ruptured. Workers discovered the leak later that morning and quickly isolated it. The facility was dewatered, and no surface contamination was found in areas where water exited a door of the facility. Outfall 085 is the outlet of the foundation drain for that facility, and it is sampled for radioactivity under the WQPP on a quarterly basis. The first sample collected following the water leak was on April 23, 2015; elevated concentrations of radioactivity, primarily from ^{89,90}Sr and ^{233,234}U, were detected. The highest concentrations measured after the water leak were from that first set of samples, and they were 6,600 pCi/L ^{89,90}Sr and 380 pCi/L ^{233,234}U. Other than the leak from the fire suppression system, the follow-up investigation discovered no changes or occurrences at the facility that would cause increases of radioactivity in the foundation drain. Concentrations have been steadily declining since April 2015, but they have not yet returned to levels that existed prior to the leak.

As reported in the 2014 *Oak Ridge Reservation Annual Site Environmental Report for 2014* (DOE 2015), levels of radioactivity started increasing at outfalls 207 and 304 in 2014 as a result of a failed pump in a groundwater suppression sump at the DOE Office of Environmental Management (EM) WOC-9 (WC-9) Low Level Liquid Waste Tank Farm, a CERCLA soil and groundwater contamination area. The stormwater collection networks for both outfalls extend to areas near WC-9, and it is believed that when it is operational, the sump pump suppresses groundwater levels, preventing or minimizing leakage of contaminated groundwater into the storm drains from the area around WC-9. The sump pump was repaired, but it is believed that levels of radioactivity continue to be elevated at Outfall 207 as a result of these 2014 events.

There were additional increases in radioactivity levels in discharges from outfall 304 in 2015. In June 2015, levels of radioactivity, primarily ^{89,90}Sr, began increasing at outfall 304. Concentrations exceeded those observed in 2014, with ^{89,90}Sr eventually peaking at 29,000 pCi/L in August and September. A dye tracer test conducted during the subsequent investigation led to the discovery that there was a leak in an underground pipe that leads from Pump Station #2 to a downstream diversion box in the PWTC and that there was a groundwater connection between the location of the leak and a nearby catch basin in the outfall 304 storm drain network. Following that discovery, the leaky section of pipe was bypassed and was taken out of service. Since the bypass was implemented, levels of radioactivity in the outfall effluent have trended downward but continue to be above DCS levels. No additional infrastructure issues affecting outfall 304 have been discovered, and it is believed that concentrations of radioactivity in outfall 304 effluent will slowly decline as concentrations of radioactivity in the groundwater surrounding the outfall pipe decline from normal hydrologic processes.

The total annual discharges (or amounts) of radioactivity measured in stream water at WOD, the final monitoring point on WOC before the stream flow leaves ORNL, were calculated from concentration and flow. Results of those calculations for each of the past 5 years are shown in Figs. 5.18 through 5.22. Because discharges of radioactivity are somewhat correlated to stream flow, annual flow volumes measured at the WOD monitoring station are given in Fig. 5.23. Discharges of radioactivity at WOD in 2015 were similar to those made in recent years, particularly when taking into account differences in annual flow volume and continue to be generally lower than in the years preceding completion of the waste area caps in Melton Valley (substantially complete by 2006).

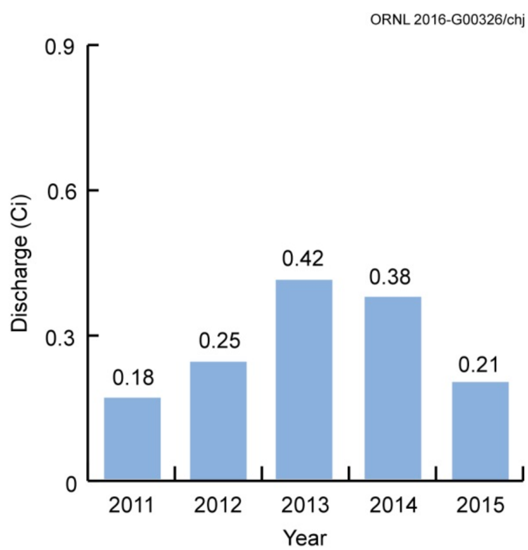

Fig. 5.18. Cesium-137 discharges at White Oak Dam, 2011–2015.

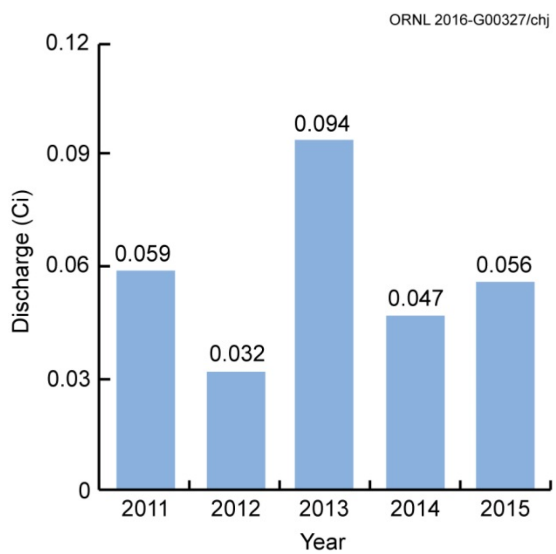

Fig. 5.19. Gross alpha discharges at White Oak Dam, 2011–2015.

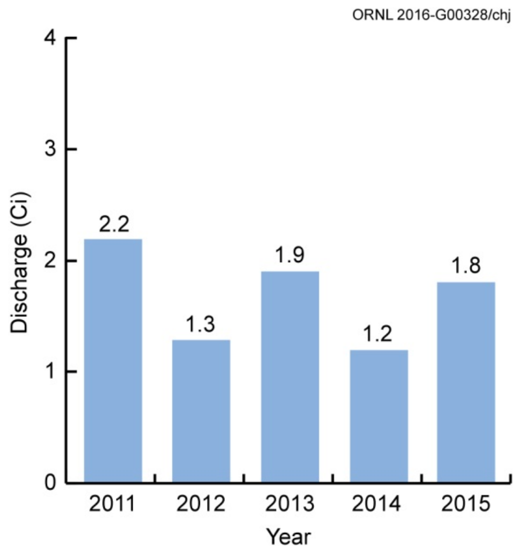

Fig. 5.20. Gross beta discharges at White Oak Dam, 2011–2015.

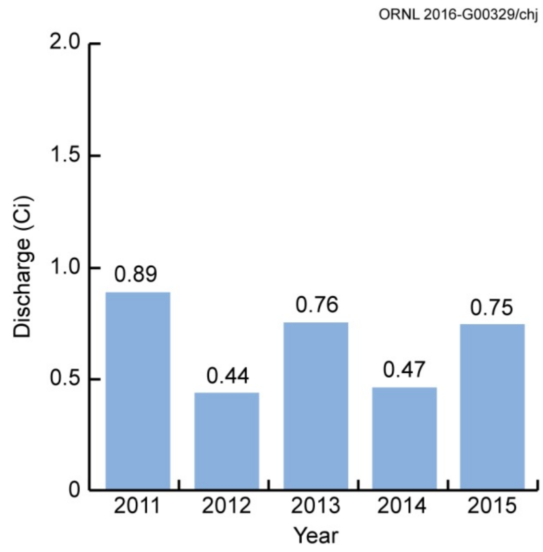

Fig. 5.21. Total radioactive strontium discharges at White Oak Dam, 2011–2015.

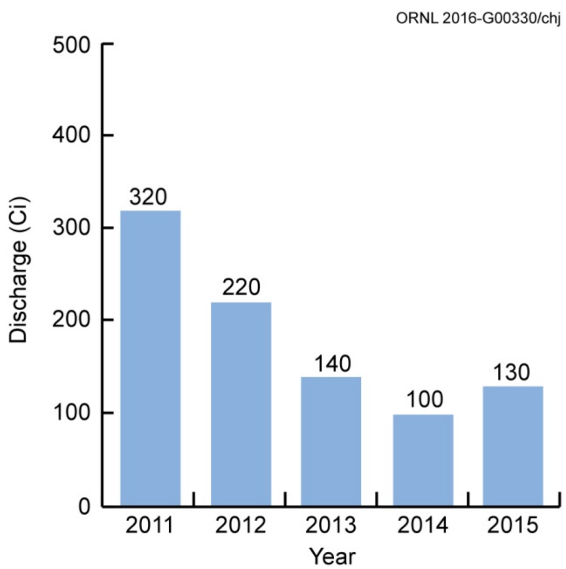

Fig. 5.22. Tritium discharges at White Oak Dam, 2011–2015.

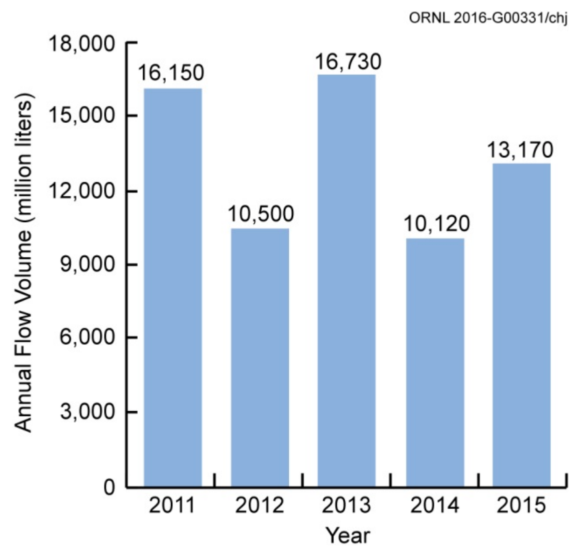

Fig. 5.23. Annual flow volume at White Oak Dam, 2011–2015.

Radiological monitoring at category outfalls in 2015 also included monitoring of 10 storm water outfalls during storm runoff conditions. Storm water samples were analyzed for gross alpha, gross beta, Sr-89/90, and tritium activities. A gamma scan analysis was also performed. The monitoring plan calls for additional analyses to be added when sufficient gross alpha and/or gross beta activity is present in a sample to indicate that levels of radioactivity may exceed DCS levels, but in 2015 no additional analyses were required.

Concentrations of radioactivity in storm water discharges were compared with DCSs if a DCS existed for that parameter (there are no DCSs for gross alpha or gross beta activities) and if the concentration was greater than or equal to the minimum detectable activity for the measurement. The $^{89/90}$Sr concentration at outfall 004 was 17% of the DCS.

5.5.4 Mercury in the White Oak Creek Watershed

Legacy mercury environmental contamination exists at ORNL, largely as a result of spills and releases that occurred in the 1950s during pilot-scale isotope separation work in Buildings 3503, 3592, 4501, and 4505. As a result, mercury is present in soils and groundwater in and around the four facilities. Buildings 3592 and 3503 were taken down and removed under the CERCLA remedial process in 2011 and 2012, respectively. Mercury is also present in Fifth Creek and WOC surface streams that receive surface runoff and groundwater flow from the area of these buildings.

In the past, process wastewater drains and building sumps from Buildings 4501 and 4505, the facilities where most of the ORNL mercury work was conducted, were routed via underground collection-system piping to the ORNL PWTC for treatment to remove constituents, including mercury, before discharge to WOC. Since 2007, three additional groundwater sumps have been redirected to receive treatment for mercury removal, and a mercury pretreatment system was installed on one of the sumps, in Building 4501. These recent actions have significantly diminished the release of legacy mercury contamination from the ORNL site to the WOC watershed (Fig. 5.24).

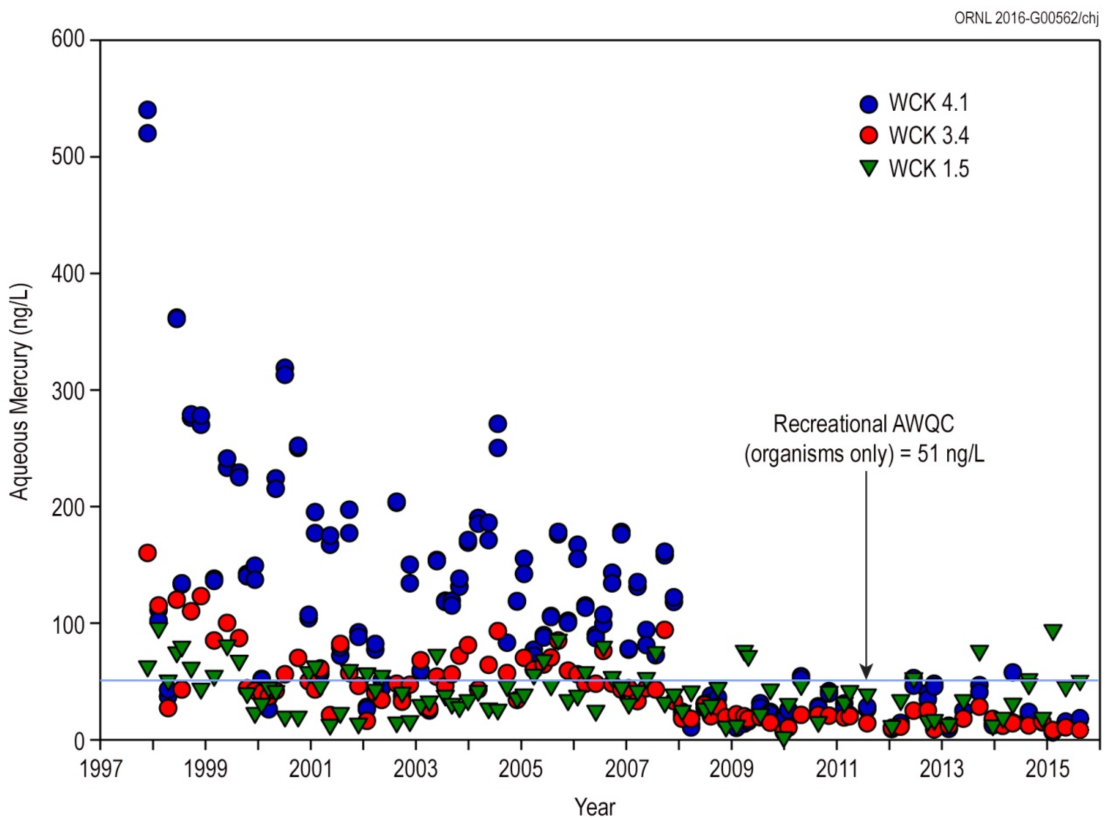

Fig. 5.24. Total aqueous mercury concentrations at sites in White Oak Creek downstream from Oak Ridge National Laboratory, 1998–2015. *(AWQC = ambient water quality criterion; WCK = White Oak Creek kilometer.)*

For the WQPP mercury-investigation component, effluent sampling at various outfalls and instream reaches is being conducted to help prioritize future abatement actions and to delineate mercury sources.

In 2015, monitoring conducted under WQPP included dry-weather sampling at a number of instream points in the WOC watershed upstream, within, and downstream from ORNL and ORNL NPDES outfalls where previous monitoring or site history has shown the potential for effluent mercury. Flow measurements were made for instream and outfall sampling locations. Values for concentration and flux (the amount of a substance detected per unit time in flowing water) were measured and calculated. Selected results of the 2015 monitoring are shown in Fig. 5.25. Semiannual monitoring at Melton Branch kilometer (MEK) 0.6 was discontinued in 2015 due to the consistently low mercury levels found there from 2009 to 2014. Complete mercury monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to OREIS can be requested via email (oreis@ettp.doe.gov) or by telephone (865-574-3257).

