5. Oak Ridge National Laboratory

ORNL is the largest science and energy national laboratory in the DOE system. ORNL's scientific programs focus on materials, neutron science, energy, high-performance computing, systems biology, and national 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
- 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 2013 the ORNL operations of UT-Battelle, WAI, UCOR, Isotek, and SEC Federal Services Corporation (SEC) were conducted in compliance with contractual and regulatory environmental requirements with the exception of five issues identified during a joint EPA-TDEC-RCRA inspection. There were no NOVs or penalties 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.

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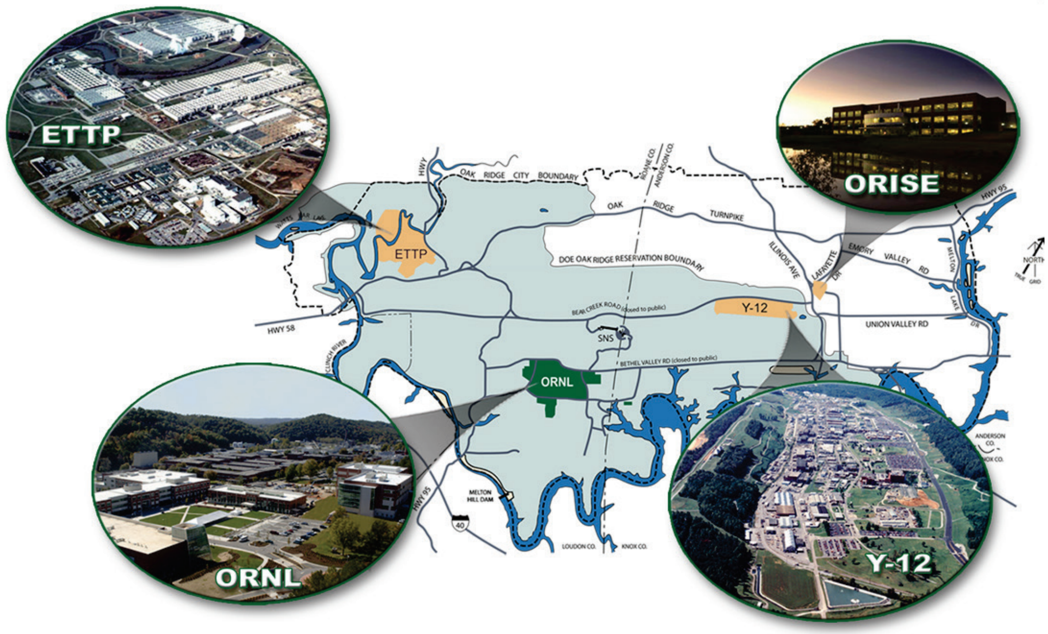

Fig. 5.1. Location of Oak Ridge National Laboratory within the Oak Ridge Reservation and its relationship to other local US Department of Energy facilities.

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.

NTRC is an alliance among UT-Battelle, the University of Tennessee, DOE, and the Development Corporation of Knox County. NTRC is a two building complex consisting of NTRC1 and NTRC2/Manufacturing Demonstration Facility (MDF). The buildings, co-located on a 2.4 ha (6-acre) site in the Pellissippi Corporate Center, are leased to UT-Battelle and the University of Tennessee separately by Pellissippi Investors LLC. NTRC1, a 7,897 m^2 (85,000 ft^2) building, is the site of activities that span the whole range of transportation research. NTRC2/MDF, a 5,667 m^2 (61,000 ft^2) building, houses the Battery Manufacturing Facility, the country's largest dry, open-access battery manufacturing R&D center.

CFTF, located in the Horizon Center Business Park in Oak Ridge, is a pilot project to develop ways of making low-cost carbon fiber inexpensively using research from Oak Ridge National Laboratory (Fig. 5.2). Operations at the 3,902 m^2 (42,000 ft^2) CFTF began in March 2013.

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, contact-handled (CH) debris waste in December 2005, and remote-handled (RH) debris waste in May 2008. Based on the definition of TRU waste, some waste being managed as TRU is later determined to be low-level waste (LLW) or mixed LLW.

Fig. 5.2. Production of lower cost carbon fiber at the Carbon Fiber Technology Facility.

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, Isotek continued to plan and prepare for future programmatic transfers and direct disposal of the remaining ^{233}U inventory.

Since 2010 SEC has performed deactivation, demolition, and removal/disposition activities for multiple facilities at ORNL. To accomplish this, SEC was awarded two separate contracts, the Miscellaneous Facilities Decontamination and Decommissioning (D&D) project, which was completed in 2012, and the Hot Cell project, which included work activities and removal actions regulated by CERCLA.

The main objective of the Hot Cell project was to perform decommissioning of the Building 3026 C/D hot cell complex and legacy material removal from Building 3038 at ORNL. Building 3026 C/D facilities were to be brought down to their concrete foundation slabs. As a result of budget constraints this project was curtailed in February 2013 when partially completed. It has since been turned over to UCOR to be managed under a surveillance and maintenance agreement.

UT-Battelle performs air and water quality monitoring for CFTF and the Building 3019 complex and water quality monitoring for TWPC. TWPC air 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 CFTF, Isotek, and WAI operations at ORNL.

About 5 ha (12 acres) in the central portion of ORNL has been leased to Halcyon, LLC, a CROET subsidiary, for development into 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. In addition, the former Building 2033, also leased to Halcyon, LLC, is now known as HCC and continues to attract tenants. The largest tenant in HCC is Roane State Community College, which is offering job training classes on-site in the areas of carbon fiber manufacturing and solar energy technology. Other HCC tenants include 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 since 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 June 2007 and June 2010 by NSF International Strategic Registrations, Ltd (NSF-ISR). No nonconformities were identified during the most recent reregistration audit. Detailed information on the UT-Battelle EMS is provided in Sections 5.2.1 through 5.2.1.7. 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 May 2011, 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.

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, 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.

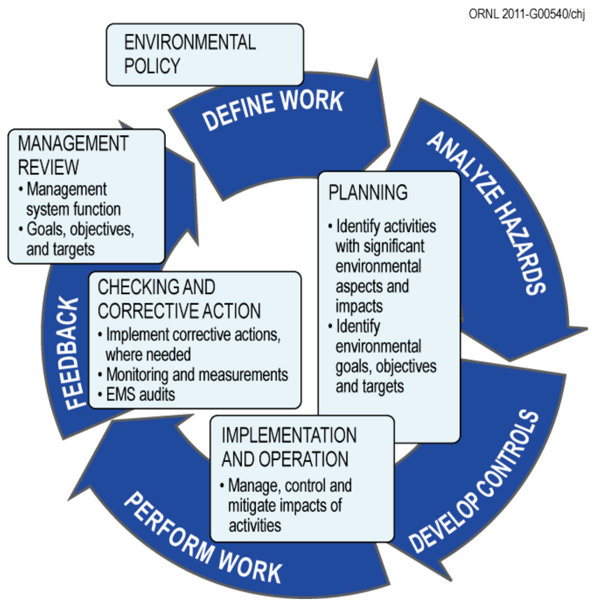

Fig. 5.3. The relationship between the UT-Battelle Environmental Management System and the Integrated Safety Management System.

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.

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,
- radioactive waste,
- mixed waste,
- energy use/intensity,
- GHG emissions,
- permitted air emissions,
- regulated liquid discharges, and
- storage or use 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 2013 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,
- environmental sampling and data evaluation, and
- CERCLA interface.

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

- waste services representatives who work with waste generators to identify, characterize, package, and certify wastes for disposal;
- 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 hazardous material spill response team, which is the first line of response to hazardous materials spills at ORNL and controls and contains such spills until the situation is stabilized; and
- the Environmental Management Program Office (EMPO), which coordinates and directs specific CERCLA decommissioning and demolition work being done on the UT-Battelle site. EMPO activities include developing and implementing interface agreements applicable to multiple contractors, CERCLA applicable or relevant and appropriate requirements, and project work plans.

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.

Figure 5.5 summarizes FY 2013 infrastructure modernization projects. Table 5.1 summarizes FY 2013 performance and planned actions to achieve future sustainability goals.

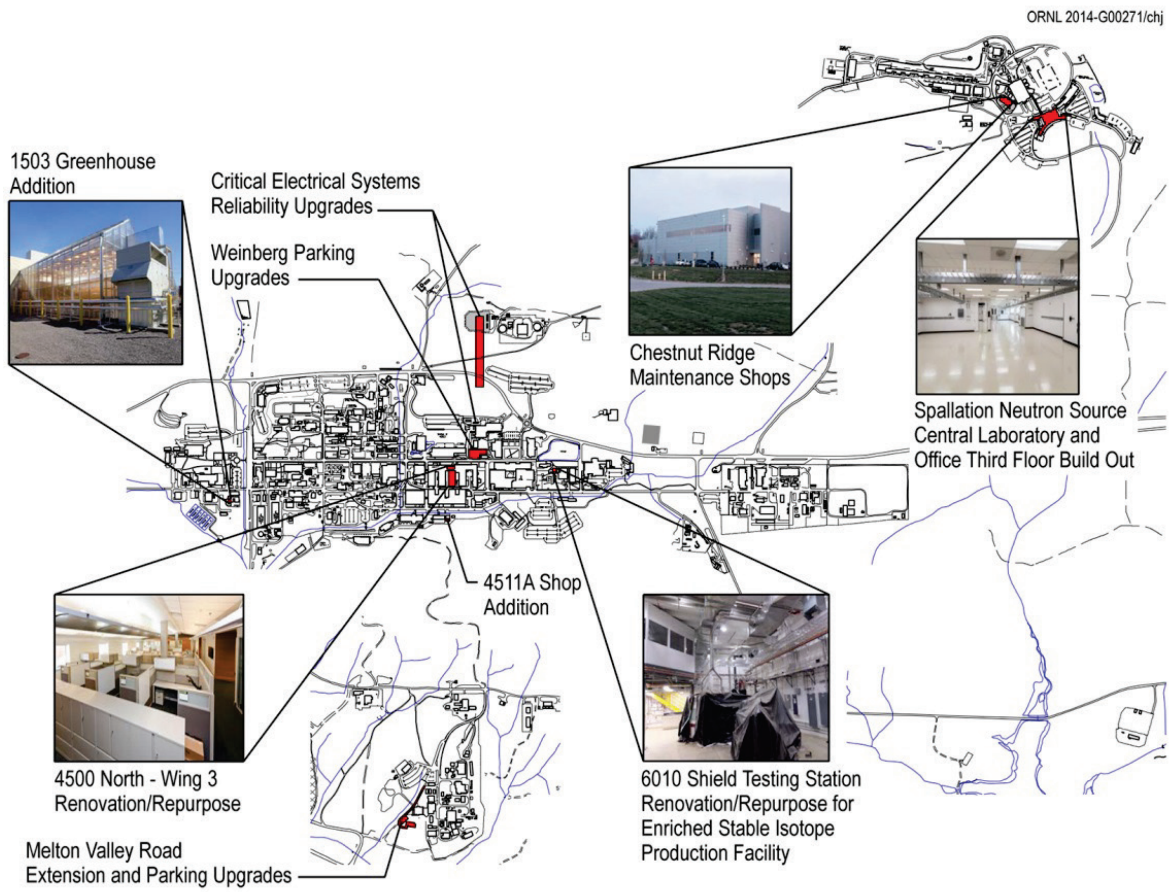

Fig. 5.5. Modernization and facilities revitalization.

Table 5.1. Summary of UT-Battelle progress toward attainment of DOE sustainability goals, 2013

SC/SSPP/ OMB Goal	DOE Goal	Performance Status through FY 2013	Planned Actions and Contributions
Goal 1: Greenhouse Gas Reduction and Comprehensive Greenhouse Gas Inventory			
1.1	28% Scopes 1 & 2 GHG reduction by FY 2020 from a FY 2008 baseline (2013 target: 17% reduction)	**Scope 1**—~43,895 metric tons of CO_2e, a decrease of 51% from FY 2008. **Scope—**~307,660 metric tons of CO_2e, an increase of 23% from FY 2008 after allowances for purchased RECs **Scopes 1 & 2** combined—~351,555 metric tons of CO_2e, an increase of 4% from the baseline year of 2008	**Scope 1** reductions are expected to exceed the target based on key projects and initiatives planned for the future **Meeting Scope 2** reduction goals is more challenging due to growth in electricity demands for high-energy mission-specific facilities.
1.2	13% Scope 3 GHG reduction by FY 2020 from a FY 2008 baseline (2013 target: 4% reduction)	**Scope 3**—~42,559 metric tons of CO_2e. Overall Scope 3 emissions have increased by 4%. A 23% increase in T&D losses limits overall performance	Employee engagement programs (i.e., responsible business travel, commuting, and telework programs) continue. However while T&D losses and purchased electricity will increase, a substation coming online in 2015 will reduce T&D losses by ~3% (~0.75 MW) and thus reduce power purchases and Scope 3 GHG emissions
Goal 2: Buildings, Energy Savings Performance Contract Initiative Schedule, and Regional and Local Planning			
2.1	30% energy intensity (Btu/gsf) reduction by FY 2015 from a FY 2003 baseline (2013 target: 24%)	UT-Battelle has achieved a reduction of 46.5% and is on track to exceed the FY 2015 goal (Fig. 5.6). Fig. 5.7 shows building energy performance at ORNL for the last decade	Ongoing energy audits will identify future energy conservation projects
2.2	Each year evaluate a minimum of 25% of 75% of facility energy use over a 4-year cycle per EISA Section 432	Over 25% evaluated during this first year of a second 4-year cycle	Continue pace of 25% or more through current cycle (end of FY 2016). Use data from prior cycles to conduct focused evaluations
2.3	Individual buildings metered for 90% of electricity by October 1, 2012; for 90% of steam, natural gas, and chilled water by October 1, 2015 (2013 target: 40%). Data Centers to be metered at 100% by FY15 (2013 target: 70%)	As of 2013, metering status of individual buildings was 90.3% metering for electrical use, (100% of data centers). • 5.5% steam • 94.4% natural gas • 67.8% chilled water	Continued implementation of metering plan will allow progress toward meeting metering goals
2.4	All new roofs must meet cool roof standards and have thermal resistance of at least R-30	UT-Battelle completed one new roofing project in FY 2013 which met all requirements	New construction and renovation actions will use cool roof technologies
2.5	15% of existing buildings greater than 5,000 gsf to comply with the GPs for HPSBs by FY 2015 (2013 target: 11%)	Six additional existing buildings achieved HPSB status in 2013 for a total of 23, exceeding the DOE goal of 22 HSPBs	Efforts will continue toward expanding the existing HPSB inventory—planning for two additional buildings in FY 2014

Table 5.1. (continued)

SC/SSPP/ OMB Goal	DOE Goal	Performance Status through FY 2013	Planned Actions and Contributions
2.6	All new construction, major renovations, and alterations of buildings greater than 5,000 gsf must comply with the GPs	To date, 16 new facilities have been LEED certified.	All new construction is specified for LEED Gold. Two facilities are expected to be in design phase in FY 2014
		Goal 3: Fleet Management	
3.1	10% annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline (2013 target: 114% cumulative since 2005)	To date alternative fuel use is 68% of total fuel consumed	Continue to replace older vehicles with AFVs and to procure electric LSVs
3.2	2% annual reduction in fleet petroleum consumption by FY 2020 relative to a FY 2005 baseline (2013 target: 16% cumulative since 2005).	UT-Battelle has achieved a 53% reduction in fleet petroleum consumption based on the 2005 baseline	Continue to replace inefficient vehicles with AFVs and hybrids and to procure electric LSVs
3.3	75% of light-duty vehicle purchases must consist of AFVs by FY 2000 and thereafter	100% of the light duty vehicles purchased in FY 2013 were AFVs	Continue to purchase AFVs as funds are available (Fig. 5.8).
3.4	Reduce fleet inventory of non-mission-critical vehicles by 35% by FY 2013 relative to a FY 2005 baseline	UT-Battelle's commitment for this goal has been met	Not applicable
		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 2013 target: 12%).	Water use intensity measured 145 gal/gsf (an 18% reduction since 2007)	Future reductions will include eliminating additional OTC and repairing leaks in the water distribution system. Fig. 5.9 shows reductions since 2007 and expected progress through 2020
4.2	20% water consumption reduction of ILA water by FY 2020 from a FY 2010 baseline	No ILA water is used by UT-Battelle.	Not applicable
		Goal 5: Pollution Prevention and Waste Reduction	
5.1	Divert at least 50% of nonhazardous solid waste, excluding construction and demolition debris, by FY 2015	A 34% diversion rate was achieved in FY 2013. While less than the target, this represents a significant improvement in the past year	Continue initiatives to reduce the amount of material going to the landfill
5.2	Divert at least 50% of construction and demolition materials and debris by FY 2015	UT-Battelle’s diversion rate for construction and demolition debris for FY 2013 is 39%	Continue process improvements to meet or exceed the goal. Additional focus will be placed on segregation of waste

Table 5.1. (continued)

SC/SSPP/ OMB Goal	DOE Goal	Performance Status through FY 2013	Planned Actions and Contributions
		Goal 6: Sustainable Acquisition	
6.1	Procurements meet requirements by including necessary provisions and clauses (Sustainable Procurements/Biobased Procurements)	100% of procurement transactions in FY 2013 (excluding purchase card transactions) contained terms and conditions that invoke requirements for sustainable acquisition	Procurement transactions will continue to include terms stipulating sustainable acquisition requirement
		Goal 7: Electronic Stewardship and Data Centers	
7.1	All data centers are metered to measure monthly PUE by FY 2015 (2013 target: 80%)	All existing data center equipment is metered	Plans are being developed for adding meters in the 5800 Chiller Plant
7.2	Maximum annual weighted average PUE of 1.4 by FY 2015 (2013 target: 1.60).	The calculated PUE value at the end of FY 2013 was 1.29 for the MRF data center and 1.26 for the CSB data center	Automated real-time PUE calculation for all data centers to be in place in FY 2014. Efforts to provide monthly and annual PUE calculations will continue
7.3	Electronic Stewardship—100% of eligible equipment with power management implemented and in use by FY 2012	100% of the eligible PCs, laptops, and monitors are being actively power-managed	Continue to ensure all eligible computing equipment is power-managed
		Goal 8: Renewable Energy	
8.1	20% of annual electricity consumption from renewable sources by FY 2020 (2013 target: 7.5%)	UT-Battelle produced on-site renewable electricity of less than 0.024% of consumption and purchased a small amount of green power from TVA. In addition, a number of local (TVA) and marketplace REC purchases resulted in a total of 57,558 MWh of renewable attributes, exceeding the 7.5% FY 2013 goal at 10.02%	Annual REC purchases will permit UT-Battelle to meet the goal until additional cost-effective on-site generation is implemented

Acronyms and Abbreviations

AFV = alternative fuel vehicle
Btu = British thermal unit
CO_2e = carbon dioxide equivalent
CSB = Computational Science Building
DOE = US Department of Energy
ECM = energy conservation measure
EISA = Energy Independence and Security Act
ESPC = Energy Savings Performance Contract
FY = fiscal year
gal = gallons
GHG = greenhouse gas
GPs = guiding principles
gsf = gross square feet
HPSB = High Performance Sustainable Buildings
ILA = industrial, landscaping, and agricultural
LEED = Leadership in Energy and Environmental Design
LSV = low-speed vehicle
MAXLAB = Maximum Energy Efficiency Laboratory
MRF = Multiprogram Research Facility
MW = megawatt
MWh = megawatt-hour
OMB = Office of Management and Budget
ORNL = Oak Ridge National Laboratory
OTC = once-through-cooling
PC = personal computer
PUE = power usage effectiveness
RE = renewable energy
REC = renewable energy credit (also, renewable energy certificate)
SC = Sustainable Campus (ORNL)
SSPP = Strategic Sustainability Performance Plan (DOE)
T&D = transmission and distribution
TVA = Tennessee Valley Authority

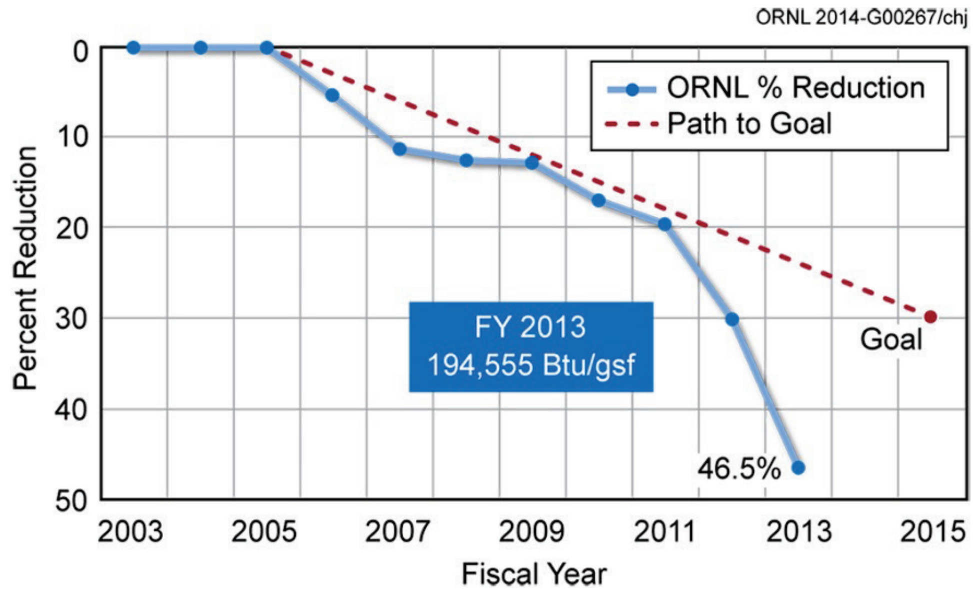

Fig. 5.6. Summary of energy intensity reduction results and progress toward goal (30% reduction), which was met in 2012. (Btu = British thermal unit; gsf = gross square foot.)

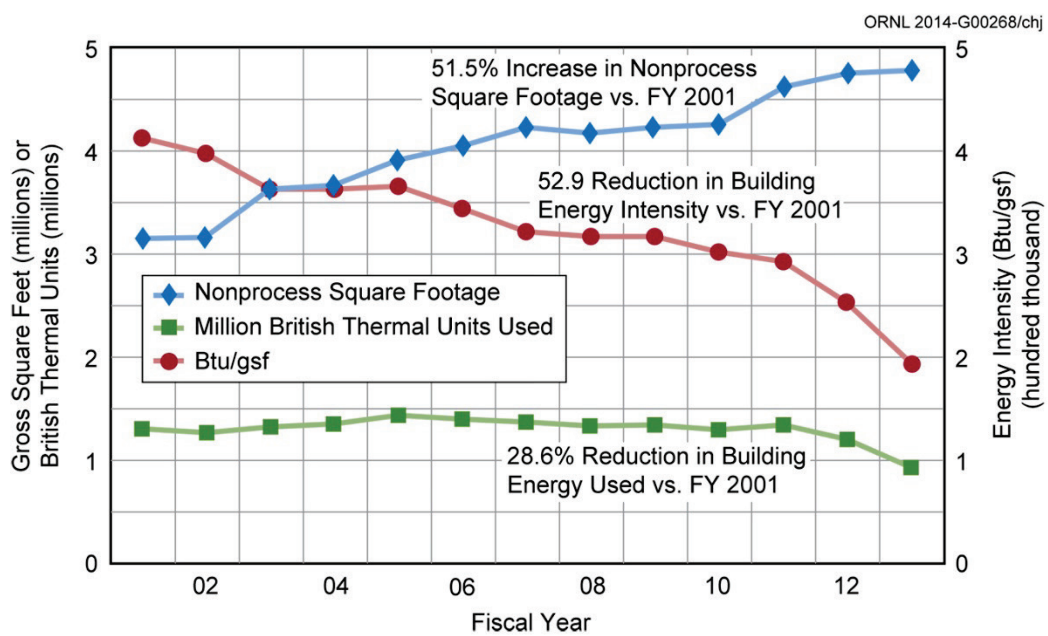

Fig. 5.7. ORNL building energy performance from FY 2001 through FY 2013.

