5. Oak Ridge National Laboratory

ORNL is the largest science and energy national laboratory in the DOE system, conducting basic and applied research to deliver transformative solutions to compelling problems in energy and security. ORNL partners with the State of Tennessee, universities, and industry to solve challenges in energy, advanced materials, manufacturing, security, and physics. The laboratory's science and technology innovations are translated into applications for economic development and global security. The laboratory is home to several of the world's top supercomputers and is a leading neutron science and nuclear energy research facility that includes SNS and HFIR. ORNL hosts a DOE leadership computing facility, home of the Titan supercomputer; one of DOE's nanoscience centers, the Center for Nanophase Materials Sciences; one of DOE's energy research centers, the BioEnergy Science Center; and the Consortium for Advanced Simulation of Light-Water Reactors, a DOE innovation hub. ORNL operates 10 user facilities that draw thousands of research scientists and visitors each year.

- Building Technologies Research and Integration Center
- Carbon Fiber Technology Facility (CFTF)
- Center for Nanophase Materials Sciences
- Center for Structural Molecular Biology
- HFIR
- High Temperature Materials Laboratory
- National Center for Computational Sciences
- National Transportation Research Center (NTRC)
- Shared Research Equipment Collaborative Research Center
- SNS

ORNL is managed by UT-Battelle, LLC, a partnership between the University of Tennessee and Battelle Memorial Institute. During 2014 the ORNL operations of UT-Battelle, WAI, UCOR, and Isotek Systems LLC (Isotek) were conducted in compliance with contractual and regulatory environmental requirements with the exception of three issues identified during a joint TDEC-RCRA inspection. TDEC issued an NOV to UT-Battelle on December, 11, 2014, for failure to notify TDEC of the demolition of two small structures (each about 300 ft^2). Although the facilities did not contain asbestos, the regulations require TDEC to be notified before any building demolition. No other environmental NOVs or penalties were issued by the regulatory agencies.

Because of differing permit reporting requirements and instrument capabilities, various units of measurement are used in this report. The list of units of measure and conversion factors provided on pages xxvii and xxviii is intended to help readers convert numeric values presented here as needed for specific calculations and comparisons.

5.1 Description of Site, Mission, and Operations

ORNL, which is managed for DOE by UT-Battelle, LLC, a partnership of the University of Tennessee and Battelle Memorial Institute, lies in the southwest corner of the DOE 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.

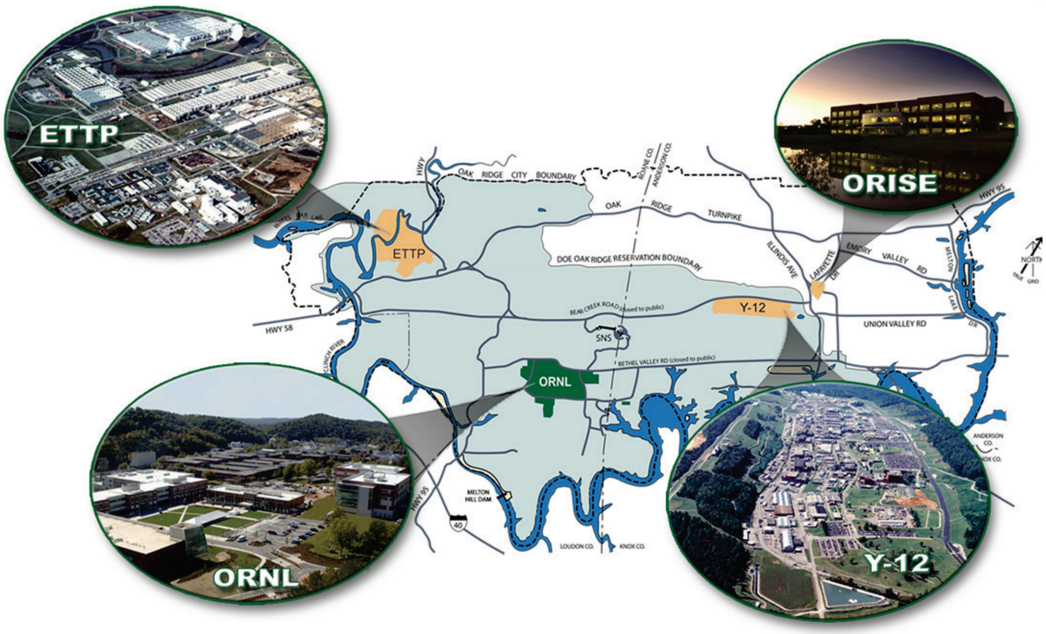

Fig. 5.1. Location of Oak Ridge National Laboratory within the Oak Ridge Reservation and its relationship to other local US Department of Energy facilities.

UT-Battelle also manages several facilities located off the main ORNL campus. These include several buildings and trailers located at the Y-12 Complex, the American Museum of Science and Energy in the city of Oak Ridge, and several other locations around the Oak Ridge vicinity, described below.

The Hardin Valley Campus (HVC) is home to the National Transportation Research Center (NTRC), a user facility dedicated to transportation research and development. HVC is located on a 2.4 ha (6-acre) site that is owned by Pellissippi Investors LLC and leased to UT-Battelle and the University of Tennessee separately. Two highly sophisticated experimental research laboratories, NTRC1 and NTRC2/Manufacturing Demonstration Facility (MDF), are at HVC. NTRC1 (76,500 ft^2) is the site of activities that span the entire range of transportation research and advanced power electronics and electric machinery research. NTRC2/MDF (52,200 ft^2) houses the Vehicle Systems Integration Laboratory, Battery Manufacturing Facility (DOE's largest open research dry room–cell assembly lab), and DOE's first MDF where additive manufacturing research is being conducted on projects such as the first 3-D printed vehicle, a Shelby Cobra. MDF also serves as the regional home for local high school students to build and analyze robots in conjunction with FIRST Robotics, a program to inspire students to pursue education and career opportunities in science, technology, engineering, and math.

CFTF is a pilot project to develop ways of making lower cost carbon fiber inexpensively using ORNL research (Fig. 5.2). Operations at CFTF, located in the Horizon Center Business Park in Oak Ridge, Tennessee, started up in 2013 and continued in 2014.

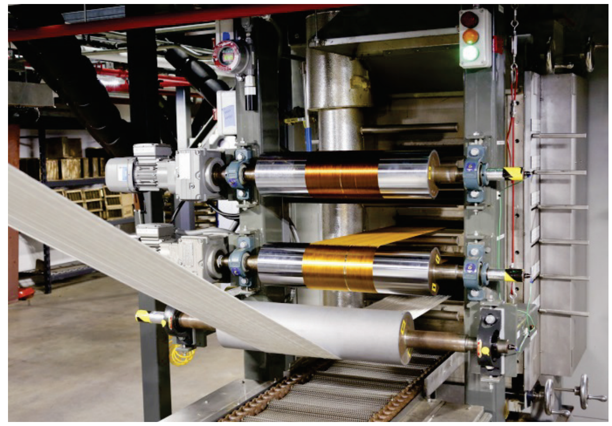

Fig. 5.2. Production of lower cost carbon fiber at the Carbon Fiber Technology Facility. *[Photo by Jason Richards.]*

URS | CH2M Oak Ridge LLC (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, TRU waste storage, and operation of the liquid low-level and process waste systems and the off-gas collection and treatment system.

TWPC, managed by WAI for DOE, is located on the western boundary of ORNL on about 10.5 ha (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, CH debris waste in December 2005, and 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 waste (LLW) or mixed LLW.

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 NNSA for future reuse and disposal at 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.

UT-Battelle provides air and water quality monitoring support for the Building 3019 complex and several UCOR facilities and water quality monitoring for WAI operations at TWPC. TWPC and UCOR stack radiological emission monitoring information is included in the ORR Rad-NESHAPs annual report (DOE 2014). Therefore, the UT-Battelle air and water monitoring discussions in this chapter include results for Isotek, UCOR, and WAI operations at ORNL.

About 5 ha (12 acres) in the central portion of ORNL has been leased to Heritage Center, LLC, a CROET subsidiary, for development into the Oak Ridge Science and Technology Park (ORSTP). ORSTP provides space for private companies doing research at ORNL, partner universities, start-up companies built around ORNL technologies, and ORNL contractors to conduct business within a short distance of ORNL researchers and DOE user facilities such as SNS, the Center for Nanophase Materials Sciences, and HFIR. Construction of the first ORSTP facility, Pro2Serve’s 10,684 m^2 (115,000 ft^2) National Security Engineering Center, was completed in 2009, and the company is now well-established in the building. Current ORSTP tenants include Roane State Community College, which is offering on-site training in the areas of carbon fiber manufacturing and solar energy technology; several consulting firms; and a carbon fiber manufacturer that is partnering with UT-Battelle for materials research. Expansion of ORSTP will continue as more environmental cleanup in ORNL's central campus is completed. EPA has designated ORSTP lessees as collocated workers because they are located on DOE property and are issued security badges to access the facilities.

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, UCOR and Isotek have implemented EMSs, modeled after 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.

UT-Battelle's EMS was initially registered to the ISO 14001 standard by a third-party registrar in 2004 and was reregistered in July 2013 by NSF 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. WAI's EMS for activities at TWPC was registered to the ISO 14001:2004 standard by NSF-ISR in May 2008. NSF-ISR conducted a recertification audit for the WAI EMS program in April 2014, and no nonconformities or issues were identified and several significant practices were noted. Section 5.2.2 describes the WAI 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). In May 2012, DOE conducted another validation audit and issued a memorandum documenting that Isotek's EMS for the U-233 Disposition Project conforms to the ISO 14001:2004 standard. (Note: The UCOR EMS is discussed in Section 3.2.)

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), 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., 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), EMS assists the line organizations in identifying and addressing environmental issues in accordance with SBMS requirements.

5.2.1.1 Integration with Integrated Safety Management System

The UT-Battelle EMS and 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 ES&H goals. ISMS and EMS both strive for continual improvement through "plan-do-check-act" cycles. Under ISMS, the term "safety" also encompasses environmental safety and health, including pollution prevention, waste minimization, and resource conservation. Therefore, the guiding principles and core functions in ISMS apply both to the protection of the environment and to safety. Figure 5.3 depicts the relationship between EMS and ISMS.

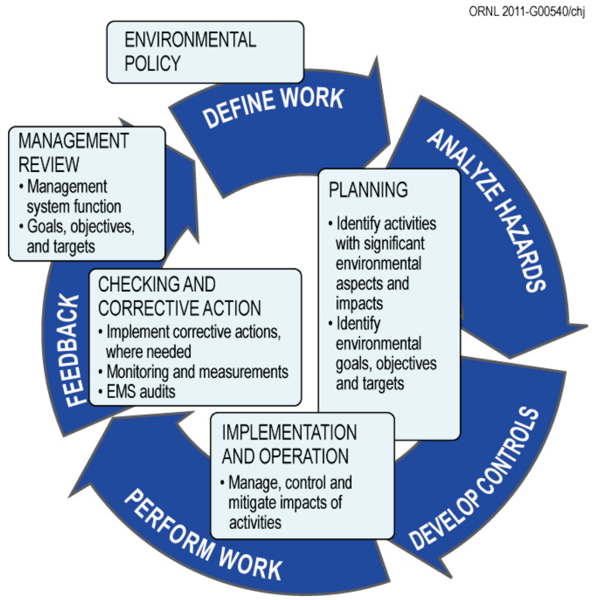

Fig. 5.3. The relationship between the UT-Battelle Environmental Management System and the Integrated Safety Management System.

The UT-Battelle EMS is consistent with 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. 5.4) 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. 5.4. 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;
- GHG emissions;
- permitted air emissions;
- regulated liquid discharges; and
- storage, use, or transportation of chemicals or 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 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. 5.4. Information on UT-Battelle's 2014 compliance status, activities, and accomplishments is presented in Section 5.3.

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

- waste management,
- NEPA compliance,
- air quality compliance,
- water quality compliance,
- US Department of Agriculture (USDA) compliance,
- transportation safety,
- environmental sampling and data evaluation, and
- CERCLA interface.

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

- 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 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 work with waste generators to collect and document waste characterization, identify proper disposal paths, complete disposal paperwork to submit for waste acceptance, and arrange and schedule waste removal from generator areas;
- the waste-handling team, which performs waste-packing operations and conducts inspections of waste items, areas, and containers;
- the waste and materials 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 2018.

Table 5.1 summarizes FY 2014 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* (https://sustainability-ornl.org/Documents/Sustainability-Plans/2014-SSP-ORNL.PDF).

Table 5.1. Summary of UT-Battelle progress toward attainment of DOE sustainability goals, 2014

SSPP Goal	DOE Goal	Performance Status through FY 2014	Planned Actions and Contributions
		Goal 1: Greenhouse Gas Reduction	
1.1	28% Scopes 1 and 2 GHG reduction by FY 2020 from a FY 2008 baseline (2014 target: 19%)	Scope 1 estimate is 63,163 MT CO_2e, a decrease of 30% from FY 2008 Scope 2 estimate is 332,462 MT CO_2e, an increase of 33% from FY 2008 after allowances for purchased renewable energy credits (RECs) The combined estimate for Scopes 1 and 2 is 395,625 MT CO_2e, an increase of 17% from the baseline year of FY 2008	Scope 1 reductions are on target due to ECM efforts, ESPC implementation, and SF_6 process reductions Scope 2 reductions represent more of a challenge due to growth in electricity demands for mission critical facilities (HEMSFs)
1.2	13% Scope 3 GHG reduction by FY 2020 from a FY 2008 baseline (2014 target: 5%)	Scope 3 estimate is 43,509 MT CO_2e. Overall, Scope 3emissions have increased by 6%. All Scope 3 elements are on trend to meet targets with the exception of T&D. Increased electricity consumption and a 33% increase in T&D losses limits the overall performance	Employee engagement focus areas such as responsible business travel and employee commute and telework programs will ensure progress toward Scope 3 reductions. T&D losses will grow along with purchased electricity; however, a new substation coming online in FY 2015 will increase efficiency and reduce the effect of T&D losses
		Goal 2: Sustainable Buildings	
2.1	30% energy intensity (Btu/gsf) reduction by FY 2015 from a FY 2003 baseline (2014 target: 27%)	UT-Battelle achieved a reduction of 29.5%, exceeding the FY 2014 goal	Ongoing energy audits in progress will identify additional energy conservation projects to achieve the 30% goal
2.2	EISA Section 432 energy and water evaluations	More than 25% evaluated during this second year of the current 4-year cycle	Continue pace of 25% or more through current cycle (end of FY 2016). Leverage knowledge from previous cycles to conduct focused evaluations

Table 5.1. (continued)

SSPP Goal	DOE Goal	Performance Status through FY 2014	Planned Actions and Contributions
2.3	Individual building metering for 90% of electricity (by October 1, 2012) and for 90% of steam, natural gas, and chilled water (by October 1, 2015) (2014 targets: 90% and 50%, respectively)	UT-Battelle is in compliance with DOE mandates by achieving 91% for electrical use. The balance of the metering is anticipated to be completed by the end of FY 2015. UT-Battelle is progressing toward full compliance for remaining systems	Continued implementation of metering plan will allow progress toward metering of all commodities. Goals have been met with respect to electricity, natural gas, and chilled water
2.4	Cool roofs—all new roofs and roof replacements must meet cool roof standards and have thermal resistance of at least R-30 (unless uneconomical or excluded)	Reroofing projects on two facilities added 23,014 ft^2 to the UT-Battelle cool roof inventory	Continue to ensure compliance
2.5	15% of existing buildings greater than 5,000 gsf are compliant with the HPSB GPs by FY 2015 (2014 target: 13%)	Two additional existing buildings achieved HPSB status in FY 2014 for a total of 25. The target goal of 15% (22 buildings) was exceeded in FY 2013, 2 years ahead of schedule	Efforts will continue toward expanding the existing HPSB inventory—planning for three additional buildings in FY 2015
2.6	All new construction, major renovations, and alterations of buildings greater than 5,000 GSF must comply with HPSB GPs	To date, 16 new facilities have been built to LEED and GP standards. One other building has been designed to meet LEED Gold standards and will be completed in 2015	All new construction is designed for LEED Gold as a routine part of the facility development process
		Goal 3: Fleet Management	
3.1	10% annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline (2014 target: 136% cumulative since 2005)	To date, alternative fuel use has increased from the 2005 baseline by 220%, exceeding the target	Continue to use alternative fuels and continue to educate drivers about the importance of using alternative fuels in flex fuel vehicles
3.2	2% annual reduction in fleet petroleum consumption by FY 2020 relative to a FY 2005 baseline (2014 target: 18% cumulative since 2005)	UT-Battelle has achieved a 55% reduction in fleet petroleum consumption compared to the 2005 baseline	Continue to use alternative fuel. Continue to ensure biodiesel quality is maintained
3.3	100% of light duty vehicle purchases must be AFVs by FY 2015 and thereafter	100% of light duty vehicle purchases in FY 2014 were AFVs	Continue to purchase AFVs from GSA schedules as funds and approvals are available

Table 5.1. (continued)

SSPP Goal	DOE Goal	Performance Status through FY 2014	Planned Actions and Contributions
		Goal 4: Water Use Efficiency and Management	
4.1	26% potable water intensity (gal/gsf) reduction by FY 2020 from a FY 2007 baseline, (FY 2014 target: 14%)	Water use intensity measured 138 gal/gsf in FY 2014 (a reduction of 22% to date, exceeding the interim goal)	Additional savings are planned that include eliminating once-through cooling and repair of leaks in the water distribution system. However, new facilities to be commissioned in FY 2018 could reverse the trend
4.2	20% reduction of ILA water use by FY 2020 from a FY 2010 baseline	No ILA water use at ORNL	No ILA water use at ORNL
		Goal 5: Pollution Prevention and Waste Reduction	
5.1	Divert at least 50% of nonhazardous solid waste, excluding C&D debris, by FY 2015	A 35% diversion rate was achieved in FY 2014. While less than the target, this represents a modest improvement in the past year	Continue mitigation measures and process improvements to close the gap for this goal in FY 2015 and beyond
5.2	Divert at least 50% of C&D materials and debris by FY 2015	UT-Battelle's diversion rate for C&D debris for FY 2014 is 70%	Continue process improvements. Additional focus will be placed on segregation of waste
		Goal 6: Sustainable Acquisition	
6.1	Procurements meet requirements by including necessary provisions and clauses in 95% of applicable contracts	100% of all applicable contracts in FY 2014 contained terms and conditions that invoke requirements for sustainable acquisitions	Procurement transactions will continue to include standard terms and conditions containing sustainable acquisition requirements
		Goal 7: Electronic Stewardship and Data Centers	
7.1	All core data centers are metered to measure monthly PUE of 100% by FY 2015 (2014 target: 90%)	All data center equipment is metered	Plans are being developed for adding meters in the 5800 chiller plant
7.2	Core data center maximum annual weighted average PUE of 1.4 by FY 2015 (2014 target: 1.5)	The calculated PUE value at the end of FY 2014 is 1.27 for the CSB data center, exceeding the goal	More accurate monthly and annual PUE calculations will facilitate progress toward even better performance
7.3	100% of eligible PCs, laptops, and monitors with power management actively implemented and in use by FY 2012	100% of the eligible PCs, laptops, and monitors are being actively power managed	Continue to actively ensure all eligible computing equipment is power managed
7.4	95% of eligible electronics acquisitions meet EPEAT standards	95% of eligible computers, monitors, and laptops meet EPEAT standards	Continue to actively ensure all computers, monitors, and laptops are meeting EPEAT standards

Table 5.1. (continued)

SSPP Goal	DOE Goal	Performance Status through FY 2014	Planned Actions and Contributions
		Goal 8: Renewable Energy	
8.1	20% of annual electricity consumption from renewable sources by FY 2020 (2014 target: 7.5%)	UT-Battelle produced on-site renewable electricity of 0.035% of consumption. Local (TVA) and marketplace REC purchases resulted in a total of 53,716 MWh of renewable attributes, exceeding the FY 2014 goal at 9%	Annual REC purchases will permit UT-Battelle to meet the goal until additional cost-effective on-site generation is implemented
		Goal 9: Climate Change Resilience	
9.1	Address DOE Climate Adaptation Plan goals	In FY2014 an ORNL Climate Change Resiliency team was chartered to ensure continued collaboration and focus on climate change between operations and scientific research staff and to increase awareness of climate events that could impact critical missions, operations, and personnel	The CCR team will ensure that appropriate climate change resiliency elements are considered in future planning for ORNL programs and activities
		Goal 10: Energy Performance Contracts	
10.1	Use of energy performance contracts	The ESPC with Johnson Controls, Inc., is a primary mechanism for achieving EPAct-related goals at ORNL	UT-Battelle will continue to consider opportunities to leverage energy performance contracting to make improvements that will aid in realizing sustainability goals

Acronyms

AFV = alternative fuel vehicle
Btu = British thermal unit
C&D = construction and demolition
CCR = Climate Change Resiliency (team)
CO_2e = carbon dioxide equivalent
CSB = Computational Science Building
DOE = US Department of Energy
ECM = energy conservation measure
EISA = Energy Independence and Security Act
EPAct = Energy Policy Act (2005)
EPEAT = Electronic Product Environmental Assessment Tool
ESPC = Energy Savings Performance Contract
FY = fiscal year
GHG = greenhouse gas
GPs = guiding principles
GSA = General Services Administration
gsf = gross square feet
HEMSF = high-energy, mission-specific facility
HPSB = High Performance Sustainable Buildings
ILA = industrial, landscaping, and agricultural
LEED = Leadership in Energy and Environmental Design
MWh = megawatt-hour
ORNL = Oak Ridge National Laboratory
PC = personal computer
PUE = power usage effectiveness
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 48 new pollution prevention projects at ORNL during 2014, eliminating more than 3.5 million kg (about 7.9 million lb) of waste. In total, these projects and ongoing reuse/recycle projects led to cost savings/avoidance of more than $2.2 million (Fig. 5.5.) Source reduction actions pursued in 2014 included moving toward paperless work processes; resource-efficient supercomputing; and recycling efforts for paper, scrap metal, lead, electronics, and construction and demolition (C&D) debris. Fig 5.6 summarizes recycling results for 2014.

Fig. 5.5. Recycling with the BigBelly Solar System. *[Photo by Jason Richards.]*

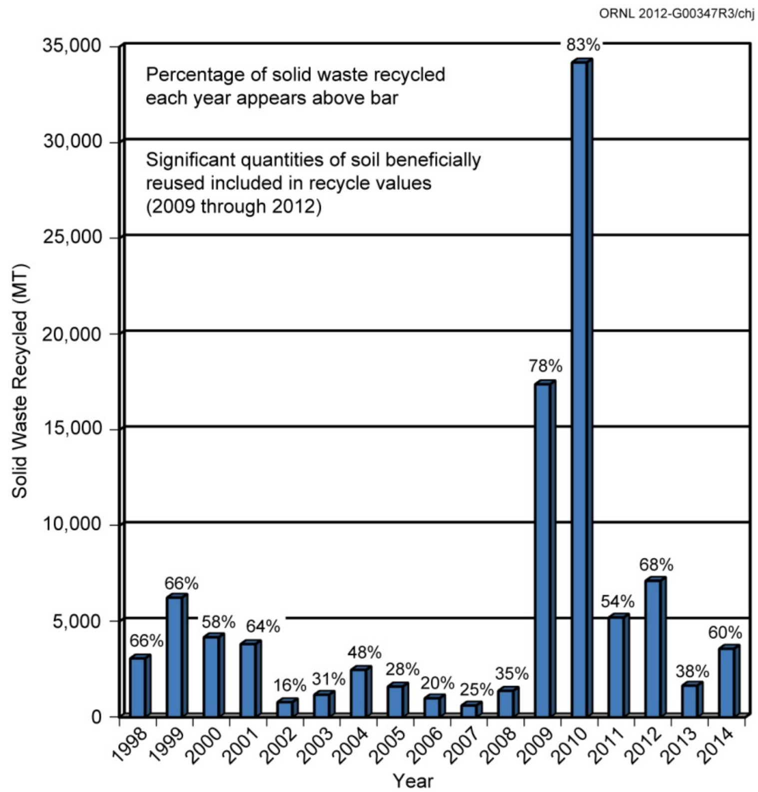

Fig. 5.6. Solid waste recycled at Oak Ridge National Laboratory as a result of recycling programs.

Oak Ridge National Laboratory Pollution Prevention/Sustainability Awards

- 2014 DOE Presidential Migratory Bird Federal Stewardship Award Competition Honorable Mention awarded to ORO and UT-Battelle for the identification of significant migratory bird habitat on ORR.
- 2014 Federal Green Challenge National Award for sustainable electronics stewardship efforts including contracting with a recycler certified to the Responsible Recycling Standard and continuing a transition to the use of zero client servers to replace desktop computers.

- 2014 Tennessee Chamber of Commerce and Industry Solid and Hazardous Waste Management Achievement Certificate for the UT-Battelle recycling program and for teaming with the Michael Dunn Center, a facility that provides services to children and adults with developmental disabilities (Fig. 5.7).

- 2014 DOE Sustainability Award for championing sustainability across ORNL and beyond.

Fig. 5.7. UT-Battelle teamed with the Michael Dunn Center for its award-winning recycling program.

