# 5. ORNL Environmental Monitoring Programs

The Oak Ridge National Laboratory (ORNL), managed by UT-Battelle, LLC, is the Department of Energy's largest science and energy laboratory. ORNL has a staff of more than 4,200 and annually hosts approximately 3,000 guest researchers who spend two weeks or longer in Oak Ridge. Annual funding exceeds $1.2 billion. As an international leader in a range of scientific areas that support the Department of Energy's mission, ORNL has six major mission roles: neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale, and national security. ORNL's leadership role in the nation's energy future includes hosting the U.S. project office for the International Thermonuclear Experimental Reactor international fusion experiment and the Office of Science−sponsored Bioenergy Science Center.

## 5.1 Description of Site and Operations

### 5.1.1 Mission

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 days of the Manhattan Project. ORNL is an international leader in a range of scientific areas that support DOE's mission. UT-Battelle's six major mission roles at ORNL include neutron science, energy, high-performance computing, bioenergy, materials sciences at the nanoscale level, and national security. ORNL is the home of the world's largest facility for materials research with the recently completed Spallation Neutron Source (SNS) and the upgraded High Flux Isotope Reactor (HFIR), as well as 16 other designated national user facilities. These facilities are available to national and international laboratory, industrial, and academic users.

ORNL lies in the southwest corner of DOE's Oak Ridge Reservation (Fig. 5.1). The main ORNL site occupies approximately 1,809 ha and includes facilities in two valleys (Bethel and Melton) and on a major ridge (Chestnut). The ORNL site has many of the same functions and requirements as a small city. It is supported by a dedicated fire department, medical center, and security force. It has extensive utilities with both centralized (e.g., steam and sewage treatment plants) and distributed systems. Thirty-seven miles of paved roads, 180 miles of unpaved roads, and 47 ha of maintained grounds provide access to the site.

UT-Battelle also manages 15 DOE Office of Science facilities and one DOE Office of Nuclear Energy facility located off of the main campus. Seven buildings and one trailer are located at Y-12, and three buildings and one trailer, which house the American Museum of Science and Energy (AMSE), are located in the city of Oak Ridge. UT-Battelle leases six buildings, five near Oak Ridge and one in Washington, D.C.

The National Transportation Research Center (NTRC), an alliance among ORNL, 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 site in the Pellissippi Corporate Center and is leased to ORNL and the University of Tennessee separately by Pellissippi Investors LLC.

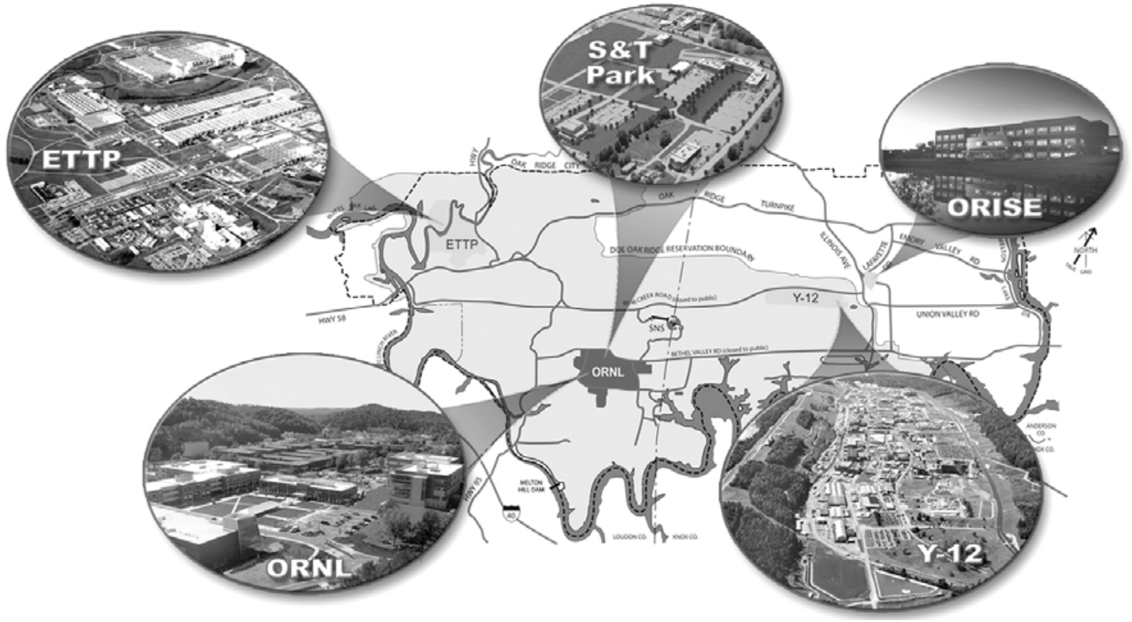



**Fig. 5.1. Location of Oak Ridge National Laboratory within the Oak Ridge Reservation and its relationship to other local U.S. Department of Energy facilities.**

The Transuranic (TRU) Waste Processing Center (TWPC), managed by EnergX for DOE, is located on the western boundary of ORNL on about 2 ha of land adjacent to the Melton Valley Storage Tanks along State Route 95. The TWPC's mission is to receive TRU wastes for processing, treatment, repackaging, and shipment to designated facilities for final disposal. The TWPC consists of the Waste Processing Facility, the Contact-Handled Staging Area, the Personnel Building, and numerous support buildings and storage areas. The TWPC began processing supernatant liquid from the Melton Valley Storage Tanks in 2002 and contact-handled solids in December 2005.

In March 2007, Isotek assumed responsibility for surveillance and maintenance activities at Building 3019 Complex at ORNL. DOE awarded this contract to accomplish the following principal objectives:

- process, down-blend, and package the DOE inventory of $^{233}$U stored in the Building 3019 Complex to eliminate the need for safeguards, security, and nuclear criticality controls and to render the material suitable for disposition;
- remove the $^{233}$U material from the Building 3019 Complex; and
- place the Building 3019 Complex in safe and stable shutdown for transfer to the DOE program for future decommissioning.

UT-Battelle continues to perform air and water quality monitoring for this facility, and the discussions in Chap. 5 include the results for Isotek operations at ORNL.

In 2007, approximately 5 ha in the central portion of the ORNL was leased to Halcyon, LLC, a subsidiary of the Community Reuse Organization of East Tennessee (CROET) for development into the Oak Ridge Science and Technology Park (ORSTP). The ORSTP will provide space for 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 the SNS, the Center for Nanophase Materials Sciences and the HFIR. In 2007, site preparation activities began to support installation of the infrastructure for the site. Construction of the first building in the ORSTP is scheduled to begin in 2008.

### 5.1.2 Facilities Revitalization Program

In 1943, more than 6,000 workers began construction of some 150 buildings that became known as Oak Ridge National Laboratory. Sixty-five years later, a massive effort to revitalize the site is literally rebuilding the laboratory. Since 2000, over 1,900,000 $ft^2$ of aged, expensive-to-maintain buildings have been vacated and some 1,000,000 $ft^2$ of new and renovated space constructed. The average age of ORNL facilities has decreased from 42 to 31 years. A combination of federal, state, and private financing has supported the construction of the new facilities listed in Table 5.1.

For the most part, the revitalization of ORNL's Chestnut Ridge and East Campuses is complete; the West and Melton Valley Campuses will be completed within the next five years. Over the next ten years, ORNL will continue to leverage federal, state, and private financing to deliver the site, facilities and infrastructure which will serve science and technical research at the laboratory for the twenty-first century. Table 5.2 summarizes the levels and sources of funding for campus modernization to date.

**Table 5.1. New Oak Ridge National Laboratory facilities constructed since 2000**

| Building number | Building name | Funding source |
|---|---|---|
| 1060 | Environmental and Life Sciences Laboratory | DOE |
| 7972 | Small-Angle Neutron Scattering Guide Hall Extension | DOE |
| 1005 | Laboratory for Comparative and Functional Genomics | DOE |
| 7625 | Multiprogram High Bay Facility | DOE |
| 3625 | Advanced Materials Characterization Laboratory | DOE |
| 5200 | Research Support Center | DOE |
| 8610 | Center for Nanophase Materials Sciences | DOE |
| NTRC | National Transportation Research Center | Private |
| 5600 | Computational Science Building | Private |
| 5800 | Engineering Technology Facility | Private |
| 5700 | Research Office Building | Private |
| 5300 | Multiprogram Research Facility | Private |
| 5100 | Joint Institute for Computational Sciences & Oak Ridge Center for Advanced Technologies | State |
| 1520 | Joint Institute for Biological Sciences | State |
| 7880BB | Contact-Handled Marshalling Building | DOE |

**Table 5.2. Levels and sources of funding for ORNL campus modernization**

| Source | Funding ($) |
|---|---|
| DOE | 520M |
| Private sector | 140M |
| State of Tennessee | 10M |
| Total | 670M |

### 5.1.2.1 2007 Modernization Activities at ORNL

During FY 2007, ORNL modernization efforts provided new facilities, enhanced staff interaction and space utilization, upgraded utility systems, and demolished old, expensive-to-maintain facilities.