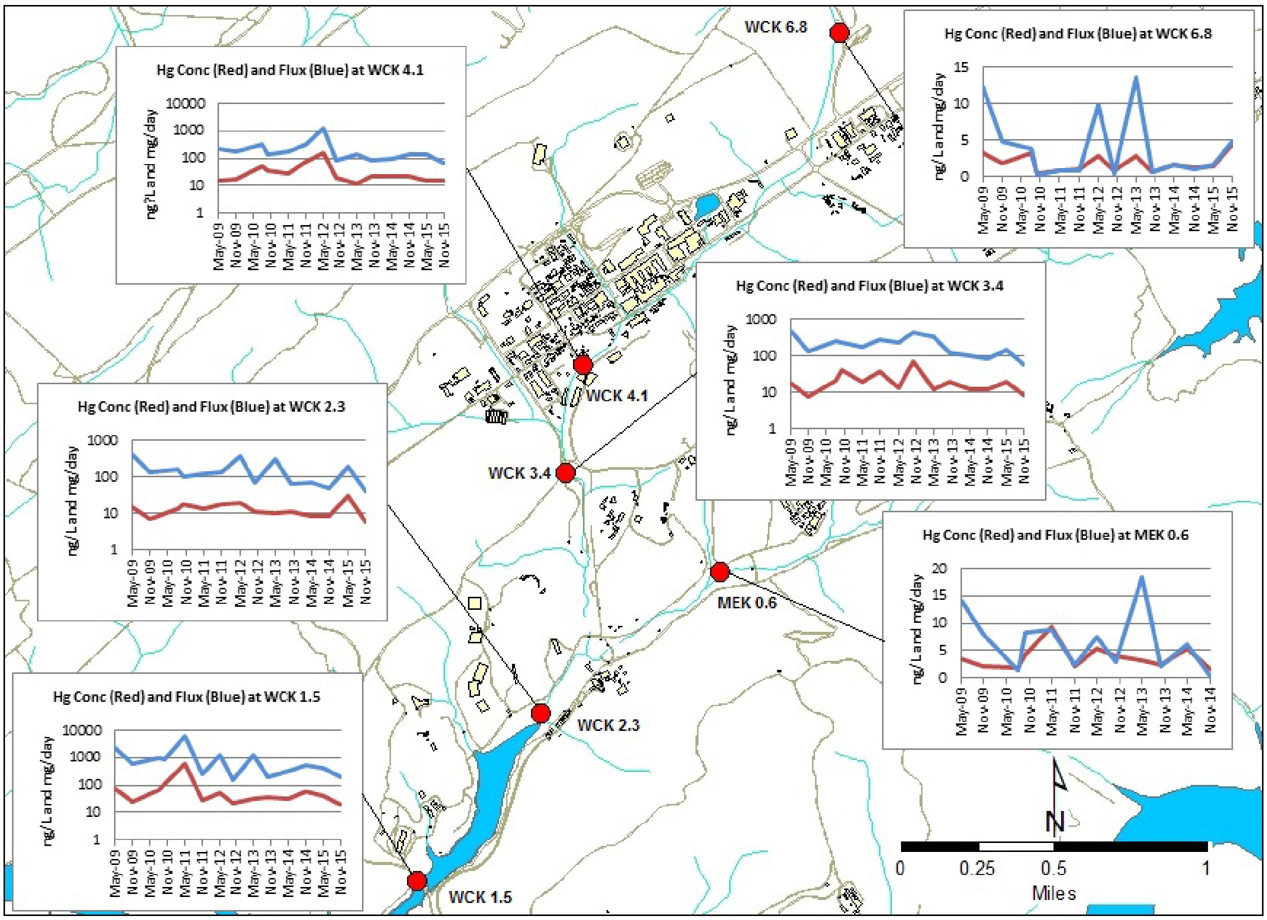

Fig. 5.25. Total mercury concentration and flux at selected Oak Ridge National Laboratory instream locations, 2009 through 2015.

Monitoring results for 2015 indicated that Tennessee mercury water-quality criteria (WQCs) were met at all instream locations monitored in the WOC watershed.

In 2015, targeted WQPP mercury monitoring included repeating a study that was first done in 2011, where selected reaches of two ORNL streams, Fifth Creek and WOC, were monitored for mercury at various locations and time intervals. The purpose of the study was to assess whether mercury concentrations in a reach of stream increase or decrease from the upper end to the lower end, and if so, whether there are discernable spatial or temporal patterns to the changes. Both stream reaches studied showed consistent increases in mercury flux and concentration, moving from the upper to the lower end, as would be expected given that individual ORNL storm water outfalls along the reaches were shown to introduce mercury into their respective stream reaches. One main finding from the study was that mercury concentrations and fluxes were significantly lower in several of the locations monitored than at those same spots in 2011; this was mainly true in the WOC locations. The data also showed apparent mercury flux increases occurring in the lower (downstream) end of both stream reaches that were not completely explained by the flux data from the individual outfalls. A follow-up study is being planned for the future to investigate these two stream sub-reaches more closely.

In 2015 the WQPP Mercury Subteam began drafting an internal ORNL mercury “white paper,” a narrative information summary of mercury on the ORNL site, past and present. The white paper will include summaries of the work done under the WQPP and will remain an open/living document for future augmentation.

In 2015, improvements were made at the ORNL PWTC, the wastewater treatment facility where mercury-bearing legacy wastewater is treated before being released to WOC. The PWTC treatment units include granular activated carbon filter columns, and in 2014 the filter media in one of the columns was replaced with sulfur-impregnated carbon that is optimized for mercury removal. PWTC effluent-monitoring data collected in 2015 continue to show noticeable improvement in the plant’s mercury-removal efficiency. An ongoing WQPP mercury-characterization monitoring protocol, which has been maintained at various instream- and outfall-monitoring locations in the WOC watershed since 2009, continued in 2015.

5.5.5 Storm Water Surveillances and Construction Activities

Substantive requirements of the appropriate water pollution control permits are followed for construction areas at ORNL that are part of CERCLA remediation, but official permit coverage is not required. Figure 5.26 depicts the location of construction sites that were active in 2015. Only two sites were inspected to evaluate overall effectiveness of the best management practices in use. They were considered significant and thus subject to inspection because they occupy an area of nearly 1 acre or more than 1 acre and/or because of the requirements of a Tennessee construction general permit. In general, while some short-term impacts to receiving streams were noted, no long-term adverse impacts were observed.

Land use within drainage areas is typical of office/industrial settings with surface features including laboratories, support facilities, paved areas, and grassy lawns. Outdoor material storage is most prevalent in the 7000 area on the east end of the main ORNL facility (where most of the craft and maintenance shops are located), with other smaller outdoor storage areas located throughout the facility in and around loading docks and material delivery areas at laboratory and office buildings. The types of materials stored outside include metal items (sheeting, pipes, and parts); equipment awaiting use, disposal, or repair; construction material; and deicer product.

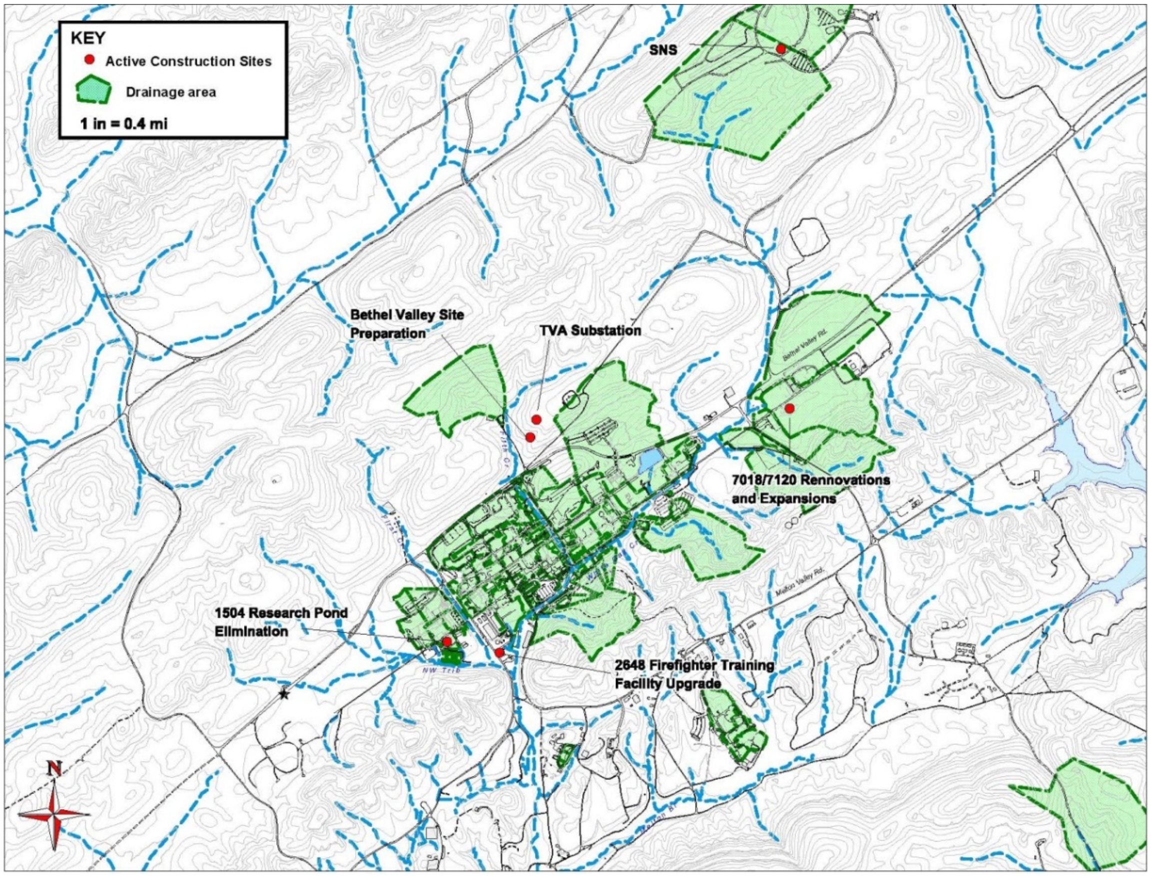

Fig. 5.26. Active construction sites and Oak Ridge National Laboratory Water Quality Protection Plan monitoring locations, 2015.
(SNS = Spallation Neutron Source, TVA = Tennessee Valley Authority)

Some construction activities are performed on third-party-funded construction projects under agreement with other local, state, and federal agencies on the ORR. There are mechanisms in place for ensuring effective storm water controls at these third-party sites, one of which includes staff from UT-Battelle acting as points of contact for communication interface on environmental, spill/emergency response, and other key issues.

5.5.6 Biological Monitoring

5.5.6.1 Bioaccumulation Studies

The bioaccumulation task for BMAP addresses two NPDES permit requirements at ORNL: (1) evaluate whether mercury at the site is contributing to a stream at a level that will adversely affect fish and other aquatic life or that will violate the recreational criteria and (2) monitor the status of PCB contamination in fish tissue in the WOC watershed. Concentrations of mercury in fish in the WOC watershed are monitored annually and are evaluated relative to the EPA AWQC of 0.3 mg/g in fish fillets, a concentration considered to be protective of human health and the environment. Concentrations of PCBs in fish fillets are also monitored annually and are evaluated relative to the TDEC fish advisory limit of 1 μg/g.

5.5.6.1.1 Mercury in Water

In continuation of a monitoring effort initiated in 1997, bimonthly water samples were collected from WOC at four sites in 2015. Stream conditions were selected to be representative of seasonal base-flow conditions (dry weather, clear flow) based on historical results that indicate higher mercury concentrations under those conditions.

The concentration of mercury in WOC upstream from ORNL was less than 2 ng/L in 2015. Long-term trends in waterborne mercury in the WOC system downstream of ORNL are shown in Fig. 5.24. Waterborne mercury downstream of ORNL declined abruptly in 2008 and remained low through 2015 as a result of rerouting highly contaminated sump water in Building 4501 to PWTC in December 2007. The mean total mercury concentration at WCK 4.1 was 13.7 ± 4.8 ng/L in 2015 compared with 108 ± 33 ng/L in 2007. The decrease was also apparent but less pronounced at WCK 3.4, with mercury averaging 10.6 ± 3.4 ng/L in 2015 versus 49 ± 23 ng/L in 2007. Mercury concentrations at these two sites were significantly lower than levels in 2007. A pretreatment system for the sump water, which started operation on October 22, 2009, removes almost all of the mercury before sending the water to PWTC. This system reduces the mercury concentration in the PWTC influent and effluent. Average aqueous mercury concentration at WOD was 52.4 ± 31.1 ng/L in 2015, higher than concentrations reported in recent years, possibly due to elevated particulates from a beaver dam.

5.5.6.1.2 Bioaccumulation in Fish

In WOC, mercury and PCB concentrations in fish have been at or near human health risk thresholds [e.g., EPA recommended fish-based AWQC (0.3 µg/g for mercury), TDEC fish advisory limits for PCBs]. Actions taken in 2007 to treat a mercury-contaminated sump resulted in significant decreases in mercury concentrations in fish throughout WOC. The decreases were most apparent at upstream locations closest to the sump water reroute (Fig. 5.27). Mean fillet concentrations decreased from 0.24 µg/g in 2014 to 0.16 µg/g in 2015 at WCK 3.9 and from 0.29 µg/g in 2014 to 0.21 µg/g in 2015 at WCK 2.9 (Fig. 5.27). These concentrations are below the AWQC for mercury in fish. Mercury concentrations in largemouth bass collected from WCK 1.5 (White Oak Lake) have been decreasing in recent years but remained above the guideline in 2015 (0.36 µg/g). Mercury concentrations in bluegill collected from WCK 1.5 showed the same decreasing trend as largemouth bass and remained below the recommended guideline. Mean PCB concentrations in redbreast sunfish at WCK 3.9 and WCK 2.9 (0.27 and 0.43µg/g, respectively) were comparable to values recorded in recent years. Mean PCB concentrations in largemouth bass from WCK 1.5 were near typical concentrations and resulted in a TDEC fish advisory limit of ~1 µg/g in 2015 (Fig. 5.28).

