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 nine user facilities that draw thousands of research scientists and visitors each year.

- Building Technologies Research and Integration Center
- 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 2011 the ORNL operations of UT-Battelle, WAI, UCOR, Isotek, and Safety and Ecology Corporation 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.

Due to 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 herein as needed for specific calculations and comparisons.

5.1 Description of Site, Mission, and Operations

ORNL lies in the southwest corner of the DOE ORR (Fig. 5.1) and is managed for DOE by UT-Battelle, LLC, a partnership of the University of Tennessee and Battelle Memorial Institute. The main ORNL site occupies about 1,809 ha (4,470 acres) and includes facilities in two valleys (Bethel and Melton) and on Chestnut Ridge. ORNL was established in 1943 as a 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.

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

ORNL 2011-G00538/chj

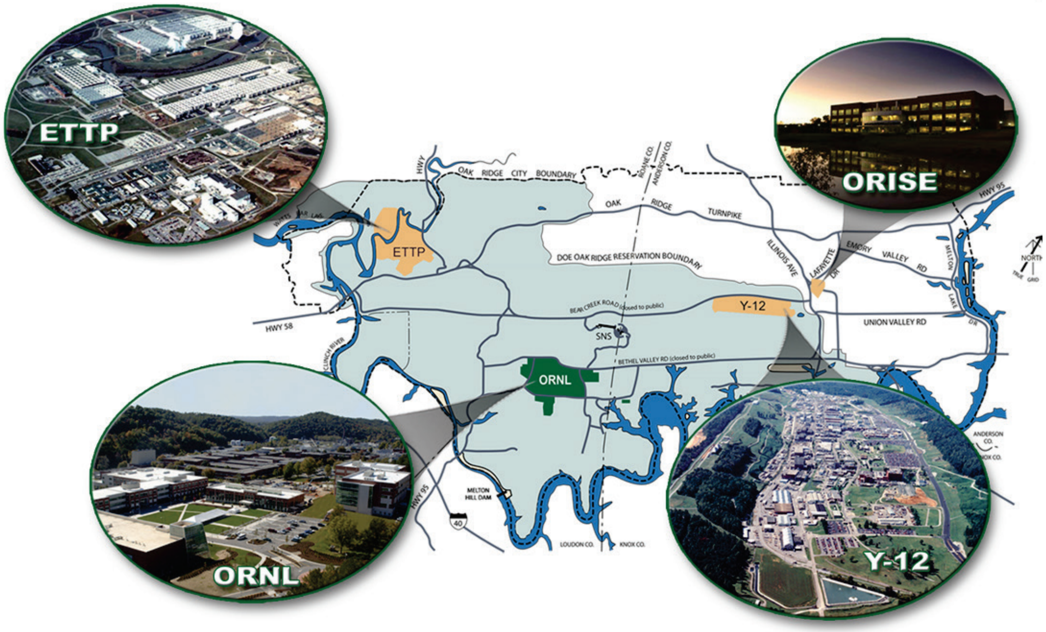

Fig. 5.1. Location of ORNL within ORR and its relationship to other local DOE facilities.

NTRC, an alliance among UT-Battelle; the University of Tennessee; DOE; NTRC, Inc.; and the Development Corporation of Knox County, is the site of activities that span the whole range of transportation research. The center is an 85,000 ft^2 building, located on a 2.4 ha (6-acre) site in the Pellissippi Corporate Center and is leased to UT-Battelle and the University of Tennessee separately by Pellissippi Investors LLC.

TWPC, managed by WAI for DOE, is located on the western boundary of ORNL on about 10 ha (25 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.

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 U-233 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 of canisters of Consolidated Edison Uranium Solidification Project material 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 the transfer of ZPR plate canisters to the NNSA Critical Safety Program located at the Device Assembly Facility at NNSS.

Since 2010 the SEC mission has been to complete deactivation, demolition, and removal activities for multiple facilities at ORNL. Work activities and removal actions are regulated by CERCLA. The objective of the Southeast Contaminated Laboratory Complex, General Maintenance Facilities Complex, and Small Facilities Complex deactivation, demolition, and disposition (D^3) projects is to demolish 34 facilities in the ORNL Central Campus totaling almost 115,902 ft^2. Historically, these facilities were used in support of reactor area operations and for various laboratory support activities. The project includes characterization, abatement, and removal of radioactive and hazardous materials; deactivation of buildings; removal of equipment; and demolition of facilities to grade level. The objective of the Central Campus Legacy Material Disposition Project is to remove material and miscellaneous legacy materials from six facilities (Buildings 3025M, 3095, 3112, 3503A, 3550T, and 4501) and six radioisotope thermoelectric generators near Building 3517 in the ORNL Central Campus. In addition, SEC was also awarded a separate contract 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 are to be removed to their concrete foundation slabs. SEC will closely coordinate with UT-Battelle and DOE on numerous environmental issues such as sitewide environmental reports, environmental monitoring, and reporting.

UT-Battelle performs air and water quality monitoring for the 3019 facility and water quality monitoring for TWPC. Therefore, the UT-Battelle air and water monitoring discussions in this chapter include the results for the 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 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*, UT-Battelle, WAI, UCOR and Isotek have implemented EMSs, modeled after ISO 14001:2004 (ISO 2004), as a tool 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 Order 450.l A, *Environmental Protection Program*." (This validation was good through June 2012. In June 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.)

Consistent with the SEC environmental policy, SEC is committed to protecting and sustaining human, natural, and cultural resources that could be impacted by the project and to completing the project safely with reduced risks to the public, the workers, and the environment. SEC is also committed to implementation of processes and procedures that minimize exposure to ionizing radiation for employees, the public, and the environment to levels that are as low as reasonably achievable.

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 service 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 environment, safety, and health 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 5.2 depicts the relationship between EMS and ISMS.

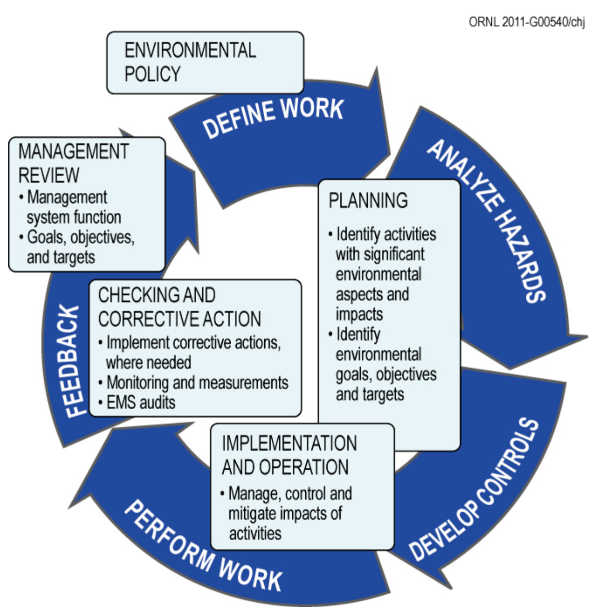

Fig. 5.2. The relationship between the UT-Battelle Environmental Management System and the Integrated Safety Management System.

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. 5.3) 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.

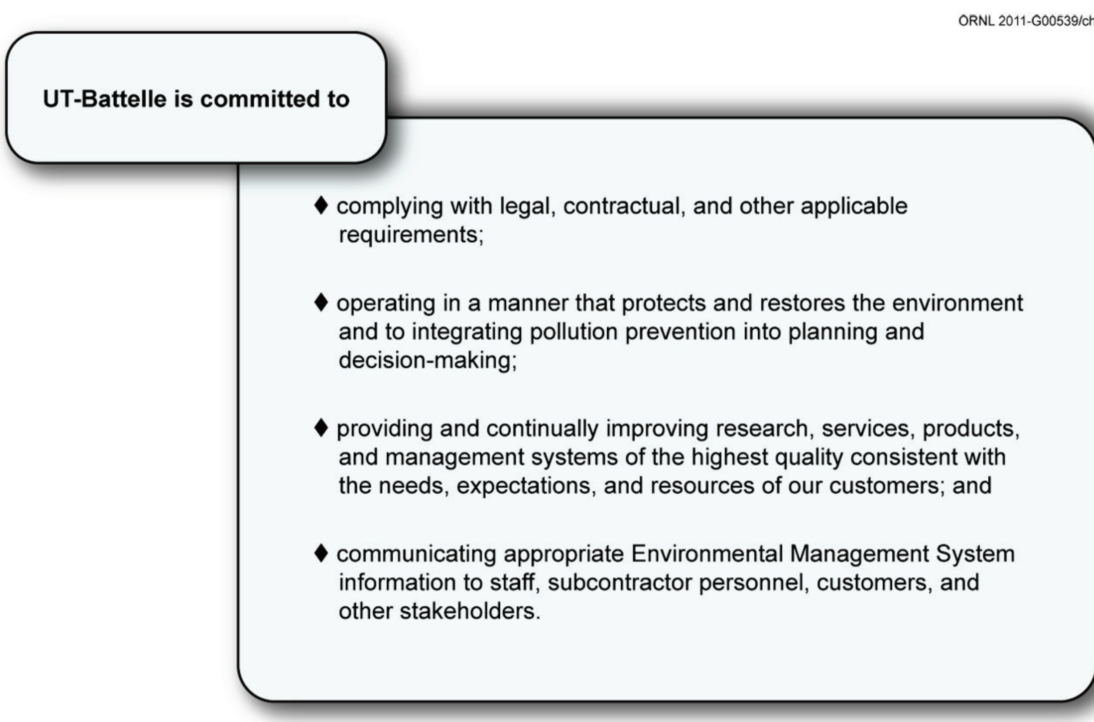

Fig. 5.3. UT-Battelle environmental policy statements.

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. In 2011, laboratory-level and organization-level objectives and targets focused on chemical inventory reduction, energy conservation, waste minimization, and recycling.

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. 5.3. Information on UT-Battelle's 2011 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 ARARs, 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. UT-Battelle implemented this multidisciplinary initiative to provide an overarching support structure to capture current efforts, to accelerate future implementation, and to provide a comprehensive sustainable vision of ORNL in the future. The ultimate goal is to achieve benchmark sustainability in campus operation and in the research, development, and deployment of key technologies by 2018. The initiative was launched in October 2008 and continues a modernization program that began in 2000.

A team was formed to develop and implement a roadmap to achieve target levels of sustainability at ORNL by 2018. Four components collectively build a base for the roadmap. The first component, "foundational methods," includes historically proven methods such as energy efficiency in buildings and processes, process water reduction, solid waste reduction, zero adverse health effects, recycle and reuse strategies, and employee and family engagement. The second component, "known technology," includes recently proven methods such as renewable energy sources, green building design, hybrid vehicles, and certain alternative fuel applications. The third component, "leading-edge technology," involves bringing together known technologies in innovative ways and includes methods currently being tested such as solar-assisted charging stations for plug-in electric vehicles (EVs), solar applications with highly efficient buildings, innovative transportation technology, advanced building design technologies, and biofuel developments. The fourth component, "transformational technology," is forward-thinking high-impact demonstration projects.

Highlights of sustainable successes achieved at ORNL during 2011 are discussed in the following sections. In addition, the sustainable campus annual report (ORNL 2012) and more detailed information on ORNL's Sustainable Campus Initiative may be found at: http://sustainability-ornl.org.

5.2.1.4.1 Modernization and Facilities Revitalization

As ORNL approaches its 70th anniversary, infrastructure that originally supported a single purpose has been transformed to host multiple world-leading scientific research facilities. Over the last decade major science program investments, including the $1.4B SNS and modernization investments exceeding $750M, have yielded modern research capability and capacity that have enabled expansion of ORNL core competencies and opportunities to best meet customer needs. More than 1 million ft^2 of Leadership in Energy and Environmental Design (LEED)–certified campus space provides a multitude of opportunities to perform research on emerging energy-efficient technologies, green construction, and proper operation and maintenance of green facilities. An aggressive commitment to building LEED-certified buildings at ORNL and the incorporation of other energy-saving measures into existing buildings had added 46%

more facility and building area by 2011 with only a 4% increase in energy consumption compared to a 2000 baseline.

New facilities have resulted in new research thrusts and growth of existing research programs. Ongoing investment will be focused to ensure the laboratory remains ready to serve the nation in the years ahead.

Efforts to modernize research facilities, to decrease facility square footage through more efficient building use, and to eliminate obsolete structures continued in 2011 and included the following.

- Construction of the Chemical and Material Sciences Building, a three-story (LEED Gold) building housing 160,000 ft^2 of state-of-the art research space (Fig. 5.4).
- Attainment of advanced project approvals for the Maximum Energy Efficiency Building Research Project (to enable the coupling of discovery science with applied engineering) and the Carbon Fiber Technology Facility (to facilitate future commercial scale production of low cost carbon fiber).
- Completion of site infrastructure projects including construction of the ORNL Guest House (LEED Silver) (Fig 5.5), construction of the Melton Valley Support Facility (LEED Gold), and replacement and/or upgrade of portions of the utility infrastructure including replacement of the 1940's water reservoir and improvement in power equipment.

In 2012, planning to address energy consumption in high-energy mission-specific facilities at ORNL will continue. These include SNS, HFIR, the Holifield Radioactive Ion Beam Facility, and the supercomputing facilities. (Note: The Holifield Radioactive Ion Beam Facility ceased operations April 15, 2012.)

ORNL 2011-P02629

Fig. 5.4. Dr. William F. Brinkman, Director of DOE's Office of Science, dedicates new ORNL Chemical and Material Sciences Building. [*Source:* Dobie Gillispie, ORNL.]

ORNl 2011-P02164

Fig. 5.5. Modernization and facilities revitalization, ORNL Guest House. [*Source:* Jason Richards, ORNL photographer.]

Integrated Facilities Disposition Initiative at ORNL

Plans to disposition 1,500,000 ft^2 of aged, expensive-to-maintain facilities located at ORNL are proposed as part of the DOE Oak Ridge Office Integrated Facility Disposition Project (IFDP). IFDP is a multibillion dollar collaborative proposal developed by the DOE Offices of Environmental Management, Science, and Nuclear Energy and NNSA that will complete the environmental cleanup of ORR and enable ongoing modernization efforts at ORNL and the Y-12 Complex.

IFDP will reduce risk to workers and the public, minimize ORNL and Y-12 Complex mission risks resulting from the presence of deteriorating facilities and excess “legacy” materials, and provide valuable real estate for modernization and the continued enhancement of complex facilities and infrastructure.

Although the details of the IFDP baseline plan for the next 10 years have yet to be finalized, it is expected that the remaining 95 Office of Science facilities identified in the approved Critical Decision-1 will be demolished by IFDP in future years.

During FY 2011, ORNL’s complementary Excess Facilities Deactivation and Disposition Program activities focused on readying facilities for transfer to IFDP for demolition. As noted, the influx of ARRA funding accelerated the IFDP demolition schedule and, as a result, operations in several Office of Science facilities had to be relocated, facilities had to be cleaned out to meet space criteria for transfer, and the real property asset information management system had to be updated to reflect the facility status change. Concurrently, these facilities were deactivated and all utilities isolated and air-gapped before transfer and demolition. Efforts over the 10-year planning period will continue to support IFDP but will expand to support the UT-Battelle master plan for the 7000 area. Efforts will focus on cleanout and demolition of facilities to support new facilities construction.

5.2.1.4.2 Energy Management and Conservation

The UT-Battelle Energy Management Program makes improvements in energy efficiency in UT-Battelle facilities, coordinates energy-related efforts across UT-Battelle organizations, and promotes employee awareness of energy conservation programs and opportunities. The program also includes activities related to the accomplishment of the goals of EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management,* (EO 2007) and the DOE Transformational Energy Action Management (TEAM) initiative.

The Energy Policy Act of 2005 (EPAct 2005) established the goal of reducing building energy intensity using 2003 as the baseline year. EO 13423 (EO 2007) sets a more stringent reduction goal of 3% per year for the same time period, resulting in a planned 30% reduction over 10 years. As shown in Fig. 5.6, UT-Battelle energy conservation efforts have exceeded those levels with a 19.6% building energy intensity reduction between FY 2003 and FY 2011. In fact, between 1985 and 2011, UT-Battelle has realized energy intensity reductions at ORNL of about 42%.

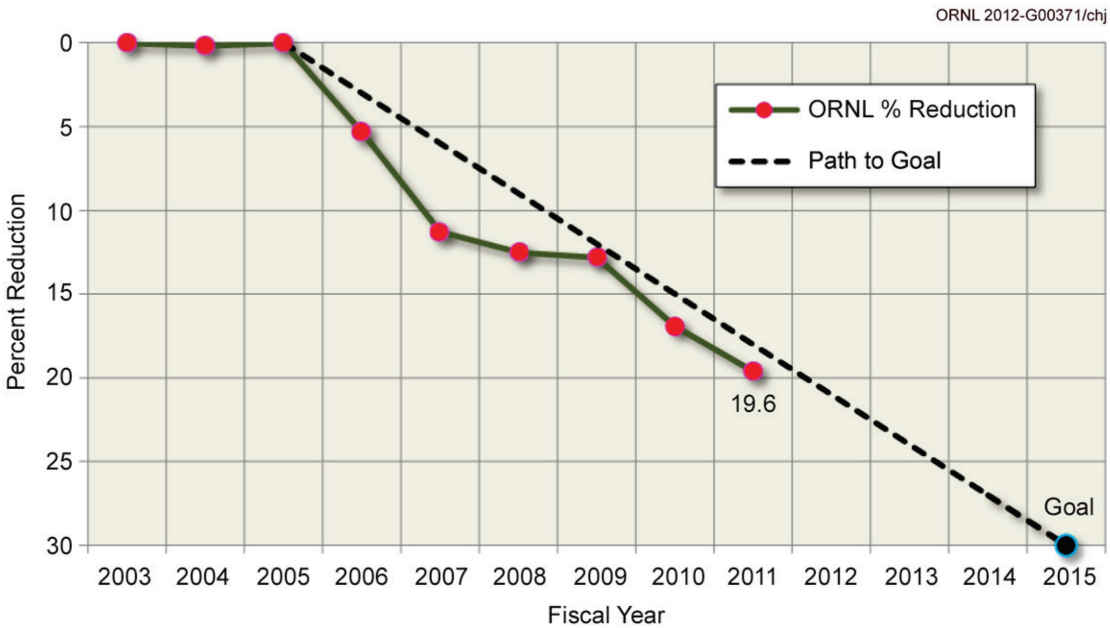

Fig. 5.6. ORNL building energy reduction versus the DOE Transformational Energy Action Management goal.

Based on FY 2011 data, buildings category energy use at ORNL was 1.36 × 1,012 Btu, accounting for ORNL excluding facilities as defined by the Energy Policy Act of 1992 (EPAct 1992). Given a building area of 4,632,267 gross square feet (gsf), the FY 2011 estimated energy intensity was 292,563 Btu/gsf, which represents a 3.22% reduction compared to FY 2010.

Since 2008, DOE has had an ESPC with Johnson Controls, Inc., for ORNL. Annual savings from the ESPC will be about $8 million. Table 5.1 demonstrates the ESPC goals implemented to meet or exceed TEAM goals.

Table 5.1. Energy savings performance contracting goals, 2011

	Transformational Energy Action Management goal	Projected results
Percentage energy intensity reduction	30	50
Percentage water usage reduction	16	23
Required advanced electric metering installations	100	100
Percentage of energy from renewable sources	7.5	21
Measurement and verification of results	Yes	Yes
Incorporate sustainable designs	Yes	Yes

Future energy intensity reductions will be realized through continued construction of new facilities and demolition of legacy facilities combined with ongoing audits and energy conservation measures (ECMs) and new efforts in building commissioning. Several ECMs are in place or are near completion, including steam system decentralization, building management system improvements, mechanical equipment upgrades, and a new biomass steam plant. In recent years, additional ECMs not included in the ESPC have been implemented to further reduce energy use, including EStar assessments and related actions; improvements in heating, venting, and air conditioning equipment; lighting improvements, replacing motors with more efficient units; and improving the efficiency of the steam distribution system. The energy audit program is progressing, with audits completed in FY 2009 and FY 2011 covering more than 50% of the ORNL campus square footage.

Supercomputing

The Computational Sciences Building (CSB) at ORNL, a 350,000 ft^2 facility, was among the first LEED-certified computing facilities in the country. It includes a specially designed computer room housing the machines, special cooling systems for each of the computer cabinets, modified chilled water system, and innovative programming.

All of these improvements have allowed CSB, which houses the Jaguar Supercomputer, the University of Tennessee-managed National Science Foundation-funded Kraken, the National Oceanic and Atmospheric Administration’s Gaea, and several smaller systems, to attain a power usage effectiveness (PUE) rating of 1.25 (the closer to 1, the more efficient). This means that for every 1.25 megawatts of energy consumed by CSB, 1 megawatt is used to power the machines and accelerate science. The other 0.25 megawatts is used for lighting, the dispersion of heat generated by the machines, and various other support equipment. A study of 22 large-scale data centers by Lawrence Berkeley National Laboratory reflected an average PUE of 1.83. The CSB’s PUE rating makes it almost 32% more efficient than its average counterpart, a direct result of aggressive energy conservation measures.

Grid

To better monitor electricity use and manage demand, advanced meters are being installed at ORNL. Forty-three buildings are currently equipped with advanced meters; however, almost every building that consumes electricity has a standard meter.

Another five buildings are awaiting advanced meter installation, and once the project is completed, advanced metering will monitor 85% of ORNL’s electrical consumption. These meters will be especially important as continued new construction increases energy demand. Currently, two systems are being used to improve demand-side management and efficiency.

Four solar arrays on the ORNL campus provide research opportunities as well as renewable energy to the laboratory. ORNL’s first solar collector, an array of 24 solar panels, was originally used as a symbol of alternative energy research and continues to generate renewable electricity. The second solar collector is an 88 m by 3 m (288 ft by 10 ft) collector made up of 168 modules. Designed to provide 51.25 kW at peak power, the array feeds direct current to an inverter that produces alternating current for the ORNL distribution grid. A total of 88 MWh of direct current is produced annually, or about 70 MWh alternating current (equivalent to the average annual power needs of 5.5 Tennessee homes). This array is designed to be 18.7% efficient and to displace about 51,710 kg (114,000 lb) of carbon dioxide every year (more than 7 times the amount produced annually by the average American). The electricity added to the grid is used to offset electricity for Building 3156. This array supports UT-Battelle’s aggressive maximum energy-efficiency building goal, which will transform the four existing buildings in the ORNL Building Technologies Research and Integration Center to maximum energy-efficient buildings. UT-Battelle accomplished the first step in meeting this goal by achieving certification of Building 3156, an 18-year-old building, as a net-zero-energy building, which included decreasing its energy consumption from about 100 MWh/year to 65 MWh/year, which is offset by the solar power. During 2011, UT-Battelle completed the installation of two additional arrays, one of 47 kW for solar-assisted EV charging and one atop the new Building 4100 on campus.

Steam

The ORNL Biomass Steam Plant will be ready for production in 2012. This innovative and collaborative project will use wood chips supplied from sources within a 100 mile radius of ORNL in a gasification process to replace most of the natural gas and fuel oil currently used at ORNL. The Biomass Steam Plant will reduce the ORNL on-site fossil fuel consumption by more than 77%, and it is anticipated this project will yield an annual GHG reduction of about 20,000 tons. Use of biomass fuel will provide a direct economic benefit to the region because the fuel source will be renewable, locally grown and processed, and supplied by a number of local small businesses.

The project also includes improvements to the steam distribution system and upgrades to improve the efficiency of the existing natural gas boilers.

Water

Water consumption is another major component of planned utility renovations. Sixty-five buildings have received plumbing upgrades such as dual-flush toilets, low-flow showers and urinals, and improved sink aerators. Additionally, system leaks are being repaired and once-through cooling water systems are being corrected. When those activities are completed, ORNL's water consumption will be reduced by more than 200 million gal/year (MGY), or about 25%. These conservation efforts are critical to offsetting the increase in water consumption from newly constructed facilities and any future facilities.

In FY 2011, ORNL's water conservation efforts reduced water use and associated waste water generation by more than 288 MGY with a cost avoidance of more than $388 thousand/year. In the last 4 fiscal years, cumulatively, water use at ORNL has been reduced by more than 386 MGY with a cumulative cost avoidance of more than $757 thousand/year. In total, once all identified water conservation efforts are complete, more than 435 MGY in reductions in water use and associated wastewater generation at ORNL will be realized, with an expected cost avoidance of more than $5.4 million/year (Fig. 5.7).

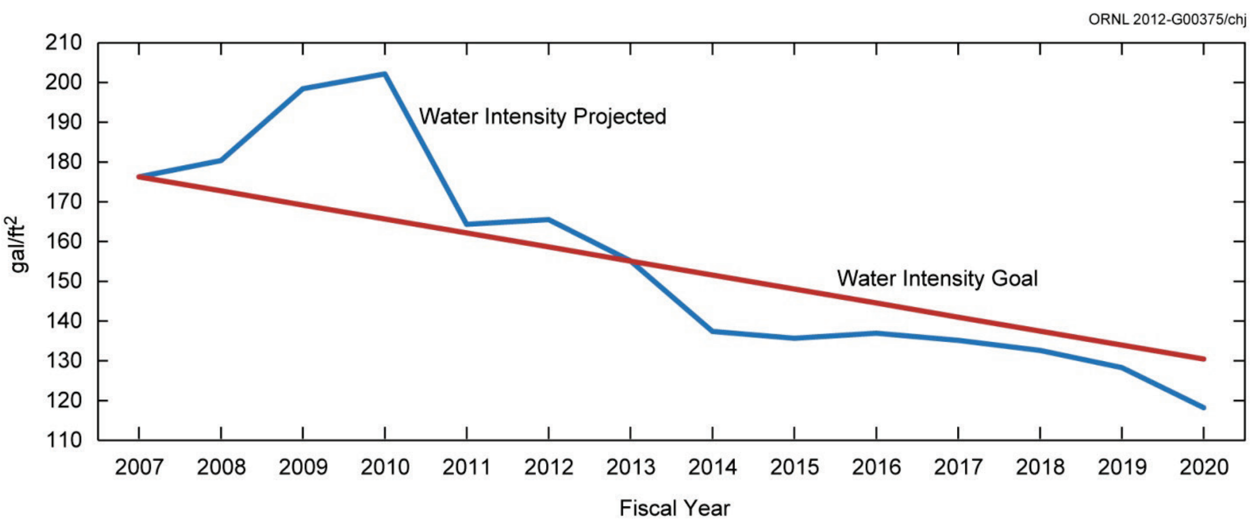

Fig. 5.7. Water use intensity.

Central Energy Data System

ORNL is actively developing a Central Energy Data System which will collect and manage data on all forms of energy consumption for the campus. It will have the capacity to collect data for water, electricity, natural gas, steam, renewable power, and EV charging and to trend and analyze the information by building and by system.

Over time, the system will have the capability to help manage peak power demand, improve electric grid performance, and reduce energy consumption. This centralized energy data repository allows role-based users (e.g., facility managers, engineers, and energy managers) to monitor and collect just-in-time data for trending and managing resources to maximize efficiencies.

Renewable Energy

UT-Battelle uses on-site solar collectors capable of producing 117 MWh per year and purchases another 675 MWh of renewable power each year from TVA's Green Power Switch Program. Additionally, in FY 2011 ORNL purchased 90,000 MWh in renewable energy certificates in support of renewable technologies, far exceeding the FY 2011 goal.