#### 5.1.2.1.1 East Campus

The Multiprogram Research Facility (MRF), located on ORNL's East campus, reached full operational capability in April 2007. The MRF consists of approximately 214,000 $ft^2$ of laboratories, training spaces, offices, and necessary support infrastructure (see Fig. 5.2).

Other 2007 projects in the East Campus provided increased electrical and chilled water capacity, new parking lots, and chemical storage pods.

**Fig. 5.2. The Oak Ridge National Laboratory Multiprogram Research Facility—Leadership in Energy and Environmental Design (LEED) Gold.**

#### 5.1.2.1.2 West Campus

In June 2007 DOE announced that the BioEnergy Science Center (BESC) would be located at ORNL. BESC is located in the recently completed 36,000-$ft^2$ Joint Institute for Biological Sciences (JIBS) laboratory, an office building constructed by the state of Tennessee. The mission of BESC is to promote research aimed at converting biomass into sugars enabling the production of biofuels and reducing the need for imported petroleum.

In parallel to JIBS construction, renovations and upgrades to existing West Campus facilities were initiated. A reconfiguration of Building 1504 was completed in 2007 adding both office and laboratory space. The majority of west-campus offices were updated with new furniture, carpet, and paint. Major maintenance was completed on electrical switchgear, water heaters, air-handling units, and building vacuum pumps.

Modernization of the west campus continues into 2008 with additional laboratory modifications and the new construction of a Research Support Building. Parking, pedestrian walkways, and landscaping will be upgraded to address safety and work environment issues.

#### 5.1.2.1.3 Melton Valley Campus

The disposition of five old office trailers was completed in 2007. The trailers were replaced by two multiplex modular units, and offices in other buildings were updated with furniture, paint, and carpet. Additional trailer replacements are planned for 2008, along with the construction of a 9,000-$ft^2$ warehouse.

#### 5.1.2.1.4 Demolition

Several demolition and/or removal activities were completed at ORNL in 2007 in support of campus modernization efforts. These efforts included the demolition of Building 2010, the old ORNL cafeteria (Fig. 5.3); demolition of Building 3082; removal of several office trailers across the site, and demolition of several R&D facilities.

**Fig. 5.3. Old cafeteria at Oak Ridge National Laboratory.**

### 5.1.2.2 Integrated Facilities Disposition Initiative

Plans to disposition an additional 550,000 $ft^2$ of aged, expensive-to-maintain facilities located at ORNL are proposed as part of the DOE Oak Ridge Office (DOE-ORO) Integrated Facility Disposition Project (IFDP), which received Critical Decision in June 2007. The IFDP is a multi-billion-dollar collaborative proposal developed by DOE Offices of Environmental Management (EM), Science, and Nuclear Energy and the National Nuclear Security Administration (NNSA) that will complete the environmental cleanup of the DOE ORR and enable ongoing modernization efforts at ORNL and the Y-12 National Security Complex. The IFDP will reduce risk to workers and the public, minimize ORNL and Y-12 mission risks resulting from the presence of deteriorating facilities and excess “legacy” materials, and provide valuable real estate for continued modernization.

## 5.2 Environmental Management System

An important priority for UT-Battelle in carrying out ORNL management and operations activities is the demonstration of environmental excellence through a high-level policy (Table 5.3) which clearly states expectations for continual improvement, pollution prevention, and compliance with regulations and other requirements.

**Table 5.3. UT-Battelle policy for the Oak Ridge National Laboratory**

UT-Battelle is committed to

- complying with legal, contractual, and other applicable requirements;
- operating in a manner that protects and restores the environment and to integrating pollution prevention into planning and decision-making;
- providing and continually improving research, services, products, and management systems of the highest quality consistent with the needs, expectations, and resources of our customers; and
- communicating appropriate Environmental Management System information to staff, subcontractor personnel, customers, and other stakeholders.

UT-Battelle has implemented an Environmental Management System (EMS), modeled after the ISO 14001:2004 EMS, an international environmental management standard, 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. The EMS is a fully integrated set of environmental management services for UT-Battelle activities and facilities. These services include pollution prevention, waste management, effluent management, regulatory review, reporting, permitting, and other environmental management programs. UT-Battelle's EMS was initially registered to the ISO 14001 Standard by a third-party registrar in 2004. In June 2007, NSF International Strategic Registrations, Ltd., conducted a re-registration audit of the ORNL EMS to ensure continued conformance to the ISO requirements. No nonconformances were noted by the audit team and a number of noteworthy practices were identified.

Through the UT-Battelle Standards-Based Management System (SBMS), the EMS establishes the 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, 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, the EMS assists the line organizations in identifying and addressing environmental issues in accordance with the SBMS requirements.

### 5.2.1 Integration with ISMS

The EMSs and Integrated Safety Management Systems (ISMSs) at DOE facilities 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 a "plan-do-check-act" cycle. 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 to both the protection of the environment and to safety. Figure 5.4 depicts the relationship between EMS and ISMS.


**Fig. 5.4. The relationship between EMS and the ISMS.**

The 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.

## 5.2.2 Policy

The UT-Battelle Policy (Table 5.3) for ORNL 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.

### 5.2.3 Planning

#### 5.2.3.1 Environmental Aspects

Environmental aspects are elements of an organization's activities, products, or services that can interact with the environment. UT-Battelle identifies environmental aspects associated with its activities, products, and services at both the project and activity level and has identified the following aspects as potentially having significant environmental impacts:

- hazardous waste,
- radioactive waste,
- mixed waste,
- polychlorinated biphenyl (PCB) waste,
- permitted air emissions,
- regulated liquid discharges,
- storage or use of chemicals or radioactive materials.

UT-Battelle activities that are relative to any of these aspects are carefully controlled to minimize or eliminate impacts to the environment.

#### 5.2.3.2 Legal and other Requirements

Legal and other requirements that apply to the environmental aspects include federal, state, and local 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.

#### 5.2.3.3 Objectives and Targets

UT-Battelle has established and implemented objectives, targets, and performance indicators for relative functions and levels within the Laboratory. Where practical these objectives, targets and performance indicators are measurable and in all cases, are consistent with the UT-Battelle Policy and supportive of the Laboratory Agenda.

#### 5.2.3.4 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 system includes programs led by experts in environmental protection and compliance, energy and resource conservation, pollution prevention, and waste management to assure that Laboratory activities are conducted in accordance with the environmental policy statements outlined in Table 5.3.

##### 5.2.3.4.1 Environmental Compliance

UT-Battelle has established an organizational structure to help achieve full compliance with all applicable environmental regulatory requirements and permits. Environmental compliance experts provide critical support services to maintain a proper balance between cost and risk in the following areas:

- Solid and hazardous waste compliance,
- NEPA compliance,
- Air quality compliance,
- Water quality compliance,
- Environmental protection programs,

- Environmental sampling and data evaluation, and
- CERCLA interface compliance.

#### 5.2.3.4.2 Waste Management and Spill Response

The UT-Battelle staff includes experts who provide critical waste management and disposition support services to ORNL research, operations, and support divisions. These teams 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 ORNL's newly generated waste; and
- the hazardous material spill response team, which is ORNL's first line of response to hazardous materials spills and controls and contains such spills until the situation is stabilized.

#### 5.2.3.4.3 Pollution Prevention Program

ORNL’s Pollution Prevention (P2) programs have evolved from project-specific waste reduction efforts to a laboratory-wide philosophy of implementing sustainable practices that reduce ORNL’s environmental impacts and provide monetary benefit to ORNL, DOE, and the nation. The UT-Battelle EMS establishes annual goals and targets to reduce the impact of each organization’s environmental aspects.

Over the past several years, UT-Battelle’s P2 Program has been recognized by EPA and DOE with the receipt of DOE Office of Science Pollution Prevention-Best in Class Awards in 2004, 2005, 2006, and 2008, two DOE P2 Star Awards in 2008, White House “Closing the Circle” Awards in 2004 and 2008, and an EPA WasteWise Gold Achievement Award in 2007.