ORNL 2011-P01759

Fig. 5.8. ORNL's solar-assisted electric vehicle charging station.

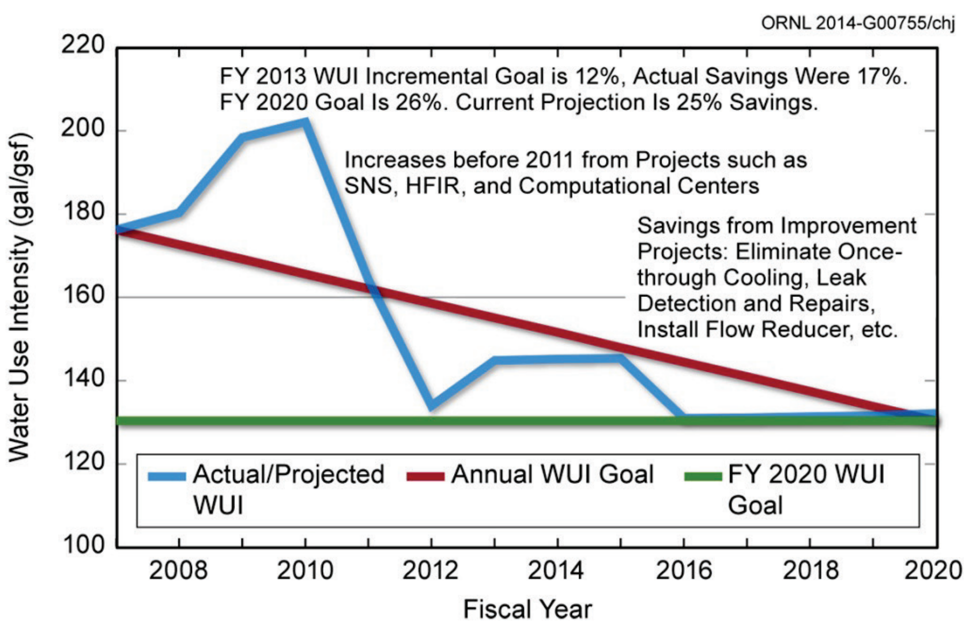

Fig. 5.9. ORNL water use intensity (WUI) FY 2007–FY 2020, including 2020 and incremental DOE goals.

5.2.1.4.1 Pollution Prevention and Waste Reduction

UT-Battelle implemented 42 new pollution prevention projects at ORNL during 2013, eliminating more than 46 million kg (about 102 million lb) of waste, which included about 11.8 million gal of wastewater. Excluding the wastewater efforts, these projects eliminated about 1.7 million kg (about 3.7 million lb) of waste. In total, all of these projects led to cost savings/avoidance of more than $5.9 million (including ongoing reuse/recycle projects). In addition to the successful resource conservation and sustainable transportation initiatives discussed previously, source reduction actions such as efforts related to the contracting organization going paperless; resource-efficient supercomputing; and recycling programs for lead, electronics, and C&D debris were also implemented during 2013 (Fig 5.10). During the year UT-Battelle aggressively supported the recycling program at ORNL with more than 38% of FY 2013–generated materials being diverted for recycle or beneficial use. Large construction projects incorporated comprehensive project-specific recycling efforts.

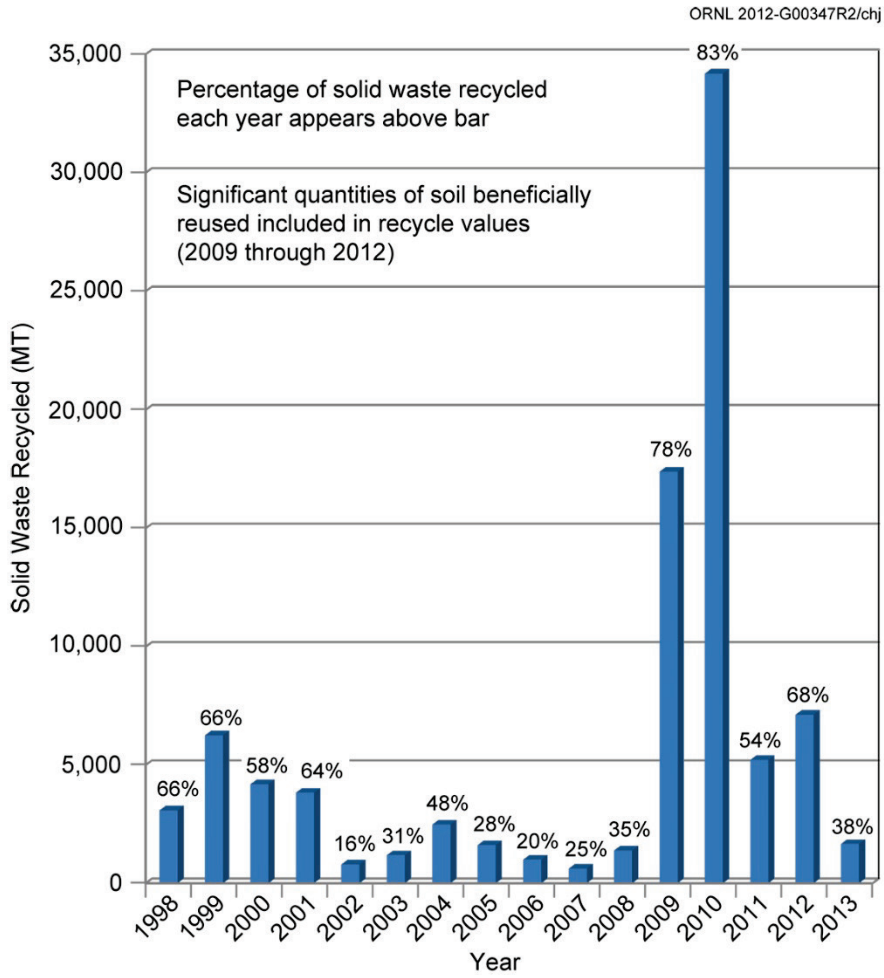

Fig. 5.10. Solid waste recycled at Oak Ridge National Laboratory as a result of recycling programs.

ORNL Site Pollution Prevention/Sustainability Awards

- Chemical and Materials Sciences Building (CMSB) Award—McCarthy Building Companies, Inc., and UT-Battelle shared a Construction Management Association of America Project Achievement Award for "Buildings, New Construction Project with Constructed Value Less Than $100 Million." CMSB (Fig. 5.11) cost about $95 million and earned a LEED-Gold rating from the U.S. Green Buildings Council.

ORNL 2012-P02822

Fig. 5.11. Chemical and Materials Sciences Building.

- Green Achievers Award—received from GoGreen East Tennessee for participation in the GoGreen.com Business Recognition Program, showcasing the environmental efforts at ORNL and encouraging green business practices throughout the community.
- DOE Vehicle Technologies Office Annual Awards—three awards received at the 2013 DOE Vehicle Technologies Office Annual Merit Review in recognition of leadership in transitioning reactivity-controlled compression ignition combustion from a single cylinder to a multicylinder engine using biorenewable fuels; exemplary achievements on the Advanced Engine Cross-Cut Team, U.S. DRIVE Engine Tech Team and 21st Century Truck; and management of the fueleconomy.gov website.
- 2013 Roane Beautification Award—received from the Roane County Industrial Development Board in recognition of the significant modernization and sustainable campus improvements made at ORNL over the past decade.
- 2013 Federal Energy and Water Management Award—received for UT-Batelle's FY 2012 water resource management efforts that minimized quantity and maximized quality.
- 2013 Tennessee Chamber of Commerce and Industry Air Quality Outstanding Achievement Award (formerly the Air Quality Excellence Award)—received in recognition of the new ORNL Biomass Steam Plant and its impact on air quality.
- 2013 Presidential GreenGov Award—in the "Good Neighbor" category in recognition of recent initiatives with Indian River State College in Florida to create a sustainable campus modeled on the ORNL design and for partnering with the electric vehicles (EVs) charging project in Tennessee to install charging stations across Tennessee.
- 2013 First Place in the Smart Trips Commuter Challenge, Heavyweight Division—awarded based on total number of new participants who signed up for Smart Trips during the challenge, the number of employees who met challenge requirements, and the overall enthusiasm of participants.
- 2013 DOE Sustainability Award—received for championing sustainable pollution prevention efforts at ORNL.
- 2013 DOE Sustainability Award—awarded for the sustainability success of the Biomass Steam Plant at ORNL.
- 2013 Federal Laboratory Consortium (FLC) Excellence in Technology Transfer and 2013 R&D 100 Awards—received for excellence in technology transfer for the ClimateMaster Trilogy 40 Q-Mode Geothermal Heat Pump, which was developed by ClimateMaster and UT-Battelle through a cooperative R&D agreement. The water-to-air packaged heat pump provides significantly lower energy costs; reduces peak demand for electricity; and provides environmental benefits, especially through reductions in greenhouse gases and pollutants.
- 2013 FLC Excellence in Technology Transfer and 2013 R&D 100 Awards–awarded to UT-Battelle and Porous Power Technologies LLC for excellence in technology transfer for the SYMMETRIX HPX-F Nanocomposite Separator for Improved Lithium Ion Battery. SYMMETRIX HPX-F reduces lithium ion battery costs and improves safety through the replacement of polymer separators.
- 2013 BuildingGreen Product Award—received by UT-Battelle and the Fraunhofer Institute for Building Physics, IBP, in Germany for the joint development of a family of PC-based modeling tools (called WUFI for "Wärme und Feuchte Instationär") that calculate heat and moisture transfer in multilayer building components.

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.

In 2013, EISA requirements were not applicable to any of the construction projects started during the year.

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 2013, 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 May 2011, 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 93 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.

5.3 Compliance Programs and Status

During 2013 UT-Battelle, UCOR, WAI, Isotek, and SEC operations were conducted in compliance with contractual and regulatory environmental requirements.

There were no NOVs or penalties issued by the regulatory agencies. Table 5.2 presents a summary of environmental audits conducted at ORNL in 2013.

Table 5.2. Summary of regulatory environmental audits, evaluations, inspections, and assessments conducted at ORNL, 2013

Date	Reviewer	Subject	Issues
February 19	City of Oak Ridge	CFTF Wastewater Inspection	0
June 10–11	TDEC	Annual RCRA Inspection for ORNL	0
August 6	Knox County	Annual CAA Inspection for NTRC	0
August 9	TDEC	Annual CAA Inspection for ORNL and CFTF	0
September 26–30	TDEC	NPDES Compliance Evaluation Inspection	0
September 30	City of Oak Ridge	CFTF Wastewater Inspection	0
October 23	TDEC	Annual TWPC CAA Inspection	0
November 4–5	TDEC	Annual RCRA Inspection of ORNL at Y-12 Facilities	0

Acronyms

CAA = Clean Air Act
CFTF = Carbon Fiber Technology Facility
ORNL = Oak Ridge National Laboratory
NPDES = National Pollutant Discharge Elimination System
NTRC = National Transportation Research Center
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation
TWPC = Transuranic Waste Processing Center
Y-12 = Y-12 National Security Complex

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 2013 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 effective in 2013 at ORNL.

Table 5.3. Oak Ridge National Laboratory environmental permits, 2013

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Title V Operating Permit, ORNL	562765	08-16-11	08-15-16	DOE	UT-B	UT-B
CAA	Construction Permit, CFTF facility	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	Title V Operating Permit, ORNL	562860	07-16-10	07-15-15	DOE	UCOR	UCOR
CAA	Construction Permit, WAI emergency generator	967178P	07-01-13	07-01-14	DOE	DOE	WAI
CAA	Title V Operating Permit, Isotek	560898	07-27-09	07-26-14	DOE	Isotek	Isotek
CWA	ORNL NPDES Permit (ORNL sitewide wastewater discharge permit)	TN0002941	07-01-08	07-30-13	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—ORNL Modernization of Laboratory Facilities	TNR133485	05-29-09	05-23-16	DOE	DOE	UT-B
CWA	Tennessee Storm Water Multi-Sector General Permit for Industrial Activities for Storm Water Discharges Associated with Construction Activity (CGP)—0975 Water Reservoir	TNR133727	07-08-10	05-14-14	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit TNR10-0000, Storm Water Discharges from Construction Activities—ORNL Melton Valley Access Road and Parking Lot	TNR133893	08-30-11	05-23-16	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit TNR10-0000, Storm Water Discharges from Construction Activities—Biomass Gasification System Project	TNR133428	06-09-10	05-23-16	DOE	DOE	JCI
CWA	Tennessee General (NPDES) Permit TNR10-1000, Storm Water Discharges from Construction Activities—Maximum Energy Efficiency Building Research Laboratory	TNR133932	05-24-11	05-23-16	DOE	DOE	UT-B

Table 5.3. (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	Industrial and Commercial User Waste Water Discharge Permit (Carbon Fiber Technology Facility, located near ETTP)	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	TN Operating Permit (sewage)	SOP-02056	02-01-13	12-31-17	DOE	WAI	WAI
CWA	Tennessee General Permit TNR10-0000, Storm Water Discharges from Construction Activity—Site Expansion Project	TNR 133560	08-31-09	NA	DOE	WAI	WAI
CWA	Aquatic Resource Alteration Permit for Temporary Disturbance to 0.02 Acres of Wetland at Melton Branch Circle	ARAP NR1203.123	09-13-12	09-13-13	DOE	UT-B	UT-B
RCRA	Hazardous Waste Transporter Permit	TN1890090003	12-21-12	01-31-14	DOE	DOE	UT-B, UCOR
RCRA	Hazardous Waste Corrective Action Permit	TNHW-121	09-28-04	09-28-14	DOE	DOE/all[c]	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]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
CGP = Construction General Permit
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
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 2013.

Table 5.4. National Environmental Policy Act (NEPA) activities, 2013

Types of NEPA documentation	Number of instances
Oak Ridge National Laboratory	
Approved under general actions[a] or generic CX determinations	45
New generic CXs[b] for research and development	2
Project-specific CX[b] determinations for demolition activities	2
Wastren Advantage, Inc.	
Approved under general actions[a] or generic CX determinations	0

[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.

Abbreviations
CX = categorical exclusion

During 2013, 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 and 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 first sitewide operating air permit was issued in 2004. 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 were no UT-Battelle, Isotek, or WAI CAA violations or exceedances in 2013.

Section 5.4 provides detailed information on 2013 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 2013, 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 2013 was 100%, with no measurements exceeding numeric NPDES permit limits. However, there were three fish kills at ORNL in 2013. They occurred on July 31, 2013; October 4, 2013; and October 6, 2013. Each was attributed to inadequate dechlorination of cooling water discharges. Mechanical and administrative improvements have been made to guard against future occurrences. 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 2013, 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 2013, 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 2013. 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 2013, UT-Battelle and UCOR were permitted to transport hazardous wastes under an EPA ID number issued for ORNL activities. After notification to TDEC, UT-Battelle ceased operation in 2013 of a registered ORNL transfer facility for temporary storage (less than 10 days) of hazardous waste transported from off-site locations because the facility was no longer needed.

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 2013 was 1,028,106 kg (1,133.3 tons). Mixed wastewater accounted for 783,170 kg (863.3 tons). Excluding the wastewater generation, 2013 hazardous waste generation increased about 14%. The increase is attributed to debris from building cleanout and demolition and TRU waste generation. ORNL generators treated 3,438.5 kg (3.8 tons) of hazardous/mixed waste by elementary neutralization and silver recovery; and 892 kg (0.98 tons) of hazardous/mixed waste was received from UT-Battelle generators at the Y-12 Complex—which was stored at ORNL and subsequently shipped to off-site treatment, storage, and disposal facilities for treatment/disposal. The quantity of hazardous/mixed waste treated in RCRA-permitted treatment facilities at ORNL in 2013 was 35,912 kg (39.6 tons). This includes waste treated by amalgamation, macroencapsulation, size reduction, and stabilization/solidification. In addition, 783,170 kg (863.3 tons) of mixed waste was treated at an on-site wastewater treatment facility. The amount of hazardous/mixed waste shipped off-site to commercial treatment, storage, and disposal facilities decreased about 7% to 226,907 kg (250.1 tons) in 2013.

In June 2013, TDEC conducted an annual RCRA inspection of ORNL generator areas; battery collection areas; RCRA-permitted treatment, storage, and disposal facilities; and RCRA records. During the June inspection, all activities and records were found to be in compliance with RCRA regulations and the RCRA permits, and no NOVs or penalties were associated with this inspection.

At NTRC DOE and UT-Battelle were regulated as "conditionally exempt small-quantity generators" in 2013, 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 or the 0800 Area in 2013. The 0800 Area is a location on ORR adjacent to ORNL that has been assigned EPA identification number TNR000019760.

In 2013 DOE and UT-Battelle applied for and received an EPA identification number for the 1916-T2 Warehouse in Oak Ridge for hazardous waste generation and shipping activities associated with cleanout of two of the warehouse bays. This facility was classified as a "small quantity generator" in 2013, meaning that between 100 and 1,000 kg (between 220.5 and 2,205 lb) of hazardous waste was generated during at least one calendar month. This activity is expected to be intermittent.

Table 5.5. Oak Ridge National Laboratory Resource Conservation and Recovery Act operating permits, 2013

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 & Treatment Unit

Table 5.5 (continued)

Permit number	Storage and Treatment Units/description
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
	Building 7880BB TWPC-6 (Contact-Handled Marshaling Building) Container Storage Unit
	Building 7880AA TWPC-7 (Drum-Venting Building) Container Storage Unit
	Building 7880QQ TWPC-8 (Multipurpose Building) Container Storage Unit
	Macroencapsulation T-1 Treatment Unit
	Amalgamation T-2[a] Treatment Unit
	Solidification/Stabilization T-3[a] Treatment Unit
	Hot Cell Table T-4[a] Treatment Unit
	Size Reduction T-5[a] 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 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 2013 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 2014.

In May 2005, Bechtel Jacobs, Inc., LLC, applied for a RCRA postclosure permit for solid waste storage area (SWSA) 6. In November 2013, TDEC denied issuance of a postclosure permit, following a request from DOE to withdraw the permit application. SWSA 6 is currently being managed under CERCLA.

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 EMPO performs both direct EM work and an integration function for the DOE EM-funded 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 has effectively participated in the completion of ARRA-funded cleanup work to accelerate

ORNL revitalization. Directly performed work included the cleanout of legacy material from Building 4501 Hot Cell D, cleanout of legacy material from Building 2026, removal of the Building 3550 slab and related soil remediation activities and site restoration, removal of roughing and HEPA filters from the 3106 Filter Pit, and grouting the 4556 Filter Pit and the central campus ventilation duct between Building 4501 and the 3039 stack. During 2013, EMPO integrated and supported other DOE contractors in the removal of five radioisotope thermoelectric generators for shipment to NNSS and the stabilization of Building 3038. These activities help reduce the liabilities and risks to current and future ORNL science missions. (For additional information on these activities see Section 5.8.)

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 2013, UT-Battelle operated about 26 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. Three 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 2013, no unauthorized uses of PCBs were discovered.

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 2013 through the submittal of reports under EPCRA Sections 302, 303, 311, and 312. These reports reflect information pertinent to 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 2013.

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 material 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 2013, 19 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 2013 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.

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 2013, UT-Battelle personnel had a combined 39 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 2 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. Third year data obtained for P2 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 insects.

Stream habitat assessments were conducted at both First Creek and White Oak Creek (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 2013 survey represented the third formal assessment of post-mitigation conditions. Pre-mitigation conditions for First Creek are discussed qualitatively based on information contained in previous reports. The 2013 WOC habitat assessment was based on habitat conditions about 2 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 18, 2013) and WOC (July 19, 2013) 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 creek. 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 2013 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.

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 2013 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. 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 2013, although 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 fourth year of post-mitigation monitoring for the First Creek site will be conducted in the summer of 2014.

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 2013, with a slight improvement over 2012. Riparian vegetative zone width for 2013 also remained significantly improved over the 2011 pre-mitigation conditions. Plant species diversity remained stable and invasive species presence remained low in the WOC riparian zone for the 2013 survey period. Areas of higher habitat quality were found directly adjacent to the creek, where green ash, black willow, eastern redbud, and silky dogwood were prevalent.

A moderately diverse benthic macroinvertebrate population was recorded at the WOC site in 2013. This included some of the more tolerant taxa found in ORR streams. Fish population densities sampled within the reach were within the ranges of reference streams on ORR. The number of fish species was higher than or the same as reference streams for the October–December 2012 sampling period yet lower than reference streams for the March–May 2013 sampling period.

The third year of post-mitigation monitoring for the WOC site will be conducted in the summer of 2014.

Wetland assessments were conducted for four sites on ORR during 2013 to determine whether jurisdictional wetlands were present in areas adjacent to proposed projects. These included a steam line removal site, a storm damage area, a fence installation site, and a water tower demolition site. These sites were checked to see whether any areas satisfied USACE wetland protocols for soils, hydrology, and vegetation. For two of the sites it was determined that wetlands in the area could be avoided, and no wetlands were found in the other two areas. At two of the sites TDEC Hydrologic Determination Field Data sheets were filled out to determine whether drainages were streams or wet weather conveyances by TDEC guidance. In both instances these drainages were determined to be wet weather conveyances. A riparian zone was also evaluated at one site.

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 2013, UT Battelle cleared more than 17,000 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 2013

	Process knowledge	Radiologically surveyed
Release request totals for calendar year 2013		
Computers-for-Learning	131	2
DOE—Donations	1	0
Donations	933	466
LEDP (donations to colleges/universities)	99	0
Other federal agency transfers	112	27
DOE transfers	283	90
Landfill	0	0
Reuse at ORNL	463	101
Sales	10,468	4,268
Totals	12,490	4,954
Recycling request totals for calendar year 2013		
Used oils (gallons)	7,801	
Scrap metal (nonradiological areas) (tons)	162.27	
Used tires (each)	692	
Used auto cores and batteries (pounds)	28,656	

[a]Less than 2 ppm PCBs.
[b]Greater than 2 ppm and less than 50 ppm PCBs.

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 2013 and use of the authorized limits process was increased. In 2013 ORNL cleared 147 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 a national laboratory (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 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. In April 2013 UT-Battelle also applied for a modification to Title V Permit 562765 to incorporate 31 emergency-use electrical generators into the permit. The permit modification is anticipated to be issued in early 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 Heritage Center, in Oak Ridge, Tennessee. The initial startup of CFTF occurred in March 2013. In accordance with provisions of the 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 construction permit. The test results were provided to TDEC, and DOE–UT-Battelle will apply 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 Operating Permit for the facility and its emergency generator is anticipated to be issued in 2014 or 2015.

DOE-WAI has an operating air permit for one emission source at TWPC. DOE-Isotek has a Title V Major Source Operating permit for the Radiochemical Development Facility (Building 3019 complex). During 2013, no permit limits were exceeded.

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 2013.

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. 5.12).

- 2026 Radioactive Materials Analytical Laboratory
- 3020 Radiochemical Development Facility
- 3039 central off-gas and scrubber system, which includes the 3500 and 4500 areas' 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 (REDC)
- 8915 SNS Central Exhaust Facility stack

In 2013 there were 15 minor point/group sources, and emission calculations/estimates were made for each of them.