5.2.1.4.3 Transportation

UT-Battelle performs a broad range of green transportation–related R&D activities at ORNL and also embraces current technologies and techniques to reduce fuel consumption. UT-Battelle has implemented a multipronged approach to green transportation: (1) encouraging personnel to walk and to ride bikes on-site through innovative campus design; (2) encouraging shared transportation through taxi use on-site and carpool use off-site; (3) integrating maximized fuel efficiency features when upgrading campus roads; (4) increasing the use of hybrid, flex fuel, electric, and diesel vehicles in the UT-Battelle vehicle fleet; and (5) researching and implementing future alternative vehicles and fuel options. These efforts were key to a UT-Battelle fleet reduction from 515 vehicles in 2006 to 496 vehicles in 2011.

UT-Battelle's current fleet consists of a variety of vehicles which support research and operations activities (Fig. 5.8). In FY 2011, the UT-Battelle fleet included 41 hybrid vehicles, 38 low speed EVs, and 280 flex fuel vehicles.

ORNL 2012-G00372

Fig. 5.8. Vehicle fleet.

During 2011, a reduction in vehicle emissions was achieved at ORNL through the use of 86,997 gal of E85 to fuel the UT-Battelle fleet, an increase of more than 72% over 2010 (50,503 gal). The use of 75 diesel vehicles and numerous pieces of biodiesel-fueled equipment at ORNL in FY 2011 also contributed to the reductions in emissions.

With support from DOE, UT-Battelle is working with several other organizations and local governments to set up solar-assisted EV charging stations across Tennessee. At ORNL, a 25-space charging station (Fig. 5.9) covered by a solar panel canopy was completed in May 2011. This project, in addition to furthering employee options for sustainability, demonstrates the use and integration of renewable power, external battery storage, EVs, and the power grid to maximize energy efficiency.

ORNL 2011-P01920

Fig. 5.9. Solar-powered charging station. [*Source*: Jason Richards, ORNL photographer.]

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

EISA Section 438 establishes requirements for federal agencies to reduce storm water runoff from development projects to protect water resources. UT-Battelle complies with EISA Section 438 by using a variety of storm water management techniques referred to as “green infrastructure” (GI) or “low impact” (LI) development practices. Strategic plans for ORNL that include demolition and renovation of old facilities and construction of new facilities have considered and incorporated GI and LI development practices to infiltrate, evapotranspire, and/or harvest and use storm water on-site to the maximum extent technically feasible. GI-LI development 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

There are plans to continue modernization activities at ORNL. These plans include GI-LI approaches and technologies to mimic the natural hydrologic cycle processes of infiltration, evapotranspiration, and use.

Green Landscaping

Native plants are being used in the landscaping at ORNL as a major focal point of the Sustainable Campus Initiative (Fig. 5.10). Native plants are better adapted to local environmental conditions, and landscaping and plants can be chosen to reduce water usage, maintenance, mowing, water pollution, and use of toxic chemicals. The use of these plants also supports native birds, butterflies, dragonflies, and other wildlife—some of which are dependent on specific native plant species for food and reproduction. Major FY 2011 landscaping projects at ORNL included wetland enhancement adjacent to Building 4100, riparian buffer landscaping adjacent to the High Temperature Materials Laboratory, and native grass establishment and prairie-type community landscaping at the pond adjacent to the Visitor's Center.

ORNL 2006-P04701

Fig. 5.10. Sustainable landscaping. [*Source:* Curtis Boles, ORNL photographer.]

5.2.1.4.5 UT-Battelle Employee Involvement Opportunities

UT-Battelle's Sustainable Campus Initiative includes a large, active Employee, Family, and Community Engagement Roadmap Team, which encourages a broad suite of awareness outreach activities. For example, UT-Battelle sponsored a large Earth Day celebration at ORNL in April, 2011 and participated in several related celebrations and events within neighboring communities (Fig. 5.11).

ORNL 2011-P01419

Fig. 5.11. Oak Ridge National Laboratory Earth Day 2011.

5.2.1.4.6 Pollution Prevention

UT-Battelle implemented 35 new pollution prevention projects at ORNL during 2011, eliminating more than 1 billion kg (about 2 billion lb) of waste, which included more than 288 million gal of wastewater. Excluding the wastewater efforts, these projects eliminated about 7 million kg (about 15 million lb) of waste. In total, all of these projects led to cost savings/avoidance of more than $7 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 to go paperless; resource efficient supercomputing; and recycling programs for lead, electronics, and construction and demolition debris were also implemented during 2011 (Fig 5.12).

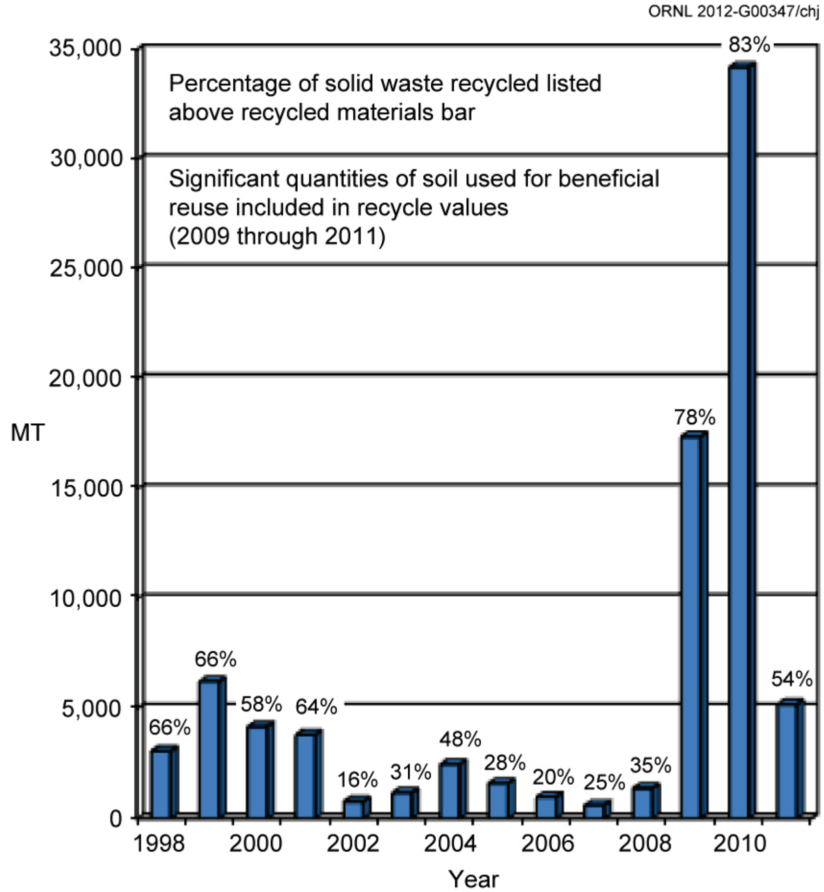

Fig. 5.12. Oak Ridge National Laboratory Recycling Program.

During the year UT-Battelle aggressively supported the recycling program at ORNL with more than 54% of FY 2011–generated materials being diverted for recycle or beneficial use. Large construction projects incorporate comprehensive project-specific recycling efforts. It was not always efficient to incorporate these efforts into smaller projects; however, one successful FY 2011 activity involved establishing a contract to recycle construction and demolition waste generated from these smaller projects.

For more information on these and other UT-Battelle conservation and recycling activities, see http://sustainability-ornl.org.

ORNL Site Pollution Prevention Awards

DOE's Environmental Sustainability Award (previously DOE Management Award)—ORNL's GreenIT Effort nomination received a DOE headquarters 2011 Sustainability Award.

Tennessee Chamber of Commerce and Industry (TCC&I) Environmental Excellence Achievement Award—ORNL's Sustainable Campus Initiative "Accelerating Sustainable Success Now and in the Future" initiative nomination received a TCC&I Environmental Excellence Award.

Inaugural East Tennessee Green Light Award—ORNL was selected by the US Green Building Council East Tennessee Chapter for its inaugural East Tennessee Green Light Award for the laboratory's "exemplary contributions to sustainability in the built environment."

National Biodiesel Board's Eye on Biodiesel Award, Innovation Category—ORNL's Keith Kline and Virginia Dale won this award because they are leaders in scientific thought and published research on the true environmental impact of biodiesel and renewable fuels.

5.2.1.5 Implementation and Operation

5.2.1.5.1 Structure and Responsibility

The UT-Battelle Environmental Policy (Fig. 5.3) represents the philosophy of UT-Battelle management for the conduct of research, operations, and other activities at ORNL. A key tenet of the policy is the integration of environmental and pollution prevention principles into work practices at all levels. Before performing any work at ORNL, all staff are required to complete comprehensive site orientation and training that outline employee responsibilities for environmental compliance and set forth expectations for all employees to comply with the policy statements and with the UT-Battelle EMS. Specific roles and responsibilities are further defined in position descriptions and individual performance plans.

An Environmental Protection Officer (EPO) Program, an Environmental Compliance Representative (ECR) Program, and a Waste Services Representative (WSR) Program have also been established to ensure that work planning activities for all UT-Battelle organizations address environmental protection and pollution prevention measures. The objectives of these programs are as follows.

- The EPO and ECR Programs
  - coordinate efforts to seek, accomplish, and maintain environmental compliance across all UT-Battelle organizations;
  - communicate environmental requirements and compliance strategies; and
  - provide liaisons between individual UT-Battelle organizations and the Environmental Protection and Waste Services Division.
- The WSR Program
  - provides a technical interface between waste generators and the Environmental Protection and Waste Services Division;
  - provides expertise in identifying, characterizing, packaging, and certifying wastes for disposal; and
  - coordinates the support required to complete necessary forms, properly classify waste streams, and develop the characterization basis to successfully complete the waste certification and disposal process.

5.2.1.5.2 Communication and Community Involvement

Information on the UT-Battelle EMS is routinely communicated internally to staff and externally to stakeholders in several ways.

- EPO, ECR, WSR, and management system owner meetings and workshops dedicated to EMS topics
- Environmental protection websites
- SBMS documentation available to all employees
- Notices on ORNL Today, an electronic publication which provides current information to staff on activities, programs, and events at the laboratory
- EMS brochures and badge cards
- *Oak Ridge Reservation Annual Site Environmental Report,* which includes information on significant aspects, compliance status, pollution prevention programs, and other EMS elements and is made available to the public, regulators, and stakeholders

5.2.1.6 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 SME 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.

5.2.1.7 Checking

5.2.1.7.1 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.

5.2.1.7.2 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.

The SBMS "Assessments" subject area 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 2011, 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 environment, safety, and health goals. The EMS and ISMS are incorporated into the *Integrated Safety Management System Description* (BJC 2009); 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 contract requirements document (WAI 2010) and its regulatory management plan (WAI 2008), 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, and batteries. During the last part of 2009, WAI evaluated and put into place a "single stream" recycling program that allows the mixing of multiple types of recyclables and increases the population of recyclable items.

"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 bio-based materials and other environmentally friendly products. In 2011, WAI procured environmentally preferable materials totaling about $69,159 for use at TWPC.

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 2011 UT-Battelle, UCOR, WAI, Isotek, and Safety and Ecology Corporation operations were conducted in compliance with contractual and regulatory environmental requirements with the exception of five issues identified during a joint EPA-TDEC RCRA inspection. These issues are summarized in Section 5.3.6.

There were no NOVs or penalties issued by the regulatory agencies. Table 5.2 presents a summary of environmental audits conducted at ORNL in 2011.

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 2011 and provide an overview of the compliance status for the year.

Table 5.2. Summary of regulatory environmental audits, evaluations, inspections, and assessments conducted at ORNL, 2011

Date	Reviewer	Subject	Issues
January 5	TDEC	Annual CAA Inspection	0
February 7	Knox County	Operating Permit Inspection for NTRC	0
April 28	Knox County	Annual CAA Inspection for NTRC Facility	0
May 16–17	TDEC	Annual RCRA Inspection	0
October 31–November 1	TDEC	Annual RCRA Inspection of UT-Battelle facilities at Y-12 Complex	0
November 7	Knox County	Operating Permit Inspection for NTRC	0
December 12–16	EPA/TDEC	RCRA Inspection	5

Abbreviations

CAA	Clean Air Act
EPA	US Environmental Protection Agency
NTRC	National Transportation Research Center
RCRA	Resource Conservation and Recovery Act
TDEC	Tennessee Department of Environment and Conservation

5.3.1 Environmental Permits

Table 5.3 contains a list of environmental permits that were effective in 2011 at ORNL.

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 2011.

During 2011, 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 CXs 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.

In 2010, an environmental assessment for the Isotek-managed U-233 Disposition Project (Building 3019 Complex) was completed, and a "finding of no significant impact" (FONSI) under the NEPA process was issued (DOE 2010). In 2011, Isotek continued to manage the project as documented in the environmental assessment and FONSI, and on November 7, 2011, DOE issued a memorandum documenting a supplemental NEPA analysis addressing recommendations that were issued in the final draft U-233 alternatives analysis phase I report (DOE 2011). DOE determined that the alternatives analysis screening report recommendations were "adequately bounded by the existing impact analysis documented in EA-1651 (DOE 2010) and findings of the FONSI." Further information on the final draft U-233 alternatives analysis phase I report can be found in Section 5.1.1.

Table 5.3. Oak Ridge National Laboratory environmental permits, 2011

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Radioactive Materials Analytical Laboratory	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Steam Plant	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Manipulator Boot Shop	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	SNS Central Utilities Building Boilers	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Surface Coating and Cleaning Operation	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	SNS and CNF (construction permit)	956542P	10/29/04	03-01-08[a]	DOE	UT-B	UT-B
CAA	SNS Central Laboratory and Office Boilers	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	EGCR Boilers	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Air Stripper (BJC permit)	547563	10/21/04	10-21-09[a]	DOE	BJC	BJC
CAA	HFIR & REDC	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Off Gas & Hot Cell Ventilation (BJC permit)	547563	10/21/04	10-21-09[a]	DOE	BJC	BJC
CAA	NTRC	0941-02[b]	03/12/09	Annually[a]	DOE	UT-B	UT-B
CAA	NTRC (Construction Permit)	0941-03[b]	12/22/10	12/22/11	DOE	UT-B	UT-B
CAA	TN Operating Permit (emissions source)	06331P	03/07/12	03-01-22	DOE	WAI	WAI
CAA	Radiochemical Development Facility	560898	07/27/09	07-26-14[a]	DOE	Isotek	Isotek
CAA	Biomass Boiler and Melton Valley Steam Plant (construction permit)	962300F	03/27/09	03-01-10[a]	DOE	UT-B	UT-B, JCI
CAA	CNMS, Boilers (Construction)	963740F	08/18/10	09/01/11	DOE	UT-B	UT-B
CAA	Title V Operating Permit	562765	08/16/11	08/15/16	DOE	UT-B	UT-B
CAA	Biomass Gasification Boiler (construction)	962300F	03/27/09	03/01/10	DOE	UT-B	UT-B
CAA	NTRC Operating Permit	0941-02	03/12/09	Annually	DOE	UT-B	UT-B
CAA	NTRC Operating Permit	0941-03	02/08/11	Annually	DOE	UT-B	UT-B
CAA	NTRC Construction Permit	C-0941-04	07/26/11	07/26/12	DOE	UT-B	UT-B
CAA	NTRC Construction Permit	C-0941-05	11/01/11	11/01/12	DOE	UT-B	UT-B
CAA	Title V Operating Permit (UCOR)	562860	07/16/10	07/15/15	DOE	UCOR	UCOR
CAA	Operating Permit	057077P	04/13/04	10/13/14	DOE	WAI	WAI

Table 5.3. (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Title V Operating Permit	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, BJC, WAI
CWA	Tennessee General (NPDES) Permit No. 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 No. 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	Corps of Engineers Nationwide Permit #39, Commercial and Institutional Developments for "Minor Wetland Fill Associated with Proposed Parking Structure, White Oak Creek Mile 2.7R, Clinch River mile 50.8R, Roane County, Tennessee, ORNL Parking Structure."	LRN-2009-01598	12-03-09	12-03-11	DOE	DOE	UT-B
CWA	Tennessee General Permit No. TNR10-0000, Stormwater Discharges from Construction Activity—ORNL Decommissioning & Demolishing Buildings	TNR1301343	05-26-05	NA	DOE	DOE	UT-B
CWA	Individual ARAP, "Installation of approximately 200 feet of culvert in an unnamed tributary to Fifth Creek and the fill of approximately 0.08 acres of associated wetland for the construction of a parking structure."	NRS09.320	01-15-10	01-14-11	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 No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL Steam Plant Boiler Building (Melton Valley Steam Plant)	TNR133507	06-09-10	05-23-16	DOE	DOE	JCI
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Biomass Gasification System Project	TNR133428	06-09-10	05-23-16	DOE	DOE	JCI

Table 5.3. (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	Tennessee General (NPDES) Permit No. 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	02-01-08	12-31-12	DOE	WAI	WAI
CWA	Tennessee General Permit No. TNR10-0000, Stormwater Discharges from Construction Activity—Site Expansion Project	TNR 133560	08-31-09	NA	DOE	WAI	WAI
CWA	Aquatic Resource Alteration Permit for Maintenance of the Flume at White Oak Creek Headwaters Monitoring Station	ARAP NR1103.115	10-11-11	10-11-12	DOE	UT-B	UT-B
RCRA	Hazardous Waste Transporter Permit	TN18900900 03	01-24-11	01-31-12	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/UCO R/WAI	UCOR/WAI

Abbreviations

CAA Clean Air Act
CNF Central Neutralization Facility
CROET Community Reuse Organization of East Tennessee
CWA Clean Water Act
DOE US Department of Energy
EGCR Experimental Gas-Cooled Reactor
HFIR High Flux Isotope Reactor
JCI Johnson Controls, Inc.
NPDES National Pollutant Discharge Elimination System
NTRC National Transportation Research Center
ORNL Oak Ridge National Laboratory
RCRA Resource Conservation and Recovery Act
REDC Radiochemical Engineering Development Center
SNS Spallation Neutron Source
UCOR URS | CH2M Hill Oak Ridge LLC
UT-B UT-Battelle
WAI Wastren Advantage, Inc.

[a]Continued construction/operation under an expired permit is allowed under air pollution control regulations when timely renewal or construction permit applications are submitted.

[b]Permit issued by Knox County Department of Air Quality Management.

[c]DOE and Oak Ridge Reservation contractors are co-operators of hazardous waste permits.

Table 5.4. National Environmental Policy Act (NEPA) activities, 2011

Types of NEPA documentation	Number of instances
Oak Ridge National Laboratory	
Environmental Assessment	1
Categorical exclusions (CXs) approved	4
Approved under general actions or generic CX documents	47[a]
Wastren Advantage, Inc.	
Approved under general actions or generic CX documents	3[a]
Isotek	
Supplemental NEPA analysis in support of the U-233 Disposition Project	1

[a]Projects that were reviewed and documented through the site NEPA compliance coordinator.

In 2011, an environmental assessment for the *Spruce and Peatland Responses Under Climatic and Environmental Change Experiment* (DOE 2011a) was completed and a FONSI was issued. This research project will be conducted by UT-Battelle researchers at the Marcell Experimental Forest near Grand Rapids, Minnesota.

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 *Cultural Resource Management Plan* (DOE 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, New Source Performance Standards, and NESHAP. 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 this Title V Major Source Operating Permit, more than 1,500 data points are collected and reported every year. In addition, there are 2 continuous monitors for criteria pollutants, 9 continuous samplers for radionuclide emissions, 15 minor radionuclide sources, and numerous demonstrations of compliance with generally applicable air quality protection requirements (asbestos, stratospheric ozone, etc.). Also, Knox County Air Quality permits are maintained for the off-site NTRC. In 2011, an annual compliance report was submitted for this permit. In summary, there were no UT-Battelle, Isotek, or WAI CAA violations or exceedances in 2011. Section 5.4 provides detailed information on 2011 activities conducted at ORNL 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 sewage treatment plants (STPs) and industrial facilities. EPA established the NPDES permitting program to regulate compliance with pollutant limitations. The program was designed to protect surface waters by limiting effluent discharges into streams, reservoirs, wetlands, and other surface waters. EPA has delegated authority for implementation and enforcement of the NPDES program to the State of Tennessee.

In 2011, 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 2011 was nearly 100%, with only one measurement exceeding numeric NPDES permit limits. On November 29, 2011, a daily maximum *Escherichia coli* permit limit was exceeded at the ORNL STP due to a rain event. Other NPDES-related issues included a January 28, 2011, miscommunication that resulted in two missed effluent measurements at the ORNL Steam Plant Wastewater Treatment Facility (SPWTF); a March 16, 2011, construction activity that accidentally breached an underground water supply pipe, resulting in the release of chlorinated tap water to Fifth Creek via NPDES storm water outfalls and causing the death of nine stoneroller minnows; and the August 9, 2011, improper (unrefrigerated) storage of an NPDES effluent sample at a contract analytical laboratory that caused a holding-time exceedance for one ammonia sample. Section 5.5 contains detailed information on the activities and programs carried out in 2011 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 1200-05-01, Public Water Systems (TDEC 2009), 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), and
- disinfectant by-product (trihalomethanes and haloacetic acids).

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 2011, sampling results for ORNL's water system residual chlorine levels, bacterial constituents, and disinfectant by-products were all within acceptable limits. TDEC requires triennial sampling of the ORNL potable water system for lead and copper; the next sampling is scheduled to be performed during June–September 2012.

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 2011, DOE and its contractors at ORNL were jointly regulated as a large-quantity generator of hazardous waste under EPA ID TN1890090003 because, collectively, they generated more than 1,000 kg of hazardous/mixed wastes in at least 1 calendar month during 2011. 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 may be shipped off-site for treatment and storage. The RCRA units operate under three permits at ORNL, TNHW-145, TNHW-134, and TNHW-121, as shown in Table 5.5. In 2011, UT-Battelle and UCOR were permitted to transport hazardous wastes under an EPA ID number issued for ORNL activities, and UT-Battelle was registered to operate a transfer facility for temporary storage (less than 10 days) of hazardous wastes transported from off-site locations (such as NTRC).

Table 5.5. Oak Ridge National Laboratory Resource Conservation and Recovery Act operating permits, 2011

Permit number	Building/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
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 TWPF-7 (Drum Venting 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
	Oak Ridge Reservation
TNHW-121	Hazardous Waste Corrective Action Permit

[a]Treatment operating units within Building 7880.

Abbreviations
TWPC Transuranic Waste Processing Center
WPB Waste Processing Building

Reporting is required for hazardous waste activities on 42 active waste streams at ORNL, some of which are mixed wastes. The quantity of hazardous/mixed waste generated at ORNL in 2011 was 911,842 kg. Mixed wastewater accounted for 719,700 kg. Excluding the wastewater generation, which remains fairly constant from year to year, 2011 hazardous waste generation decreased about 26%. ORNL generators treated 9,088 kg of hazardous/mixed waste by elementary neutralization and silver recovery; and 3,801 kg of hazardous/mixed waste was received from UT-Battelle generators at the Y-12 Complex—2,028 kg of this waste was stored at ORNL and will be processed at TWPC, and 1,773 kg was stored at ORNL and then shipped offsite to commercial RCRA-permitted facilities for treatment. The quantity of hazardous/mixed waste treated in RCRA-permitted treatment facilities at ORNL in 2011 was 42,584 kg. This includes waste treated by macroencapsulation, amalgamation, size reduction, and stabilization/solidification. In addition, 719,700 kg of mixed waste was treated at an on-site wastewater treatment facility. The amount of hazardous/mixed waste shipped off-site to commercial treatment, storage, and disposal facilities decreased about 49% to 260,911 kg in 2011.

In May 2011, TDEC conducted an annual RCRA inspection, and in December 2011, EPA and TDEC conducted a joint RCRA inspection of ORNL generator areas; battery collection areas; RCRA-permitted treatment, storage, and disposal facilities; and RCRA records, including required training, generator inspections, permitted facility records, shipments, transfer facility log, the 2010 RCRA Annual Report of Hazardous Waste Activities, and the 2010 Hazardous Waste Reduction Progress Report. During the May 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. During the December inspection, five activities/records were determined to be noncompliant with RCRA regulations and permits; however, no NOVs or penalties were associated with this inspection. The issues identified are listed below.

- A container of unlabeled used oil belonging to UT-Battelle was found and was properly labeled during the inspection.
- A small gap (between the sealing tape and the lid) was found on one end of a cardboard box containing used fluorescent lamps This container was considered to be noncompliant with a requirement that universal waste containers be closed. The container was resealed by UT-Battelle.
- A WAI SAA was determined by the inspectors to not be at or near the point of generation. The waste was moved to compliant storage and the SAA was closed.
- A WAI manifest that had not been signed by the generator was discovered and corrected during the inspection.
- A record of WAI-conducted weekly inspections of permitted facilities, required by permit TNHW-145, did not include the time of the inspections as required by the inspection forms. The inspection forms have been modified through a Class 1 permit modification to eliminate recording the time of inspection.

At NTRC and the DOE Office of Scientific and Technical Information, DOE and UT-Battelle were regulated as conditionally exempt small-quantity generators in 2011, meaning that less than 100 kg of hazardous waste per month was generated.

No hazardous/mixed wastes were generated, accumulated, or shipped by DOE or UT-Battelle at the 0800 Area* in 2011.

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 2011 for ORNL's Solid Waste Management Units and Areas of Concern were consolidated with updates for ETTP, Y-12 Complex, and ORR and were reported to TDEC, DOE, and EPA Region 4 in January 2012.

In May 2005 BJC applied for a RCRA postclosure permit for SWSA 6, which had not been issued at the time DOE transitioned environmental management responsibilities to UCOR. RCRA groundwater monitoring data are reported yearly to TDEC and EPA in the annual CERCLA remediation effectiveness report for ORR (DOE 2011b).

Periodic updates of proposed construction and demolition 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 construction and demolition 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 remedial actions and do not adversely impact future CERCLA environmental remedial actions.

The UT-Battelle EMPO manages or performs an integration function for the DOE Office of Environmental Management-funded IFDP and ARRA work at ORNL. Although the conduct of DOE Office of Environmental Management-related work (i.e., environmental remediation and building decontamination and demolition) is not a UT-Battelle core business function, UT-Battelle has endorsed participation in ARRA-funded cleanup work to accelerate ORNL revitalization by removing legacy facilities and materials, upgrading the 4500 Area Central Ventilation System, and removing several slabs

*The 0800 Area is a location adjacent to Oak Ridge National Laboratory on the Oak Ridge Reservation that has been assigned EPA identification number TNR000019760.

and associated contaminated soils in the central campus area. This reduces the liabilities and risks to current and future ORNL science missions. During 2011, EMPO supported other DOE contractors in the demolition of 21 buildings and three tanks in the ORNL Central Campus Area, including the 2061 stack; Buildings 3008, 3012, 3044, 3084, 3085, 3095, 3098, 3103, 3111, 3112, 3115, 3117A, 3119, 3132, 3503A, 3504, 3541, 3550, 3550T, 3592, and 3629; and above ground storage tanks 3085A and 3085B and Tank W-1A. Remediation activities in SWSA 3 were completed under the ROD/remedial action work plan (RAWP) for the Bethel Valley Burial Grounds. EMPO managed and completed the ARRA-funded work for the isotopes area legacy materials removal, which resulted in the disposal of legacy storage casks from the exterior storage area west of Building 3028. In addition, EMPO was able address the lead and other mixed waste materials in Buildings 3030 and 3031, which resulted in the removal of about 50,000 pounds of lead, with about 23,400 pounds being reused for mobile shielding at SNS. EMPO characterized, packaged, and disposed legacy material in the glove boxes located in the actinide process area in the 9204-3 (Beta 3) facility located at the Y-12 Complex and removed building slabs and abandoned process waste lines and remediated contaminated soil in the northwest quadrant of the central campus area. These activities and other 2011 DOE Office of Environmental Management accomplishments at ORNL are discussed in more detail in Section 5.8 and in the FY 2011 cleanup progress annual report to the Oak Ridge community (DOE 2011c).