Oak Ridge National Laboratory Awards for Pollution Prevention/Waste Reduction/Sustainability Research

- R&D Magazine R&D 100 Award for the Continuously Variable Series Reactor (CVSR) developed by UT-Battelle, SPX Transformer Solutions Inc., and the University of Tennessee. CVSR is a high power magnetic amplifier that controls power flow in power systems. CVSR's unique design helps to ensure full use of power system assets, increased reliability and efficiency, and effective use of renewable resources.

- R&D Magazine R&D 100 Award for the High Performance Silicon Carbide-Based Plug-in Hybrid Electric Vehicle Battery Charger developed by UT-Battelle, Arkansas Power Electronics International, the University of Arkansas, and Toyota. This onboard battery charger for plug-in hybrid electric vehicles incorporates silicon carbide devices to provide 10 times the power density of current commercial charging systems while delivering more efficient, higher power throughput for faster charging times. In addition, the charger significantly increases the vehicle's range, and the battery pack can be charged from any available single-phase AC power outlet, allowing for cheaper off-peak-hour charging while promoting a decreased dependence on expensive fossil-based fuels.

- R&D Magazine R&D 100 Award for the Ionic Liquid Antiwear Additives for Fuel-Efficient Engine Lubricants developed by UT-Battelle, General Motors Research and Development Center, Shell Global Solutions, and Lubrizol Corporation. The technology uses a group of ionic liquids that can be mixed with common lubricating oils to form a nanostructured protective film on bearing surfaces that effectively reduces friction and wear. This ionic lubricant technology has the potential to save the United States millions of barrels of oil each year.

- R&D Magazine R&D 100 Award for the Portable Aluminum Deposition System developed by UT-Battelle, the University of Mississippi, and United Technologies Research Center. This aluminum plating advance is expected to replace hazardous coatings such as cadmium.

- R&D Magazine R&D 100 Award for the Radio Frequency Diesel Particulate Filter Sensor developed by Filter Sensing Technologies Inc. in collaboration with UT-Battelle and the Massachusetts Institute of Technology. This technology provides rapid real-time assessment of soot on diesel particulate filters, which allows greater precision in filter control, thereby reducing fuel consumption and GHG emissions.

- R&D Magazine R&D 100 Award for Super-Hydro-Tunable HiPAS Membranes developed by UT-Battelle. This new class of membrane products can selectively separate molecules in the vapor/gas phase and perform liquid-phase separations, which could be especially useful in reducing the price of bioethanol, ethanol-gasoline blend fuels, and drop-in fuels from bio-oil processing.

- 2014 ORNL Energy and Transportation Science Division Significant Event Award for the world's first dynamic wireless charging system with coils for use in electric vehicles.

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

EISA Section 438 stipulates that the sponsor of any development or redevelopment project involving a federal facility with a footprint exceeding 5,000 ft^2 shall use site planning, design, construction, and maintenance strategies to maintain or restore, to the maximum extent feasible, the predevelopment hydrology of the property. 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."

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
- 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 the GI/LID practices mentioned above, 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 Emergency Management System 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 impact 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

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

SBMS requires organizations to perform periodic environmental assessments that cover both legal and other requirements and requires management system owners to conduct annual self-assessments of their systems to ensure the systems are effective and are continually improving.

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 the UT-Battelle EMS continues to conform to ISO requirements. In 2014, an internal audit and an external surveillance audit were conducted and verified that 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

The WAI EMS for activities at TWPC was registered to the ISO 14001:2004 Standard by NSF-ISR 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 a "plan-do-check-act" cycle is used for continual improvement in both. NSF-ISR conducted a recertification audit in April 2014, and no nonconformances or issues were identified and several significant practices were noted.

The WAI EMS incorporates applicable environmental laws, DOE orders, and other requirements (i.e., directives and federal, state, and local laws) through WAI's requirements management document (WAI 2012) and regulatory management plan (WAI 2012a), which dictate how the various requirements are incorporated into subject area documents (procedures and guidelines). EMS assists 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. WAI 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.

WAI 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 WAI EMS establishes annual goals and targets to reduce the impact of TWPC's environmental aspects.

WAI 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. WAI 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 122 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. WAI ensures environmentally preferable products are purchased by incorporating the green procurement requirements in WAI procurement procedures.

Several methods are used by WAI 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. WAI 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 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 determining whether these aspects can have significant environmental impacts. Radiological air emissions have been identified as the only Isotek environmental aspect with potentially significant environmental impacts, and an environmental management plan with measurable objectives and targets to address this aspect has been developed. Environmental aspects, potential impacts, objectives, targets, and environmental management plans are reviewed at least annually and updated 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 these compliance evaluations are used for continual improvement of the EMS.

5.3 Compliance Programs and Status

During 2014 UT-Battelle, UCOR, WAI, and Isotek operations were conducted in compliance with contractual and regulatory environmental requirements. One NOV was issued to UT-Battelle by TDEC in 2014. On December 11, 2014, after self-reporting, ORNL received an NOV from TDEC. The NOV was for failure to notify TDEC of the demolition of two small (about 300 ft^2 each) structures. Although the facilities did not contain asbestos, the regulations require that TDEC be notified before any building demolition.

Table 5.2 presents a summary of environmental audits conducted at ORNL in 2014.

Table 5.2. Summary of regulatory environmental audits, evaluations, inspections, and assessments conducted at Oak Ridge National Laboratory, 2014

Date	Reviewer	Subject	Issues
March 19	City of Oak Ridge	CFTF Wastewater Inspection	0
April 30	TDEC	UST Compliance Inspection	0
May 12–13	TDEC	Annual RCRA Inspection for ORNL	3
June 19	TDEC	Annual CAA Inspection for ORNL and CFTF	0
July 16	TDEC	Follow-Up Inspection from the FY 2013 Compliance Evaluation Inspection of CWA/NPDES programs	0
September 23	City of Oak Ridge	CFTF Wastewater Inspection	0
November 13	TDEC	Annual TWPC CAA Inspection	0
October 21–22	TDEC	Annual RCRA Inspection of ORNL at Y-12 Facilities	0
December 16	Knox County	Annual CAA Inspection for NTRC	0

Acronyms
CAA = Clean Air Act
CWA = Clean Water Act
CFTF = Carbon Fiber Technology Facility
NPDES = National Pollutant Discharge Elimination System
NTRC = National Transportation Research Center
ORNL = Oak Ridge National Laboratory
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation
TWPC = Transuranic Waste Processing Center
UST = underground storage tank

No RCRA Subtitle D disposal facilities are operated at ORNL. Industrial solid waste is sent to the Y-12 Complex industrial solid waste disposal landfills. ORNL complies with the requirements by meeting the waste acceptance criteria at the Y-12 facilities.

The following discussions summarize the major environmental programs and activities carried out at ORNL during 2014 and provide an overview of the compliance status for the year.

5.3.1 Environmental Permits

Table 5.3 contains a list of environmental permits that were in effect in 2014 at ORNL.

Table 5.3. Oak Ridge National Laboratory environmental permits, 2014

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)	965013P	03-27-12	11-01-14	DOE	UT-B	UT-B
CAA	Construction Permit, CFTF emergency generator	967180P	03/07/14	03-06-15	DOE	UT-B	UT-B
CAA	Operating Permit, NTRC	0941-05[a]	10-23-12	Annually[b]	DOE	UT-B	UT-B
CAA	Operating Permit, WAI	063331P	03-07-12	03-01-22	DOE	WAI	WAI
CAA	Operating Permit, WAI emergency generator	068459P	04-14-14	10-01-23	DOE	WAI	WAI
CAA	Title V Major Source Operating Permit, ORNL	562860	07-16-10	07-15-15	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
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	WAI
CWA	Tennessee General NPDES Permit TNR10-0000, Storm Water Discharges from Construction Activity—Site Expansion Project	TNR 133560	08-31-09	NA	DOE	WAI	WAI
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	01-17-14	01-31-15	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	UCOR/WAI

[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]TDEC issued completeness determination on 9/5/14 for the Part A and Part B renewal application. Permit is anticipated to be renewed in 2015.
[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
ORNL = Oak Ridge National Laboratory
RCRA = Resource Conservation and Recovery Act
UCOR = URS | CH2M Hill 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, 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 2014.

Table 5.4. National Environmental Policy Act activities, 2014

Types of NEPA documentation	Number of instances
Oak Ridge National Laboratory	
Approved under general actions[a] or generic CX determinations	54
Project-specific CX[b] determinations	0
Wastren Advantage, Inc.	
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 2014, UT-Battelle and WAI continued to operate under site-level procedures that provide requirements for project reviews and NEPA compliance. These procedures call for a review of each proposed project, activity, or facility to determine the potential for impacts to the environment. To streamline the NEPA review and documentation process, the DOE Oak Ridge Office has approved generic 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 NHPA 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

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, NSPSs, 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 Title V Major Source Operating Permit, renewed in 2011, was modified three times in 2014 to keep current with the latest UT-Battelle operating status. The Title V Major Source Operating Permit for Isotek operations was renewed in 2014. 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, NO_X, a criteria pollutant, 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 (asbestos, stratospheric ozone, etc.). There are also two off-site CAA permits for facilities maintained and operated by UT-Battelle: a minor source operating permit issued by Knox County Air Quality Management for NTRC and a Title V construction permit issued by TDEC for CFTF. In summary, there was one UT-Battelle CAA violation and no Isotek, UCOR, or WAI CAA violations or exceedances in 2014. The one CAA violation was for failure to provide timely notification to TDEC of the planned demolition of two small structures (about 300 ft^2 each). Although the facilities did not contain asbestos, the regulations require that TDEC be notified before any building demolition.

Section 5.4 provides detailed information on 2014 activities conducted by UT-Battelle in support of CAA.

5.3.4 Clean Water Act Compliance Status

The objective of 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 EPA’s establishment of limits on specific pollutants allowed to be discharged to US waters by municipal STPs and industrial facilities. EPA established the NPDES permitting program to regulate compliance with pollutant limitations. The program was designed to protect surface waters by limiting effluent discharges into streams, reservoirs, wetlands, and other surface waters. EPA has delegated authority for implementation and enforcement of the NPDES program to the State of Tennessee.

In 2014, 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 2014 was 100%, with no measurements exceeding numeric NPDES permit limits. Section 5.5 contains detailed information on the monitoring programs and activities carried out in 2013 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 TDEC’s Bureau of Environment Division of Water Supply. TDEC’s Bureau of Environment Division of 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,
- bacterial (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 2014, sampling results for ORNL's water system residual chlorine levels, bacterial constituents, and disinfectant by-products were all within acceptable limits. Sampling for lead and copper was conducted in 2012 and will not be required again until 2015.

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 2014, 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 (2,205 lb) of hazardous/mixed wastes in at least 1 calendar month during 2014. Mixed wastes are both hazardous (under RCRA regulations) and radioactive. Hazardous/mixed wastes are accumulated in SAAs, 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-121, as shown in Table 5.5. In 2014, UT-Battelle and UCOR were permitted to transport hazardous wastes under an EPA ID number issued for ORNL activities.

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 2014 was 441,680 kg (486.9 tons), with mixed wastewater accounting for 334,368 kg (368.6 tons). Excluding the wastewater, 2014 hazardous waste generation decreased by about 56%. This reduction is attributed to decreases in debris generated from building cleanout and demolition, a decrease in macroencapsulation of hazardous waste, and decreases in TRU waste generation. ORNL generators treated 3,850.5 kg (4.24 tons) of hazardous/mixed waste by elementary neutralization and silver recovery, and 27 kg (0.03 tons) of hazardous/mixed waste received from UT-Battelle generators at the Union Valley Property Sales facility was stored at ORNL and subsequently shipped off the site for treatment/disposal. The quantity of hazardous/mixed waste treated in RCRA-permitted treatment facilities at ORNL in 2014 was 16,438 kg (18.1 tons). This included waste treated by macroencapsulation, size reduction, and stabilization/solidification. In addition, 334,368 kg (368.6 tons) of mixed waste was treated at an on-site wastewater treatment facility. The amount of hazardous/mixed waste shipped off the site to commercial treatment, storage, and disposal facilities decreased about 50% to 113,206 kg (124.8 tons) in 2014.

In May 2014, TDEC conducted an annual RCRA inspection of ORNL generator areas; battery collection areas; RCRA-permitted treatment, storage, and disposal facilities; and RCRA records. During this inspection, all records were found to be in compliance with RCRA regulations and the RCRA permits; however, TDEC inspectors observed one container of hazardous waste in a satellite accumulation area and one container of hazardous waste in a 90-day accumulation area that were not closed. They also noted that this 90-day accumulation area was in the immediate vicinity of heavy equipment operations. The containers were immediately closed during the inspection, and the heavy equipment was subsequently moved away from the waste accumulation area.

DOE and UT-Battelle operations at NTRC and CFTF were regulated as "conditionally exempt small-quantity generators" in 2014, meaning that less than 100 kg (220.5 lb) 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 2014. The 0800 Area is a location on ORR adjacent to ORNL that has been assigned EPA identification number TNR000019760.

Table 5.5. Oak Ridge National Laboratory Resource Conservation and Recovery Act operating permits, 2014

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
	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
	Building 7880A 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
	Macroencapsulation T-1 Treatment Unit
	Amalgamation T-2a Treatment Unit
	Solidification/Stabilization T-3a Treatment Unit
	Groundwater Absorption T-4a Treatment Unit
	Size Reduction T-5a Treatment Unit
	Groundwater Filtration T-6
	Oak Ridge Reservation
TNHW-121	Hazardous Waste Corrective Action Permit

[a]Treatment operating units within Building 7880.

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

5.3.7 Oak Ridge National Laboratory RCRA-CERCLA Coordination

The ORR 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 2014 for ORNL's Solid Waste Management Units and Areas of Concern were consolidated with updates for ETTP, the Y-12 Complex, and ORR and were reported to TDEC, DOE, and EPA Region 4 in January 2015.

Periodic updates of proposed C&D activities and facilities at ORNL have been provided to managers and project personnel from the TDEC DOE Oversight 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 impact the effectiveness of previously completed CERCLA environmental remediation actions and do not adversely impact future CERCLA environmental remediation actions.

The UT-Battelle Environmental Management Program Office performs both direct EM work and an integration function for the DOE EM-funded American Recovery and Reinvestment Act (ARRA) work at ORNL. Although the completion of EM-related work (i.e., environmental remediation and building decontamination and demolition) is not a UT-Battelle core business function, UT-Battelle effectively participated in the completion of ARRA-funded cleanup work to accelerate ORNL revitalization. Activities during FY 2014 focused on Building 2026 and consisted of completion of legacy material removal projects including cleanout of Hot Cell 3, disposition of low volume/high cost chemical wastes, and cleaning of the window on Hot Cell 6. In addition, infrastructure improvements were initiated in 2015 at Building 2026 to support future down-blending of ^{233}U as part of the de-inventory of Building 3019 including cleanout of room 121 and laboratory 138, replacement of the chiller system and cooling tower, replacement of the fire alarm panel and fire suppression sprinklers, and changeout of facility HEPA filters.

5.3.7.1 Resource Conservation and Recovery Act 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 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. An amended notification was filed with TDEC—UST Section explaining that the tank is regulated under CWA Section 402 and is, therefore, excluded from the UST regulations [refer to 40 CFR 280.10(b)]. The "Tank Owner's Authorized Representative or Contact" was also changed to UCOR for this particular UST.

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 SARA. Under CERCLA, a site is investigated and remediated if it poses significant risk to health or the environment. The EPA 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 RAs on ORR. The on-site CERCLA 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 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 waste generation, transportation, and storage at ORNL are regulated under EPA ID TN1890090003. In 2014, UT-Battelle operated 16 PCB waste storage areas in generator buildings. 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. The majority of 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 Table 2.1) 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. In 2014, one unauthorized use of PCBs was discovered in pipe coating material in the 7900 area.

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

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 2014 through the submittal of reports under EPCRA Sections 302, 303, 311, and 312. 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 2014.

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 and extremely hazardous chemicals were submitted in an annual report to state and local emergency responders as required by the EPCRA Section 312 requirements. In 2014, 16 hazardous or extremely hazardous chemicals were located at ORNL in quantities above EPCRA reporting thresholds.

Private-sector lessees associated with the reindustrialization effort were not included in the 2014 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 2014, UT-Battelle reported the otherwise use of 28,863 lb of nitric acid and the manufacture of 49,318 lb of nitrate compounds. Of this, 28,736 lb of the nitric acid was used for waste treatment at PWTC and 111 lb was sent off the site for disposition. Nitrate compounds are coincidentally manufactured as by-products of neutralizing 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 2014, UT-Battelle personnel had a combined 28 permits and agreements for the receipt, movement, or controlled release of regulated articles.

5.3.12 Wetlands

Vegetation parameters were measured at the ORNL parking structure wetland (P2) about 3 years after mitigation. Percent cover by species was measured for each plot. Information was also taken on any fauna present at the time of the survey. Fourth year data showed excellent overall vegetation coverage, providing good quality habitat. Vegetation growing in the wetland included both planted and volunteer plant species. A good variety of fauna was noted in and around the wetland, including birds, frogs, and benthic macroinvertebrates (Fig. 5.8).

Fig. 5.8. Oak Ridge Reservation wetlands. *[Photo by Jason Richards.]*

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 (amount of silt, etc. between rocks), velocity/depth regime, sediment deposition, channel flow, frequency of riffles, bank stability, and vegetative cover. These parameters were measured using rapid bioassessment protocols for use in wadeable streams and rivers (Barbour et al. 1999).

First Creek mitigation activities had already been completed before the first habitat assessment, which was conducted in 2011. The 2014 survey represented the fourth formal assessment of post-mitigation conditions. Pre-mitigation conditions for First Creek are discussed qualitatively based on information contained in previous reports. The 2014 WOC habitat assessment was based on habitat conditions about 3 years after mitigation.

Riparian zone vegetation surveys were conducted by establishing 10 m by 5 m (32.8 ft by 16.4 ft) plots about 10 m (32.8 ft) apart (First Creek—east bank, WOC—north and south banks). A total of 11 plots were established at First Creek, and 13 plots were established at WOC. For each plot the following parameters were measured: trees (≥ 3 in. diameter at breast height)—measured, shrub stems (< 3 in. diameter at breast height)—counted, percent groundcover, percent canopy cover, canopy height, 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 11, 2014) and WOC (July 11, 2014) 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 100 m (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 EPT. BMAP fish survey data used for evaluation of First Creek were from 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 these 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 2014 showed that the creek continued to provide good overall habitat and 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 that 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 this narrow zone. The presence of invasive plants such as winter creeper in these zones is a potential concern. However, overall, invasive plants were not found to be a major concern on the site, and the percentage of these plants actually decreased slightly from the 2013 survey.

The survival rates of east side First Creek riparian plantings have been good thus far. In general, planted vegetation appears to be thriving and very little dead plant growth was noted during the 2014 survey.

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. Canopy cover showed a slight decrease from 2013; however, groundcover increased. Plant species diversity showed an increase from the 2013 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 2014, although the diversity was lower than that recorded in 2013 and somewhat lower than at some reference sites. This included some less tolerant taxa typically found in clear streams. Fish population densities (sampled upstream and downstream of the site) were within or higher than the ranges of densities observed in certain ORR reference streams. The number of fish species at the downstream sampling location was lower than or the same as numbers observed in reference streams. The number of fish species at the upstream sampling location was lower than numbers observed in reference streams.

The fifth year of post-mitigation monitoring for the First Creek site will be conducted in the summer of 2015.

The results of habitat measurements conducted along the WOC reach showed that the creek provided average to good overall habitat in the post-mitigation condition and remained in an unimpaired state. Epifaunal substrate was somewhat lacking in the presence of logs and snags; however, the creek provided numerous riffles, some undercut banks, a variety of particle sizes, and overhanging branches. One velocity/depth regime (fast-deep) was missing from the reach. Channel alteration from past development of the area was evident along some areas of the reach. Vegetative protection at the banks remained good for 2014. The number of riffles slightly decreased from the 2013 survey. Riparian vegetative zone width for 2014 also remained significantly improved over the 2011 pre-mitigation conditions. Some mortality of mitigation plantings was noted during the 2014 survey, and certain areas will be supplemented with additional plantings where coverage is less than optimal. However, overall survivorship and growth of plantings still remains high, and the percentage of groundcover on the site continues to increase. Plant species diversity showed an increase from the 2013 survey, and the percentage of invasive species significantly decreased from the 2013 survey. Control of winter creeper undertaken following the 2013 survey is believed to be the most significant contributor to this decrease. A moderately diverse benthic macroinvertebrate population was recorded at the WOC site in 2014, with an increase in the number of taxa from that found in 2013. This included some of the more tolerant taxa found in ORR streams. Fish population densities sampled within the reach were lower than found in reference streams on ORR. Overall fish density showed a decrease from the 2013 survey. The number of fish species was higher than one reference stream and lower than the other reference stream for the latest October–December (2013) sampling period. The number of fish species was higher or the same as reference streams for the latest March–May (2014) sampling period. Compared to last year's report, the number of fish species for the October–December sampling period decreased and the number of fish species for the March–May sampling period increased.

The fourth year of post-mitigation monitoring for the WOC site will be conducted in the summer of 2015.

A wetland assessment was conducted for one site at ORNL during 2014 to determine whether jurisdictional wetlands were present in an area adjacent to a proposed project. This site was checked to see whether any areas satisfied the USACE wetland protocols for soils, hydrology, and vegetation. A portion of the site did meet these criteria, and the site is being further evaluated for potential project impacts. A TDEC Hydrologic Determination Field Data sheet was also filled out to determine whether an associated drainage was a stream or wet weather conveyance according to TDEC guidance. The drainage was determined to be a wet weather conveyance.

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 O 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 misdelivered or damaged;
- personal items or materials;
- paper, plastic products, ABCs, toner cartridges, and other items released for recycling;
- office trash;
- housekeeping materials and associated waste;
- breakroom, cafeteria, and medical wastes;
- 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 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; these 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 O 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 O 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 free of contamination.

For large recycling programs or clearance of bulk items with low contamination potential a survey and release plan may be developed to direct the radiological survey process. For such projects, survey and release plans are developed based on guidance from MARSSIM or MARSAME (NRC 2000, 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 previously established in Table IV-1 of DOE O 5400.5 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 2014, UT Battelle cleared more than 12,000 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.

Items advertised for public sale via an auction are also surveyed independently on a random basis by State of Tennessee personnel, giving further assurance that contaminated material and equipment are not being inadvertently released.

Table 5.7. Excess items requested for release and/or recycling, calendar year 2014

	Process knowledge	Radiologically surveyed
Release request totals for calendar year 2014		
Computers-for-Learning	66	4
DOE—Donations	0	0
Other donations	1,411	328
LEDP (donations to colleges/universities)	22	0
DOE transfers	516	137
Other federal agency transfers	70	311
Landfill	0	0
Reuse at ORNL	509	83
Sales	6,912	1,769
Totals	9,506	2,632
Recycling request totals for calendar year 2014		
Used oils (gallons)	15,518	
Scrap metal (nonradiological areas) (tons)	376.33	
Used tires (each)	590	
Used auto cores and batteries (pounds)	38,181	

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 SNS and 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 (i.e., 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.

In 2012 the authorized limits process for clearing SNS and HFIR neutron scattering samples was updated and revised to incorporate improvements in the regulatory notification component based on experience gained over about 2 years of implementation.

UT-Battelle initiated an effort to make direct contact with each institution’s radiation safety officer (RSO) or health and safety official for the initial authorized limit sample clearance to that institution. The purpose of this approach was to ensure that a responsible official at the institution was informed of and understood the regulatory requirements associated with clearance of samples under the approved authorized limits. This “direct contact” approach proved to be much more effective than the previous approach of relying on use of the official user agreement to ensure that regulatory requirements were understood by the receiving institution. On May 2, 2012, UT-Battelle requested DOE approval of a minor change to the SNS and HFIR sample authorized limits process to replace the user agreement form as the primary regulatory notification tool with initial direct contact with an RSO or other health and safety official at the institution. This change was approved by DOE on May 22, 2012. No changes were made to the sample clearance activity thresholds or to the basic process for evaluating samples for clearance previously approved by DOE.

The approved revised process for notification was continued in 2014. In 2014 ORNL cleared 46 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 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 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. In 2013 UT-Battelle applied for permit modifications to incorporate source-specific conditions for the operation of the Biomass Gasification System and approval for alternative monitoring procedures for both the Biomass Gasification System and Boiler 6, located at the ORNL Steam Plant. As a result, TDEC issued Significant Modification Number 1 to Permit 562765 to DOE and UT-Battelle in March 2013. UT-Battelle also applied for a modification to Title V Major Source Operating Permit 562765 in April 2013 to incorporate 31 emergency-use electrical generators into the permit. The permit modification was issued on February 2, 2014. DOE and UT-Battelle also maintained a valid minor source operating permit with the Knox County Air Quality Management Division for NTRC facilities located 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 the hydrogen cyanide mass emission rate was 0.0024 lb per hour, far less than the maximum hourly emission rate of 0.05 lb 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. A construction permit was also obtained in 2013 for the CFTF emergency generator. The Title V Major Source Operating Permit for the facility and its emergency generator is anticipated to be issued in 2015.

DOE WAI 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 2014, 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 2014.

5.4.2 National Emission Standards for Hazardous Air Pollutants—Asbestos

Numerous facilities, structures, and facility components and various pieces of equipment at ORNL contain ACM. UT-Battelle’s Asbestos Management Program manages the compliance of work activities involving the removal and disposal of ACM, which includes 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. No releases of reportable quantities of ACM occurred at ORNL during 2014.