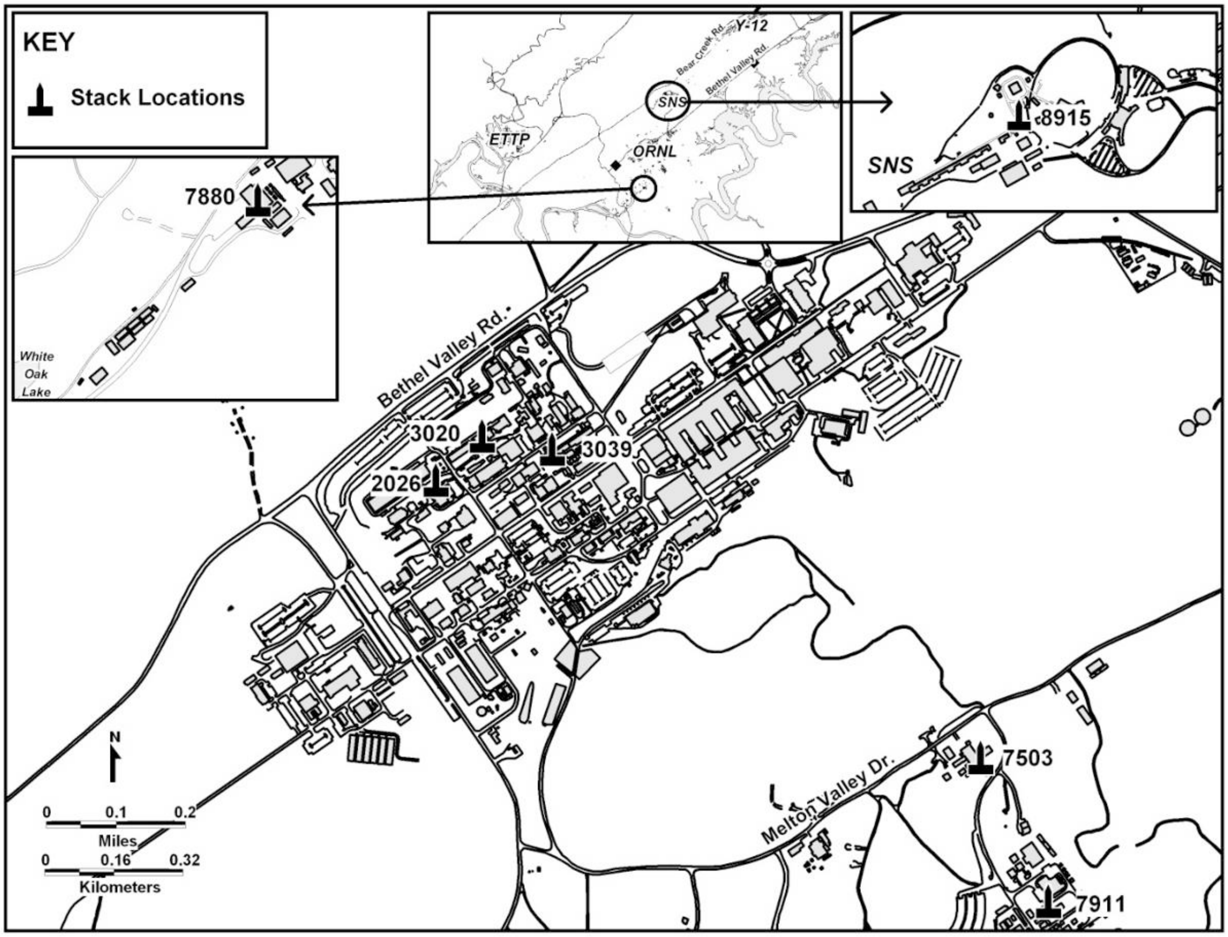

Fig. 5.12. Locations of major radiological emission points at Oak Ridge National Laboratory. (ETTP = East Tennessee Technology Park, ORNL = Oak Ridge National Laboratory, SNS = Spallation Neutron Source)

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 13.1-1969 (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 2013 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.

Table 5.8. Radiological airborne emissions from all sources at ORNL, 2013[a]

Isotope	Inhalation form[b]	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								4.75E-06	4.75E-06
^{227}Ac	M	Unspecified								3.00E-09	3.00E-09
^{228}Ac	M	Unspecified								1.75E-06	1.75E-06
^{110m}Ag	M	Unspecified								1.13E-09	1.13E-09
^{110m}Ag	S	Unspecified					1.80E-06				1.80E-06
^{111}Ag	M	Unspecified								1.72E-06	1.72E-06
^{241}Am	M	Unspecified	9.89E-07	8.57E-07				1.02E-07		2.96E-07	2.24E-06
^{241}Am	F	Unspecified			3.22E-07	1.26E-08	1.46E-06			2.79E-06	4.59E-06
^{243}Am	M	Unspecified								7.46E-09	7.46E-09
^{41}Ar	G	Unspecified						9.31E+02	5.41E+01		9.85E+02
^{131}Ba	M	Unspecified								4.01E-07	4.01E-07
^{139}Ba	M	Unspecified						1.55E-01			1.55E-01
^{140}Ba	M	Unspecified						3.05E-04		4.03E-05	3.45E-04
^{140}Ba	S	Unspecified					3.14E-05				3.14E-05
^{7}Be	M	Unspecified	1.48E-07					7.71E-07		5.29E-06	6.21E-06
^{7}Be	S	Unspecified			7.46E-06	1.68E-07	1.81E-05			4.67E-07	2.62E-05
^{206}Bi	M	Unspecified								2.19E-07	2.19E-07
^{207}Bi	M	Unspecified								1.00E-10	1.00E-10
^{210m}Bi	M	Unspecified								3.00E-16	3.00E-16
^{211}Bi	M	Unspecified								5.55E-09	5.55E-09
^{212}Bi	M	Unspecified								8.01E-08	8.01E-08
^{214}Bi	M	unspecified								6.08E-07	6.08E-07
^{249}Bk	M	unspecified								7.00E-11	7.00E-11
^{11}C	G	dioxide							5.69E+03		5.69E+03
^{14}C	M	particulate								9.55E-12	9.55E-12
^{45}Ca	M	unspecified								6.20E-13	6.20E-13
^{139}Ce	M	unspecified								1.08E-08	1.08E-08

Table 5.8. (continued)

Isotope	Inhalation form[b]	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{141}Ce	M	unspecified						3.95E-07		2.29E-07	6.24E-07
^{144}Ce	M	unspecified								3.94E-07	3.94E-07
^{249}Cf	M	unspecified								2.50E-10	2.50E-10
^{252}Cf [c]	M	unspecified						1.06E-09		2.36E-08	2.47E-08
^{242}Cm	M	unspecified								1.39E-10	1.39E-10
^{243}Cm	F	unspecified			2.26E-08	1.78E-10	7.10E-07			2.49E-07	9.82E-07
^{243}Cm	M	unspecified	5.05E-08							5.26E-11	5.06E-08
^{244}Cm	F	unspecified			2.26E-08	1.78E-10	7.10E-07			2.49E-07	9.82E-07
^{244}Cm	M	unspecified	5.05E-08	3.94E-09						3.76E-06	3.82E-06
^{245}Cm	M	unspecified								4.07E-10	4.07E-10
^{246}Cm	M	unspecified								1.38E-12	1.38E-12
^{247}Cm	M	unspecified								6.84E-14	6.84E-14
^{248}Cm [d]	M	unspecified								1.11E-13	1.11E-13
^{57}Co	M	unspecified								4.86E-07	4.86E-07
^{58}Co	M	unspecified								8.30E-09	8.30E-09
^{58}Co	S	unspecified								7.33E-13	7.33E-13
^{60}Co	M	unspecified								3.51E-05	3.51E-05
^{60}Co	S	unspecified			1.53E-06		2.39E-06			1.20E-04	1.24E-04
^{51}Cr	M	unspecified								1.26E-09	1.26E-09
^{132}Cs	F	unspecified								1.29E-07	1.29E-07
^{134}Cs	S	unspecified					1.80E-06			1.63E-13	1.80E-06
^{134}Cs	F	unspecified								3.72E-07	3.72E-07
^{136}Cs	F	unspecified								1.98E-07	1.98E-07
^{137}Cs	F	unspecified	8.13E-07	2.52E-06				4.26E-06		3.50E-04	3.57E-04
^{137}Cs	S	unspecified			7.94E-05	3.88E-08	2.05E-06			6.10E-04	6.91E-04
^{138}Cs	F	unspecified						5.03E+02			5.03E+02
^{152}Eu	M	unspecified								2.19E-07	2.19E-07

Table 5.8. (continued)

Isotope	Inhalation form[b]	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{154}Eu	M	unspecified								2.01E-07	2.01E-07
^{155}Eu	M	unspecified								4.86E-05	4.86E-05
^{55}Fe	M	unspecified								1.82E-07	1.82E-07
^{59}Fe	M	unspecified								3.19E-11	3.19E-11
^{153}Gd	M	unspecified								6.59E-10	6.59E-10
^{3}H	V	vapor	1.24E-01		8.07E+00	9.94E-01		1.09E+02	3.33E+02	5.54E-01	4.52E+02
^{175}Hf	M	unspecified								4.62E-10	4.62E-10
^{181}Hf	M	unspecified								7.73E-10	7.73E-10
^{203}Hg	M	inorganic								2.16E-07	2.16E-07
^{166m}Ho	M	unspecified								2.00E-04	2.00E-04
^{125}I	F	particulate								3.10E-07	3.10E-07
^{129}I	F	particulate					1.59E-06			4.03E-05	4.19E-05
^{131}I	F	particulate			6.40E-02		2.47E-05	1.07E-01		4.68E-07	1.71E-01
^{132}I	F	particulate			5.35E-04			8.63E-01			8.64E-01
^{133}I	F	particulate			1.22E-04			5.53E-01		1.93E-06	5.53E-01
^{134}I	F	particulate						8.29E-01			8.29E-01
^{135}I	F	particulate						1.89E+00			1.89E+00
^{114m}In	M	unspecified								2.20E-08	2.20E-08
^{192}Ir	M	unspecified								2.35E-07	2.35E-07
^{40}K	S	unspecified								4.41E-12	4.41E-12
^{40}K	M	unspecified								8.61E-06	8.61E-06
^{85}Kr	G	unspecified						6.46E+02			6.46E+02
^{85m}Kr	G	unspecified						5.14E+00			5.14E+00
^{87}Kr	G	unspecified						4.59E+01			4.59E+01
^{88}Kr	G	unspecified						4.39E+01	4.29E+01		8.68E+01
^{89}Kr [e]	G	unspecified						2.55E+01			2.55E+01
^{140}La	M	unspecified						9.11E-02		8.62E-08	9.11E-02

Table 5.8. (continued)

Isotope	Inhalation form[b]	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{140}La	S	unspecified					1.49E-05				1.49E-05
^{177}Lu	M	unspecified								1.00E-08	1.00E-08
^{54}Mn	M	unspecified								2.73E-09	2.73E-09
^{54}Mn	S	unspecified					1.96E-06			2.47E-13	1.96E-06
^{93}Mo	M	unspecified								1.36E-11	1.36E-11
^{99}Mo	M	unspecified								8.70E-07	8.70E-07
^{13}N	G	unspecified							1.25E+02		1.25E+02
^{22}Na	M	unspecified								4.93E-13	4.93E-13
^{93m}Nb	M	unspecified								1.10E-09	1.10E-09
^{94}Nb	M	unspecified								1.51E-10	1.51E-10
^{94}Nb	S	unspecified								5.81E-14	5.81E-14
^{95}Nb	M	unspecified								1.28E-07	1.28E-07
^{147}Nd	M	unspecified								1.88E-12	1.88E-12
^{59}Ni	M	particulate								8.41E-13	8.41E-13
^{63}Ni	M	particulate								2.06E-08	2.06E-08
^{237}Np	M	unspecified								8.45E-08	8.45E-08
^{239}Np	M	unspecified								2.54E-09	2.54E-09
^{191}Os	S	unspecified			6.54E-07						6.54E-07
^{191}Os	M	unspecified								2.72E-14	2.72E-14
^{32}P	M	unspecified								4.09E-09	4.09E-09
^{33}P	M	unspecified								1.02E-15	1.02E-15
^{230}Pa	M	unspecified								9.51E-08	9.51E-08
^{233}Pa	M	unspecified								2.39E-07	2.39E-07
^{210}Pb	M	unspecified								2.53E-11	2.53E-11
^{211}Pb	M	unspecified								4.03E-08	4.03E-08
^{212}Pb	M	unspecified	4.72E-01	4.79E-01				1.37E-02		2.28E-06	9.65E-01
^{212}Pb	S	unspecified			9.90E-01	1.21E-01				2.04E-02	1.13E+00

Table 5.8. (continued)

Isotope	Inhalation form[b]	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
^{209}Po [f]	M	unspecified								5.00E-11	5.00E-11
^{238}Pu	F	unspecified			1.35E-07	1.13E-09	2.00E-06			1.09E-05	1.31E-05
^{238}Pu	M	unspecified	1.62E-08	2.18E-06				1.28E-07		2.77E-07	2.60E-06
^{239}Pu	M	unspecified	1.95E-07	2.08E-06				1.19E-08		1.46E-07	2.43E-06
^{239}Pu	F	unspecified			5.80E-07	1.00E-09	9.15E-07			9.97E-07	2.49E-06
^{240}Pu	F	unspecified			5.80E-07	1.00E-09	9.15E-07			9.96E-07	2.49E-06
^{240}Pu	M	unspecified	1.95E-07					1.19E-08		3.81E-08	2.45E-07
^{241}Pu	F	unspecified								2.57E-12	2.57E-12
^{241}Pu	M	unspecified								3.19E-09	3.19E-09
^{242}Pu	M	unspecified								5.04E-09	5.04E-09
^{223}Ra	M	unspecified								1.73E-06	1.73E-06
^{224}Ra	M	unspecified								6.78E-07	6.78E-07
^{225}Ra	M	unspecified								4.12E-07	4.12E-07
^{226}Ra	M	unspecified								1.60E-08	1.60E-08
^{228}Ra	M	unspecified								1.92E-04	1.92E-04
^{219}Rn	G	unspecified								1.41E-08	1.41E-08
^{220}Rn	G	unspecified								8.01E-08	8.01E-08
^{103}Ru	M	particulate								6.29E-07	6.29E-07
^{103}Ru	S	particulate					2.58E-06				2.58E-06
^{106}Ru	M	particulate								2.96E-06	2.96E-06
^{35}S	M	inorganic								5.17E-10	5.17E-10
^{120m}Sb	M	unspecified								6.97E-08	6.97E-08
^{124}Sb	M	unspecified								8.24E-08	8.24E-08
^{125}Sb	M	unspecified								2.29E-08	2.29E-08
^{126}Sb	M	unspecified								2.51E-07	2.51E-07
^{127}Sb	M	unspecified								7.03E-07	7.03E-07

Table 5.8. (continued)

Isotope	Inhalation form[b]	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								6.75E-12	6.75E-12
^{75}Se	S	unspecified			5.42E-04		1.68E-06				5.44E-04
^{32}Si	M	unspecified								4.10E-15	4.10E-15
^{145}Sm	M	unspecified								5.82E-05	5.82E-05
^{151}Sm	M	unspecified								2.00E-11	2.00E-11
^{153}Sm	M	unspecified								1.01E+01	1.01E+01
^{117m}Sn	M	unspecified								1.32E-07	1.32E-07
^{121m}Sn	M	unspecified								1.35E-12	1.35E-12
^{125}Sn	M	unspecified								2.04E-07	2.04E-07
^{89}Sr	M	unspecified	4.91E-08	9.25E-07				7.60E-06		8.14E-12	8.57E-06
^{89}Sr	S	unspecified			3.20E-05	1.64E-07				5.37E-05	8.59E-05
^{90}Sr	M	unspecified	4.91E-08	9.25E-07				7.60E-06		3.18E-04	3.26E-04
^{90}Sr	S	unspecified			3.20E-05	1.64E-07	1.08E-05			5.37E-05	9.67E-05
^{182}Ta	M	unspecified								4.99E-09	4.99E-09
^{99}Tc	M	unspecified								5.36E-11	5.36E-11
^{99}Tc	S	unspecified					9.60E-06			1.24E-05	2.20E-05
^{125m}Te	M	particulate								2.06E-12	2.06E-12
^{129m}Te	M	particulate								1.21E-07	1.21E-07
^{132}Te	M	particulate								4.83E-07	4.83E-07
^{227}Th	S	unspecified								7.82E-07	7.82E-07
^{228}Th	S	unspecified		5.17E-08	5.53E-08	6.46E-10		4.15E-08		1.81E-07	3.30E-07
^{229}Th	S	unspecified								1.60E-13	1.60E-13
^{230}Th	F	unspecified			9.41E-09	1.26E-09				1.27E-09	1.19E-08
^{230}Th	S	unspecified	1.37E-09	3.01E-09				1.99E-08		3.89E-09	2.82E-08
^{232}Th	F	unspecified			7.48E-09	1.57E-09				8.48E-10	9.90E-09
^{232}Th	S	unspecified	3.80E-07	7.29E-07				3.53E-08		1.00E-03	1.00E-03
^{234}Th	S	unspecified								8.12E-06	8.12E-06

Table 5.8. (continued)

Isotope	Inhalation form[b]	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{208}Tl	M	unspecified								8.01E-08	8.01E-08
^{170}Tm	M	unspecified								1.20E-08	1.20E-08
^{232}U	M	unspecified								8.01E-08	8.01E-08
^{233}U	M	unspecified						9.70E-08		1.01E-09	9.80E-08
^{233}U	S	unspecified			1.17E-07	9.80E-09	7.25E-07			7.66E-06	8.51E-06
^{234}U	M	unspecified	1.39E-07	8.04E-07				9.70E-08		1.48E-05	1.59E-05
^{234}U	S	unspecified			1.17E-07	9.80E-09	7.25E-07			7.67E-06	8.52E-06
^{235}U	M	unspecified	1.91E-09	3.56E-08				2.06E-08		8.65E-05	8.66E-05
^{235}U	S	unspecified			4.42E-08	7.62E-10	1.22E-06			9.47E-07	2.21E-06
^{236}U	M	unspecified								1.91E-08	1.91E-08
^{236}U	S	unspecified								1.20E-06	1.20E-06
^{238}U	M	unspecified	3.63E-09	2.19E-08				1.71E-08		5.02E-03	5.02E-03
^{238}U	S	unspecified			5.47E-08	1.28E-09	8.87E-07			7.82E-07	1.73E-06
^{181}W	M	unspecified								3.21E-08	3.21E-08
^{185}W	M	unspecified								1.71E-07	1.71E-07
^{188}W	M	unspecified								3.50E-08	3.50E-08
^{127}Xe	G	unspecified							2.76E+01		2.76E+01
^{131m}Xe	G	unspecified						1.39E+02			1.39E+02
^{133}Xe	G	unspecified						7.80E+00			7.80E+00
^{133m}Xe	G	unspecified						1.98E+01			1.98E+01
^{135}Xe	G	unspecified			7.09E-05			3.23E+01		3.71E-06	3.23E+01
^{135m}Xe	G	unspecified						2.22E+01			2.22E+01
^{137}Xe[g]	G	unspecified						4.32E+01			4.32E+01
^{138}Xe	G	unspecified						9.07E+01			9.07E+01
^{88}Y	M	unspecified								9.01E-10	9.01E-10
^{88}Y	F	unspecified					2.73E-06				2.73E-06
^{91}Y	M	unspecified								3.19E-12	3.19E-12

Table 5.8. (continued)

Isotope	Inhalation form[b]	Chemical form	Stack								
			X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{175}Yb	M	unspecified								1.00E-08	1.00E-08
^{65}Zn	F	unspecified					4.29E-06				4.29E-06
^{65}Zn	M	unspecified								6.08E-09	6.08E-09
^{93}Zr	M	unspecified								5.66E-13	5.66E-13
^{95}Zr	M	unspecified								7.25E-08	7.25E-08
^{95}Zr	S	unspecified					4.22E-06				4.22E-06
Totals			5.96E-01	4.79E-01	9.13E+00	1.12E+00	1.47E-04	2.67E+03	6.28E+03	1.06E+01	8.97E+03

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

[b]For particulates, fast (F), moderate (M), or slow (S) refers to the form of the isotope inhaled [associated with the rate of dissolution and level of absorption into the blood (EPA 1999)]. For nonparticulates, (G) or (V) refers to the form in which the isotope was inhaled, gas or vapor, respectively.

[c]Californium-248 surrogate for Californium-252

[d]Curium-245 surrogate for Curium-248

[e]Krypton-88 surrogate for Krypton-89

[f]Polonium-210 surrogate for Polonium-209

[g]Xenon-135 surrogate for Xenon-137

Acronyms

ORNL = Oak Ridge National Laboratory

Historical trends for ^{3}H (tritium) and ^{131}I are presented in Figs. 5.13 and 5.14. For 2013, tritium emissions totaled about 451.8 Ci (Fig. 5.13), a slight increase from 2012; ^{131}I emissions totaled 0.17 Ci (Fig. 5.14), a slight increase but in line with 2012 emissions. The increase in tritium was due to SNS operations and research activities at REDC involving the processing of heavy element targets. For 2013 the major dose contributors to the off-site dose at ORNL were ^{11}C, ^{212}Pb, ^{41}Ar, ^{138}Cs, and ^{232}Th, with dose contributions of about 43%, 20%, 7%, 6%, and 5%, 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 the 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 ^{138}Cs were primarily due to research activities at REDC, which exhaust through the 7911 Melton Valley complex stack. Emissions of ^{232}Th come from a number of operations and research activities on the ORNL site. For 2013, ^{11}C emissions totaled 5,693 Ci, almost double that of 2012; ^{212}Pb emissions totaled 2 Ci; ^{232}Th emissions totaled 1.00E−03 Ci; and ^{138}Cs emissions totaled 503 Ci (Fig. 5.15). Emissions of ^{41}Ar totaled 985 Ci, which was an increase from 2012.

The calculated radiation dose to the maximally exposed individual (MEI) from all radiological airborne release points at ORR during 2013 was 0.4 mrem. The dose contribution to the MEI from all ORNL radiological airborne release points was 97.3% of the ORR dose. This dose is well below the NESHAPs standard of 10 mrem and is less than 0.1% of the roughly 300 mrem that the average individual receives from natural sources of radiation. (See Section 7.1.2 for an explanation of how the airborne radionuclide dose was determined.)

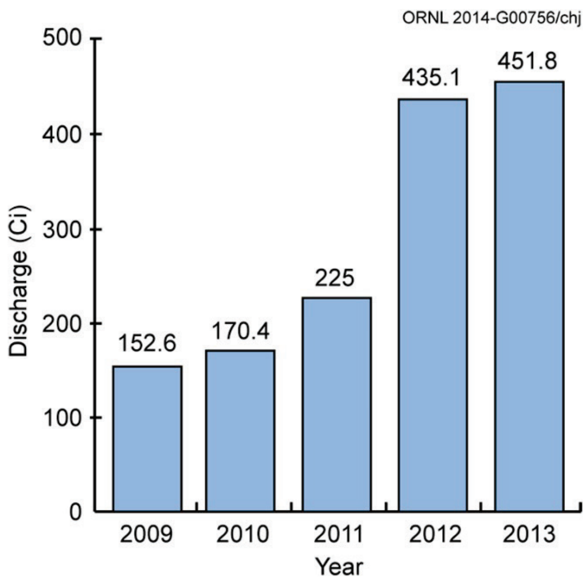

Fig. 5.13. Total curies of tritium discharged from Oak Ridge National Laboratory to the atmosphere, 2009–2013.

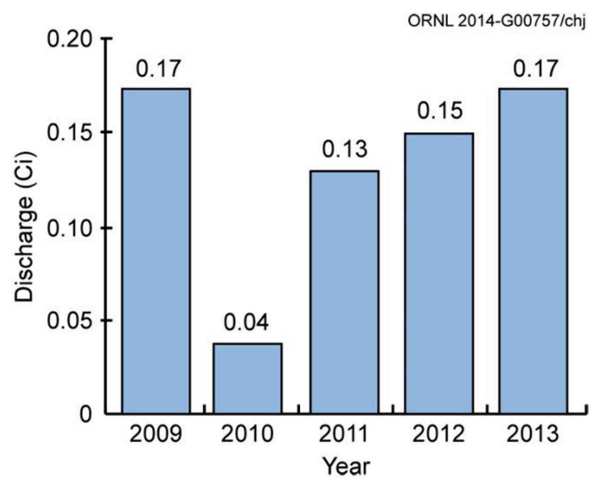

Fig. 5.14. Total curies of ^{131}I discharged from Oak Ridge National Laboratory to the atmosphere, 2009–2013.