During 2007, ORNL implemented 28 P2 initiatives with a reduction of more than 13.2 million kg of waste resulting in a cost savings/avoidance of more than $3.5 million. The following sections describe some of UT-Battelle’s 2007 sustainability, source reduction, and recycling projects.

##### 5.2.3.4.3.1 Sustainability Initiatives

Many of ORNL’s sustainability initiatives have P2 benefits including the 2007 activities highlighted in this section.

##### 5.2.3.4.3.2 ORNL’s Green Transportation and Fleet Management Initiatives

Several UT-Battelle research programs focus on the development of materials and technologies that will provide present and future opportunities to reduce fuel consumption and to employ alternative fuels. In 2007, ORNL’s green transportation initiative was successful in increasing the use of bio-based materials and alternative fuels, reducing vehicle emissions, and providing personnel with safer, more cost-effective transportation options. The multi-pronged approach to green transportation at ORNL includes: (1) encouraging personnel to walk and ride bicycles through a modernization initiative that provides campuses and commons areas within reasonable walking distances for all critical services (see Sect. 5.1.2.1), (2) encouraging shared transportation through an on-site taxi service and an employee carpooling program, (3) integrating fuel-efficiency features when upgrading roads (roundabout to minimize idle time at traffic light) (Fig. 5.5), (4) continuing the expansion of the flex-fuel vehicle fleet that included 118 flex fuel vehicles using 29,588 gal of E85 in 2007, and (5) expanding the use of alternate fuels in the vehicle fleet which, in 2007, included 45 diesel vehicles and numerous pieces of equipment that consumed 15,600 gal of biodiesel.

**Fig. 5.5. The traffic roundabout at Oak Ridge National Laboratory.**

#### 5.2.3.4.3.3 ORNL's Comprehensive Sustainability Initiative

UT-Battelle has included sustainable design and landscaping concepts in the Facility Revitalization Program (see Sect. 5.1.2). ORNL's entire new six-building East Campus consisting of approximately 750,000 ft$^2$, is Leadership in Energy and Environmental Design (LEED) certified by the U.S. Green Building Commission.

The MRF, which was available for occupancy in early 2007, was awarded LEED Gold Level Certification. This facility resides on a former brownfield site, which includes rainwater-fed landscaping with native vegetation and utilizes a five-floor orientation with 12% of the total wall space below ground to reduce building footprint. Building materials contained an average of 28% recycled content, and 83% of the materials were manufactured within 500 miles, reducing transport impacts.

Approximately 7,000 tons of debris from the construction of the six new East Campus facilities was diverted from landfills for reuse or recycling resulting in an expenditure/investment reduction of almost $1 million.

#### 5.2.3.4.3.4 Environmentally Preferable Purchasing

Environmentally preferable purchasing, previously referred to as affirmative procurement, is a term used to describe an organization's policy to purchase products made with recycled material, bio-based materials, reduced packaging, and other environmentally friendly products. In 2007, recycled-content materials totaling more than $1.2 million were procured for use at ORNL demonstrating UT-Battelle's commitment to procure environmentally preferable materials.

#### 5.2.3.4.3.5 Beneficial Landscaping Practices

DOE Order 450.1A, *Environmental Protection Program*, implements Executive Order (EO) 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," and includes requirements for incorporating, where appropriate, environmentally and economically beneficial landscape practices into new landscaping programs.

ORNL has various ongoing programs and initiatives that involve or facilitate environmentally and economically beneficial landscaping practices:

- incorporation of native plants into planning for restoration or landscaping in areas across ORNL;
- development of the *ORNL Conceptual Landscape Plan and Design Guidelines*, which calls for use of native plant species;
- use of an internal stream corridor protection effort to encourage the growth of native plants in the riparian zone surrounding ORNL creeks;
- the formation of an informal interagency Native Grass Working Group;
- integration of native-plant requirements into facilities-development projects;
- evaluation of upcoming projects by the ORNL Land and Facilities Use Committee on potential impacts, including impact on natural habitat;
- creation of an ongoing sitewide P2 Program and a storm water pollution prevention plan (SWP3) and program;
- minimal use of pesticides and fertilizers and use of organic fertilizers;
- extensive use of erosion controls in construction projects (e.g., settling ponds and bioretention areas);
- minimal use of water for irrigation;
- incorporation of plants into project designs for energy conservation by providing shade and cooling to paved surfaces;
- provision of public-awareness interaction on invasive plants, nuisance wildlife, and restoration of native grasses;
- use of brownfield areas for siting new ORNL developments, when practicable; and
- cooperative restoration projects with Tennessee Wildlife Resources Agency (TWRA) to convert fescue fields to native, warm grass habitat.

#### 5.2.3.4.3.6 Source-Reduction Initiatives

UT-Battelle continues to pursue source-reduction initiatives that reduce the level of waste generation across the Laboratory and thereby reduce ORNL’s impact on the environment. Source-reduction activities carried out at ORNL in 2007 are described in the following sections.

#### 5.2.3.4.3.7 ORNL Computed Radiography Implementation

In 2007, chemical-based radiography equipment that required the use of chemicals and water to process film was replaced with a modern digital computed radiography system and a smaller X-ray film processor This upgrade resulted in: (1) improved safety and reduced usage of floor space; (2) improved efficiency and expanded capabilities; (3) an approximate two-thirds reduction in film usage; (4) an approximate two-thirds reduction in the purchase, use, and resulting waste generation of photographic chemicals; (5) reduced need for silver recovery; (6) elimination of the annual use of approximately 500,000 gal of once-through process water and the generation of resulting photochemical-tainted wastewater; (7) reduction in the concentration of photochemical-related metals in the generated wastewater by 40 to 60%; (8) reduction in electricity usage through the elimination of one water heater; and (9) elimination of an estimated annual cost of approximately $50,000 per year due to decreased wastewater generation.

#### 5.2.3.4.3.8 UT-Battelle Low Volatile Organic Compounds Initiative

In 2007 UT-Battelle implemented a plan to reduce the amount of volatile organic compounds (VOCs) released from construction-related painting. VOCs include a variety of chemicals that have adverse health and environmental effects and may be released to the environment during use or storage.

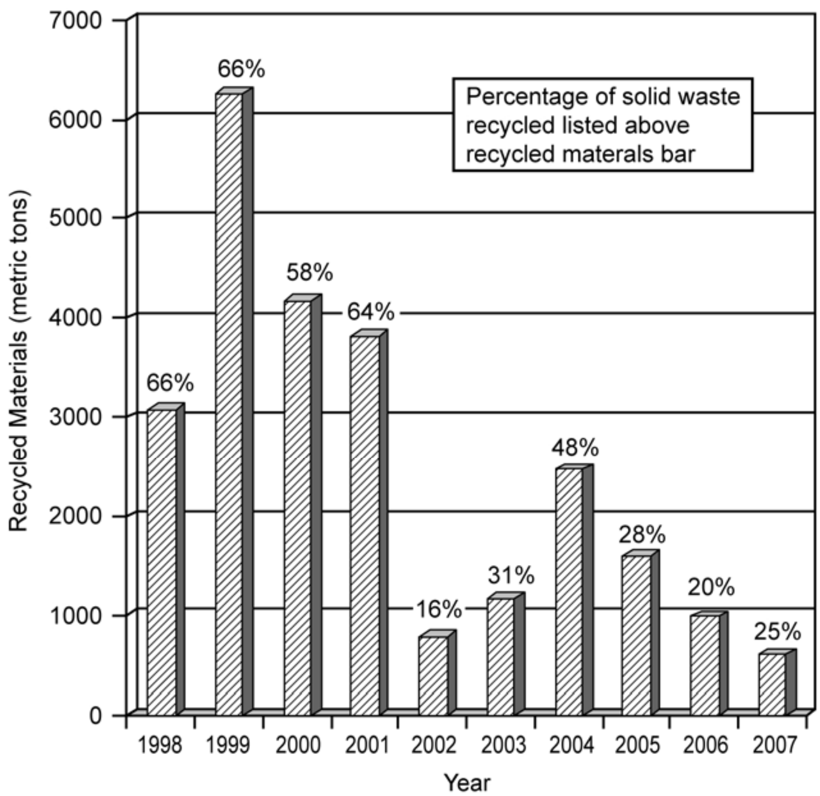
Benefits realized from this initiative include: (1) replacing paint with VOC levels of 240 to 450 ppg with paint containing less than 100 ppg, (2) improved safety through reduced environmental and personnel exposure to VOCs, (3) reduced VOC releases by up to 320 to 350 ppg of paint used, and (4) reduced VOC emissions from specific painting projects by about 60%.