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 currently deferred from regulation. This UST is inactive.

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 NPL. In 1992, the ORR FFA among EPA, TDEC, and DOE became effective and established the framework and schedule for developing, implementing, and monitoring remedial actions 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 2011, UT-Battelle operated about 17 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. Four 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 2011, 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 2011 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 2011.

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

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 the US Environmental Protection Agency (EPA)
Section 313, Toxic Chemical Release Reporting	Requires that releases of toxic chemicals be reported annually to EPA

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 EPCRA's Section 312 requirements. In 2011, 20 hazardous or extremely hazardous chemicals were located at ORNL.

Private-sector lessees associated with the reindustrialization effort were not included in the 2011 submittals. Under the terms of their lease, lessees must evaluate their own inventories of hazardous and extremely hazardous chemicals and must submit information as required by the regulations.

5.3.10.2 Toxic Chemical Release Reporting (EPCRA Section 313)

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

For CY 2011, ORNL reported the otherwise use of 59,473 lb of nitric acid and the manufacture of 78,699 lb of nitrate compounds (Table 5.7). Of this, 59,405 lb of the nitric acid was used for waste treatment at the Process Waste Treatment Complex (PWTC) and 68 lb was sent off-site for disposition. Nitrate compounds are coincidentally manufactured as by-products of neutralizing nitric acid waste and as by-products of sewage treatment. The nitrate compounds from the ORNL STP are released into the environment. The discharge of nitrate compounds is not regulated in the NPDES permit for the sewage plant.

Table 5.7. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and off-site transfer summary[a] for ORNL, 2010 and 2011

Chemical	Year	Quantity (lb)
Nitrate compounds	2010	55,260
	2011	78,699
Nitric acid	2010	32,092
	2011	59,473
Total	2010	87,352
	2011	138,172

[a]Represents total releases to air, land, and water and includes off-site waste transfers. Also includes quantities released to the environment as a result of remedial actions, catastrophic events, or one-time events not associated with production processes.

5.3.11 US Department of Agriculture/Tennessee Department of Agriculture

In 2011, UT-Battelle personnel had 7 domestic soil agreements for receipt of or movement of quarantined soils, 5 soil permits for receipt of or movement of nondomestic soils (from outside the continental United States), and 16 other permits or approvals for receipt of other material regulated by USDA, such as animal or plant viruses or genetically engineered organisms. The domestic soil agreements are jointly issued by USDA and the Tennessee Department of Agriculture, whereas permits are issued by USDA.

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 Permit includes 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 NESHAP for Radionuclides (see Sect. 5.4.3), requirements applicable to sources of ambient air criteria pollutants, and requirements applicable to sources of other hazardous air pollutants (nonradiological). In April 2009, an application was submitted to the State of Tennessee to renew this sitewide permit and the application was also updated in September 2010. As a result, the State of Tennessee issued a new sitewide Title V Operating Permit to DOE–UT-Battelle on September 1, 2011.

The primary emission points of nonradioactive emissions at ORNL included three boilers located on the main ORNL site, two boilers located at the 7600 complex, four boilers located at the SNS site, and four boilers located at the Melton Valley Steam Plant (MVSP). All of these units use fossil fuels; therefore, criteria pollutants are emitted. Actual and allowable emissions from the sources are compared in Table 5.8. Actual emissions were calculated from fuel usage and EPA emission factors. Boiler 6, located on the main ORNL site, is a 125 MBtu/h boiler and is subject to the new source performance standards of 40 CFR 60 Subpart Db with continuous emission monitoring requirements for nitrogen oxides (NO_X) and opacity.

Table 5.8. Actual versus allowable air emissions from ORNL steam production, 2011

Pollutant	Emissions (tons per year)[a]		Percentage of allowable (%)
	Actual	Allowable	
Sulfur dioxide	21.6	1277	1.7
Particulate matter	3.3	71	4.6
Carbon monoxide	34	196	17.3
Volatile organic compounds	2.2	14	15.7
Nitrogen oxides	60.1	380	15.8

[a]1 ton = 907.2 kg.

As part of the ESPC construction project initiated in 2009, significant progress was realized through physical modifications to improve operating efficiency to boilers 5 and 6 located at the main ORNL site steam plant and the installation of the MVSP to provide local steam and building heat for the 7900 complex area. The biomass gasification boiler, the main component in the ESPC construction project conducted initial start-up in accordance with the provisions of the state issued construction permit on December 8, 2011, and is expected to be incorporated into the sitewide Title V Operating Permit in 2012. The biomass boiler will gasify wood fuel to provide the ORNL facility a clean source of steam and will significantly displace fossil fuels used by the existing steam plant, which will reduce fossil fuel consumption at ORNL. All UT-Battelle emission sources operated in compliance with Title V permit conditions during 2011.

For state FY 2011, UT-Battelle paid $7,748 in annual emission fees to TDEC. The fees are based on a combination of actual and allowable emissions.

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 2011, no permit limits were exceeded.

5.4.2 National Emission Standards for Hazardous Air Pollutants—Asbestos

Numerous facilities, structures, and 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 include notifications to TDEC for all demolition activities and required renovation activities and current use of engineering controls and work practices, inspections, and monitoring for proper removal and waste disposal activities of ACM. No releases of reportable quantities of ACM occurred at ORNL during 2011.

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. 5.13).

- 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 Facility
- 7880 TWPC
- 7911 Melton Valley complex, which includes HFIR and the Radiochemical Engineering Development Center (REDC)
- 8915 SNS Central Exhaust Facility stack

In 2011, there were 19 minor point/group sources, and emission calculations/estimates were made for each of them.

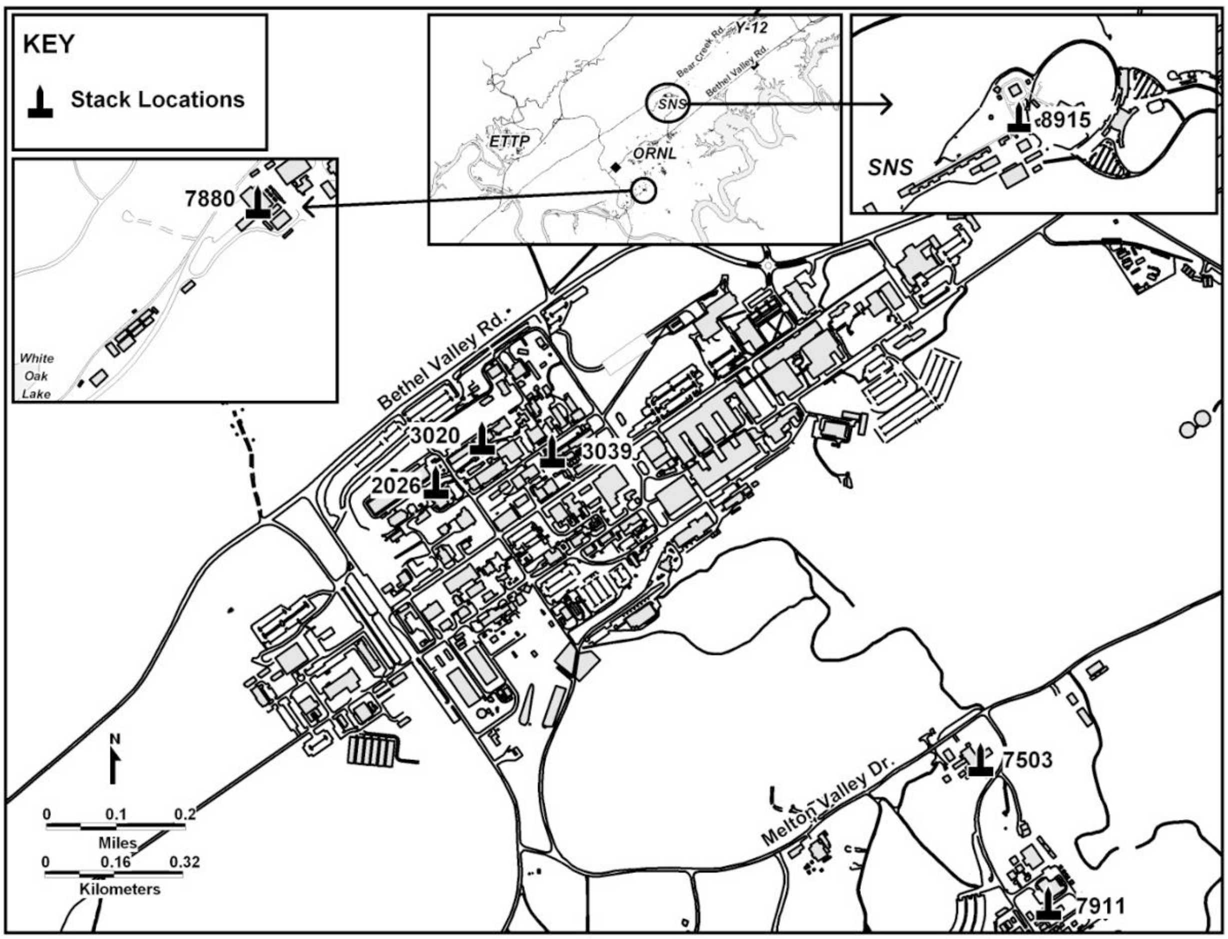

Fig. 5.13. Locations of major radiological emission points at Oak Ridge National Laboratory.

5.4.3.1 Sample Collection and Analytical Procedure

Five of the major point sources (2026, 3020, 3039, 7503, and 7911) 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. In addition to that instrumentation, the system at Stack 7911 includes 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 sample probes are annually removed, inspected, and cleaned. The 7880 stack is equipped with an in-stack source-sampling system that complies with criteria in the ANSI Health Physics Society standard ANSI/HPS N13.1-1999 (ANSI 1999). The 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 probe is annually removed, inspected, and cleaned. The 8915 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 prior to 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 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 has historically shown 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 2011 are presented in Table 5.9. 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 5.9 shows total radionuclide emissions from point sources on ORR. Also shown are the assumed lung clearance type and activity median aerodynamic diameters (AMADs). The designation of F, M, and S refers to the lung clearance type—Fast (F), Moderate (M), and Slow (S) for the given radionuclide. The default AMAD of 1.0 µm was used for modeling unless the radionuclide was a gas/vapor or it was otherwise requested. The chemical form used in most cases was unspecified, except when the chemical form was known and available in CAP88PC Version 3.

Historical trends for ^{3}H and ^{131}I are presented in Figs. 5.14 and 5.15. For 2011, ^{3}H emissions totaled about 225.0 Ci (Fig. 5.14), an increase from 2010; ^{131}I emissions totaled 0.13 Ci (Fig. 5.15), a significant increase from 2010 but in line with 2009 emissions. The increase in ^{3}H and ^{131}I were due to research activities in 2011 in REDC involving the processing of heavy element targets. Increases in ^{3}H emissions can also be attributed to increases in beam power at SNS. For 2011, the major dose contributors to the off-site dose at ORNL were ^{212}Pb, ^{125}I, ^{238}U, ^{11}C, ^{138}Cs, and ^{41}Ar, with dose contributions of about 36%, 21%, 11%, 8%, 8%, and 6%, respectively. Emissions of ^{212}Pb result from the radiation decay of legacy material stored on-site and contamination areas containing isotopes of ^{228}Th, ^{232}Th, and ^{232}U. Emissions of ^{212}Pb were from the following stacks: 2026, 3020, 3039, 7503, 7856, 7877, 7935, 7911, and STP. Emissions of ^{125}I and ^{11}C result from SNS operations and research activities. Emissions of ^{41}Ar result from HFIR operations and research activities and are emitted as a nonadsorbable gas from the 7911 Melton Valley complex stack. Emissions of ^{138}Cs result from research activities in REDC, which also exhaust through the 7911 Melton Valley complex stack. For 2011, ^{212}Pb emissions totaled 2 Ci, ^{125}I emissions totaled 0.17 Ci, ^{11}C emissions totaled 773 Ci, ^{238}U emissions totaled 7.42E-03 Ci, ^{138}Cs emissions totaled 523 Ci, and ^{41}Ar emissions totaled 635 Ci (Fig. 5.16). Emissions of ^{41}Ar decreased in 2011. Emissions of ^{138}Cs decreased because less heavy-element target process work was performed in 2011 than in 2010.

The calculated radiation dose to the maximally exposed individual (MEI) from all radiological airborne release points at ORR during 2011 was 0.3 mrem. The dose contribution to MEI from all ORNL radiological airborne release points was 0.24 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.08% of the roughly 300 mrem that the average individual receives from natural sources of radiation. (See Sect. 7.1.2.1 for an explanation of how the airborne radionuclide dose was determined.)

Table 5.9. Radiological airborne emissions from all sources at ORNL, 2011 (Ci)[a]

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{225}Ac	M								1.74E-09	1.74E-09
^{228}Ac	M								1.75E-06	1.75E-06
^{108m}Ag	M								1.34E-10	1.34E-10
^{110m}Ag	M								1.12E-09	1.12E-09
^{110m}Ag	S					2.33E-06				2.33E-06
^{26}Al	M								7.60E-24	7.60E-24
^{241}Am	S			1.06E-06						1.06E-06
^{241}Am	M	2.61E-07	4.52E-07				5.00E-07		1.14E-08	1.22E-06
^{241}Am	F				8.29E-08	1.40E-06			5.75E-07	2.06E-06
^{243}Am	M								6.69E-09	6.69E-09
^{41}Ar	G						6.18E+02	1.72E+01		6.35E+02

Table 5.9. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{137m}Ba	M								1.50E-13	1.50E-13
^{139}Ba	M						5.00E-01			5.00E-01
^{140}Ba	S					2.70E-05				2.70E-05
^{140}Ba	M						3.58E-04			3.58E-04
^{10}Be	M								5.63E-16	5.63E-16
^{7}Be	S			1.08E-05		2.02E-05			6.02E-06	3.70E-05
^{7}Be	M	6.40E-07	8.17E-08						2.22E-06	2.95E-06
^{211}Bi	M								5.82E-11	5.82E-11
^{212}Bi	S								1.58E-08	1.58E-08
^{212}Bi	M								4.73E-13	4.73E-13
^{214}Bi	M								6.08E-07	6.08E-07
^{11}C	G							7.73E+02		7.73E+02
^{14}C	M								7.30E-08	7.30E-08
^{141}Ce	M						2.45E-07		1.60E-08	2.61E-07
^{144}Ce	M								4.02E-07	4.02E-07
^{249}Cf	S								2.54E-12	2.54E-12
^{252}Cf[b]	M						3.71E-09		2.23E-08	2.60E-08
^{36}Cl	M								2.50E-09	2.50E-09
^{242}Cm	M								5.65E-08	5.65E-08
^{243}Cm	F				1.60E-08	7.20E-07			1.23E-09	7.37E-07
^{243}Cm	M						1.45E-08		8.27E-12	1.45E-08
^{244}Cm	F			5.07E-07	1.60E-08	7.20E-07			4.74E-06	5.98E-06
^{244}Cm	M	5.38E-07	6.56E-08				1.45E-08		7.36E-08	6.92E-07
^{245}Cm	F								9.13E-09	9.13E-09
^{245}Cm	M								1.12E-10	1.12E-10
^{247}Cm	M								1.14E-13	1.14E-13
^{248}Cm[c]	M								1.33E-10	1.33E-10
^{56}Co	S					2.95E-07				2.95E-07
^{57}Co	M								4.86E-07	4.86E-07
^{58}Co	M								3.37E-07	3.37E-07
^{58}Co	S								2.50E-14	2.50E-14
^{60}Co	M								3.50E-05	3.50E-05
^{60}Co	S			1.26E-06		3.11E-06			3.85E-07	4.76E-06
^{51}Cr	M								1.51E-09	1.51E-09
^{51}Cr	S								1.06E-04	1.06E-04
^{134}Cs	F								3.69E-07	3.69E-07
^{134}Cs	S					2.36E-06			2.53E-08	2.39E-06
^{135}Cs	F								2.18E-13	2.18E-13
^{137}Cs	F	1.51E-06	1.33E-06				4.72E-06		8.90E-05	9.66E-05
^{137}Cs	S			4.43E-04	2.83E-08	2.65E-06			4.94E-04	9.40E-04
^{138}Cs	F						5.23E+02			5.23E+02
^{152}Eu	M								2.25E-07	2.25E-07
^{154}Eu	M								1.82E-07	1.82E-07
^{155}Eu	M								1.04E-08	1.04E-08
^{55}Fe	M								2.84E-07	2.84E-07
^{59}Fe	M								1.14E-10	1.14E-10
^{153}Gd	M								2.15E-10	2.15E-10
^{3}H	S			1.05E+01					4.00E-01	1.09E+01
^{3}H	V	4.23E-01			1.09E+00		1.45E+02	6.67E+01	4.07E-01	2.14E+02
^{175}Hf	M								6.39E-10	6.39E-10
^{181}Hf	M								9.68E-09	9.68E-09

Table 5.9. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{203}Hg	M								2.16E-07	2.16E-07
^{166m}Ho	M								4.07E-10	4.07E-10
^{122}I	F							2.58E+00		2.58E+00
^{123}I	F							8.50E-01		8.50E-01
^{124}I	F								1.08E-08	1.08E-08
^{125}I	F							1.70E-01	1.36E-06	1.70E-01
^{126}I	F								9.11E-06	9.11E-06
^{129}I	F								1.98E-05	1.98E-05
^{130}I	F								5.28E-10	5.28E-10
^{131}I	F			2.47E-09		2.23E-05	7.00E-02		9.11E-13	7.00E-02
^{131}I	V								5.88E-02	5.88E-02
^{132}I	F						3.26E-01			3.26E-01
^{133}I	F						2.08E-01		4.05E-10	2.08E-01
^{134}I	F						8.90E-01			8.90E-01
^{135}I	F						6.06E-01		3.69E-32	6.06E-01
^{192}Ir	M								2.35E-07	2.35E-07
^{40}K	M								8.25E-06	8.25E-06
^{40}K	S								3.84E-05	3.84E-05
^{79}Kr	G							3.03E+01	2.88E-13	3.03E+01
^{81}Kr	G								5.55E-12	5.55E-12
^{85}Kr	G						3.94E+02		5.61E-04	3.94E+02
^{85m}Kr	G						4.17E+00	1.00E+01		1.42E+01
^{87}Kr	G						4.04E+01	1.36E+01		5.40E+01
^{88}Kr	G						5.09E+01	4.76E+00		5.57E+01
^{89}Kr[d]	G						4.03E+01			4.03E+01
^{140}La	M						3.17E-02		1.33E-13	3.17E-02
^{140}La	S					1.38E-05				1.38E-05
^{54}Mn	M								3.89E-08	3.89E-08
^{54}Mn	S					2.66E-06			4.60E-15	2.66E-06
^{93}Mo	M								1.26E-09	1.26E-09
^{13}N	G							1.69E+01		1.69E+01
^{22}Na	F								3.72E-14	3.72E-14
^{22}Na	M								5.35E-16	5.35E-16
^{92}Nb[e]	M								1.25E-08	1.25E-08
^{93m}Nb	M								2.42E-10	2.42E-10
^{94}Nb	M								1.15E-11	1.15E-11
^{95}Nb	M								6.13E-08	6.13E-08
^{95m}Nb	M								2.80E-12	2.80E-12
^{147}Nd	M								3.10E-12	3.10E-12
^{59}Ni	M								4.39E-06	4.39E-06
^{63}Ni	M								1.41E-07	1.41E-07
^{237}Np	M								4.80E-11	4.80E-11
^{239}Np	M								2.84E-09	2.84E-09
^{191}Os	M						4.37E-05		1.42E-10	4.37E-05
^{191}Os	S			9.33E-05						9.33E-05
^{32}P	M								7.69E-12	7.69E-12
^{33}P	M								2.92E-15	2.92E-15
^{210}Pb	M								1.29E-10	1.29E-10
^{212}Pb	M	6.30E-01	6.16E-01				2.28E-02		2.20E-06	1.27E+00
^{212}Pb	S			1.09E+00	9.54E-02				3.74E-02	1.22E+00
^{214}Pb	M								4.17E-13	4.17E-13

Table 5.9. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{238}Pu	F			1.03E-07	1.15E-08	1.68E-06			3.65E-07	2.16E-06
^{238}Pu	M	1.45E-08	3.43E-07				1.03E-07		3.03E-07	7.64E-07
^{239}Pu	M	1.08E-07	2.06E-07				3.17E-08		1.30E-08	3.59E-07
^{239}Pu	F			9.44E-07	1.41E-08	6.40E-07			1.75E-07	1.77E-06
^{240}Pu	F					6.40E-07			4.30E-08	6.83E-07
^{240}Pu	M						3.17E-08		1.18E-09	3.29E-08
^{241}Pu	F								8.91E-10	8.91E-10
^{241}Pu	M								1.78E-07	1.78E-07
^{242}Pu	M								4.27E-09	4.27E-09
^{223}Ra	M								4.64E-11	4.64E-11
^{224}Ra	M								2.40E-12	2.40E-12
^{225}Ra	M								1.38E-08	1.38E-08
^{226}Ra	M								2.67E-15	2.67E-15
^{228}Ra	M								1.75E-06	1.75E-06
^{88}Rb	M							2.19E+00		2.19E+00
^{188}Re	M								3.64E-13	3.64E-13
^{219}Rn	G								3.80E-11	3.80E-11
^{103}Ru	S					2.78E-06				2.78E-06
^{103}Ru	M								1.01E-09	1.01E-09
^{106}Ru	M								2.79E-06	2.79E-06
^{106}Ru	S					2.20E-05			1.16E-07	2.21E-05
^{35}S	M								1.05E-09	1.05E-09
^{124}Sb	M								2.02E-07	2.02E-07
^{125}Sb	M								1.34E-08	1.34E-08
^{125}Sb	S								5.28E-07	5.28E-07
^{46}Sc	M								8.80E-11	8.80E-11
^{75}Se	F								1.41E-11	1.41E-11
^{75}Se	S			1.12E-03		2.23E-06				1.12E-03
^{32}Si	M								2.36E-15	2.36E-15
^{113}Sn	M								1.54E-10	1.54E-10
^{117m}Sn	M								2.89E-11	2.89E-11
^{119m}Sn	M								1.40E-10	1.40E-10
^{121}Sn	M								1.20E-13	1.20E-13
^{89}Sr	M	9.90E-08	8.75E-07				7.05E-06		6.74E-09	8.03E-06
^{89}Sr	S			1.00E-05	1.81E-08				9.41E-05	1.04E-04
^{90}Sr	M	9.90E-08	8.75E-07				7.05E-06		1.87E-04	1.95E-04
^{90}Sr	S			1.00E-05	1.81E-08	6.54E-06			9.41E-05	1.11E-04
^{179}Ta	M								5.95E-14	5.95E-14
^{182}Ta	M								2.11E-09	2.11E-09
^{99}Tc	M								9.59E-11	9.59E-11
^{99}Tc	S					8.55E-06				8.55E-06
^{123m}Te	M								7.26E-12	7.26E-12
^{125m}Te	M								1.82E-12	1.82E-12
^{129}Te	M								9.92E-12	9.92E-12
^{129m}Te	M								7.52E-07	7.52E-07
^{227}Th	S								5.50E-08	5.50E-08
^{228}Th	S	2.45E-08	5.43E-09	2.91E-08	7.88E-10		8.28E-09		7.43E-08	1.42E-07
^{229}Th	S								3.82E-12	3.82E-12
^{230}Th	F			1.05E-08	6.59E-10				5.47E-09	1.66E-08
^{230}Th	S	1.56E-09	2.46E-09				3.68E-09		2.00E-08	2.77E-08
^{232}Th	S	1.11E-09	2.50E-09				6.33E-09		9.69E-11	1.00E-08

Table 5.9. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{232}Th	F			1.21E-08	7.33E-10				3.46E-09	1.63E-08
^{234}Th	S								8.12E-06	8.12E-06
^{208}Tl	M								1.69E-13	1.69E-13
^{232}U	M								2.82E-12	2.82E-12
^{233}U	M						4.58E-08		1.38E-11	4.58E-08
^{233}U	S				9.35E-09	6.00E-07			6.86E-06	7.47E-06
^{234}U	M	1.27E-07	1.16E-07				4.58E-08		2.78E-05	2.81E-05
^{234}U	S			1.91E-07	9.35E-09	6.00E-07			2.84E-04	2.85E-04
^{235}U	M	8.93E-09	2.05E-08				1.28E-08		2.38E-04	2.38E-04
^{235}U	S			2.19E-08	2.14E-09	9.56E-07			1.49E-05	1.58E-05
^{236}U	M								1.10E-14	1.10E-14
^{236}U	S								1.29E-06	1.29E-06
^{238}U	M	6.08E-09	1.73E-08				1.71E-08		6.58E-03	6.58E-03
^{238}U	S			4.17E-08	2.72E-09	1.08E-06			8.40E-04	8.41E-04
^{181}W	M								7.94E-11	7.94E-11
^{181}W	F								1.19E-11	1.19E-11
^{185}W	M								3.77E-08	3.77E-08
^{188}W	M								1.05E-08	1.05E-08
^{122}Xe	G							2.63E+00		2.63E+00
^{123}Xe	G							7.64E+00		7.64E+00
^{125}Xe	G							1.40E+01		1.40E+01
^{127}Xe	G							5.57E+00	1.23E-07	5.57E+00
^{129m}Xe	G								9.83E-06	9.83E-06
^{131m}Xe	G						1.40E+02		1.79E-03	1.40E+02
^{133}Xe	G						5.67E+00		2.04E-02	5.69E+00
^{133m}Xe	G						1.80E+01		1.94E-04	1.80E+01
^{135}Xe	G						2.36E+01		1.93E-23	2.36E+01
^{135m}Xe	G						1.66E+01			1.66E+01
^{137}Xe[f]	G						4.14E+01			4.14E+01
^{138}Xe	G						1.11E+02			1.11E+02
^{88}Y	F					3.10E-06				3.10E-06
^{90}Y	M								1.56E-08	1.56E-08
^{91}Y	M								1.60E-08	1.60E-08
^{65}Zn	F					5.28E-06			6.28E-13	5.28E-06
^{65}Zn	M								2.69E-10	2.69E-10
^{95}Zr	M								4.11E-08	4.11E-08
^{95}Zr	S					5.23E-06			4.57E-10	5.23E-06
Totals		1.05E+00	6.16E-01	1.16E+01	1.19E+00	1.61E-04	2.17E+03	9.68E+02	9.35E-01	3.16E+03

[a]1 Ci = 3.7E+10 Bq.
[b]^{248}Cf surrogate for ^{252}Cf.
[c]^{245}Cm surrogate for ^{248}Cm.
[d]^{88}Kr surrogate for ^{89}Kr.
[e]^{94}Nb surrogate for ^{92}Nb.
[f]^{135}Xe surrogate for ^{137}Xe.