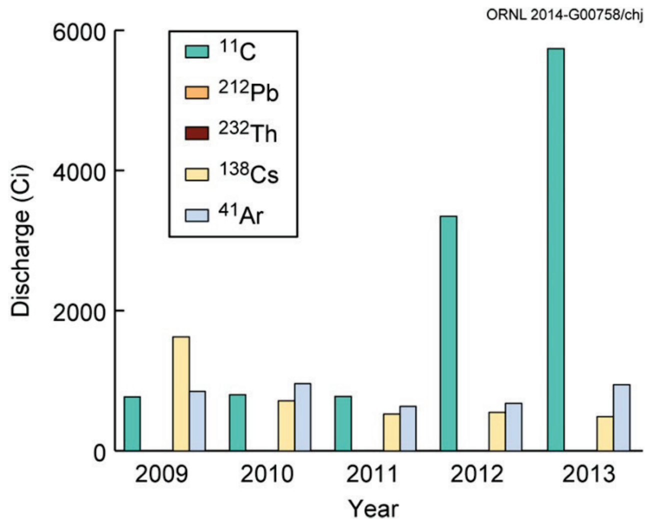

Fig. 5.15. Total discharges of ^{41}Ar, ^{11}C, ^{138}Cs, ^{212}Pb, and ^{232}Th from Oak Ridge National Laboratory to the atmosphere, 2009–2013. (Note: Levels of ^{212}Pb and ^{232}Th discharged were too low to accurately depict on this figure.)

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 objectives of the ORNL ambient air monitoring program are to collect samples at site PAM stations located in areas most likely to show impacts of airborne emissions from ORNL and to provide information to support emergency response activities. Four stations, identified as stations 1, 2, 3, and 7, make up the ORNL PAM network (Fig. 5.16). During 2013 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.

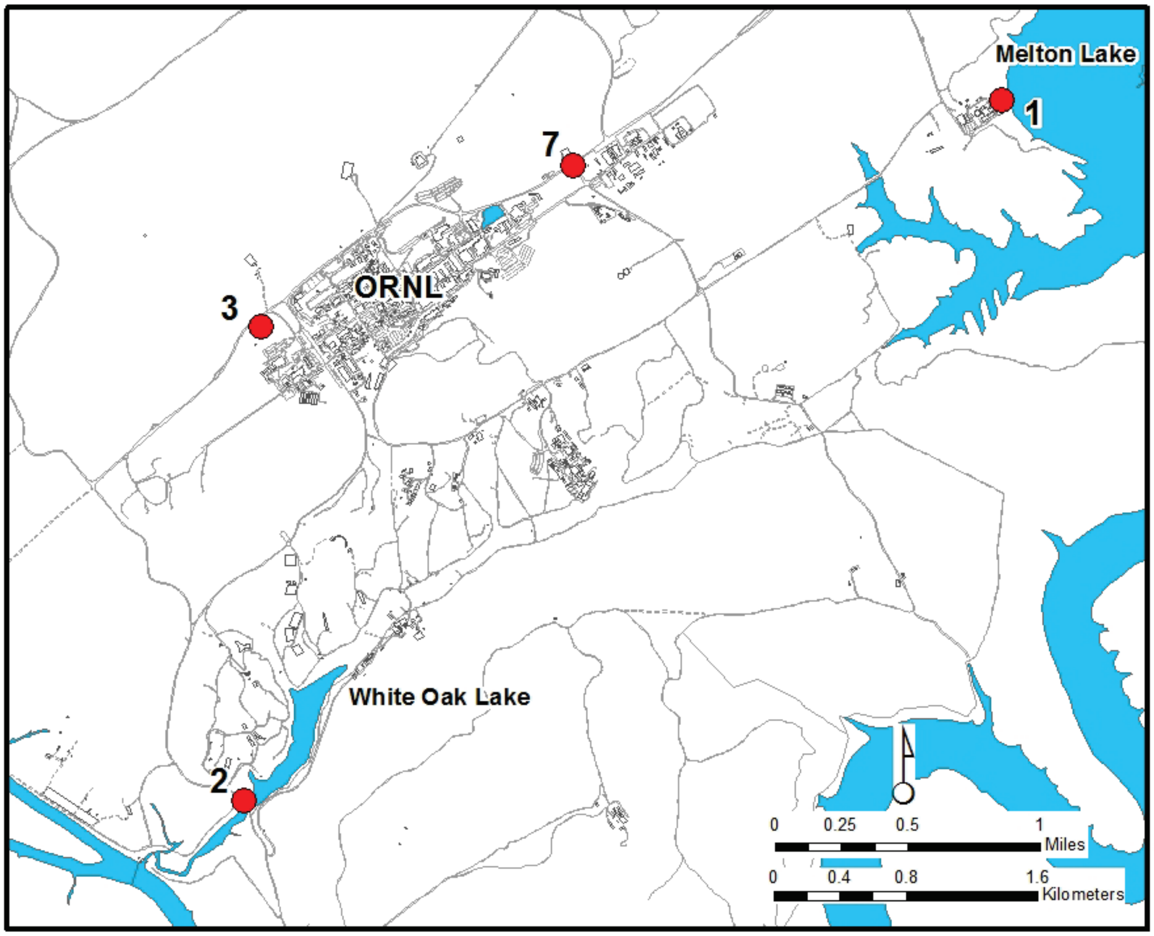

Fig. 5.16. Locations of ambient air monitoring stations at Oak Ridge National Laboratory.

Table 5.9. Radionuclide concentrations (pCi/mL)[a] measured at Oak Ridge National Laboratory perimeter air monitoring stations, 2013

Parameter	Number detected/ sampled	Concentration		
		Average	Minimum	Maximum
		Station 1		
Alpha	4/4	2.30E-09	1.90E-09	3.18E-09
^{7}Be	4/4	3.44E-08	3.16E-08	3.96E-08
Beta	4/4	8.88E-09	6.19E-09	1.11E-08
^{3}H	1/4	5.38E-06	-1.6E-06	1.13E-05
^{40}K	0/4	-3.65E-10	-6.19E-10	-3.10E-11
^{234}U	4/4	4.12E-12	2.41E-12	7.96E-12
^{235}U	2/4	1.82E-13	-1.89E-13	3.55E-13
^{238}U	4/4	2.29E-12	1.93E-12	2.55E-12
Total U	4/4	6.60E-12	4.15E-12	1.06E-11

Table 5.9. (continued)

Parameter	Number detected/ sampled	Concentration		
		Average	Minimum	Maximum
		Station 2		
Alpha	1/1	6.63E-09	*b*	*b*
^{7}Be	1/1	1.95E-08	*b*	*b*
Beta	1/1	1.85E-08	*b*	*b*
^{3}H	0/4	2.69E-06	1.45E-06	3.94E-06
^{40}K	0/1	5.76E-10	*b*	*b*
^{234}U	1/1	5.31E-12	*b*	*b*
^{235}U	1/1	8.02E-13	*b*	*b*
^{238}U	1/1	2.99E-12	*b*	*b*
Total U	1/1	9.09E-12	*b*	*b*
		Station 3		
Alpha	1/1	5.49E-09	*b*	*b*
^{7}Be	1/1	2.08E-08	*b*	*b*
Beta	1/1	1.61E-08	*b*	*b*
^{3}H	0/4	2.93E-06	-8.65E-07	6.07E-06
^{40}K	0/1	-6.96E-11	*b*	*b*
^{234}U	1/1	9.59E-12	*b*	*b*
^{235}U	1/1	3.70E-13	*b*	*b*
^{238}U	1/1	3.07E-12	*b*	*b*
Total U	1/1	1.31E-11	*b*	*b*
		Station 7		
Alpha	1/1	7.56E-09	*b*	*b*
^{7}Be	1/1	1.90E-08	*b*	*b*
Beta	1/1	1.81E-08	*b*	*b*
^{3}H	2/4	1.11E-05	-1.67E-09	1.88E-05
^{40}K	0/1	8.71E-10	*b*	*b*
^{234}U	1/1	1.35E-11	*b*	*b*
^{235}U	0/1	1.85E-12	*b*	*b*
^{238}U	1/1	5.97E-12	*b*	*b*
Total U	1/1	2.13E-11	*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 2013, 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 2008 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 5.17 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.

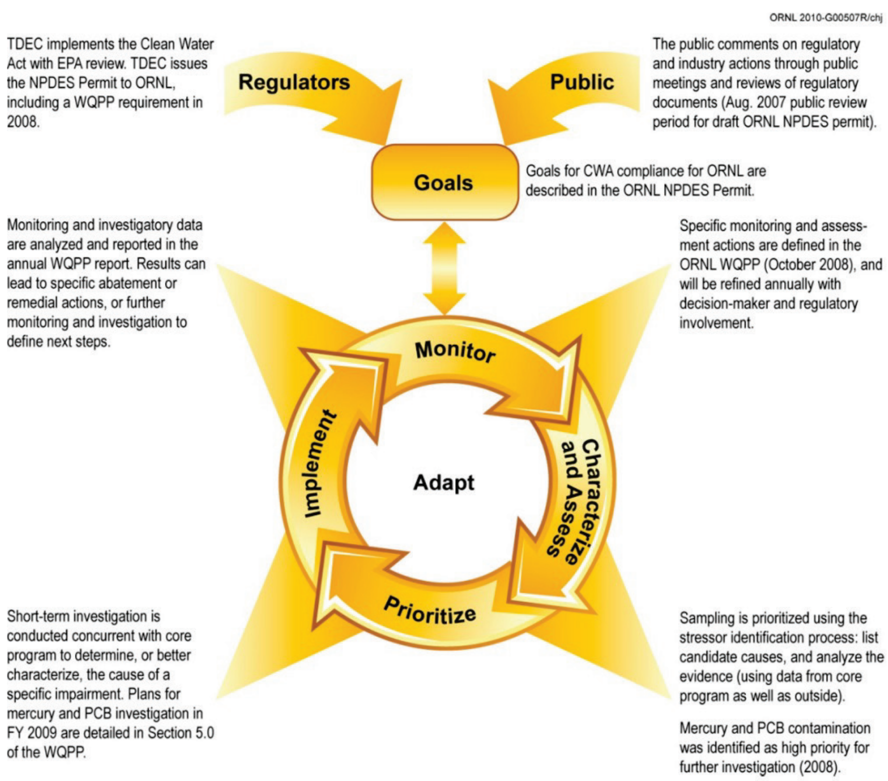

Fig. 5.17. Diagram of the adaptive management framework with step-wise planning specific to the Oak Ridge National Laboratory Water Quality Protection Plan (WQPP). [Adapted from the US Environmental Protection Agency (EPA) stressor guidance document (EPA 2000). Acronyms: CWA = Clean Water Act, NPDES = National Pollutant Discharge Elimination System, ORNL = Oak Ridge National Laboratory, PCB = polychlorinated biphenyl, TDEC = Tennessee Department of Environment and Conservation.]

The first two steps of the stressor identification process were initiated in 2009, focusing first on mercury impairment (Fig. 5.18) 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.

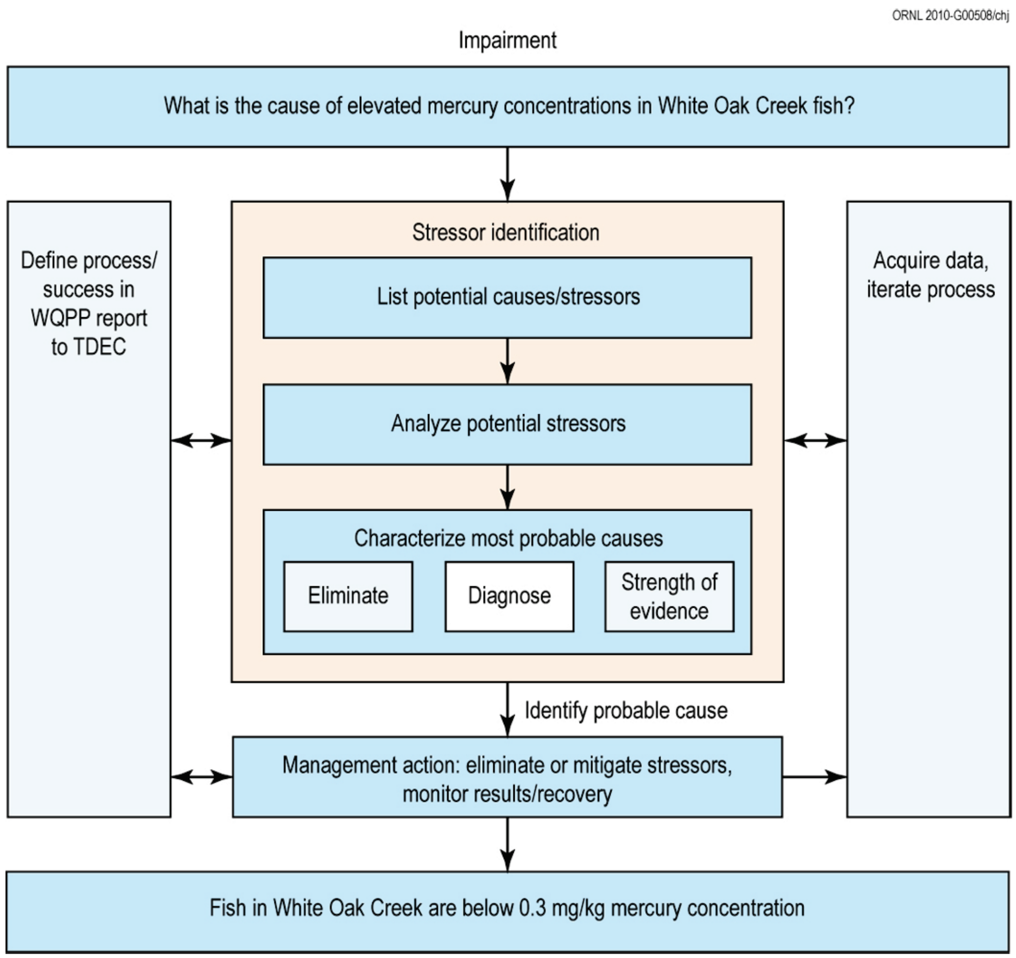

Fig. 5.18. Application of stressor identification guidance to address mercury impairment in the White Oak Creek watershed. [Modified from Figure 1-1 in the US Environmental Protection Agency stressor guidance document (EPA 2000). TDEC = Tennessee Department of Environment and Conservation, WQPP = water quality protection plan.]

5.5.1 Treatment Facility Discharges

Two on-site wastewater treatment systems were operated at ORNL in 2013 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 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 2013.

Table 5.10. National Pollutant Discharge Elimination System compliance at Oak Ridge National Laboratory, 2013 (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	4	100
X01 (ORNL Sewage Treatment Plant)								
LC_{50} for *Ceriodaphnia* (%)					69.4	0	2	100
LC_{50} for fathead minnows (%)					69.4	0	2	100
Ammonia, as N (summer)	6.26	9.39	2.5	3.75		0	26	100
Ammonia, as N (winter)	13.14	19.78	5.25	7.9		0	27	100
Carbonaceous biological oxygen demand	19.2	28.8	10	15		0	53	100
Dissolved oxygen					6	0	53	100
Escherichia coliform (col/100 mL)			941	126		0	53	100
IC_{25} for *Ceriodaphnia* (%)					15.5	0	2	100
IC_{25} for fathead minnows (%)					15.5	0	2	100
Oil and grease	19.2	28.8	10	15		0	13	100
pH (standard units)				9	6	0	53	100
Total suspended solids	57.5	86.3	30	45		0	53	100
X12 (Process Waste Treatment Complex)								
LC_{50} for *Ceriodaphnia* (%)					100	0	2	100
LC_{50} for fathead minnows (%)					100	0	2	100
Arsenic, total			0.007	0.014		0	6	100
Cadmium, total	1.73	4.60	0.003	0.038		0	6	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]
Chromium, total	11.40	18.46	0.22	0.44		0	6	100
Copper, total	13.8	22.53	0.07	0.11		0	6	100
Cyanide, total	4.33	8.00	0.008	0.046		0	2	100
Lead, total	2.87	4.60	0.028	0.69		0	6	100
IC_{25} for *Ceriodaphnia* (%)					30.5	0	2	100
IC_{25} for fathead minnows (%)					30.5	0	2	100
Oil and grease	66.7	100	10	15		0	13	100
pH (standard units)				9.0	6.0	0	53	100
Temperature (ºC)				30.5		0	53	100
Instream chlorine monitoring points								
Total residual oxidant			0.011	0.019		0	288	100

[a]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 twice per year each, using two test species. In 2013, 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 lower 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 261 times. Table 5.11 lists instances in 2013 where outfalls were found to be in excess of the TRO action level. Three outfalls, 265 and 363 on Fifth Creek and 210 on WOC, exceeded the action level during 2013. The sources for outfall 265 have been determined to be aging underground water pipes that are leaking drinking water.

Table 5.11. Outfalls exceeding total residual oxidant action level[a] in 2013

Sample date	Outfall	TRO concentration (mg/L)	Flow (gpm)	Load (grams/ day)	Receiving stream	Downstream integration point	Instream TRO point
2/4/2013	210	2.25	60	735.75	White Oak Creek	WCK 3.9	X22
4/11/2013	265	0.95	25	129.44	Fifth Creek	FFK 0.2	X19
4/11/2013	363	0.25	6	8.18	Fifth Creek	FFK 0.2	X19
10/17/2013	263	0.5	18	49.05	Fifth Creek	FFK 0.2	X19

[a]1.2 g/day

Acronyms
FFK = Fifth Creek kilometer
TRO = total residual oxidant
WCK = White Oak Creek kilometer

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 2013. 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 stream kilometer 3.9 [WOC kilometer (WCK) 3.9]. The towers chosen for WET testing were those thought to have the greatest influence on water quality in that stream reach. The same cooling towers were tested for WET in 2013 as were tested in 2012. Initially plans were to test a different set of towers in 2013, but the decision was made to repeat testing at these locations to evaluate an operational change. Between the 2012 and 2013 test periods a different vendor was selected to oversee chemical maintenance on these cooling towers, which resulted in a change in the brand of chemicals used to maintain the towers.

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 2013 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*).

Two of the towers that were tested discharge through outfalls where blowdown is mixed with other effluents before the blowdown reaches the receiving stream, so 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 2013 are shown in Table 5.12. 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 5.12. Summary results of chronic *Ceriodaphnia dubia* toxicity tests of ORNL cooling towers and outfalls conducted during September 2013

Location	NOEC[a]	IC_{25}[b]	96-hour LC_{50}[c]
Cooling tower 4510/4521	75%	86%	>100%
Cooling tower 5600	25%	31%	44%
Outfall 227	25%	58%	>100%
Cooling tower 5807	25%	38%	>100%
Outfall 231	100%	100%	>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 5.12 indicate that if a population of *C. dubia* was to be continually exposed to a mixture of water composed of roughly 25% or more of blowdown from these cooling towers (the remaining portion in the mixture being natural stream water for example), a negative effect on *C. dubia* reproduction could potentially occur. At higher concentrations of blowdown, those approaching 100% (i.e., full strength/undiluted effluent), survival might also be affected. In the driest summer conditions in WOC, it is possible for concentrations of blowdown in the receiving stream [instream waste concentration (IWC)] at some locations to be as high as 30% or 40% on an intermittent basis. However, more work needs to be done to determine whether such impacts (to *C. dubia* and other organisms) are actually occurring in the stream. As mentioned previously, 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. In addition, WET tests done in the past have generally showed that when actual stream water is used as the diluent when making up the various dilutions to be tested (as opposed to the standard degassed mineral water as the diluent), the organisms tend to fare better. The blowdown samples that were tested were prepared with standard diluent.

As mentioned above, two outfalls (227 and 231) receiving these blowdown discharges were tested for WET as well. In similar tests conducted on effluents from the same outfalls in 2012, results indicated that when blowdown sources were mixed with other wastewaters before discharge, the blended effluents were not toxic under test conditions. In 2013, similar results were obtained for outfall 231. Outfall 227, however, tested differently in 2013 compared to 2012. The 2013 results suggest that under some circumstances, after blending with other wastewaters but before mixing with the receiving stream, the effluent from outfall 227 could potentially cause reproductive effects to *C. dubia*. That finding is based on a single test result and has not been confirmed.

In 2013, additional samples of full strength blowdown from the 4510/4521 cooling tower were subjected to some form of treatment (one treatment technology per sample) and were then tested for WET. The treatment technologies used included chelation by addition of ethylenediaminetetraacetic acid (EDTA), particulate removal by filtration, UV light exposure, and activated carbon treatment. The only treatment technology that resulted in lower toxicity in comparison to the untreated sample was chelation with EDTA, which indicated that dissolved metals (at least those that can be removed by EDTA) could be at least partially responsible for the toxicity measured in samples of blowdown from the 4510/4521 tower. This was in contrast to the 2012 results, in which a full strength effluent sample from the same location was treated with EDTA and showed no improvement in toxicity (EDTA was the only treatment technology tested in 2012). Though the EDTA-treated sample fared better than the associated untreated sample in 2013 monitoring, the sample still showed some survival and reproductive effects relative to the control (100% diluent) sample. The investigation is ongoing, but one theory under consideration is that the variable toxicity to *C. dubia* under test conditions may result from nonoxidizing biocide residuals in the blowdown samples, perhaps exacerbated at times by elevated concentrations of dissolved metals.

A change in the nonoxidizing biocide that is used in these cooling towers to control biological growth is being considered, and the alternative product has a potential to result in reduced toxicity of blowdown. If these changes are implemented, plans are to repeat WET testing of these same towers to determine whether the expected improvements in toxicity are achieved. Attempts are also under way to simulate more realistic cooling tower blowdown exposure scenarios for the aquatic organisms inhabiting the reach of WOC that is impacted by these discharges to improve on the interpretation of the WET test results (i.e., the comparison of concentration-based test metrics to more realistic estimations of IWCs).

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, total metals, and total suspended solids. Results of that monitoring are shown in Table 5.13.

Table 5.13. Field parameters and results from laboratory analyses of blowdown from Oak Ridge National Laboratory cooling towers

Parameter	Cooling Tower Sampled		
	4510/4521	5600	5807
Conductivity (mS/cm)	0.873	0.859	0.835
Dissolved oxygen (mg/L)	7.9	10.6	10.7
pH (standard units)	8.2	8.7	8.5
Temperature (ºC)	25.2	21	22.4
Chemical oxygen demand (mg/L)	37.7	27.4	31.4
Total suspended solids (mg/L)	2	15	3
Ag (mg/L)	< 0.000619	< 0.000619	< 0.000619
As (mg/L)	< 0.001	0.00115	< 0.001
Be (mg/L)	< 0.000686	< 0.000686	< 0.000686
Ca (mg/L)	123	138	124
Cd (mg/L)	< 0.000782	< 0.000782	< 0.000782
Cr (mg/L)	< 0.001	< 0.001	< 0.001
Cu (mg/L)	0.00308	0.00642	0.00836
Fe (mg/L)	< 0.0206	< 0.0206	< 0.0206
Mg (mg/L)	39	43.3	37.3
Mn (mg/L)	< 0.000953	< 0.000953	< 0.000953
Mo (mg/L)	0.0177	< 0.000931	< 0.000931
Ni (mg/L)	0.0028	0.00284	0.00271
Pb (mg/L)	< 0.001	< 0.001	< 0.001
Sb (mg/L)	0.00241	< 0.00081	< 0.00081
Se (mg/L)	< 0.0406	< 0.0406	< 0.0406
Zn (mg/L)	0.128	0.107	0.104

[a]Towers 5600 and 5807 sampled August 26, 2013; Tower 4510/4521 sampled September 16, 2013.