### 5.2.3.4.3.9 ORNL 2007 Once-Through Cooling Water Elimination

In 2007, a UT-Battelle Chemical Sciences Division initiative to replace once–through cooling water systems with closed loop systems resulted in a reduction in once-through cooling water usage of approximately 188,000 gal per year (an 8% reduction). This source reduction initiative: (1) improved operational efficiency by reducing water usage and costs; (2) reduced wastewater generation; and (3) eliminated piping, thereby reducing the potential for leaks.

### 5.2.3.4.3.10 UT-Battelle Recycling Initiatives

UT-Battelle has a well-established recycling program at ORNL and continues to identify new material-recycling streams and to expand the types of materials included in the program. As shown in Fig. 5.6, UT-Battelle has diverted thousands of metric tons of materials from the landfill into viable recycle processes. Currently, recycled material streams at ORNL range from office materials such as paper, aluminum cans, and toner cartridges to operations-oriented materials such as scrap metal, tires, and batteries. Highlights of the 2007 UT-Battelle recycling program successes at ORNL are presented in the following sections.




NOTE: The total quantity of materials recycled at ORNL has been reduced significantly since FY 2001 because the ORNL Steam Plant was converted to burn natural gas and thus no longer generates coal ash. Environmental Management recycled much less material in 2002 (49.01 metric tons [MT]) than in 2001 (2,608.21 MT). It did not report any ORNL-specific recycling data as of 2003 to present.

**Fig. 5.6. Oak Ridge National Laboratory recycling results.**

### 5.2.3.4.3.11 ORNL Lead Solder Management and Recycling Efforts

The UT-Battelle Fusion Energy Division and the Engineering Sciences and Technology Division both implemented successful efforts in 2007 to reduce the volume of lead-contaminated waste from soldering operations (Fig. 5.7). These efforts resulted in (1) the collection of 5.5 kg of lead materials for recycling and reuse, (2) elimination of the generation of approximately 6.3 kg of hazardous waste, and (3) an approximate cost avoidance of $275.


**Fig. 5.7. Example of reusable lead solder-scrap metal.**

#### 5.2.3.4.3.12 UT-Battelle Spallation Neutron Source Mercury Recycle Initiative

During 2007, SNS staff designed a drainage rack that enabled the recovery of 342 lb of mercury from 605 storage flasks. The recovered mercury was then stored in 5 flasks for future use. Additional benefits of this project included a reduction of approximately 4,517 lb of generated waste, and an estimated cost avoidance of more than $60,000.

#### 5.2.3.4.3.13 UT-Battelle Tyvek Recycling Initiative

In 2007, UT-Battelle completed a project to recycle disposable Tyvek garments used in specific non-radioactive areas at ORNL (Fig. 5.8). Disposable Tyvek suits are supplied to infrequent users of ORNL facilities where protective clothing is required, and after use, have historically been disposed of as sanitary waste. Under this initiative, some disposable Tyveks are reused several times before segregation for recycling. This recycling activity diverts a waste stream of 1 to 5 cubic yards per year from the sanitary landfill, generates a small income from the sale of the used Tyveks, and reduces waste disposal fees. In FY 2007, 341 Tyvek garments totaling 155 kg were recycled resulting in an approximate cost avoidance of $133.

### 5.2.3.4.4 Energy Management

The ORNL Energy Management Program seeks to advance continuous 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 *Energy Management and Implementation Plan for Oak Ridge National Laboratory FY 2007* (Parker 2007) outlines the general strategy for managing and implementing energy and energy-related activities at ORNL.

The Energy Policy Act (EPACT) of 2005 establishes the goal of reducing building energy intensity by 2% annually from FY 2006 through FY 2015 specifying 2003 as the baseline year. Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," sets a more stringent reduction goal of 3% per year for the same time period resulting in a planned 30% reduction over ten years. As shown in the Fig. 5.9, UT-Battelle energy conservation efforts have exceeded these levels with an 11% building energy intensity reduction between FY 2003 and FY 2007. In fact, UT-Battelle has realized energy intensity reductions at ORNL of about 28% since 1985.

**Fig. 5.8. Example of personal protective equipment sent for recycle.**

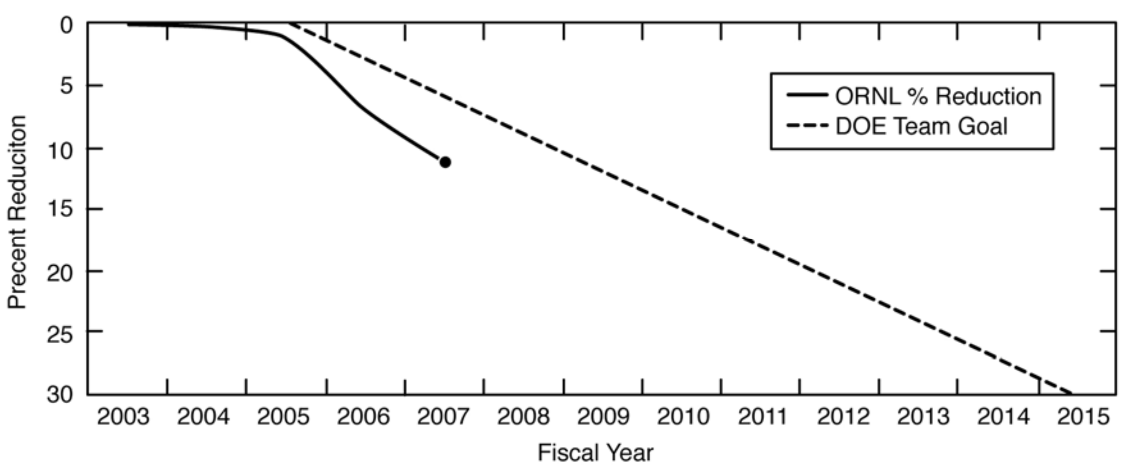



**Fig. 5.9. ORNL building energy reduction.**

The EPACT also requires federal agencies to install advanced electric metering, where practical, to enable improving operating efficiencies of federal buildings. Measuring and managing energy usage at the building level allow facility managers to develop baseline data for assessing the effectiveness of energy savings programs, and promote energy use awareness among building managers and occupants. Data obtained through metering activities is essential for identifying cost-effective equipment retrofit opportunities, optimizing building and equipment operations, purchasing of energy resources, and planning and allocating resources.

UT-Battelle has proactively employed a policy of installing standard meters at ORNL facilities for several years. Virtually all ORNL buildings that use electricity have at least a standard meter. The six new East Campus buildings have advanced meters which enable measuring and recording interval data and the Computational Science Building has three advanced meters enabling individual monitoring of energy usage in various areas. Metering status for ORNL buildings is shown in Table 5.4, and a schedule for installation advanced meters in UT-Battelle facilities at ORNL is presented in Table 5.5.

**Table 5.4. Metering status**

| Building classification | Number of buildings |
|---|---|
| Total number of buildings at ORNL[a] | 450 |
| Number of standard meters on site | 350 |
| Total number of buildings considered for metering | 121 |
| Number of buildings with advanced meters[b] | 8 |
| Number of buildings with no existing meter/standard meter requiring advanced meters | 33 |

[a]Many of the 450 structures at ORNL are warehouses, equipment sheds, and storage areas that use little or no electricity.

[b]Once implemented, advanced metering will be present in buildings representing 65% of the electrical consumption. All buildings will have at least a standard meter.

**Table 5.5. Buildings to receive advanced meters**

| Year | Building number |
|---|---|
| 2007 | 1505, 4500S |
| 2008 | 1005, 3500, 4500N, 4508, 4509, 4515, 7920, 7930 |
| 2009 | 2519, 3525, 4501, 4505, 6000, 7601, 7900 |
| 2010 | 1506, 2026, 3019A, 3025M, 3047, 5500, 5505, 7603 |
| 2011 | 1060, 2033, 3012, 3144, 5510, 7012, 7710, 7917 |

In 2007 UT-Battelle initiated the development of an Energy Savings Performance Contract (ESPC) to support and modernize facility infrastructure, provide utility support and capacity, and ensure that mission-related activities can be performed without interruption.

Specific benefits of the ESPC will include

- significant improvements to the existing steam plant and distribution system;
- improved chilled water system efficiency and reliability;
- installation of advanced metering technology;
- extensive heating, ventilating, and air-conditioning system improvement;
- approximately $65 million in deferred infrastructure improvements funded through energy savings;
- annual energy savings of 432,059 million BTU;
- water use reduction of over 15 million gal per year;
- annual emission reductions of 730,282 (17%) tons of greenhouse gases ($CO_2$) (this is equivalent to planting over 32 million trees or taking over 2.1 million passenger cars off of the road);

- annual emission reductions of 1,567 tons of nitrogen oxides ($NO_x$); and
- annual emission reductions of 3,778 tons of sulfur dioxide ($SO_2$).