On December 11, 2014, ORNL received an NOV from TDEC for failure to notify TDEC before demolition of two small structures (about 300 ft^2 each). On August 25, 2014, ORNL notified TDEC of the intent to demolish numerous small structures. Two structures were not originally identified for demolition and so were not included in the notification. After further evaluation, the final disposition of the two structures was determined to be demolition. The two structures were demolished before issuance of a revised notification to TDEC. Although the facilities did not contain asbestos, the regulations require that TDEC be notified before any building demolition. Once ORNL identified the failure to provide the proper revised notification, the issue was self-reported to TDEC on October 21, 2014. The original notification was revised on October 29, 2014, and provided to TDEC. No further actions were required.

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 six stacks located in Bethel and Melton Valleys and the SNS Central Exhaust Facility stack 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 (MSRE) Facility
- 7880 TWPC
- 7911 Melton Valley complex, which includes HFIR and the Radiochemical Engineering Development Center
- 8915 SNS Central Exhaust Facility stack

In 2014 there were 14 minor point/group sources, and emission calculations/estimates were made for each of them.

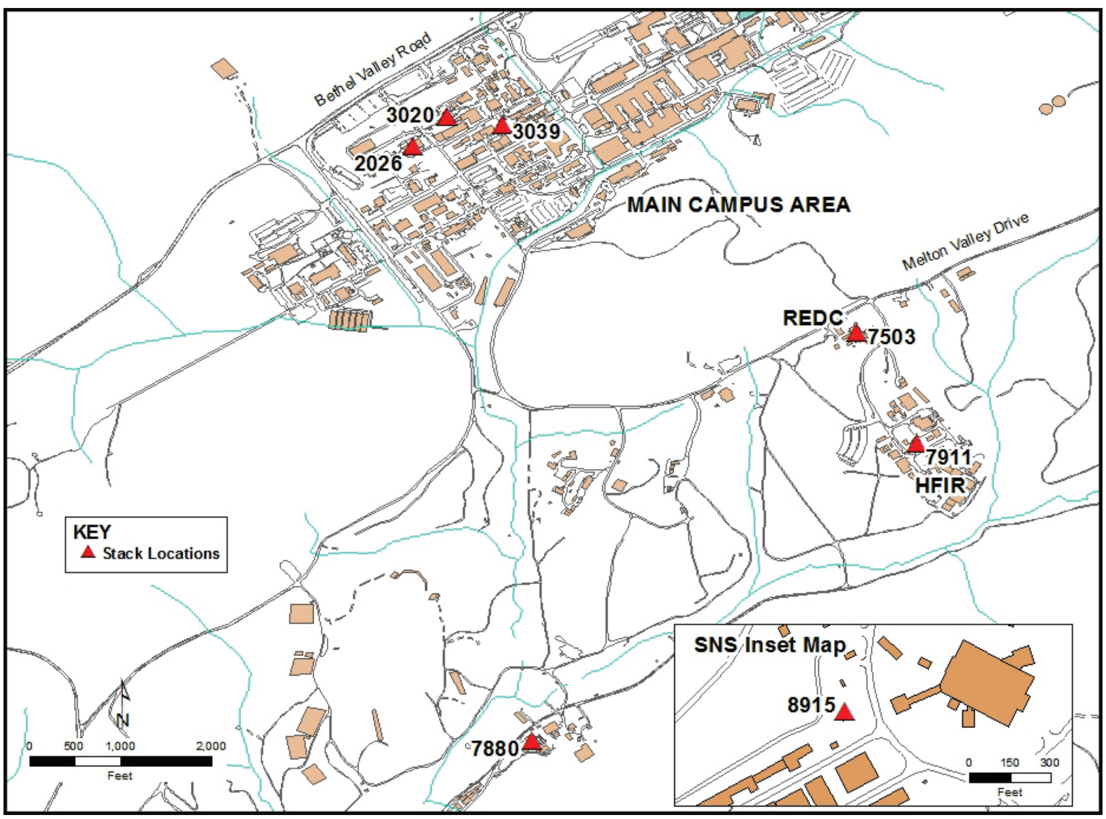

Fig. 5.9. Locations of major radiological emission points at Oak Ridge National Laboratory. *(HFIR = High Flux Isotope Reactor, REDC = Radiochemical Engineering Development Center, and SNS = Spallation Neutron Source.)*

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 a NOMAD analyzer, which allows 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 following the criteria in EPA Method 2 (EPA 2010) at major and some minor sources. 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 against 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 8915 and 7880, 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, 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 2014 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 ^{3}H (tritium) and ^{131}I are presented in Figs. 5.10 and 5.11. For 2014, tritium emissions totaled about 534.2 Ci (Fig. 5.10), a slight increase from 2013; ^{131}I emissions totaled 0.11 Ci (Fig. 5.11), a slight decrease but in line with emissions from the past 3 years. The increase in tritium was due to SNS operations. For 2014, the major dose contributors to the off-site dose at ORNL were ^{11}C, ^{212}Pb, ^{237}Np, ^{3}H, and ^{153}Sm, with dose contributions of about 59%, 14%, 7%, 3%, and 3%, respectively. Emissions of ^{11}C result from SNS operations and research activities. Emissions of ^{212}Pb result from the radiation decay of legacy material stored on-site and contamination areas containing isotopes of ^{228}Th, ^{232}Th, and ^{232}U. Emissions of ^{212}Pb were from the 2026, 3020, 3039, 7503, 7856, 7935, and 7911 stacks; the STP sludge drier; and the 4000 area laboratory hoods. Emissions of ^{237}Np were primarily due to releases from 7000 and 4000 area laboratory hoods. Emissions of ^{153}Sm result from 6000 area laboratory hood releases. For 2014, ^{11}C emissions totaled 12,400 Ci, double that of 2013; ^{212}Pb emissions totaled 2 Ci; ^{237}Np emissions totaled 0.0028 Ci; and ^{138}Cs emissions totaled 123 Ci (Fig. 5.12). Emissions of ^{41}Ar totaled 305 Ci, which was a decrease from 2013.

The calculated radiation dose to the maximally exposed individual (MEI) from all radiological airborne release points at ORR during 2014 was 0.6 mrem. The dose contribution to the MEI from all ORNL radiological airborne release points was 97.5% of the ORR dose. This dose is well below the NESHAPs standard of 10 mrem and is less than 0.2% 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 Oak Ridge National Laboratory, 2014[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	unspecified								4.84E-06	4.84E-06
^{226}Ac	M	unspecified								6.27E-07	6.27E-07
^{227}Ac	M	unspecified								6.67E-09	6.67E-09
^{228}Ac	M	unspecified								2.34E-05	2.34E-05
^{108m}Ag	M	unspecified								1.65E-07	1.65E-07
^{110m}Ag	S	unspecified					2.52E-06				2.52E-06
^{110m}Ag	M	unspecified								3.95E-08	3.95E-08
^{111}Ag	M	unspecified								5.48E-06	5.48E-06
^{241}Am	F	unspecified			2.13E-07	3.00E-08	1.57E-06			3.79E-08	1.85E-06
^{241}Am	M	unspecified	5.32E-08	3.42E-07				1.05E-07		9.73E-06	1.02E-05
^{243}Am	M	unspecified								7.00E-09	7.00E-09
^{41}Ar	G	unspecified						1.87E+02	1.18E+02		3.05E+02
^{131}Ba	M	unspecified								3.32E-07	3.32E-07
^{139}Ba	M	unspecified						1.65E-01			1.65E-01
^{140}Ba	S	unspecified					3.55E-05				3.55E-05
^{140}Ba	M	unspecified						2.79E-04		5.03E-04	7.82E-04
^{7}Be	M	unspecified	2.26E-07	2.31E-07						3.08E-06	3.54E-06
^{7}Be	S	unspecified			5.95E-06					4.15E-07	6.36E-06
^{206}Bi	M	unspecified								4.03E-08	4.03E-08
^{211}Bi	M	unspecified								1.21E-08	1.21E-08
^{212}Bi	M	unspecified								2.00E-07	2.00E-07
^{214}Bi	M	unspecified								1.23E-13	1.23E-13
^{249}Bk	M	unspecified								7.00E-11	7.00E-11
^{11}C	M	particulate							1.24E+04		1.24E+04
^{14}C	M	particulate								7.28E-11	7.28E-11
^{45}Ca	M	unspecified								7.60E-11	7.60E-11
^{109}Cd	M	unspecified								3.86E-07	3.86E-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
^{115}Cd	M	unspecified								2.82E-06	2.82E-06
^{139}Ce	M	unspecified								7.61E-08	7.61E-08
^{141}Ce	M	unspecified						7.65E-07		5.38E-07	1.30E-06
^{144}Ce	M	unspecified								9.55E-07	9.55E-07
^{249}Cf	M	unspecified								2.61E-11	2.61E-11
^{250}Cf	M	unspecified								4.76E-11	4.76E-11
^{251}Cf	M	unspecified								1.80E-12	1.80E-12
^{252}Cf[b]	M	unspecified						5.80E-09		1.33E-08	1.91E-08
^{242}Cm	M	unspecified								4.30E-12	4.30E-12
^{243}Cm	F	unspecified			1.69E-08	2.14E-08	7.35E-07			1.77E-09	7.75E-07
^{243}Cm	M	unspecified	1.01E-07							3.87E-12	1.01E-07
^{244}Cm	M	unspecified	1.01E-07	7.35E-09						3.67E-06	3.78E-06
^{244}Cm	F	unspecified			1.69E-08	2.14E-08	7.35E-07			1.77E-09	7.75E-07
^{245}Cm	M	unspecified								5.15E-10	5.15E-10
^{246}Cm	M	unspecified								4.66E-14	4.66E-14
^{247}Cm	M	unspecified								6.84E-14	6.84E-14
^{248}Cm[c]	M	unspecified								1.40E-09	1.40E-09
^{57}Co	M	unspecified								4.65E-12	4.65E-12
^{58}Co	M	unspecified								1.09E-12	1.09E-12
^{60}Co	M	unspecified								2.64E-05	2.64E-05
^{60}Co	S	unspecified			5.43E-07		2.87E-06				3.41E-06
^{51}Cr	M	unspecified								1.51E-08	1.51E-08
^{51}Cr	S	unspecified								8.65E-05	8.65E-05
^{132}Cs	F	unspecified								2.21E-07	2.21E-07
^{134}Cs	S	unspecified					2.35E-06				2.35E-06
^{134}Cs	F	unspecified								3.87E-07	3.87E-07
^{136}Cs	F	unspecified								8.11E-07	8.11E-07
^{137}Cs	F	unspecified	6.55E-07	1.15E-06				4.12E-06		4.84E-04	4.90E-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
^{137}Cs	S	unspecified			3.92E-05	2.74E-08	2.76E-06			3.31E-04	3.73E-04
^{138}Cs	F	unspecified						1.23E+02			1.23E+02
^{152}Eu	M	unspecified								2.58E-04	2.58E-04
^{152}Eu	F	unspecified			6.78E-08						6.78E-08
^{154}Eu	M	unspecified								4.87E-05	4.87E-05
^{155}Eu	M	unspecified								2.94E-05	2.94E-05
^{156}Eu	F	unspecified					4.32E-06				4.32E-06
^{156}Eu	M	unspecified								1.20E-07	1.20E-07
^{55}Fe	M	unspecified								9.20E-10	9.20E-10
^{59}Fe	M	unspecified								2.31E-12	2.31E-12
^{153}Gd	M	unspecified								3.91E-10	3.91E-10
^{3}H	V	vapor	4.14E-02		5.47E+00	8.73E-01		9.33E+01	4.34E+02	5.48E-01	5.34E+02
^{203}Hg	M	inorganic								6.12E-14	6.12E-14
^{166m}Ho	M	unspecified								2.00E-04	2.00E-04
^{125}I	F	particulate								2.85E-07	2.85E-07
^{129}I	F	particulate					3.20E-06			2.54E-05	2.86E-05
^{131}I	F	particulate			4.94E-03		2.39E-05	1.01E-01		2.12E-06	1.06E-01
^{132}I	F	particulate						1.05E+00			1.05E+00
^{133}I	F	particulate						6.39E-01		2.68E-06	6.39E-01
^{134}I	F	particulate						1.07E+00			1.07E+00
^{135}I	F	particulate						2.49E+00			2.49E+00
^{114m}In	M	unspecified								8.60E-13	8.60E-13
^{192}Ir	M	unspecified								4.50E-12	4.50E-12
^{40}K	M	unspecified								7.99E-05	7.99E-05
^{85}Kr	G	unspecified						1.27E+03			1.27E+03
^{85m}Kr	G	unspecified						1.12E+00			1.12E+00
^{87}Kr	G	unspecified						1.20E+01			1.20E+01
^{88}Kr	G	unspecified						3.63E+01	9.30E+01		1.29E+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
^{89}Kr[d]	G	unspecified						2.17E+01			2.17E+01
^{140}La	M	unspecified						3.74E-03		9.78E-07	3.74E-03
^{140}La	S	unspecified					1.74E-05				1.74E-05
^{54}Mn	M	unspecified								1.02E-10	1.02E-10
^{54}Mn	S	unspecified					2.64E-06				2.64E-06
^{93}Mo	M	unspecified								7.70E-11	7.70E-11
^{99}Mo	M	unspecified								1.94E-06	1.94E-06
^{13}N	G	unspecified							2.72E+02		2.72E+02
^{91m}Nb	M	unspecified								2.32E-11	2.32E-11
^{93m}Nb	M	unspecified								1.98E-10	1.98E-10
^{94}Nb	M	unspecified								5.81E-14	5.81E-14
^{95}Nb	M	unspecified								2.82E-07	2.82E-07
^{147}Nd	M	unspecified								6.45E-07	6.45E-07
^{59}Ni	M	particulate								3.36E-11	3.36E-11
^{63}Ni	M	particulate								7.03E-09	7.03E-09
^{237}Np	M	unspecified								2.80E-03	2.80E-03
^{239}Np	M	unspecified								1.70E-09	1.70E-09
^{191}Os	M	unspecified								4.53E-15	4.53E-15
^{32}P	M	unspecified								1.15E-14	1.15E-14
^{33}P	M	unspecified								1.65E-16	1.65E-16
^{228}Pa	M	unspecified								6.44E-08	6.44E-08
^{230}Pa	M	unspecified								8.03E-07	8.03E-07
^{232}Pa	M	unspecified								9.19E-08	9.19E-08
^{233}Pa	M	unspecified								3.18E-06	3.18E-06
^{210}Pb	M	unspecified								2.53E-11	2.53E-11
^{211}Pb	M	unspecified								4.26E-08	4.26E-08
^{212}Pb	M	unspecified	4.89E-01	5.26E-01				1.53E-02		1.08E-05	1.03E+00
^{212}Pb	S	unspecified			9.68E-01	1.50E-01				3.03E-02	1.15E+00

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
^{214}Pb	M	unspecified								2.50E-13	2.50E-13
^{148m}Pm	M	unspecified								2.28E-07	2.28E-07
^{236}Pu	M	unspecified								1.01E-16	1.01E-16
^{238}Pu	M	unspecified	2.00E-08	2.78E-07				1.86E-08		2.23E-05	2.26E-05
^{238}Pu	F	unspecified			5.15E-08	8.38E-09	1.40E-06			3.40E-08	1.49E-06
^{239}Pu	M	unspecified	2.37E-08	3.92E-07				4.75E-09		1.25E-07	5.45E-07
^{239}Pu	F	unspecified			2.54E-07	9.65E-09	6.30E-07			7.42E-09	9.01E-07
^{240}Pu	F	unspecified			2.54E-07	9.65E-09	6.30E-07			7.42E-09	9.01E-07
^{240}Pu	M	unspecified	2.37E-08					4.75E-09		1.71E-08	4.56E-08
^{241}Pu	M	unspecified								1.10E-10	1.10E-10
^{242}Pu	M	unspecified								4.53E-09	4.53E-09
^{244}Pu[e]	M	unspecified								9.96E-24	9.96E-24
^{223}Ra	M	unspecified								3.01E-04	3.01E-04
^{224}Ra	M	unspecified								1.45E-06	1.45E-06
^{225}Ra	M	unspecified								9.40E-08	9.40E-08
^{226}Ra	M	unspecified								1.60E-08	1.60E-08
^{228}Ra	M	unspecified								2.44E-05	2.44E-05
^{219}Rn	G	unspecified								2.49E-08	2.49E-08
^{220}Rn	G	unspecified								2.00E-07	2.00E-07
^{103}Ru	M	particulate								1.68E-06	1.68E-06
^{106}Ru	M	particulate								5.30E-07	5.30E-07
^{35}S	M	inorganic								5.00E-08	5.00E-08
^{120b}Sb	M	unspecified								1.00E-08	1.00E-08
^{124}Sb	M	unspecified								4.84E-07	4.84E-07
^{125}Sb	S	unspecified			6.71E-07						6.71E-07
^{125}Sb	M	unspecified								2.18E-07	2.18E-07
^{126}Sb	M	unspecified								9.97E-07	9.97E-07
^{127}Sb	M	unspecified								1.25E-06	1.25E-06

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
^{46}Sc	M	unspecified								1.44E-10	1.44E-10
^{75}Se	S	unspecified			8.92E-03						8.92E-03
^{145}Sm	M	unspecified								2.91E-05	2.91E-05
^{153}Sm	M	unspecified								3.00E+01	3.00E+01
^{117m}Sn	M	unspecified								4.00E-03	4.00E-03
^{125}Sn	M	unspecified								5.96E-07	5.96E-07
^{85}Sr	M	unspecified								4.00E-09	4.00E-09
^{89}Sr	M	unspecified	6.25E-08	2.41E-07				6.10E-06		3.21E-04	3.27E-04
^{89}Sr	S	unspecified			5.15E-06	2.14E-08				3.19E-05	3.70E-05
^{90}Sr	S	unspecified			5.15E-06	2.14E-08	8.82E-05			3.19E-05	1.25E-04
^{90}Sr	M	unspecified	6.25E-08	2.41E-07				6.10E-06		7.42E-03	7.42E-03
^{182}Ta	M	unspecified								5.26E-13	5.26E-13
^{99}Tc	M	unspecified								7.05E-07	7.05E-07
^{99}Tc	S	unspecified					1.33E-05			8.98E-06	2.23E-05
^{123m}Te	M	particulate								8.78E-10	8.78E-10
^{129m}Te	M	particulate								1.07E-07	1.07E-07
^{132}Te	M	particulate								7.87E-07	7.87E-07
^{227}Th	S	unspecified								2.39E-06	2.39E-06
^{228}Th	S	unspecified	1.02E-08	5.73E-09	1.02E-08	4.32E-09		5.35E-09		3.97E-07	4.33E-07
^{229}Th	S	unspecified								7.43E-12	7.43E-12
^{230}Th	F	unspecified			1.11E-08	3.07E-10				2.75E-09	1.42E-08
^{230}Th	S	unspecified	9.95E-10	3.25E-09				8.44E-09		7.06E-08	8.33E-08
^{231}Th	S	unspecified								1.63E-06	1.63E-06
^{232}Th	F	unspecified			8.28E-09					1.44E-09	9.72E-09
^{232}Th	S	unspecified	1.15E-09	2.55E-09		6.56E-10		2.95E-09		8.56E-06	8.57E-06
^{208}Tl	M	unspecified								3.20E-06	3.20E-06
^{170}Tm	M	unspecified								1.07E-11	1.07E-11
^{171}Tm	M	unspecified								4.84E-08	4.84E-08

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
^{232}U	M	unspecified								2.00E-07	2.00E-07
^{233}U	M	unspecified	3.24E-08					4.55E-08		1.30E-04	1.30E-04
^{233}U	S	unspecified			5.65E-08	1.30E-08	6.15E-07			5.48E-06	6.16E-06
^{234}U	M	unspecified	3.24E-08	1.29E-07				4.55E-08		1.42E-04	1.42E-04
^{234}U	S	unspecified			5.65E-08	1.30E-08	6.15E-07			5.48E-06	6.16E-06
^{235}U	M	unspecified	7.59E-09	1.00E-08				1.32E-08		5.60E-07	5.91E-07
^{235}U	S	unspecified			1.57E-08	3.77E-09	1.30E-06			8.67E-07	2.19E-06
^{236}U	M	unspecified								1.93E-24	1.93E-24
^{236}U	S	unspecified								1.14E-06	1.14E-06
^{238}U	S	unspecified			2.43E-08	2.43E-09	1.09E-06			7.40E-07	1.86E-06
^{238}U	M	unspecified	5.85E-09	1.04E-08				1.65E-08		5.11E-05	5.12E-05
^{181}W	M	unspecified								6.89E-10	6.89E-10
^{185}W	M	unspecified								1.21E-08	1.21E-08
^{188}W	M	unspecified								1.64E-09	1.64E-09
^{127}Xe	G	unspecified							1.63E+01		1.63E+01
^{131m}Xe	G	unspecified						1.66E+02			1.66E+02
^{133}Xe	G	unspecified						4.20E+00			4.20E+00
^{133m}Xe	G	unspecified						1.89E+01			1.89E+01
^{135}Xe	G	unspecified						5.41E+00			5.41E+00
^{135m}Xe	G	unspecified						8.88E+00			8.88E+00
^{137}Xe[f]	G	unspecified						2.11E+01			2.11E+01
^{138}Xe	G	unspecified						2.45E+01			2.45E+01
^{88}Y	M	unspecified								3.09E-08	3.09E-08
^{88}Y	F	unspecified					3.36E-06				3.36E-06
^{91}Y	M	unspecified								7.05E-13	7.05E-13
^{65}Zn	F	unspecified					6.52E-06				6.52E-06
^{65}Zn	M	unspecified								2.75E-10	2.75E-10
^{95}Zr	M	unspecified								8.86E-07	8.86E-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
^{95}Zr	S	unspecified					5.59E-06				5.59E-06
Totals			**5.30E-01**	**5.26E-01**	**6.45E+00**	**1.02E+00**	**2.24E-04**	**2.00E+03**	**1.33E+04**	**3.06E+01**	**1.54E+04**

[a]Emissions given in curies (Ci). 1 Ci = 3.7E+10 Bq.
[b]Californium-248 surrogate for californium-252.
[c]Curium-245 surrogate for curium-248.
[d]Krypton-88 surrogate for krypton-89.
[e]Plutonium-239 surrogate for plutonium-244.
[f]Xenon-135 surrogate for xenon-137.

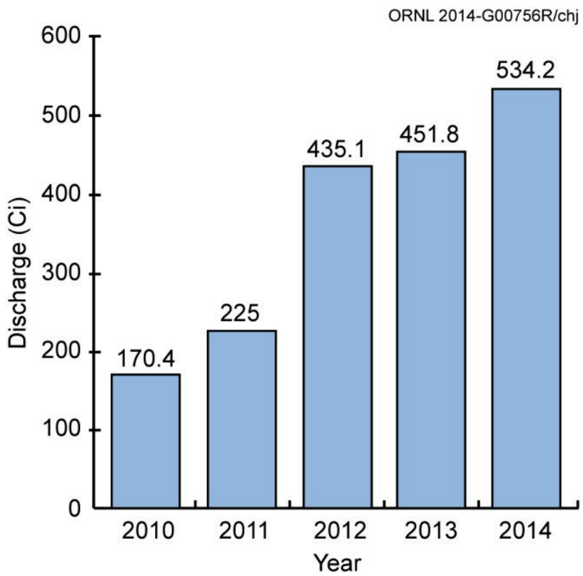

Fig. 5.10. Total curies of tritium discharged from Oak Ridge National Laboratory to the atmosphere, 2010–2014.

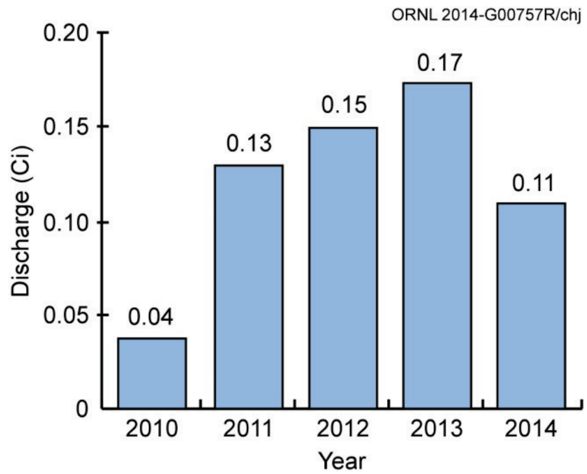

Fig. 5.11. Total curies of ^{131}I discharged from Oak Ridge National Laboratory to the atmosphere, 2010–2014.