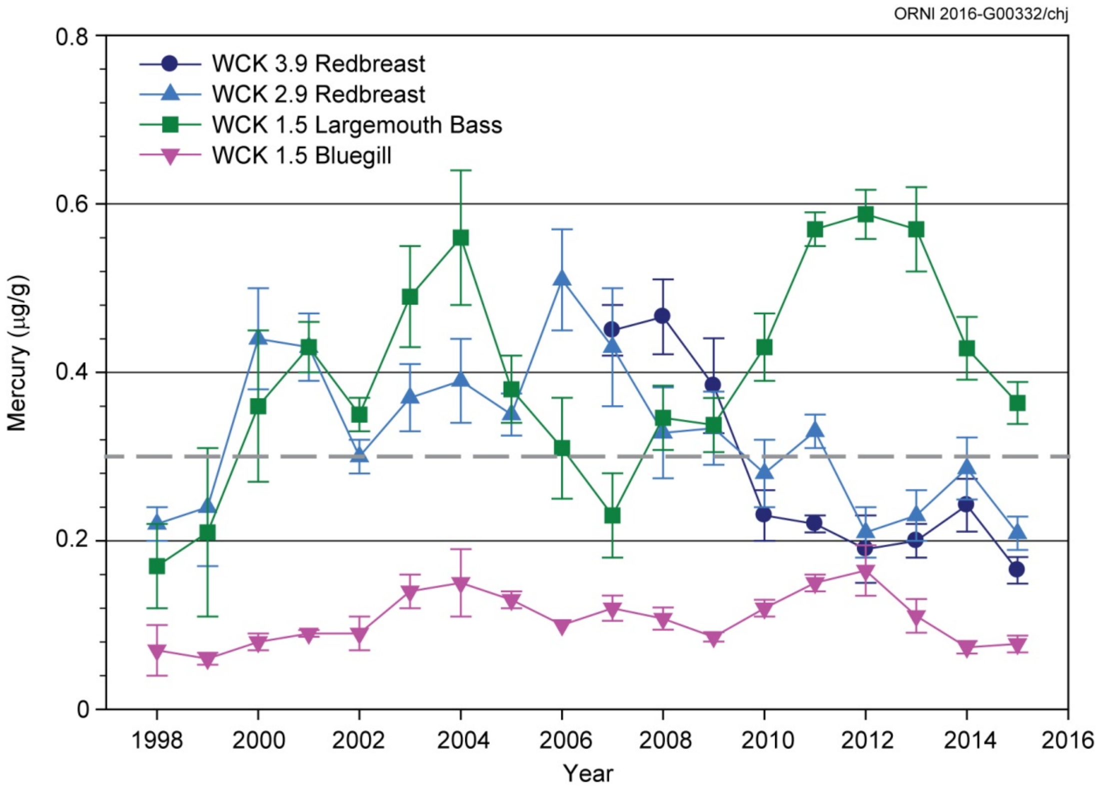

Fig. 5.27. Mean concentrations of mercury (± standard error, N = 6) in muscle tissue of sunfish and bass from White Oak Creek [White Oak Creek kilometers (WCKs) 3.9 and 2.9] and White Oak Lake (WCK 1.5), 1998–2015. *[Dashed grey line indicates the US Environmental Protection Agency ambient water quality criterion for mercury (0.3 µg/g in fish tissue).]*

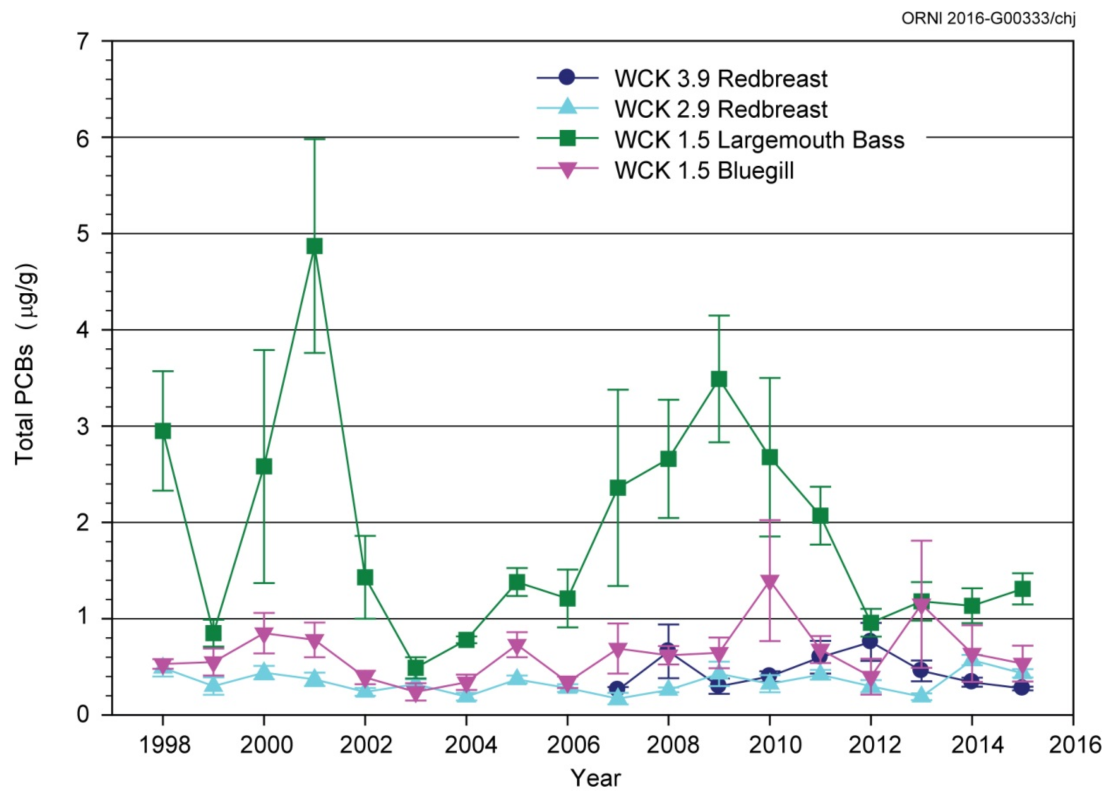

Fig. 5.28. Mean total polychlorinated biphenyl (PCB) concentrations (± standard error, N = 6) in fish fillets collected from the White Oak Creek watershed, 1998–2015.
(WCK = White Oak Creek kilometer.)

5.5.6.2 Benthic Macroinvertebrate Communities

Monitoring of benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2015. Additionally, monitoring of the macroinvertebrate community in lower Melton Branch (MEK 0.6) continued under the EM Water Resources Restoration Program (WRRP). Benthic macroinvertebrate samples are collected once annually following two sets of protocols: protocols developed by ORNL staff and used since 1986 and TDEC protocols. The protocols developed by ORNL staff provide a continuous long-term record (29 years) of spatial and temporal trends in the invertebrate community from which the effectiveness of pollution abatement and remedial actions taken at ORNL can be evaluated and verified. The ORNL protocols also provide quantitative results that can be used to statistically evaluate changes in trends relative to historical conditions. TDEC protocols, on the other hand, provide a qualitative estimate of the condition of a macroinvertebrate community relative to a state-defined reference condition. The results from both protocols are used to help assess ORNL compliance with current NPDES permit requirements. This report provides a summary of available results from both sets of protocols through 2015.

Compared with the TDEC-derived reference condition, the only site monitored in the WOC watershed that has consistently been rated as unimpaired is White Oak Creek kilometer (WCK) 6.8, which until construction of SNS had served as the reference site for WOC (Fig. 5.29). The invertebrate community at all other sites except MEK 0.6 was rated as slightly impaired in 2015, while MEK 0.6 was rated as unimpaired.

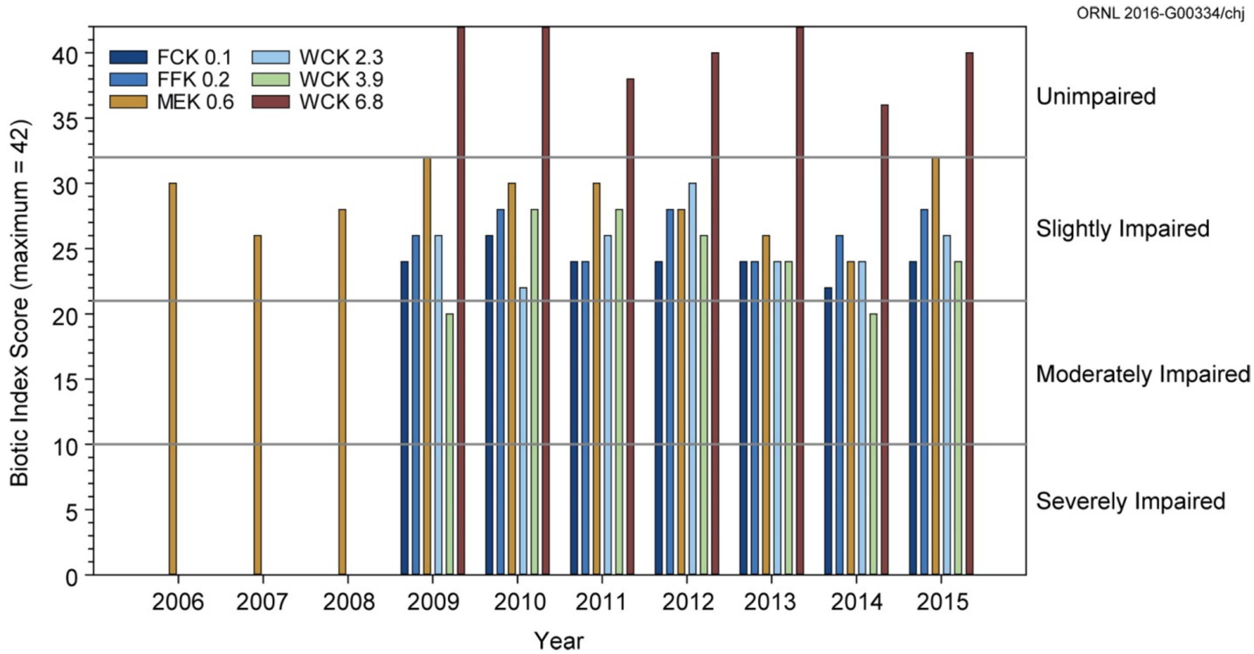

Fig. 5.29. Temporal trends in Tennessee Department of Environment and Conservation Biotic Index Scores for White Oak Creek watershed, August 2006–August 2015. *Horizontal lines show the lower thresholds for biotic condition ratings for index scores; respective narrative ratings for each threshold are shown at right of graph. (FCK = First Creek kilometer, FFK = Fifth Creek kilometer, MEK = Melton Branch kilometer, and WCK = White Oak Creek kilometer.)*

At the time of publication, 2015 sample results for benthic macroinvertebrate communities in First Creek, Fifth Creek, and WOC downstream of effluent discharges were not available. These results will be reported in the 2016 annual report. The 2014 results indicated significant recovery in these communities since 1987, but community characteristics indicated that ecological impairment remains (Figs. 5.30–5.32). Relative to respective upstream reference sites, total taxonomic richness (i.e., the mean number of different species per sample) and richness of the pollution-intolerant taxa (i.e., the mean number of different mayfly, stonefly, and caddisfly species per sample or Ephemeroptera, Plecoptera, and Trichoptera [EPT] taxa richness) continued to be lower at these downstream sites. After modest increases in the mid-1990s, total taxa richness appeared to have generally decreased at First Creek kilometer (FCK) 0.1, and in 2014 the total number of taxa was the lowest it had been since 1989. Similarly, the number of pollution intolerant EPT taxa decreased in 3 consecutive years, and in 2014 EPT taxa richness was the lowest it had been since the early 1990s. These results suggest a change may have occurred in conditions in lower First Creek. If change has occurred, it is not known whether it is related to a change in chemical conditions (e.g., change in water quality or the possible presence of a toxicant), physical conditions (e.g., unstable substrate, increased frequency of high discharge events), or natural variation. Trends in metrics at Fifth Creek kilometer (FFK) 0.2 since the mid-1990s suggest that a change in conditions at that site occurred between 2007 and 2008. More recent results, however, suggest that improvements have occurred, and the condition of the invertebrate community is now comparable to what it was from the late 1990s through the early 2000s. Metric values for WCK 2.3 and WCK 3.9 continued to remain within the ranges of values found since the early 2000s, although they also continued to be notably lower than those for the reference sites, suggesting that no additional major changes had occurred at those sites for roughly 12 years.

Macroinvertebrate community metrics for lower Melton Branch (MEK 0.6, Fig. 5.33) suggested that in 2014 taxa richness metrics continued to be similar to reference conditions. However, like the results from the TDEC protocols, other invertebrate community metrics potentially sensitive to more specific types of pollutants, such as the percent density of pollution-intolerant and pollution-tolerant species (not shown), continued to fluctuate annually between comparable values and values below those of the reference sites. Thus, while the condition of the invertebrate community at MEK 0.6 was generally at or near reference conditions, annual changes in some characteristics of the community suggested that annual fluctuations in environmental conditions at the site appear to have some minor negative influence on the condition of the community.

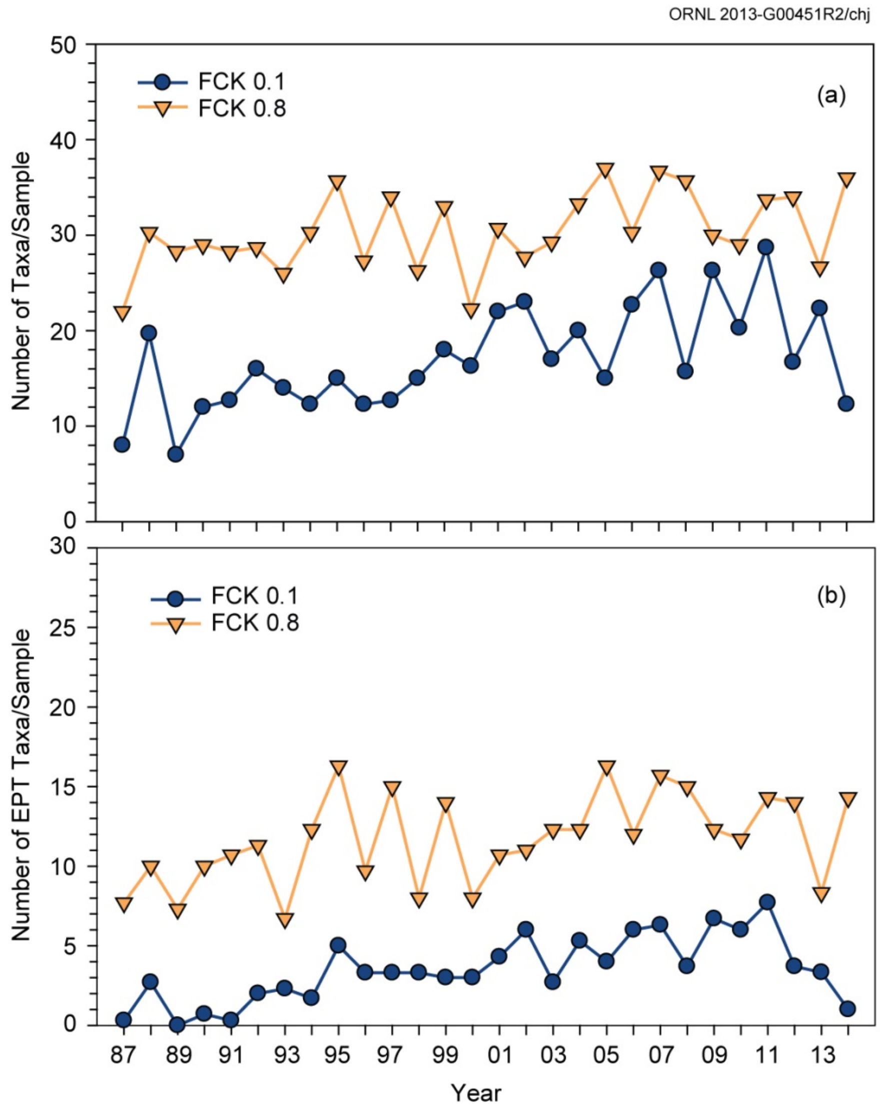

Fig. 5.30. Benthic macroinvertebrate communities in First Creek: (a) total taxonomic richness (mean number of all taxa/sample) and (b) taxonomic richness of the pollution-intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], April sampling periods, 1987−2014. Results for 2015 were not available at the time of publication. *(FCK = First Creek kilometer; FCK 0.8 = reference site.)*