### 5.2.3.4.4.1 UT-Battelle Employee Energy Conservation Education and Involvement Opportunities

During 2007, UT-Battelle sponsored several events to promote employee awareness of opportunities to conserve energy and promote energy efficiency.

### 5.2.3.4.4.2 Clean Energy Day

ORNL's Energy Efficiency and Renewable Energy Program celebrated Clean Energy Day on Tuesday, August 5, 2007. A highlight of this event was the presentation of a refund check to a family owning a Habitat for Humanity zero-energy house designed with state-of-the-art, ORNL-tested, energy-efficient building technologies. The refund was for electricity the solar-panel-equipped home fed back into the power grid (Fig. 5.10).

**Fig. 5.10. Habitat for Humanity zero-energy house.**

### 5.2.3.4.4.3 ORNL Energy Education Day

Energy Education Day was held at ORNL on May 9, 2007 to communicate the importance of energy efficiency and UT-Battelle’s goal for making ORNL the most energy efficient DOE laboratory. The event included seminars on the benefits of adopting energy efficiency practices in work activities and provided hands-on demonstrations of various technologies that promote energy efficiency. The event also provided a forum for ORNL researchers to investigate collaborative opportunities with commercial businesses to further develop leading solutions for energy efficiency.

#### 5.2.3.4.4.4 ORNL Energy Management Education Day

Energy Management Education Day was held on February 21, 2007, to share information and ideas on saving energy with ORNL employees. The Energy Management Team demonstrated related, ongoing Laboratory projects, and new technologies were demonstrated.

#### 5.2.3.4.4.5 ORNL Earth Day Celebration

ORNL's Earth Day 2007 celebration, held on April 17, 2007, was headlined with a talk by Corporate Fellow and Environmental Sciences Division researcher Tom Wilbanks, titled "Toward a Sustainable World: What One Person Can Do." The slate of activities for the celebration also included an East Campus Pond tour, which was highlighted by fish and turtle releases, and tours of ORNL's LEED Buildings.

## 5.2.4 Implementation and Operation

### 5.2.4.1 Structure and Responsibility

The UT-Battelle policy statements (Table 5.3) represent the philosophy of UT-Battelle management for the conduct of research, operations, and other activities at ORNL. A key tenet of this policy is the integration of environmental and pollution prevention principles into work practices at all levels. Prior to performing any work at ORNL, all staff are required to complete comprehensive site orientation and training that outlines employee responsibilities for environmental compliance and sets forth expectations for all employees to comply with the policy statements and with the ORNL 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 work planning activities for all UT-Battelle organizations address environmental protection and pollution prevention measures. Their objectives 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 a liaison 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 characterization basis to successfully complete the waste certification and disposal process.

### 5.2.4.2 Communication and Community Involvement

Information on the 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 web sites;
- SBMS documentation available to all employees;

- EMS brochures and badge cards; and
- the *ORR 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, to regulators and to stakeholders.

#### 5.2.4.3 Emergency Preparedness and Response

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

### 5.2.5 Checking

#### 5.2.5.1 Monitoring and Measurement

Monitoring and measurement processes have been developed and implemented 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.

#### 5.2.5.2 EMS Assessments

Several methods are used by UT-Battelle to evaluate compliance with legal and other requirements. Most of these compliance evaluation activities are implemented by the EMS or are a part of line organization assessment activities.

The SBMS Assessment 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 continual improvement.

UT-Battelle also uses the results from numerous external compliance inspections conducted by regulators to verify compliance to 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 2007, a re-registration audit was conducted by NSF-ISR. Four auditors reviewed all elements of the UT-Battelle EMS against ISO 14001 requirements. No nonconformances were identified during this audit.

## 5.3 Compliance Status

### 5.3.1 Environmental Permits

Table 5.6 contains a list of environmental permits that were effective in 2007 at ORNL.

### 5.3.2 Notices of Violations and Penalties

ORNL did not receive any NOVs or penalties for RCRA inspections by regulators during 2007.

A letter of deficiency from EPA dated August 17, 2007, was received by ORNL for deficiencies noted during a September 12, 2006, inspection of ORNL oil storage facilities and the *ORNL Spill Prevention, Control, and Countermeasures Plan* (SPCC). The cited deficiencies were addressed, and

**Table 5.6. Oak Ridge National Laboratory environmental permits, 2007[a]**

| 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 | DOE | UT-B | UT-B |
| CAA | Radiochemical Development Facility | 556850 | 10-21-04 | 10-21-09 | DOE | UT-B | UT-B |
| CAA | Steam Plant | 556850 | 10-21-04 | 10-21-09 | DOE | UT-B | UT-B |
| CAA | Manipulator Boot Shop | 556850 | 10-21-04 | 10-21-09 | DOE | UT-B | UT-B |
| CAA | SNS Central Utilities Building Boilers | 556850 | 10-21-04 | 10-21-09 | DOE | UT-B | UT-B |
| CAA | Surface Coating and Cleaning Operation | 556850 | 10-21-04 | 10-21-09 | DOE | UT-B | UT-B |
| CAA | Spallation Neutron Source and Central Exhaust Facility (construction permit) | 956542P | 10-29-04 | 03-01-08 | DOE | UT-B | UT-B |
| CAA | SNS Central Laboratory and Office Boilers | 556850 | 10-21-04 | 10-21-09 | DOE | UT-B | UT-B |
| CAA | EGCR Boilers | 556850 | 10-21-04 | 10-21-09 | DOE | UT-B | UT-B |
| CAA | Air Stripper (BJC permit) | 547563 | 10-21-04 | 10-21-09 | DOE | BJC | BJC |
| CAA | HFIR & Radiochemical Engineering Development Center | 556850 | 10-21-04 | 10-21-09 | DOE | UT-B | UT-B |
| CAA | Off Gas & Hot Cell Ventilation (BJC permit) | 547563 | 10-21-04 | 10-21-09 | DOE | BJC | BJC |
| CAA | National Transportation Research Center | 0904-12[b] | 05-10-01 | Annually | DOE | UT-B | UT-B |
| CAA | TN Operating Permit (Emissions Source) | 057077P | 04-13-04 | 10-31-14 | TDEC | FW | FW |
| CWA | ORNL NPDES Permit (ORNL site-wide wastewater discharge permit) | TN0002941 | 02-03-97 | 12-06-01 | DOE | DOE | UT-B, BJC |
| CWA | ORNL NPDES permit (for SNS cooling tower blowdown) | TN0077895 | 12-01-03 | 10-31-06 | DOE | DOE | UT-B |
| CWA | Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—SNS | TNR139975 | 09-30-00 | NA | DOE | DOE | UT-B |
| CWA | Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL Research Support Center | TNR130471 | 06-02-03 | NA | DOE | DOE | UT-B |

**Table 5.6** (continued)

| Regulatory driver | Permit title/description | Permit number | Issue date | Expiration date | Owner | Operator | Responsible contractor |
|---|---|---|---|---|---|---|---|
| CWA | General Permit For Utility Line Crossings—ORNL 24-Inch Water Line Replacement Project | NR0603.037 | 06-23-06 | NA | DOE | DOE | UT-B |
| CWA | Department of Army Nationwide Permit #18, Minor Discharges—Placement of Fill Material into Existing Concrete Boathouse Foundation on Freels Bend | File No. 2006-01152 | 06-01-06 | 03-18-07 | DOE | DOE | UT-B |
| CWA | Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL 24-Inch Water Line Replacement | TNR132022 | 06-23-06 | NA | DOE | DOE | UT-B |
| CWA | Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Pro2Serve National Security Engineering Center | | 10-06 | NA | DOE | DOE | Pro2Serve |
| CWA | TN Operating Permit (sewage) | SOP-02056[c] | 02-28-07 | 12-31-07 | TDEC | FW | FW |
| CWA | Tennessee Multi-Sector General NPDES Storm Water Permit No Exposure Exclusion | TNR053814 | 11-22-05 | 11-22-10 | TDEC | FW | FW |
| CWA | Tennessee NPDES Storm Water Permit for Construction Activities | TNR132619 | 06-29-07 | 05-30-10 | TDEC | DOE, EnergX TN LLC | FW |
| RCRA | Hazardous Waste Transporter Permit | TN1890090003 | 01-22-08 | 01-31-09 | DOE | DOE | UT-B, BJC, Weskem |
| RCRA | Hazardous Waste Corrective Action Permit | TNHW-121 | 09-28-04 | 09-28-14 | DOE | DOE, BJC and all ORR co-operators of hazardous waste permits | BJC/ FW/ EnergX |
| RCRA | Hazardous Waste Container Storage and Treatment Units | TNHW-10A | 05-30-95 | 05-30-05[d] | DOE | DOE/BJC | BJC/ Weskem |