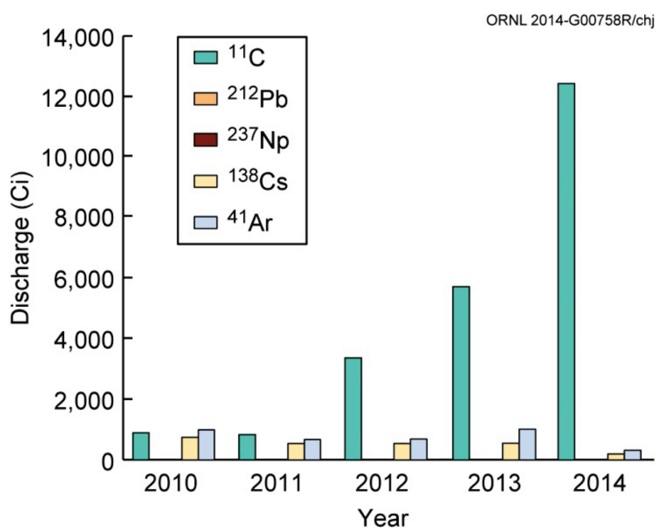

Fig. 5.12. Total discharges of ^{41}Ar, ^{11}C, ^{138}Cs, ^{212}Pb, and ^{237}Np from Oak Ridge National Laboratory to the atmosphere, 2010–2014. *(Note: Levels of ^{212}Pb and ^{237}Np discharged were too low to accurately depict on this figure.)*

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 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. 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 four stations located in areas most likely to show the impacts of airborne emissions from ORNL (Fig. 5.13). During 2014 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 the laboratory for analysis. A silica-gel column is used for collection of tritium as tritiated water. These samples are typically collected biweekly or weekly, depending on ambient humidity levels, and composited quarterly for tritium analysis.

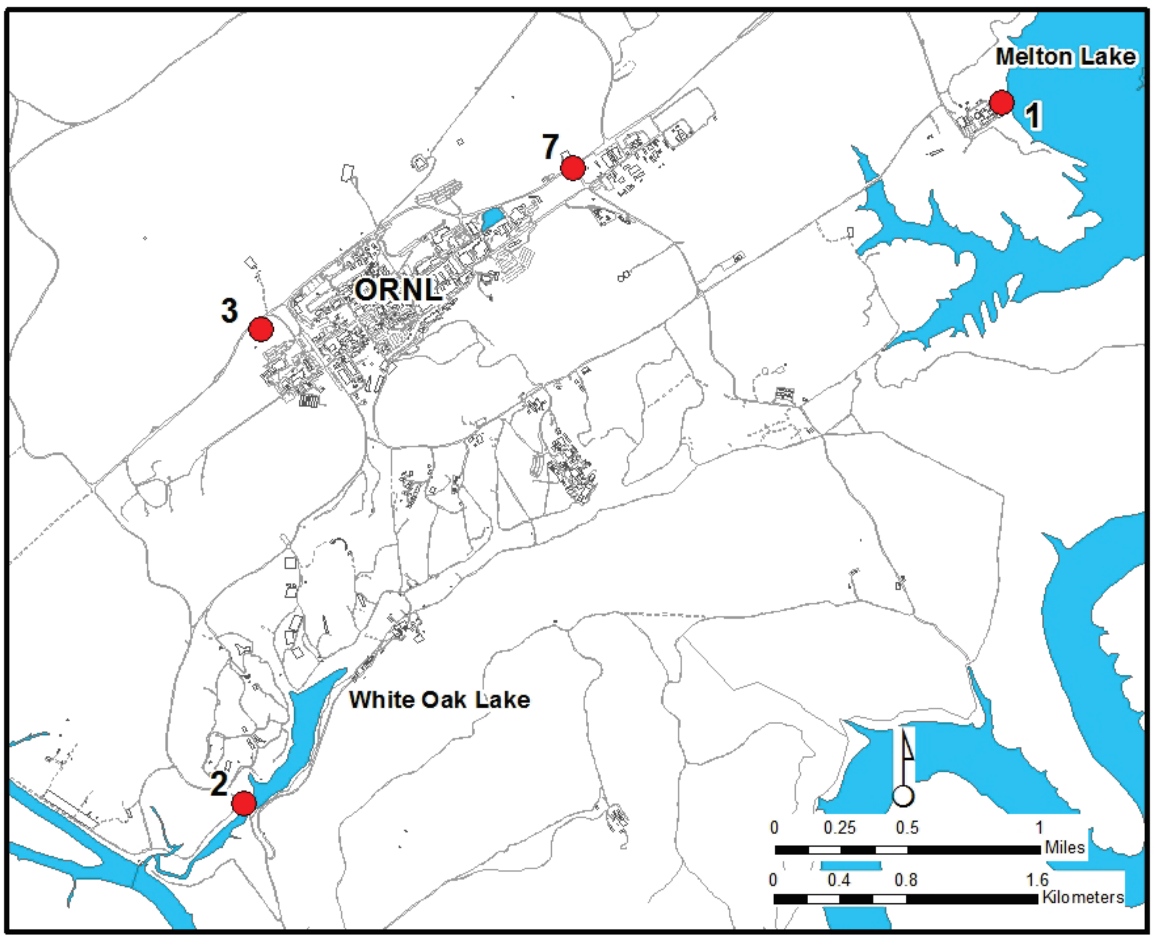

Fig. 5.13. Locations of ambient air monitoring stations at Oak Ridge National Laboratory.

Table 5.9. Radionuclide concentrations (pCi/mL)[a] measured at Oak Ridge National Laboratory perimeter air monitoring stations, 2014

Parameter	Number detected/ sampled	Concentration		
		Average	Minimum	Maximum
		Station 1		
Alpha	4/4	2.79E-09	2.09E-09	3.15E-09
^{7}Be	4/4	3.28E-08	2.29E-08	4.09E-08
Beta	4/4	9.19E-09	7.88E-09	1.04E-08
^{40}K	0/4	2.31E-09	-4.84E-10	4.32E-09
^{99}Tc	1/2	1.31E-10	6.36E-11	1.99E-10
^{3}H	4/4	4.92E-06	1.02E-06	8.50E-06
^{234}U	4/4	1.98E-12	1.55E-12	2.32E-12
^{235}U	3/4	2.92E-13	2.18E-13	3.64E-13
^{238}U	4/4	1.98E-12	1.14E-12	2.32E-12
Total U	4/4	4.24E-12	3.03E-12	5.00E-12
		Station 2		
Alpha	1/1	1.07E-08	*b*	*b*
^{7}Be	1/1	1.69E-08	*b*	*b*
Beta	1/1	1.89E-08	*b*	*b*
^{40}K	0/1	9.85E-09	*b*	*b*
^{234}U	1/1	5.75E-12	*b*	*b*
^{235}U	0/1	3.29E-13	*b*	*b*
^{238}U	1/1	4.49E-12	*b*	*b*
Total U	1/1	1.06E-11	*b*	*b*
		Station 3		
Alpha	1/1	9.89E-09	*b*	*b*
^{7}Be	1/1	1.78E-08	*b*	*b*
Beta	1/1	1.86E-08	*b*	*b*
^{40}K	0/1	-9.19E-10	*b*	*b*
^{234}U	1/1	8.08E-12	*b*	*b*
^{235}U	0/1	-1.67E-13	*b*	*b*
^{238}U	1/1	4.96E-12	*b*	*b*
Total U	1/1	1.29E-11	*b*	*b*
		Station 7		
Alpha	1/1	9.87E-09	*b*	*b*
^{7}Be	1/1	1.85E-08	*b*	*b*
Beta	1/1	1.74E-08	*b*	*b*
^{40}K	0/1	1.35E-09	*b*	*b*
^{234}U	1/1	4.47E-12	*b*	*b*
^{235}U	0/1	0.00E+00	*b*	*b*
^{238}U	1/1	5.30E-12	*b*	*b*
Total U	1/1	9.74E-12	*b*	*b*

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

5.4.5.1 Results

The ORNL PAM stations are designed to provide data for collectively assessing the specific impact of ORNL operations on local air quality. Sampling data from the ORNL PAM stations (Table 5.9) are compared with DCSs for air established by DOE as guidelines for controlling exposure to members of the public. During 2014, average radionuclide concentrations measured for the ORNL network were less than 1% of the applicable DCS in all cases.

5.5 Oak Ridge National Laboratory Water Quality Program

The NPDES permit issued to DOE for the ORNL site, TN 0002941, was renewed by the State of Tennessee in 2014 and includes requirements for discharging wastewaters from the three ORNL on-site wastewater treatment facilities and for the development and implementation of a water quality protection plan (WQPP). The permit calls for 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 approved by TDEC in 2008, and WQPP monitoring was initiated in 2009. WQPP incorporated several control plans that were required under the previous NPDES permit, including a BMAP (ORNL 1986), a chlorine control strategy, an SWPPP (ORNL 2007), a non-storm-water best management practices plan (ORNL 1997), and an NPDES radiological monitoring plan (ORNL 2008). 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 AWQC 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 listing potential causes and analyzing the available evidence on mercury and PCB contamination in the WOC watershed, it was clear that additional investigation was needed to complete the third step of the stressor identification process, “characterizing the cause.” 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 will be analyzed, interpreted, reported, and compared with past results in the WQPP annual report. This information will provide 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.

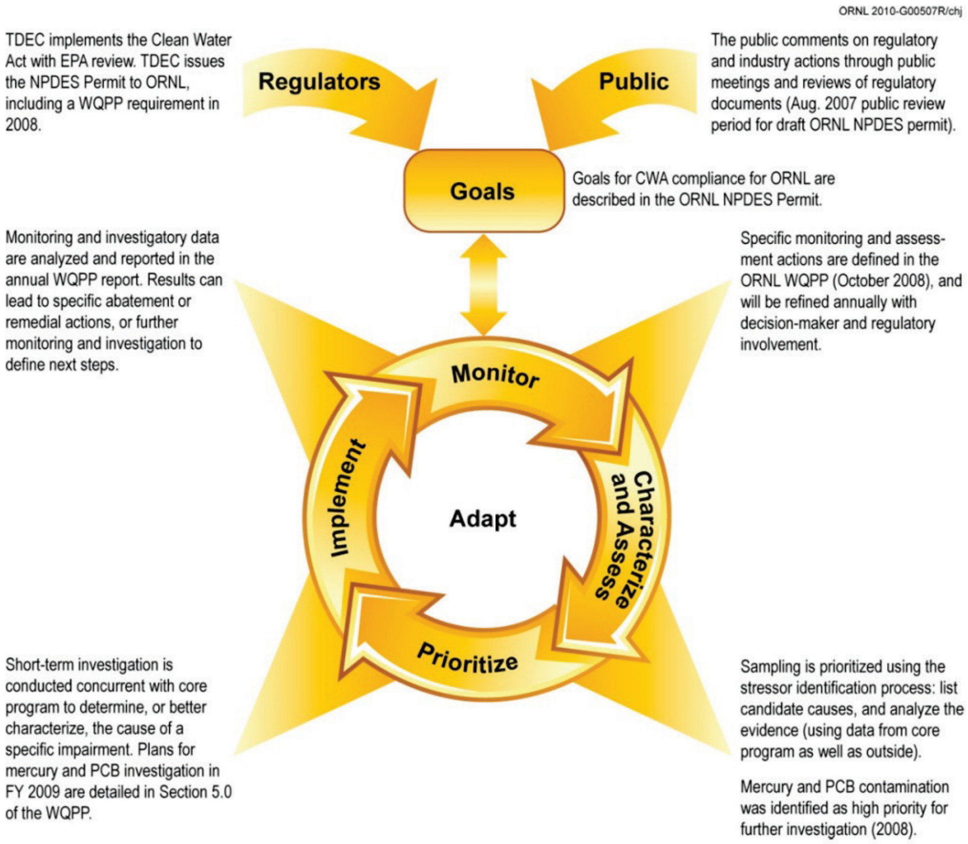

Fig. 5.14. Diagram of the adaptive management framework with step-wise planning specific to the Oak Ridge National Laboratory Water Quality Protection Plan (WQPP). *[Adapted from the US Environmental Protection Agency (EPA) stressor guidance document (EPA 2000). Acronyms: CWA = Clean Water Act, NPDES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

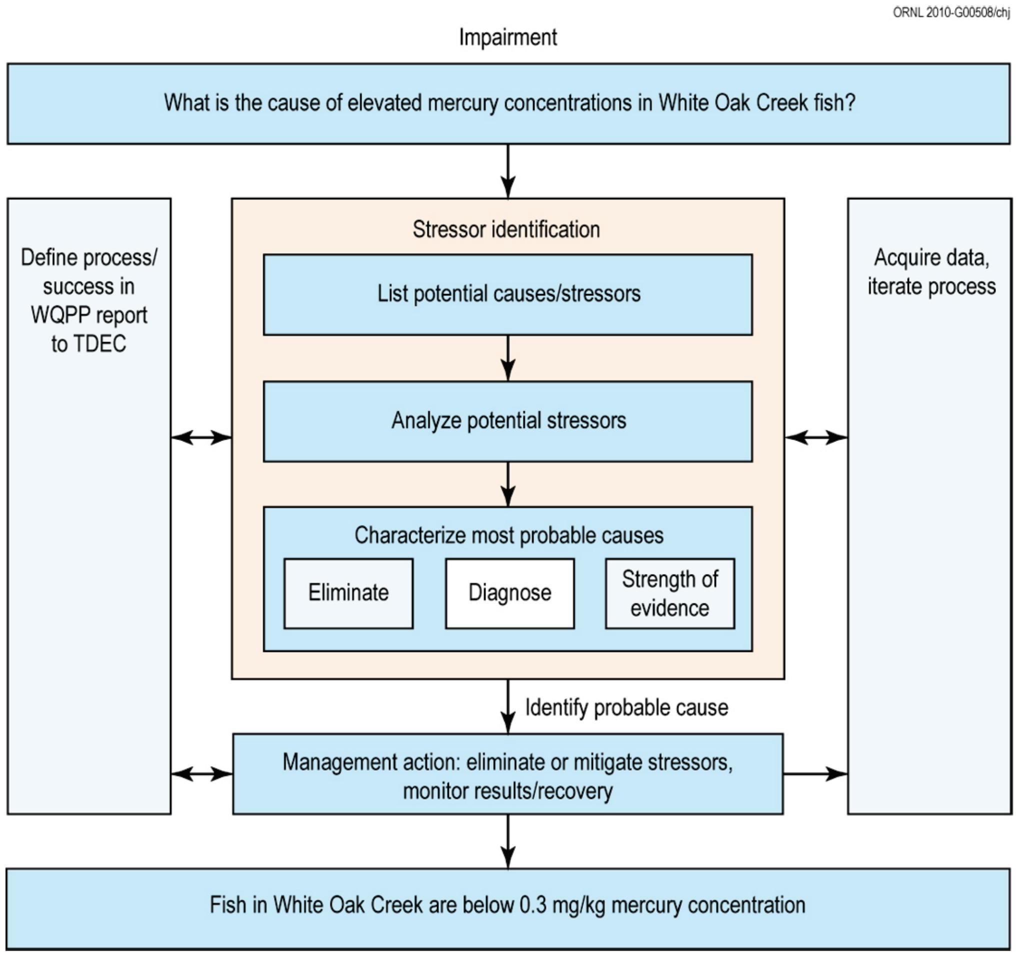

Fig. 5.15. Application of stressor identification guidance to address mercury impairment in the White Oak Creek watershed. *[Modified from Figure 1-1 in the US Environmental Protection Agency stressor guidance document (EPA 2000). TDEC = Tennessee Department of Environment and Conservation, WQPP = water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

5.5.1 Treatment Facility Discharges

Two on-site wastewater treatment systems were operated at ORNL in 2014 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 Process Waste Treatment Complex (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 renewed by TDEC in March 2014; therefore, Table 5.10 includes data from monitoring conducted under one version of the permit from January through March 2014, and Table 5.11 includes data from monitoring conducted under the renewed version of the permit from April through December 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 also provided in Table 5.10. ORNL wastewater treatment facilities achieved 100% compliance with permit limits and conditions in 2014. The ORNL STP has experienced infrequent instances where the plant goes to partial-treatment mode (disinfection) if the influent handling capacity is exceeded due to heavy rain storms. A project to upgrade the ORNL STP is in design, including increased influent handling capacity. The project is estimated to be completed in 2016.

Table 5.10. National Pollutant Discharge Elimination System compliance at Oak Ridge National Laboratory, January through March 2014
(NPDES permit effective August 1, 2008)

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]
Outfall 585 (Melton Valley Steam Plant)								
pH (standard units)				9	6	0	1	100
X01 (ORNL Sewage Treatment Plant)								
LC_{50} for *Ceriodaphnia* (%)					69.4	0	0[b]	100
LC_{50} for fathead minnows (%)					69.4	0	0[b]	100
Ammonia, as N (summer)	6.26	9.39	2.5	3.75		0	0[b]	100
Ammonia, as N (winter)	13.14	19.78	5.25	7.9		0	12	100
Carbonaceous biological oxygen demand	19.2	28.8	10	15		0	12	100
Dissolved oxygen					6	0	12	100
Escherichia coliform (col/100 mL)			941	126		0	12	100
IC_{25} for *Ceriodaphnia* (%)					15.5	0	0[b]	100
IC_{25} for fathead minnows (%)					15.5	0	0[b]	100
Oil and grease	19.2	28.8	10	15		0	3	100
pH (standard units)				9	6	0	12	100
Total suspended solids	57.5	86.3	30	45		0	12	100
X12 (Process Waste Treatment Complex)								
LC_{50} for *Ceriodaphnia* (%)					100	0	0[b]	100
LC_{50} for fathead minnows (%)					100	0	0[b]	100
Arsenic, total			0.007	0.014		0	2	100
Cadmium, total	1.73	4.60	0.003	0.038		0	2	100
Chromium, total	11.40	18.46	0.22	0.44		0	2	100
Copper, total	13.8	22.53	0.07	0.11		0	2	100
Cyanide, total	4.33	8.00	0.008	0.046		0	1	100

Table 5.10 (continued)

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]
Lead, total	2.87	4.60	0.028	0.69		0	2	100
IC_{25} for *Ceriodaphnia* (%)					30.5	0	0[b]	100
IC_{25} for fathead minnows (%)					30.5	0	0[b]	100
Oil and grease	66.7	100	10	15		0	3	100
pH (standard units)				9.0	6.0	0	12	100
Temperature (ºC)				30.5		0	12	100
Instream chlorine monitoring points								
Total residual oxidant			0.011	0.019		0	72	100

[a]Percentage of compliance = 100 [(number of noncompliances/number of samples) × 100].
[b]No samples for this parameter collected between January and March.

Acronyms

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

Table 5.11. National Pollutant Discharge Elimination System compliance at Oak Ridge National Laboratory, April through December 2014
(NPDES permit effective April 1, 2014)[a]

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[b]
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		0		100
Ammonia, as N (winter)	13.14	19.78	5.25	7.9		0		100
Carbonaceous biological oxygen demand	19.2	28.8	10	15		0	40	100

Table 5.11 (continued)

Effluent parameters	Permit limits: Monthly average (lb/day)	Daily max. (lb/day)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Permit compliance: Number of noncompliances	Number of samples	Percentage of compliance[b]
Dissolved oxygen					6	0	40	100
Escherichia coliform (col/100 mL)			941	126		0	40	100
Oil and grease				15		0	1	100
pH (standard units)				9	6	0	40	100
Total suspended solids	57.5	86.3	30	45		0	40	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	3	100
Chromium, total				0.44		0	3	100
Copper, total				0.11		0	4	100
Cyanide, total				0.046		0	1	100
Lead, total				0.69		0	3	100
Oil and grease				15		0	9	100
pH (standard units)				9.0	6.0	0	40	100
Temperature (ºC)				30.5		0	40	100
Instream chlorine monitoring points								
Total residual oxidant			0.011	0.019		0	216	100

[a]Note: Monitoring at outfall 585 is not required under the renewed NPDES permit, effective April 1, 2014.

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

Acronyms

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 STP have been 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. These have been tested using EPA chronic and acute test protocols at frequencies ranging from two to four times per year.

Test results have been excellent. PWTC effluent has always been shown to be nontoxic. 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 2014, 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 TRO concentration instream. 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 investigates and implements 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.

Thirty-two individual outfalls are checked for TRO semiannually, quarterly, monthly, or bimonthly. Flow was detected 259 times. Table 5.12 lists instances in 2014 where TRO levels at outfalls were found to be in excess of the permit action level. One outfall, 265, on Fifth Creek, exceeded the action level during 2014. The source for outfall 265, aging underground water pipes leaking drinking water, was eliminated in 2014.

Table 5.12. Outfalls exceeding total residual oxidant permit action level in 2014[a]

Sample date	Outfall	TRO concentration (mg/L)	Flow (gpm)	Load (grams/ day)	Receiving stream	Downstream integration point	Instream TRO point
6/2/2014	265	0.60	15	49.1	Fifth Creek	FFK 0.2	X19

[a]1.2 g/day

Acronyms
FFK = Fifth Creek kilometer
TRO = total residual oxidant

5.5.3 Cooling Tower Blowdown Whole Effluent Toxicity Monitoring

As part of the WQPP at ORNL, samples of blowdown from three cooling towers/cooling tower systems (5600, 5807, and 4510/4521) were tested for whole effluent toxicity (WET) in August and September 2014. This was done in support of the WQPP investigation to identify the causes of biological community impairments in the WOC watershed. That investigation is initially focusing on the reach of WOC that encompasses WOC kilometer (WCK) 3.9. These towers have been the focus of WET testing since 2012 because they are believed to be the towers that have the greatest influence on water quality in that stream reach.

In WET testing, standard test organisms are exposed to multiple concentrations of effluent under standard test conditions, and the organisms' responses (e.g., survival, reproduction) are measured. The cooling tower blowdown samples evaluated in 2014 were tested with *C. dubia* using a three-brood survival and reproduction test, which is a chronic toxicity test that has been shown to be more sensitive for testing cooling tower blowdown effluents than are acute tests using fathead minnows (*Pimephales promelas*).

At two of the towers that were tested, blowdown is discharged through outfalls where the blowdown is mixed with other effluents before it reaches the receiving stream. Effluents from those outfalls were also tested concurrently for WET. The outfalls tested were outfall 227, which receives blowdown from the 5600 cooling tower, and outfall 231, which receives blowdown from the 5807 tower. Blowdown from 4510/4521 is discharged through outfall 014, but is not blended with other wastewaters before discharge; therefore, it was not necessary to perform a separate test of outfall 014 effluent.

WET test results from cooling towers and outfalls tested in 2014 are shown in Table 5.13. It should be noted that samples were collected from the basins under the towers instead of directly from the blowdown lines because of difficulty accessing closed blowdown piping systems for sampling with an automatic water sampler.

Table 5.13. Summary results of chronic *Ceriodaphnia dubia* toxicity tests of ORNL cooling towers and outfalls conducted during August and September 2014

Location	NOEC[a]	IC_{25}[b]	96-hour LC_{50}[c]
Cooling tower 4510/4521	50%	60%	>100%
Cooling tower 5600	25%	34%	>100%
Outfall 227	50%	>100%	>100%
Cooling tower 5807	5%	14%	>100%
Outfall 231	25%	35%	>100%

[a]NOEC = No-observed-effect concentration for survival and reproduction.
[b]IC_{25} = Inhibition concentration which would cause a 25% reduction in mean young per female.
[c]LC_{50} = Lethal concentration which would cause a 50% reduction in survival in 96 hours (estimated with this type of chronic test).

The results presented in Table 5.13 indicate that if a population of *C. dubia* was to be continually exposed to a mixture of water composed of roughly 25% or more (and perhaps as low as 5% on occasion) of blowdown from these cooling towers, a negative effect on *C. dubia* reproduction could occur. It has been estimated that in the driest summer conditions in WOC, it is possible for concentrations of blowdown in the receiving stream (instream waste concentration) at some locations to be as high as 30% or 40% on an intermittent basis. Table 5.13 also provides results from WET testing of the two outfalls (227 and 231) that receive these blowdown discharges. Results indicate that after blending with other wastewaters but before mixing with the receiving stream, the effluents from these two outfalls could also potentially cause reproductive effects to *C. dubia*; however, samples from the outfalls did show less toxicity than samples collected directly from the corresponding towers, so blending with other wastewaters did provide a benefit. Some WET testing of water collected directly from the stream below cooling water discharges (samples include a mixture of effluents from cooling towers, other upstream outfalls, and natural background stream flow) has been conducted and has generally not shown toxicity [based on one WET test of stream water conducted in each of the last two years (2013 and 2014)].

In 2014, as in 2013, tests were conducted on blowdown samples that were exposed in the laboratory to various forms of water treatment. This was done to determine which treatments, if applied to actual discharges of blowdown, might be effective in reducing or eliminating toxicity and to infer what chemical constituents of the blowdown might be causing effluents to be toxic. Samples of full strength blowdown from the 4510-4521 cooling tower system were subjected to metals chelation by addition of ethylenediaminetetraacetic acid (EDTA), particulate removal by filtration through a 1.2 μm filter, and activated carbon treatment. None of these treatments achieved significant reductions in toxicity. Full strength blowdown samples from the 5600 and 5807 towers and outfalls 227 and 231 were also treated with activated carbon. The effects of all treatments have been variable, both spatially (between different towers) and temporally (year-to-year variability within individual towers). In 2014, chelation with EDTA seemed to provide some reduction in toxicity but did not completely eliminate toxicity. Activated carbon sometimes provided partial benefit but in some cases seemed to result in slightly decreased reproduction in test organisms. One potential explanation for the spatial and temporal variability and inconsistency in the effects of treatments is that the series of samples collected for testing may have had variable chemical concentrations due to the temporal variability of the sources being sampled. Some maintenance chemicals used in the cooling towers are added to the towers intermittently (e.g., 2 times per week for the nonoxidizing biocides) and in a batch process. The samples collected for WET testing were 24-hour time-proportional composite samples collected 3 times per week, with collection schedules that most likely varied in relation to the dosing of maintenance chemicals.