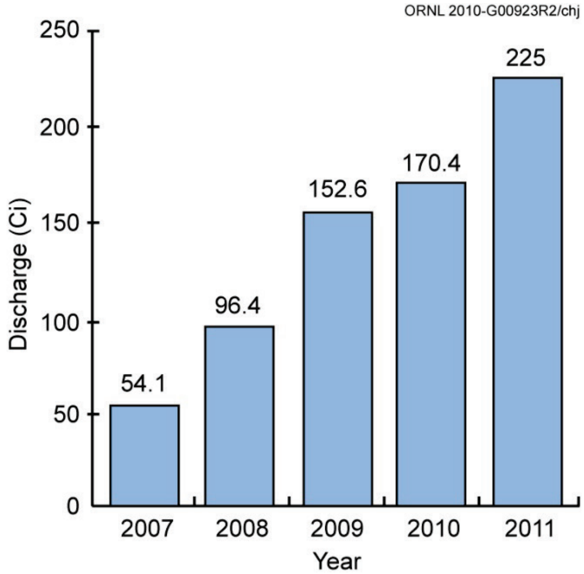

Fig. 5.14. Total discharges of ^{3}H from Oak Ridge National Laboratory to the atmosphere, 2007–2011.

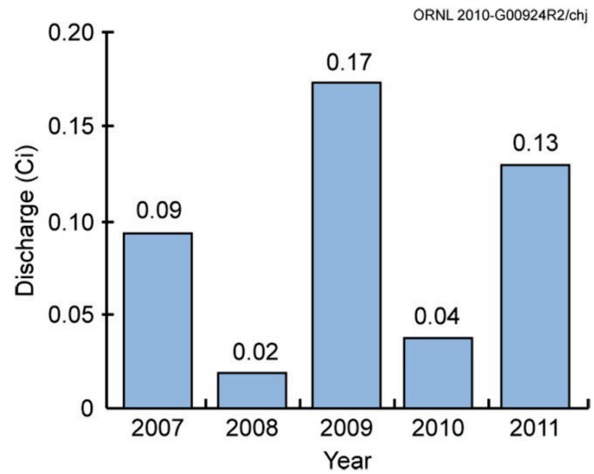

Fig. 5.15. Total discharges of ^{131}I from Oak Ridge National Laboratory to the atmosphere, 2007–2011.

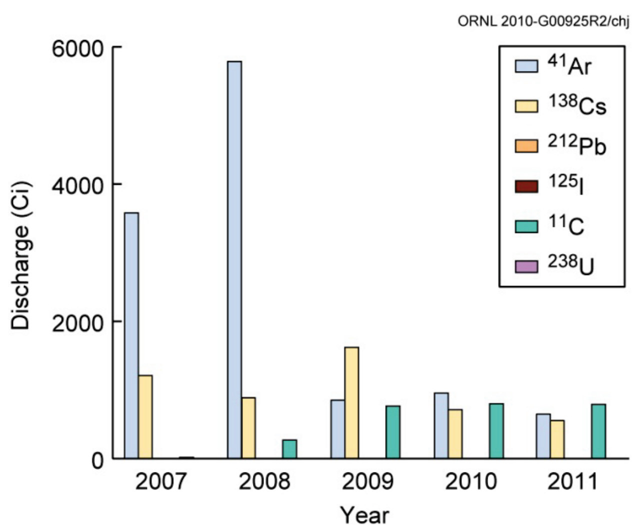

Fig. 5.16. Total discharges of ^{41}Ar, ^{138}Cs, ^{212}Pb, ^{125}I, ^{11}C, and ^{238}U from Oak Ridge National Laboratory to the atmosphere, 2007–2011.

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 (Fig. 5.17) make up the ORNL PAM network. During 2011, sampling was conducted at each station to quantify levels of tritium; uranium; adsorbable gases (e.g., iodine); and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.10).

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 charcoal cartridge located behind the glass-fiber particulate filter is used to collect adsorbable gases. The charcoal cartridges were changed out and analyzed biweekly through September 2011. The January 18, 2011, sample data from Station 7 were omitted because of instrument failure during the sampling period. The analysis of the charcoal cartridges was discontinued in October 2011 because no gamma emitting radionuclides originating from ORNL in concentrations above natural background levels had been detected in more than 5 years. The small concentrations of ^{131}I and ^{137}Cs detected in March and April 2011 were consistent with levels detected by EPA across the United States following the March 2011 nuclear accident in Fukushima, Japan. The charcoal cartridges continue to be used in the sampling system, allowing for analyses in the event of some unusual operation or event. 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.

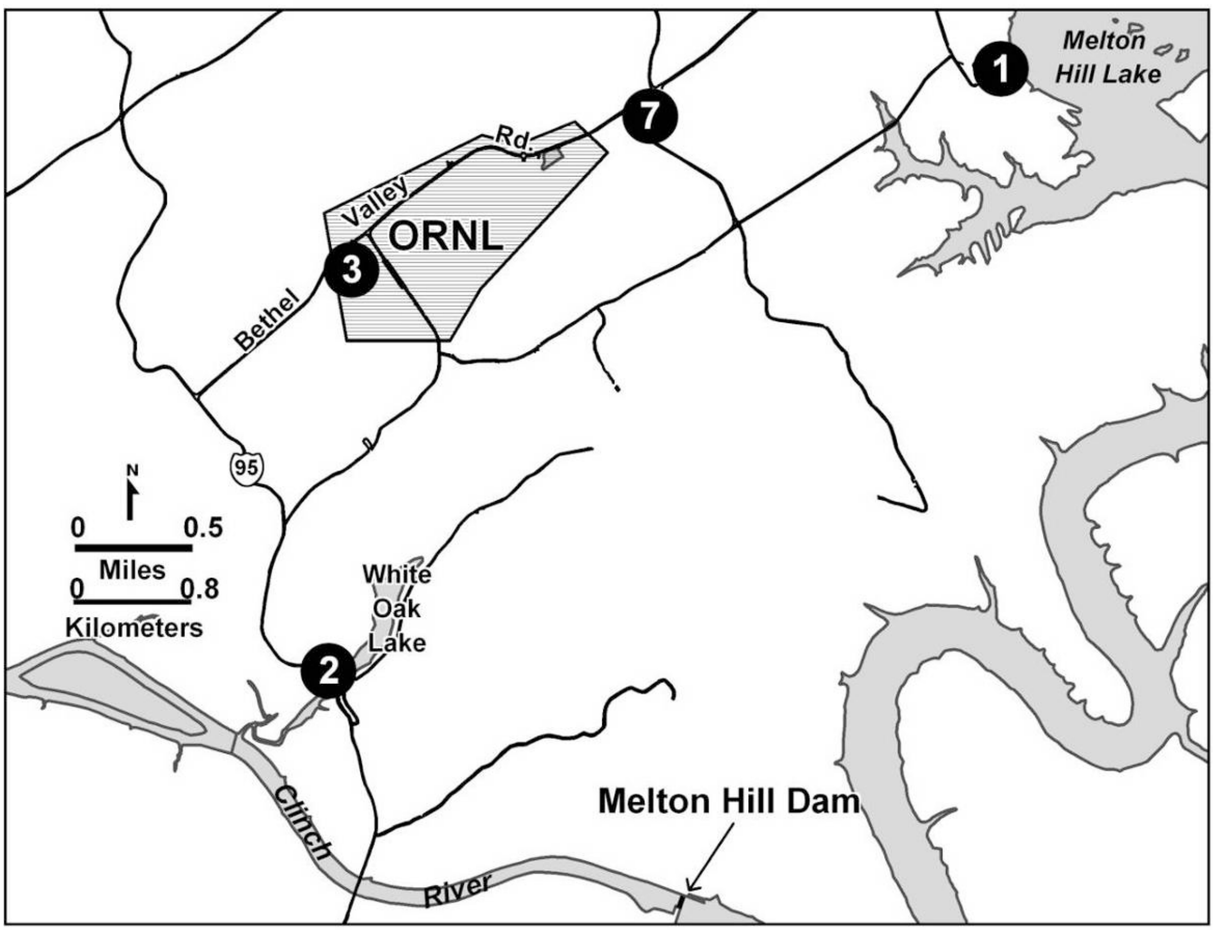

Fig. 5.17. Locations of ambient air monitoring stations at Oak Ridge National Laboratory.

Table 5.10. Radionuclide concentrations (pCi/mL)[a] measured at ORNL perimeter air monitoring stations, 2011

Parameter	No. detected/ sampled	Concentration		
		Average	Minimum	Maximum
		Station 1		
Alpha	1/1	7.86E-09	*b*	*b*
^{7}Be	1/1	1.86E-08	*b*	*b*
Beta	1/1	1.71E-08	*b*	*b*
^{137}C	1/4	c	c	2.20E-09
^{3}H	0/4	9.78E-07	-1.87E-06	4.66E-06
^{131}I	2/19	c	c	5.10E-08
^{40}K	19/19	2.26E-07	1.58E-07	3.08E-07
^{234}U	1/1	6.81E-12	*b*	*b*
^{235}U	0/1	9.83E-13	*b*	*b*
^{238}U	0/1	1.63E-12	*b*	*b*
		Station 2		
Alpha	1/1	8.8E-09	*b*	*b*
^{7}Be	1/1	2.14E-08	*b*	*b*
Beta	1/1	1.78E-08	*b*	*b*
^{3}H	0/4	3.91E-06	1.44E-06	6.36E-06
^{131}I	2/19	c	c	4.83E-08
^{40}K	19/19	2.35E-07	1.59E-07	2.72E-07
^{234}U	0/1	4.13E-12	*b*	*b*
^{235}U	0/1	6.84E-14	*b*	*b*
^{238}U	1/1	4.54E-12	*b*	*b*
		Station 3		
Alpha	1/1	8.49E-09	*b*	*b*
^{7}Be	1/1	1.97E-08	*b*	*b*
Beta	1/1	1.70E-08	*b*	*b*
^{3}H	0/4	1.17E-06	-5.81E-07	4.03E-06
^{40}K	19/91	2.40E-07	1.64E-07	4.89E-07
^{131}I	2/19	c	c	5.47E-08
^{234}U	0/1	3.70E-12	*b*	*b*
^{235}U	0/1	4.14E-13	*b*	*b*
^{238}U	1/1	7.13E-12	*b*	*b*
		Station 7		
Alpha	1/1	9.872-09	*b*	*b*
^{7}Be	1/1	2.38E-08	*b*	*b*
Beta	1/1	1.97E-08	*b*	*b*
^{3}H	0/3	3.37E-06	8.85E-07	7.35E-06
^{131}I	2/19	c	c	5.78E-08
^{40}K	18/18	2.56E-07	1.93-07	3.15E-07
^{234}U	1/1	5.52E-12	*b*	*b*
^{235}U	0/1	2.45E-13	*b*	*b*
^{238}U	1/1	4.93E-12	*b*	*b*

[a]1 pCi = 3.7×10^{-2} Bq.

[b]Not applicable.

[c]Parameter detected in at least one test for radiological gamma emitters. If parameter not detected, no result is provided by the analytical laboratory. Therefore, average and minimum values are not reported.

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 5.10) are compared with the derived concentration standards (DCSs) for air established by DOE as guidelines for controlling exposure to members of the public. During 2011, 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, 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.

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, a storm water pollution prevention plan (ORNL 2007), a non-storm water best management practices plan (ORNL 1997), and an NPDES water quality protection 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 5.18 summarizes this process. The process involves three major steps for identifying the cause of any impairment:

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

The first two steps of the stressor identification process were initiated in 2009, focusing first on mercury impairment (Fig. 5.19) and then on PCBs because mercury and PCB concentrations in fish from White Oak Creek (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 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.

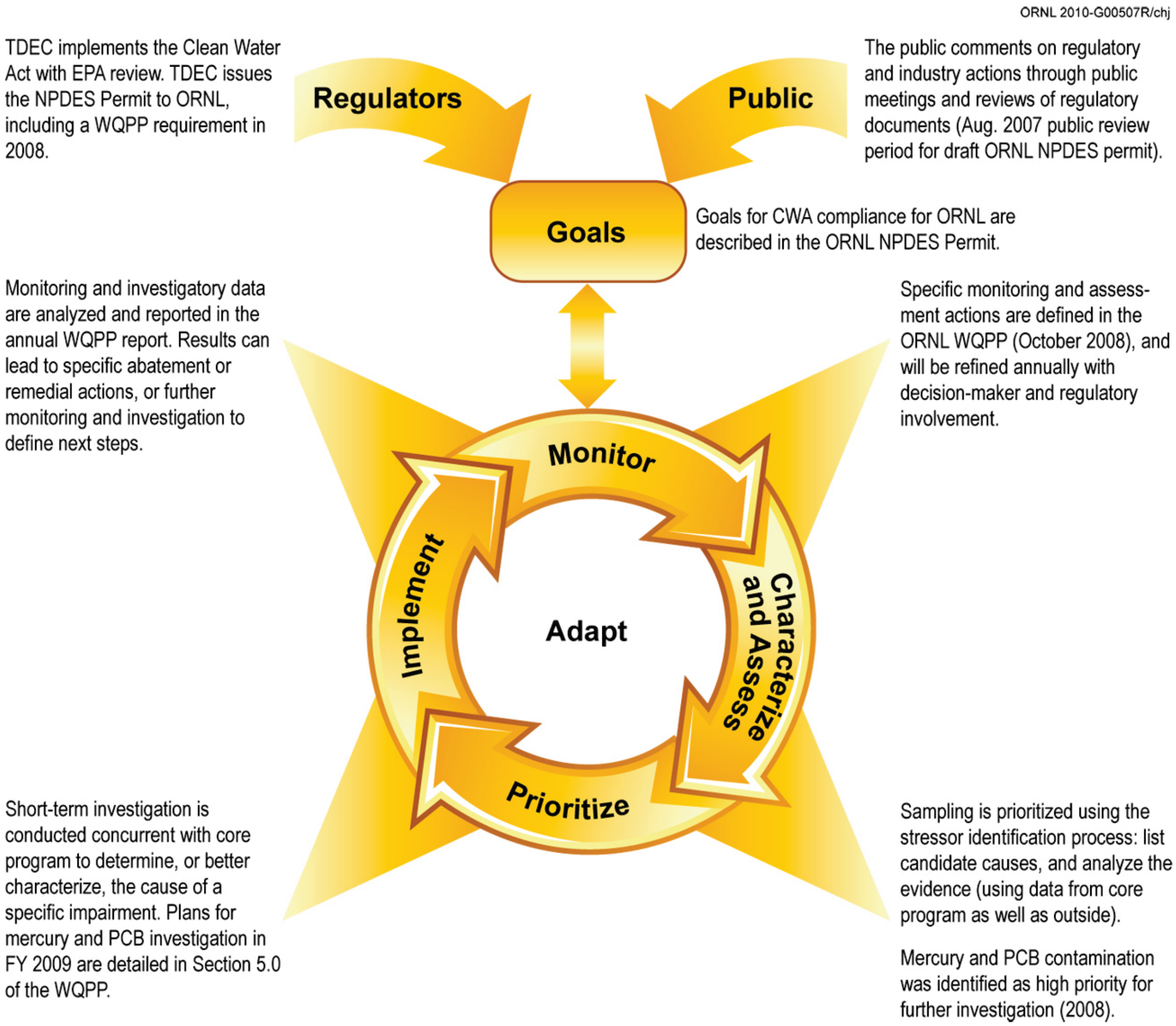

Fig. 5.18. Diagram of the adaptive management framework, with step-wise planning specific to the Oak Ridge National Laboratory Water Quality Protection Plan. [Adapted from the EPA stressor guidance document (EPA 2000).]

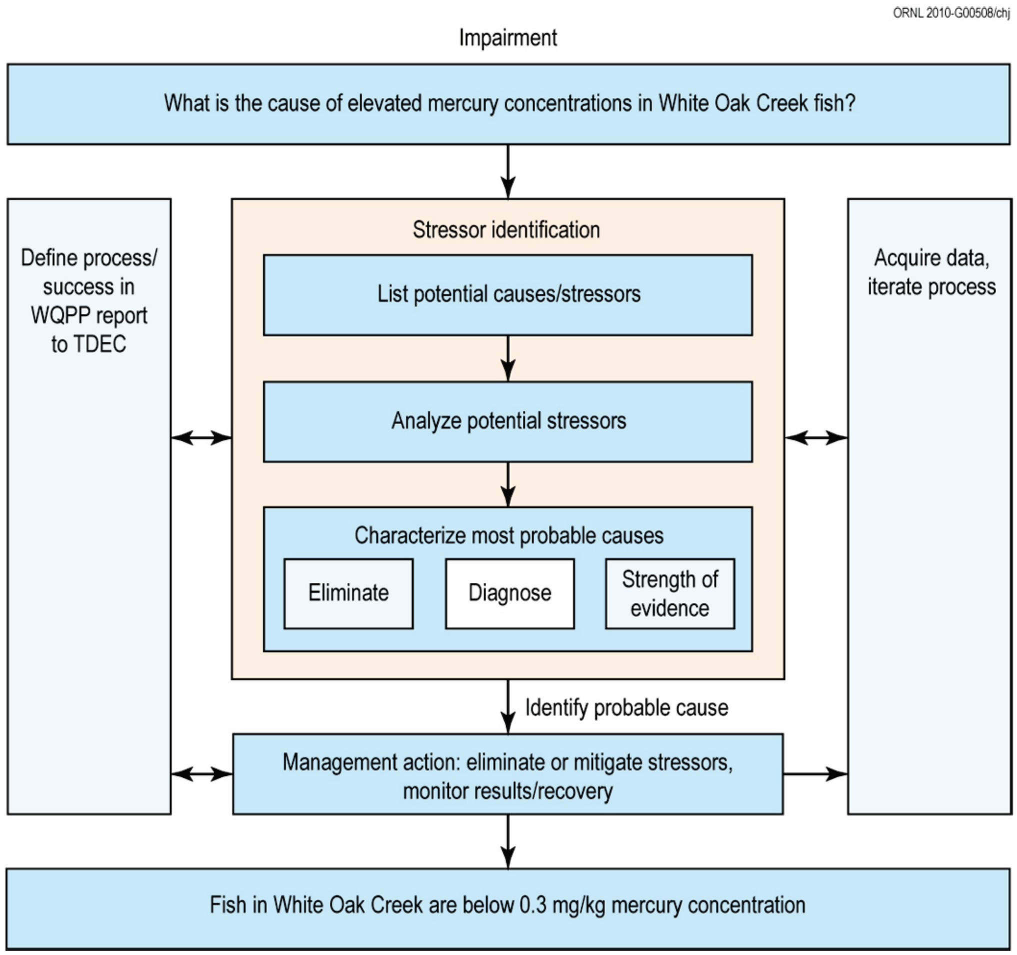

Fig. 5.19. Application of stressor identification guidance to address mercury impairment in the White Oak Creek watershed. [Modified from Figure 1-1 in the EPA stressor guidance document (EPA 2000).]

5.5.1 Treatment Facility Discharges

Three on-site wastewater treatment systems are operated at ORNL to provide appropriate treatment of the various R&D, operational, and domestic wastewaters generated by site staff and activities. All three are permitted to discharge treated wastewater and are monitored under NPDES permit TN0002941, issued to DOE for the ORNL site by TDEC. These are the ORNL STP (Outfall X01), the ORNL SPWTF (Outfall X02), and PWTC (Outfall X12). The ORNL NPDES permit requirements include monitoring the three 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 5.11. ORNL facilities achieved 99.9% compliance with permit limits and conditions in 2011.

Table 5.11. National Pollutant Discharge Elimination System compliance at Oak Ridge National Laboratory, 2011 (NPDES permit effective August 1, 2008)

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (lb/d)	Daily max. (lb/d)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
				X01 (ORNL STP)				
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	26	100
Carbonaceous biological oxygen demand	19.2	28.8	10	15		0	52	100
Dissolved oxygen					6	0	52	100
Escherichia coliform (col/100 mL)			941	126		1[b]	52	98
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	12	100
pH (standard units)				9	6	0	52	100
Total suspended solids	57.5	86.3	30	45		0	52	100
				X02 (ORNL SPWTF)				
pH (standard units)				9.0	6	1[c]	51	98
Total suspended solids				50		0	6	100
Conductivity				Report		1[c]	51	98
				X12 (PWTC)				
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
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

Table 5.11. (continued)

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (lb/d)	Daily max. (lb/d)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
Oil and grease	66.7	100	10	15		0	12	100
pH (standard units)				9.0	6.0	0	52	100
Temperature (ºC)				30.5		0	52	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].

[b]The exceedance of *E. coli* at X01 occurred on November 29, 2011, and was attributed to heavy rainfall which resulted in modified operations at the Sewage Treatment Plant.

[c]On January 28, 2011, SPWTF treated and discharged a batch of wastewater without NPDES effluent measurements being taken. Operational data indicated that the effluent met specifications, but the missed NPDES measurements constitute technical nonconformance.

Abbreviations

LC_{50} 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 caused 25% reduction in survival, reproduction, or growth of the test organisms.

NPDES National Pollutant Discharge Elimination System

ORNL Oak Ridge National Laboratory

PWTC Process Waste Treatment Complex

SPWTF Steam Plant Wastewater Treatment Facility

STP ORNL Sewage Treatment Plant

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 and SPWTF 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*, 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. SPWTF and PWTC effluent have 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 STP and PWTC twice per year each, using two test species. The toxicity potential of SPWTF was mitigated in 2003 by the removal of the ORNL Steam Plant's coal yard (the steam plant was converted from coal burning to natural gas), thereby removing the need to treat and discharge coal yard storm water runoff. It was determined by TDEC that toxicity testing of the SPWTF effluent, which now includes only treated boiler blowdown and water-softener regeneration wastewaters from the ORNL Steam Plant, was no longer necessary. In 2011, 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 5.11).

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-three individual outfalls were checked for TRO semiannually, quarterly, monthly, or bimonthly throughout the year for a total of 283 attempts. Flow was detected 254 times. Table 5.12 lists instances in 2011 where outfalls were found to be in excess of the TRO action level. Four outfalls, 265 on Fifth Creek, 341 on First Creek, 081 on Melton Branch, and 207 on WOC, exceeded the action level during 2011. The sources for Outfalls 265, 207, and 081 have been determined to be aging, underground water pipes that are leaking drinking water.

Table 5.12. Outfalls exceeding total residual oxidant (TRO) action level[a] in 2011

Sample date	Outfall	TRO concentration (mg/L)	Flow (gpm)	Load (grams/ day)	Receiving stream	Downstream integration point	Instream TRO point
2/10/2011	207	0.35	12	22.89	White Oak Creek	WCK 3.9	X21
3/14/2011	341	0.25	10	13.63	First Creek	FCK 0.1	X16
4/14/2011	207	0.6	12	39.24	White Oak Creek	WCK 3.9	X21
4/14/2011	265	0.85	8	37.06	Fifth Creek	FFK 0.2	X19
7/14/2011	207	0.2	5.5	6.0	White Oak Creek	WCK 3.9	X21
7/14/2011	265	0.7	8.5	32.43	Fifth Creek	FFK 0.2	X19
9/19/2011	081	0.75	30	122.63	Melton Branch	MEK 2.1	N/A
10/3/2011	081	1	75	408.75	Melton Branch	MEK 2.1	N/A
10/4/2011	207	0.4	8	17.44	White Oak Creek	WCK 3.9	X21
10/4/2011	265	0.3	4	6.54	Fifth Creek	FFK 0.2	X19
10/17/2011	081	0.25	18	24.53	Melton Branch	MEK 2.1	N/A
11/7/2011	081	0.5	50	136.25	Melton Branch	MEK 2.1	N/A
12/5/2011	081	0.75	25	102.19	Melton Branch	MEK 2.1	N/A

[a]1.2 g/day.

5.5.3 Cooling Tower Blowdown Monitoring

As part of WQPP at ORNL, cooling tower blowdown effluents were monitored twice in 2011, once in February and once more in August. Only field parameters (conductivity, dissolved oxygen, pH, and temperature) were collected during the February sampling event. In August, field parameters were measured and the following laboratory analyses were performed on grab samples from blowdown effluents: chemical oxygen demand, total suspended solids, and total metals.

The cooling towers that were monitored in 2011 are listed in Table 5.13. Two towers were targeted for sampling but were not sampled in either the February or August sampling events: tower 2535 was not operating during any sampling events, and tower 7923 was not sampled because blowdown does not reach a receiving stream (blowdown infiltrates into the ground before reaching a receiving stream). Field measurements are presented in Table 5.14, and results from laboratory analyses are presented in Table 5.15.

Where possible, cooling towers were sampled at the outfalls where blowdown is discharged to the receiving streams. In a few instances, tower water was sampled at the basin under the cooling tower. This was necessary in cases where it was not possible to determine if and when blowdown was present at the outfall. The release of cooling tower blowdown is intermittent, and its presence or absence can be masked when blowdown is commingled with other wastewaters before discharge.

The State of Tennessee has established WQC for instream temperature as a basis to control the effects of wastewater discharges on receiving waters designated for fish and aquatic life, recreation, domestic water supply, and/or industrial water supply uses. The WQC addresses maximum instream temperature (30.5°C), maximum rate of instream temperature change (2°C/h), and instream temperature change relative to an upstream control point (3°C). Monitoring of instream temperature in the vicinity of the major cooling water discharges at ORNL was conducted on August 29, 2011. Monitoring was targeted to the third calendar quarter of the year when stream flows are typically low, air and water temperatures are warm, and cooling demand is typically at a maximum. Individual temperature measurements from the August 29 monitoring are presented Table 5.16, and results of calculations of rates of temperature change and temperature changes relative to upstream control points for the August 29 monitoring are provided in Table 5.17.

Table 5.13. Cooling tower/cooling tower systems monitored at Oak Ridge National Laboratory in 2011

Cooling tower/tower system	NPDES outfall receiving blowdown	Sampled location
2026	249	Tower Basin
2539	204	Tower Basin
3047	367	Tower Basin
3517	304	Tower Basin
4510/4521	014	Outfall
5300	363	Outfall
5309	363	Tower Basin
5600	227	Outfall
5807	231	Tower Basin
6018	314	Tower Basin
7619	291	Outfall
7626	191	Outfall
7902	281	Outfall
8913	435	Outfall

Abbreviations

NPDES National Pollutant Discharge Elimination System

Table 5.14. Field measurements collected in blowdown from ORNL cooling towers in 2011

Cooling tower[a]	Sampled location	Date	Flow[b] (gpm)	Conductivity (mS/cm)	Dissolved oxygen (mg/L	pH (standard unit)	Temperature °C
2026	2026 basin	2/10/2011	*Tower was not operating during the February sampling attempt*				
2026	2026 basin	8/11/2011	Unknown	1.3	9.6	8.9	28
2539	2539 basin	2/10/2011	Unknown	0.388	7.9	8	10.5
2539	2539 basin	8/11/2011	Unknown	0.382	6.8	8.1	25.4
3047	3047 basin	2/10/2011	*Tower was not operating during the February sampling attempt*				
3047	3047 basin	8/11/2011	Unknown	1.51	9.8	8.8	27.1
3517	3517 basin	2/10/2011	Unknown	0.339	7.9	8	6.9
3517	3517 basin	8/11/2011	*Tower was not operating during the August sampling attempt*				
5300	Outfall 363	2/10/2011	10	1.01	7.9	7.9	8.5
5300	Outfall 363	8/11/2011	7	0.702	9	8	22.6
5309	5309 basin	2/10/2011	25	1.31	6.6	8.6	15.7
5309	5309 basin	8/11/2011	Unknown	1.02	9.1	8	24.5
5600	Outfall 227	2/10/2011	50	0.255	6.2	8	38
5600	Outfall 227	8/11/2011	30	1.16	10.1	8.2	26
5807	5807 basin	2/10/2011	*Tower was not operating during the February sampling attempt*				
5807	5807 basin	8/11/2011	Unknown	1.26	10.2	8.6	24.5
6018	6018 basin	2/10/2011	Unknown	1.14	6.6	8.4	17.4
6018	6018 basin	8/11/2011	Unknown	1.2	8.8	8	26.3
7619	Outfall 291	2/10/2011	15	0.302	9	8.2	6
7619	Outfall 291	8/11/2011	0.1	0.217	6.3	7.9	23.1
7626	Outfall 191	2/10/2011	14	0.352	7.8	8.1	5.1
7626	Outfall 191	8/11/2011	2	0.208	6.1	7.8	24.7
7902	Outfall 281	2/10/2011	75	0.645	7	8	23.9
7902	Outfall 281	8/11/2011	75	1.52	8.6	7.8	26.1
8913	Outfall 435	2/10/2011	90	0.394	9.1	7.9	9.6
8913	Outfall 435	8/11/2011	75	0.302	9.4	7.4	20.8
4510/4521	Outfall 014	2/10/2011	*Tower was not operating during the February sampling attempt*				
4510/4521	Outfall 014	8/11/2011	25	1.14	10.2	8.5	24.3

[a]Cooling towers 2535 and 7923 were not operating during either the February or August sampling attempts and are therefore not included in this table.