**Table 5.6** (continued)

| Regulatory driver | Permit title/description | Permit number | Issue date | Expiration date | Owner | Operator | Responsible contractor |
|---|---|---|---|---|---|---|---|
| RCRA | Hazardous Waste Container Storage and Treatment Units | TNHW-097 | 09-30-97 | 09-30-07[d] | DOE | DOE/BJC/ Weskem/ FW | BJC/ Weskem, FW/EnergX |

[a]Abbreviations:
BJC = Bechtel Jacobs Company
CAA = Clean Air Act
CWA = Clean Water Act
DOE = U.S. Department of Energy
EGCR = Experimental Gas-Cooled Reactor
FW= Foster Wheeler
HFIR = High Flux Isotope Reactor
NPDES = National Pollutant Discharge Elimination System
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation
RCRA = Resource Conservation and Recovery Act
SNS = Spallation Neutron Source
TDEC = Tennessee Department of Environment and Conservation
UT-B = UT-Battelle
[b]Permit issued by Knox County Department of Air Quality Management.
[c]SOP-02056 Permit Renewal submitted to TDEC 6/2007.
[d]Permit renewal applied for; TDEC reissuance of permit pending.

DOE provided a response letter to EPA on October 15, 2007. It was concluded that the cited deficiencies were for requirements that were not applicable to ORNL; therefore, no corrective actions were required other than to revise wording on two pages of the ORNL SPCC to clarify the inapplicability.

### 5.3.3 Audits and Oversight

Table 5.7 presents a summary of environmental audits conducted at ORNL in 2007.

### 5.3.4 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 maintains 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 5.8 summarizes NEPA activities conducted at ORNL during 2007.

During 2007, UT-Battelle continued to operate under a site-level procedure that provides requirements for project reviews and NEPA compliance. This procedure calls 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, DOE-ORO has approved "generic" categorical exclusions (CXs) that cover proposed bench- and pilot-scale research activities and generic CXs that cover proposed nonresearch activities (i.e., 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. Table 5.8 provides information on project-specific CXs that were approved by DOE-ORO during 2007.

**Table 5.7. Summary of environmental audits, assessments and regulatory visits conducted at Oak Ridge National Laboratory, 2007[a]**

| Date | Reviewer | Subject | Issues |
|---|---|---|---|
| | | **UT-Battelle** | |
| May 7–10 | TDEC, RCRA | TDEC Annual RCRA Inspection | 0 |
| May 22 | TDEC | ORNL NPDES Permit Renewal | 0 |
| May 31 | TDEC | ORNL NPDES Permit Renewal | 0 |
| June 18–21 | NSF-ISR | EMS Reassessment Audit | 0 |
| July 19 | TDEC | ORNL NPDES Permit Renewal | 0 |
| August 10 | TDEC | ORNL NPDES Permit Renewal | 0 |
| September 11–12 | RAC | ORNL Dose Assessment | 0 |
| September 27 | TDEC | ORNL NPDES Permit Renewal | 0 |
| November 5–7 | TDEC | TDEC Annual RCRA inspection at Y-12 Complex | 0 |
| November 20 | TDEC | ORNL NPDES Permit Renewal | 0 |
| December 6 | TDEC | ORNL NPDES Permit Renewal | 0 |
| NA | EPA/TDEC | RCRA Inspection at NTRC | 0 |
| NA | TDEC | RCRA Inspection at 0800 | 0 |
| | | **Bechtel Jacobs Company/WESKEM/Energy Solutions** | |
| May 7–10 | TDEC | TDEC inspection of permitted RCRA waste management units | 0 |
| | | **Foster Wheeler/EnergX** | |
| May 7–10 | TDEC, RCRA | TDEC Annual RCRA Inspection | 0 |
| August 1 | TDEC, CAA | TDEC Air Pollution Inspection | 0 |

[a]Abbreviations:
CAA = Clean Air Act
EMS = Environmental Management System
EPA = Environmental Protection Agency
NPDES = National Pollutant Discharge Elimination System
NSF-ISR = NSF International Strategic Registrations, LTD
ORNL = Oak Ridge National Laboratory
RAC = Radiological Assessment Corporation
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation

**Table 5.8. National Environmental Policy Act (NEPA) activities during 2007**

| Types of NEPA documentation | Number of instances |
|---|---|
| Categorical exclusions (CX) approved | 7 |
| Approved under general actions or generic CX documents | 47[a] |
| Environmental assessment | 1 |

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

UT-Battelle utilizes 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, along with principal investigators, environmental compliance representatives, and environmental protection officers within each ORNL division, participate in recommending appropriate NEPA decisions.

The ORNL interpretative plan and a machinery/equipment survey were both completed in 2007. The interpretive plan explains the significance of specific ORNL properties and makes tangible the functions and historical importance of facilities no longer physically in existence. The history of ORNL has been recorded in a variety of ways, and this plan serves to further elaborate and define the historical importance of the site during World War II and the Cold War. The machinery equipment survey documents the machinery and equipment associated with the historic missions of the ORNL during World War II, particularly during the Manhattan project, and scientific research and development during the Cold War era. The survey met "Standards and Guidelines for Archeology and Historic Preservation" (48 CFR 44716) guidelines by identifying, tracking, and preserving important pieces of machinery and equipment that can be used in conveying the history of ORNL at an important period in U.S. history.

Compliance with National Historic Preservation Act (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).

### 5.3.5 Clean Air Act

The Clean Air Act (CAA), passed in 1970 and amended in 1977 and 1990, forms the basis for the national air pollution control effort. This legislation establishes comprehensive federal and state regulations to limit air emissions and includes four major regulatory programs: the National Ambient Air Quality Standards, State Implementation Plans (SIPs), New Source Performance Standards (NSPS), and National Emission Standards for Hazardous Air Pollutants (NESHAP). Airborne discharges from DOE Oak Ridge facilities, both radioactive and nonradioactive, are subject to regulation by EPA and the Tennessee Department of Environment and Conservation (TDEC) Division of Air Pollution Control. There were no ORNL CAA violations or exceedances in 2007. Section 5.4 provides more detailed information on 2007 UT-Battelle activities conducted in support of the CAA.

### 5.3.6 Clean Water Act

The objective of the Clean Water Act (CWA) is to restore, maintain, and protect the integrity of the nation's waters. This act serves as the basis for comprehensive federal and state programs to protect the nation's waters from pollutants. (See Appendix D for water reference standards.) One of the strategies developed to achieve the goals of the CWA was EPA's establishment of limits on specific pollutants allowed to be discharged to U.S. waters by municipal sewage treatment plants and industrial facilities. The EPA established the National Pollutant Discharge Elimination System (NPDES) Permitting Program to regulate compliance with these 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 2007, compliance was determined by approximately 7000 laboratory analyses in addition to numerous field observations by ORNL field technicians. The NPDES permit limit compliance rate for all discharge points for 2007 was nearly 100% with only one measurement exceeding numeric NPDES permit limits. This measurement also caused calculated exceedance of a second, monthly-average permit limit. The noncompliances occurred at the ORNL Coal Yard Runoff Treatment Facility (CYRTF), now known as the Steam Plant Wastewater Treatment Facility (SPWTF), where measurements of 1.31 mg/L iron on January 11, 2007, exceeded the daily maximum limit of 1.0 mg/L. The monthly average concentration of 1.07 mg/L also exceeded the monthly average limit of 1.0 mg/L. An investigation into the exceedance was conducted, with no certain cause for the exceedance being identified. The condition did not recur during the remainder of 2007. Information on the exceedances is provided in Appendix E, Sect. E.3. Neither of the two exceedances resulted in any discernable ecological impact. Section 5.5 contains summaries of the activities and programs carried out at 2007 at ORNL in support of the CWA.

In 2007 ORNL and TDEC held a series of negotiation meetings and discussions in the process of developing a new draft for the renewal of ORNL's NPDES permit. TDEC placed the draft permit out for public and EPA review on August 20, 2007. As of December 2007, TDEC was resolving and incorporating comments. It is expected that the final version of the ORNL permit will be issued in mid-2008.