The type of nonoxidizing biocide used in the cooling towers to control biological growth was changed between the 2013 and 2014 testing periods. The new biocide was expected to result in blowdown that exhibited a lesser degree of toxicity to test organisms for two reasons. First, the new biocide breaks down rapidly in the cooling towers following dosing (perhaps not complete breakdown prior to blowdown discharge, but residual biocide concentrations in untreated blowdown should be considerably less than with the previous biocide). Second, the treatment that is used at cooling towers to remove chlorine from the blowdown stream should also be effective in eliminating any residual of this new biocide. The WET test results indicate that the benefit was not realized, which could mean that either the breakdown of the biocide or its removal by the treatment system was not as expected or that the nonoxidizing biocides (both the old and new) were not the primary cause of the toxicity that has been measured (Table 5.13).

Questions remain about how closely the WET tests that have been conducted predict the actual impacts of cooling tower blowdown on biological communities in WOC, primarily due to differences between test conditions and actual instream exposure conditions. For example, the WET tests that were performed are chronic tests, which measure impacts to organisms under a continuous exposure scenario lasting several days or longer. In reality, discharges of cooling tower blowdown are intermittent, triggered by a control system that uses measurements of specific conductivity to control opening and closing of the discharge valve. Despite the limitations, WET testing done to date does suggest that measures that could be taken to reduce the toxicity of cooling tower blowdown discharges have a promising potential to improve biological communities in WOC. Additional WET testing will be conducted in the future in an attempt to identify what constituents of tower blowdown are responsible for the toxicity that has been measured and to help select which abatement actions would be most effective.

During the period in which the towers were undergoing WET testing, they were also monitored with grab samples for field parameters (conductivity, dissolved oxygen, pH, and temperature), chemical oxygen demand, TSS, dissolved metals, and total metals. Results of that monitoring are shown in Table 5.14.

Table 5.14. Field parameters and results from laboratory analyses of blowdown from Oak Ridge National Laboratory cooling towers

Parameter	Cooling Tower Sampled[a]		
	4510/4521	5600	5807
Conductivity (mS/cm)	0.837	0.81	0.798
Dissolved oxygen (mg/L)	8.2	7	9.1
pH (standard units)	8.3	8.3	8.1
Temperature (ºC)	25.4	23.1	22.4
Chemical oxygen demand (mg/L)	74.2	144	107
Total suspended solids (mg/L)	< 2	3	< 2
Ag, dissolved (mg/L)	< 0.000619	< 0.000619	< 0.000619
Ag, total (mg/L)	< 0.000619	< 0.000619	< 0.000619
As, dissolved (mg/L)	< 0.001	< 0.001	< 0.001
As, total (mg/L)	< 0.001	< 0.001	< 0.001
Be, dissolved (mg/L)	< 0.000686	< 0.000686	< 0.000686
Be, total (mg/L)	< 0.000686	< 0.000686	< 0.000686
Ca, dissolved (mg/L)	105	103	98
Ca, total (mg/L)	127	124	121
Cd, dissolved (mg/L)	< 0.000782	< 0.000782	< 0.000782
Cd, total (mg/L)	< 0.000782	< 0.000782	< 0.000782
Cr, dissolved (mg/L)	< 0.001	< 0.001	< 0.001
Cr, total (mg/L)	< 0.001	< 0.001	< 0.001
Cu, dissolved (mg/L)	0.0909	0.0287	0.119
Cu, total (mg/L)	0.124	0.124	0.407
Fe, dissolved (mg/L)	< 0.0206	< 0.0206	< 0.0206
Fe, total (mg/L)	< 0.0206	< 0.0206	< 0.0206
Mg, dissolved (mg/L)	28.9	30.1	28
Mg, total (mg/L)	36.8	38.6	38.1
Mn, dissolved (mg/L)	0.00229	0.00102	< 0.000953
Mn, total (mg/L)	0.00331	0.00212	0.00155
Mo, dissolved (mg/L)	0.0013	0.00109	0.00104
Mo, total (mg/L)	0.00142	0.00108	0.00107
Ni, dissolved (mg/L)	< 0.00138	< 0.00138	< 0.00138
Ni, total (mg/L)	0.00248	0.00227	0.0019
Pb, dissolved (mg/L)	< 0.001	< 0.001	< 0.001
Pb, total (mg/L)	0.00374	0.00103	< 0.001
Sb, dissolved (mg/L)	0.00174	< 0.00081	< 0.00081
Sb, total (mg/L)	0.00192	< 0.00081	< 0.00081
Se, dissolved (mg/L)	< 0.0406	< 0.0406	< 0.0406
Se, total (mg/L)	< 0.0406	< 0.0406	< 0.0406
Zn, dissolved (mg/L)	0.139	0.103	0.101
Zn, total (mg/L)	0.154	0.16	0.213

[a] All samples were collected on August 25, 2014.

5.5.4 Radiological Monitoring

At ORNL, monitoring of liquid effluents and selected instream locations for radioactivity is conducted under the WQPP. Table 5.15 details the targeted monitoring frequencies and analyses performed on samples collected in 2014 at 2 treatment facility outfalls, 3 instream monitoring locations, and 20 category outfalls (outfalls which 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 2014, dry-weather grab samples were collected at 15 of the 20 category outfalls targeted for sampling. Five category outfalls (080, 203, 205, 241, and 284) were not sampled because there was no discharge present during sampling attempts.

Two ORNL treatment facilities were monitored for radioactivity in 2014: STP (outfall X01) and PWTC (outfall X12). The three instream locations that were monitored were X13 on Melton Branch, X14 on WOC, and X15 at WOD (Fig. 5.16). At each treatment facility and instream monitoring location, monthly flow-proportional composite samples were collected using dedicated automatic water samplers.

Radioisotope specific guideline concentration values are published in DOE directives and are 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 these 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. It should be noted that although effluents and instream concentrations are compared to DCSs, 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 085, 204, 207, 302, 304, X01, and X12 and at instream sampling location X15 (Fig. 5.17).

In 2014, two outfalls had a mean radioactivity concentration greater than 100% of a DCS. Outfalls 207 and 304 both had average total radioactive strontium (^{89,90}Sr) concentrations that exceeded the DCS for ^{90}Sr (it is reasonable, for an ORNL environmental sample, 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 420% and 120% of the DCS at outfalls 207 and 304 respectively. Only one measurement of ^{89,90}Sr was made at outfall 207 in 2014 because ^{89,90}Sr is only measured at that outfall when other levels of radioactivity are elevated enough to exceed screening criteria defined in the monitoring plan. Judging from the gross beta activities measured at outfall 207 during the remaining three quarters of 2014, had ^{89,90}Sr been measured those other times the annual average ^{89,90}Sr activity would have been considerably lower but would have still exceeded 100% of the DCS. Consequently, concentrations of radioactivity in discharges from outfalls 207 and 304 were also greater than DCS levels on a sum-of-fractions (summation of DCS percentages of multiple radiological parameters) basis; the sum-of-fractions were 448% and 135%, respectively.

Table 5.15. Radiological monitoring conducted under the Oak Ridge National Laboratory Water Quality Protection Plan, 2014

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[a]	Monthly										
Outfall 081	Annual	X									
Outfall 085	Quarterly	X	X	X		X					
Outfall 203[a]	Annual										
Outfall 204	Semiannual	X	X			X					
Outfall 205[a]	Annual										
Outfall 207	Quarterly	X	X[b]			X[b]		X[b]	X[b]	X[b]	X[b]
Outfall 211	Annual	X									
Outfall 234	Annual	X									
Outfall 241[a]	Quarterly										
Outfall 265	Annual	X									
Outfall 281	Quarterly	X	X[b]	X							
Outfall 282	Quarterly	X									
Outfall 284[a]	Annual										
Outfall 302	Monthly	X	X	X		X	X[b]	X[b]	X[b]	X[b]	X[b]
Outfall 304	Monthly	X	X	X		X	X[b]	X[b]	X[b]	X[b]	X[b]
Outfall 365	Semiannual	X									
Outfall 368	Annual	X									
Outfall 383	Annual	X		X							
STP (X01)	Monthly	X	X	X	X	X					
PWTC (X12)	Monthly	X	X	X		X	X[b]	X			
Melton Branch (X13)	Monthly	X	X	X		X					
WOC (X14)	Monthly	X	X	X		X					
WOD (X15)	Monthly	X	X	X		X					

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

[b]The parameter is not a required parameter for this location in the Water Quality Protection Plan and therefore may have been monitored on a frequency less than indicated in the second column of 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).

Acronyms

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

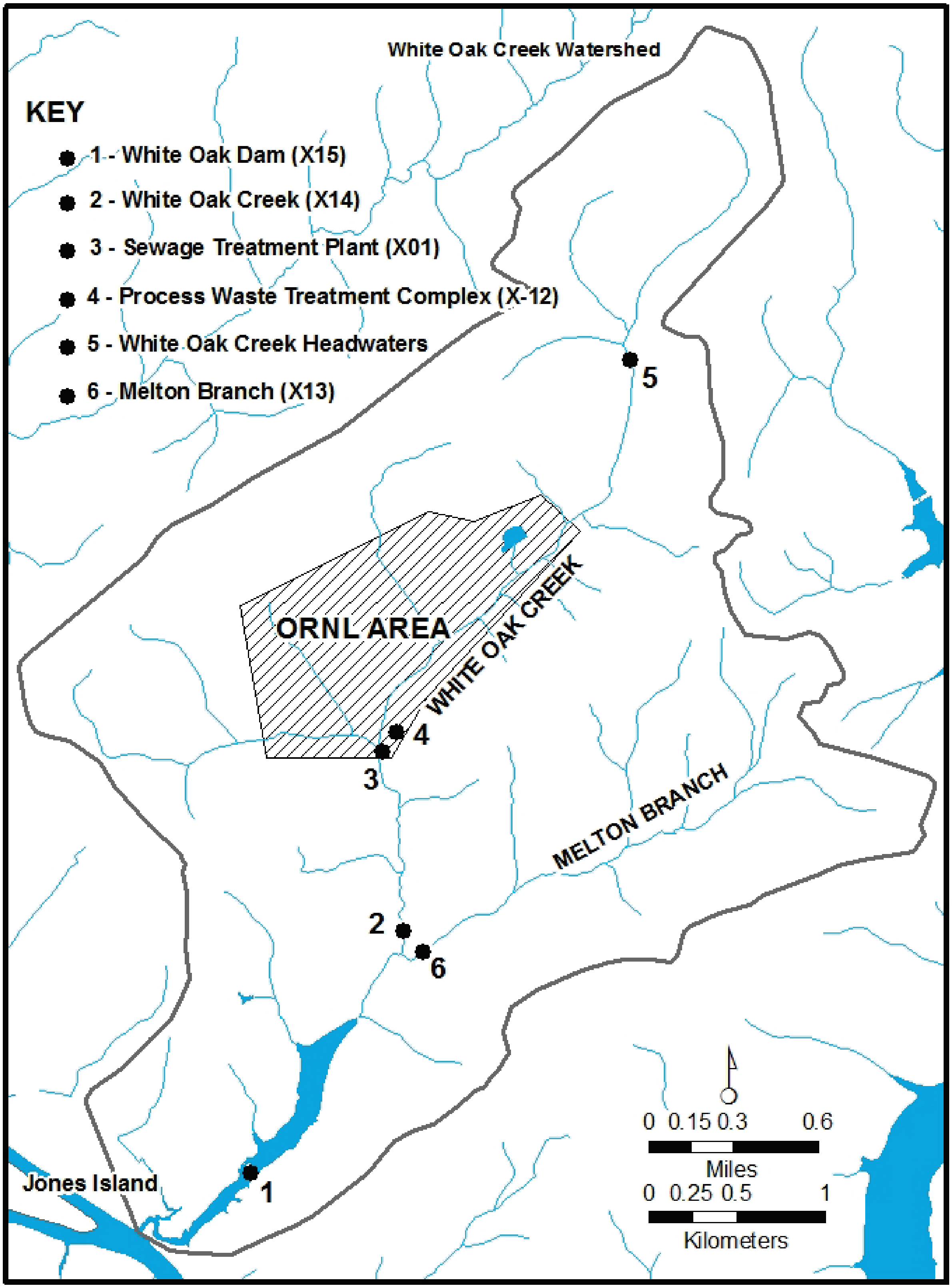

Fig. 5.16. Oak Ridge National Laboratory (ORNL) surface water, National Pollutant Discharge Elimination System, and reference sampling locations.

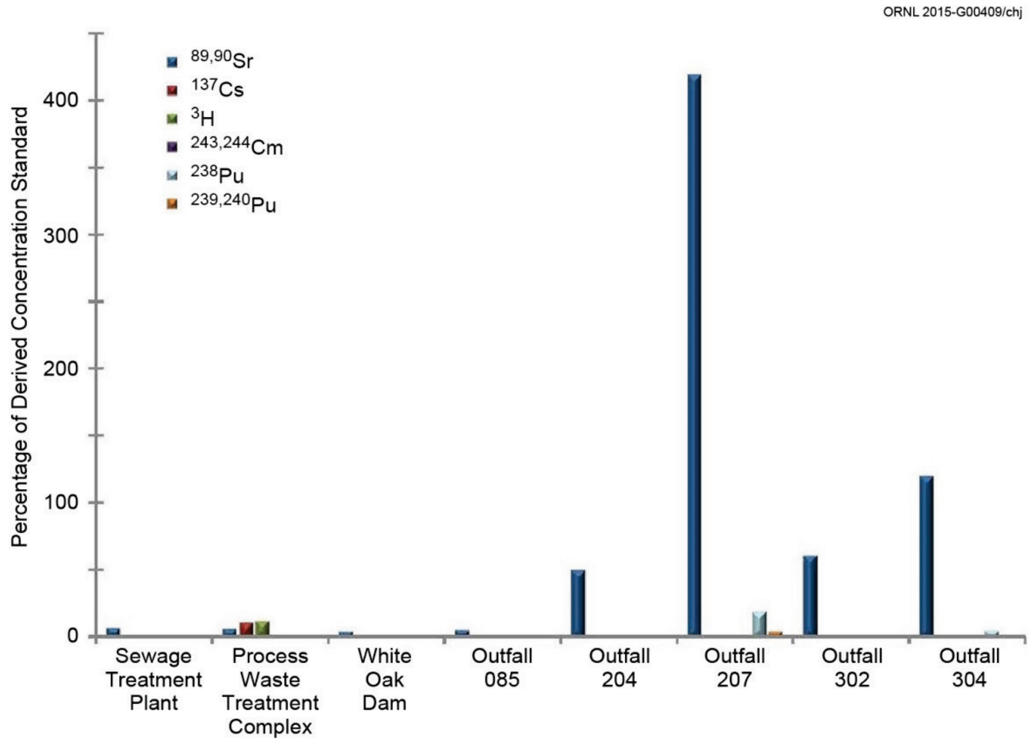

Fig. 5.17. Outfalls at Oak Ridge National Laboratory with average radionuclide concentrations greater than 4% of the relevant derived concentration standards in 2014.

The 2014 increases in radioactivity concentrations at both outfalls were found to have a common cause. The storm water collection networks for both outfalls extend to areas near the EM WOC-9 (WC-9) Low Level Liquid Waste Tank Farm, a CERCLA soil and groundwater contamination area. A dry well with a sump pump at WC-9 collects contaminated groundwater and routes it for treatment. The sump pump failed prior to the observed increase in radioactivity levels at these two outfalls. It is believed that when the sump is operational it acts to suppress groundwater levels, preventing or minimizing leakage of contaminated groundwater into these storm drains from the area around WC-9. After the pump was restored to service, concentrations and fluxes of radioactivity declined at both outfalls.

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 2014 are similar to 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).

Radiological monitoring at category outfalls in 2014 also included monitoring during storm runoff conditions. A total of 10 storm water outfalls were monitored. Storm water samples were analyzed for gross alpha, gross beta, and tritium activities. A gamma scan analysis was also performed. Additional analyses were added when there was sufficient gross alpha and/or gross beta activity in a sample to indicate that levels of radioactivity could exceed DCS levels. In 2014, additional analyses were performed on samples from one outfall, outfall 301.

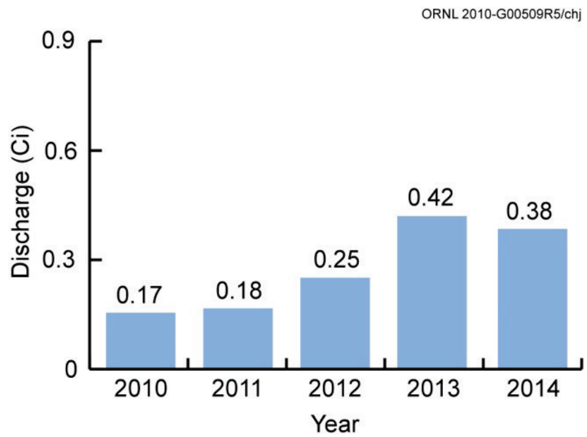

Fig. 5.18. Cesium-137 discharges at White Oak Dam, 2010–2014.

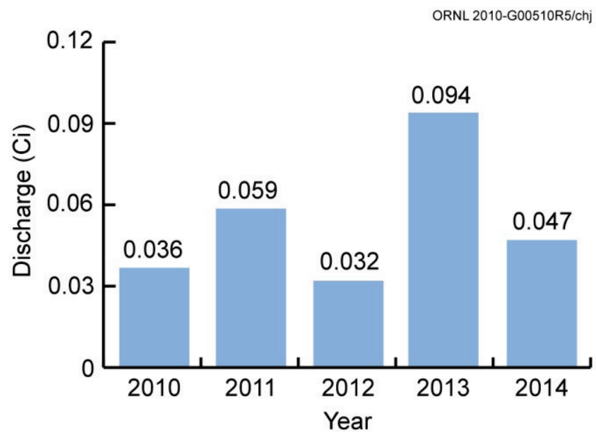

Fig. 5.19. Gross alpha discharges at White Oak Dam, 2010–2014.

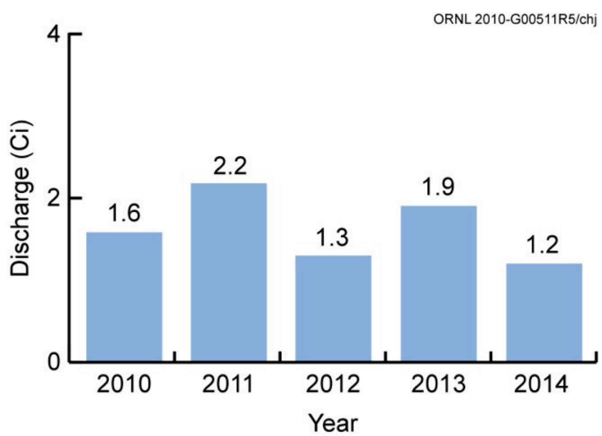

Fig. 5.20. Gross beta discharges at White Oak Dam, 2010–2014.

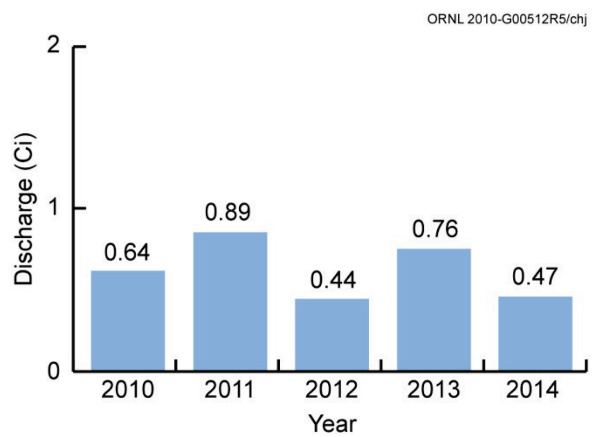

Fig. 5.21. Total radioactive strontium discharges at White Oak Dam, 2010–2014.

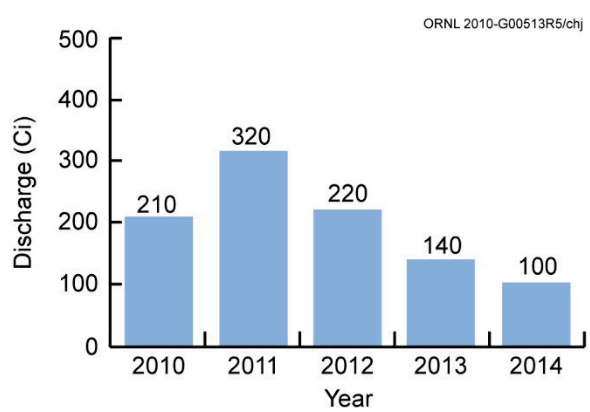

Fig. 5.22. Tritium discharges at White Oak Dam, 2010–2014.

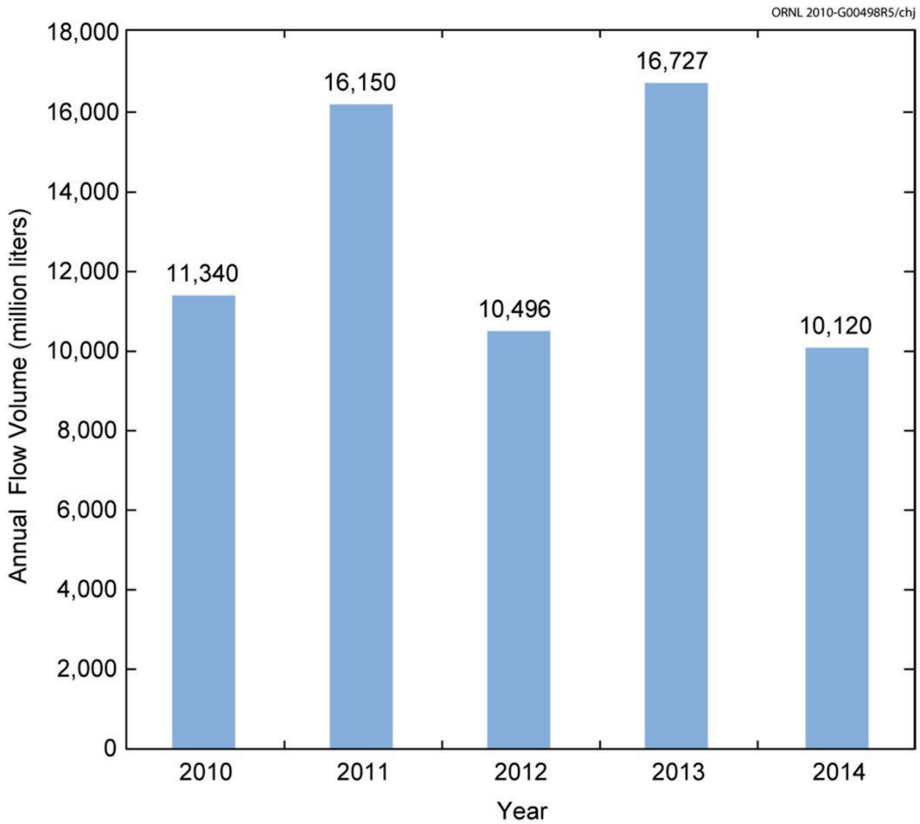

Fig. 5.23. Annual flow volume at White Oak Dam, 2010–2014.

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 and gross beta activities) and if the concentration was greater than or equal to the minimum detectable activity level for the measurement. Three outfalls had measurements of radionuclide concentrations in storm water that were greater than 4% of DCS levels: at outfall 204, ^{137}Cs was measured at 14% of the DCS; at outfall 301, ^{137}Cs was measured at 12% of the DCS and $^{89/90}$Sr was measured at 29% of the DCS for ^{90}Sr; and at outfall 582, $^{89/90}$Sr was measured at 13% of the DCS for ^{90}Sr.

5.5.5 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 isotope separation pilot-scale work in Buildings 3503, 3592, 4501, and 4505. Because of this, mercury is present in soils and groundwater in and around these 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 these 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).