[b]Cooling tower blowdown flow rates are not known for towers that were sampled at the tower basins.

Table 5.15. Results (in mg/L) from laboratory analyses of blowdown from ORNL cooling towers
(Date Sampled: August 11, 2011)

	Cooling Towers (and Cooling Tower Sample Locations)												
	2026 (2026 basin)	2539 (2539 basin)	3047 (3047 basin)	4510/4521 (Outfall 014)	5300 (Outfall 363)	5309 (5309 basin)	5600 (Outfall 227)	5807 (5807 basin)	6018 (6018 basin)	7619 (Outfall 291)	7626 (Outfall 191)	7902 (Outfall 281)	8913 (Outfall 435)
COD	84.1	35.3	76.8	54.8	30.4	57.2	37.7	76.8	30.4	28	28	35.3	J 15.8
TSS	< 2	< 2	< 2	4	< 2	< 2	< 2	< 2	< 2	10	30	< 2	4
Ag	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619
As	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Be	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686
Ca	175	46.8	216	202	111	157	173	189	206	40.9	35.8	237	59.9
Cd	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782
Cr	0.00198	< 0.001	0.00194	0.00154	0.00278	0.0015	0.00131	0.0015	0.0016	< 0.001	< 0.001	0.00222	< 0.001
Cu	0.404	0.0102	0.0521	0.00821	0.0588	0.0223	0.00664	0.0264	0.0341	0.00218	0.00234	0.00798	0.00239
Fe	0.0909	0.193	0.0452	0.0273	0.0575	0.0384	0.029	0.0495	0.0302	0.142	0.173	0.0938	0.138
Mg	50.9	11.2	66.5	53.5	31.5	47.1	46.9	49.9	60.4	9.71	5.51	59.1	18.3
Mn	0.00748	0.0124	0.00471	0.0026	0.0128	0.00244	0.00332	0.00487	0.00272	0.0355	0.0548	0.00484	0.12
Mo	0.173	0.759	0.215	0.0989	0.0869	0.125	0.0549	0.121	0.0512	0.00101	0.00339	0.00197	0.00749
Ni	0.00388	0.00143	0.00302	0.00275	0.002	0.00399	0.00211	0.0125	0.00404	< 0.00138	0.00951	0.00427	0.0016
Pb	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.00102	< 0.001	< 0.001	0.00152	0.005	< 0.001
Sb	< 0.00081	< 0.00081	< 0.00081	0.00224	< 0.00081	< 0.00081	< 0.00081	< 0.00081	< 0.00081	< 0.00081	< 0.00081	0.00206	< 0.00081
Se	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406
Zn	0.753	0.117	0.555	0.278	0.245	0.421	0.229	0.384	0.304	0.0553	0.176	0.394	0.0492

Abbreviations
COD = chemical oxygen demand
TSS = total suspended solids

Table 5.16. Field Measurements from 2011 instream temperature assessment
(Monitoring Date: August 29, 2011)

Monitoring Locations	Field Measurements							
	Round 1		Round 2		Round 3		Round 4	
	Temp. (°C)	Time (EDT)	Temp. (°C)	Time (EDT)	Temp. (°C)	Time (EDT)	Temp. (°C)	Time (EDT)
Upstream of Outfall 014	21.8	08:30	22.0	09:41	23.5	12:15	23.6	13:30
Downstream of Outfall 014	22.0	08:31	22.0	09:42	23.5	12:16	23.6	13:31
Upstream of Outfall 227	20.4	08:35	21.0	09:47	22.0	12:23	22.2	13:35
Downstream of Outfall 227	24.3	08:36	24.4	09:48	26.2	12:24	24.5	13:36
Upstream of Outfall 281	18.7	09:05	19.2	10:18	19.8	12:53	20.3	14:08
Downstream of Outfall 281	24.0	09:06	24.1	10:19	24.4	12:54	24.3	14:09
Upstream of Outfall 314	21.2	08:42	21.2	09:54	21.2	12:30	21.2	13:42
Downstream of Outfall 314	21.7	08:43	21.6	09:55	21.7	12:31	21.5	13:43
Upstream of Outfall 363	17.7	08:48	18.1	10:01	19.7	12:36	20.1	13:49
Downstream of Outfall 363	17.7	08:49	18.4	10:02	19.7	12:37	20.2	13:50
Upstream of Outfall 435	16.1	08:55	16.2	10:09	19.2	12:44	19.6	13:59
Downstream of Outfall 435	18.2	08:56	18.3	10:10	19.6	12:45	19.6	14:00

Table 5.17. Measurements of instream temperature changes for stream reaches receiving cooling tower blowdown at Oak Ridge National Laboratory
(Monitoring Date: August 29, 2011)

Outfall/cooling system assessed	Temperature change over length of stream reach (upstream to downstream of cooling system)				Rate of temperature change at downstream end of stream reach between rounds of sampling		
	Round 1 (°C)	Round 2 (°C)	Round 3 (°C)	Round 4 (°C)	Round 1 to Round 2 (°C/h)	Round 2 to Round 3 (°C/h)	Round 3 to Round 4 (°C/h)
Outfall 014 (4510/4521 cooling system)	0.2	0.0	0.0	0.0	0.0	0.6	0.1
Outfall 227 (5600 cooling system)	3.9	3.4	4.2	2.3	0.1	0.7	-1.4
Outfall 281 (7902 cooling system)	5.3	4.9	4.6	4.0	0.1	0.1	-0.1
Outfall 314 (6018 cooling system)	0.5	0.4	0.5	0.3	-0.1	0.0	-0.2
Outfall 363 (5300 and 5308 cooling systems)	0.0	0.3	0.0	0.1	0.6	0.5	0.4
Outfall 435 (8913 cooling system)	2.1	2.1	0.4	0.0	0.1	0.5	0.0

Two ORNL outfalls had temperature changes relative to an upstream control point that were in excess of 3°C. The 7902 cooling tower discharges through NPDES Outfall 281 to a small tributary to Melton Branch. The upstream to downstream temperature change in all four rounds of measurements collected on August 29 were greater than 3°C (the range was 4.0 to 5.3°C). Blowdown from the 7902 tower is discharged at a rate which is much greater than the background flow rate in the receiving stream and therefore it dominates the water quality in the stream below the discharge. This situation has been discussed with TDEC, and at TDEC's request ORNL has been monitoring temperature change in the receiving stream upstream and downstream of Outfall 281 on a quarterly basis. The second NPDES outfall associated with instream temperature increases in excess of 3°C was Outfall 227. Temperature change across the reach of WOC encompassing Outfall 227 was greater than 3°C in three of the four rounds of measurements collected on August 29 (the range was 3.4 to 4.2°C). This was the first time in more than a decade of monitoring that such an increase was detected in this stream reach and it is believed to have been a temporary occurrence. It is suspected that there was a temporary malfunction in the condensate recovery system for the Building 5600 heat exchanger.

5.5.4 Radiological Monitoring

Monitoring of effluents and instream locations for radioactivity is conducted under the ORNL WQPP. Table 5.18 details the monitoring frequency and target analyses for 3 treatment facility outfalls, 3 instream monitoring locations, and 22 category outfalls (outfalls that discharge effluents with relatively minor constituents that receive little or no treatment before discharge). 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 groundwater enters category outfall collection systems from building and facility sumps, building footer drains, and direct infiltration. In 2011, dry-weather grab samples were collected at 18 of the 22 category outfalls targeted for sampling. The remaining four outfalls were not sampled because there was no discharge present during sampling attempts.

The three treatment facilities monitored for radioisotopes during 2011 were STP (Outfall X01), SPWTF (Outfall X02), and PWTC (Outfall X12). The three instream monitoring locations were X13 on Melton Branch, X14 on WOC, and X15 at White Oak Dam (WOD) (Fig. 5.20). At each monitoring location, monthly flow-proportional composite samples were collected using dedicated automatic water samplers.

For years, radioisotope specific guideline concentration values have been published in DOE directives and have been 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. It should also be noted that though effluents and instream concentrations were compared to DCSs as a point of reference, ORNL effluents or ambient waters are not sources of drinking water.

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 another convenient comparison point. 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, 241, 302, 304, X01, X02, and X12 and at instream sampling locations X14 and X15 (Fig. 5.21). Of those, two outfalls had mean radioactivity concentrations that were greater than 50% of the applicable DCS: $^{89/90}$Sr at outfall 302 (62% of the DCS) and $^{89/90}$Sr at outfall 304 (77% of the DCS). In 2011, no sampling results indicated outfalls with annual average radionuclide concentrations exceeding 100% of DCS concentrations for individual radioisotopes or for a sum-of-fractions (summation of DCS percentages of multiple radiological parameters measured at a given location).

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. 5.22 through 5.26. Discharges of radioactivity at WOD in 2011 continue to be generally lower than in the years preceding completion of the waste area caps in Melton Valley. Because discharges of radioactivity are somewhat correlated to stream flow, annual flow volumes measured at the WOD monitoring station are given in Fig. 5.27.

Table 5.18. Radiological monitoring conducted under the Oak Ridge National Laboratory Water Quality Protection Plan, 2011

Location	Frequency	Gross alpha/beta[a]	Gamma scan	^{3}H	Total rad Sr	Isotopic uranium	^{14}C	$^{243/244}Cm$
Outfall 001	Annually	X						
Outfall 080	Monthly	X	X	X	X			X
Outfall 081	Annually	X						
Outfall 085	Quarterly	X	X	X	X	X		
Outfall 203 [b]	Annually	X	X		X			
Outfall 204	Semiannually	X	X		X			
Outfall 205 [b]	Annually	X						
Outfall 207	Quarterly	X	X		X			
Outfall 211	Annually	X						
Outfall 217	Annually	X						
Outfall 219 [b]	Annually	X						
Outfall 234	Annually	X						
Outfall 241	Quarterly	X	X	X	X	X		
Outfall 265	Annually	X						
Outfall 281	Quarterly	X		X				
Outfall 282	Quarterly	X						
Outfall 284 [b]	Annually	X						
Outfall 302	Monthly	X	X	X	X	X		
Outfall 304	Monthly	X	X	X	X	X		
Outfall 365	Semiannually	X						
Outfall 368	Annually	X						
Outfall 383	Annually	X		X				
STP (X01)	Monthly	X	X	X	X		X	
SPWTF (X02)	Monthly	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 discharge present during sampling attempts.

Abbreviations

PWTC Process Waste Treatment Complex
SPWTF Steam Plant Wastewater Treatment Facility
STP ORNL Sewage Treatment Plant
WOC White Oak Creek
WOD White Oak Dam

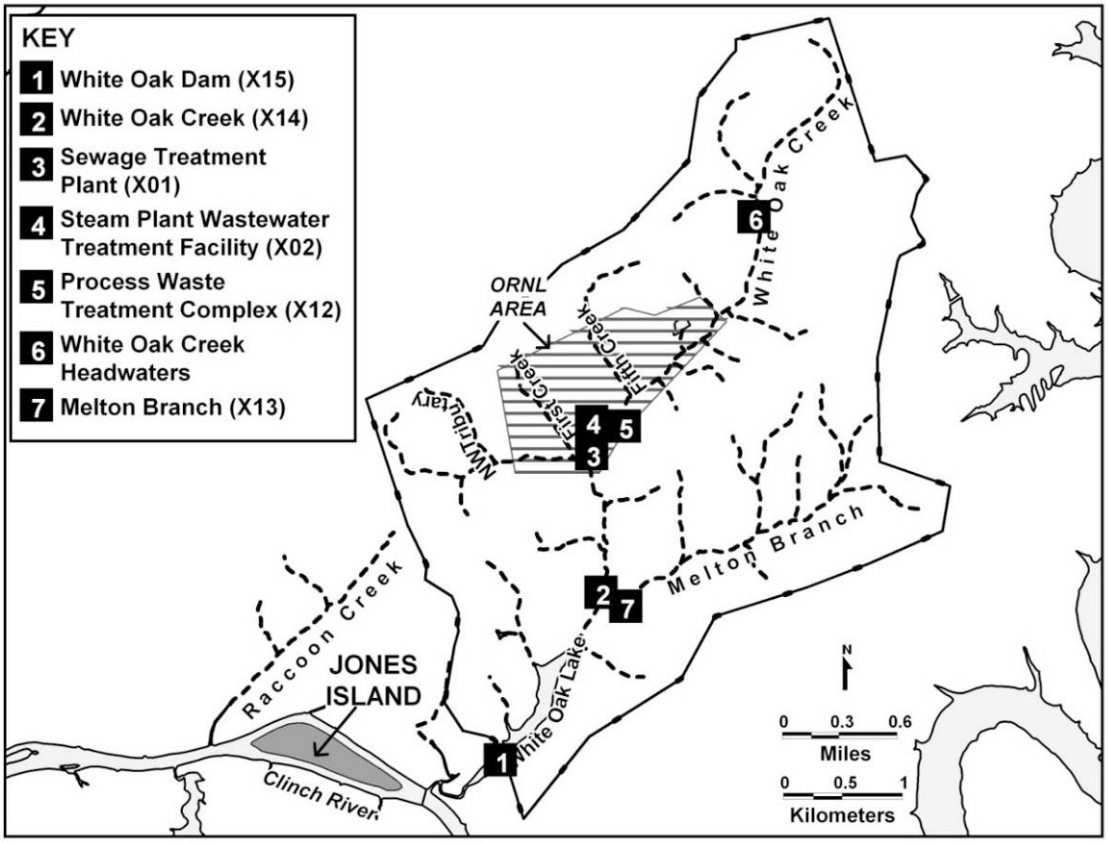

Fig. 5.20. Oak Ridge National Laboratory surface water, National Pollutant Discharge Elimination System, and reference sampling locations.

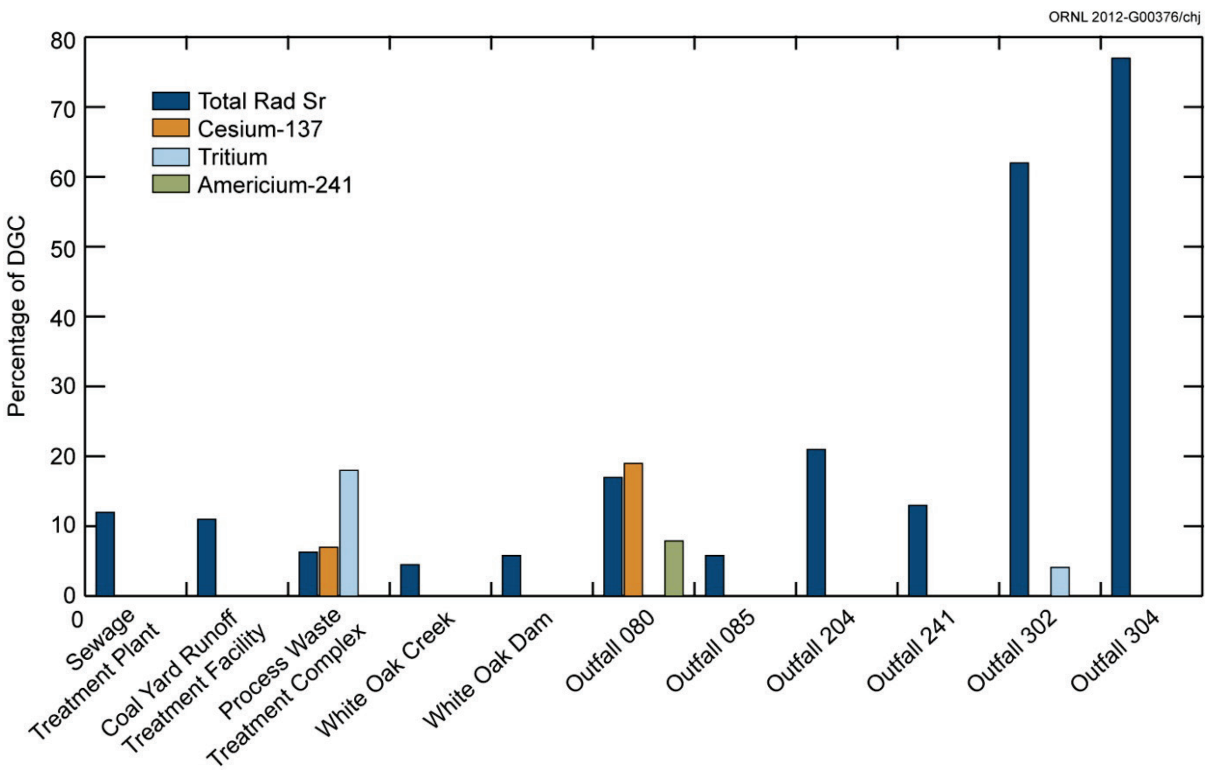

Fig. 5.21. Radionuclides at Oak Ridge National Laboratory sampling sites having average concentrations greater than 4% of the relevant derived concentration guides in 2011.

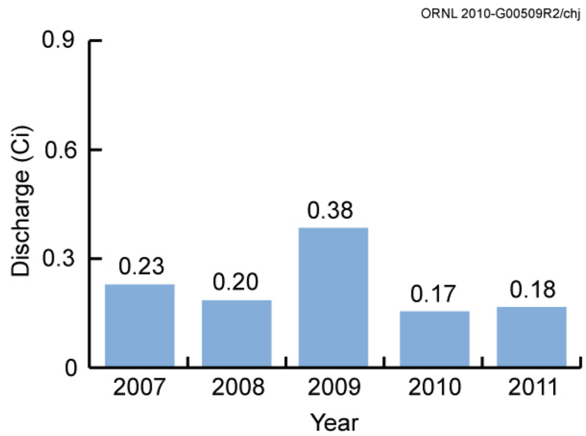

Fig. 5.22. Cesium-137 discharges at White Oak Dam, 2007–2011.

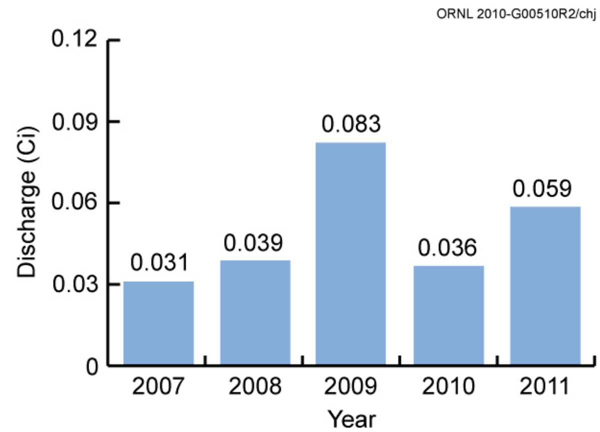

Fig. 5.23. Gross alpha discharges at White Oak Dam, 2007–2011.

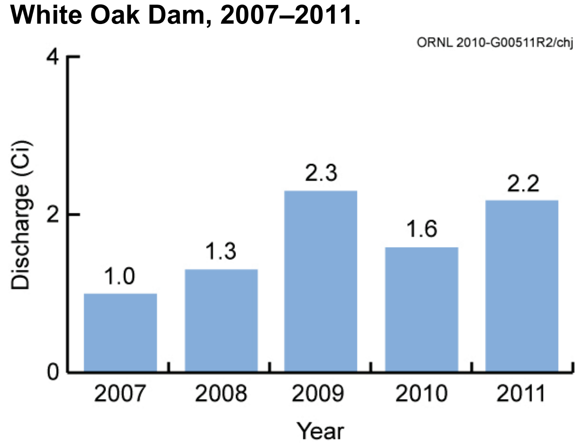

Fig. 5.24. Gross beta discharges at White Oak Dam, 2006–2011.

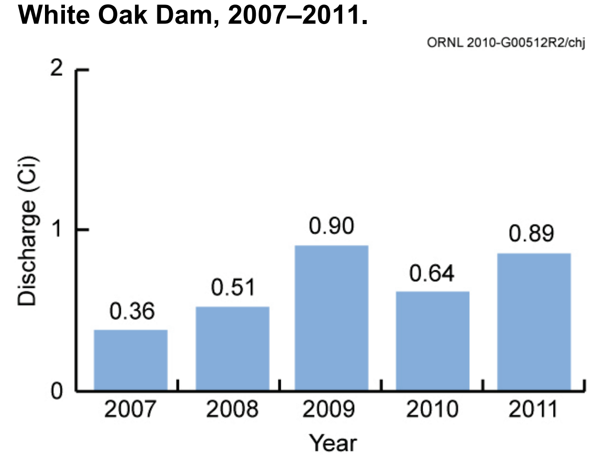

Fig. 5.25. Total radioactive strontium discharges at White Oak Dam, 2007–2011.

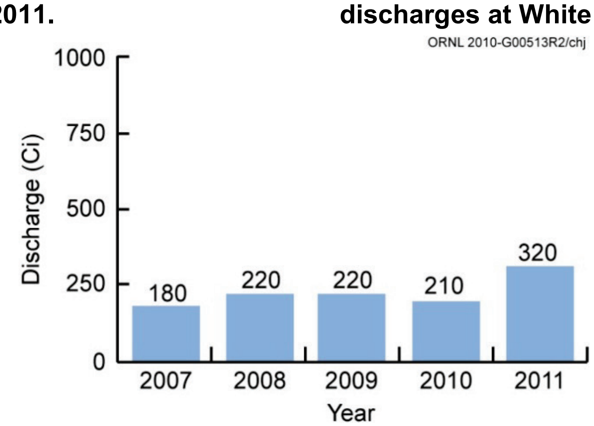

Fig. 5.26. Tritium discharges at White Oak Dam, 2007–2011.

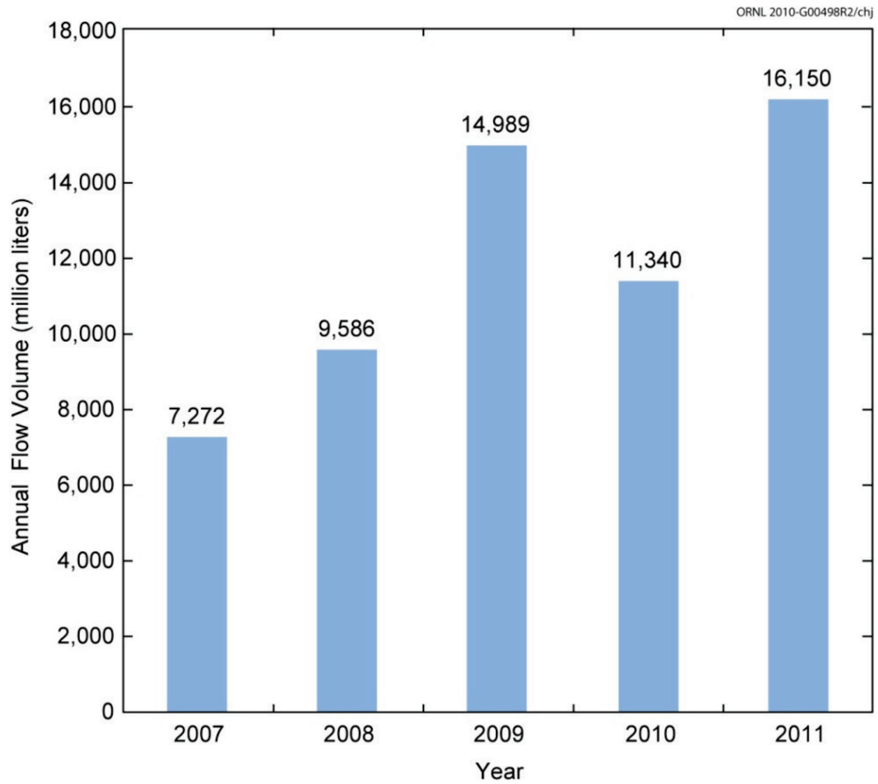

Fig. 5.27. Annual flow volume at White Oak Dam, 2007–2011.

5.5.5 Mercury in the White Oak Creek Watershed

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

Process wastewater drains and building sumps from Buildings 4501 and 4505, the facilities where most of the ORNL mercury work was conducted, are routed via underground collection-system piping to the ORNL PWTC for treatment to remove constituents, including mercury, before discharge to WOC. In 2007, another groundwater sump in Building 4501 that had accumulated legacy mercury contamination from building foundation drains was rerouted from storm drain Outfall 211 to PWTC, and in 2009 a mercury pretreatment unit was installed in Building 4501 to remove most of the mercury from the sump discharge before routing to PWTC for final treatment. In 2011, a groundwater sump in Building 4500N that was found to contain water with low concentrations of mercury was also rerouted to PWTC. These recent actions have significantly diminished the release of legacy mercury contamination from the ORNL site to the WOC watershed (Fig. 5.28).

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 2011, 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 2011 monitoring are shown in Fig. 5.29, and complete mercury monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone (865-574-3257).

Monitoring results for 2011 indicated that Tennessee mercury criteria were largely met at instream locations. In 2011, studies were conducted in reaches of Fifth Creek and WOC to better characterize the extent of spatial and temporal variability of mercury concentrations in those areas. As a result of this work, 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 and will be the subject of additional investigation in 2012.