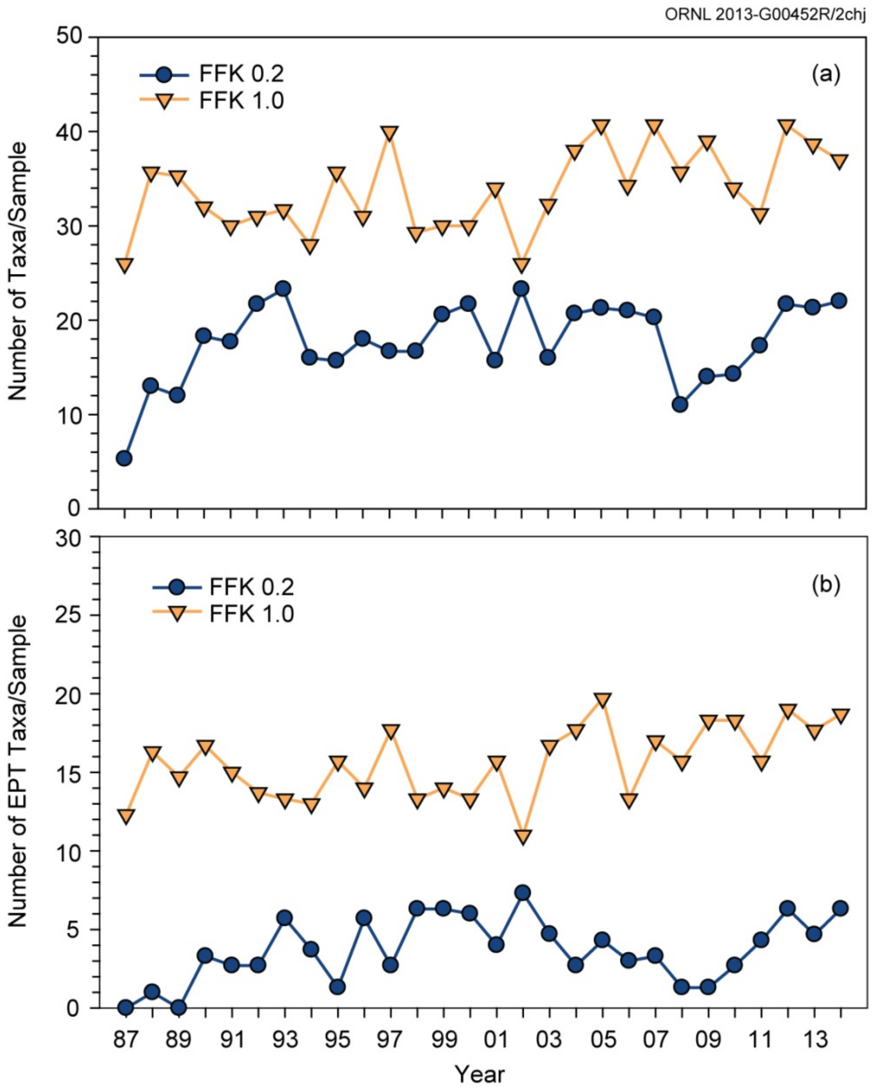

Fig. 5.31. Benthic macroinvertebrate communities in Fifth Creek: (a) total taxonomic richness (mean number of all taxa/sample) and (b) taxonomic richness of the pollution-intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], April sampling periods, 1987−2014. Results for 2015 were not available at the time of publication. *(FFK = Fifth Creek kilometer; FFK 1. 0 = reference site.)*

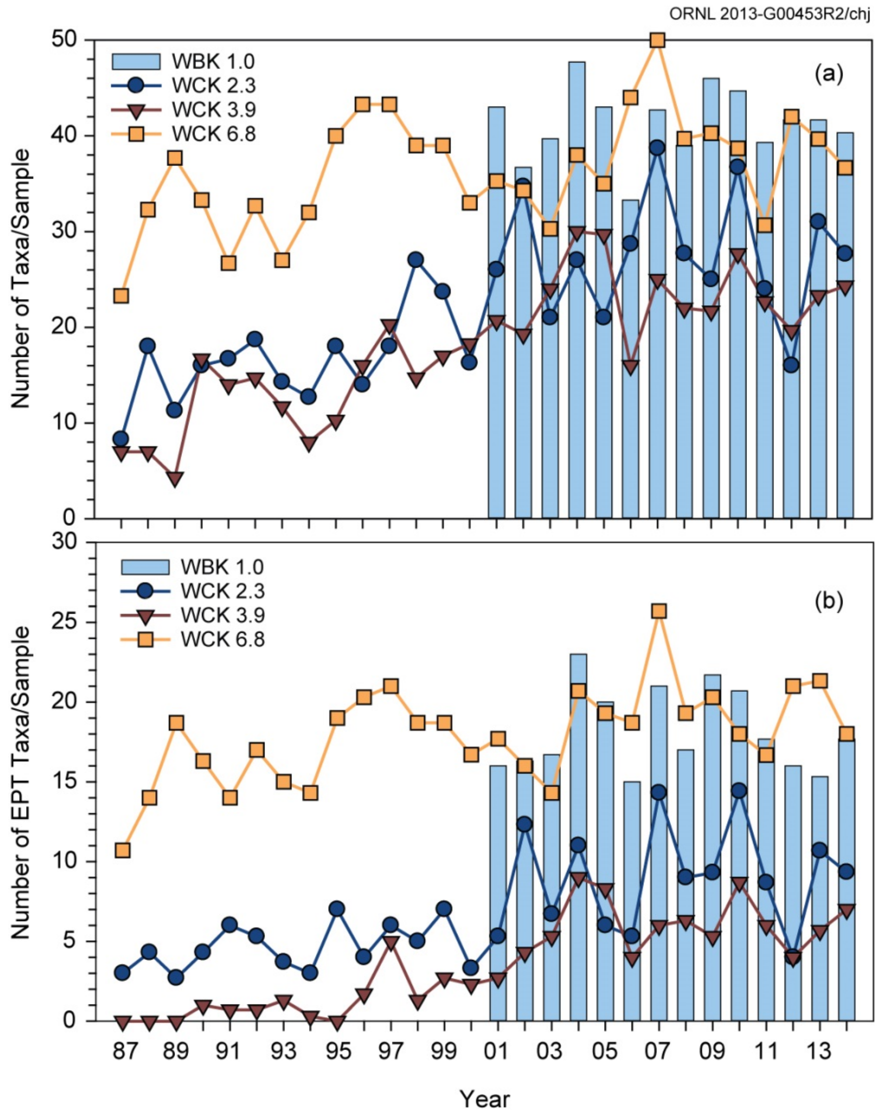

Fig. 5.32. Benthic macroinvertebrate communities in White Oak Creek: (a) total taxonomic richness (mean number of all taxa/ sample) and (b) taxonomic richness of the pollution-intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], April sampling periods, 1987−2014. Results for 2015 were not available at the time of publication. *(WCK = White Oak Creek kilometer and WBK = Walker Branch kilometer; WBK 1.0 = reference site.)*

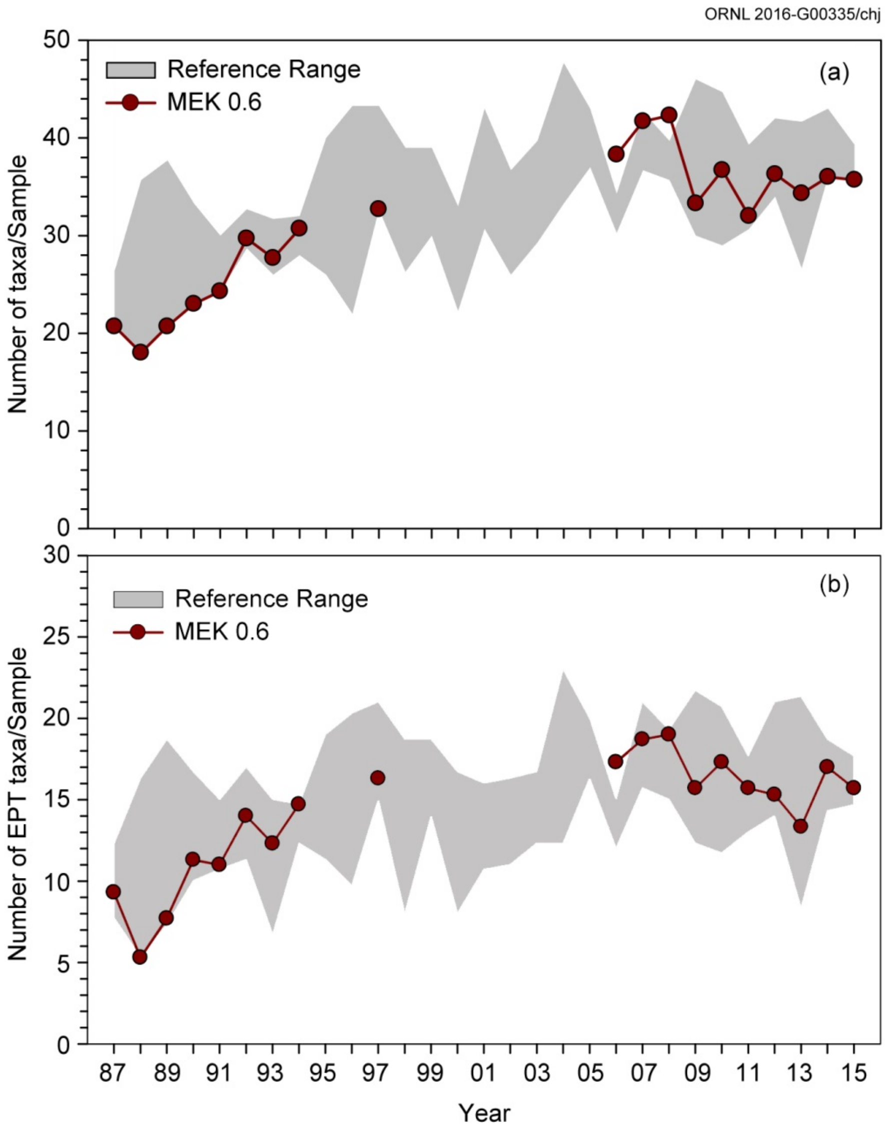

Fig. 5.33. Benthic macroinvertebrate communities in lower Melton Branch: (a) total taxonomic richness (mean number of all taxa/sample) and (b) taxonomic richness of the pollution-intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], April sampling periods, 1987−2015. *[MEK = Melton Branch kilometer; reference range = minimum and maximum values for Oak Ridge National Laboratory Biological Monitoring and Abatement Program reference sites on upper Melton Branch (1987–1997), First Creek and Fifth Creek (1987–2014), Walker Branch (2001–2014), and White Oak Creek (1987–2000, 2007–2014), and other Oak Ridge Reservation reference sites]*

5.5.6.3 Fish Communities

Monitoring fish communities in WOC and major tributaries continued in 2015. Fish community surveys were conducted at 11 sites in the WOC watershed, including five sites in the main channel, two sites in First Creek, two sites in Fifth Creek, and two sites in Melton Branch. Streams located near or within the city of Oak Ridge (Mill Branch and Brushy Fork) were also sampled as reference sites for comparison.

In the WOC watershed, the fish community continued to be slightly degraded in 2015 compared with communities in reference streams. Sites closest to outfalls within the ORNL campus have lower species richness (number of species) (Fig. 5.34), fewer pollution-sensitive species, more pollution-tolerant species, and elevated density (number of fish per square meter) of pollution-tolerant species compared with similar-sized reference streams. Seasonal fluctuations in diversity and density are expected and explain some of the variability seen at these sites as well as recent fish introduction work. Overall, the fish communities in tributary sites adjacent to and downstream of ORNL outfalls also remained negatively affected by ORNL effluent in 2015 relative to reference streams or upstream sites.

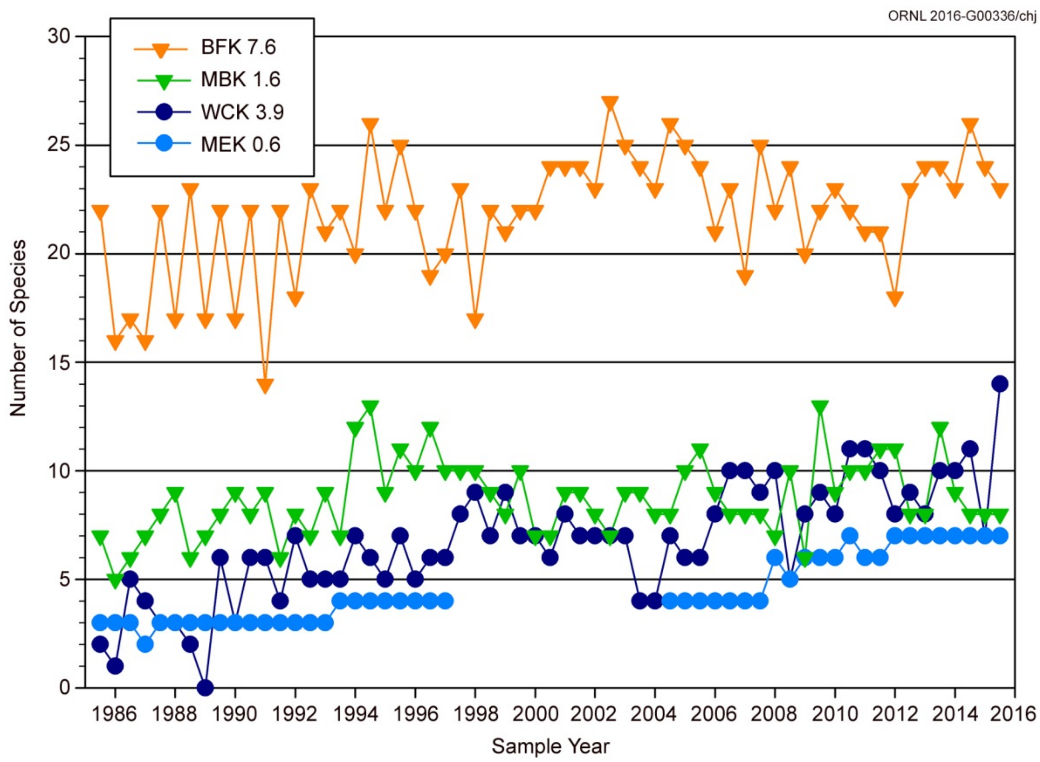

Fig. 5.34. Fish species richness (number of species) in upper White Oak Creek and lower Melton Branch compared with two reference streams (Brushy Fork and Mill Branch) 1985–2015. *(BFK = Brushy Fork kilometer; MBK = Mill Branch kilometer; MEK = Melton Branch kilometer; and WCK = White Oak Creek kilometer.)*

A project to introduce fish species that were not found in the WOC watershed but that exist in similar systems on the ORR and that may have historically existed in WOC was initiated in 2008 with the stocking of six such native species. Reproduction has been noted for five of the species, and several species have expanded their ranges downstream from initial introduction sites to establish new reproducing populations. In general, introduced species have had more difficulty establishing populations at upstream sites in both WOC and Melton Branch, and as a result, introductions to supplement the small populations of these fish species will continue at sites within the watershed. The introductions have enhanced species richness at almost all sample locations within the watershed and illustrate the capacity of this watershed to support increased diversity, which seems to be limited by impassible barriers such as dams, weirs, and culverts, and by limited access to source populations.