### 5.3.7 Safe Drinking Water Act

ORNL's water distribution system is designated as a Non-Transient, Non-Community water system by TDEC's Division of Water Supply. The *Tennessee Regulations for Public Water Systems and Drinking Water Quality*, Chap. 1200-5-1, 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:

- chlorine residual levels,
- bacteriological (total coliform),
- lead and copper, and
- disinfectant by-products (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 the ORR, north of the Y-12 complex, is owned and operated by the city of Oak Ridge.

In 2007, TDEC completed a sanitary survey on ORNL's potable water system . ORNL received a perfect score. In response to TDEC comments, ORNL has completed revisions to the site cross-connection control program.

In 2007, sampling results for chlorine residual levels, bacterial constituents, and disinfectant by-products were all within acceptable limits. The ORNL potable water system is currently in triennial sampling for lead and copper. The next scheduled sample period is June–September 2009.

### 5.3.8 Resource Conservation and Recovery Act

ORNL is regulated as a large-quantity generator of hazardous waste because the facility generates more than 1000 kg of hazardous waste per month. This amount includes the amount of hazardous waste that is generated under permitted activities (including repackaging or treatment residuals). At the end of 2007, ORNL had roughly 350 generator accumulation areas for hazardous or mixed waste serving the various contractor organizations, including UT-Battelle, Bechtel Jacobs Company (BJC), Energy Solutions, Isotek, and others.

ORNL is also regulated as a handler of universal waste (e.g., fluorescent lamps, batteries, and other items regulated under 40 CFR 273); however, mercury-containing equipment is still being managed at ORNL (by UT-Battelle staff) as hazardous waste.

ORNL is regulated as a generator of used oils under 40 CFR 279. At the end of 2007, ORNL had approximately 100 used oil areas for management of used oil prior to off-site recycle or disposal.

ORNL's NTRC was classified as a conditionally exempt small-quantity generator for CY 2007, meaning that site generated less than 100 kg of hazardous waste per month. The NTRC operated three generator areas in support of operations that generate hazardous wastes at the end of 2007 and intermittently operated a 180-d accumulation area for temporary storage of hazardous wastes prior to off-site transport. In addition, the NTRC operated one used oil area for management of recyclable used oil.

The 0800 Area and the Freel's Bend Area generated no regulated wastes or used oils in 2007.

ORNL is registered as a large-quantity generator under EPA Identification (ID) No. TN1890090003 and is permitted to transport hazardous wastes, to operate a transfer facility for temporary storage of hazardous wastes transported from off-site locations (such as NTRC), and to operate RCRA-permitted hazardous waste treatment and storage units. During 2007, 21 units operated as permitted units; another 7 units were permitted as proposed units (but will not be built and have been eliminated in permit renewal applications submitted in 2006); and 1 unit (previously permitted, Building 7507W for mixed waste storage) was certified closed in May 2007 (permit No. TNHW-10A).

ORNL's RCRA storage and treatment facilities (or units) operate under three permits: TNHW-097, TNHW-010A, and TNHW-121. TNHW-121 is the existing RCRA Hazardous and Solid Waste Amendments permit for the ORR (see Table 5.9). The permits are modified when necessary. Ten permit

**Table 5.9. Oak Ridge National Laboratory (ORNL) Resource Conservation and Recovery Act operating permits, 2007**

| Permit number | Building/description |
|---|---|
| | **ORNL** |
| TNHW-10A[a] | Building 7651 Container Storage Unit |
| | Building 7652 Container Storage Unit |
| | Building 7653 Container Storage Unit |
| | Building 7654 Container Storage Unit |
| | Building 7669 Container Storage Unit |
| | Portable Buildings 1 & 2 Container Storage Unit |
| | Building 7572 Container Storage Unit |
| TNHW-097[a] | Building 7574 Container Storage Unit |
| | Building 7576 Container Storage Unit |
| | Building 7577 Container Storage Unit |
| | Building 7580 Container Storage Unit |
| | Building 7823 Container Storage Unit |
| | Building 7842 Container Storage Unit |
| | Building 7855 Container Storage Unit |
| | Building 7878 Container Storage Unit |
| | Building 7879 Container Storage Unit |
| | Building 7883 Container Storage Unit |
| | Building 7884 Container Storage Unit |
| | Building 7880 Waste Processing Facility 2 |
| | Building 7880 Waste Processing Facility 4 |
| | Building CHSA Waste Processing Facility 1 |
| | Building DAC Waste Processing Facility 3 |
| | Building CSA Waste Processing Facility 5 |
| | Building CHMB Waste Processing Facility 6 |
| | Macroencapsulation T-1[b] |
| | Amalgamation T-2[b] |
| | Solidification/Stabilization T-3[b] |
| | **Oak Ridge Reservation** |
| TNHW-121 | Hazardous Waste Corrective Action Permit |

[a]When approved, permit reapplications submitted in 2006 eliminate the following proposed units: 7669, 7576, 7577, 7580, 7842, 7878, 7884.

[b]Treatment operating units within Building 7880.

modifications were approved by TDEC in 2007. The process for adding the Foster Wheeler TRU units to the TNHW-097 permit that was started at the end of CY 2005 was approved in June 2007. Those Foster Wheeler units operated under an interim approval during the first half of 2007. Most of the permit modifications submitted and approved in 2007 were minor and addressed administrative, editorial, or other nonintent changes. Contractor-level modifications were handled as Class 1-1 or Class 2 modifications. The renewal applications for the TNHW-010A and TNHW-097 permits submitted in previous years were still pending throughout 2007.

### 5.3.9 RCRA Underground Storage Tanks

USTs containing petroleum and hazardous substances are regulated under Subtitle I of RCRA (40 CFR 280). TDEC has been granted authority by EPA to regulate USTs containing petroleum under TDEC Rule 1200-1-15; however, hazardous-substance USTs are still regulated by EPA. Table 5.10 summarizes the status of ORNL USTs.

**Table 5.10. Oak Ridge National Laboratory underground storage tank (UST) status, 2007**

| | |
|---|---|
| Active/in-service | 3 |
| Closed, deferred or excluded | 51[a] |
| Hazardous substance | 0[b] |
| Known or suspected sites | 0 |
| Total | 54 |

[a]The 51 "closed" USTs include deferred or excluded tanks of various categories, as detailed in the text.

[b]Closed tanks include two hazardous substance tanks, both of which were excavated, removed, and dismantled.

ORNL has responsibility for 54 USTs registered with TDEC under Facility ID Number 0-730089. These 54 USTs can be classified as follows:

- 49 USTs closed to meet the RCRA Subtitle I requirements,
- 3 USTs in service that meet the 1998 standards for new UST installations, and
- 2 USTs still in service that are deferred or exempt from Subtitle I because they are regulated by other statutes (1 UST under the RCRA Subtitle C and 1 UST under the CWA).

Of the 49 closed USTs, 24 were replaced by double-walled, concrete-encased aboveground storage tanks; three were replaced by the new, state-of-the-art USTs; and 22 were not replaced because they were no longer needed. Closure approval letters have been received for all USTs closed between 1988 and 1998.

### 5.3.10 Comprehensive Environmental Response, Compensation, and Liability Act

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

In 1989, the ORR was placed on EPA's NPL, a list of facilities that pose a sufficient threat to human health and/or the environment and warrant cleanup under CERCLA. In 1992, the ORR Federal Facility Agreement among EPA, TDEC, and DOE became effective and established the framework and schedule for developing, implementing, and monitoring remedial actions on the ORR. The on-site CERCLA Waste Facility, located in Bear Creek Valley, is used for disposal of waste resulting from CERCLA cleanup actions on the ORR, including ORNL. The CERCLA Waste Facility is an engineered landfill that accepts low-level radioactive and hazardous wastes in accordance with specific waste acceptance criteria under an agreement with state and federal regulators.

### 5.3.11 Toxic Substances Control Act

#### 5.3.11.1 Polychlorinated Biphenyls

ORNL is regulated as a polychlorinated biphenyl (PCB) waste generator, transporter, and storage facility under the EPA ID number TN1890090003. ORNL operated roughly 12 PCB waste storage areas in generator buildings in 2007 and used some of ORNL's RCRA-permitted storage buildings for longer-term storage of PCB/radioactive wastes when necessary. ORNL operated four PCB waste storage areas in 2007 at Y-12 facilities. ORNL is also regulated for the continued use of authorized PCBs in electrical systems and/or equipment (transformers, capacitors, rectifiers, etc.). ORNL has disposed of the majority of its TSCA-regulated equipment. However, some of the ORNL facilities at Y-12 continue to use (or store for future reuse) PCB equipment (such as transformers, capacitors, and rectifiers).