5.5.4 Radiological Monitoring

At ORNL, monitoring of effluents and instream locations for radioactivity is conducted under the WQPP. Table 5.14 details the monitoring frequencies and target analyses for 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 2013, dry-weather grab samples were collected at 16 of the 20 category outfalls targeted for sampling. Four category outfalls (203, 205, 241, and 284) were not sampled because there was no discharge present during sampling attempts.

Table 5.14. Radiological monitoring conducted under the Oak Ridge National Laboratory Water Quality Protection Plan, 2013

Location	Frequency	Gross alpha/beta[a]	Total rad Sr	Tritium (^{3}H)	Gamma scan	Isotopic uranium	$^{243/244}Cm$
Outfall 001	Annual	X					
Outfall 080	Monthly	X	X	X	X		X
Outfall 081	Annual	X					
Outfall 085	Quarterly	X	X	X	X		
Outfall 203[b]	Annual	X	X		X		
Outfall 204	Semiannual	X	X		X		
Outfall 205[b]	Annual	X					
Outfall 207	Quarterly	X					
Outfall 211	Annual	X					
Outfall 234	Annual	X					
Outfall 241[b]	Quarterly	X	X			X	
Outfall 265	Annual	X					
Outfall 281	Quarterly	X		X			
Outfall 282	Quarterly	X					
Outfall 284[b]	Annual	X					
Outfall 302	Monthly	X	X	X	X	X	
Outfall 304	Monthly	X	X	X	X	X	
Outfall 365	Semiannual	X					
Outfall 368	Annual	X					
Outfall 383	Annual	X		X			
STP (X01)	Monthly	X	X	X	X		
PWTC (X12)	Monthly	X	X	X	X	X	
Melton Branch 1 (X13)	Monthly	X	X	X	X		
WOC (X14)	Monthly	X	X	X	X		
WOD (X15)	Monthly	X	X	X	X		

[a]Isotopic analyses are performed to identify contributors to gross activities when results exceed screening criteria described in the Water Quality Protection Plan, October 2008.

[b]No sample collected because no discharge present during sampling attempts.

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

Two ORNL treatment facilities were monitored for radioactivity in 2013: 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 White Oak Dam (WOD) (Fig. 5.19). 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 080, 085, 204, 302, 304, X01, and X12 and at instream sampling location X15 (Fig. 5.20).

In 2013, one outfall had a mean radioactivity concentration greater than 100% of a DCS. The average concentration of total radioactive strontium (^{89,90}Sr) was 110% of 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). Consequently, concentrations of radioactivity in discharges from that outfall were also greater than DCS levels on a sum-of-fractions (summation of DCS percentages of multiple radiological parameters) basis; the sum-of-fractions was 133%. Concentrations of radioactivity at this outfall were below DCS levels in 2012. The cause of the increased concentrations in 2013 is still under investigation, though the probable cause has already been identified and mitigated by the DOE EM Program. In January 2014, an increase in gross alpha and gross beta activity was detected at a different outfall, NPDES outfall 207. An investigation ensued, and the increase at outfall 207 was suspected to be related to a failed pump in the WC-9 tank farm dry well (which collects contaminated groundwater from a CERCLA soil and groundwater contamination area and routes it for treatment). The storm water collection system for outfall 207 is in close proximity to the tank farm. The pump was repaired shortly after the detection of elevated radioactivity at outfall 207, which resulted in an almost immediate reduction in the concentration of radioactivity in that discharge. Similar to outfall 207, the storm water collection system for outfall 304 traverses multiple soil and groundwater contamination areas, including some groundwater contamination areas in the vicinity of the WC-9 tank farm (infiltration of contaminated groundwater from areas other than WC-9 are thought to be responsible for the baseline levels of radioactivity in outfall 304 discharges). Following the pump repair, outfall monitoring conducted by the DOE EM Program showed that concentrations and fluxes of radioactivity also began to decline at outfall 304, as did the flow rate from the outfall. As of early 2014, both outfalls continue to be monitored, including additional monitoring conducted by the DOE EM Program, to determine whether the mitigation that has already taken place will result in radioactivity concentrations returning to and remaining below DCS levels 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. 5.21 through 5.25. Because discharges of radioactivity are somewhat correlated to stream flow, annual flow volumes measured at the WOD monitoring station are given in Fig. 5.26. Discharges of radioactivity at WOD in 2013 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).

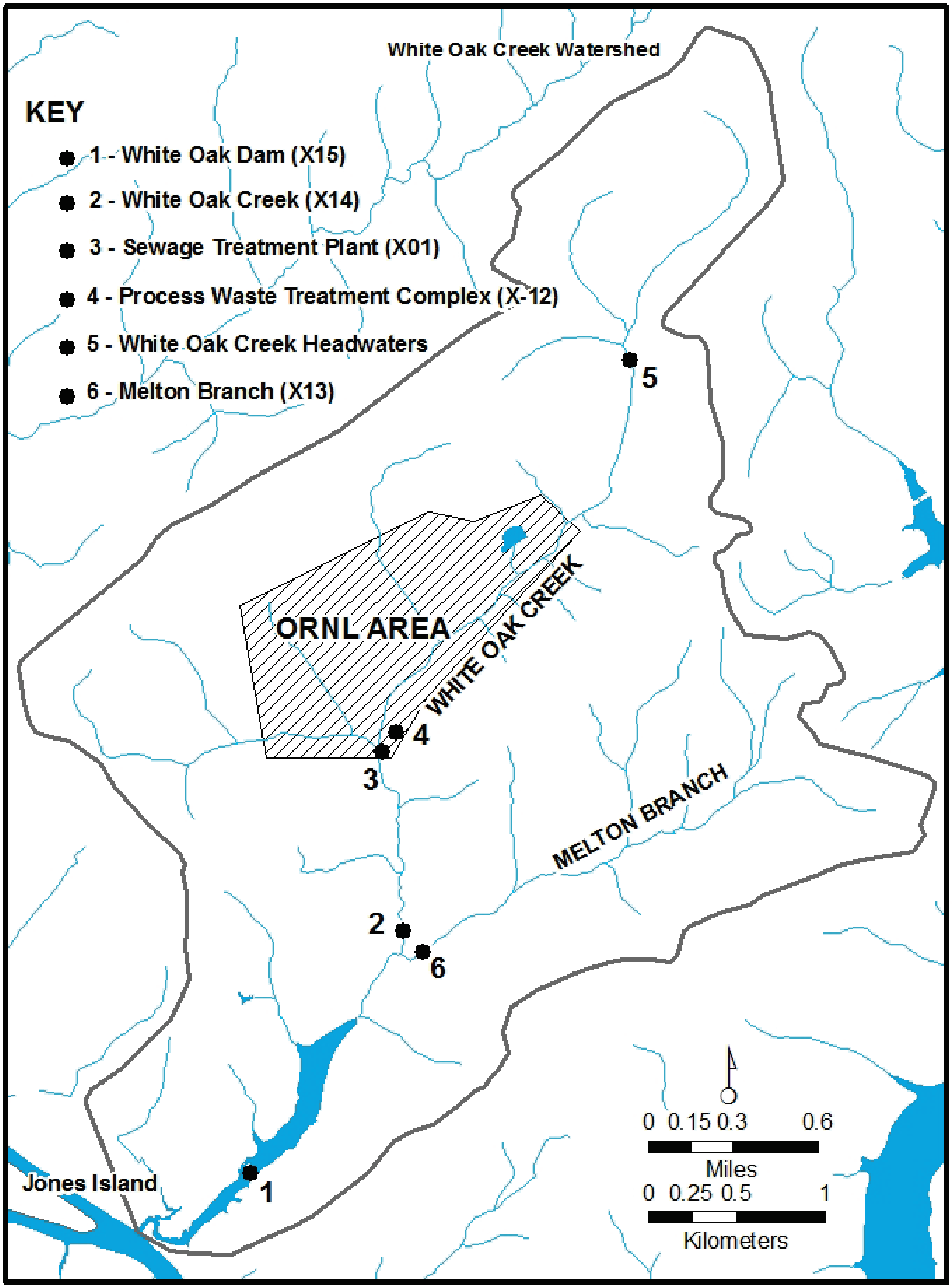

Fig. 5.19. Oak Ridge National Laboratory surface water, National Pollutant Discharge Elimination System, and reference sampling locations.

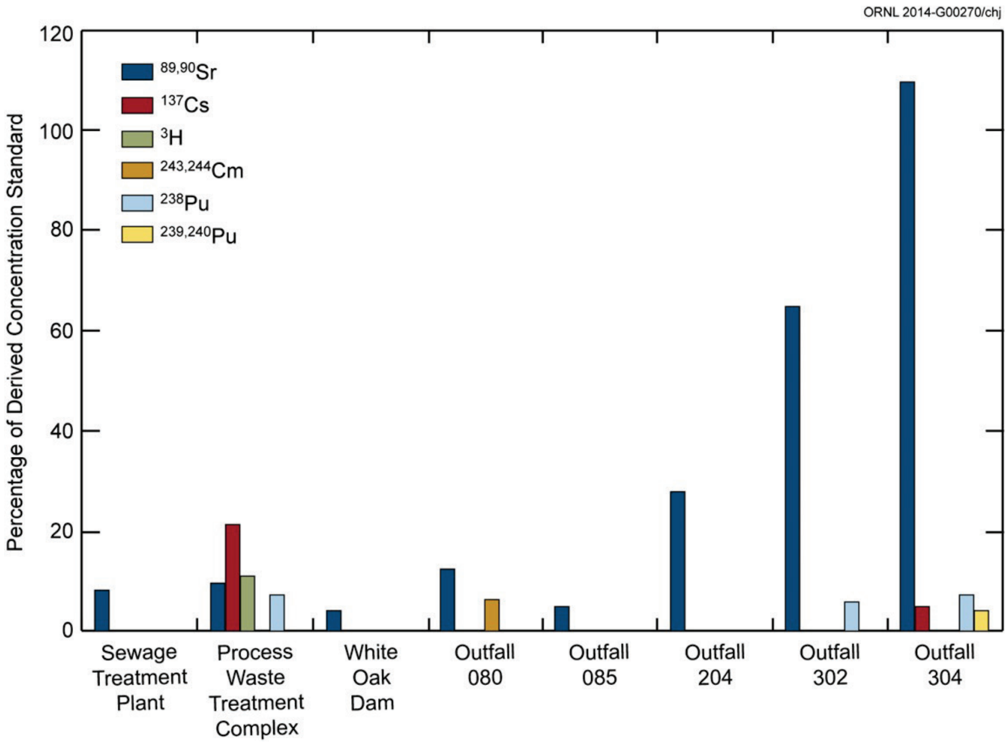

Fig. 5.20. Outfalls at Oak Ridge National Laboratory with average radionuclide concentrations greater than 4% of the relevant derived concentration standards in 2013.

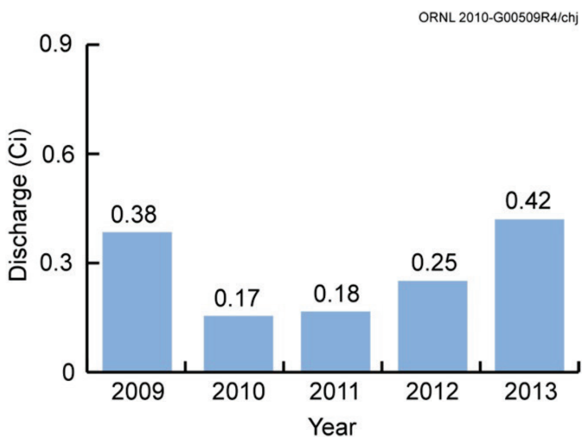

Fig. 5.21. Cesium-137 discharges at White Oak Dam, 2009–2013.

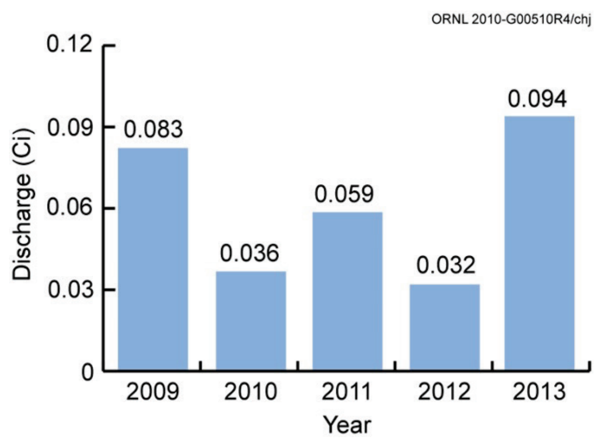

Fig. 5.22. Gross alpha discharges at White Oak Dam, 2009–2013.

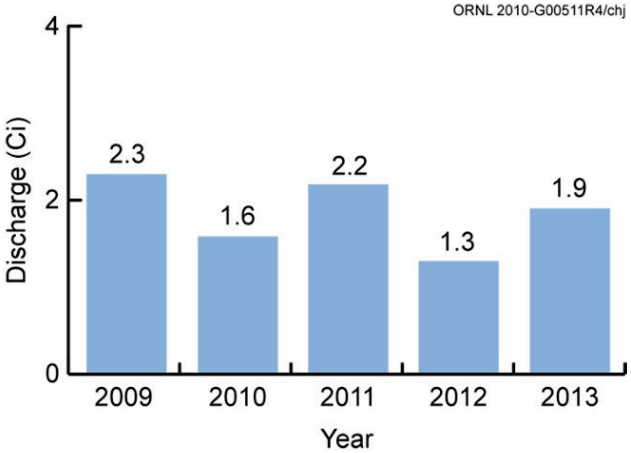

Fig. 5.23. Gross beta discharges at White Oak Dam, 2009–2013.

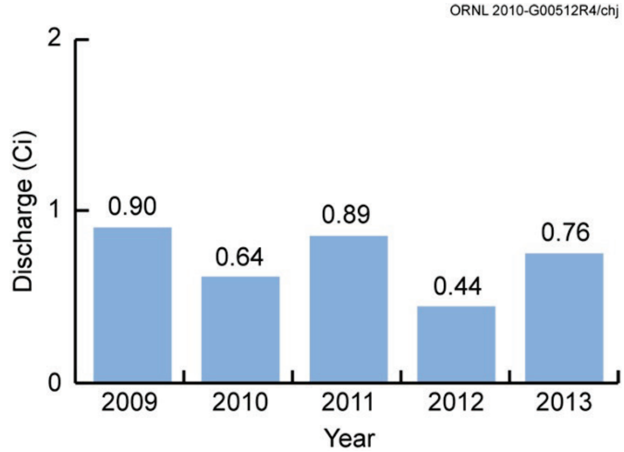

Fig. 5.24. Total radioactive strontium discharges at White Oak Dam, 2009–2013.

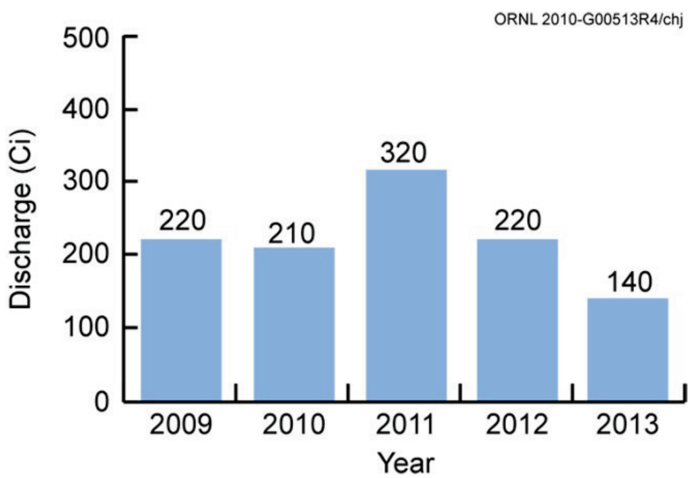

Fig. 5.25. Tritium discharges at White Oak Dam, 2009–2013.

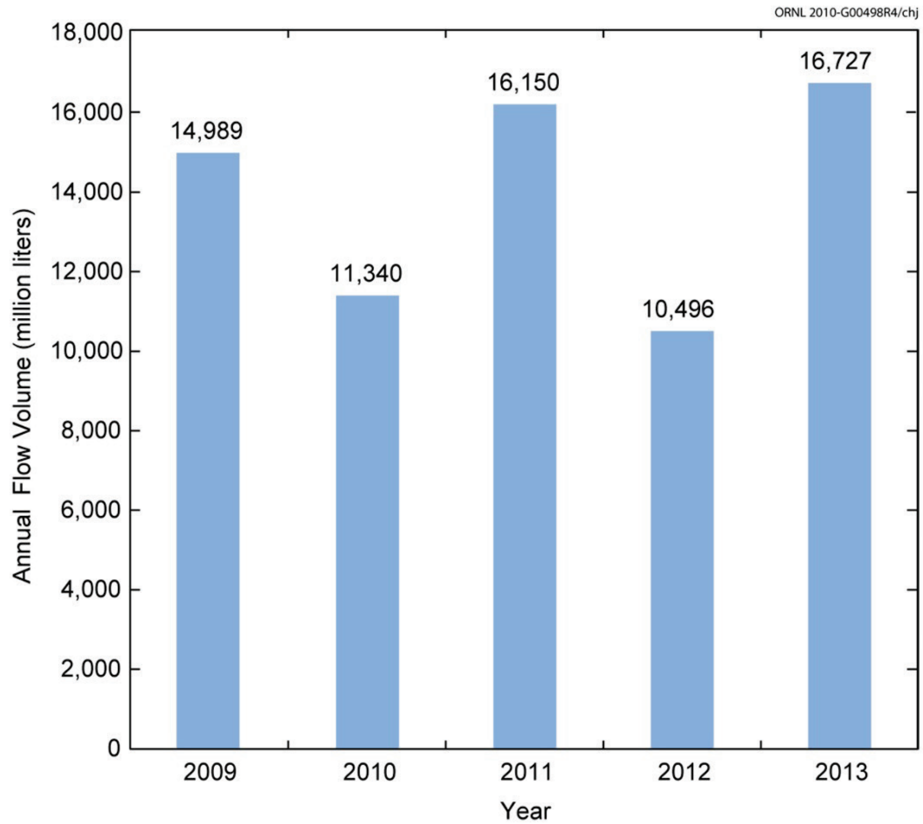

Fig. 5.26. Annual flow volume at White Oak Dam, 2009–2013.

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. 5.27).

For the mercury-investigation component of WQPP, data collected during initial monitoring indicates effluent sampling at additional outfalls and instream reaches needs to be incorporated in future WQPP revisions to help prioritize future abatement actions and to delineate mercury sources.

In 2013, 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 2013 monitoring are shown in Fig. 5.28, 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).

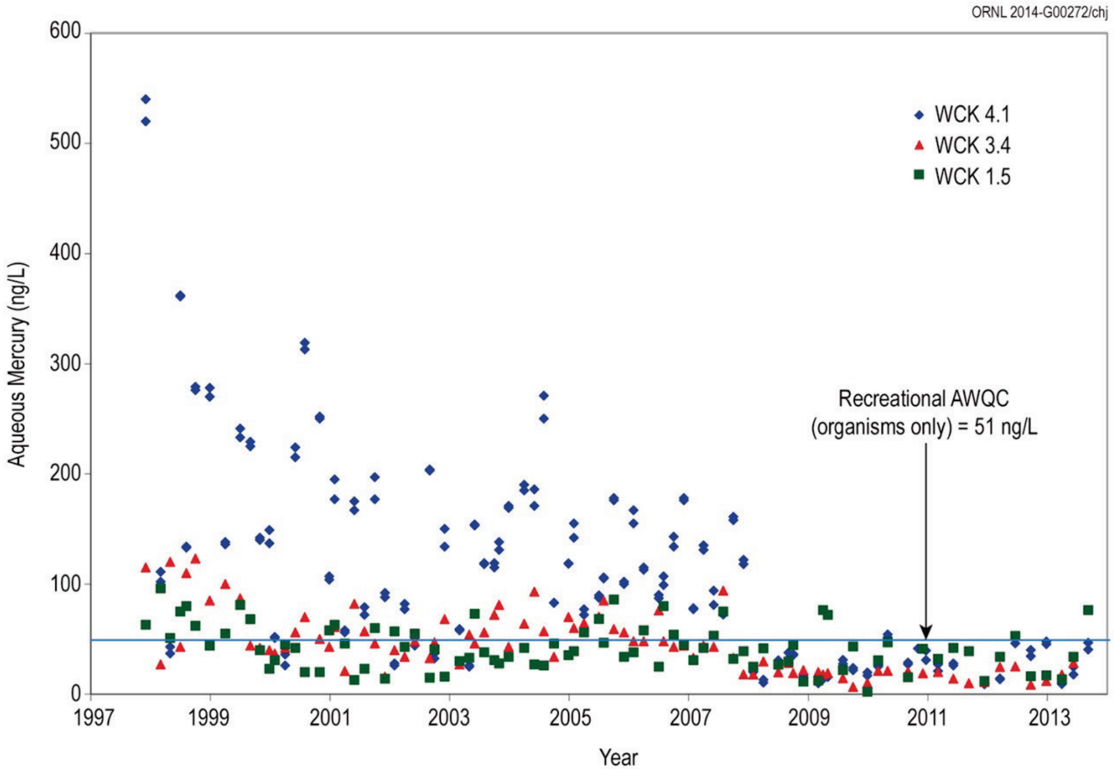

Fig. 5.27. Total aqueous mercury concentrations at sites in White Oak Creek downstream from Oak Ridge National Laboratory, 1998–2013. (AWQC = ambient water quality criterion; WCK = White Oak Creek kilometer.)

Monitoring results for 2013 indicated that Tennessee mercury criteria were largely met at instream locations. 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. Locations where water was infiltrating the network were discovered. Two sources of water inleakage to the outfall 265 pipe network were identified; both were from leaking underground pipes that supply water to a fire hydrant and associated valve. It is believed that the water in leakage contributes to mobilization of legacy mercury contamination in or near the outfall 265 underground pipe network. Since the water sources were repaired in 2012 and 2013, mercury concentrations in outfall 265 effluent have declined. However, outfall 265 monitoring continues to indicate a mercury presence above background levels. Investigation of additional portions of the outfall 265 drainage network that may be contributing to the mercury flux from that outfall is planned for 2014.

In 2013, WQPP mercury investigative efforts also focused on legacy-mercury-bearing sediment, a sediment-clogged dechlorination unit, and effluent mercury concentrations, all associated with storm water outfall 211. In 2013 the outfall 211 dechlorinator unit was replaced with a system that is less susceptible to clogging by sediment and gravel, and the old dechlorinator and associated piping were removed from the bank of WOC under an ARAP from TDEC. An in-pipe flow-monitoring unit was used to measure effluent flow rates from the outfall 211 pipe under varying conditions (e.g., dry-weather and storm-event) to help build a more complete data record of flow rates from the outfall 211 storm drain network. Plans for 2014 include continuing to investigate sources of supply-water and/or mercury to the outfall 265 drain network; sources of water from buildings within the outfall 211 storm-drain-network drainage area; flow monitoring at various accessible points in the outfall 211 network; and a time-series tracer-dilution study of the mid reach of Fifth Creek. 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 2014.