5.5.7 Polychlorinated Biphenyls in the White Oak Creek Watershed

The objective of this task was to identify the stream reaches, outfalls, or sediment areas that are contributing to elevated PCB exposure in the WOC watershed. Results for largemouth bass collected from White Oak Lake show that tissue PCB concentrations continue to be higher than those recommended by TDEC and EPA for frequent consumption (Fig. 5.28), but the mobility of the fish precludes the possibility of source identification. Because PCBs are hydrophobic, they tend not to be dissolved in water, and therefore aqueous PCB concentrations are often below the detection limits of conventional methods, even at contaminated sites. Therefore, the source identification task involved the use of semipermeable membrane devices (SPMDs) to assess the chronic low-level sources of PCBs at critical sites on the reservation. SPMDs are thin plastic sleeves filled with oil in which PCBs are soluble. Because SPMDs are in contact with water at a given site for 4 weeks and have a high affinity for PCBs, a time-integrated semiquantitative index of the mean PCB concentration in the water column during the deployment period is obtained. SPMDs also have advantages over “snapshot” water concentration analyses. The long deployment period enables distinction between the relative PCB inputs at sites whose aqueous PCB concentrations are below detection limits in water.

While past monitoring efforts were instrumental in establishing a baseline for PCBs, the focus has historically been on relating PCB levels in fish to safe levels for consumption. These studies were not designed to identify specific stream reaches or sources contributing to PCB bioaccumulation.

In 2015, ORNL’s PCB monitoring efforts continued focusing on the First Creek watershed, which was identified previously as a source of PCBs. SPMDs were deployed in pipe networks for outfalls 249 and 250, which contribute to First Creek (Fig. 5.35). The results are summarized in Table 5.13.

The results from the 2015 assessment confirm that the upper parts of the outfall 249 and 250 pipe networks continue to be of primary interest for investigation of legacy PCB sources in the First Creek watershed. The results from sample location 250-19 (Table 5.13) indicate that PCBs remain available in that area despite recent actions to remove PCB-contaminated building materials from the upper part of the 250 watershed. Results for outfalls 249 and 250 were within the ranges of past monitoring, giving no indication that the nature of PCB movement is significantly changing in those networks.

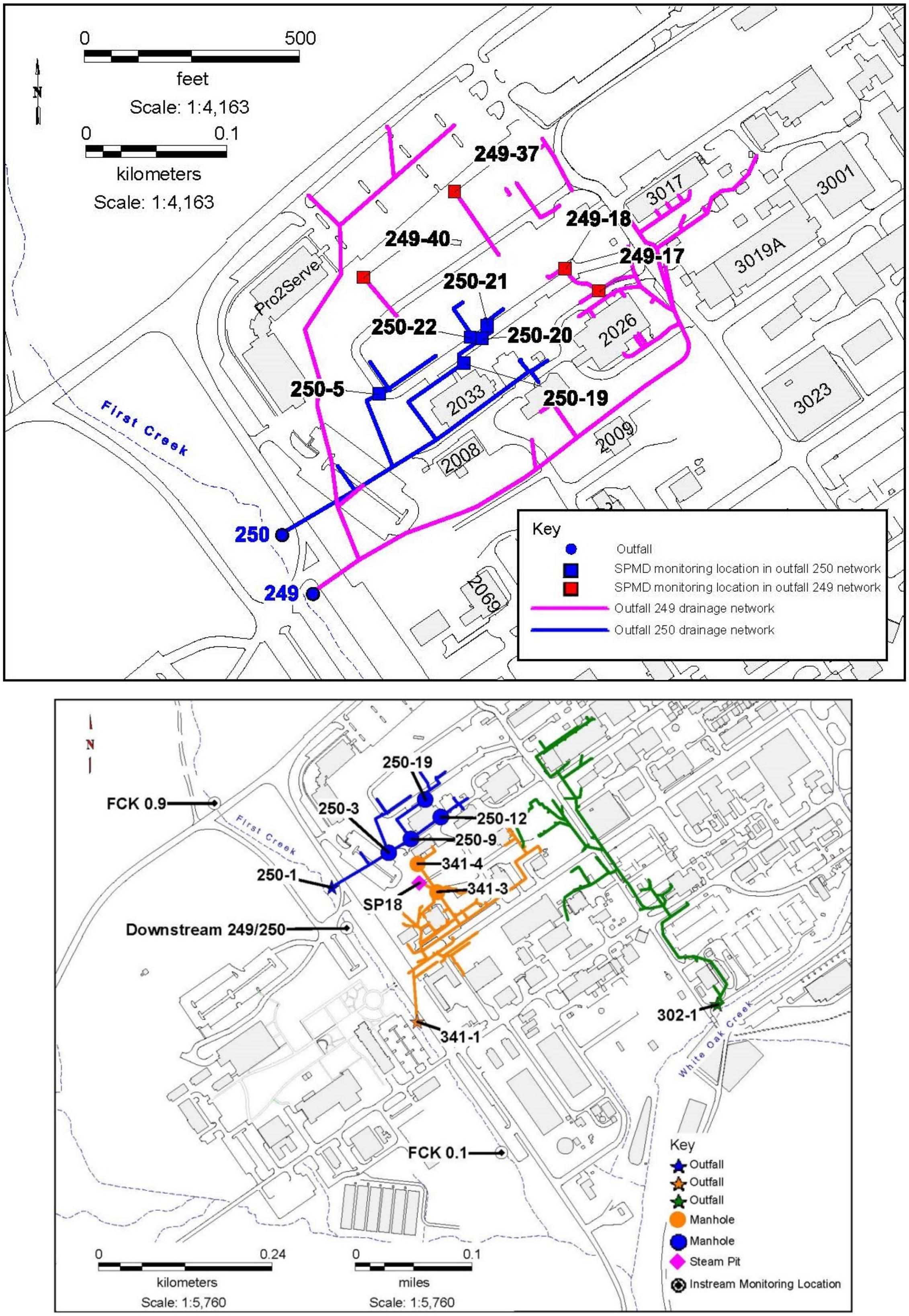

Fig. 5.35. Locations of monitoring points for First Creek source investigation.
(FCK = First Creek kilometer.)

Table 5.13. First Creek PCB source assessment, May 2015
[Total PCBs (parts per billion)]

Sample location	Location type	SPMD
249-17	Outlet	396
249-18	Outlet	2500
249-37	Outlet	871
249-40	Outlet	354
250-5	Inlet	314
250-19	Inlet/Outlet	22530
250-20	Inlet	4560
250-21	Inlet	855
250-22	Inlet	6320

Acronyms
PCB = polychlorinated biphenyl
SPMD semipermeable membrane device

5.5.8 Oil Pollution Prevention

CWA Section 311 regulates the discharge of oils or petroleum products to waters of the United States and requires the development and implementation of spill prevention, control, and countermeasures (SPCC) plans to minimize the potential for oil discharges. These requirements are provided in 40 CFR 112, *Oil Pollution Prevention*. Each ORR facility implements a site-specific SPCC plan. NTRC, which is located off ORR, also has an SPCC plan covering the oil inventory at its location. CFTF is also located off ORR; however, that facility was evaluated, and a determination was made that it did not require an SPCC plan. There were no regulatory or permitting actions related to oil pollution prevention at ORNL or NTRC in 2015. An oil-handler training program exists to comply with training requirements in 40 CFR 112.

5.5.9 Surface Water Surveillance Monitoring

The ORNL surface water monitoring program is conducted in conjunction with the ORR surface water monitoring activities discussed in Section 6.4 to enable assessing the impacts of ongoing DOE operations on the quality of local surface water. The sampling locations (Fig. 5.36) are used to monitor conditions upstream of ORNL main plant waste sources (WCK 6.8), within the ORNL campus (FFK 0.1), and downstream of ORNL discharge points (WCK 1.0).

Sampling frequencies and parameters vary by site and are shown in Table 5.14. Radiological monitoring at the discharge point downstream of ORNL (White Oak Lake at WOD) is conducted monthly under the ORNL WQPP (Section 5.5.3) and, therefore, is not duplicated by this program. Radiological monitoring at a point upstream of ORNL is conducted monthly under the ORNL WQPP (Section 5.5.3) and, therefore, is not duplicated by this program. Total radioactive strontium is monitored quarterly by this surveillance program.

Samples are collected and analyzed for general water quality parameters and are screened for radioactivity at all locations (either under this program or under WQPP). Samples are further analyzed for specific radionuclides when general screening levels are exceeded. Samples from White Oak Lake at WOD are also checked for volatile organic compounds (VOCs), PCBs, and mercury. WCK 6.8 and WCK 1.0 are classified by the State of Tennessee for freshwater fish and aquatic life. Tennessee WQCs associated with these classifications are used as references where applicable. The Tennessee WQCs do not include criteria for radionuclides. Four percent of the DOE DCS is used for radionuclide comparison because that value is roughly equivalent to the 4 mrem dose limit from ingestion of drinking water on which the EPA radionuclide drinking water standards are based.

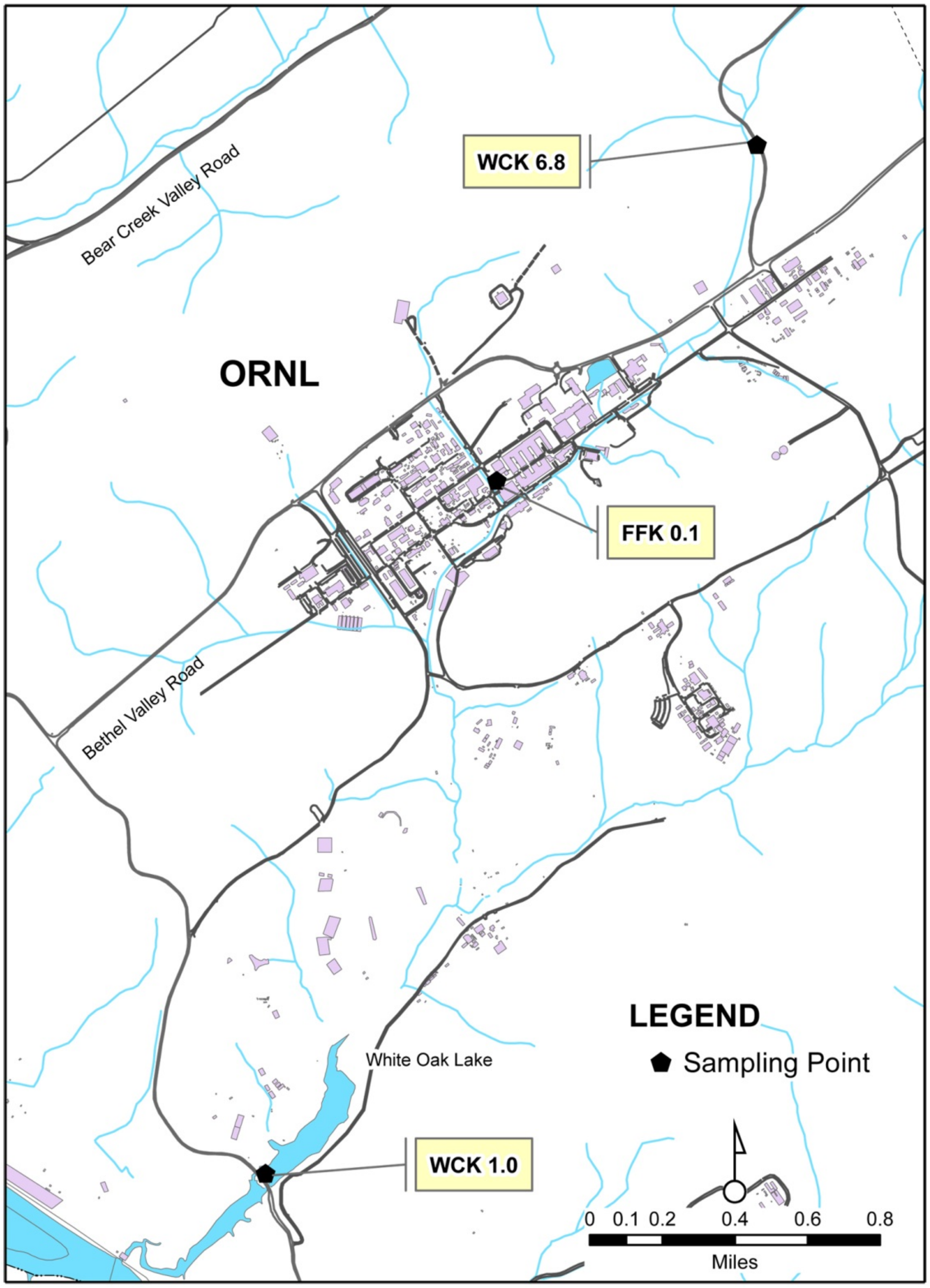

Fig. 5.36. Oak Ridge National Laboratory surface water sampling locations.
(FFK = Fifth Creek kilometer; WCK = White Oak Creek kilometer.)

Table 5.14. Oak Ridge National Laboratory surface water sampling locations, frequencies, and parameters, 2015

Location[a]	Description	Frequency and type	Parameters[b]
WCK 1.0	White Oak Lake at WOD	Quarterly, grab	Volatiles, mercury, PCBs, field measurements
WCK 6.8	WOC upstream from ORNL	Quarterly, grab	Total radioactive strontium, field measurements
FFK 0.1	Fifth Creek just upstream of WOC (ORNL)	Semiannually, grab	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements

[a]Locations identify bodies of water and locations on them (e.g., WCK 1.0 is 1 km upstream from the confluence of White Oak Lake and the Clinch River).
[b]Field measurements consist of dissolved oxygen, pH, and temperature.

Acronyms

FFK = Fifth Creek kilometer
ORNL = Oak Ridge National Laboratory
PCB = polychlorinated biphenyl
WCK = WOC kilometer
WOC = White Oak Creek
WOD = White Oak Dam

The results from the ORR upstream reference site (CRK 66) may be compared with results from the ORNL surface water monitoring program as applicable to evaluate potential impacts to area surface water as a result of DOE activities at ORNL (Section 6.4.1). Overall radionuclide results from 2015 surveillance monitoring efforts are consistent with historical data.

There were no radionuclides reported above 4% of DCS at either the upstream White Oak Creek (WCK 6.8) or the Fifth Creek (FFK 0.1) location. Radionuclide results from samples collected at WOD (immediately before WOC empties into the Clinch River) are discussed in Section 5.5.3.

Neither mercury nor PCBs were detected during 2015 in WOC at WOD.

5.5.10 Carbon Fiber Technology Facility Waste Water Monitoring

Facility and process waste water from activities at CFTF are discharged to the City of Oak Ridge sanitary sewer system under conditions established in City of Oak Ridge Industrial Waste Water Discharge Permit 1-12. Permit limits, parameters, and 2015 compliance status for this permit are summarized in Table 5.15.

Table 5.15. Industrial and Commercial User Waste Water Discharge Permit compliance at the Oak Ridge National Laboratory Carbon Fiber Technology Facility, 2015

Effluent parameters	Permit limits		Permit compliance		
	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
Outfall 01 (Underground Quench Water Tank)					
Cyanide		4.2	0	1	100
pH (standard units)	9.0	6.0	0	1	100
Outfall 02 (Electrolytic Bath Tank)					
pH (standard units)	9.0	6.0	0	17	100
Outfall 03 (Sizing Bath Tank)					
Copper		0.87	0	5	100
Zinc		1.24	0	5	100
Total phenol		4.20	0	5	100
pH (standard units)	9.0	6.0	0	5	100

[a] Percentage compliance = 100 – [(number of noncompliances/number of samples) × 100].

5.6 Groundwater Monitoring Program

Groundwater monitoring at ORNL was conducted under two sampling programs in 2015: DOE EM monitoring and DOE Office of Science (OS) surveillance monitoring. The DOE EM groundwater monitoring program was conducted by UCOR in 2015. The OS groundwater monitoring surveillance program was conducted by UT-Battelle.