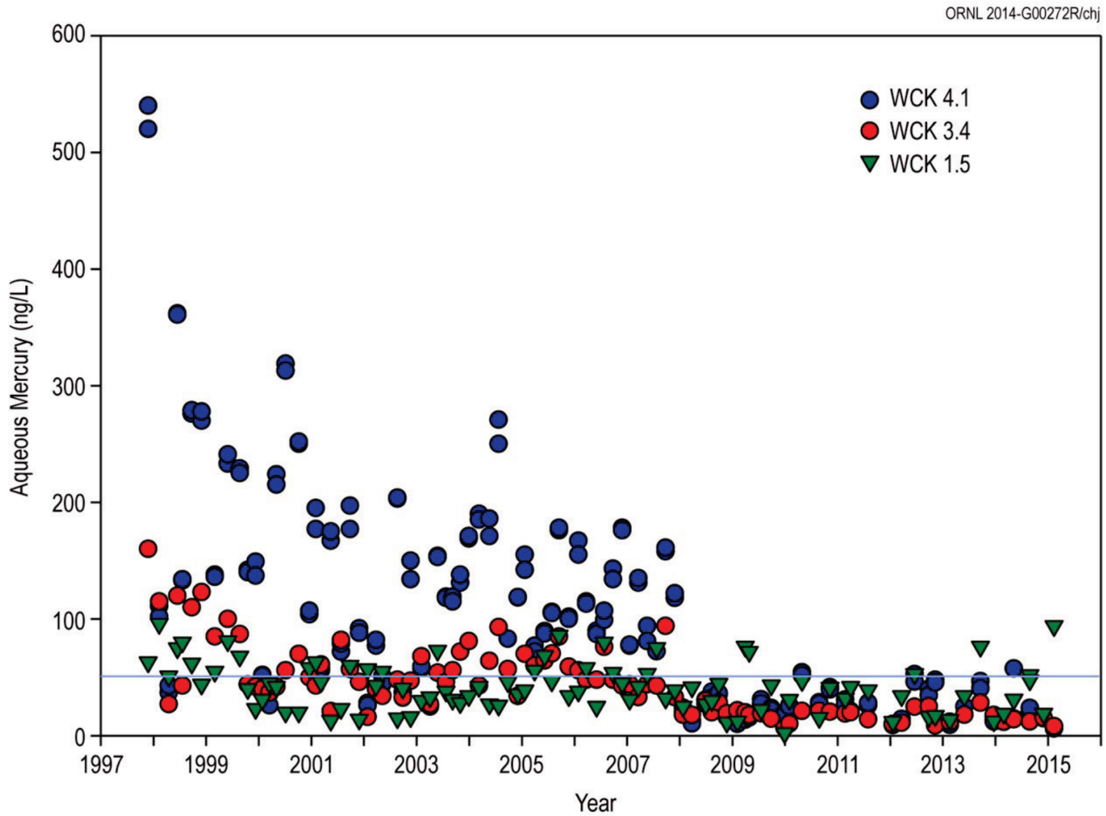

Fig. 5.24. Total aqueous mercury concentrations at sites in White Oak Creek downstream from Oak Ridge National Laboratory, 1998–2014. *(AWQC = ambient water quality criterion; WCK = White Oak Creek kilometer.)*

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 2014, 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. Concentration and flux values were measured and calculated. Selected results of the 2014 monitoring are shown in Fig. 5.25, and complete mercury monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone (865-574-3257).

Monitoring results for 2014 indicated that Tennessee mercury criteria were met at all instream locations in the WOC watershed with the exception of one water sample that was collected at the lower end of White Oak Lake. As a result of 2011 targeted stream-reach mercury investigations, a storm drain outfall on Fifth Creek, outfall 265, was found to be a more significant source of mercury release than had previously been known. In 2012 this outfall's network of underground piping and catch basins was investigated using a remote video camera to identify sources of water "inleakage," and in 2012–2013 repairs were made to underground water utilities that improved the outfall 265 situation. Investigation continued in 2014, and in September 2014 a nearby underground water-supply pipe that had been found to be leaking was isolated, at which point dry-weather flow from outfall 265 ceased. Subsequent monitoring indicates that outfall 265 is no longer a significant source of mercury flux to WOC.

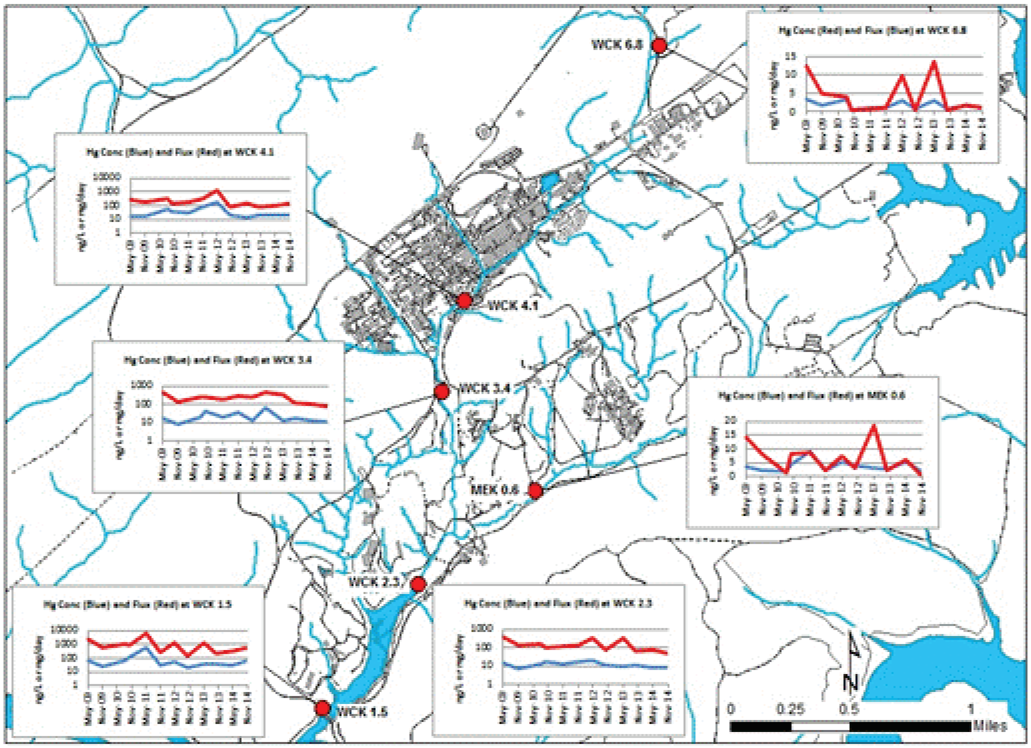

Fig. 5.25. Total mercury concentration and flux at selected Oak Ridge National Laboratory instream locations, 2009 through 2014.

Also in 2014, 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 since the carbon replacement have shown noticeable improvement in the plant's mercury-removal efficiency. An ongoing mercury-characterization monitoring protocol, which has been maintained at various instream- and outfall-monitoring locations in the WOC watershed since 2009, will be continued in 2015.

5.5.6 Storm Water Surveillances and Construction Activities

Figure 5.26 depicts the location of construction sites that were active in 2014. (Substantive requirements of the appropriate water pollution control permits are followed for construction areas that are part of CERCLA remediation, but official permit coverage is not required.) Only four sites were considered significant due to footprints close to or greater than 1 acre and/or the need to be covered by a Tennessee construction general permit and were inspected to evaluate overall effectiveness of the best management practices in use. 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.

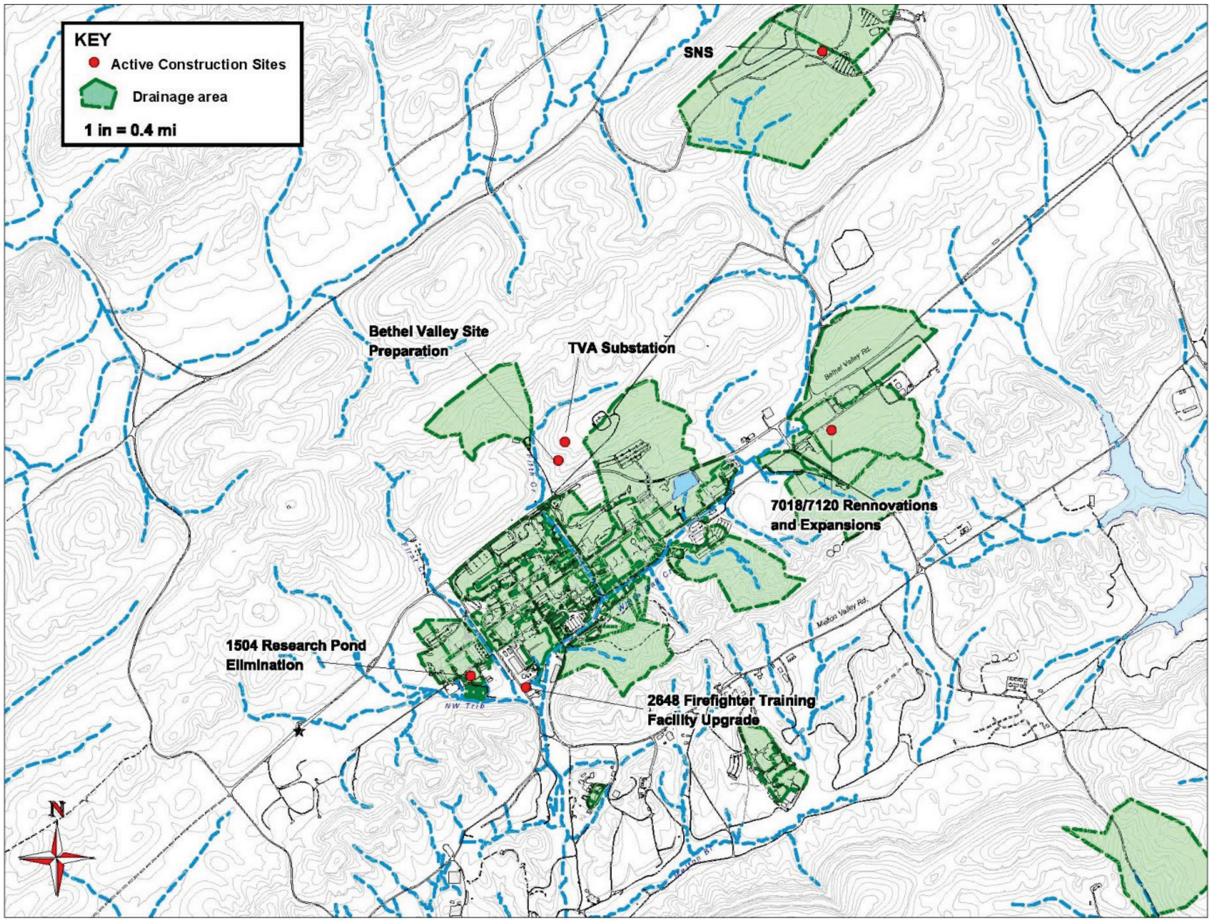

Fig. 5.26. Active construction sites and Oak Ridge National Laboratory Water Quality Protection Plan monitoring locations, 2014. *(SNS = Spallation Neutron Source, TVA = Tennessee Valley Authority)*

Some construction activities are performed on third-party-funded construction projects under agreement with other local, state, and federal agencies on the DOE reservation. 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.

5.5.7 Biological Monitoring

5.5.7.1 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 impact fish and aquatic life or 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.

Mercury in Water. In continuation of a monitoring effort initiated in 1997, bimonthly water samples were collected from WOC at four sites in 2014. 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 these conditions.

The concentration of mercury in WOC upstream from ORNL was less than 5 ng/L in 2014. 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 2014 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 21.3 ± 15.2 ng/L in 2014 compared with 108 ± 33 ng/L in 2007. The decrease was also apparent but less pronounced at WCK 3.4, with mercury averaging 12.2 ± 2.8 ng/L in 2014 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 started operation on October 22, 2009, and will remove 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 33.74 ± 15.58 ng/L in 2014, a level similar to results reported in recent years.

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 (0.3µg/g), TDEC fish advisory limits]. Actions taken in 2007 to treat a mercury-contaminated sump resulted in significant decreases in mercury concentrations in fish throughout WOC, though since 2012 concentrations have been slowly increasing in fish collected from the creek (Fig. 5.27). Mean fillet concentrations increased from 0.20 µg/g in 2013 to 0.24 µg/g in 2014 at WCK 3.9 and from 0.23 µg/g in 2013 to 0.29 µg/g in 2014, approaching the AWQC, at WCK 2.9 (Fig. 5.27). 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 2014 (0.43 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. Interestingly, patterns of mercury bioaccumulation in WOC in recent years have been opposite to those seen in White Oak Lake. When mercury concentrations in fish collected from the creek were decreasing from 2007–2012, concentrations in fish from White Oak Lake were increasing, and since 2012, while mercury concentrations in fish collected from the creek have been increasing, concentrations in fish collected from White Oak Lake have been decreasing. The reason for opposite patterns of bioaccumulation in the lower end of the WOC watershed is not known, but differences in sediment or mercury methylation rates within the lake could affect bioaccumulation.

Mean PCB concentrations in redbreast sunfish at WCK 3.9 and WCK 2.9 (0.34 and 0.57 µg/g, respectively) were comparable to recent years. Mean PCB concentrations in largemouth bass from WCK 1.5 were near typical concentrations and resulted in a TDEC fish advisory limit in 2014 (i.e., ~1 µg/g) (Fig. 5.28).

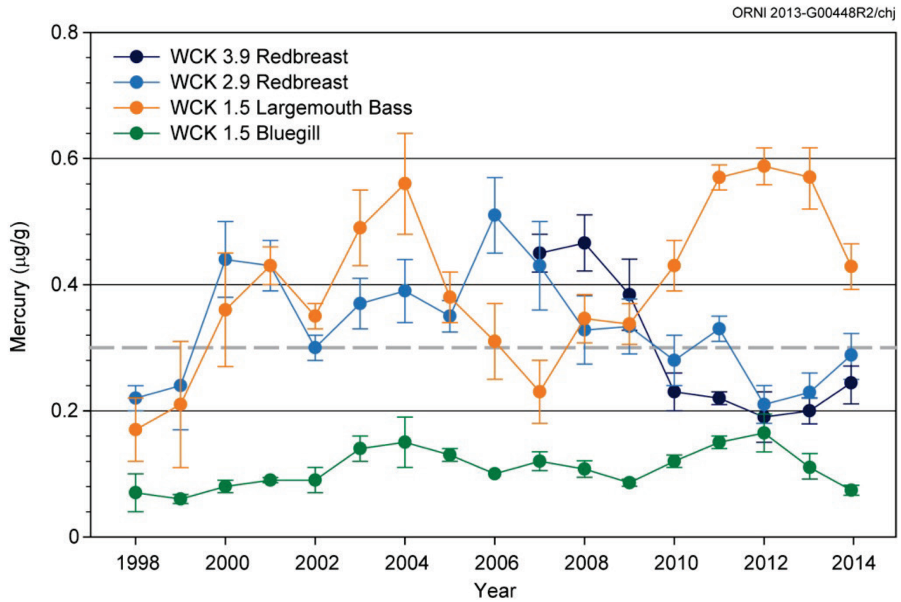

Fig. 5.27. Mean concentrations of mercury (± standard error, N = 6) in muscle tissue of sunfish and bass from White Oak Creek [White Oak Creek kilometers (WCKs) 3.9 and 2.9] and White Oak Lake (WCK 1.5), 1998–2014. *[Dashed grey line indicates the US Environmental Protection Agency ambient water quality criterion for mercury (0.3 µg/g in fish tissue).]*

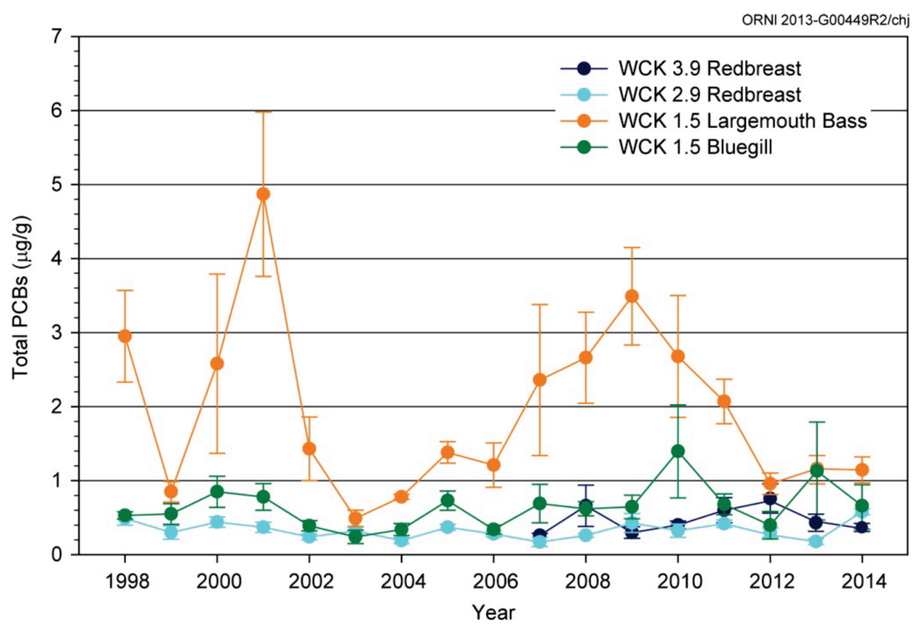

Fig. 5.28. Mean total polychlorinated biphenyl (PCB) concentrations (± standard error, N = 6) in fish fillets collected from the White Oak Creek watershed, 1998–2014. *(WCK = White Oak Creek kilometer.)*

5.5.7.2 Benthic Macroinvertebrate Communities

Monitoring of benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2014. Additionally, monitoring of the macroinvertebrate community in lower Melton Branch [Melton Branch kilometer (MEK) 0.6] continued under the EM WRRP. Benthic macroinvertebrate samples are collected once annually following two protocols: protocols developed by ORNL and used since 1986 and TDEC protocols. ORNL protocols provide a continuous long-term record (28 years) of spatial and temporal trends in the invertebrate community from which the effectiveness of pollution abatement and RAs 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 results from both sets of protocols through 2014.

Compared with the TDEC-derived reference condition, the only site monitored in the WOC watershed that has consistently rated as unimpaired is 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 WCK 3.9 was rated as slightly impaired in 2014, while WCK 3.9 was rated as moderately impaired. The benthic macroinvertebrate communities in First Creek, Fifth Creek, and WOC downstream of effluent discharges have recovered significantly since 1987, but community characteristics indicate that ecological impairment remains (Figs. 5.30–5.32). Relative to their 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 EPT taxa richness) continue to be lower at these downstream sites. After modest increases in the mid-1990s, total taxa richness appears to have generally decreased at First Creek kilometer (FCK) 0.1, and in 2014 the total number of taxa was the lowest it has been since 1989. Similarly, the number of pollution intolerant EPT taxa has decreased in 3 consecutive years, and in 2014 EPT taxa richness was the lowest it has 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 continue to remain within the ranges of values found since the early 2000s, although they also continue to be notably lower than those for the reference sites, suggesting that no additional major changes have occurred at those sites for roughly 12 years.

Macroinvertebrate community metrics for lower Melton Branch (MEK 0.6, Fig. 5.33) suggest that conditions at this site continue to be relatively stable, and taxa richness metrics continue to be similar to reference conditions. However, other macroinvertebrate community metrics (not shown here) such as unusually high total densities of some of the most pollution-tolerant species (e.g., Orthocladiinae midges and aquatic worms) with corresponding lower densities of some of the pollution-intolerant taxa (e.g., mayflies and stoneflies) continue to suggest the presence of elevated concentrations of nutrients (e.g., phosphorus and/or nitrogen). Potential sources of nutrients in lower Melton Branch may be from direct inputs (e.g., effluent discharges or storm water runoff from developed land surfaces) or indirect inputs (e.g., natural release from freshly disturbed soils or underdeveloped riparian areas).

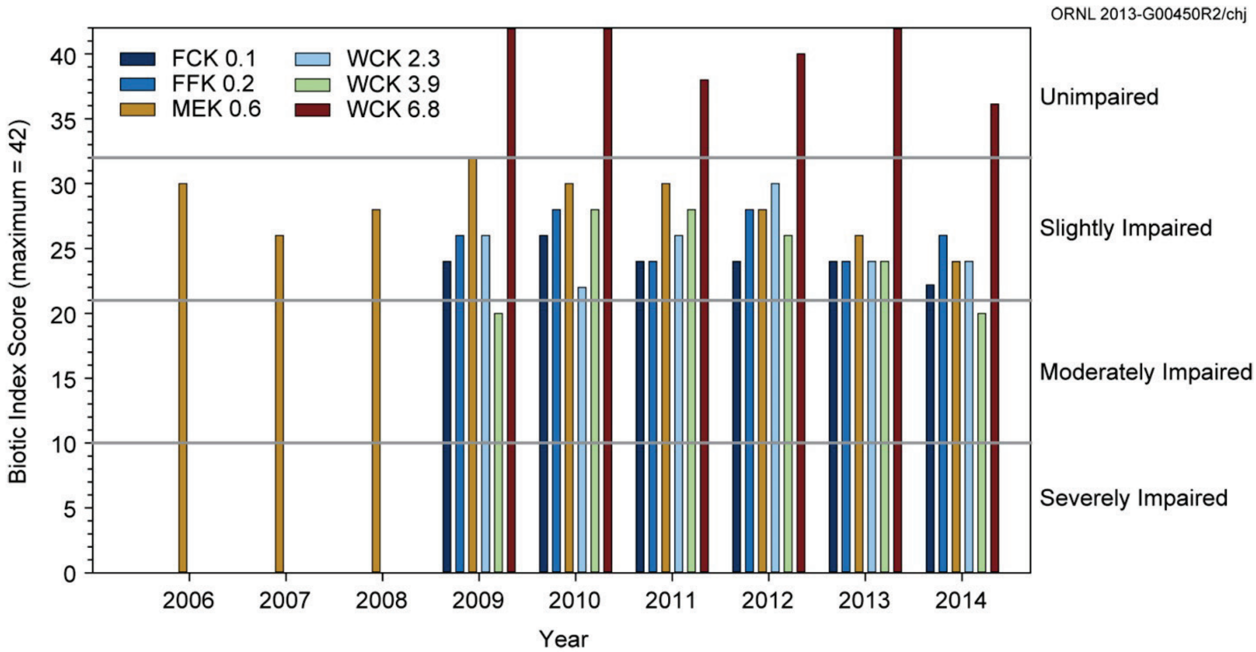

Fig. 5.29. Temporal trends in Tennessee Department of Environment and Conservation Biotic Index Scores for White Oak Creek watershed, August 2006–August 2014. *Horizontal lines show the lower thresholds for biotic condition ratings for index scores; respective narrative ratings for each threshold are shown at right of graph. (FCK = First Creek kilometer, FFK = Fifth Creek kilometer, MEK = Melton Branch kilometer, and WCK = White Oak Creek kilometer.)*

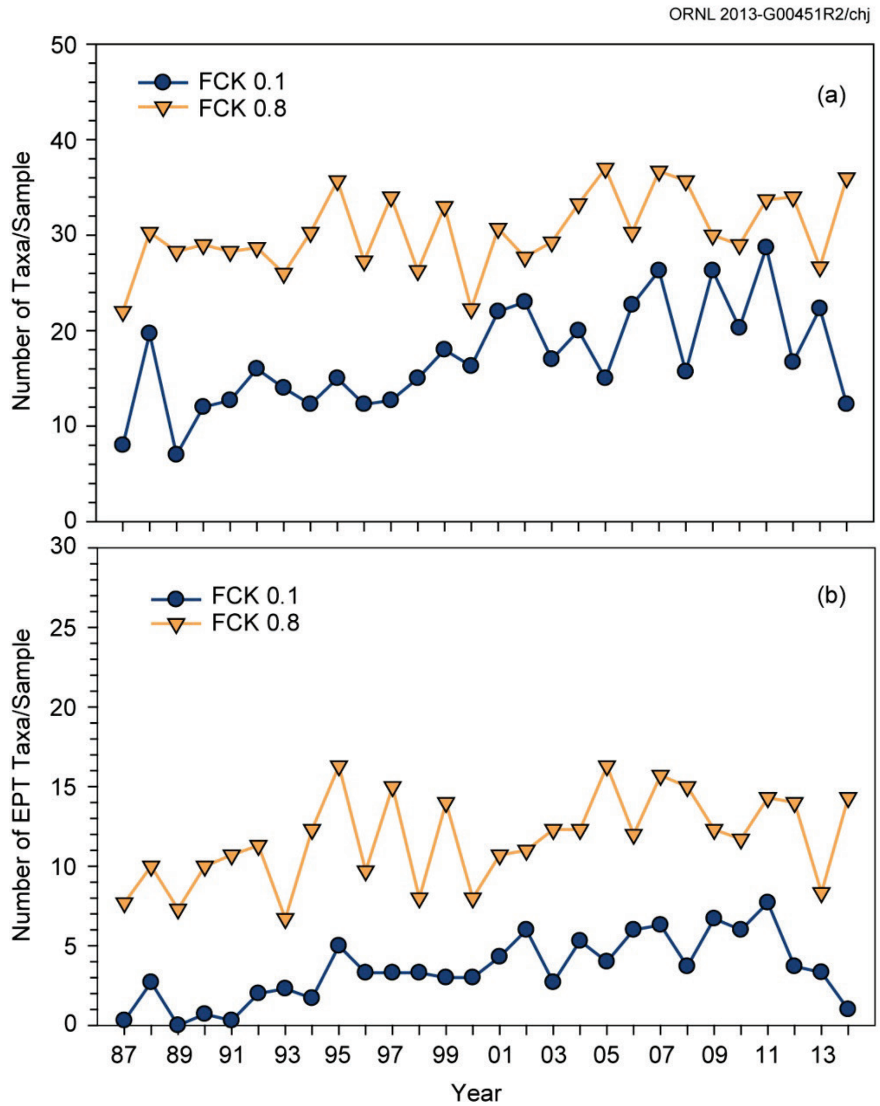

Fig. 5.30. Benthic macroinvertebrate communities in First Creek: (a) total taxonomic richness (mean number of all taxa/sample) and (b) taxonomic richness of the pollution intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], April sampling periods, 1987−2014. *(FCK = First Creek kilometer; FCK 0.8 = reference site.)*