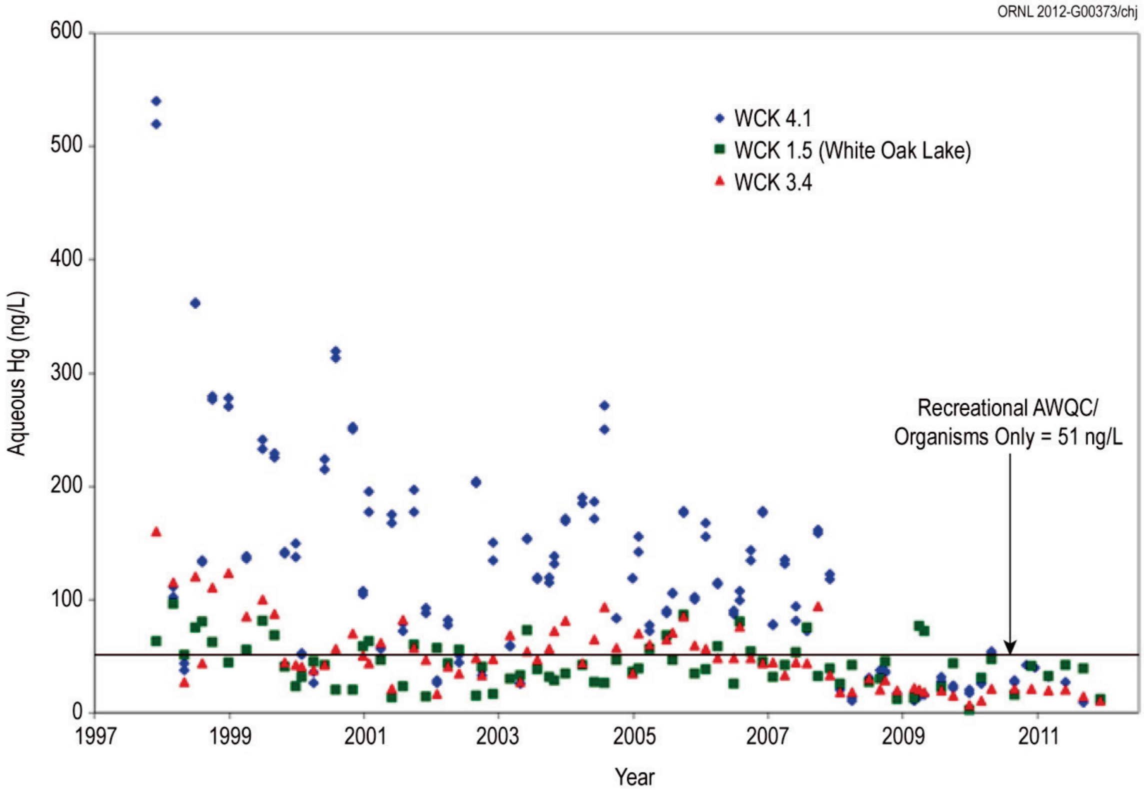

Fig. 5.28. Total aqueous mercury concentrations at sites in White Oak Creek downstream from Oak Ridge National Laboratory, 1997–2011.

In 2012, WQPP mercury investigative efforts will focus on areas of interest that were identified through 2011 monitoring activities (e.g., the increased presence of mercury in storm drain Outfall 265 and the influence of storm drain pipe sediments on the mercury presence in storm drain Outfall 211). A subset of the 2009 characterization-monitoring protocol will also be conducted in 2011 to maintain ongoing data on the presence of mercury in the WOC watershed.

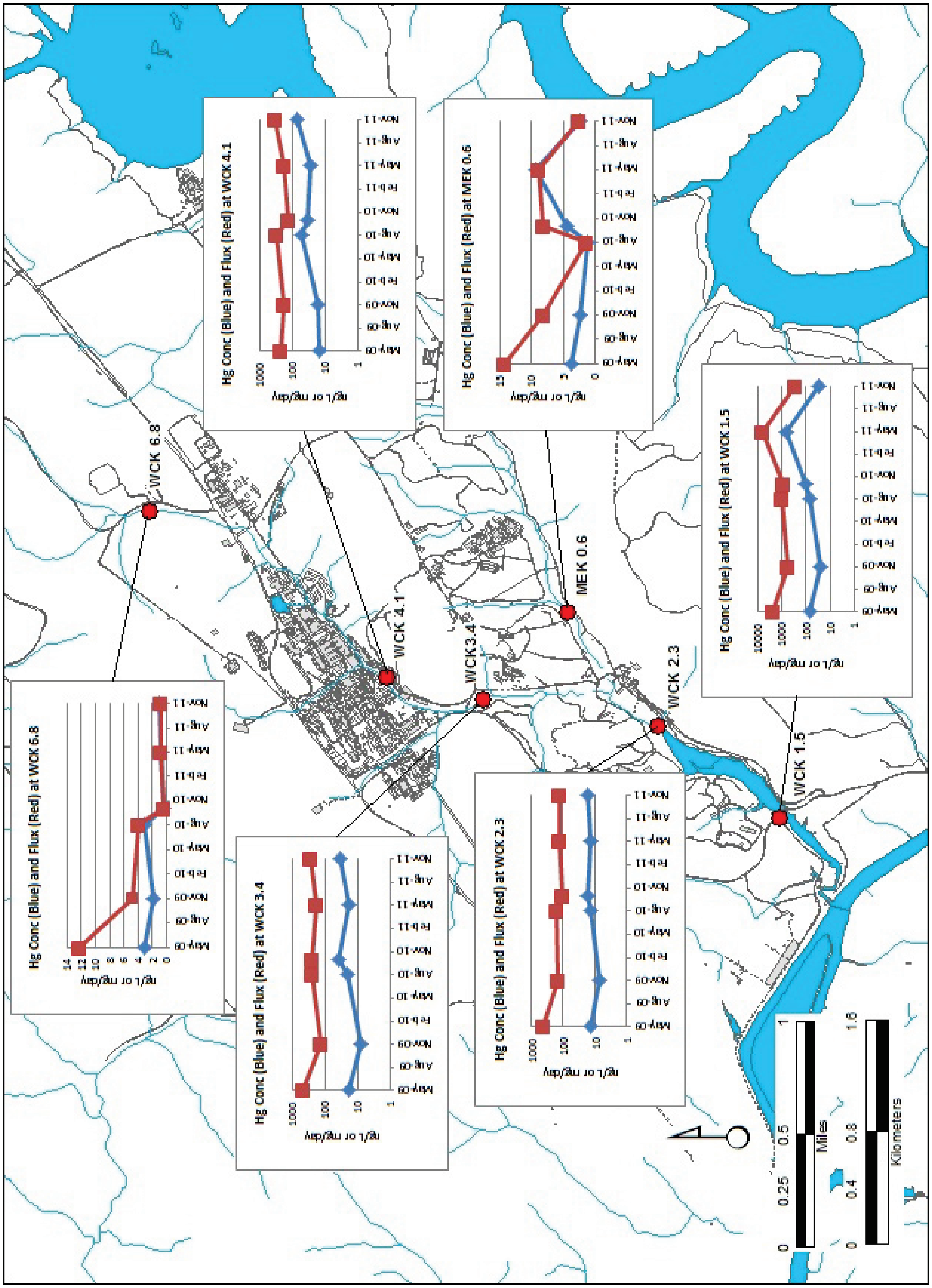

Fig. 5.29. Total mercury concentration and flux at selected Oak Ridge National Laboratory instream locations, 2009 through 2011.

5.5.6 Water Quality Assessment of Selected Stream Reaches in the Oak Ridge National Laboratory Main Campus Area

In 2011, monitoring was conducted under the ORNL WQPP to characterize water quality in stream reaches of First Creek and WOC that are in heavily developed portions of the ORNL complex. Both instream and outfall locations were sampled. Monitoring of outfalls and instream locations within a particular geographic area were monitored concurrently to more directly assess the influence of outfall discharges on instream water quality. The outfalls selected for monitoring were judged to be the most significant in terms of potential to affect instream water quality. Monitoring was performed in dry-weather (baseflow) conditions at three instream locations and seven outfalls in the upper reaches of WOC (Fig. 5.30). Wet-weather (storm runoff) monitoring was conducted at four instream locations and six outfalls in First Creek and the mid reaches of WOC (Fig. 5.31). The primary objective of this monitoring was to support one of the overall WQPP objectives: to discover the reasons for biological community impairments and to ultimately eliminate or reduce those impairments.

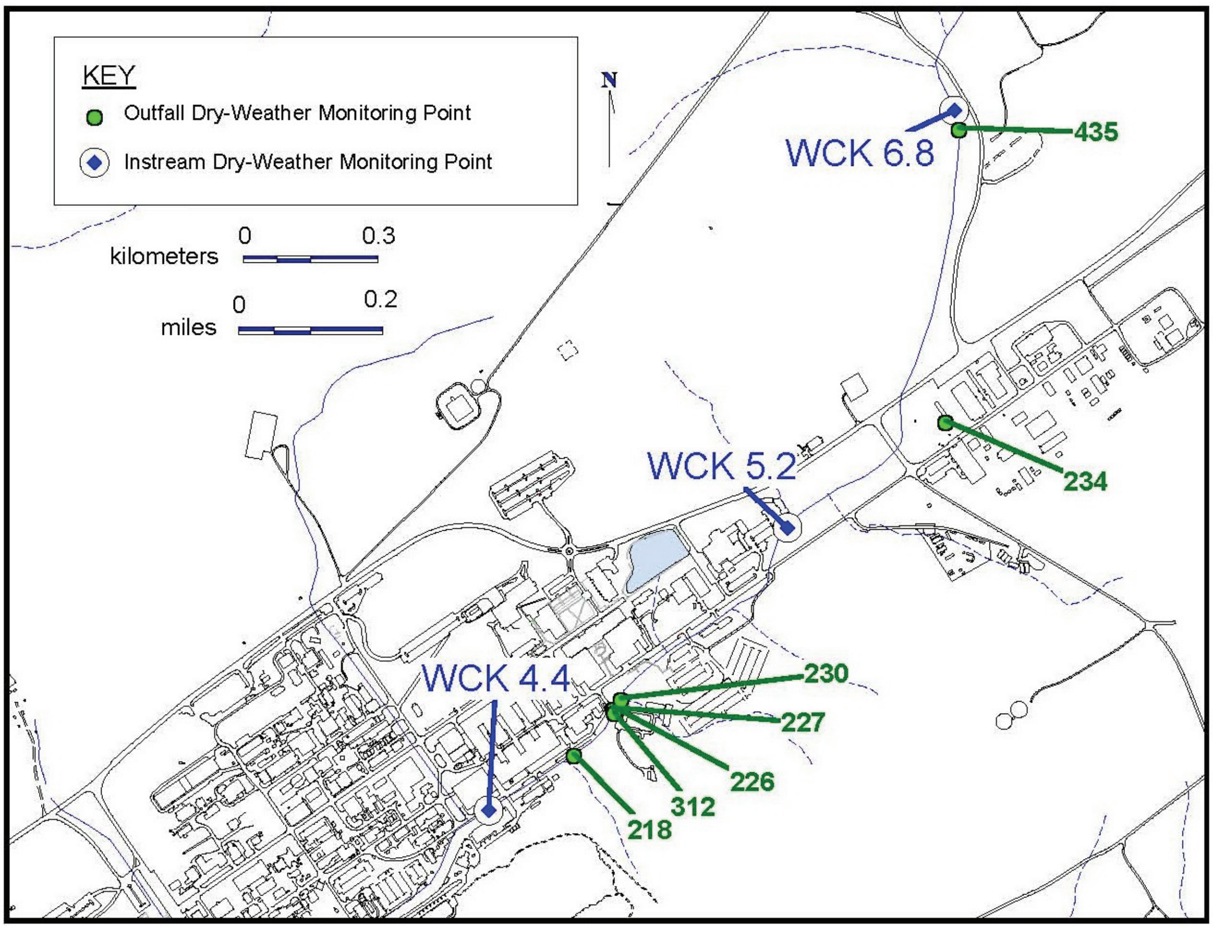

Fig. 5.30. Instream locations and outfalls sampled for water quality parameters under the Oak Ridge National Laboratory Water Quality Protection Plan during dry-weather conditions, 2011.

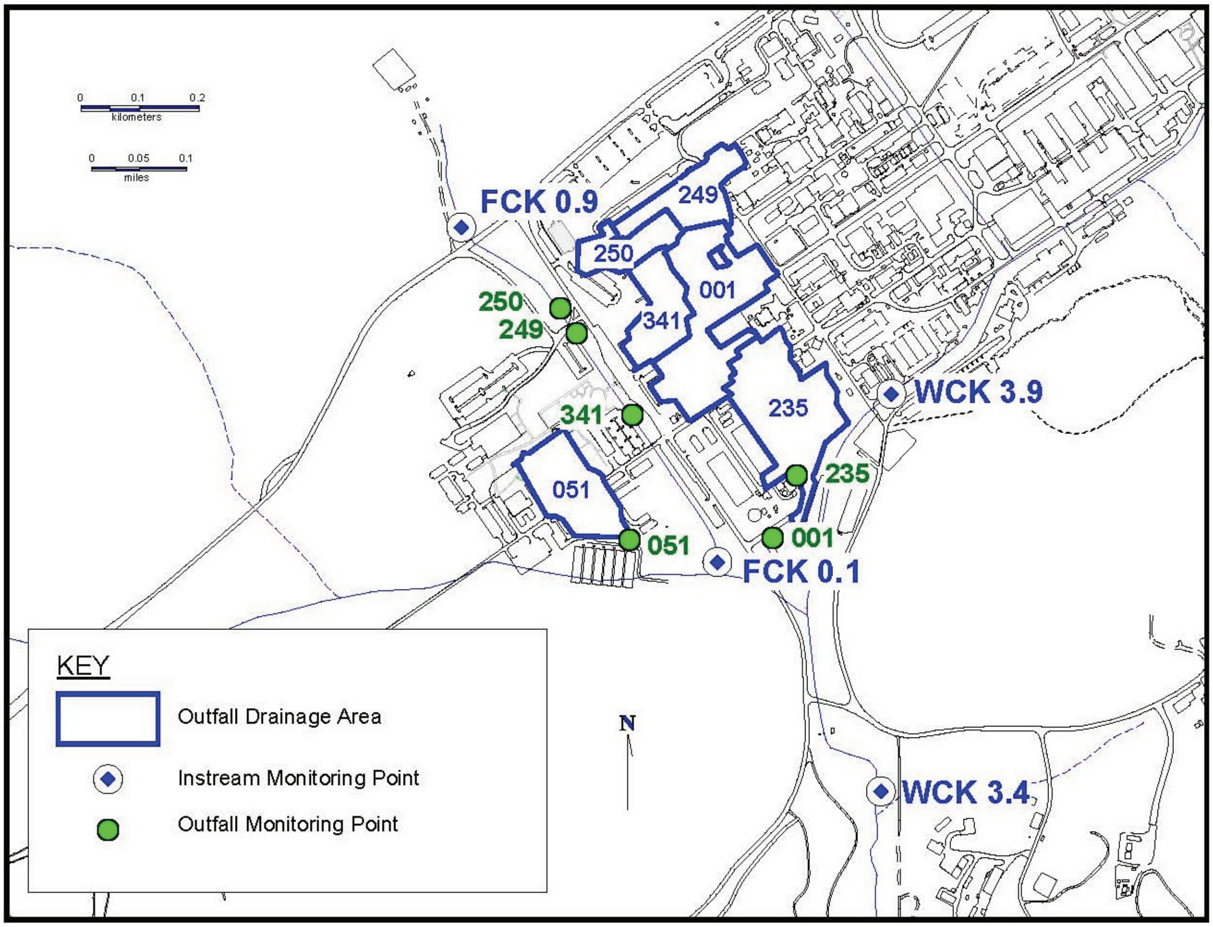

Fig. 5.31. Instream locations and outfalls sampled for water quality parameters under the Oak Ridge National Laboratory Water Quality Protection Plan during wet-weather conditions, 2011.

In both wet- and dry-weather sampling, samples were collected for solids (suspended and dissolved), metals (total and dissolved), and nutrients (total phosphorus, Kjeldahl nitrogen, nitrate+nitrite nitrogen, and ammonia) and submitted for laboratory analysis. Dry-weather samples were 24 h time-proportional composite samples for both instream and outfall locations. Wet-weather samples for instream locations were flow-proportional composites. For outfall locations, both flow-proportional composite and first flush grab samples were collected. At all locations, in both wet- and dry-weather conditions, grab sample field measurements were made for conductivity, dissolved oxygen, flow, pH, temperature, and turbidity. The results from this water quality sampling are being used to guide future efforts under WQPP and, along with data from future sampling, will be useful in determining causes of biological community impairments in the WOC watershed. The data collected to date suggest that parameters warranting additional study under WQPP are nutrients and metals.

5.5.7 Storm Water Surveillances and Construction Activities

Figure 5.32 depicts the location of construction sites that were considered significant in 2011 because of the need to be covered under the general Tennessee NPDES permit for construction activities and/or an aquatic resource alteration permit or because they had a footprint of more than 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.) Nine of these sites were inspected in 2011 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.

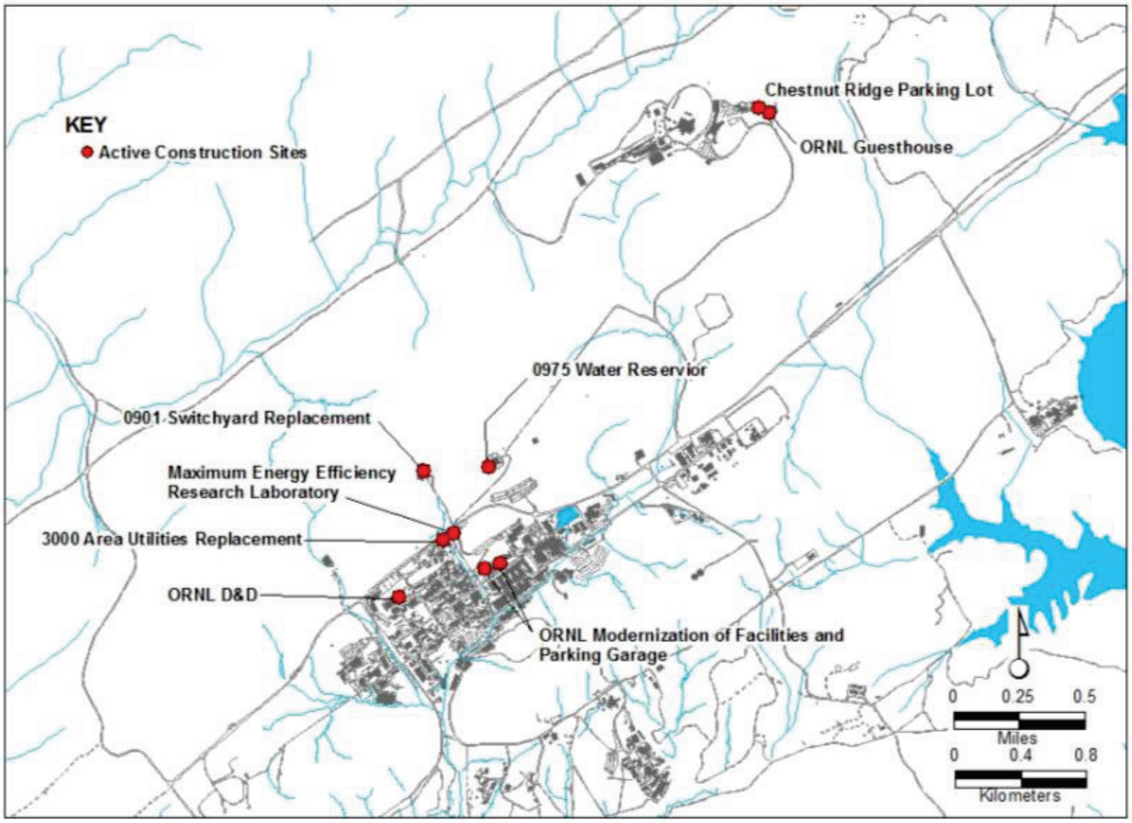

Fig. 5.32. Active construction sites and WQPP monitoring locations at ORNL, 2011.

NPDES outfall drainage areas were also inspected twice in 2011. 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. Flaking paint on some buildings (slated to be dismantled in the near future) also poses a potential mobile storm water pollutant source.

Some construction activities are performed by third-party contractors working as tenants 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.

Certain instream and outfall locations identified under WQPP were monitored in 2011 in storm conditions. A more detailed description of the WQPP wet-weather monitoring scenario can be found in Section 5.5.6.

5.5.8 Biological Monitoring

5.5.8.1 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 2011. 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 2011. Long-term trends in waterborne mercury in the WOC system downstream of ORNL are shown in Fig. 5.28. Waterborne mercury downstream of ORNL declined abruptly in 2008 and remained low through 2011 as a result of rerouting highly contaminated sump water in Building 4501 to PWTC in December 2007. The mean total mercury concentration at WOC kilometer (WCK) 4.1 was 19.3 ± 11.4 ng/L in 2011 compared with 108 ± 33 ng/L in 2007. The decrease was also apparent but less pronounced at WCK 3.4, with mercury averaging 15.8 ± 4.6 ng/L in 2011 versus 49 ± 23 ng/L in 2007. Mercury concentrations at these two sites were significantly lower than levels in 2007, and were slightly lower than in 2010. 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 31.3 ± 13.5 ng/L in 2011, 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 WCK 2.9 were below the 0.3 µg/g AWQC for the first time in 10 years but increased slightly in 2011 to 0.33 ± 0.02. Although above the AWQC, this concentration is still below concentrations observed in this species before the sump water reroute in 2007 (Fig. 5.33). Mean fillet concentrations at WCK 3.9 decreased from 0.45 µg/g in 2007 to 0.22 µg/g in 2011, bringing the mean concentrations observed at this site below AWQC (Fig. 5.33). It is too early to determine whether these decreases are due to natural interannual variation or actual responses to the lowered aqueous concentrations at these sites, but the fact that 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) continued to increase in 2011 such that mean concentrations in both species were the highest observed since 1998. The reason for the increase in the lower end of the WOC watershed is not known, but changes in sediment or food chain processes could affect bioaccumulation.

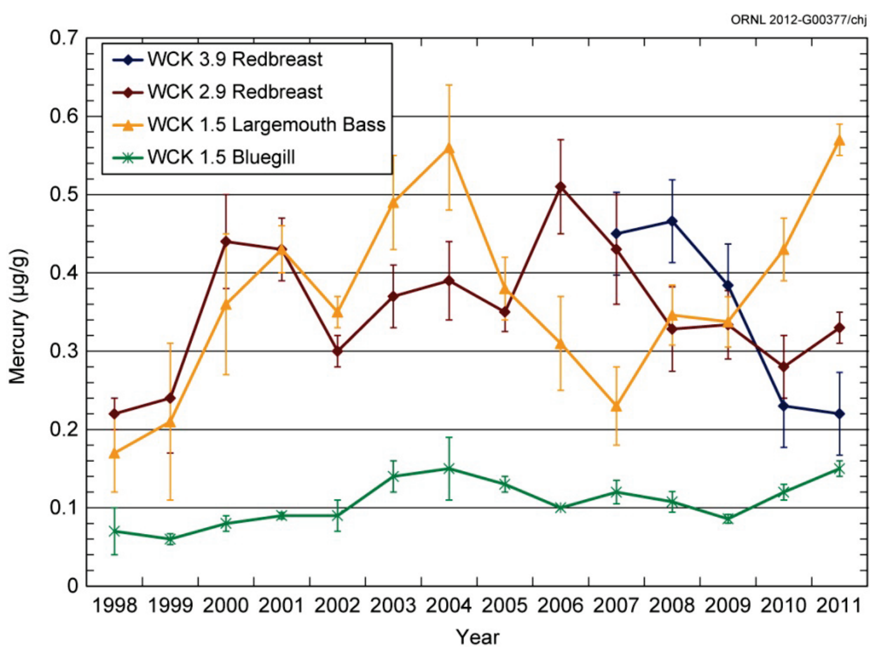

Fig. 5.33. Mean concentrations of mercury (µg/g, ± Standard Error, N = 6) in muscle tissue of sunfish and bass from WOC (WCK 3.9, WCK 2.9) and White Oak Lake (WCK 1.5), 1998–2011.

Mean PCB concentrations in redbreast sunfish at WCK 3.9 and WCK 2.9 (0.60 and 0.42 µg/g, respectively) were comparable to recent years. Mean PCB concentrations in bluegill from WCK 1.5 were substantially lower in 2011 (0.68 µg/g) than in 2010 and were comparable to concentrations observed in previous years. The mean PCB concentrations in bass collected from WCK 1.5 have been decreasing over the past 2 years but in 2011 remained above typical concentrations that result in a TDEC fish advisory limit (i.e., > 1 µg/g) (Fig. 5.34).

Benthic Macroinvertebrate Communities. Monitoring of benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2011. Additionally, monitoring of the macroinvertebrate community in lower Melton Branch [Melton Branch kilometer (MEK) 0.6] continued under the DOE Office of Environmental Management WRRP. Benthic macroinvertebrate samples are collected once annually following two protocols: protocols developed by ORNL and used since 1986 and TDEC protocols. ORNL protocols are used to help evaluate and verify the effectiveness of pollution abatement and remedial actions taken at ORNL, while TDEC protocols provide a comparison against state-derived reference conditions. The results from both protocols are used to help assess ORNL's compliance with current NPDES permit requirements. The results from TDEC protocols are provided in this summary; results from ORNL protocols will be summarized in FY13.

Compared with TDEC's derived reference condition, the only site monitored in WOC watershed that has consistently exhibited nonimpaired conditions is WCK 6.8, which until construction of SNS had served as the reference site for WOC (Fig. 5.35). The remaining sites monitored using TDEC protocols exhibited biotic index scores rated as slightly impaired.

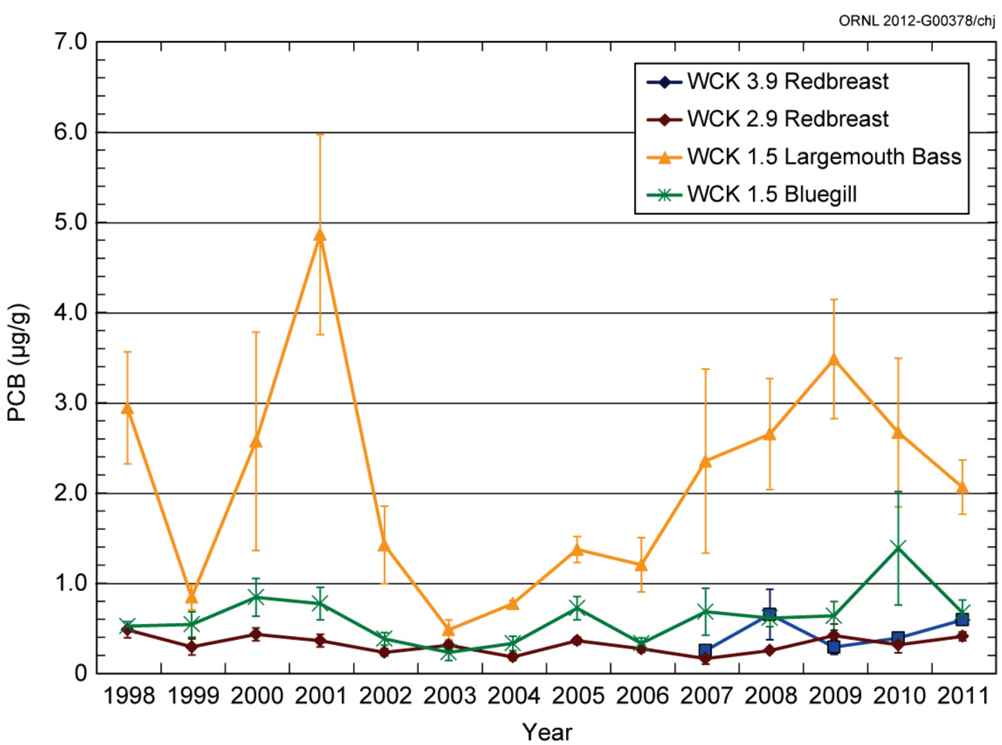

Fig. 5.34. Mean PCB concentrations (µg/g, ± standard error N = 6) in fish fillets collected from the White Oak Creek (WOC) watershed, 1998–2011. (WCK = WOC kilometer.)