5.6.1 DOE Office of Environmental Management Groundwater Monitoring

Monitoring was performed as part of an ongoing comprehensive CERCLA cleanup effort in Bethel and Melton Valleys, the two administrative watersheds at the ORNL site. Groundwater monitoring for baseline and trend evaluation in addition to measuring effectiveness of completed CERCLA RAs is conducted as part of the WRRP. WRRP is managed by UCOR for the DOE EM program. The results of CERCLA monitoring for ORR for FY 2015, including monitoring at ORNL, are evaluated and reported in the 2016 remediation effectiveness report (DOE 2016) as required by the ORR FFA. The monitoring results and remedial effectiveness evaluations for Bethel and Melton Valley are reported in Sections 2 and 3, respectively, in that report.

Groundwater monitoring conducted as part of the EM program at ORNL includes routine sampling and analysis of groundwater in Bethel Valley to measure performance of several RAs and to continue contaminant and groundwater quality trend monitoring. In Melton Valley, where CERCLA RAs were completed in 2006 for the extensive waste management areas, the groundwater monitoring program includes monitoring groundwater levels to evaluate the effectiveness of hydrologic isolation of buried waste units. Additionally, groundwater is sampled and analyzed for a wide range of general chemical and contaminant parameters in 46 wells within the interior portion of the closed waste management area.

In FY 2010 DOE initiated activities on a groundwater treatability study at the Bethel Valley 7000 Services Area VOC plume. This plume contains trichloroethylene (TCE) and its transformation products cis-1,2-DCE and vinyl chloride, all at concentrations greater than EPA primary drinking water standards.

The treatability study is a laboratory and field demonstration to determine whether microbes inherent to the existing subsurface microbial population can fully degrade the VOCs to nontoxic end products.

During FY 2015 postremediation monitoring continued at Solid Waste Storage Area (SWSA) 3 following completion of hydrologic isolation of the area by construction of a multilayer cap and upgradient stormflow/shallow groundwater diversion drain. RAs and monitoring were specified in a CERCLA RA work plan that was developed by DOE and approved by EPA and TDEC before the project was started.

During FY 2015 EM continued to collect and analyze samples from the off-site groundwater monitoring well array west of the Clinch River adjacent to Melton Valley. In addition, exit pathway groundwater monitoring in Melton Valley is conducted as part of the EM program, including sampling at six multiport monitoring wells in western Melton Valley (wells 4537, 4538, 4539, 4540, 4541, 4542).

During FY 2014 the EM Groundwater Program staff conducted planning for an ORR off-site groundwater quality assessment and started development of an ORR regional groundwater flow model. The off-site groundwater assessment project is aimed at documenting water quality in selected residential water supply wells and at springs to the west and southwest of the ORR. General water chemistry, metals, organic compounds, and radionuclides are included in the suite of analytes to be assessed. During FY 2015 two sampling events were completed in accordance with an approved work plan. A confirmatory sampling event and preparation and issuance of a report of results are planned for 2016 for the groundwater flow model task. Efforts were initiated to develop an ORR-wide regional flow model. The geologic framework for the regional-scale flow model was completed in 2015. Testing activities on a test case model were also completed in 2015. Construction of the regional-scale flow model is continuing in 2016. The model will serve as an underlying framework to support future cleanup decisions and actions.

5.6.1.1 Summary of DOE Office of Environmental Management Groundwater Monitoring

5.6.1.1.1 Bethel Valley

During FY 2011 construction was completed for RAs at two former waste storage sites, SWSA 1 and SWSA 3, which were used for disposal of radioactively contaminated solid wastes between 1944 and 1950. Wastes disposed of at SWSA 1 originated from the earliest operations of ORNL; those at SWSA 3 originated from ORNL, Y-12, the K-25 Site (ETTP), and off-site sources. Although most of the waste disposed of at SWSA 3 was solid, some were containerized liquid wastes. Some wastes were encapsulated in concrete after placement in burial trenches, but most of the waste was soil-covered. The Bethel Valley Record of Decision (ROD) (DOE 2002) selected hydrologic isolation using multilayer caps and groundwater diversion trenches as the RA for the waste burial grounds and construction of soil covers over the former contractor's landfill and contaminated soil areas near SWSA 3. The baseline monitoring conducted during FY 2010 included measurement of groundwater levels to obtain baseline data to allow evaluation of postremediation groundwater-level suppression. Sampling and analysis of groundwater quality and contaminants were also conducted. Postremediation monitoring was specified for SWSA 3 in the *Phased Construction Completion Report for the Bethel Valley Burial Grounds at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE 2012). Required monitoring includes quarterly groundwater-level monitoring in 42 wells with continuous water-level monitoring in 8 wells to confirm cap performance. Groundwater samples are collected semiannually at 13 wells for laboratory analyses to evaluate groundwater contaminant concentration trends.

During FY 2015 monitoring results showed that the cap was effective although target groundwater elevations were exceeded at three of eight wells. Comparison of preremediation to postremediation groundwater contaminant concentrations showed that evaluated contaminant levels increased at one location, decreased at seven locations, were stable at six locations, and exhibited no trend at one location.

During FY 2015, as part of the DOE EM program, three groundwater monitoring wells in Bethel Valley to the west of Tennessee Highway 95 were monitored to detect and track contamination from the SWSA 3 area. Data from those three wells supplement data being collected from a multiport well (4579) near SWSA 3 for exit pathway groundwater monitoring in western Bethel Valley. Groundwater monitoring near SWSA 3, along with the exit pathway, and groundwater and surface water monitoring at the northwest tributary of WOC and in the headwaters of Raccoon Creek allow integration of data concerning SWSA 3 contaminant releases. The data are presented in the 2016 remediation effectiveness report (DOE 2016).

Groundwater monitoring continued at the ORNL 7000 Area during FY 2015 to evaluate treatability of the VOC plume at that site. Site characterization testing of the endemic microbial community showed that microbes were present that are capable of fully degrading TCE and its degradation products if sufficient electron donor compounds were present in the subsurface environment. During FY 2011 a mixture of emulsified vegetable oil and a hydrogen-releasing compound was injected into four existing monitoring wells in the 7000 area. Monitoring of the stimulation of the endemic microbial community along with concentrations of chlorinated VOCs continued through FY 2015. Results of the monitoring show that the microbial community responded well to the addition of the carbon electron donor, and the VOC concentrations in the treated area have decreased significantly.

The other principal element of the Bethel Valley ROD (DOE 2002) remedy that requires groundwater monitoring is the containment pumping to control and treat discharges from the ORNL Central Campus core hole 8 plume. The original action for the plume was a CERCLA removal action that was implemented in 1995. The remedy had performed well until the latter portion of FY 2008 when conditions changed and ^{90}Sr and $^{233/234}$U concentrations in monitoring wells and the groundwater collection system began increasing. Leaking utility waterlines near the source area are suspected to have increased the mass of contaminants feeding the plume. Increased infiltration of plume water into storm drains has allowed increased contaminant flux to First Creek, a tributary of WOC. During FY 2009 the remedy did not meet its performance goal, which is a reduction of ^{90}Sr in WOC. In March 2012 DOE completed refurbishment and enhancement of the groundwater collection system to increase the plume containment effectiveness. Since FY 2013 the remedy has met its performance goal of reducing ^{90}Sr levels in WOC as measured at the 7500 bridge.

5.6.1.1.2 Melton Valley

The Melton Valley ROD (DOE 2000) established goals for a reduction of contaminant levels in surface water, groundwater-level fluctuation reduction goals within hydrologically isolated areas, and minimization of the spread of groundwater contamination. Groundwater monitoring to determine the effectiveness of the remedy in Melton Valley includes groundwater-level monitoring in wells within and adjacent to hydrologically isolated shallow waste burial areas and groundwater quality monitoring in selected wells adjacent to buried waste areas.

Groundwater-level monitoring shows that the hydrologic isolation component of the Melton Valley remedy is effectively minimizing the amount of percolation water contacting buried waste and is reducing contaminated leachate formation. The total amount of rainfall during FY 2015 was slightly more than the long-term annual average for ORR. In a few areas groundwater levels within capped areas continue to respond to groundwater fluctuations imposed from areas outside the caps, but contact of groundwater with buried waste is minimal. Overall the hydrologic isolation systems are performing as designed.

Groundwater quality monitoring in the interior of Melton Valley shows that in general groundwater contaminant concentrations are declining or are stable following RAs. Groundwater quality monitoring substantively equivalent to the former RCRA monitoring continues at SWSA 6. Several VOC substances continue to be detected in wells along the eastern edge of the site.

During the past 10 years of groundwater monitoring in the Melton Valley exit pathway, several site-related contaminants have been detected in groundwater near the Clinch River. Low concentrations of ^{90}Sr, tritium, uranium, and VOCs have been detected intermittently in a number of the multizone sampling locations. Groundwater in the exit pathway wells has high alkalinity and sodium and exhibits elevated pH. During FY 2015 an off-site groundwater monitoring well array west of the Clinch River and adjacent to Melton Valley was monitored as part of the EM program. Monitoring included groundwater-level monitoring to evaluate potential flowpaths near the river and sampling and analysis for a wide array of metals, anions, radionuclides, and VOCs. Groundwater-level monitoring showed that natural head gradient conditions cause groundwater seepage to converge toward the Clinch River from both the DOE (eastern) and off-site (western) sides of the river. The maximum concentrations of ^{90}Sr, ^{3}H, and ^{99}Tc for the on-site exit pathway groundwater monitoring network during FY 2015 were estimated by the analytical laboratory (as indicated by the "J" flag on the reported results) indicating the presence of concentrations below quantitation limits. These estimated values were very low in comparison with the maximum contaminant levels (MCLs) specified in EPA regulations:

- Sr-90: 2.45 pCi/L (8 pCi/L MCL-derived concentration),
- H-3: 169 J pCi/L (20,000 pCi/L MCL-derived concentration), and
- Tc-99: 5.3 J pCi/L (900 pCi/L MCL-derived concentration).

Monitoring results are summarized in the 2016 remediation effectiveness report (DOE 2016).

5.6.1.1.3 Off-Site Groundwater Monitoring

In 2015, EM conducted groundwater monitoring in off-site wells adjacent to Melton Valley to determine whether contaminants were migrating off the ORR. Through its extensive groundwater monitoring efforts, EM has detected certain signature man-made contaminants near former Melton Valley waste disposal areas on DOE property. These contaminants include tritium; ^{90}Sr; ^{99}Tc; and chlorinated organic compounds, including TCE (an industrial solvent) and its degradation products. During FY 2015 DOE detected ^{90}Sr at very low concentrations in seven samples collected from six off-site monitoring wells (max of 0.74 pCi/L compared to the 8 pCi/L EPA MCL-derived concentration). Technetium-99 was detected in two of the Melton Valley off-site monitoring wells at estimated levels (maximum of 4.93 pCi/L compared to the 900 pCi/L MCL-derived concentration). Tritium was detected in six samples collected from five of the off-site monitoring wells (max of 220 pCi/L compared to the 20,000 pCi/L MCL).

5.6.2 DOE Office of Science Groundwater Monitoring

DOE O 458.1 (DOE 2011b) is the primary requirement for a sitewide groundwater protection program at ORNL. As part of the groundwater protection program, and to be consistent with UT-Battelle management objectives, groundwater surveillance monitoring was performed to monitor ORNL groundwater exit pathways and UT-Battelle facilities ("active sites") potentially posing a risk to groundwater resources at ORNL. Results of the DOE OS groundwater surveillance monitoring program are reported in the following sections.

Exit pathway and active-sites groundwater surveillance monitoring points sampled during 2015 included seep/spring and surface-water monitoring locations in addition to groundwater surveillance monitoring wells. Seep/spring and surface-water monitoring points located in appropriate groundwater discharge areas were used in the absence of monitoring wells.

Groundwater monitoring performed under the exit pathway groundwater surveillance and active-sites monitoring programs are not regulated by federal or state rules. Consequently, no permit or standards exist for evaluating sampling results. To provide a basis for evaluating analytical results and to assess groundwater quality at locations monitored by UT-Battelle, current federal drinking water standards and/or Tennessee WQCs for radiological and nonradiological contaminants were used as reference standards. If no federal or state standard had been established for a particular radionuclide, 4% of the DCSs for radionuclides found in DOE O 458.1 was used to evaluate sampling results. Although drinking water standards and DOE DCSs were used for comparative purposes, it is important to note that no members of the public consume groundwater from ORNL wells, nor do any groundwater wells furnish drinking water to personnel at ORNL.

5.6.2.1 Exit Pathway Monitoring

During 2015, exit pathway groundwater surveillance monitoring was performed in accordance with the *UT-Battelle Sampling and Analysis Plan for Surveillance Monitoring of Exit Pathway Groundwater at Oak Ridge National Laboratory* (Bonine 2012). Groundwater exit pathways at ORNL include areas from watersheds or sub-watersheds where groundwater discharges to the Clinch River–Melton Hill Reservoir to the west, south, and east of the ORNL main campus. The exit pathway monitoring points were chosen based on hydrologic features, screened interval depths (for wells), and locations relative to discharge areas proximate to DOE facilities operated by or under the control of UT-Battelle. The groundwater exit pathways at ORNL include four discharge zones identified by a data quality objectives process. One of the original exit pathway zones, the East End Discharge Area, was subsequently divided into two zones—the Southern Discharge Area Exit Pathway and the East End Discharge Area Exit Pathway.

The five zones are as follows:

- the WOC Discharge Area Exit Pathway,
- the 7000–Bearden Creek Watershed Discharge Area Exit Pathway,
- the East End Discharge Area Exit Pathway,
- the Northwestern Discharge Area Exit Pathway, and
- the Southern Discharge Area Exit Pathway.

Figure 5.37 shows the locations of the exit pathway monitoring points sampled in 2015.