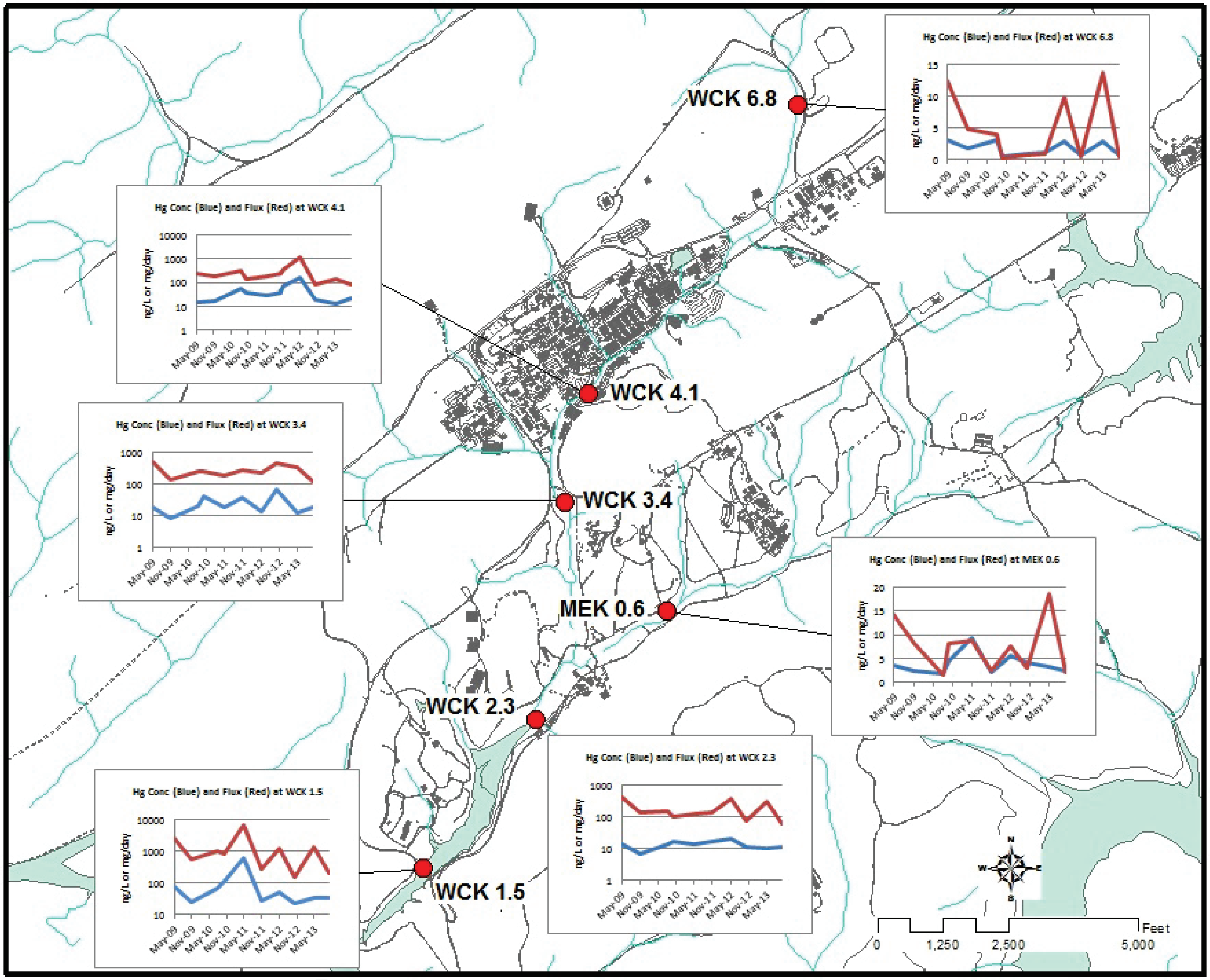

Fig. 5.28. Total mercury concentration and flux at selected Oak Ridge National Laboratory instream locations, 2009 through 2013.

5.5.6 Storm Water Surveillances and Construction Activities

Figure 5.29 depicts the location of construction sites that were considered significant in 2013 because of the need to be covered under the general Tennessee NPDES permit for construction activities and/or an ARAP or because they had a footprint greater than 0.405 ha (1 acre). (Construction areas that are part of CERCLA remediation follow substantive requirements of the appropriate water pollution control permits but are not required to obtain official permit coverage). Three of these sites were inspected in 2013 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.

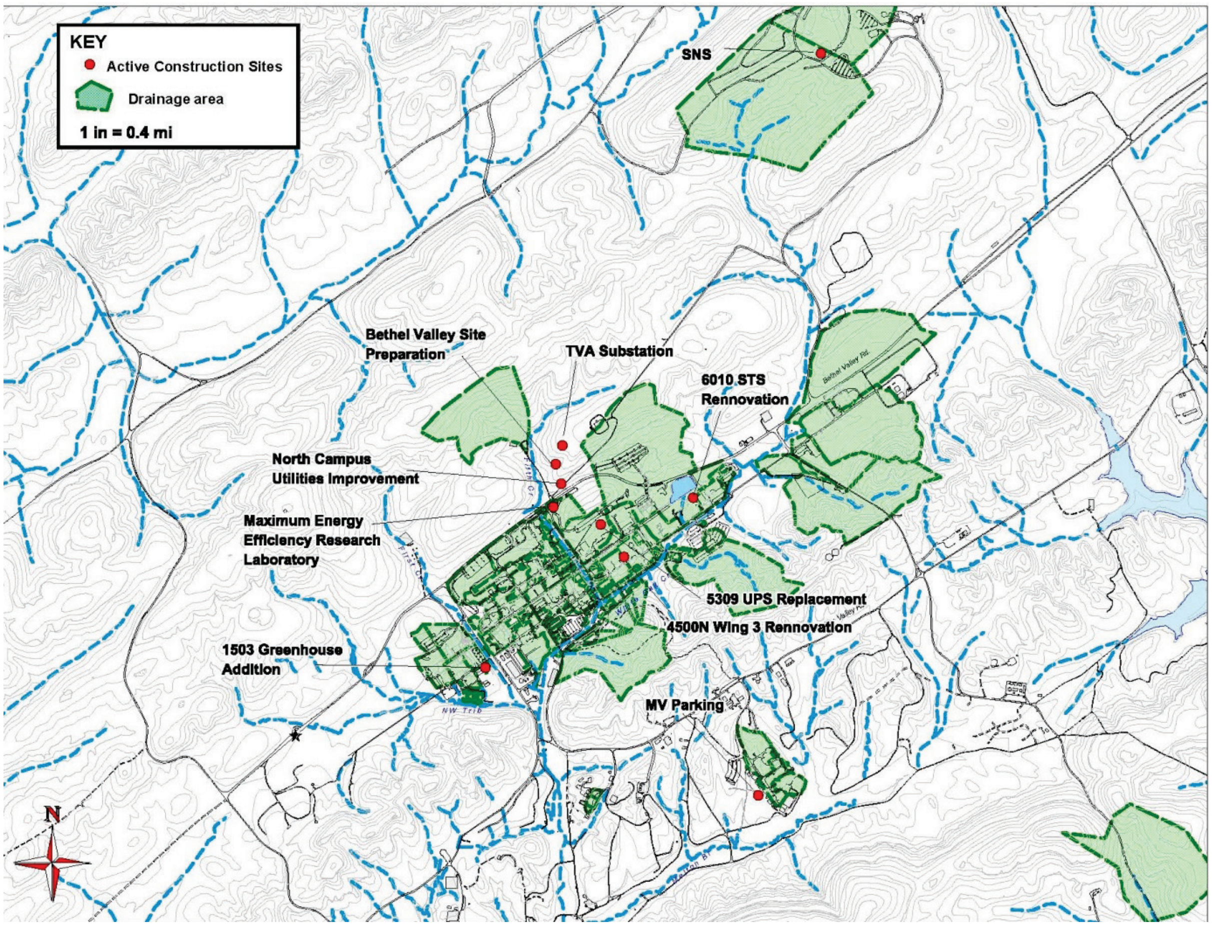

Fig. 5.29. Active construction sites and Oak Ridge National Laboratory Water Quality Protection Plan monitoring locations, 2013. (MV = Melton Valley, STS = Shield Testing Station, TVA = Tennessee Valley Authority, UPS = uninterruptible power supply.)

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.

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.

Mercury in Water. In continuation of a monitoring effort initiated in 1997, bimonthly water samples were collected from WOC at four sites in 2013. 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 2013. Long-term trends in waterborne mercury in the WOC system downstream of ORNL are shown in Fig. 5.27. Waterborne mercury downstream of ORNL declined abruptly in 2008 and remained low through 2013 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 21.8 ± 14.5 ng/L in 2013 compared with 108 ± 33 ng/L in 2007. The decrease was also apparent but less pronounced at WCK 3.4, with mercury averaging 19.0 ± 6.8 ng/L in 2013 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 34.11 ± 29.9 ng/L in 2013, 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, TDEC fish advisory limits). In 2010, mercury concentrations in redbreast sunfish fillets collected from WOC were below the 0.3 µg/g AWQC for the first time in 10 years, and this decreasing trend has continued through 2013 (Fig. 5.30). Mean fillet concentrations at WCK 3.9 decreased from 0.45 µg/g in 2007 to 0.20 µg/g in 2013 (Fig. 5.30). Because these trends have persisted for several years and because the decreases in fish tissue were more pronounced at upstream sites where the decreases in aqueous mercury concentrations were most evident suggests a causal response. Mercury concentrations in bluegill and largemouth bass collected from WCK 1.5 (White Oak Lake) have been increasing in recent years and remained elevated in 2013. The reason for the increase in the lower end of the WOC watershed is not known, but changes 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 (0.46 and 0.19 µg/g, respectively) were comparable to recent years. Mean PCB concentrations in bluegill from WCK 1.5 (1.15 µg/g) increased in 2013 such that concentrations in this species were similar to those seen in largemouth bass and were near typical concentrations that result in a TDEC fish advisory limit (i.e., ~1 µg/g) (Fig. 5.31).

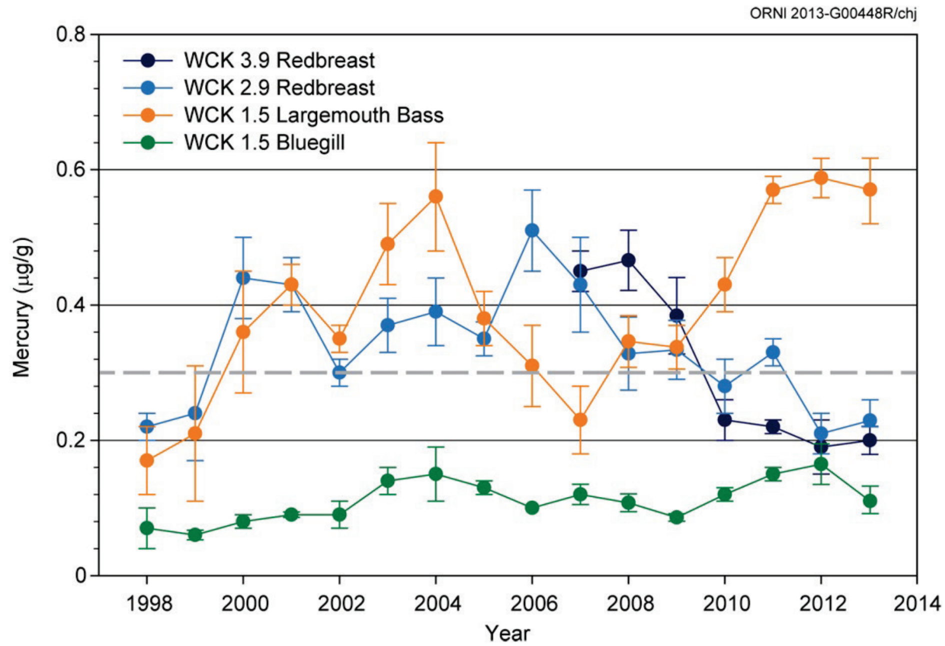

Fig. 5.30. Mean concentrations of mercury (± standard error, N = 6) in muscle tissue of sunfish and bass from White Oak Creek [White Oak Creek kilometers (WCKs) 3.9 and 2.9] and White Oak Lake (WCK 1.5), 1998–2013. [Dashed grey line indicates the US Environmental Protection Agency ambient water quality criterion for mercury (0.3 μg/g in fish tissue).]

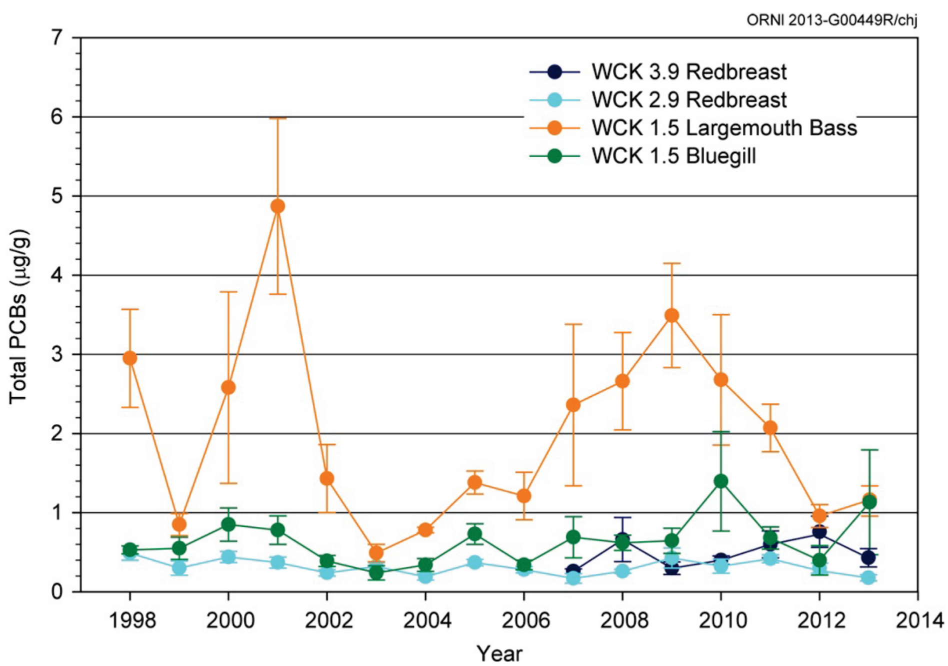

Fig. 5.31. Mean polychlorinated biphenyl (PCB) concentrations (± standard error, N = 6) in fish fillets collected from the White Oak Creek watershed, 1998–2013. (WCK = White Oak Creek kilometer.)

5.5.7.2 Benthic Macroinvertebrate Communities

Monitoring of benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2013. 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 data set that allows the most effective means of evaluating and verifying the effectiveness of pollution abatement and RAs taken at ORNL since 1986. These protocols also provide the most effective means of determining the significance of changes in trends relative to historical conditions. TDEC protocols, on the other hand, provide an estimate of the condition of a macroinvertebrate community relative to a state-derived 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 through 2013 from both sets of protocols.

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. 5.32). Except in 2009 when results with TDEC protocols classified MEK 0.6 as unimpaired and WCK 3.9 as moderately impaired, the invertebrate communities at all other sites in WOC watershed have consistently been classified as slightly 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. 5.33, 5.34, and 5.35). Relative to 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, metrics at First Creek kilometer (FCK) 0.1 have exhibited no persistent trends in change, thus suggesting that no major changes have since occurred. 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 before 2008. Metrics values for WCK 2.3 and WCK 3.9 continue to remain notably lower than those for the reference sites, suggesting that no further major changes have occurred at those sites for roughly 10 years.

Macroinvertebrate community metrics for lower Melton Branch (MEK 0.6, Fig. 5.36) 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 fertilized land) or indirect inputs (e.g., natural release from freshly disturbed soils or underdeveloped riparian areas).

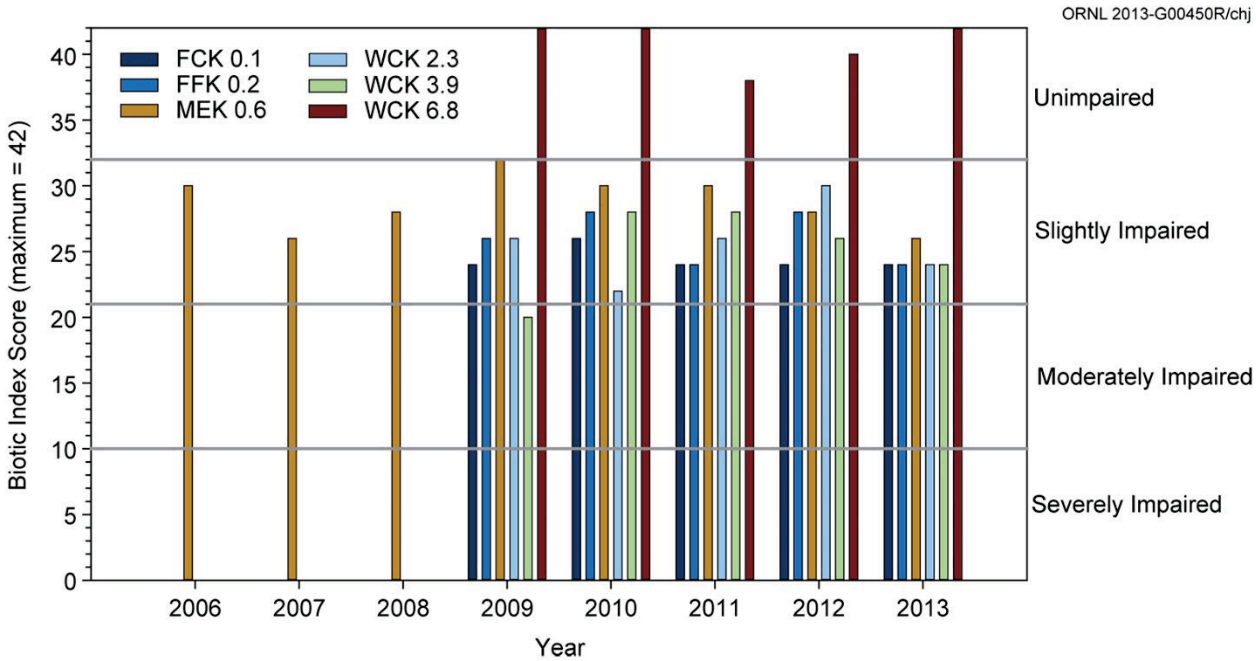

Fig. 5.32. Temporal trends in Tennessee Department of Environment and Conservation Biotic Index Scores for White Oak Creek watershed, August 2006–August 2013. Horizontal lines show the lower thresholds for biotic condition ratings for index scores; respective narrative ratings for each threshold are shown at right of graph. (FCK = First Creek kilometer; FFK = Fifth Creek kilometer; MEK = Melton Branch kilometer; WCK = White Oak Creek kilometer.)

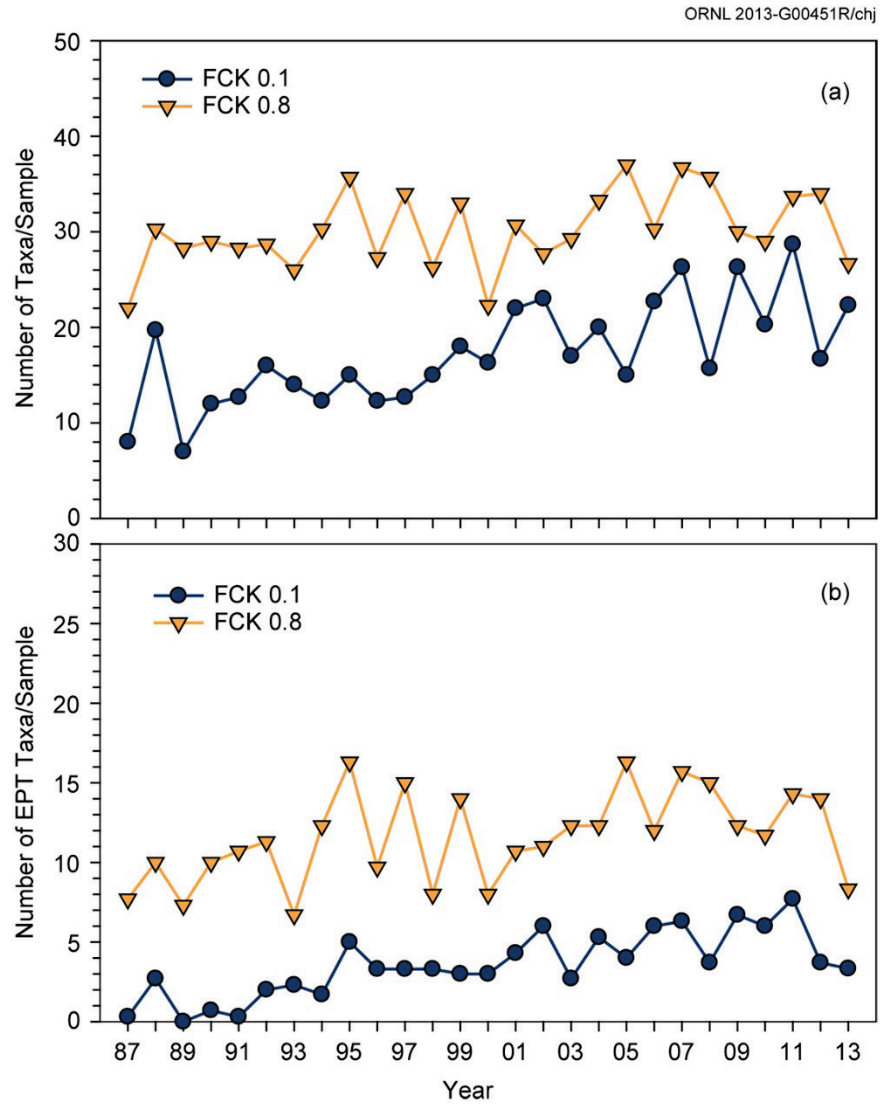

Fig. 5.33. Taxonomic richness (mean number of all taxa/sample) (a) and taxonomic richness of the pollution intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample] (b) of the benthic macroinvertebrate community in First Creek, April sampling periods, 1987−2013. (FCK = First Creek kilometer; FCK 0.8 = reference site.)

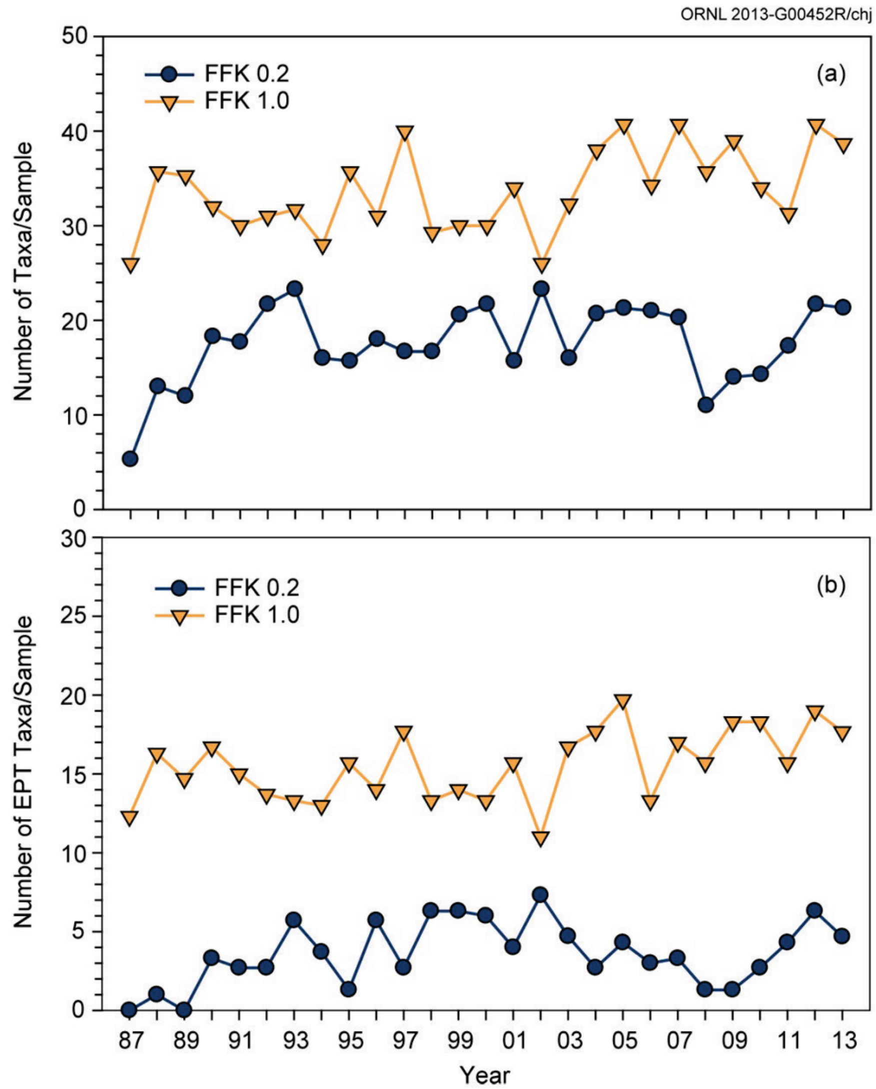

Fig. 5.34. Total taxonomic richness (mean number of all taxa/sample) (a) and taxonomic richness of the pollution intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], (b) of the benthic macroinvertebrate community in Fifth Creek, April sampling periods, 1987−2013. (FFK = Fifth Creek kilometer; FFK 1. 0 = reference site.)