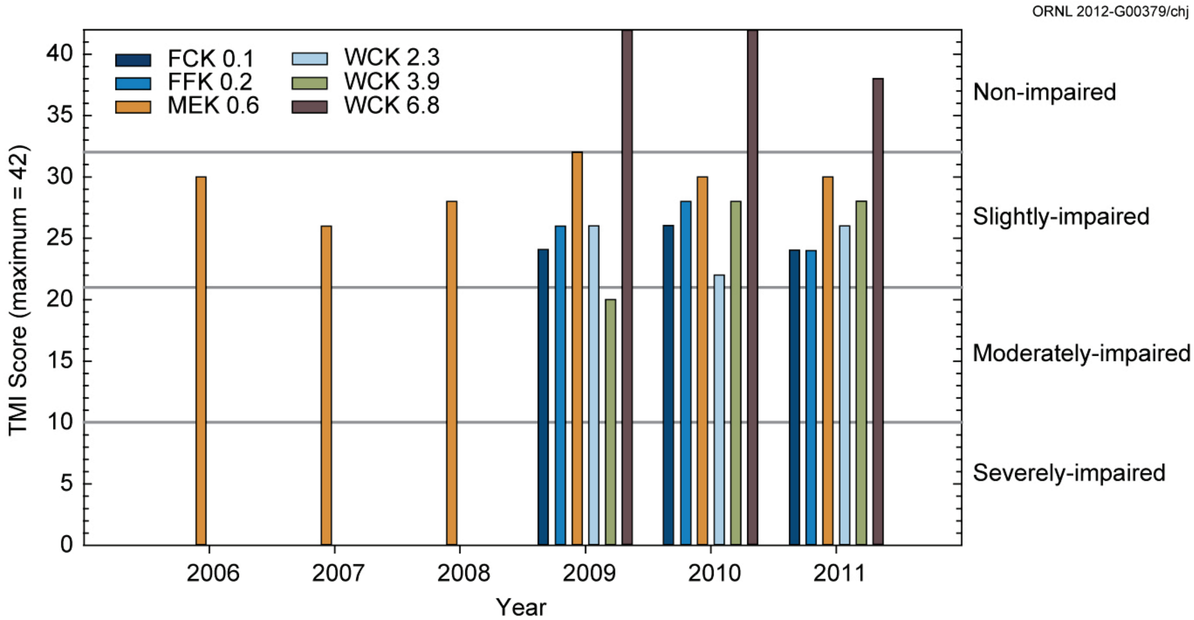

Fig. 5.35. Temporal trends in TDEC Biotic Index Scores for White Oak Creek watershed, August 2006–August 2011. Horizontal lines show the lower thresholds for biotic condition ratings for index scores; respective narrative ratings for each threshold are shown on right side of graph. (FCK = First Creek kilometer; FFK = Fifth Creek kilometer; MEK = Melton Branch kilometer; WCK = White Oak Creek kilometer.)

5.5.8.2 Fish Communities

Monitoring fish communities in WOC and major tributaries continued in 2011. Fish samples were taken at 11 sites in the WOC watershed in the spring and fall. Streams located near or within the city of Oak Ridge were also sampled as reference sites: Mill Branch as a reference for smaller upstream locations within WOC and Brushy Fork as a reference for the larger downstream portions of WOC.

In WOC, the fish community continued to be degraded in 2011 compared with communities in reference streams, with sites closest to the outfalls having lower species richness (number of species), 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 2011 relative to reference streams or upstream sites. For example, in Fifth Creek the density values of the fish community have varied greatly over the past few years, with some samples having few or no fish present (Fig. 5.36). This variability may be related to occasional waterline breaks and pulses of chlorinated water into Fifth Creek.

A project to introduce missing fish species into the watershed was initiated in 2008 by stocking six native species. Reproduction was noted for three of the species, and several species expanded their range beyond initial introduction sites. Increased richness was observed in several of the WOC sites, due in part to this introduction program. During 2011, seven sites had introduced species, with WCK 2.3 supporting five introduced species and sites WCK 3.4 and WCK 3.9 supporting three species. The initial success of the introductions in much of WOC suggests that overall water quality has improved in the watershed over the past two decades. An additional site (MEK 1.4) was selected for species introductions in 2011.

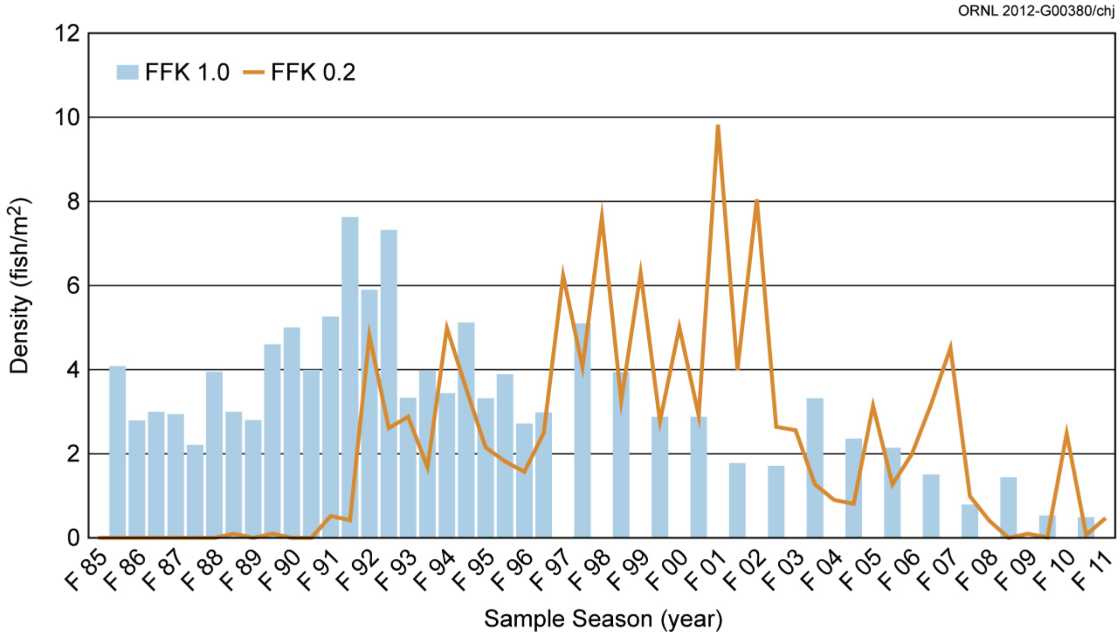

Fig. 5.36. Density estimates of fish communities in Fifth Creek, 1985–2011. (FFK = Fifth Creek kilometer.)

5.5.9 PCBs 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 overlying water 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 2011, ORNL's PCB monitoring efforts continued focusing on the First Creek watershed, which has been identified previously as a source of PCBs.

The SPMD results in this study provide information on the relative contributions of various stream reaches within the First Creek watershed. Instream, end-of-pipe, and pipe network locations were monitored with SPMDs (Fig. 5.37). The results confirm previous results which show that historical operations in the First Creek watershed are continuing to contribute PCBs to First Creek. SPMDs deployed at the reference site upstream of the campus, First Creek kilometer 0.9, had background levels of PCBs, while all the other sites were above background levels.

In addition to SPMDs, clams were deployed in selected sites in First Creek. Clams feed on plankton and other fine particles and provide a relative measure of the total PCB levels in these sites, whereas SPMDs provide a relative measure of dissolved PCBs. The results from this study indicate that the central reach of First Creek is where PCBs are most available for bioaccumulation (Table 5.19).

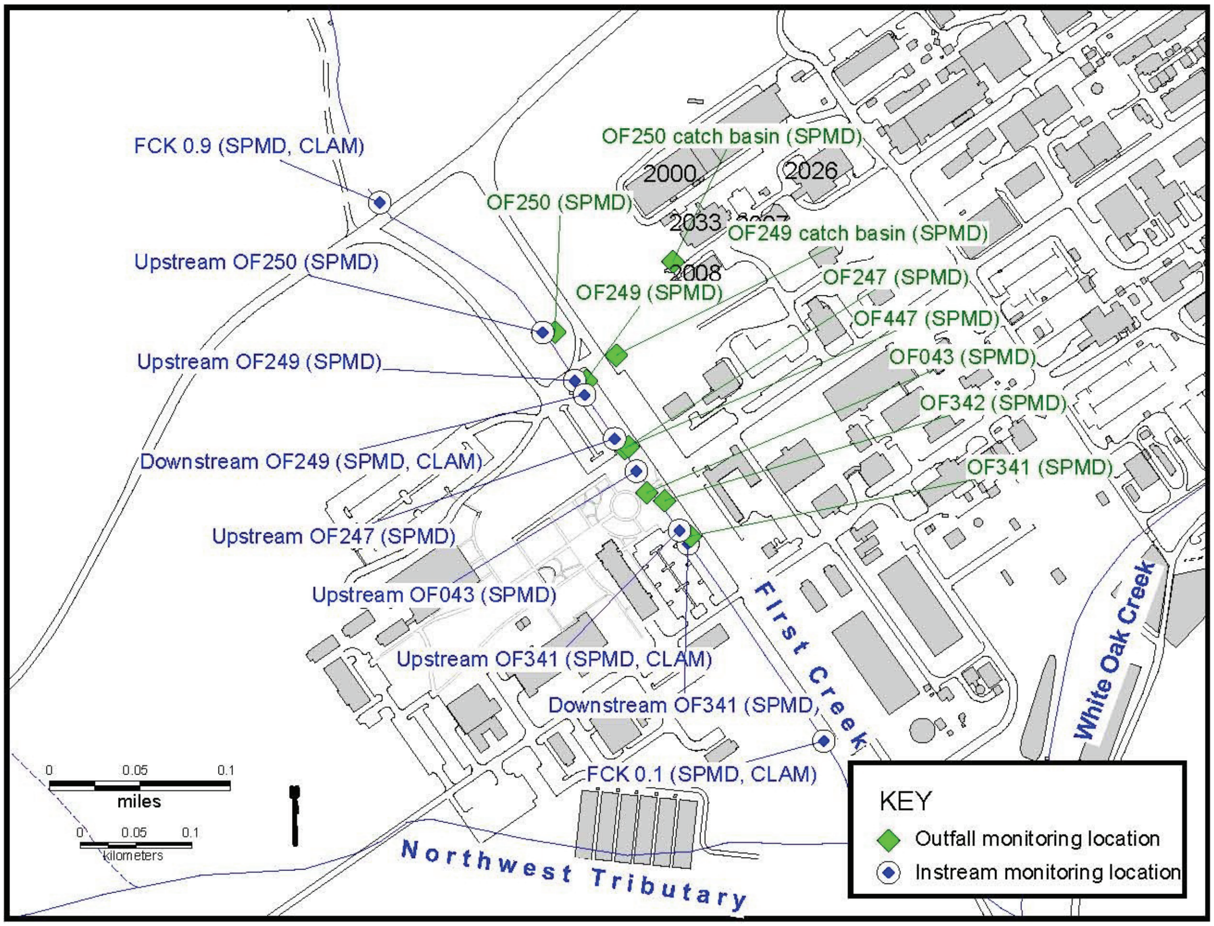

Fig. 5.37. Locations of monitoring points for First Creek source investigation. (FCK = First Creek kilometer; SPMD = semipermeable membrane device.)

Table 5.19. First Creek PCB source assessment, June 2011
[Total PCBs (parts per billion)]

Location Name	Location Type	SPMD	Clams
FCK 0.9	Reference site	84	9
Upstream Outfall 250	Instream	0	
Outfall 250	End of Pipe	109,000	
Outfall 250 catch basin	Pipe Network	52,000	
Outfall 249 catch basin	Pipe Network	605	
Upstream Outfall 249	Instream	20,500	
Outfall 249	End of Pipe	1,127	
Downstream Outfall 249	Instream	17,900	1,382
Upstream Outfall 247	Instream	24,000	
Outfall 247	End of Pipe	570	
Upstream Outfall 043	Instream	920	

Table 5.19. (continued)
[Total PCBs (parts per billion)]

Location Name	Location Type	SPMD	Clams
Outfall 043	End of Pipe	56,000	
Outfall 342	End of Pipe	190	
Outfall 447	End of Pipe	920	
Upstream Outfall 341	Instream	55,000	2,898
Outfall 341	End of Pipe	14,600	
Downstream Outfall 341	Instream	59,000	
FCK 0.1	Instream	63,000	2,787

Abbreviations
FCK First Creek kilometer
SPMD semipermeable membrane device

5.5.10 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. There were no regulatory or permitting actions related to oil pollution prevention at ORNL in 2011. The ORNL SPCC plan was revised in November 2011 to comply with regulatory requirements. An oil handler training program, which includes an initial training module and annual refreshers, is being implemented to comply with new training requirements in 40 CFR 112.

5.5.11 Surface Water Surveillance Monitoring

The ORNL surface water monitoring program includes sample collection and analysis from several locations at ORNL and around ORR. This 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. Sampling locations include streams downstream of ORNL waste sources and reference points on streams and reservoirs upstream of waste sources (Fig. 5.38).

Sampling frequencies and parameters vary by site. For the first three quarters of 2011, sampling was conducted at 12 locations, indicated in Table 5.20. Effective October 1, 2011, sampling was discontinued at eight locations which are not in areas that could be impacted by current operations at ORNL. The four remaining sites are used to monitor conditions upstream of ORNL main plant waste sources (WCK 6.8); within the ORNL campus (Fifth Creek kilometer 0.1); and at two locations downstream of ORNL discharge points (WCK 2.6 and WCK 1.0).

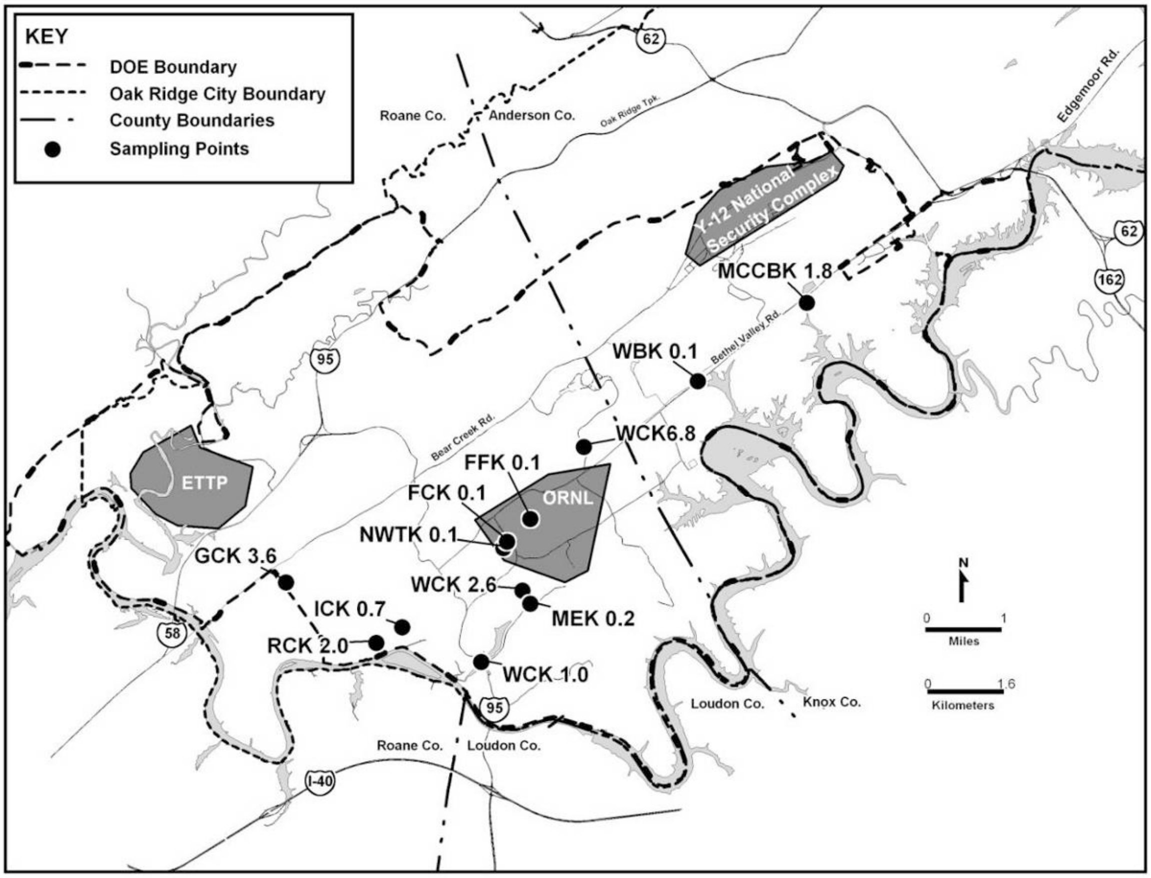

Fig. 5.38. Oak Ridge National Laboratory surface water sampling locations.

Table 5.20. Oak Ridge National Laboratory surface water sampling locations, frequencies, and parameters, 2011

Location[a]	Description	Frequency	Parameters[c]
MEK 0.2[b]	Melton Branch downstream from ORNL	Bimonthly (Jan., March, May, July, Sept., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements
WCK 1.0	White Oak Lake at WOD	Monthly	Volatiles, metals, PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements
WCK 2.6	WOC downstream from ORNL	Bimonthly (Jan., March, May, July, Sept., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements
WCK 6.8	WOC upstream from ORNL	Quarterly (Feb., May, Aug., Nov.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
WBK 0.1[b]	Walker Branch before it enters CRK 53.4	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements
GCK 3.6[b]	Grassy Creek upstream of Energy Solutions and IT Corp. at CRK 23	Semiannually (April, Oct.)	Lead, gross alpha, gross beta, gamma scan, field measurements

Table 5.20. (continued)

Location[a]	Description	Frequency	Parameters[c]
ICK 0.7 [b]	Ish Creek prior to entering CRK 30.8	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements
MCK 1.8[b]	McCoy Branch prior to entering CRK 60.3	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements
RCK 2.0[b]	Raccoon Creek sampling station prior to entering CRK 31	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
NWTK 0.1[b]	Northwest Tributary before the confluence with First Creek	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
FCK 0.1[b]	First Creek prior to the confluence with Northwest Tributary	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
FFK 0.1	Fifth Creek just upstream of WOC (ORNL)	Semiannually (April, Oct.)	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 km upstream from the confluence of White Oak Lake and the Clinch River).

CRK	Clinch River kilometer
FCK	First Creek kilometer
FFK	Fifth Creek kilometer
GCK	Grassy Creek kilometer
ICK	Ish Creek kilometer
MCK	McCoy Branch kilometer
MEK	Melton Branch kilometer
NWTK	Northwest Tributary kilometer
RCK	Raccoon Creek kilometer
WBK	Walker Branch kilometer
WCK	WOC kilometer
WOC	White Oak Creek
WOD	White Oak Dam

[b]Sampling at this location was discontinued beginning October 1, 2011.

[c]Field measurements consist of dissolved oxygen, pH, and temperature.

Grab samples are collected and analyzed for general water quality parameters and are screened for radioactivity at all locations. 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 metals. Four of the 12 sampling locations included in the 2011 program are classified by the State of Tennessee for freshwater fish and aquatic life. Tennessee WQC associated with these classifications are used as references where applicable. The Tennessee WQC do not include criteria for radionuclides. Four percent of the DOE DCS is used for radionuclide comparison because this value is roughly equivalent to the 4 mrem dose limit from ingestion of drinking water on which the EPA radionuclide drinking water standards are based.

The ORR upstream reference site (Clinch River kilometer 66) can 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 2011 surveillance monitoring efforts are consistent with historical data. The locations with the highest radionuclide levels are in the ORNL main plant area or at locations downstream of the main plant and near or downstream of CERCLA sites. These concentrations are expected to decrease as future remedial actions are completed at ORNL.

No radionuclides were detected in surface water at WCK 6.8. Radionuclides are highest downstream from ORNL (WCK 2.6), reflecting known contamination issues. Before WOC empties into the Clinch River (at WOD), radionuclide concentrations decreased somewhat from those upstream at WCK 2.6.

The gross beta result from the April sampling event at Walker Branch kilometer 0.1 was 19.5 pCi/L; this is not consistent with historical results and is thought to overstate actual gross beta activity. The analytical laboratory reanalyzed the sample and a duplicate from within the batch. Both sample and duplicate results are less than the minimum detectable activity (MDA), which is consistent with historical results; however, the reanalysis was performed after the holding time allowed by the analytical method and is therefore not defensible.

PCB-1254 was detected at estimated levels once during 2011 at WOC at WOD; PCBs have not been detected there since 2001. The VOC chloroform continued to be detected at low levels at WOC at WOD in 5 of the 12 sampling events.

5.6 Groundwater Protection Program

As in years past, groundwater monitoring at ORNL was conducted under two sampling programs in 2011: DOE Office of Environmental Management (EM) monitoring and DOE Office of Science surveillance monitoring. The Office of Environmental Management groundwater monitoring program was performed by BJC through the end of July 2011, at which time UCOR became responsible for such activities. The Office of Science groundwater monitoring surveillance program was conducted by UT-Battelle.

Radiological and metal contaminant concentrations observed in groundwater exit pathway discharge areas were generally consistent with observations reported in past ASERs. Several polycyclic aromatic hydrocarbon compounds were identified at estimated low concentrations in samples collected from northwestern and WOC discharge area wells. One VOC was identified at low estimated concentrations in samples collected from the WOC, East End, and southern discharge area sampling locations. One phthalate compound was detected in several wells in 2011. The phthalate compound has been observed historically in these wells. Based on the results of the 2011 monitoring effort, there is no indication that current Office of Science operations are significantly impacting groundwater at ORNL.

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 remedial actions 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 2011, including monitoring at ORNL, are evaluated and reported in the *2012 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE 2012) 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.

WRRP also conducts groundwater monitoring at SWSA 6 and submits the required annual groundwater monitoring report to TDEC in response to the RCRA Permit.

Groundwater monitoring conducted as part of the DOE Office of Environmental Management program at ORNL includes routine sampling and analysis of groundwater from 27 wells in Bethel Valley. In Melton Valley, where CERCLA remedial actions were completed in 2006 for the extensive waste management areas, the groundwater monitoring program includes monitoring groundwater levels in 80 wells 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.

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 2011 remedial action construction was completed at two former low-level solid waste storage areas in Bethel Valley—SWSA 1 and SWSA 3. Remedial actions and monitoring were specified in a CERCLA RAWP that was developed by DOE and was approved by EPA and TDEC before the project was started. Required monitoring will resume in FY 2012.

During FY 2011 an offsite groundwater monitoring well array west of the Clinch River adjacent to Melton Valley was monitored as part of the DOE Office of Environmental Management program. In addition to offsite groundwater quality monitoring near Melton Valley, exit pathway groundwater monitoring in Melton Valley is conducted as part of the DOE Office of Environmental Management 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 remedial actions 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 remedial action for the waste burial grounds and construction of soil covers over the former contractor's landfill and contaminated soil areas near SWSA 3. The baseline monitoring conducted during FY 2010 included measurement of groundwater levels to obtain baseline data to allow evaluation of postremediation groundwater-level suppression. Sampling and analysis of groundwater quality and contaminants were also conducted. During FY 2011 the DOE EM program monitored three new 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 2012 remediation effectiveness report (DOE 2012).

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. DOE is in the process of modifying the groundwater collection system to increase the plume containment effectiveness. During FY 2011 DOE construction work was ongoing to install additional plume contaminant collection wells and refurbish the existing plume collection infrastructure, which had become unreliable because of its age.

Groundwater contaminant monitoring in other areas of Bethel Valley showed that contaminant levels are generally stable.

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 2011 greater than average annual rainfall occurred for the third 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; however, groundwater level control at the SWSA 4 downgradient collection trench was challenged following large rain events. DOE proposes to conduct maintenance actions on that element of the remedy to improve its performance.

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

During the past 7 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, ^{3}H, 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 2011 the EM Program monitored an offsite groundwater monitoring well array west of the Clinch River adjacent to Melton Valley. 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. Groundwater quality monitoring showed that aggressive off-site well pumping related to well construction may have drawn chlorinated VOCs associated with DOE beneath the river. Those compounds were detected only during the first of five sampling events. DOE provided funding for installation of utility water supplies to residents near the Clinch River opposite the Melton Valley area in response to the potential vulnerability of off-site well pumping drawing contaminants off ORR. Monitoring results are summarized in the 2012 remediation effectiveness report (DOE 2012).

5.6.2 DOE Office of Science Groundwater Monitoring

During 2011 DOE O 5400.5 (replaced by DOE O 458.1 in 2011) was 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 Office of Science groundwater surveillance monitoring program are reported in the following sections.

Exit pathway and active-sites groundwater surveillance monitoring points sampled during 2011 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 the Office of Science, federal drinking water standards and Tennessee WQC for domestic water supplies (TDEC 2009) 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.

5.6.2.1 Exit Pathway Monitoring

During 2011, exit pathway groundwater surveillance monitoring was performed in accordance with the Bonine SAP (Bonine 2011). 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 main campus of ORNL. 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 5.39 shows the locations of the exit pathway monitoring points sampled in 2011.

Unfiltered samples collected from the UT-Battelle exit pathway groundwater surveillance monitoring points in 2011 were analyzed for VOCs, semi-volatile organic compounds (SVOCs), metals (including mercury), and radionuclides (including gross alpha/gross beta activity, gamma emitters, total radioactive strontium, and 3H). Under the monitoring strategy outlined in the Exit Pathway Sampling and Analysis Plan, samples were collected semiannually during the wet (March, April, and May) and dry (August) seasons.

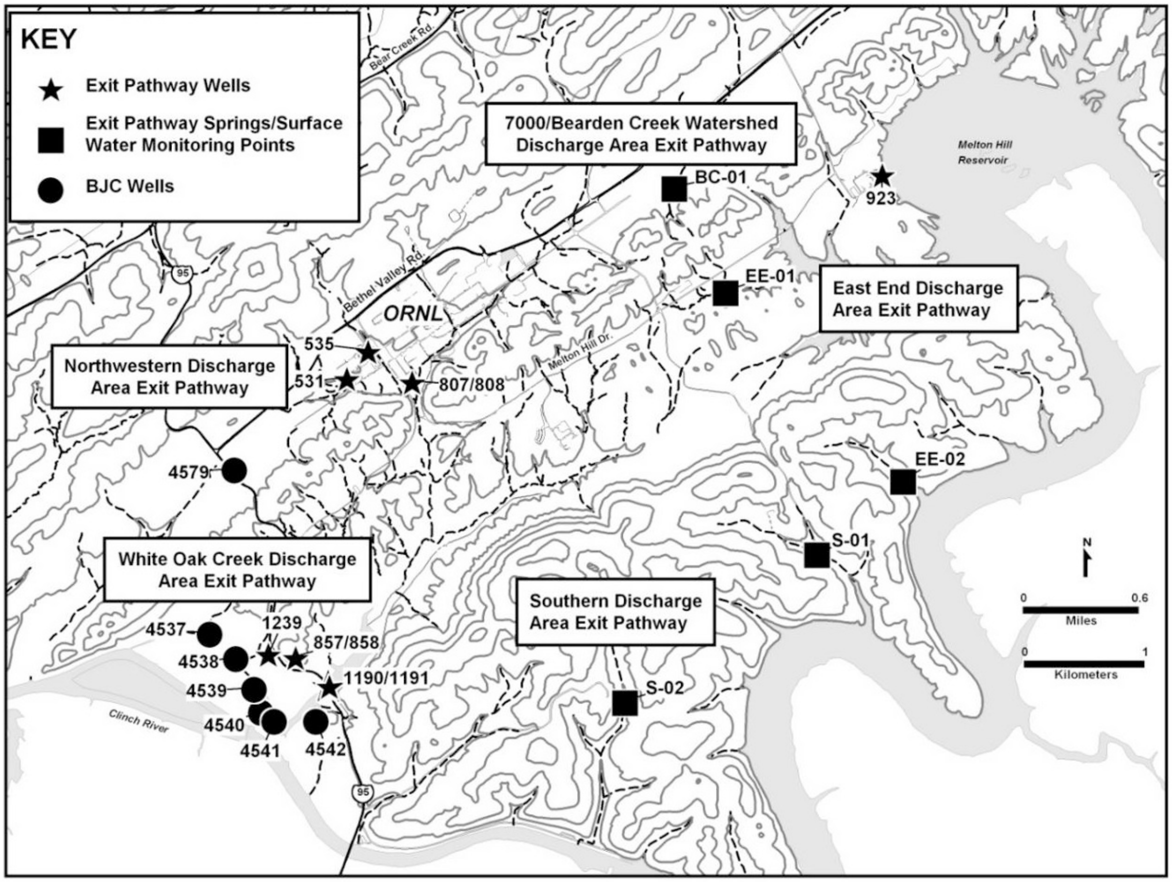

Fig. 5.39. UT-Battelle exit pathway groundwater monitoring locations at Oak Ridge National Laboratory, 2011.