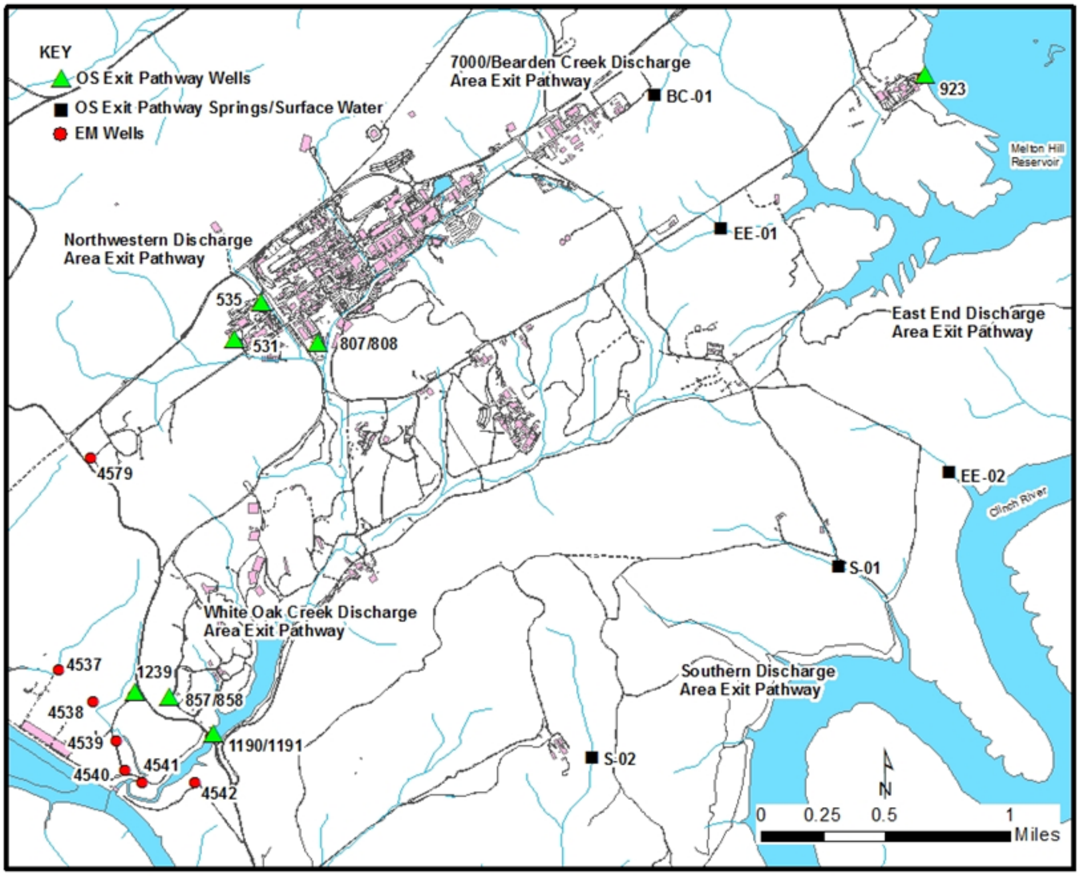

Fig. 5.37. UT-Battelle exit pathway groundwater monitoring locations at Oak Ridge National Laboratory, 2015. *[EM = Environmental Management and OS = Office of Science (both Department of Energy).]*

The efficacy of the exit pathway monitoring program was reviewed in late 2011. As a result, the groundwater monitoring program was modified through an optimization approach that included frequency analysis of parameters and their concentrations based on an exhaustive review of historical groundwater sampling data. The modification resulted in a 10-year staggered groundwater monitoring schedule and analytical suite selection. This approach was initiated in 2012. The groundwater monitoring program implemented in 2015 is outlined in Table 5.16.

Unfiltered samples were collected from the exit pathway groundwater surveillance monitoring points in 2015. The organic suite was composed of VOCs and semivolatile organic compounds (SVOCs); the metallic suite included heavy and non-heavy metals; and the radionuclide suite was composed of gross alpha/gross beta activity, gamma emitters, total radioactive strontium, and tritium. Under the monitoring strategy outlined in the *Sampling Analysis Plan* (Bonine 2012), samples were collected semiannually during the wet (April) and dry (August) seasons.

Table 5.16. Scheduled 2015 exit pathway groundwater monitoring

Discharge area	Monitoring point	Wet season	Dry season
White Oak Creek	857	Radiological	Radiological
	858	Radiological	Radiological, organic, and metals
	1190	Radiological, organic, and metals	Radiological, organic, and metals
	1191	Radiological, organic, and metals	Radiological, organic, and metals
	1239	Radiological	Radiological
Northwestern	531	Radiological	Radiological
	535	Radiological	Radiological
	807	Radiological	Radiological, organic, and metals
	808	Radiological	Radiological
7000–Bearden Creek	BC-01	Radiological	Radiological, organic, and metals
East End	923	Radiological	Radiological
	EE-01	Radiological	Radiological
	EE-02	Radiological	Radiological
Southern	S-01	Radiological	Radiological
	S-02	Radiological	Radiological, organic, and metals

5.6.2.1.1 Exit Pathway Monitoring Results

Statistical trend analyses were performed on 2015 exit pathway monitoring data sets containing data exceeding reference standards. The bases used for the trend analyses were the historical data collected from the late 1980s through 2015. Trend analyses were not performed on data sets where minimum detection limits exceeded reference standards [i.e., the SVOCs atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol] and were not performed on parameters for which there are no reference standards or where data densities were insufficient. Parameters that exhibited statistically significant (80% to 99% confidence levels) upward or downward trends are reported. Trend analysis results are summarized in Table 5.17.

Samples were not collected at S-01 during the wet and dry season in 2015. Additionally, no sample was collected from EE-02 during the dry season. Samples were not collected due to a lack of water flow at the locations. Samples were collected at all other monitoring points during both the wet and dry seasons. Monitoring results are available in OREIS. Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone (865-574-3257).

Table 5.18 provides a summary of radiological parameters detected in samples collected from exit pathway monitoring points during 2015. Metals are ubiquitous in groundwater exit pathways and so are not summarized here.

Table 5.17. 2015 exit pathway groundwater monitoring—results of trend analyses for parameters exceeding reference standards

Discharge area	Monitoring point	Parameter	Statistically significant trend
White Oak Creek	1190	Iron	Downward
		Manganese	Downward
		Tritium	Downward
	1191	Iron	Downward
		Manganese	Upward
		Gross beta	Downward
		Total radioactive strontium	None detected
		Tritium	Downward
	807	Iron	None detected
		Manganese	None detected
Southern	S-02	Aluminum	None detected
		Iron	None detected
7000-Bearden Creek	BC-01	Aluminum	None detected

Table 5.18. 2015 exit pathway groundwater monitoring results—detected radiological parameters

Discharge Area	Monitoring Station	Radionuclide	Wet season (pCi/L)	Dry season (pCi/L)
White Oak Creek	857	Beta activity	3.2	*a*
		Bismuth-214	67	120
		Lead-214	77	*a*
	858	Beta activity	5.1	6.4
		Bismuth-214	*a*	19
		Lead-214	*a*	17
		Potassium-40	*a*	35
	1190	Alpha activity	1.7	6
		Beta activity	6.1	3.7
		Bismuth-214	71	24
		Lead-212	7.6	*a*
		Lead-214	74	23
		Tritium	23,000	23,000
	1191	Alpha activity	3	*a*
		Beta activity	430	330
		Bismuth-214	110	*a*
		Lead-214	130	22
		Strontium-89/90	190	150
		Tritium	32,000	15,000
	1239	Beta activity	2.6	*a*
		Potassium-40	*a*	51

Table 5.18 (continued)

Discharge Area	Monitoring Station	Radionuclide	Wet Season (pCi/L)	Dry Season (pCi/L)
Northwest	531	Beta activity	*a*	1.6
		Bismuth-214	13	*a*
		Lead-214	14	*a*
	535	Beta activity	2.1	6.8
		Bismuth-214	34	*a*
		Lead-214	31	*a*
		Tritium	230	*a*
	807	Alpha activity	2.2	*a*
		Beta activity	2.4	*a*
		Bismuth-214	150	19
		Lead-214	170	18
		Tritium	390	500
	808	Alpha activity	3	*a*
		Beta activity	9.6	2.2
		Bismuth-214	[a]	7
		Thallium-208	3	*a*
East End	923	Beta activity	2.6	7.5
		Bismuth-214	*a*	15
		Lead-214	*a*	19
	EE-01	Bismuth-214	11	*a*
		Lead-214	23	*a*
	EE-02	Bismuth-214	170	*b*
		Lead-214	180	*b*
Southern	S-01	*b*	*b*	*b*
	S-02	Bismuth-214	31	16
		Lead-214	38	20
7000-Bearden Creek	BC-01	Beta activity	2.1	*a*
		Bismuth-214	36	15
		Lead-214	33	16

[a] Parameter was not detected in sample aliquot.
[b] No sample was collected because the spring was dry.

Summary

A summary of 2015 analytical results associated with the OS exit pathway groundwater surveillance program monitoring efforts ORNL is presented below:

- Nine radiological contaminants were detected in exit pathway groundwater samples collected in 2015. Tritium, total radioactive strontium, and gross beta activity were the only radiological contaminants exceeding reference standards at any of the discharge areas and, as in past years, those three contaminants were observed at the WOC discharge area in 2015 (in wells 1190 and 1191). Statistical trend analyses show that the concentration trends for those parameters continue downward. No other radiological contaminants exceed reference standards at other discharge areas.

- Twenty-seven metallic contaminants were detected in exit pathway groundwater samples collected in 2015; however only four metals (iron, manganese, lead, and aluminum) were detected at concentrations exceeding reference standards. These metals are commonly found in groundwater at ORNL

- No organics (VOCs or SVOCs) were detected in exit pathway groundwater at ORNL during 2015.

Radiological and metal contaminant concentrations observed in groundwater exit pathway discharge areas were generally consistent with observations reported in past ORR annual site environmental reports. Based on the results of the 2015 monitoring effort, there is no indication that current OS operations are having a significant adverse effect on groundwater at ORNL.

5.6.2.2 Active Sites Monitoring

5.6.2.2.1 Active Sites Monitoring—High Flux Isotope Reactor

Outfall pipelines intercepting groundwater from the HFIR area are routinely monitored. The sampling is required under the ORNL NPDES permit. (See Section 5.5 for a discussion of results.)

5.6.2.2.2 Active Sites Monitoring—Spallation Neutron Source

Active sites groundwater surveillance monitoring was performed in 2015 at the SNS site under the SNS operational monitoring plan (OMP) (Bonine et al. 2007) due to the potential for adverse impact on groundwater resources at ORNL if a release were to occur. Operational monitoring was initiated following a 2-year (2004–2006) baseline monitoring program and will continue throughout the duration of SNS operations.

The SNS site is located atop Chestnut Ridge, northeast of the main ORNL facilities. The site slopes to the north and south, and small stream valleys, populated by springs and seeps, lie on the ridge flanks. Surface water drainage from the site flows into Bear Creek to the north and WOC to the south.

The SNS site is a hydrologic recharge area underlain by geologic formations that form karst geologic features. Groundwater flow directions at the site are based on the generally observed tendency for groundwater to flow parallel to geologic strike (parallel to the orientation of the rock beds) and via karst conduits that break out at the surface in springs and seeps located downgradient of the SNS site. A sizable fraction of infiltrating precipitation (groundwater recharge) flows to springs and seeps via the karst conduits.

SNS operations have the potential for introducing radioactivity (via neutron activation) in the shielding berm surrounding the SNS linac, accumulator ring, and/or beam transport lines. A principal concern is the potential for water infiltrating the berm soils to transport radionuclide contamination generated by neutron activation to saturated groundwater zones. The ability to accurately model the fate and transport of neutron activation products generated by beam interactions with the engineered soil berm is complicated by multiple uncertainties resulting from a variety of factors, including hydraulic conductivity differences in earth materials found at depth, the distribution of water-bearing zones, the fate and transport characteristics of neutron activation products produced, diffusion and advection, and the presence of karst geomorphic features found on the SNS site. These uncertainties led to the initiation of the groundwater surveillance monitoring program at the SNS site. Objectives of the groundwater monitoring program outlined by the OMP include (1) maintaining compliance with applicable DOE contract requirements and environmental quality standards and (2) providing uninterrupted monitoring of the SNS site.

Seven seeps/springs and surface water sampling points (seeps/springs S-1, S-2, S-3, S-4, S-5, and SP-1 and surface-water point SW-1) were routinely monitored as analogues to, and in lieu of, groundwater monitoring wells. Locations were chosen based on hydrogeological factors and proximity to the beam line. Figure 5.38 shows the locations of the specific monitoring points sampled during 2015.

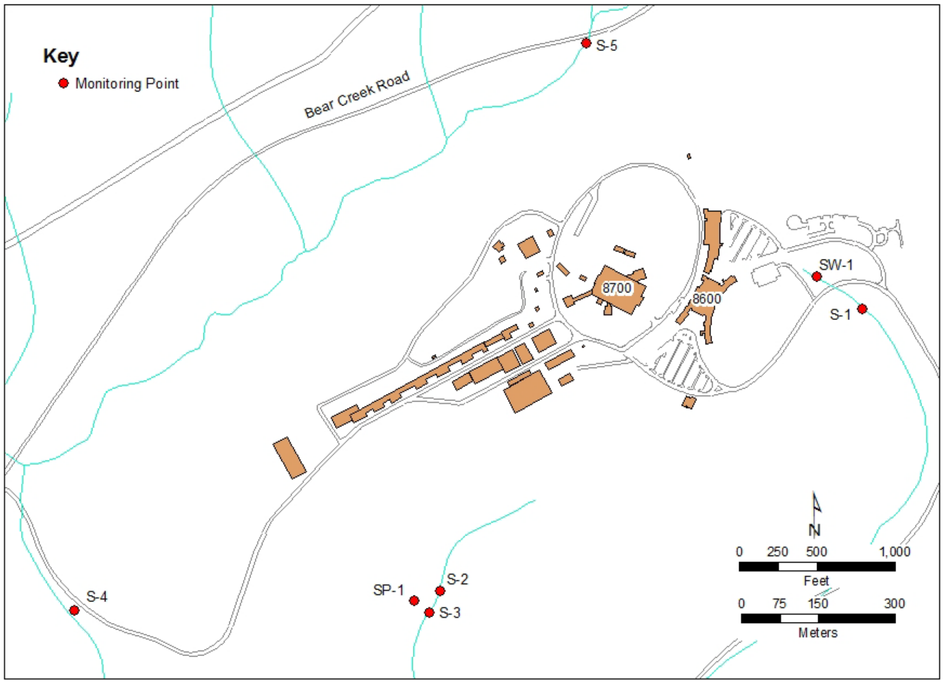

Fig. 5.38. Groundwater monitoring locations at the Spallation Neutron Source, 2015.

In November 2011 the SNS historical tritium data were evaluated to determine whether sampling could be optimized. The influence of flow condition on the proportion of tritium detects and nondetects in water samples collected at SNS from April 2004 through September 2011 was examined. In addition, the effect of seasonality on the proportion of detects and nondetects was examined for the same data set. The results of the analysis indicated that the proportion of detects to nondetects is not related to flow conditions or seasonality. This implies that samples could be collected during any flow condition and season with the expectation that there would be no statistical difference in the proportion of tritium detects to nondetects. The results of this statistical analysis of the April 2004–September 2011 data set were the basis for the modified OMP monitoring scheme implemented in 2015.

Taking a conservative approach, quarterly sampling at each monitoring point continued in 2015, allowing the opportunity for wet and dry season monitoring. All sampling performed in 2015 was performed in conjunction with rainfall events, with samples being collected during rising or falling (recession) limb flow conditions (see Fig. 5.39). Table 5.19 shows the sampling and parameter analysis schedule followed in 2015.

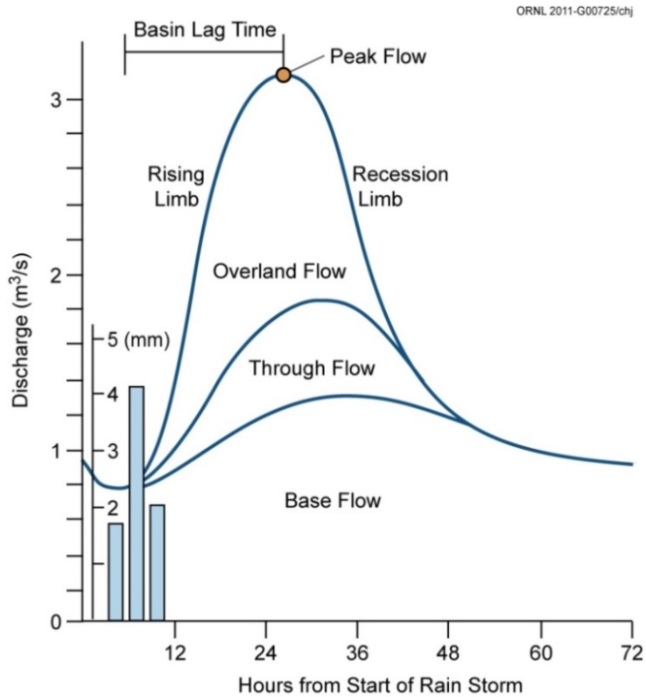

Fig. 5.39. Simple hydrograph of spring discharge vs. time after initiation of rainfall.