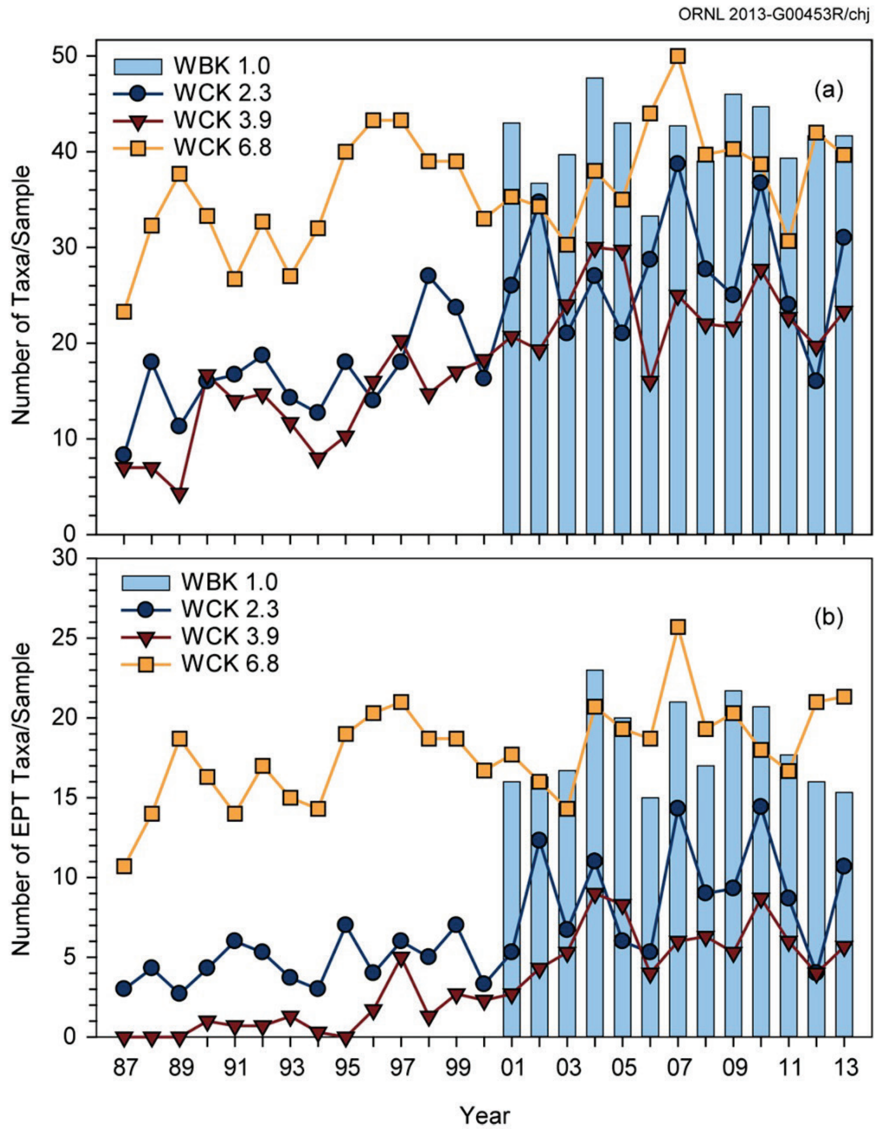

Fig. 5.35. Total taxonomic richness (mean number of all taxa/ sample) (a) and taxonomic richness of the pollution intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], (b) of the benthic macroinvertebrate communities in White Oak Creek, April sampling periods, 1987−2013. (WCK = White Oak Creek kilometer; WBK = Walker Branch kilometer; WBK 1.0 = reference site.)

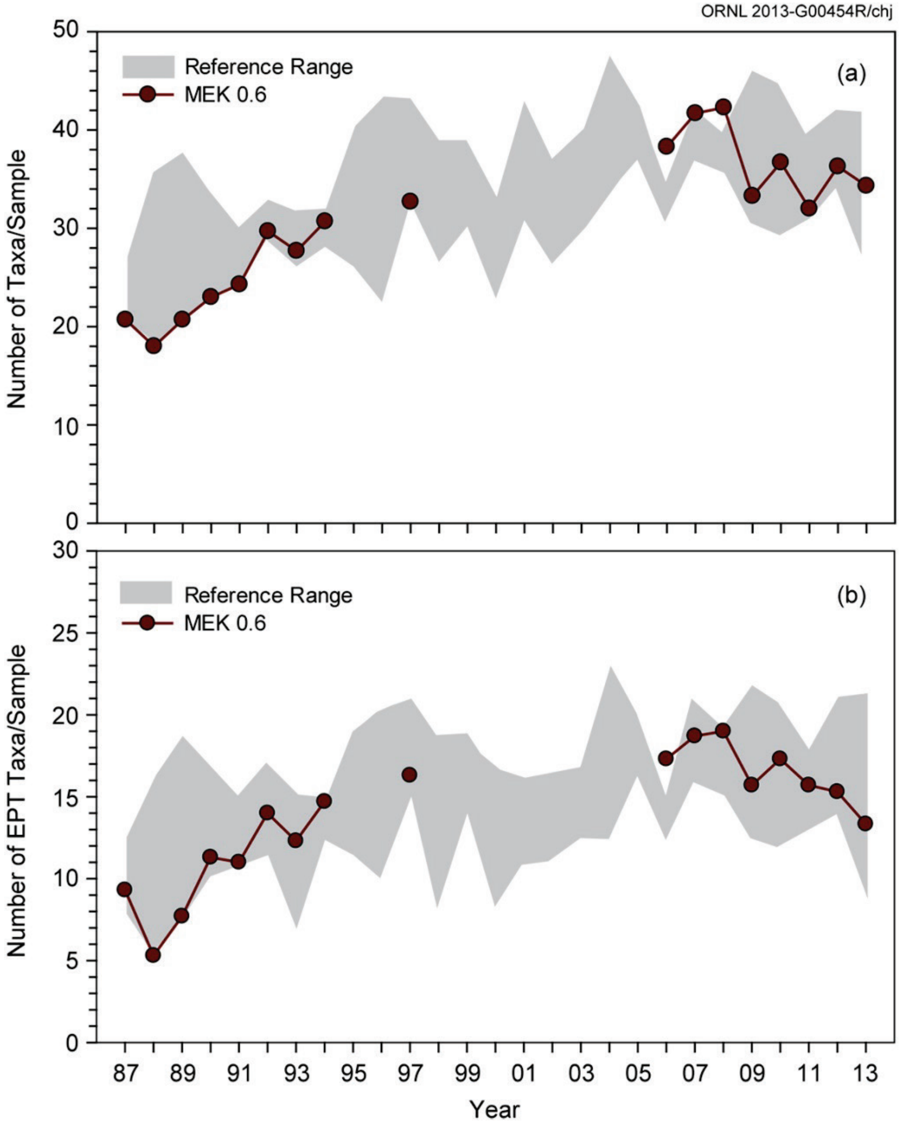

Fig. 5.36. Total taxonomic richness (mean number of all taxa/sample) (a) and taxonomic richness of the pollution intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [(EPT); mean number of EPT taxa/sample], (b) of the benthic macroinvertebrate communities in lower Melton Branch, April sampling periods, 1987−2013. [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 2013. Fish community surveys were conducted at 11 sites in the WOC watershed in the fall and 10 sites in the spring. 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 2013 compared with communities in reference streams, with sites closest to outfalls within the ORNL campus having lower species richness (number of species) (Fig. 5.37), fewer pollution-sensitive species, more pollution-tolerant species, and elevated density (number of fish per square meter) compared with similar-sized reference streams. Generally, the fish communities in tributary sites adjacent to and downstream of ORNL outfalls also remained impacted in 2013 relative to reference streams or upstream sites.

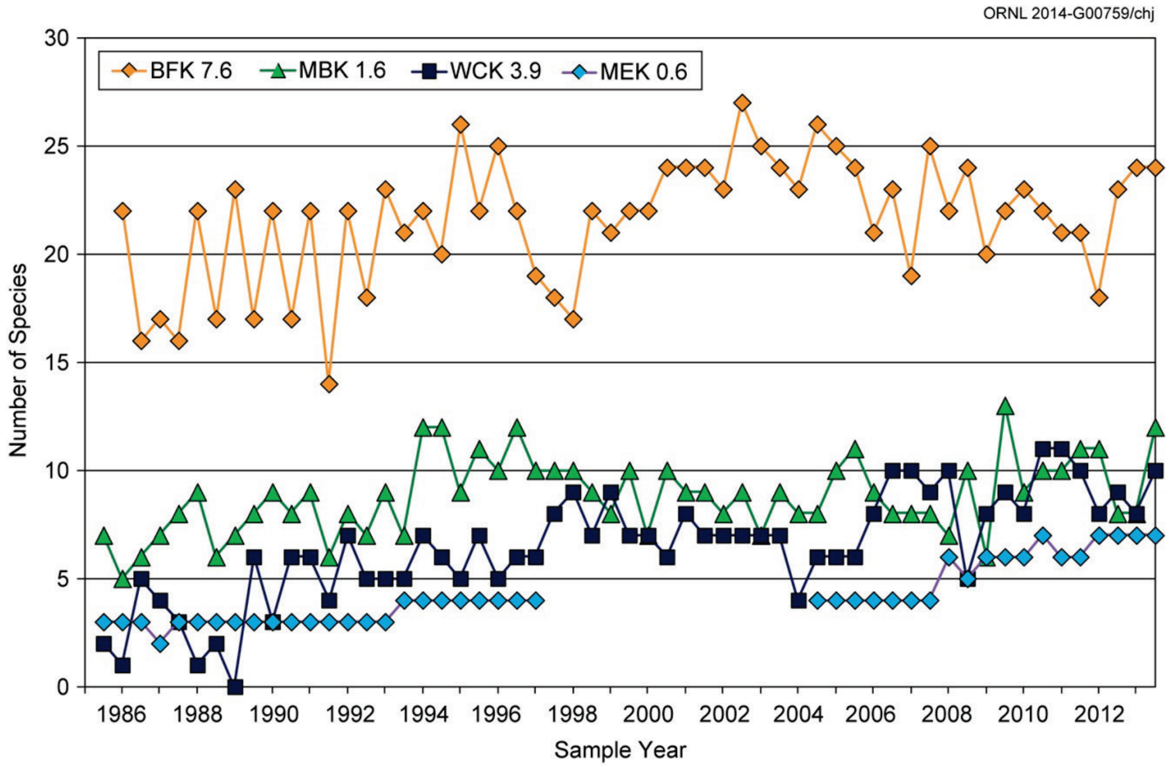

Fig. 5.37. Fish species richness (number of species) in upper White Oak Creek and lower Melton Branch compared with two reference streams (Brushy Fork and Mill Branch). (BFK = Brushy Fork kilometer; MBK = Mill Branch kilometer; MEK = Melton Branch kilometer; and WCK = White Oak Creek kilometer.)

A project to introduce fish species that were not historically found in the WOC watershed but exist in similar systems on ORR 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 range 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.

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. Largemouth bass collected from White Oak Lake continue to have tissue PCB concentrations 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 remain submerged 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 2013, ORNL's PCB monitoring efforts continued focusing on the First Creek watershed, which has been 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. 5.38). The results are summarized in Table 5.15.

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. Inlets 341-3 and 250-3, which collect storm water from the same drainage area, had the highest SPMD accumulations among the inlet samples. The results from the 2013 assessment continue to confirm that the upper parts of the outfalls 250 and 341 pipe networks are of primary interest for legacy PCB sources in the First Creek watershed. The 2013 clam results continue to confirm that sources in the drainage areas served by outfalls 249 and 250 contain PCBs in amounts that are bioaccumulating above background levels.

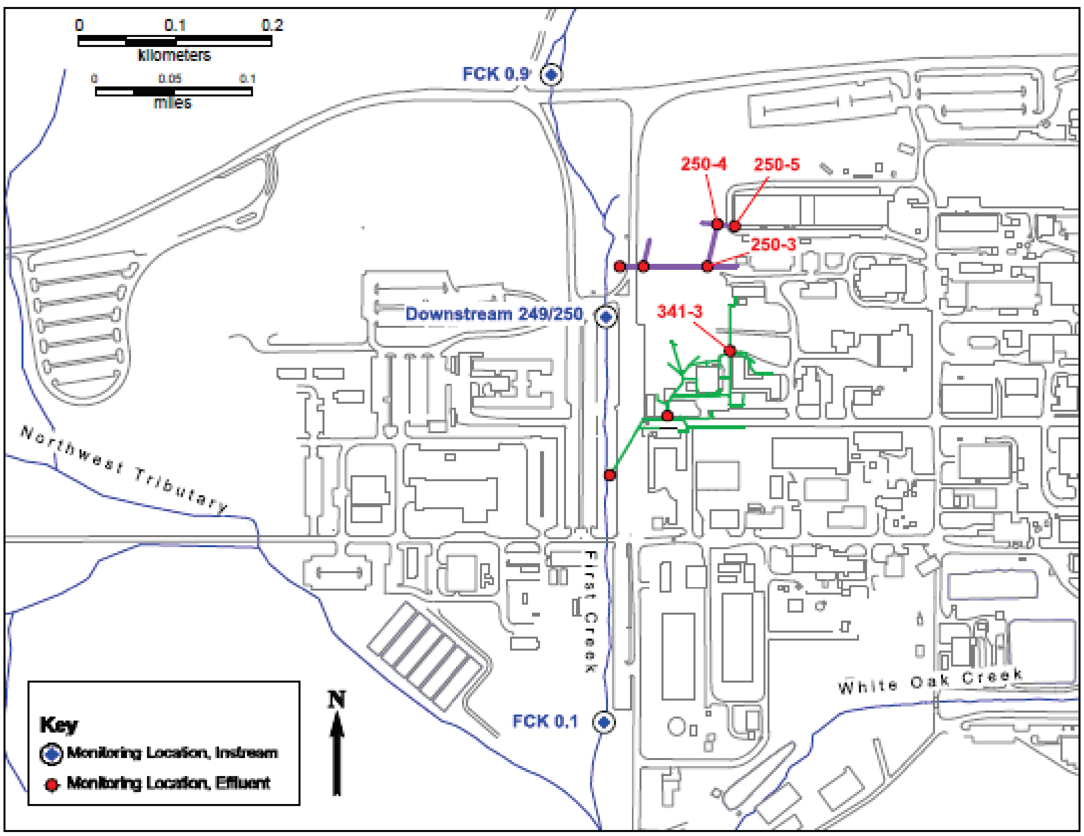

Fig. 5.38. Locations of monitoring points for First Creek source investigation.
(FCK = First Creek kilometer)

Table 5.15. First Creek PCB source assessment, August 2013
[Total PCBs (parts per billion)]

Sample location	Location type	SPMD	Clams
FCK 0.9	Reference Site	101	3.05
Catch Basin 250-5	Inlet	1,200	—
Manhole 250-4	Inlet/Outlet	1,200	—
Manhole 250-3	Inlet 1	6,300	—
Manhole 250-3	Inlet 2	5,100	—
Manhole 250-3	Inlet 3	14,000	—
Manhole 250-3	Outlet	12,000	—
Downstream Outfall 249/250	Instream	17,000	1,350
Manhole 341-3	Inlet 1	26,700	—
Manhole 341-3	Inlet 2	8,100	—
Manhole 341-3	Inlet 3	14,800	
Manhole 341-3	Outlet	15,300	—
FCK 0.1	Instream	20,200	1,895

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. 5.39) 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 5.16. 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.

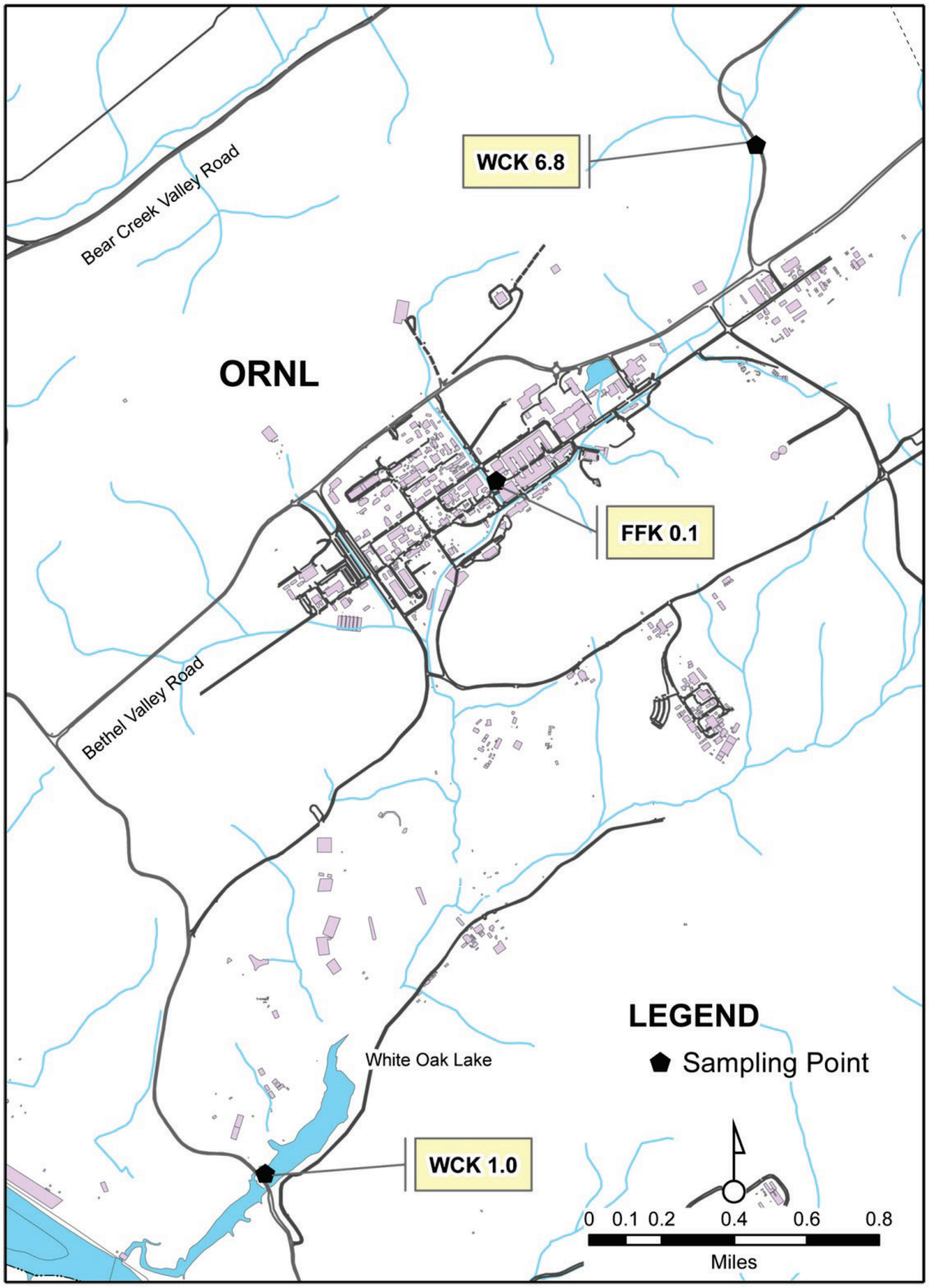

Fig. 5.39. Oak Ridge National Laboratory surface water sampling locations. (FFK = Fifth Creek kilometer; WCK = White Oak Creek kilometer.)

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.

Table 5.16. Oak Ridge National Laboratory surface water sampling locations, frequencies, and parameters, 2013

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

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

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

The 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 2013 surveillance monitoring efforts are consistent with historical data.

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

Neither mercury nor PCBs were detected during 2013 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 2013 compliance status for this permit are summarized in Table 5.17.

Table 5.17. Industrial and Commercial User Waste Water Discharge Permit compliances at ORNL Carbon Fiber Technology Facility, 2013
(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	3	100
pH (standard units)	9.0	6.0	0	3	100
		Outfall 02 (Electrolytic Bath Tank)			
pH (standard units)	9.0	6.0	0	15	100
		Outfall 03 (Sizing Bath Tank)			
Copper		0.87	0	4	100
Zinc		1.24	0	4	100
Total Phenol		4.20	0	4	100
pH (standard units)	9.0	6.0	0	4	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 2013: DOE EM monitoring and DOE Office of Science (OS) surveillance monitoring. The DOE EM groundwater monitoring program was performed by UCOR in 2013. 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 2013, including monitoring at ORNL, are evaluated and reported in the 2014 remediation effectiveness report (DOE 2014a) 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 this report.

Following discussions between DOE and TDEC, during 2013 TDEC declined to issue a RCRA Post-Closure Permit for SWSA 6. From this point forward, substantively equivalent reporting of groundwater quality in wells at the perimeter of SWSA 6 is to be reported in the annual CERCLA RER.

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 2013 post-remediation monitoring continued at 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 2013 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).

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 2013 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 2013 the DOE EM Program monitored three groundwater monitoring wells in Bethel Valley to the west of Tennessee Highway 95 to detect and monitor 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 monitoring 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 as presented in the 2014 remediation effectiveness report (DOE 2014a).

Groundwater monitoring continued at the ORNL 7000 Area during FY 2013 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 2013. 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. During FY 2013 the remedy 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 2013 greater than average annual rainfall occurred for the fifth consecutive year since the remedy was completed in 2006. 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. During FY 2013 a maintenance action was implemented at the SWSA 4 downgradient collection trench. All 14 groundwater extraction wells in the downgradient trench were redeveloped and faulty pumps were replaced. After this maintenance action the system performance improved as measured by improved groundwater-level suppression in the groundwater collection trench.

Groundwater quality monitoring in the interior of Melton Valley shows that in general groundwater contaminant concentrations are declining or are stable following RAs.

During the past 9 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 2013 an off-site groundwater monitoring well array west of the Clinch River 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 2013 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 one multiport well sampling location at an activity level less than half the derived drinking water limit equivalent level. Monitoring results are summarized in the 2014 remediation effectiveness report (DOE 2014a).

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 2013 included seep/spring and surface-water monitoring locations in addition to groundwater surveillance monitoring wells. Seep/spring and surface-water monitoring locations were used in the absence of monitoring wells located in appropriate groundwater discharge areas.