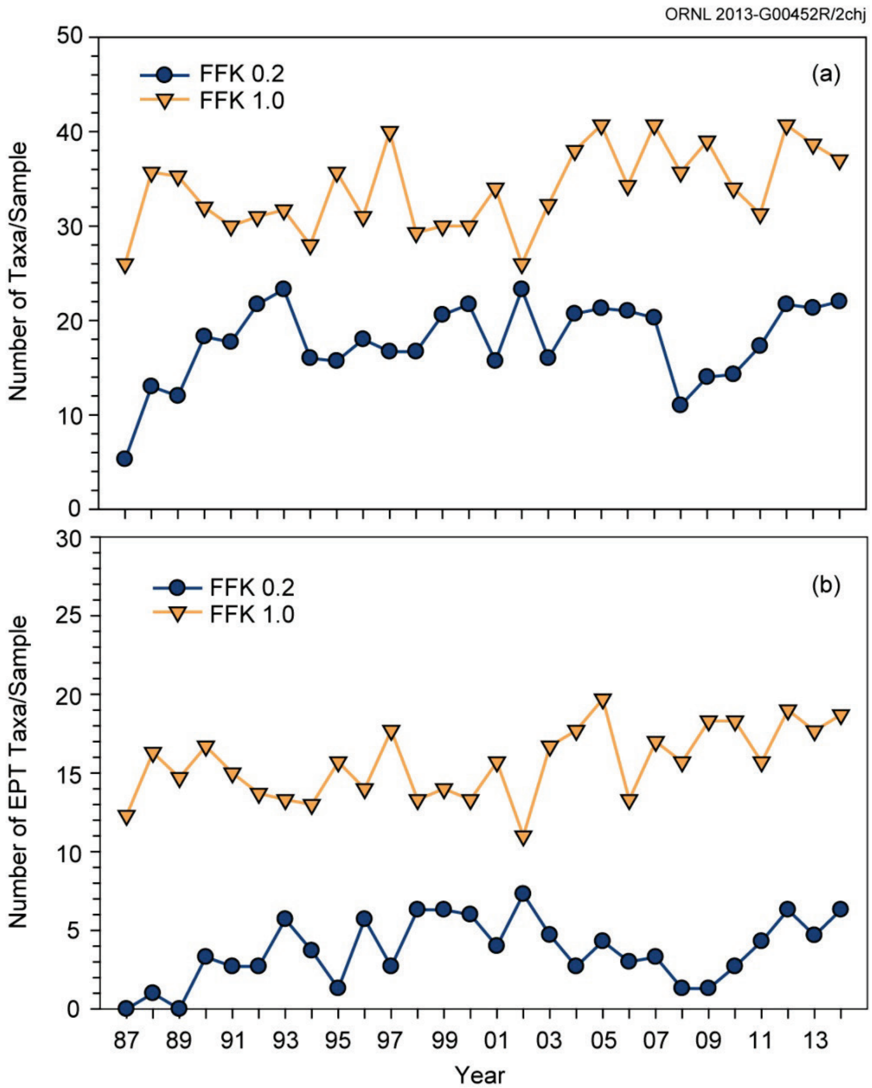

Fig. 5.31. Benthic macroinvertebrate communities in Fifth Creek: (a) total taxonomic richness (mean number of all taxa/sample) and (b) taxonomic richness of the pollution intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], April sampling periods, 1987−2014. *(FFK = Fifth Creek kilometer; FFK 1. 0 = reference site.)*

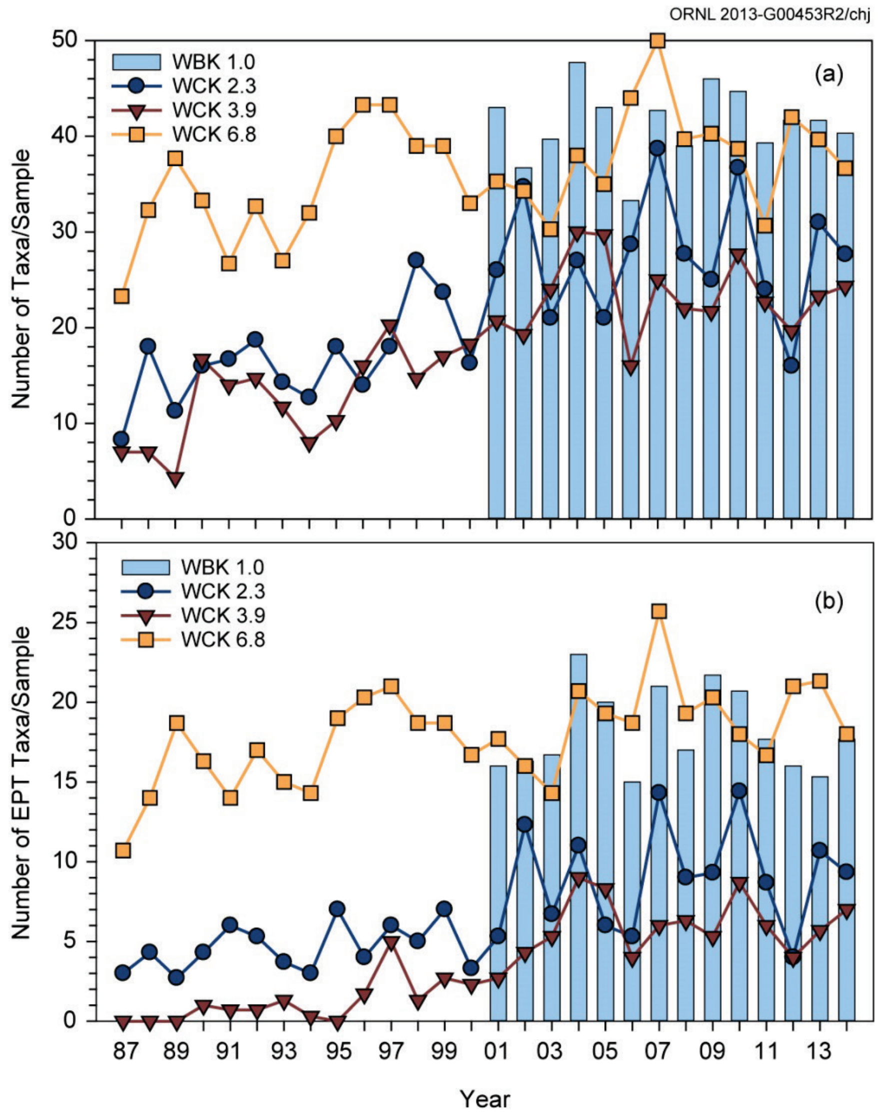

Fig. 5.32. Benthic macroinvertebrate communities in White Oak Creek: (a) total taxonomic richness (mean number of all taxa/ sample) and (b) taxonomic richness of the pollution intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], April sampling periods, 1987−2014. *(WCK = White Oak Creek kilometer and WBK = Walker Branch kilometer; WBK 1.0 = reference site.)*

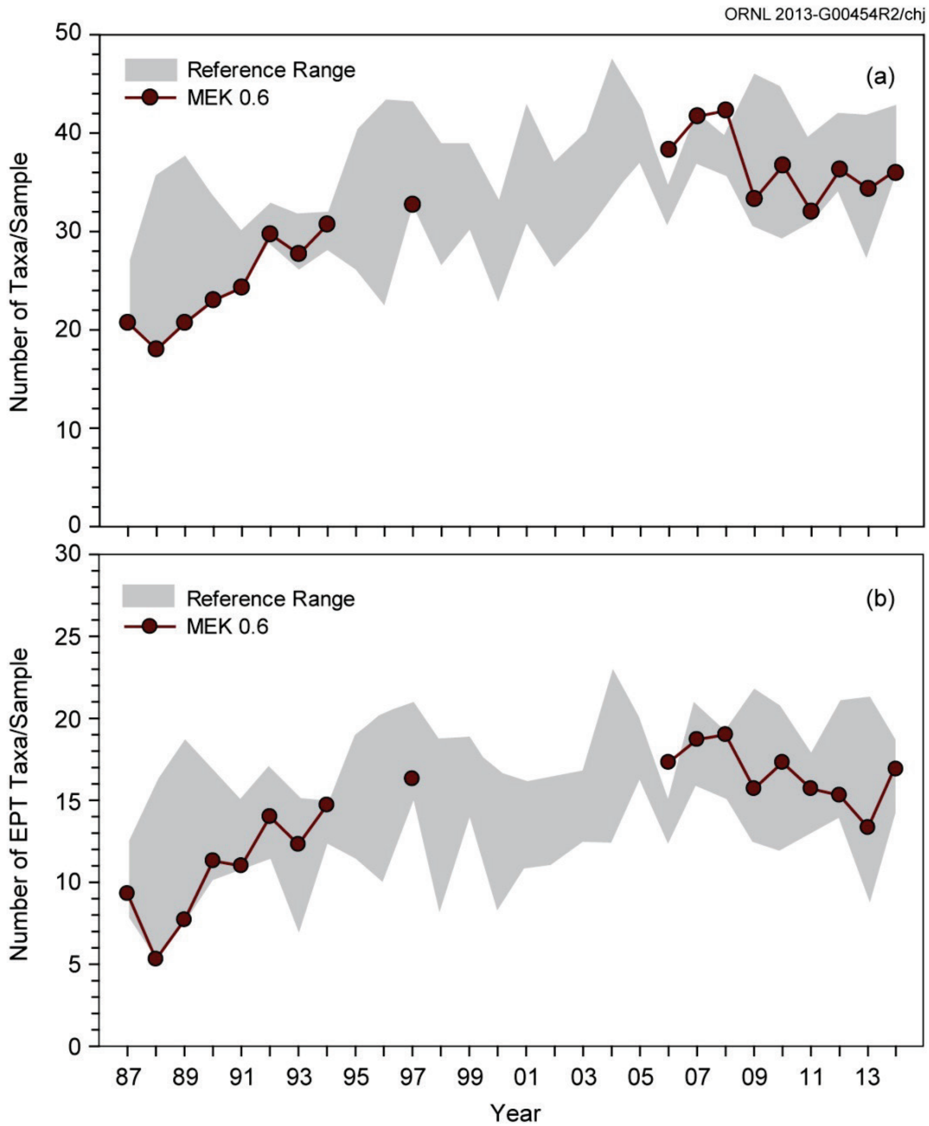

Fig. 5.33. Benthic macroinvertebrate communities in lower Melton Branch: (a) total taxonomic richness (mean number of all taxa/sample) and (b) taxonomic richness of the pollution intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], April sampling periods, 1987−2014. *[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 (1987–2013), Walker Branch (2001–2013), and White Oak Creek (1987–2000, 2007–2013).]*

5.5.7.3 Fish Communities

Monitoring fish communities in WOC and major tributaries continued in 2014. Fish community surveys were conducted at 11 sites in the WOC watershed in the spring and 10 sites in the fall. Streams located near or within the city of Oak Ridge (Mill Branch and Brushy Fork) were also sampled as reference sites each season.

In WOC, the fish community continued to be degraded in 2014 compared with communities in reference streams, with sites closest to outfalls within the ORNL campus having 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. Generally, the fish communities in tributary sites adjacent to and downstream of ORNL outfalls also remained impacted in 2014 relative to reference streams or upstream sites.

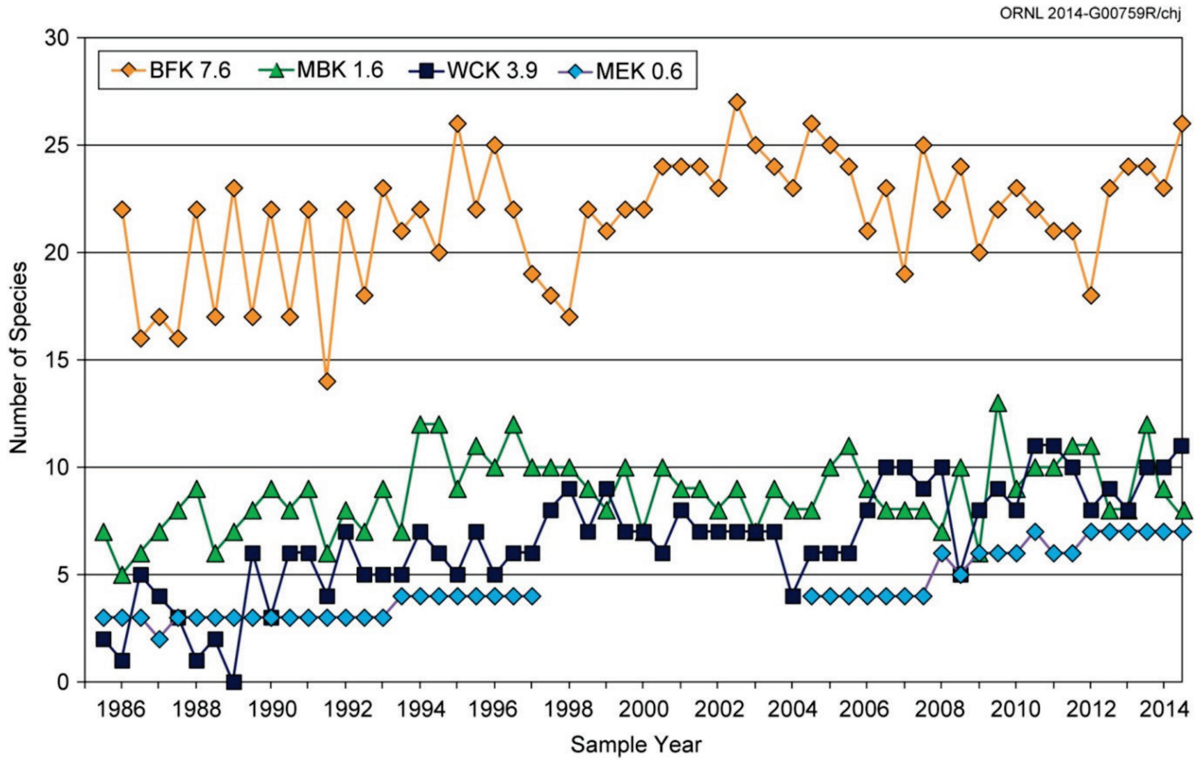

Fig. 5.34. Fish species richness (number of species) in upper White Oak Creek and lower Melton Branch compared with two reference streams (Brushy Fork and Mill Branch). *(BFK = Brushy Fork kilometer; MBK = Mill Branch kilometer; MEK = Melton Branch kilometer; and WCK = White Oak Creek kilometer.)*

A project to introduce fish species that were not found in the WOC watershed but exist in similar systems on ORR and may have historically existed in WOC was initiated in 2008 by stocking 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 are continuing at sites on the main ORNL campus. These introductions have enhanced species richness in the watershed and illustrate the capacity of this stream to support increased diversity, which seems to be limited significantly upstream by impassible barriers such as dams, weirs, and culverts.

5.5.8 Polychlorinated Biphenyls in the White Oak Creek Watershed

Past monitoring has shown that while PCBs are present in the watershed, they are not discharged from ORNL outfalls into the WOC watershed at levels detected by standard analytical methods. Results for largemouth bass collected from White Oak Lake show tissue PCB concentrations continue to be higher than those recommended by TDEC and EPA for frequent consumption. 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.

The mobility of the fish populations used in traditional bioaccumulation monitoring studies precludes the possibility of source identification. 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 provided. 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.

In 2014, ORNL's PCB monitoring efforts continued focusing on the First Creek watershed, which was identified previously as a source of PCBs. SPMDs and clams were deployed in First Creek. SPMDs were deployed in pipe networks for outfalls 250 and 341, which contribute to First Creek (Fig. 5.35). The results are summarized in Table 5.16. The outfall 302 pipe was added as an SPMD site in 2014. Outfall 302 had not been monitored with an SPMD in the past, but even though it discharges to WOC, it was added because its drainage area is adjacent to the drainage areas of the First Creek outfalls that were tested.

The SPMD deployed at the reference site upstream of the ORNL campus, FCK 0.9, had background levels of PCBs. The PCB concentration for FCK 0.1 was greater than the background levels at FCK 0.9, confirming that the First Creek watershed is a source of PCBs. The results from the 2014 assessment confirm that the upper parts of the outfall 250 and 341 pipe networks continue to be of primary interest for investigation of legacy PCB sources in the First Creek watershed. Manhole 250-19 results indicate that PCBs remain available in that area despite recent actions to remove PCB-contaminated buildings from the upper part of the 250 watershed. Steam Pit 18 sump water accumulated PCBs on its discharge path to Manhole 341-3, indicating a possible undiscovered PCB source. Results for outfalls 250 and 341 were within the ranges of past monitoring, giving no indication that the nature of PCB movement is changing in those networks. Outfall 302 results were at the low end of measured outfall concentrations in past monitoring on First Creek, indicating that further investigation may not be needed.

The 2014 clam results confirm that sources in the areas drained by outfalls 249 and 250 continue to contain PCBs in amounts that are bioaccumulating above background levels.

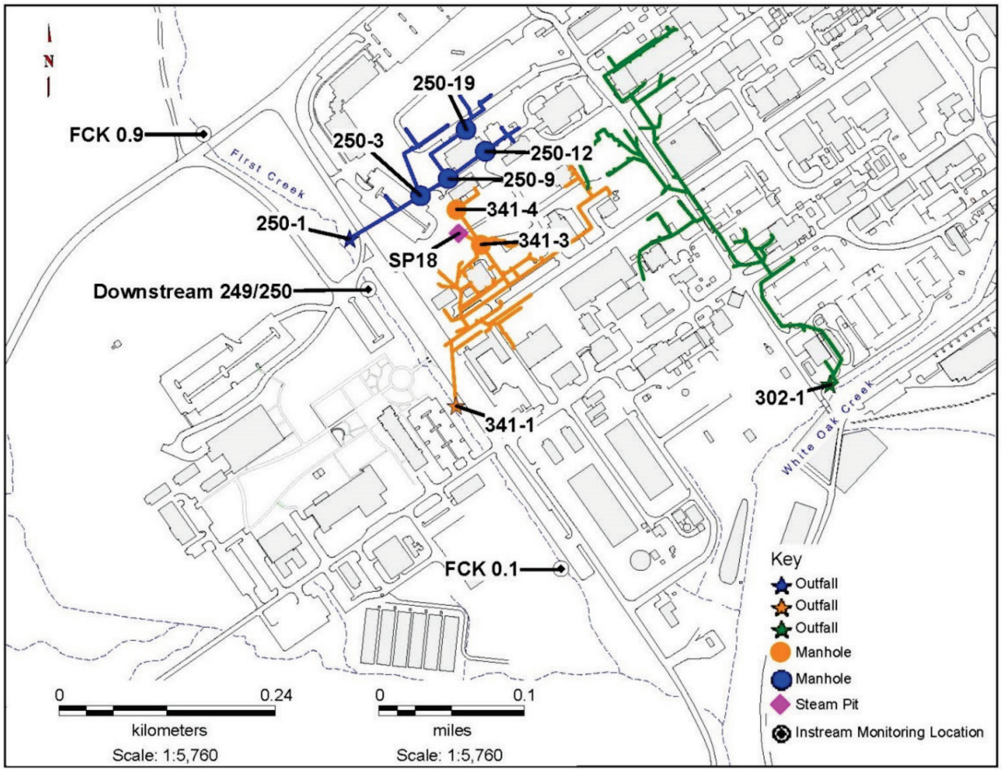

Fig. 5.35. Locations of monitoring points for First Creek source investigation.
(FCK = First Creek kilometer.)

Table 5.16. First Creek PCB source assessment, September 2014
[Total PCBs (parts per billion)]

Sample location	Location type	SPMD	Clams
FCK 0.9	Reference Site	176	<92.9
Manhole 250-19	Inlet/Outlet	53,146	—
Manhole 250-12	East Inlet	1,398	—
Manhole 250-12	Northeast Inlet	148	—
Manhole 250-12	Outlet	2,593	—
Manhole 250-9	East Inlet	6,420	—
Manhole 250-9	North Inlet	7,865	—
Manhole 250-9	Outlet	7,660	—
Manhole 250-3	Inlet	3,253	—
Manhole 250-3	Outlet	7,412	—
Outfall 250	Outfall	7,245	—
Downstream Outfall 249/250	Instream	2,111	1,780
Manhole 341-4	Inlet/Outlet	456	—
Steam Pit 18	Sump	269	—
Manhole 341-3	North Inlet Top from Steam Pit 18 Sump	2,471	—
Manhole 341-3	North Inlet Bottom	708	—
Manhole 341-3	East Inlet	2,121	—

Table 5.16 (continued)

Sample location	Location type	SPMD	Clams
Manhole 341-3	Outlet	2,727	—
Outfall 341	Outfall	10,889	—
FCK 0.1	Instream	5,385	1,530
Outfall 302	Outfall	2,935	—

Acronyms

FCK First Creek kilometer
PCB = polychlorinated biphenyl
SPMD semipermeable membrane device

5.5.9 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 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, this facility was evaluated and a determination made that an SPCC plan was not required. There were no regulatory or permitting actions related to oil pollution prevention at ORNL or NTRC in 2013. An oil handler training program exists to comply with training requirements in 40 CFR 112.

5.5.10 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 5.17. Radiological monitoring at the discharge point downstream of ORNL, White Oak Lake at WOD, is conducted monthly under the ORNL WQPP (Section 5.5.4) and, therefore, is not duplicated by this program. Radiological monitoring at the discharge point upstream of ORNL is conducted monthly under the ORNL WQPP (Section 5.5.4) 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 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 this 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.

The ORR upstream reference site (CRK 66) may be compared with results from this 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 2014 surveillance monitoring efforts are consistent with historical data.

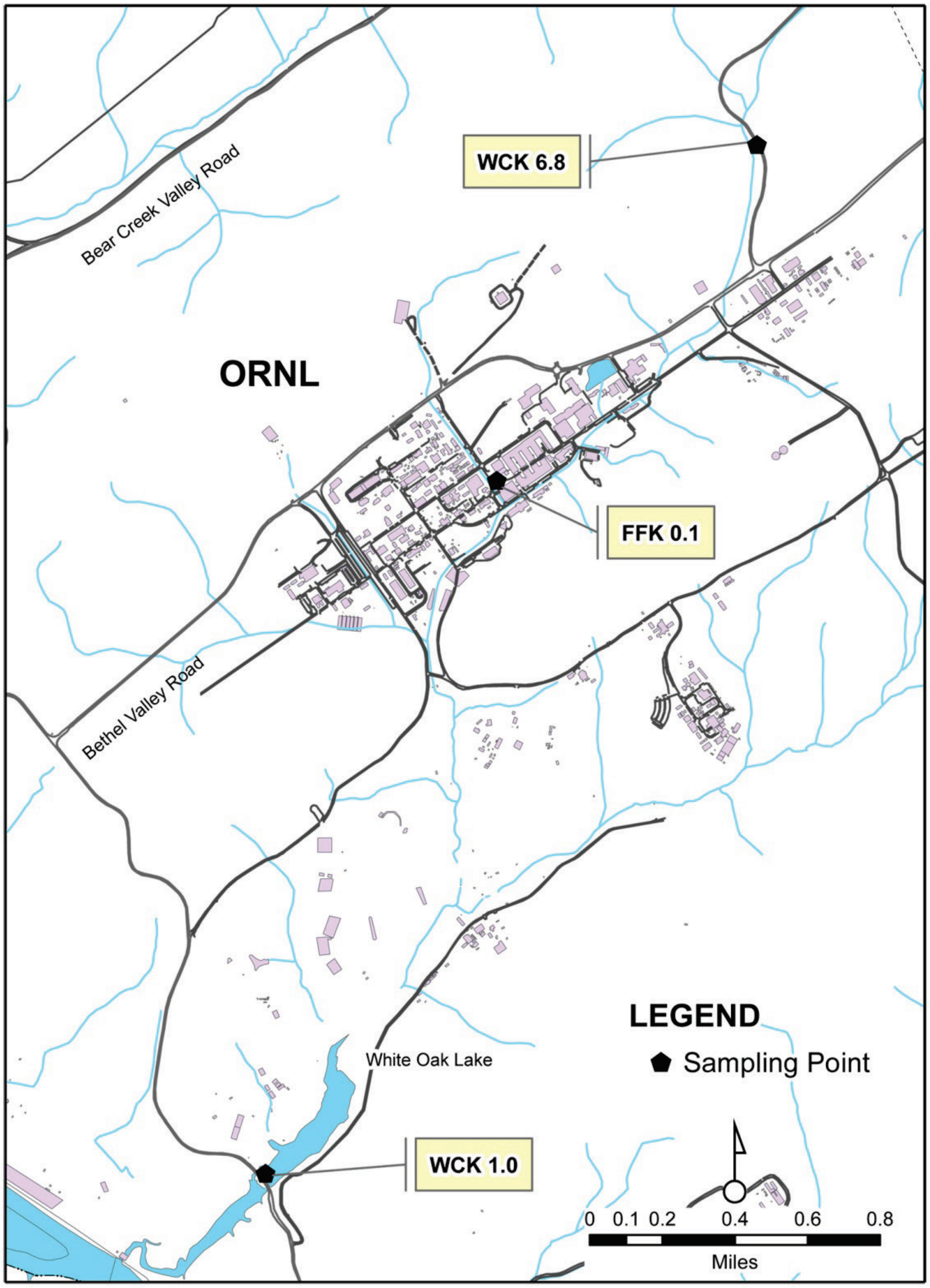

Fig. 5.36. Oak Ridge National Laboratory surface water sampling locations.
(FFK = Fifth Creek kilometer; WCK = White Oak Creek kilometer.)

Table 5.17. Oak Ridge National Laboratory surface water sampling locations, frequencies, and parameters, 2014

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

Radionuclides were detected at the Fifth Creek location (FFK 0.1); however, none were above 4% of the DOE DCS. Radionuclide results from samples collected at WOD (immediately before WOC empties into the Clinch River) are discussed in Section 5.5.4.