5.6.2.1.1 Exit Pathway Monitoring Results

Statistical trend analyses were performed on 2011 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 2011. Trend analyses were not performed on data sets that were reported as being “undetected” by the laboratory when minimum detection limits exceeded reference standards (e.g., 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 5.21. Samples were not collected at BC-01, EE-01, EE-02 or S-01 during the dry season due to a lack of water flow at these locations. Samples were collected at all other monitoring points during both the wet and dry seasons. Monitoring results are available in OREIS. Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone (865-574-3257).

Table 5.21. 2011 exit pathway groundwater monitoring—results of trend analyses for parameters exceeding reference standards

Discharge Area	Mon. Point	Parameter	Trend
White Oak Creek	857	Aluminum	Up
		Iron	Down
		Lead	Down
	1190	Iron	Down
		Manganese	Down
		Tritium	Down
	1191	Iron	Down
		Manganese	Up
		Gross Beta	Down
		Total Radioactive Strontium	None
		Tritium	Down
Northwest	531	Aluminum	Down
	535	Iron	None
		Manganese	None
	807	Iron	Up
		Manganese	None
7000Area/Bearden Creek	BC-01	Aluminum	None
		Iron	None
Eastern	923	Iron	None
	EE-01	Iron	None
Southern	S-02	Aluminum	None
		Iron	None

Table 5.22 provides a summary of radiological parameters detected in samples collected from exit pathway monitoring points during 2011. Table 5.23 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. Parameters (including metals) exceeding reference standards during 2011 are summarized in Table 5.21.

Table 5.22. 2011 exit pathway groundwater monitoring results—detected radiological parameters[a]

Discharge Area	Monitoring Point	Parameter	Wet Season	Dry Season
White Oak Creek	857	Tritium	390	330
	1190	Beta	4.7	2.8
		Tritium	24000	23000
	1191	Beta	300	350
		Total Radioactive Sr	150	190
		Tritium	32000	42000
	1239	Alpha	2.3	2.4
		Beta	2.8	[b]
Northwestern	535	Bi-214	[b]	8.2
		Tritium	[b]	350
	807	Beta	4.7	6.2
		Bi-214	[b]	7.2
		Total Radioactive Sr	[b]	2
		Tritium	[b]	410
	808	Beta	[b]	2.9
East End	923	Tl-208	4.4	[b]

[a]Radiological units—pCi/L
[b]Not detected

Table 5.23. 2011 exit pathway groundwater monitoring results—detected organic parameters[a]

Discharge Area	Monitoring Point	Organic Parameter	Wet Season	Dry Season
White Oak Creek	857	Toluene	[b]	J0.32
	858	Benzo(g,h,i)perylene	J0.31[c]	[b]
		Bis(2-ethylhexyl)phthalate	13	[b]
		Dibenz(a,h)anthracene	J0.62	[b]
		Ideno(1,2,3 cd)pyrene	J0.31	[b]
	1190	Bis(2-ethylhexyl)phthalate	80	170
	1191	Bis(2-ethylhexyl)phthalate	51	120
	1239	Bis(2-ethylhexyl)phthalate	[b]	11
Northwestern	531	Benz(a)anthracene	J0.23	[b]
	807	Benz(a)anthracene	J0.45	[b]
		Benzo(a)pyrene	J0.21	[b]
		Benzo(k)fluoranthene	J0.24	[b]
		Chrysene	J0.45	[b]
	808	Benz(a)anthracene	J0.31	[b]
East End	923	Bis(2-ethylhexyl)phthalate	[b]	12
	EE-02	Toluene	J0.51	[b]
Southern	S-01	Toluene	J0.28	[b]

[a]Organic units (µg/L)
[b]Not detected
[c]J—Detected (estimated value)

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 ^{3}H concentrations observed since the repair of the subsurface leak site discovered in 2001. Since then, outfall pipelines intercepting groundwater have been monitored for ^{3}H 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 2011 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 2011 under a groundwater monitoring plan for the site (Bonine, Ketelle, and Trotter 2007). Operational monitoring was initiated following a 2-year (2004–2006) baseline monitoring program and will continue throughout the duration of SNS operations.

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

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

SNS operations have the potential for introducing radioactivity (via neutron activation) in the shielding berm surrounding the SNS linac, accumulator ring, and/or beam transport lines. A principal concern is the potential for water infiltrating the berm soils to transport radionuclide contamination generated by neutron activation to saturated groundwater zones. The ability to accurately model the fate and transport of neutron activation products generated by beam interactions with the engineered soil berm is complicated by multiple uncertainties resulting from a variety of factors, including hydraulic conductivity differences in earth materials found at depth, the distribution of water-bearing zones, the fate and transport characteristics of neutron activation products produced, diffusion and advection, and the presence of karst geomorphic features found on the SNS site. These uncertainties led to the initiation of the groundwater surveillance monitoring program at the SNS site. Objectives of the groundwater monitoring program outlined by Bonine, Ketelle, and Trotter (2007) include the following: (1) maintain compliance with applicable 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 5.40 shows the locations of the specific monitoring points sampled during 2011.

Because of the presence of karst geomorphic features at the SNS site (and the lack of groundwater wells at the SNS site), sampling of the seeps/springs was performed quarterly to characterize the radionuclide content of the water throughout the expected range of flow at each monitoring location. Three grab samples were collected from each seep/spring: one sample to represent base flow (collected during dry periods between rainfall events) and two samples collected during rainfall events representing higher stage/flow rates [i.e., one representing the rising limb of the storm hydrograph (water flow induced by the initial pulse of rainfall percolating through the system) and one representing the falling limb of the storm hydrograph (water flowing in the system after peak flow induced by rainfall has occurred)], as shown in Fig. 5.41. Given their fate and transport characteristics, ^{3}H and ^{14}C are the principal groundwater constituents of concern at the SNS site. In 2011, samples were collected on a quarterly basis for ^{3}H and ^{14}C analyses. Additionally, samples were collected during wet-season base flow conditions for gross activity (alpha and beta) and for selected gamma spectroscopic parameters.

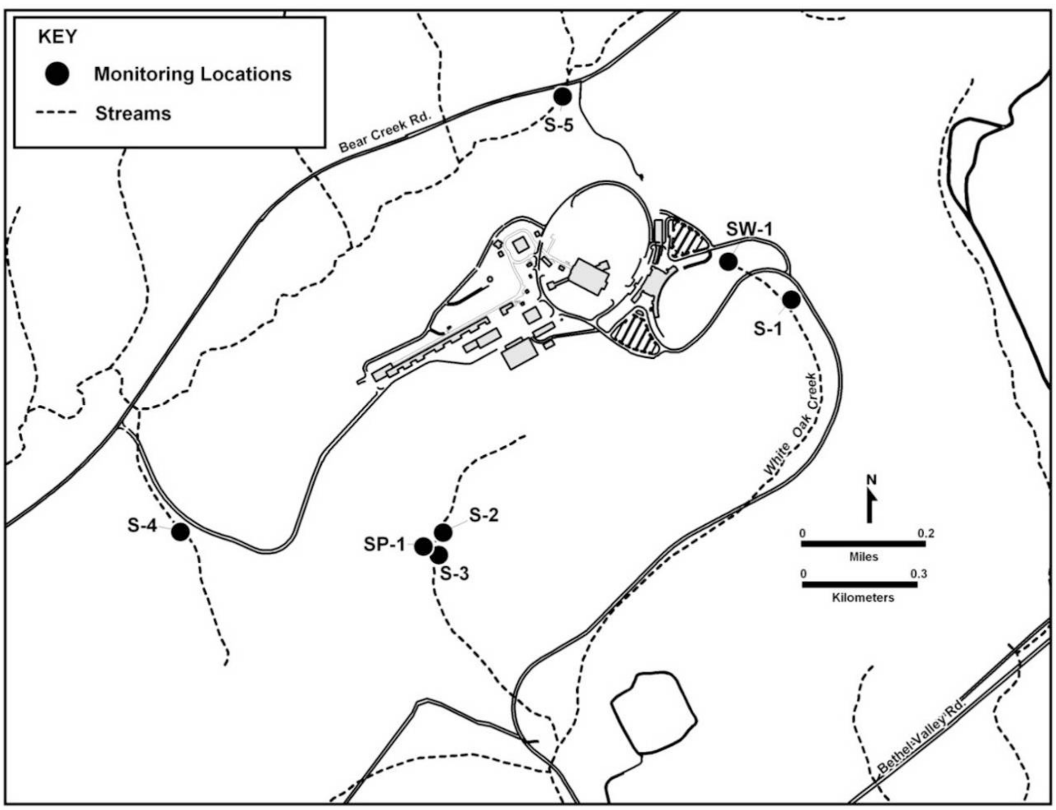

Fig. 5.40. Groundwater monitoring locations at the Spallation Neutron Source, 2011.

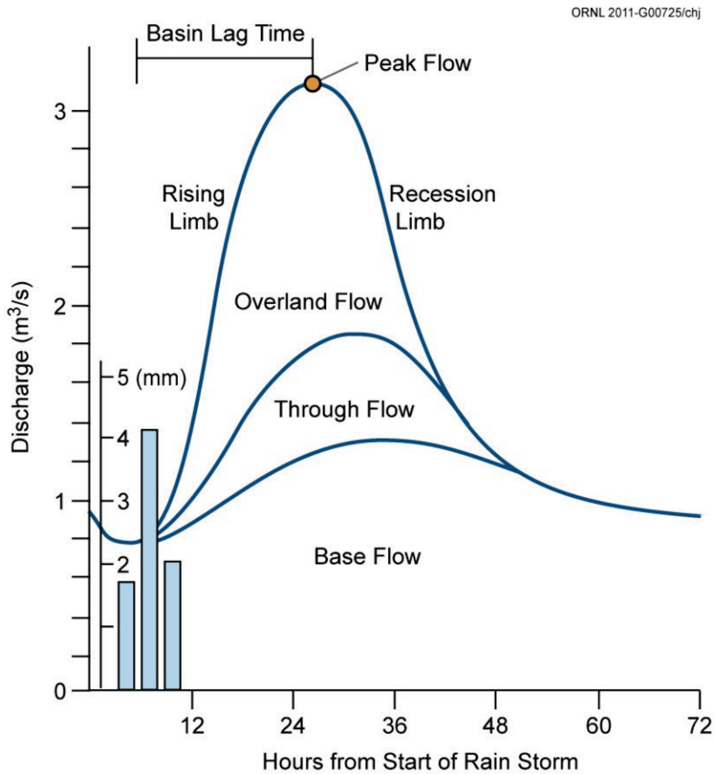

Fig. 5.41. Simple hydrograph of spring discharge vs. time after initiation of rainfall.

Spallation Neutron Source Site Results

Sampling at the SNS site occurred during February, March, May, June, August, September, October, and December 2011. No SNS sample results exceeded reference standard thresholds in 2011. Carbon-14, alpha activity, and gamma-emitting radionuclides were not detected in samples collected at the SNS site during 2011. Low concentrations of gross beta activity were detected in samples collected from S-5 during base flow conditions in March. Low concentrations of ^{3}H were detected numerous times at very low concentrations during 2011. Table 5.24 provides a summary of the locations, flow conditions, and sampling events for ^{3}H detections observed during 2011.

Table 5.24. Spallation Neutron Source groundwater monitoring results—^{3}H detections in 2011

Monitoring Point	Flow Condition		
	Base Flow	Rising Limb	Falling Limb
S-1	May and August	None	May
S-2	March, May, August, and October	February, June, September, and December	February, May, September, and December
S-3	May	None	May
S-4	None	None	None
S-5	None	None	May
SP-1	None	None	None
SW-1	Mar, May, August, and October	February and December	February, May, and December

5.7 Quality Assurance Program

UT-Battelle implements the requirements of DOE O 414.1D, *Quality Assurance*, 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.

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 Integrated Document Management System (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 2011 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. The DOE Environmental Management Consolidated Audit Program performs oversight of subcontracted commercial laboratories. This program, administered by DOE and subcontractors from across the DOE complex, establishes required internal and external laboratory control and performance evaluation programs and conducts on-site laboratory reviews that monitor the performance of all subcontracted laboratories and verify that all quality requirements are met.

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-NESHAP Inventory Web Application and the Rad NESHAP 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

Because of past waste disposal practices and unintentional releases, portions of land and facilities on ORR are contaminated with radioactive elements, mercury, asbestos, polychlorinated biphenyls, and industrial wastes. The DOE Office of Environmental Management conducts cleanup programs across the reservation to correct the contamination remaining from years of energy research and weapons production (Fig. 5.42).

ORNL 2012-G00346/chj

Fig. 5.42. Demolition preparations at Oak Ridge National Laboratory Building 3026 hot cells.

DOE EM has divided ORNL into two major cleanup areas: Bethel Valley and Melton Valley. The Bethel Valley area was used for reactors and the principal research facilities, and the Melton Valley Area was used for reactors and waste management. The following sections summarize some of the 2011 EM activities undertaken at ORNL. More detailed information is available in the 2011 cleanup progress report to the Oak Ridge community (DOE 2011c).

5.8.1 Unneeded Oak Ridge National Laboratory Facilities Demolished

During 2011, legacy material removal and demolition activities continued at contaminated nonreactor facilities which are no longer needed. As part of the 34-building D^3 Project, legacy material was removed from more than 32,000 ft^2 of facility space, 26 buildings (a total of 84,015 ft^2) were demolished, and more than 24,720 ft^3 of demolition debris was disposed of. The 26 buildings, located in the central campus portion of ORNL, were safely and successfully demolished without impacting adjacent laboratory facilities. One of the more challenging structures was the 2061 Smoke Stack (Fig. 5.43), which stood 175 ft tall and was formerly used to power the ORNL coal plant in the World War II era. Demolition of the remaining 8 of the 34 buildings is scheduled for completion in FY 2012.

ORNL 2011-P01640

Fig. 5.43. 2061 smoke stack.

5.8.2 Hot Cells Being Prepared for Deactivation, Demolition, and Disposition

Building 3026 C&D, one of the original ORNL buildings constructed in the 1940s, has been inactive since the 1990s. During 2011 characterization and planning was undertaken to appropriately evaluate the levels of contamination and develop the technical approach to prepare these facilities for demolition. A waste handling plan for hot cell demolition and waste disposition was approved by EPA and TDEC in FY 2011.

Two of the six structures in 3026 C&D (3026C "Counting Room" and 3026C "Tritium Lab") were decontaminated in FY 2011. This work included removal of internal equipment, the final step to make these structures ready for demolition.

Decontamination of the four remaining structures is under way. In March 2011, higher levels of contamination than anticipated were found in 3026D during initial characterization. As a result, the technical approach for the hot cell cleanout is being reevaluated. Mock-ups were created for 3026D to simulate entering the facility through ports using a remote arm to collect samples.

5.8.3 Building 3038 Cleanout

Building 3038, the Isotope Development Laboratory, is a 6,900 ft^2 nuclear facility located in the ORNL Central Campus area. Building 3038 was constructed in 1949 and housed the packaging, inspection, and shipping activities for radioisotopes. Radioactive materials are located in hot cells, glove boxes, and containers at the facility. A waste handling plan for Building 3038 was submitted for EPA and TDEC review in FY 2011.

In May 2011, the contractor took over operational responsibility for surveillance and maintenance activities for Building 3038. As of September 2011, the team had cleaned out about 750 ft^2 of floor space and packaged material for disposal in preparation for Building 3038 intrusive work. Work in FY 2011 also included constructing mock-up units, performing prework demonstrations, and characterizing waste.

5.8.4 2000 Complex Demolition Completed

The remaining two facilities associated with the 2000 Complex at ORNL were demolished in 2011. The complex, located in the northwest corner of the ORNL Central Campus, comprised eight facilities and structures totaling about 58,000 ft^2. The facilities were constructed in the late 1940s to support various ORNL research projects. They were in severe disrepair and had been vacant for about 6 years.

Demolition was completed in FY 2011 with the removal of Buildings 2000 and 2034, a combined area of 23,200 ft^2. The specific hazards encountered in this facility complex included the extremely poor physical condition of the structures, constant flaking of PCB-containing paint, extensive quantities of friable and nonfriable asbestos in restricted attic areas, and radiologically contaminated ductwork and fume hoods. Phase 2 demolition work in FY 2011 resulted in 180 shipments of building debris (more than 1,900 yd^3 of waste) to be disposed at EMWMF.

5.8.5 Isotope Row Material Removal Begins

Work was initiated in FY 2011 on the removal of legacy materials from the Isotope Row area in the central portion of ORNL. Historically, Isotope Row facilities served as radioisotope production laboratories and support facilities.

Work to characterize, inspect, package, and dispose of 44 shielded carriers located outside of Building 3028 was completed in FY 2011. A contract is in place for planned work in FY 2012 to remove, package, and dispose lead shielding in Buildings 3030 and 3031.

5.8.6 Tank W-1A Removal

UCOR began excavation in September 2011 to remove Tank W-1A at ORNL. Operational readiness reviews were completed before excavation of the contaminated area. The fieldwork is expected to be completed in spring 2012.

A plume of contamination emanates from the soil that surrounded the tank, which was located in the central portion of ORNL, and migrates southward to the Corehole 8 groundwater plume and then westward to First Creek. The principal plume contaminants are ^{90}Sr and uranium isotopes. Since late 1994, DOE has been implementing various coordinated actions to minimize the release of contaminants to the environment from Tank W-1A and the pipeline feeding it.

The remediation process includes excavating, packaging, and transporting contaminated soil for disposal and removing, size-reducing, containerizing, and transporting the concrete pad and tank supports and tank shell to NNSS.

A RAWP to address the additional soil removal will be submitted to the regulators in 2012.

5.8.7 Bethel Valley Burial Ground Remediation Completed

The Bethel Valley Burial Ground Remediation was completed in 2011. This project included capping of two SWSAs: SWSA 1 in Central Bethel Valley and SWSA 3 in West Bethel Valley. Remediation of contaminated soil hot spots and five landfills near the two SWSAs were also part of the project.

Capping of SWSA 1 was completed in 2010, and the SWSA 3 cap was completed in August 2011. Two areas of soil contamination and the former Closed Scrap Metal Area were also covered by the SWSA 3 cap. A gravel road that crosses the capped area was rebuilt on top of the cap. Both caps are constructed of several layers of impermeable cap material placed to prevent migration of contaminants. This process is called hydrologic isolation, which also involves various other methods to keep water from infiltrating the buried waste. The SWSA 3 cap included two upgradient French drains and surface water ditches that will divert shallow groundwater and rain water away from the capped area, further enhancing the hydrologic isolation of the waste.

SWSAs 1 and 3 and the associated remediated areas will be inspected periodically and maintained to ensure that they remain in good condition and that damage, if any, is quickly repaired. Groundwater and surface water sampling and analyses will be performed and reported annually in the remediation effectiveness report.

5.8.8 Uranium-233 Disposition Plan

A significant inventory of ^{233}U is stored in Building 3019A at ORNL. In FY 2011, the final design for the Building 3019 modifications necessary to support the dissolution and downblending of the ^{233}U inventory was completed.

Uranium-233 is a special nuclear material that requires strict safeguards and security controls to protect against access. The ^{233}U Project was initiated to address safeguards and security requirements, eliminate safety and nuclear criticality concerns, and ship the material to an approved disposal site. Treating the ^{233}U inventory as expeditiously as possible will reduce the substantial annual costs associated with safeguards and security requirements, eliminate the risk of a nuclear criticality event, and avoid the need for future facility upgrades to Building 3019A to ensure safe storage of the inventory.

DOE commissioned a review of alternatives for dispositioning the ^{233}U inventory. Phase I of the Alternatives Analysis, which screened and identified potential alternatives, was completed in January 2011. The Deputy Secretary of Energy endorsed the review recommendations in April 2011, and the team began planning a two-part direct disposition campaign. This campaign involved identifying inventory for other programmatic uses and potentially disposing of an inventory associated with a uranium solidification project.

Phase II of the Alternatives Analysis will provide a more detailed evaluation of processing options for the inventory that can’t be directly dispositioned.

5.8.9 Soils and Sediment Remediation

The removal of selected slabs and the remediation of contaminated soils at ORNL commenced in 2011 as part of the Bethel Valley Soils and Sediment Project. This project is intended to remove contaminated soils and sediments at ORNL to protect workers and groundwater in the area.

The RAWP for the project provides the approach that will be followed to characterize and evaluate soils and sediments, ensuring that the soil cleanup requirements for Bethel Valley are met. The work plan was submitted to the regulators in FY 2008 and was approved in early FY 2010. The cleanup strategy includes a series of workshops to identify sampling needs in specific portions of Bethel Valley. More than 20 workshops have been conducted, and field sampling activities, which focused on the northwest corner of the ORNL main campus, have been completed and sampling results received. This effort has resulted in more than 487 acres being identified as requiring no action.

Additional workshops and field characterization activities on the remaining areas will be continued in FY 2012.

5.8.10 Bethel Valley Groundwater

Several activities were initiated in FY 2011 to address Bethel Valley groundwater, including the following.

7000 Area Groundwater Treatability Study. The 7000 area covers the maintenance facilities on the east end of ORNL. A treatability study was initiated in 2010 to determine the feasibility of using bacteria to eliminate TCE in groundwater. In late December 2010 and early January 2011, a dilute solution of emulsified vegetable oil was injected into the TCE plume through four existing groundwater monitoring wells.

The purpose of the injection was to provide a source of carbon to stimulate existing TCE-degrading microbes in the groundwater system. The injection will aid in destroying TCE and its daughter products. Postinjection monitoring is being conducted to measure the effectiveness of the pilot test injections. The monitoring results have shown that TCE is decreasing.

Corehole 8 Intercept Extraction System. Surface water monitoring in First Creek indicates ^{90}Sr in groundwater is bypassing the Corehole 8 intercept extraction system and surfacing at First Creek on the west side of ORNL.

A groundwater engineering study concluded that the Corehole 8 plume, which is the source of ^{90}Sr in groundwater, is moving along the bedrock deeper than the current interceptor extraction system components. The source of the Corehole 8 plume is Tank W-1A (see Section 5.8.6). The solution is to install deeper extraction wells to intercept the groundwater before it reaches First Creek.

Two new bedrock wells were installed and connected to the extraction system in FY 2011. The extraction system flow controls and piping were upgraded to provide added transfer capacity and to improve the reliability of the system, which will be restarted in FY 2012.

Three new monitoring wells were installed west of Highway 95 along Raccoon Creek. The wells were installed to monitor a ^{90}Sr plume that originates at the SWSA 3 landfill.

Wells were installed at 50- and 100-feet depths. Information about these wells will be published in the SWSA 3 Phased Construction Completion Report at the conclusion of the capping activities. Monitoring conducted to date shows ^{90}Sr at concentrations below drinking water standards in a shallow well in the area where seepage from SWSA 3 is known to enter the headwaters of Raccoon Creek.

Monitoring of the new wells, SWSA 3, and Raccoon Creek will continue to measure the effectiveness of remedial actions completed in 2011.

5.8.11 Oak Ridge National Laboratory Waste Management

5.8.11.1 Oak Ridge National Laboratory Wastewater Treatment

At ORNL, 118 million gal of wastewater was treated and released at PWTC in 2011. In addition, the liquid LLW evaporator at ORNL treated 190,500 gal of waste. The waste treatment activities supported both Office of Environmental Management and Office of Science mission activities, ensuring that wastewaters for both programs' activities were managed in a safe and compliant manner.

5.8.11.2 Oak Ridge National Laboratory Newly Generated Waste Management

ORNL is the largest, most diverse Office of Science 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 the management of wastes generated from R&D activities and wastes generated from operation of the R&D facilities.

Wastes generated from ongoing research and operational activities are termed "newly generated wastes." At ORNL, newly generated wastes consist of chemical waste streams, waste containing or contaminated with radioactivity, and chemical waste that also contains radioactivity (known as mixed waste). Most newly generated radioactive waste at ORNL meets the definition of low-level radioactive waste, but a small quantity of TRU waste is generated. Most newly generated radioactive waste contains very small quantities of radioactivity and can be handled without special-handling protocols. (This waste is known as CH waste.) However, some wastes generated at ORNL nuclear facilities contain enough radioactivity to require special-handling procedures such as transport in special casks that provide shielding of the radioactivity. (This waste is known as RH waste.) Less than 5% of newly generated radioactive waste at ORNL meets the criteria of being RH waste.

Newly generated waste at ORNL continues to be safely and effectively dispositioned using a combination of commercial waste vendors and government-owned waste disposal sites. UT-Battelle maintains contracts with a variety of commercial waste vendors to provide for the required transport, treatment, and safe disposal of hazardous, mixed, and some radioactive waste streams. The other radioactive waste streams from ORNL are dispositioned at NNSA's NNSS (formerly known as the Nevada Test Site). Standard industrial waste generated at ORNL is dispositioned in DOE's ORR industrial waste landfills located near Y-12. Finally, certain waste streams generated from environmental remediation projects at ORNL may also be dispositioned in the Oak Ridge EMWMF located near Y-12, if approved by regulatory agencies in accordance with the Oak Ridge FFA.

Management of newly generated waste at ORNL is fully regulated by a number of federal and state laws and associated regulations. In Oak Ridge, most of these regulations are implemented by the State of Tennessee, with TDEC overseeing waste management activities. UT-Battelle waste management officials routinely meet with TDEC DOE Oversight Division staff to brief them on the status of waste management activities, and compliance audits of waste management activities are routinely performed by TDEC. Radioactive waste management activities at ORNL are performed under the authority of DOE's radioactive waste management order (DOE O 435.1). Radioactive waste activities are routinely reviewed with DOE officials to ensure the requirements of the radioactive waste order are being met.

5.8.11.3 Transuranic Waste Processing Center

TRU waste-processing activities carried out for DOE in 2011 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 2011, 173.4 m^3 of CH waste and 59.3 m^3 of RH waste were processed. In CY 2011, 178.18 m^3 of CH waste and 17.15 m^3 of RH waste were shipped off-site.

5.8.12 SEC Federal Services Corporation Waste

In 2011 SEC completed demolition and stabilization of 24 structures totaling 8,301 yd^3 of waste.

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