Groundwater monitoring performed under the exit pathway groundwater surveillance and active-sites monitoring programs is not regulated by federal or state regulations. Consequently, no permit or standards exist for evaluating sampling results. To provide a basis for evaluating analytical results and for assessment of groundwater quality at locations monitored by UT-Battelle for OS, federal drinking water standards and Tennessee WQCs for domestic water supplies (TDEC 2012) were used as reference standards in the following discussions. Four percent of the DCSs established by DOE O 458.1 were used if no federal or state standards had been established for a particular radionuclide. Although drinking water standards and DOE DCSs are 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. One organic compound was detected in samples collected from two WOC discharge area sampling locations. Based on the results of the 2013 monitoring effort, there is no indication that current OS operations are significantly impacting groundwater at ORNL.

5.6.2.1 Exit Pathway Monitoring

During 2013, exit pathway groundwater surveillance monitoring was performed in accordance with the exit pathway sampling and analysis plan (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 5.40 shows the locations of the exit pathway monitoring points sampled in 2013.

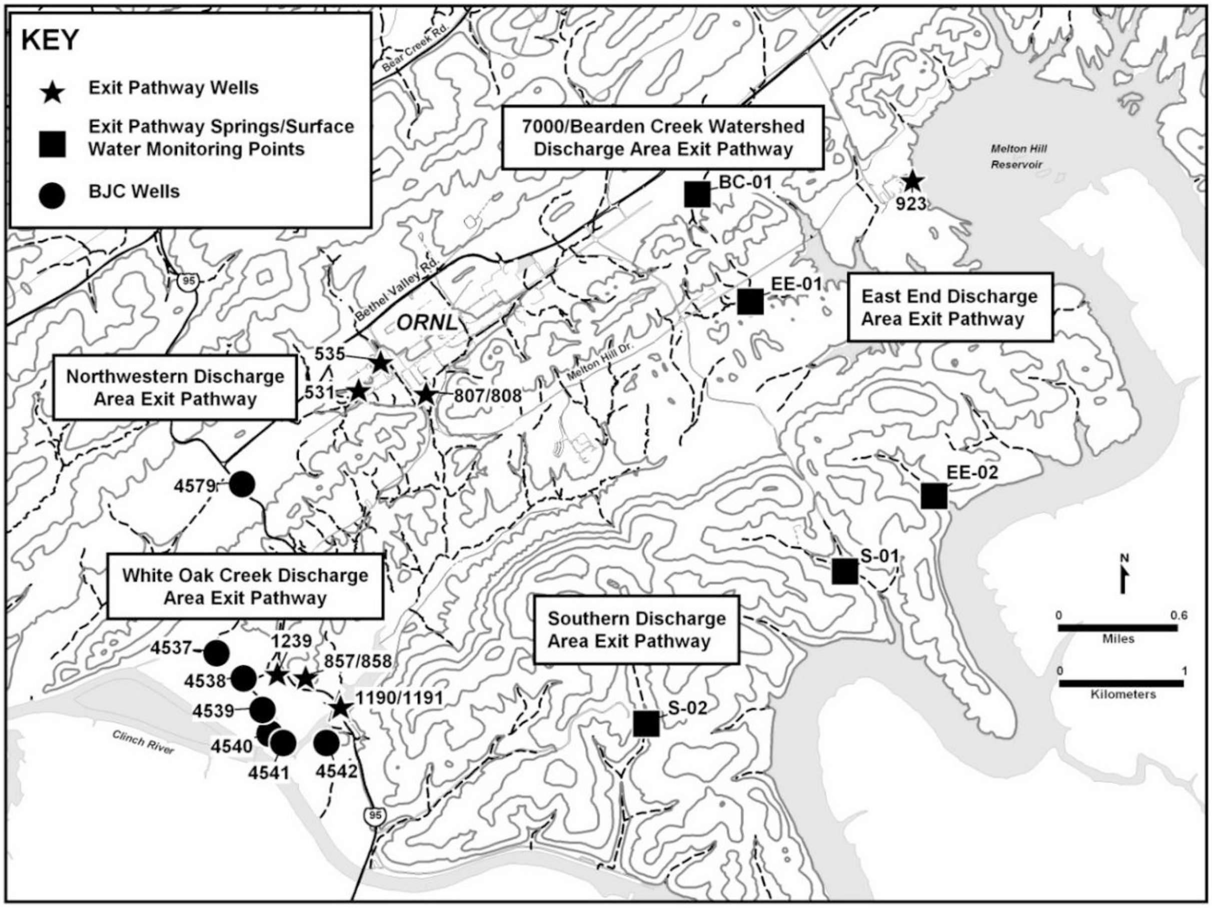

Fig. 5.40. UT-Battelle exit pathway groundwater monitoring locations at Oak Ridge National Laboratory, 2013. (BJC = Bechtel Jacobs, Inc., LLC.)

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 2013 is outlined in Table 5.18.

Unfiltered samples were collected from the exit pathway groundwater surveillance monitoring points in 2013. The organic suite was composed of VOCs and semivolatile organic compounds (SVOCs); the metallic suite included metals (e.g., aluminum, iron, lead, 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 (April) and dry (August and September) seasons.

Table 5.18. Scheduled 2013 exit pathway groundwater monitoring

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

5.6.2.1.1 Exit Pathway Monitoring Results

Statistical trend analyses were performed on 2013 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 2013. 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 5.19.

Samples were not collected at S-01 during the dry season due to a lack of water flow at that location. 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 5.20 provides a summary of radiological parameters detected in samples collected from exit pathway monitoring points during 2013. Table 5.21 summarizes organics parameters detected in samples collected from exit pathway monitoring points. Given that metal parameters are ubiquitously detected in exit pathway groundwater monitoring points, they are not likewise summarized.

Table 5.19. 2013 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
		Tritium	Downward
Northwestern	531	Iron	None
Eastern	EE-02	Aluminum	None
		Iron	None
		Manganese	None
	923	Iron	None
		Manganese	None

Table 5.20. 2013 exit pathway groundwater monitoring results—detected radiological parameters[a]

Discharge area	Monitoring point	Radiological parameter	Wet season	Dry season
White Oak Creek	857	Bismuth-214	27	31
		Lead-214	35	40
		Tritium	230	190
	1190	Gross beta	2.6	3.1
		Bismuth-214	42	15
		Lead-214	36	18
		Thallium-208	*b*	2.8
		Tritium	21,000	21,000
	1191	Gross beta	350	310
		Bismuth-214	*b*	13
		Lead-214	18	14
		Potassium-40	44	*b*
		Total radioactive strontium	150	130
		Tritium	30,000	21,000
	1239	Gross beta	2.3	*b*
Northwestern	531	Bismuth-214	*b*	1,100
		Lead-214	*b*	1,400
	535	Gross alpha	3.8	*b*
		Bismuth-214	*b*	11
		Lead-214	*b*	13
		Tritium	380	270
	807	Gross beta	4.6	4.4
		Bismuth-214	*b*	58
		Lead-214	*b*	56

Table 5.20. (continued)

Discharge area	Monitoring point	Radiological parameter	Wet season	Dry season
		Tritium	570	480
	808	Gross beta	4.2	3.9
		Potassium-40	*b*	26
7000-Bearden Creek	BC-01	Bismuth-214	16	9.4
East End	EE-01	Gross beta	*b*	2.8
		Bismuth-214	*b*	11
	EE-02	Bismuth-214	420	25
		Lead-212	*b*	4.6
		Lead-214	*b*	25
	923	Gross beta	4	3.7
		Bismuth-214	11	5.8
		Lead-214	10	*b*
Southern	S-01	Bismuth-214	66	*c*
	S-02	Gross beta	*b*	3.3
		Bismuth-214	18	8.9

[a]Units: pCi/L.
[b]Not detected.
[c]Not sampled due to lack of water flow.

Table 5.21. 2013 exit pathway groundwater monitoring results—detected organic parameters[a]

Discharge area	Monitoring point	Organic parameter	Wet season	Dry season
White Oak Creek	1190/1191	Bis(2-ethyhexyl) phthalate	27/100	*b*

[a]Units—µg/L.
[b]Not detected.

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 2013 (in wells 1190 and 1191). Statistical trend analyses show that the concentration trends for these parameters continue downward. The downward trend in radiological contaminants in the WOC discharge area is very likely attributable to the continued EM remediation effort in Melton Valley. 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. Only three metals (iron, manganese, and aluminum) were detected at concentrations exceeding reference standards. These metals are commonly found in groundwater at ORNL. One SVOC, bis(2-ethyhexyl) phthalate, was detected in samples collected from Wells 1190 and 1191 in the WOC discharge area. Based on the results of the 2013 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

Groundwater monitoring conducted by the Research Reactors Division ceased in 2007 based on declining tritium concentrations observed since the repair of the subsurface leak site discovered in late 2000. Since then, outfall pipelines intercepting groundwater have been monitored for tritium routinely 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 2013 at the SNS site. The site was monitored based on the potential for adverse impact on groundwater resources at ORNL should a release occur. Monitoring at the SNS site was performed in 2013 under the SNS operational monitoring plan (OMP) (Bonine et al. 2007). Operational monitoring was initiated at the initiation of SNS operations 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 5.41 shows the locations of the specific monitoring points sampled during 2013.

In November 2011 the SNS historical tritium data set underwent review and analysis 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. Consequently, neither flow condition nor season affects the proportion of tritium detects to nondetects. This implies that samples can be collected during any flow condition and season with the expectation that no *statistical* difference in the proportion of tritium detects to nondetects exists. The results of this statistical analysis of the April 2004–September 2011 data set are the basis for the modified OMP monitoring scheme implemented in 2013.

Taking a conservative approach, samples were collected from each monitoring point on a quarterly basis in 2013, allowing the opportunity for wet and dry season monitoring. All sampling performed in

2013 was performed in conjunction with rainfall events, with samples being collected during rising or falling (recession) limb flow conditions (see Fig. 5.42). Table 5.22 shows the sampling and parameter schedule followed in 2013.

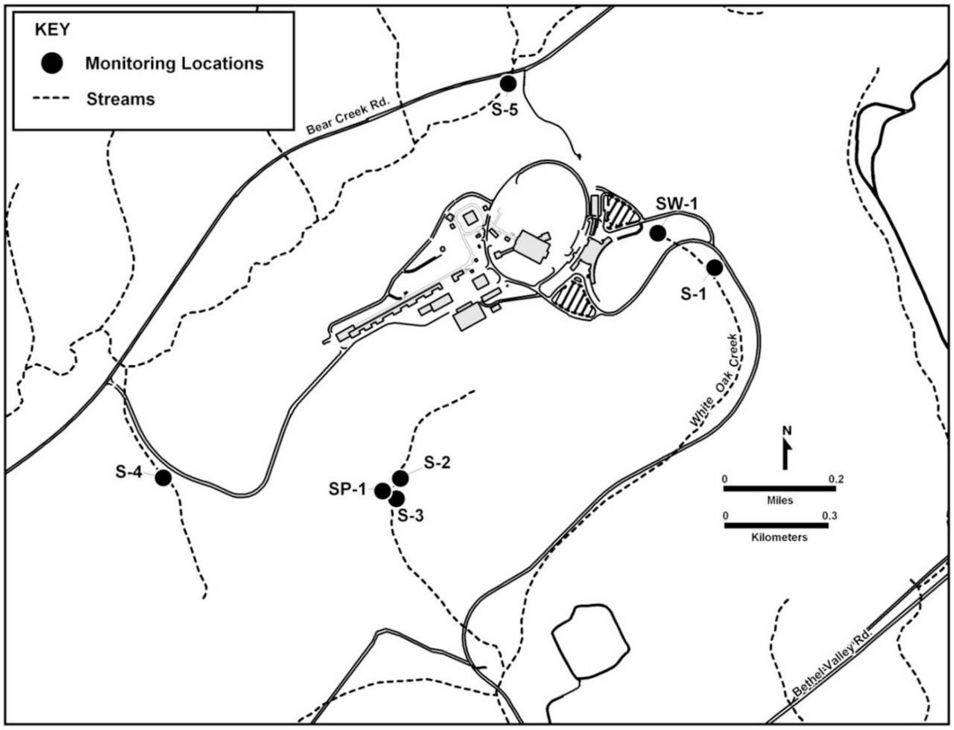

Fig. 5.41. Groundwater monitoring locations at the Spallation Neutron Source, 2013.

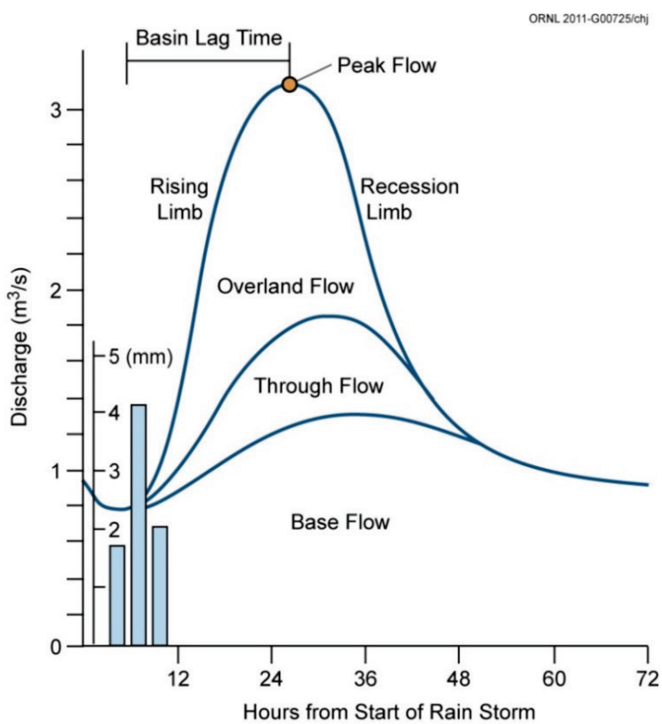

Fig. 5.42. Simple hydrograph of spring discharge vs time after initiation of rainfall.

Table 5.22. 2013 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 and expanded suite[a]	Tritium	Tritium	Tritium
S-1	Tritium and expanded suite	Tritium	Tritium	Tritium
S-2	Tritium	Tritium and expanded suite	Tritium	Tritium
S-3	Tritium	Tritium and expanded suite	Tritium	Tritium
S-4	Tritium	Tritium	Tritium and expanded suite	Tritium
S-5	Tritium	Tritium	Tritium and expanded suite	Tritium
SP-1	Tritium	Tritium	Tritium	Tritium and expanded suite

[a]The expanded suite includes gross alpha and gross beta and gamma emitters.

Spallation Neutron Source Site Results

In 2013 sampling at the SNS site occurred during February (quarter 1), June (quarter 2), September (quarter 3), and November (quarter 4). Low concentrations of tritium were detected numerous times during 2013. Table 5.23 provides a summary of the locations and sampling events for tritium detections observed during 2013. The reference standard for tritium was not exceeded at any SNS monitoring location in 2013.

Table 5.23. Spallation Neutron Source groundwater monitoring results—tritium detections in 2013

Monitoring point	Detected in
S-1	1st quarter
S-2	1st, 2nd, and 4th quarters
S-3	Not detected
S-4	Not detected
S-5	Not detected
SP-1	Not detected
SW-1	1st, 2nd, 3rd,and 4th quarters

Table 5.24 provides a summary of the locations and sampling events for other radionuclide detections observed in 2013.

Table 5.24. Spallation Neutron Source groundwater monitoring results—other radionuclide detections in 2013

Monitoring Location	Gross alpha	Gross beta	^{214}Bi	^{214}Pb	^{137}Cs	^{233,234}U	^{238}U
S-1	ND	ND	ND	1st quarter	ND	ND	ND
S-2	ND	ND	ND	2nd quarter	ND	ND	ND
S-3	ND	2nd quarter	2nd quarter	ND	2nd quarter	ND	ND
S-4	ND	ND	3rd quarter	3rd quarter	ND	ND	ND
S-5	3rd quarter	3rd quarter	3rd quarter	3rd quarter	ND	3rd quarter	3rd quarter
SP-1	ND	ND	ND	ND	ND	ND	ND
SW-1	ND	ND	1st quarter	1st quarter	ND	ND	ND

ND = not detected in sample.

The only radionuclide exceeding its reference standard during 2013 was gross alpha activity (18.9 pCi/L) at S-5 in the third quarter. The reference standard for gross alpha activity is 15 pCi/L. Cesium-137 was detected at a low concentration in a sample collected from S-3 during the second quarter. The origin of the ^{137}Cs is unknown. Gross activity and uranium detected in S-5 during the third quarter 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 and Waste Services Division (EP&WSD).

UT-Battelle uses SBMS to provide a systematic approach for integrating QA, environmental, and safety considerations into every aspect of ORNL environmental monitoring. 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, EP&WSD 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. UT-Battelle Facilities and Operations Instrumentation and Control Technical Support 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. EP&WSD 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, continuous monitors used for CAA compliance monitoring at specific ORNL boilers are subjected to rigorous quality assurance 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 relative accuracy audit is performed on PEMS using a second, calibrated system to verify the accuracy of the on-stack system. A calibration error opacity audit is performed quarterly on continuous opacity monitoring systems. This audit is performed at low-, mid-, and high-ranges. Automated zero and span checks are performed daily. The results of these QA tests are provided to TDEC quarterly and 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. EP&WSD 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

EP&WSD 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 2013 and information on the number of findings identified, if any. EP&WSD 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 ORNL 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. Corrective actions, if required, are documented and tracked in the WAI Issues Management Database and the Isotek Assessment and Commitment Tracking System, respectively.

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 2013 EM activities undertaken at ORNL. More detailed information is available in the 2013 cleanup progress report (DOE 2013).

5.8.1 3026 Hot Cells Facility Downgraded and Maintained in Surveillance and Maintenance Mode

The 3026 hot cells facility (Fig. 5.43) has been downgraded from a Hazard Category 3 nuclear facility to a radiological facility. Three of the facility's five hot cells were previously demolished. However, due to unanticipated conditions, the remaining hot cells were downgraded and placed into surveillance and maintenance. In FY 2013 a report documenting the work completed and work remaining was submitted to EPA and TDEC.

Fig. 5.43. A concrete berm being poured as part of the 3026 stabilization activities.

5.8.2 Bethel Valley Groundwater Monitoring

Groundwater monitoring in the Bethel Valley 7000 Area continued in FY 2013. The 7000 Area includes the maintenance facilities on the east end of ORNL. A treatability study was initiated earlier to determine the feasibility of using bacteria to eliminate TCE in groundwater.

5.8.3 Off-Site Groundwater Monitoring

Groundwater monitoring was conducted in FY 2013 in off-site wells adjacent to Melton Valley to determine whether any contaminant migration off the reservation was occurring. Signature human-made contaminants that have been detected in groundwater near former Melton Valley waste disposal areas on DOE property include the radionuclides tritium, ^{90}Sr, and ^{99}Tc and chlorinated organic compounds and related degradation products. None of these contaminants were detected in off-site groundwater.

5.8.4 Upgrade of 4500 Area Gaseous Waste System

The objective of the 4500 Area gaseous waste system upgrades project (Fig 5.44) was to deactivate one of the five cell ventilation system branches and remove several facilities from the central hot off-gas system.

The ventilation system branches and off-gas system are part of the central gaseous waste system at ORNL that vents through the 3039 stack. The project plans include providing localized ventilation systems to the 4501, 4505, 4500N, and 4507 facilities; stabilizing the hot cells in Building 4507; cleaning out filter pits 3106 and 4556; and stabilizing hundreds of feet of deactivated underground ductwork.

Demolition, removal of existing equipment, and fabrication and installation of the replacement ventilation system for the 4501, 4505, and 4500N facilities were completed in January of 2013. In September of 2013, characterization and stabilization of the underground ductwork and cleanout of the 3106 and 4556 filter pits were completed.

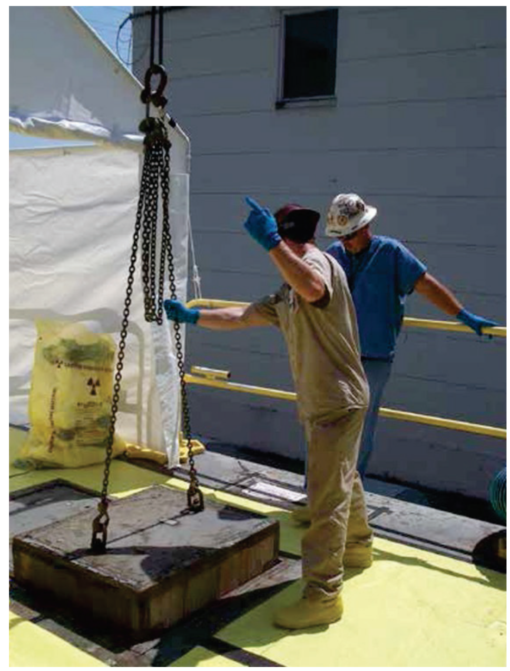

Fig. 5.44. HEPA shield plug being removed from a filter pit.

5.8.5 Excavation of Building 3550 Slab

In 2013, the Building 3550 slab, located on Central Avenue at ORNL, was excavated, along with 2 ft of contaminated soil. A completion report was submitted to EPA and TDEC.

5.8.6 Uranium-233 Project

A significant inventory of ^{233}U is stored in ORNL's Building 3019A. The ^{233}U project was initiated to address safeguards and security requirements, eliminate safety and nuclear criticality concerns, and safely dispose of this material. At the end of FY 2013 preparations necessary for shipment and disposal of stored material from a 1980s project were complete, but shipment of the material had not been initiated pending resolution of issues on disposal with the State of Nevada.

Conceptual plans for processing and disposing of the ^{233}U inventory were initiated in 2013, but follow-on design activities in FY 2014 will be contingent on budget availability.

5.8.7 Building 3038 Waste Removal and Stabilization

Building 3038, a 722 m^2 (7,773 ft^2) nuclear facility in ORNL's Central Campus area, was used for packaging, inspecting, and shipping activities for radioisotopes until 1994. In FY 2013, in preparation for building demolition, all waste was removed from the building, stabilization activities were completed, the local ventilation system was restarted, air monitoring equipment was placed online, and a report documenting completion was submitted to EPA and TDEC.

5.8.8 Molten Salt Reactor Experiment Flush and Fuel Salt Removal

The MSRE Facility, a graphite-moderated, liquid-fueled reactor, operated from 1965 through 1969. Since shutdown, several studies and removal actions have been performed to address contaminated fuel and flush salts in the facility. In 1998, a ROD for an interim action to remove fuel and flush salts was approved.

In FY 2013, comments on the MSRE Remediation Strategy Plan were received from EPA and TDEC, and a revised plan was prepared and submitted.

Also in FY 2013, additional waste from defueling performed in 2006 was identified. An inventory of the waste was completed, and a waste disposition plan was prepared and submitted to EPA and TDEC.

5.8.9 Oak Ridge National Laboratory Waste Management

5.8.9.1 Oak Ridge National Laboratory Wastewater Treatment

At ORNL, DOE EM operates PWTC and the Liquid Low-Level Waste Treatment Facility. In 2013 462 million L (122 million gal) of wastewater was treated and released at PWTC. In addition, the liquid LLW evaporator at ORNL treated 793,044 L (209,500 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.

5.8.9.2 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 2013, ORNL performed 73 waste shipments to off-site hazardous/radiological/mixed waste treatment and/or disposal vendors with no shipment rejections or violations.

5.8.9.3 Transuranic Waste Processing Center

TRU waste-processing activities carried out for DOE in 2013 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 2013, 104.2 m^3 (136.3 yd^3) of CH waste and 97.5 m^3 (127.5 yd^3) of RH waste were processed. In CY 2013, 86.7 m^3 (113.4 yd^3) of CH waste and 53.2 m^3 (69.6 yd^3) of RH waste were shipped off-site.

5.8.10 SEC Federal Services Corporation Waste

In 2013 SEC shipped 79.46 m^3 (103.93yd^3) of material from the Hot Cells Project. This included waste from Building 3026 and Building 3038.

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