Neither mercury nor PCBs were detected during 2014 at WOC at WOD. Other than a couple of PCB detections in 2011 and 2012, PCBs have not been detected since 2001 at WOC at WOD.

5.5.11 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 2014 compliance status for this permit are summarized in Table 5.18.

Table 5.18. Industrial and Commercial User Waste Water Discharge Permit compliance at the Oak Ridge National Laboratory Carbon Fiber Technology Facility, 2014
(permit effective October 15, 2012)

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	2	100
pH (standard units)	9.0	6.0	0	2	100
Outfall 02 (Electrolytic Bath Tank)					
pH (standard units)	9.0	6.0	0	10	100

Table 5.18 (continued)

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 03 (Sizing Bath Tank)			
Copper		0.87	0	8	100
Zinc		1.24	0	8	100
Total Phenol		4.20	0	8	100
pH (standard units)	9.0	6.0	0	8	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 2014: DOE EM monitoring and DOE Office of Science (OS) surveillance monitoring. The DOE EM groundwater monitoring program was performed by UCOR in 2014. 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 at ORNL, 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 WRRP. WRRP is managed by UCOR for the DOE EM program. The results of CERCLA monitoring for ORR for fiscal year 2014, including monitoring at ORNL, are evaluated and reported in the 2015 remediation effectiveness report (DOE 2015) 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 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 that microbes inherent to the existing subsurface microbial population can fully degrade the VOCs to nontoxic end products.

During FY 2014 post-remediation 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 was approved by EPA and TDEC before the project was started.

During FY 2014 the EM monitoring program continued sampling and analysis in the off-site groundwater monitoring well array west of the Clinch River adjacent to Melton Valley. In addition to off-site groundwater quality monitoring near Melton Valley, 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 ORR. General water chemistry, metals, organic compounds, and radionuclides are included in the suite of analytes to be assessed. For the groundwater flow model task, a technical advisory group including representatives from DOE, EPA, TDEC, the US Geological Survey (USGS), UCOR, and a private consultant was convened to oversee the processes of model selection, testing, and conceptual model formulation.

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 at SWSA 1 originated from the earliest operations of ORNL while those at SWSA 3 originated from ORNL, Y-12, the K-25 Site (ETTP), and off-site sources. Although most of the disposed waste was solid waste, some containerized liquid wastes were disposed at SWSA 3. Some wastes were encapsulated in concrete after placement in burial trenches while most of the waste was soil-covered. The Bethel Valley 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 post-remediation groundwater-level suppression. Sampling and analysis of groundwater quality and contaminants were also conducted. Post-remediation 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 2014 monitoring results showed that the cap was effective although target groundwater elevations were exceeded at three of eight wells. Comparison of pre-remediation to post-remediation groundwater contaminant concentrations showed that evaluated contaminant levels decreased at four locations, were stable at five locations, and exhibited no trend at three locations.

During FY 2014, 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. These 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 [presented in the 2015 remediation effectiveness report (DOE 2015)].

Groundwater monitoring continued at the ORNL 7000 Area during FY 2014 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 2014. 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 this 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. Remedy effectiveness groundwater monitoring 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. During FY 2014 annual rainfall dipped below the long-term annual average for ORR following a 5-year period of elevated annual rainfall. 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 2014 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. During FY 2014 no site-related radionuclides (tritium, ^{90}Sr, ^{99}Tc) or VOCs were detected in the off-site monitoring wells. The only site-related radionuclide detected in the DOE on-site exit pathway wells near the Clinch River was ^{90}Sr, which was detected in three multiport well sampling locations at an activity level less than half the derived drinking water limit equivalent level. Monitoring results are summarized in the 2015 remediation effectiveness report (DOE 2015).

5.6.1.1.3 Off-Site Groundwater Monitoring

In 2014, EM conducted groundwater monitoring in off-site wells adjacent to Melton Valley to determine whether contaminants were migrating off 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. However, despite a growing network of sample locations, none of these signature man-made contaminants were detected in any of the monitored off-site groundwater wells.

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 2014 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 is not controlled by federal or state regulations. 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, federal drinking water standards and Tennessee WQCs for domestic water supplies (TDEC 2012) were used as reference standards. If no federal or state standard had been established for a particular radionuclide, 4% of the DCS established by 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.

Results of OS monitoring of groundwater exit pathway discharge areas for radiological and metal contaminants were generally consistent with results reported in past ASERs. Two organic compounds were detected in samples collected from two discharge area sampling locations. Based on the results of the 2014 monitoring effort, there is no indication that current OS operations are significantly impacting groundwater at ORNL.

5.6.2.1 Exit Pathway Monitoring

During 2014, exit pathway groundwater surveillance monitoring was performed in accordance with the exit pathway SAP (Bonine 2012). Groundwater exit pathways at ORNL include areas from watersheds or subwatersheds 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 was split into two zones for geographic expediency. The Southern Discharge Area Exit Pathway was carved from 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 2014.

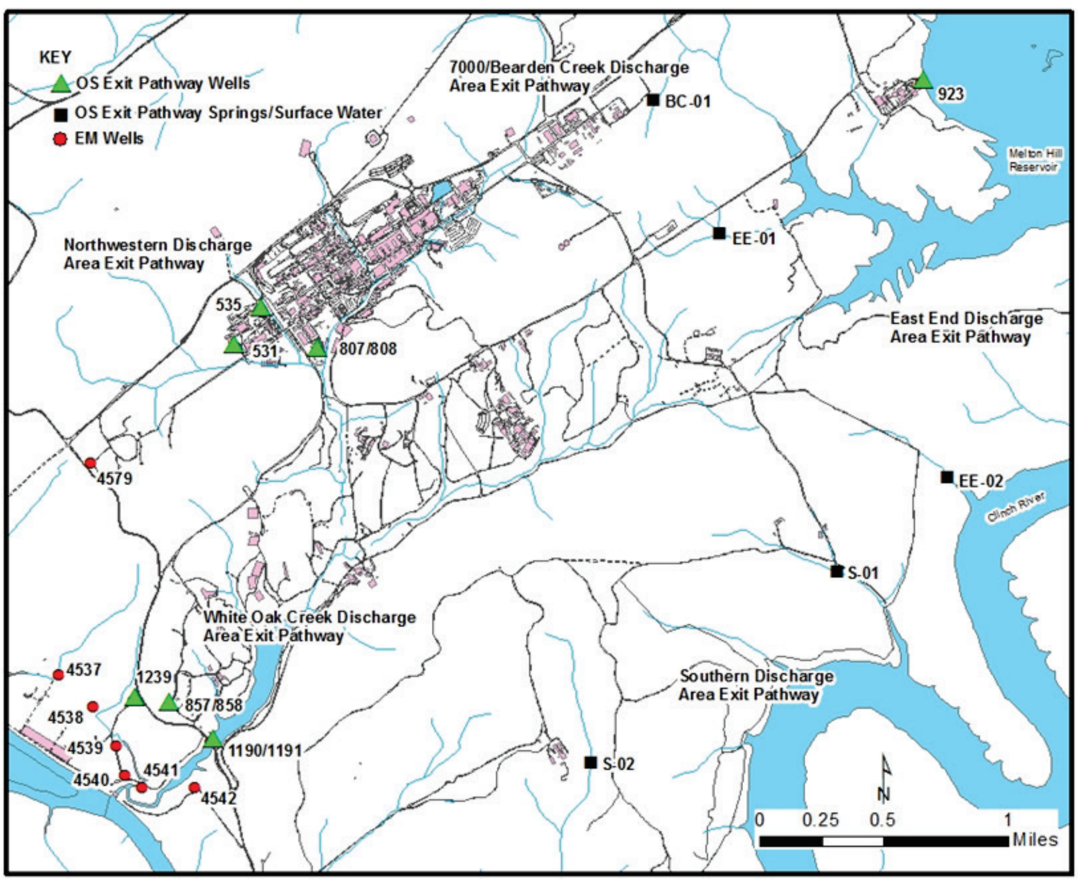

Fig. 5.37. UT-Battelle exit pathway groundwater monitoring locations at Oak Ridge National Laboratory, 2014. *[EM = Environmental Management and OS = Office of Science (both Department of Energy).]*

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 2014 is outlined in Table 5.19.

Unfiltered samples were collected from the exit pathway groundwater surveillance monitoring points in 2014. The organic suite was composed of VOCs and semivolatile organic compounds (SVOCs); the metallic suite included aluminum, iron, lead, and mercury; 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 exit pathway SAP, samples were collected semiannually during the wet (March) and dry (August) seasons.

Table 5.19. Scheduled 2014 exit pathway groundwater monitoring

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

5.6.2.1.1 Exit Pathway Monitoring Results

Statistical trend analyses were performed on 2014 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 2014. 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 5.20.

Table 5.20. 2014 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
Northwestern	535	Iron	None detected
		Aluminum	None detected
		Manganese	None detected
	857	Iron	None detected
		Aluminum	None detected
		Lead	Downward
Southern	S-01	Iron	None detected
		Aluminum	None detected
		Lead	None detected
		Manganese	None detected

Samples were not collected at S-01 and EE-02 during the dry season due to a lack of water flow at those 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 5.21 provides a summary of radiological parameters detected in samples collected from exit pathway monitoring points during 2014. Table 5.22 summarizes organic parameters detected in samples collected from exit pathway monitoring points. Metals are ubiquitous in groundwater exit pathways and so are not summarized here.

Table 5.21. 2014 exit pathway groundwater monitoring results—detected radiological parameters[a]

Discharge Area	Monitoring Point	Radiological Parameter	Wet Season	Dry Season
White Oak Creek	857	Gross alpha	1.9	*b*
		Gross beta	18	*b*
		^{214}Bi	76	13
		^{214}Pb	79	*c*
	858	Gross beta	*b*	3.7
	1190	Gross beta	1.8	11
		^{214}Bi	47	*b*
		^{60}Co	*c*	33
		^{212}Pb	6.9	*c*

Table 5.21 (continued)

Discharge Area	Monitoring Point	Radiological Parameter	Wet Season	Dry Season
		^{214}Pb	53	*b*
		^{3}H	19,000	31,000
	1191	Gross alpha	2.1	*b*
		Gross beta	260	360
		^{214}Bi	11	*b*
		^{212}Pb	4.7	*b*
		^{214}Pb	13	*b*
		$^{89/90}Sr$	130	170
		^{3}H	7,500	32,000
	1239	Gross beta	3.1	*b*
Northwestern	531	Gross beta	*b*	2.8
	535	^{214}Bi	42	18
		^{214}Pb	41	19
	807	Gross beta	13	5.1
		^{214}Bi	38	49
		^{214}Pb	35	34
		$^{89/90}Sr$	10	*b*
		^{3}H	480	540
	808	Gross beta	1.9	5.3
		$^{89/90}Sr$	*b*	2.1
7000-Bearden Creek	BC-01	^{214}Bi	41	*c*
		^{212}Pb	*c*	7.9
		^{214}Pb	38	*c*
East End	EE-01	Gross beta	1.9	*b*
		^{214}Bi	15	*c*
		^{214}Pb	12	*c*
	EE-02	^{214}Bi	77	*d*
		^{212}Pb	5.2	*d*
		^{214}Pb	78	*d*
		^{208}Tl	3.8	*d*
	923	^{214}Bi	11	*c*
		^{214}Pb	13	*c*
Southern	S-01	^{214}Bi	480	*d*
		^{214}Pb	52	*d*
	S-02	Gross alpha	*b*	2.8
		^{214}Bi	420	*c*
		^{214}Pb	490	*c*

[a]Units—pCi/L.
[b]Undetected.
[c]Not reported.
[d]No sample collected due to dry conditions.

Table 5.22. 2014 exit pathway groundwater monitoring results—detected organic parameters[a]

Discharge Area	Monitoring Point	Parameter	Wet Season	Dry Season
White Oak Creek	857	Bis(2-ethyhexyl) phthalate	J8.9	*b*
Southern	S-01	Acetone	J3.3	*b*

[a]Units—µg/L.
[b]Not reported.

Radiological and metal contaminant concentrations observed in groundwater exit pathway discharge areas were generally consistent with observations reported in past ASERs. 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, these three contaminants were observed at the WOC discharge area in 2014 (in wells 1190 and 1191). Statistical trend analyses show that the concentration trends for these parameters continue downward. No other radiological contaminants exceed reference standards at other discharge areas. Metals were detected in groundwater monitoring locations in all of the exit pathway discharge areas. Four metals (iron, manganese, lead, and aluminum) were detected at concentrations exceeding reference standards. These metals are commonly found in groundwater at ORNL. Two organics, bis(2-ethyhexyl) phthalate and acetone, were detected in samples collected from well 857 and monitoring point S-01 in the WOC and Southern Discharge Area Exit Pathways, respectively. Based on the results of the 2014 monitoring effort, there is no indication that current OS operations are significantly impacting 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 are routinely monitored under the ORNL NPDES permit. (See Section 5.5.4 for a discussion of results.)

5.6.2.2.2 Active Sites Monitoring—Spallation Neutron Source

Active sites groundwater surveillance monitoring was performed in 2014 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 should a release 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 down gradient 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 the following: (1) maintain compliance with applicable DOE contract requirements and environmental quality standards and (2) provide uninterrupted monitoring of the SNS site.

A total of 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 2014.

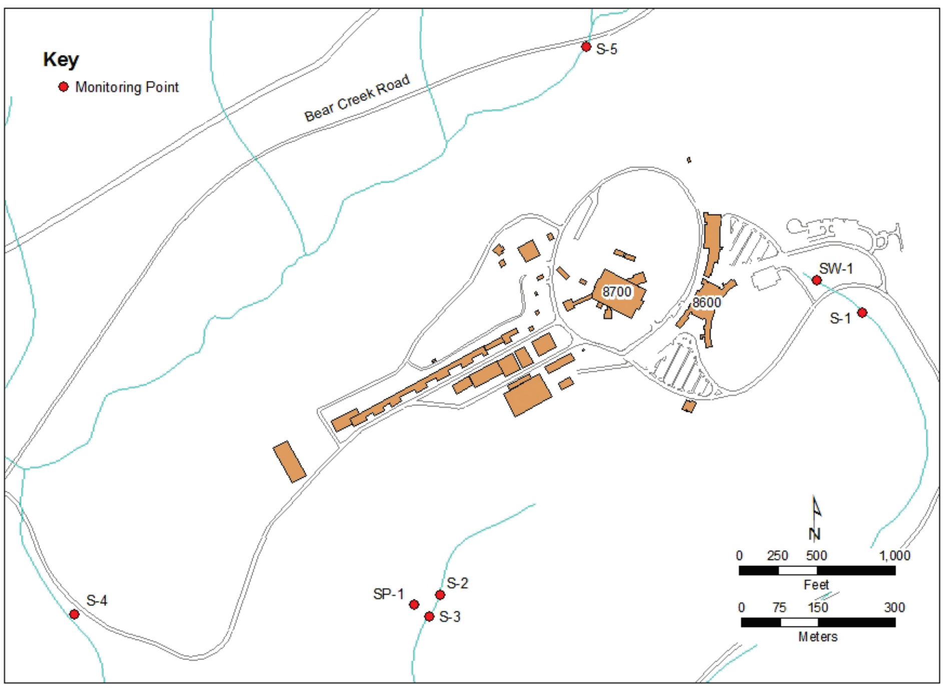

Fig. 5.38. Groundwater monitoring locations at the Spallation Neutron Source, 2014.

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 2014.

Taking a conservative approach, quarterly sampling at each monitoring point continued in 2014, allowing the opportunity for wet and dry season monitoring. All sampling performed in 2014 was performed in conjunction with rainfall events, with samples being collected during rising or falling (recession) limb flow conditions (see Fig. 5.39). Table 5.23 shows the sampling and parameter analysis schedule followed in 2014.

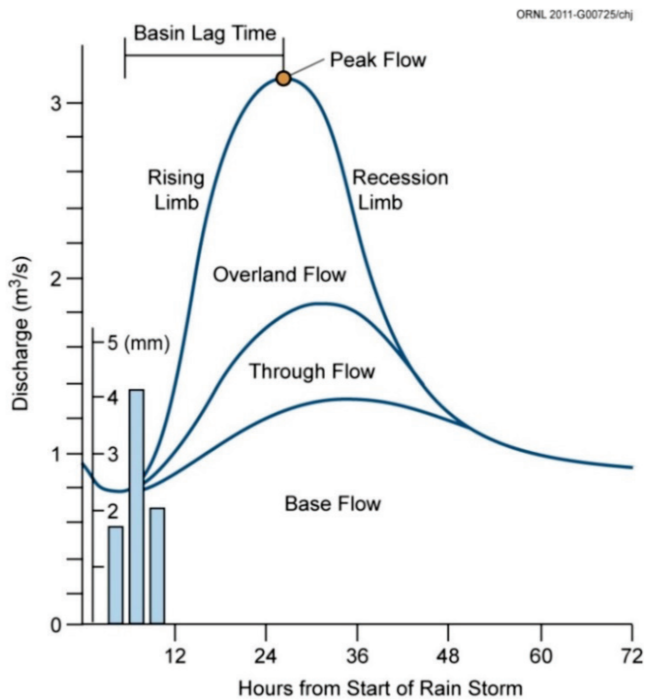

Fig. 5.39. Simple hydrograph of spring discharge vs. time after initiation of rainfall.

Table 5.23. 2014 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	Tritium and expanded suite[a]
S-1	Tritium	Tritium	Tritium	Tritium and expanded suite
S-2	Tritium and expanded suite	Tritium	Tritium	Tritium
S-3	Tritium and expanded suite	Tritium	Tritium	Tritium
S-4	Tritium	Tritium and expanded suite	Tritium	Tritium
S-5	Tritium	Tritium and expanded suite	Tritium	Tritium
SP-1	Tritium	Tritium	Tritium and expanded suite	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 2014 sampling at the SNS site occurred during February (quarter 1), June (quarter 2), August (quarter 3), and December (quarter 4). Low concentrations of several radionuclides were detected numerous times during 2014. Table 5.24 provides a summary of the locations for radionuclide detections observed during 2014. The reference standard for tritium was not exceeded at any SNS monitoring location in 2014.

Table 5.24. Analytical results for parameters detected in samples collected at the Spallation Neutron Source during 2014

Location	Quarter	Parameter	Value[a]	Reference Standard[a]
S-2	1	^{214}Bi	40	10,595
S-2	1	^{214}Pb	39.6	8,000
S-2	1	Tritium	368	20,000
S-3	1	^{214}Bi	53.6	10,595
S-3	1	^{214}Pb	65.9	8,000
SW-1	1	Tritium	239	20,000
S-2	2	Tritium	263	20,000
S-5	2	Alpha	16.6	15
S-5	2	Beta	16.4	50
SW-1	2	Tritium	245	20,000
S-1	3	Tritium	1,620	20,000
S-2	3	Tritium	1,810	20,000
SW-1	3	Tritium	1,700	20,000
S-1	4	Tritium	526	20,000
S-2	4	Tritium	872	20,000
SW-1	4	Tritium	1,790	20,000

[a]Units—pCi/L.

Reference standards for ^{14}Bi and ^{214}Pb are 4% of the DOE O 458.1 DCSs. Reference standards for the remainder of the parameters are the National Primary Drinking Water Standards (40 CRF Part 141).

The only radionuclide exceeding a reference standard during 2014 was gross alpha activity (16.6 pCi/L) at S-5 in the second quarter. The reference standard for gross alpha activity is 15 pCi/L. Gross alpha activity detected in S-5 likely originated in the S-3 ponds located upgradient of the SNS site. S-5 is in hydrologic communication with the S-3 pond plume via karst features.

5.7 Quality Assurance Program

UT-Battelle implements the requirements of DOE O 414.1D, *Quality Assurance,* (DOE 2011c) for all programs, projects, and activities and 10 CFR 830 Subpart A, Quality Assurance Requirements, for nuclear facilities, radiological areas, and programs and activities that have the potential to impact nuclear or radiological safety. ORNL has adopted ISO 9001:2008 as the laboratory consensus standard and has been registered to the standard by a third party registrar. Adoption of ISO 9001:2008 provides the level of rigor and flexibility necessary for the wide range of activities UT-Battelle conducts at ORNL. Additional QA requirements or guidance documents are used on a project- or process-specific basis based on potential risk factors and customer requirements. The application of QA/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 laboratory-wide 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 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 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 2.1 presents a list of environmental audits and assessments performed at ORNL in 2014 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 and Isotek perform independent audits, surveillances, and internal management assessments to verify that requirements have been accurately specified and activities that have been performed conform to expectations and requirements. WAI corrective actions, if required, are documented and tracked in the WAI 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 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 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 super-computing. 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 2014 EM activities undertaken at ORNL. More detailed information is available in the 2014 cleanup progress report (UCOR 2014).

5.8.1 Waste Handling Plan Approved for the Molten Salt Reactor Experiment Facility

The MSRE Facility (Fig 5.40) was a graphite-moderated, liquid-fueled test reactor that operated at ORNL from June 1965 until December 1969. 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 are used to manage the remaining hazards associated with the facility, including periodic removal of reactive gas generated by the defueled salts.

Fig. 5.40. Molten Salt Reactor Experiment Facility.

In 2014, an addendum to the waste handling plan for the facility was approved to address disposition of remaining waste from the earlier actions. The addendum includes a schedule for characterization and disposition of 74 waste items. In 2014 30 waste items were characterized and 20 waste items were disposed. Additional studies and planning were performed to support future removal and disposal of the defueled salt. A draft report was prepared documenting the completion of defueling and the status of the salt as TRU waste eligible for disposal at WIPP.

5.8.2 Completion Reports Issued for Various ORNL Projects

Buildings 3074 and 3136

In FY 2014, EM submitted a removal action report to EPA and TDEC documenting dismantlement of Buildings 3074 and 3136. Building 3074 was a 3,500 ft^2 single-story structure built in the early 1950s and used to repair and maintain hot cell manipulators. Building 3136 was a 30-foot-tall structure built in 1994 for use as a mock-up test facility; however, it was most recently used for document storage. Both buildings were dismantled in FY 2009, and the resulting waste was disposed in FY 2012.

Building 3550

During FY 2014, EPA and TDEC approved a completion report documenting the demolition work performed on Building 3550 (Fig 5.41). One of the first facilities constructed at ORNL, Building 3550 once housed the laboratory's chemistry facilities. It is one of 34 buildings recently demolished in the ORNL Central Campus area.

Fig. 5.41. Building 3550 area after being cleared.

Building 3038

During FY 2014, EPA and TDEC approved a report documenting completion of demolition of Building 3038. Building 3038 was a 7,773 ft^2 nuclear facility located in the ORNL Central Campus area. It was used for packaging, inspecting, and shipping radioisotopes until operations ceased in 1994.

4500 Hot Cells/Duct Stabilization

During FY 2014, EPA and TDEC approved a phased construction completion report outlining finished and future stages of work for 4500 hot cells/duct stabilization. The 4500 area Central Gaseous Waste System provides containment ventilation, off-gas treatment, and discharge of gaseous waste from many ORNL Central Campus facilities.

5.8.3 Groundwater Monitoring

Reservation Groundwater Monitoring Strategy

In 2014 a team of representatives from DOE EM, EPA, TDEC, and USGS developed strategy recommendations for future ORR groundwater characterization and monitoring that included the following.

- Establish a DOE ORR groundwater program to systematically prioritize and investigate groundwater plumes and data gaps.
- Conduct "data quality objectives" workshops to define the type, quality, and quantity of data needed to evaluate off-site groundwater quality and movement. DOE is not aware of any adverse health effects from off-site groundwater. Sampling will be performed in 2015 in accordance with an approved work plan. After sampling and laboratory analysis are complete, results will be evaluated to determine whether any follow-on actions are necessary.
- Initiate efforts to develop an ORR-wide regional flow model. The model will serve as an underlying framework to support future cleanup decisions and actions.

5.8.4 Off-Site Groundwater Monitoring

In 2014, EM conducted groundwater monitoring in off-site wells adjacent to Melton Valley to determine whether contaminants were migrating off 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. However, despite a growing network of sampling locations, none of these signature man-made contaminants were detected in any of the monitored off-site groundwater wells.

5.8.5 Oak Ridge National Laboratory Waste Management

5.8.5.1 Oak Ridge National Laboratory Wastewater Treatment

At ORNL, DOE EM operates PWTC and the Liquid Low-Level Waste Treatment Facility. In 2014 346 million L (91 million gal) of wastewater was treated and released at PWTC. In addition, the liquid LLW evaporator at ORNL treated 335,028 L (88,505 gal) 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.

5.8.5.2 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 2014, ORNL performed

66 waste shipments to off-site hazardous/radiological/mixed waste treatment and/or disposal vendors with no shipment rejections or violations.

5.8.5.3 Transuranic Waste Processing Center

TRU waste-processing activities carried out for DOE in 2014 by WAI addressed CH solids/debris and RH solids/debris and involved processing, treating, repackaging, and off-site transportation and disposal at NNSS, WIPP, and other approved off-site facilities. Planning for treating RH sludge continued this year.

During CY 2014, 67.4 m^3 (88.2 yd^3) of CH waste and 121.6 m^3 (159.1 yd^3) of RH waste were processed and 51.9 m^3 (67.9 yd^3) of mixed LLW (TRU waste that dropped out as low level) was shipped off the site.

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