Table 5.19. 2015 Spallation Neutron Source monitoring program schedule

Monitoring location	Quarter 1 January–March	Quarter 2 April–June	Quarter 3 July–September	Quarter 4 October–December
SW-1	Tritium	Tritium	Tritium and expanded suite[a]	Tritium
S-1	Tritium	Tritium	Tritium and expanded suite	Tritium
S-2	Tritium	Tritium	Tritium	Tritium and expanded suite
S-3	Tritium	Tritium	Tritium	Tritium and expanded suite
S-4	Tritium and expanded suite	Tritium	Tritium	Tritium
S-5	Tritium and expanded suite	Tritium	Tritium	Tritium
SP-1	Tritium	Tritium and expanded suite	Tritium	Tritium

[a] The expanded suite includes gross alpha and gross beta activity, carbon-14, hydrogen-3, and gamma emitters.

Spallation Neutron Source Site Results

In 2015 sampling at the SNS site occurred during March (quarter 1), June (quarter 2), September (quarter 3), and November (quarter 4). Low concentrations of several radionuclides were detected numerous times during 2015. Table 5.20 provides a summary of the locations for radionuclide detections observed during 2015. The reference standard for tritium was not exceeded at any SNS monitoring location in 2015.

Table 5.20. Analytical results for parameters detected in samples collected at the Spallation Neutron Source during 2015 (pCi/L)

Location	Quarter	Parameter	Result	Reference standard
S-1	1	Tritium	376	20,000
S-4	1	Bi-214	20.3	10,595
S-4	1	Pb-214	11.7	8,000
S-5	1	Beta	4.8	50
S-5	1	Bi-214	23.6	10,595
S-5	1	Pb-214	21.3	8,000
S-2	1	Tritium	378	20,000
S-5	1	Tritium	956	20,000
S-1	2	Tritium	301	20,000
S-2	2	Tritium	345	20,000
SW-1	2	Tritium	1,770	20,000
S-2	3	Tritium	241	20,000
S-1	3	Beta	3.67	50
S-1	3	Bi-214	31.4	10,595
S-1	3	Pb-214	25.6	8,000
SW-1	3	Bi-214	71.6	10,595
SW-1	3	Pb-214	90.9	8,000
SW-1	3	Tritium	1,210	20,000
S-2	4	Tritium	1,700	20,000
S-3	4	Tritium	269	20,000
S-4	4	Tritium	1,620	20,000
S-2	4	Beta	4.59	50
S-2	4	Bi-214	5.42	10,595
SP-1	4	Tritium	511	20,000
SW-1	4	Tritium	694	20,000

Reference standards for ^{14}Bi and ^{214}Pb are 4% of the DOE O 458.1 derived concentration standards. Reference standards for the remainder of the parameters are the National Primary Drinking Water Standards (40 CFR Part 141).
No radionuclides exceeded a reference standard during 2015.

5.7 Quality Assurance Program

The UT-Battelle Quality Management System (QMS) has been developed to implement the requirements defined in DOE Order 414.1D, *Quality Assurance*. The methods used for successful implementation of the QMS rely on the integration and implementation of quality elements/criterion flowed-down through multiple management systems and daily operating processes. These management systems and processes are described in the Standards-Based Management System (SBMS), where basic requirements are communicated to staff. Additional or specific customer requirements are addressed at the project or work activity level. The QMS provides a graded approach to implementation based upon risk. The application of QA and quality assurance (QC) programs specifically focused on environmental monitoring activities on ORR is essential for generating data of known and defensible quality. Each aspect of an environmental monitoring program from sample collection to data management and record keeping must address and meet applicable quality standards. The activities associated with administration, sampling, data management, and reporting for ORNL environmental programs are performed by the UT-Battelle Environmental Protection Services Division (EPSD).

UT-Battelle uses SBMS to provide a systematic approach for integrating QA, environmental, and safety considerations into every aspect of environmental monitoring at ORNL. SBMS is a web-based system that provides a single point of access to all the requirements necessary for staff to safely and effectively perform work. SBMS translates laws, orders, directives, policies, and best-management practices into laboratorywide subject areas and procedures.

5.7.1 Work/Project Planning and Control

UT-Battelle’s work/project planning and control directives establish the processes and requirements for executing work activities at ORNL. All environmental sampling tasks are performed following the four steps required in the work control subject areas:

- define scope of work;
- perform work planning—analyze hazards and define controls;
- execute work; and
- provide feedback.

In addition, EPSD has approved project-specific standard operating procedures for all activities controlled and maintained through the Integrated Document Management System (IDMS).

Environmental sampling standard operating procedures developed for UT-Battelle environmental sampling programs provide detailed instructions on maintaining chain of custody, sample identification, sample collection and handling, sample preservation, equipment decontamination, and collection of quality control samples such as field and trip blanks, duplicates, and equipment rinses.

5.7.2 Personnel Training and Qualifications

The UT-Battelle Training and Qualification Management System provides employees and nonemployee staff of UT-Battelle with the knowledge and skills necessary to perform their jobs safely, effectively, and efficiently with minimal supervision. This capability is accomplished by establishing site-level procedures and guidance for training program implementation with an infrastructure of supporting systems, services, and processes.

Likewise, the WAI/NWSol Training and Qualification program provides employees with the knowledge and skills necessary to perform their jobs safely, effectively, and efficiently with minimal supervision. This capability is accomplished by establishing site-level procedures and guidance for training program implementation with an infrastructure of supporting systems, services, and processes.

5.7.3 Equipment and Instrumentation

5.7.3.1 Calibration

The UT-Battelle Quality Management System includes subject area directives that require all UT-Battelle staff to use equipment of known accuracy based on appropriate calibration requirements that are traceable to an authority standard. The UT-Battelle Facilities and Operations Instrumentation and Control Services team tracks all equipment used in the environmental monitoring programs conducted by UT-Battelle for the ORNL site and ORR through a maintenance recall program to ensure that equipment is functioning properly and within defined tolerance ranges. The determination of calibration schedules and frequencies is based on a graded approach at the activity planning level. EPSD environmental monitoring programs follow rigorous calibration schedules to eliminate gross drift and the need for data adjustments. Instrument tolerances, functions, ranges, and calibration frequencies are established based on manufacturer specifications, program requirements, actual operating environment and conditions, and budget considerations.

In addition, a continuous monitor used for CAA compliance monitoring at ORNL boiler 6 is subject to rigorous QA protocols as specified by EPA methods. A relative accuracy test audit (RATA) is performed annually to certify the Predictive Emissions Monitoring System (PEMS) for nitrogen oxides and oxygen. The purpose of RATA is to provide a rigorous QA assessment in accordance with EPA 40 CFR, Performance Specification 16. Three out of four quarters a RATA is performed on PEMS using a second, calibrated system to verify the accuracy of PEMS. The results of these QA tests are provided to TDEC quarterly, semiannually, or annually as applicable.

5.7.3.2 Standardization

The UT-Battelle IDMS provides the necessary functionality and controls to ensure that controlled documents are managed, distributed, revised, and maintained in accordance with ORNL document control requirements. EPSD sampling procedures are maintained in IDMS and include requirements and instructions for the proper standardization and use of monitoring equipment. Requirements include the use of traceable standards and measurements; performance of routine, before-use equipment standardizations; and actions to follow when standardization steps do not produce required values. Standard operating procedures for sampling also include instructions for designating nonconforming instruments as “out-of-service” and initiating requests for maintenance.

5.7.3.3 Visual Inspection, Housekeeping, and Grounds Maintenance

EPSD environmental sampling personnel conduct routine visual inspections of all sampling instrumentation and sampling locations. These inspections identify and address any safety, grounds keeping, general maintenance, and housekeeping issues or needs.

5.7.4 Assessment

Independent audits, surveillance, and internal management assessments are performed to verify that requirements have been accurately specified and activities that have been performed conform to expectations and requirements. External assessments are scheduled based on requests from auditing agencies. Table 5.2 presents a list of environmental audits and assessments performed at ORNL in 2015 and information on the number of findings identified, if any. EPSD also conducts internal management assessments of UT-Battelle environmental monitoring procedural compliance, safety performance, and work planning and control. Surveillance results, recommendations, and completion of corrective actions, if required, are also documented and tracked in the UT-Battelle Assessment and Commitment Tracking System.

WAI/NWSol and Isotek perform independent audits, surveillances, and internal management assessments to verify that requirements have been accurately specified and that activities that have been performed conform to expectations and requirements. WAI/NWSol corrective actions, if required, are documented and tracked in an Issues Management Database or Deficiency Reporting Database, and Isotek corrective actions are tracked in its Assessment and Commitment Tracking System.

5.7.5 Analytical Quality Assurance

The contract laboratories that perform analyses of environmental samples from the UT-Battelle environmental monitoring programs at ORNL and on ORR are required to have documented QA/QC programs, trained and qualified staff, appropriately maintained equipment and facilities, and applicable certifications. Several laboratories are contracted under basic ordering agreements to perform analytical work to characterize UT-Battelle environmental samples. As applicable, these laboratories participate in accreditation, certification, and performance evaluation programs, including the National Environmental Laboratory Accreditation Program, Mixed Analyte Performance Evaluation Program, Discharge Monitoring Report Quality Assurance Study, and DOE Environmental Management Consolidated Audit Program. Any issues of concern identified through accreditation/certification programs or performance evaluation testing are addressed with analytical laboratories and are considered when determinations are made on data integrity.

A statement of work for each project specifies any additional QA/QC requirements and includes detailed information on data deliverables, turnaround times, and required methods and detection limits. Blank and duplicate samples are routinely submitted along with ORR environmental samples to provide an additional check on analytical laboratory performance.

5.7.6 Data Management and Reporting

Management of data collected by UT-Battelle in conjunction with ORR and ORNL environmental surveillance programs and with CWA activities at ORNL is accomplished using the Environmental Surveillance System (ESS), a web interface data management tool. A software QA plan for ESS has been developed to document ESS user access rules; verification and validation methods; configuration and change management rules; release history; software registration information; and the employed methods, standards, practices, and tools.

Field measurements and sample information are entered into ESS, and an independent verification is performed on all records to ensure accurate data entry. Sample results and associated information are loaded into ESS from electronic files provided by analytical laboratories. An automated screening is performed to ensure that all required analyses were performed, appropriate analytical methods were used, holding times were met, and specified detection levels were achieved.

Following the screening, a series of checks is performed to determine whether results are consistent with expected outcomes and historical data. QC sample results (i.e., blanks and duplicates) are reviewed to check for potential sample contamination and to confirm repeatability of analytical methods within required limits. More in-depth investigations are conducted to explain results that are questionable or problematic.

ORNL radiological airborne effluent monitoring data are managed using the Rad-NESHAPs Inventory Web Application and the Rad NESHAPs Source Data Application. Field measurements and analytical data inputs along with emission calculations results are independently verified.

5.7.7 Records Management

The UT-Battelle Records Management System provides the requirements for managing all UT-Battelle records. Requirements include creating and identifying record material; scheduling, protecting, and record storage in office areas and the UT-Battelle Inactive Records Center; and destroying records.

WAI/NWSol and Isotek maintain all records specific to their projects at ORNL, and associated records management programs include the requirements for creating and identifying record material, protecting and storing records in applicable areas, and destroying records.

5.8 Environmental Management and Waste Management Activities at Oak Ridge National Laboratory

ORNL is becoming one of the world's most modern campuses for scientific discovery in materials and chemical sciences, nuclear science, energy research, and supercomputing. However, in the midst of all this modern infrastructure are large contaminated areas—the legacy of past operations and waste disposal practices. The DOE EM program has divided ORNL into two major cleanup areas: Bethel Valley and Melton Valley. The Bethel Valley area includes reactors and the principal research facilities, and Melton Valley includes reactors and waste management areas. The following sections summarize some of the 2015 EM activities undertaken at ORNL. More detailed information is available in the 2015 cleanup progress report (UCOR 2015).

5.8.1 Uranium-233 and Consolidated Edison Uranium Solidification Project Material Disposition Activities

In 2015, DOE remained focused on disposing of a significant inventory of uranium-233 (U-233) stored in Building 3019 at ORNL. The U-233 Project objective is to address safeguards and security requirements, eliminate safety and nuclear criticality concerns, and safely dispose of the material. In 2015, DOE also successfully resolved concerns associated with the disposition of the CEUSP material. CEUSP originated from a 1960s R&D test of thorium and uranium fuel at Consolidated Edison's Indian Point 1 Nuclear Plant. Direct disposition efforts resumed during 2015, and preparations continued for a processing campaign for material that cannot be disposed of directly.

5.8.2 Waste Disposal at Molten Salt Reactor Experiment Facility

Work continued during FY 2015 to characterize and dispose of waste items from the Molten Salt Reactor Experiment facility, a graphite-moderated, liquid-fueled test reactor that operated at ORNL from June 1965 until December 1969 (Fig 5.40). In 2015, 14 waste items were characterized, and 16 waste items were disposed of, which exceeds the scheduled plan.

Since the reactor's shutdown, EM has performed several studies and removal actions to stabilize the facility, including removal of uranium deposits and defueling of the reactor salts. Routine surveillance and maintenance activities continue to manage the remaining hazards associated with the facility, including periodic removal of reactive gas generated by the defueled salts.

Fig. 5.40. The Molten Salt Reactor Experiment facility.

5.8.3 Waste Management at Oak Ridge National Laboratory

5.8.3.1 Oak Ridge National Laboratory Wastewater Treatment

At ORNL, DOE EM operates PWTC and the Liquid Low-Level Waste Treatment Facility. In 2015 358 million L of wastewater was treated and released at PWTC. In addition, the liquid LLW evaporator at ORNL treated 557,466 L of waste. The waste treatment activities of these facilities support both DOE EM and DOE OS mission activities, ensuring that wastewaters from activities associated with projects of both offices are managed in a safe and compliant manner.

5.8.3.2 Oak Ridge National Laboratory Newly Generated Waste Management

ORNL is the largest, most diverse DOE OS laboratory in the DOE complex. Although much effort is expended to prevent pollution and eliminate waste generation, some waste streams are generated as a by-product of performing research and operational activities and must be managed to ensure that the environment is protected from associated hazards. UT-Battelle, as the prime contractor for the management of ORNL, is responsible for management of most of the wastes generated from R&D activities and wastes generated from operation of the R&D facilities. TRU wastes and waste streams that can be treated by on-site liquid and/or gaseous waste treatment facilities operated by EM are treated via these systems. Other R&D waste streams are generally packaged by UT-Battelle in appropriate shipping containers for off-site transport to commercial waste-processing facilities. In CY 2015, ORNL performed 73 waste shipments to off-site hazardous/radiological/mixed waste treatment and/or disposal vendors with no shipment rejections or violations.

5.8.3.3 Transuranic Waste Processing Center

TRU waste-processing activities carried out for DOE in 2015 by NWSol addressed CH solids/debris and RH solids/debris, which involved processing, treating, and repackaging of waste. Off-site transportation and disposal of LLW at NNSS or other approved off-site facilities was also performed in 2015. TRU waste disposal at the Waste Isolation Pilot Plant will resume once the facility is reopened to receive TRU waste.

During CY 2015, 26.0 m^3 of CH waste and 53.4 m^3 of RH waste were processed and 33.8 m^3 of mixed LLW (TRU waste that dropped out as low level) was shipped off the site.

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