Because of the age of many of the ORNL facilities and the varied uses for PCBs in building construction and equipment, DOE self-disclosed the presence of unauthorized uses of PCBs to EPA in the late 1980s in gaskets, grease, and equipment. As a result, DOE and ORNL negotiated a compliance agreement with EPA (see Sect. 5.3.11.1.1) to address the compliance issues related to these unauthorized uses and to allow for their continued use pending decontamination or disposal. As a result of that agreement, DOE continues to notify EPA of additional unauthorized uses of PCBs when found at ORNL. Some of these additional unauthorized uses include finding PCBs in paint, adhesives, electrical wiring, and floor tile, and/or equipment.

##### 5.3.11.1.1 PCB Compliance Agreements

The ORR PCB Federal Facilities Compliance Agreement (ORR PCB FFCA) between EPA Region 4 and DOE-ORO became effective on December 16, 1996. The agreement addresses PCB compliance issues at East Tennessee Technology Park (ETTP), ORNL, the Y-12 Complex, and the Oak Ridge Institute for Science and Energy (ORISE). It specifically addresses the unauthorized use of PCBs, storage and disposal of PCB wastes, PCB spill cleanup and/or decontamination, PCBs mixed with radioactive materials, PCB R&D, and records and reporting requirements for the ORR.

EPA is updated annually on the status of DOE actions with regard to management and disposition of PCBs covered under the ORR PCB FFCA.

### 5.3.12 Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA) and Title III of the Superfund Amendments and Reauthorization Act (SARA) require that facilities report inventories and releases of certain chemicals that exceed specific release thresholds. These reports are submitted to the local emergency planning committee and the state emergency response commission. Table 5.11 describes the main elements of this act. UT-Battelle complied with these requirements in 2007 through the submittal of reports under EPCRA Sects. 302, 303, 311, and 312.

ORNL had no releases of extremely hazardous substances, as defined by EPCRA, in 2007.

#### 5.3.12.1 Material Safety Data Sheet/Chemical Inventory (Sections 311–312)

The required Sect. 311 notifications were made because hazardous materials were determined to be over threshold for the first time in 2007. Inventories, locations, and associated hazards of hazardous and

**Table 5.11. Descriptions of the main parts 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 (MSDS)/Chemical Inventory | Requires that either MSDSs 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 Environmental Protection Agency (EPA) |
| Section 313, Toxic Chemical Release Reporting | Requires that releases of toxic chemicals be reported annually to EPA |

extremely hazardous chemicals were submitted in an annual report to state and local emergency responders as required by the Sect. 312 requirements. Of the chemicals identified for CY 2007 on the ORR, 28 were located at ORNL.

Private-sector lessees associated with the reindustrialization effort were not included in the CY 2007 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.

#### 5.3.12.2 Toxic Chemical Release Reporting (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 as well as 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 off-site transfers were calculated for each chemical that exceeded one or more of the thresholds.

For CY 2007, ORNL reported releases of 26,904 lb of nitric acid and 35,000 lb of nitrate compounds (Table 5.12). The nitric acid is not actually released but rather is used for waste treatment at the Process Waste Treatment Complex and at HFIR, but such use is considered a “release” under the Toxic Release Inventory regulations. Nitrate compounds are coincidentally manufactured as by-products of neutralizing nitric acid waste and as by-products of sewage treatment. The neutralized nitric acid is not released but rather is stored for future disposal as rad waste since it becomes radioactive during the treatment process. The nitrate compounds from the sewage treatment plant are released into the environment. The discharge of nitrate compounds is not regulated in the NPDES permit for the sewage plant.

## 5.4 Air Quality Program

### 5.4.1 Nonradiological Monitoring

UT-Battelle holds a Title V permit for 10 emission sources. The primary sources of nonradioactive emissions at ORNL include the steam plant, boilers 1–6 on the main ORNL site, two boilers located at the 7600 complex, and four boilers located at the SNS site. These units use fossil fuels; therefore, criteria pollutants are emitted. Actual and allowable emissions from these sources are compared in Table 5.13. Actual emissions were calculated from fuel usage and EPA emission factors. All ORNL emission sources operated in compliance with permit conditions during 2007.

**Table 5.12. Emergency Planning and Community Right-to-Know Act Sect. 313 toxic chemical release and off-site transfer summary for Oak Ridge National Laboratory, 2007[a]**

| Chemical | Year | Quantity (lb)[b] |
|---|---|---|
| Nitrate compounds | 2006 | 51,000 |
| | 2007 | 35,000 |
| Nitric acid | 2006 | 54,013 |
| | 2007 | 26,904 |
| Total | 2006 | 105,013 |
| | 2007 | 61,904 |

[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.

[b]1 lb = 0.45359237 kg.

**Table 5.13. Actual vs. allowable air emissions from Oak Ridge National Laboratory steam production, 2007**

| Pollutant | Emissions (tons per year)[a] | | Percentage of allowable (%) |
|---|---|---|---|
| | Actual | Allowable | |
| $SO_2$ | 8 | 1277 | 0.6 |
| PM | 3 | 71 | 4.3 |
| CO | 32 | 196 | 16.1 |
| VOC | 2 | 14 | 14.6 |
| $NO_X$ | 54 | 380 | 14.2 |

[a] 1 ton = 907.2 kg.

Boiler 6, a 125-MBtu/h boiler, is subject to 40 CFR 60 Subpart Db continuous emission monitoring requirements for $NO_x$ and opacity. During CY 2007, no permit limits were exceeded. ORNL also holds one construction permit for the Central Exhaust Facility at the SNS. The facility will collect, monitor, and discharge radionuclides from SNS operational components. Sources will include accelerator tunnels, beam dumps, and the target building. On March 16, 2007, UT-Battelle submitted an application to TDEC requesting that the UT-Battelle Title V permit be modified to include the SNS Central Exhaust Facility. The start-up of this source occurred on December 11, 2007, and the start-up notification was submitted to TDEC on January 11, 2008.

From July 1, 2006, through June 30, 2007, ORNL paid $5,584.75 in annual emission fees to TDEC. These fees are based on a combination of actual and allowable emissions.

The TWPC holds an operating air permit for one emission source. During CY 2007, no permit limits were exceeded.

### 5.4.2 NESHAP for Asbestos

There are numerous buildings and pieces of equipment at ORNL that contain asbestos-containing materials. The compliance program for management of removal and disposal of asbestos-containing materials includes demolition and renovation notifications to TDEC and inspections, monitoring, and prescribed work practices for abatement and disposal of asbestos materials. No releases of reportable quantities of asbestos were reported at ORNL during 2007.

### 5.4.3 ORNL 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 F, Table F.1, for a list of radionuclides and associated radioactive half-lives.) These 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).

In 2006, construction of the SNS project was completed. The purpose of the project was to design, construct, and commission into operation an accelerator-based, pulsed neutron facility for studies of the structure and dynamics of materials. In December 2007, commencement of user operations for beamlines was authorized. Emissions from pre-start activities conducted in 2007 are included in this report. SNS radionuclide emissions are discharged through a single emission point, the SNS Central Exhaust Facility stack (8915), which has the potential to emit radionuclides that would result in a dose equal to or greater than 0.1 mrem/year to the most exposed member of the public; therefore, continuous emission sampling or monitoring is required.

Also in 2006, the TWPC (Building 7880) was mistakenly listed as a minor source. Even though the actual dose contribution from this source to the ORR most exposed individual was reported correctly, its potential dose was greater than 0.1 mrem/year for 2006. Annual emissions have been determined through the use of a continuous in-stack sampling system since its inception in January 2004, and an operating permit was issued April 13, 2004, under Emission Source Reference No. 73-0165-01. This source was permitted as a major source under 40 CFR Part 61, Subpart H and will be reported as a major source in this and all future reports.

The major radiological emission point sources for ORNL consist of the following six stacks located in Bethel and Melton Valleys (Fig. 5.11) and the SNS Central Exhaust Facility stack located on Chestnut Ridge:

- 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 and 3026 areas 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; and
- 8915 SNS Central Exhaust Facility stack.

The Radioactive Materials Analytical Laboratory was moved from Building 2026 to Building 4501 in 2007. Building 2026 has been slated for decontamination and decommissioning. However, the building name is still Radioactive Materials Analytical Laboratory.

In 2007, there were 15 minor point/group sources, and emission calculations/estimates were made for each of them.

#### 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 (ANSI 1969). The sampling systems generally consist of a multipoint in-stack

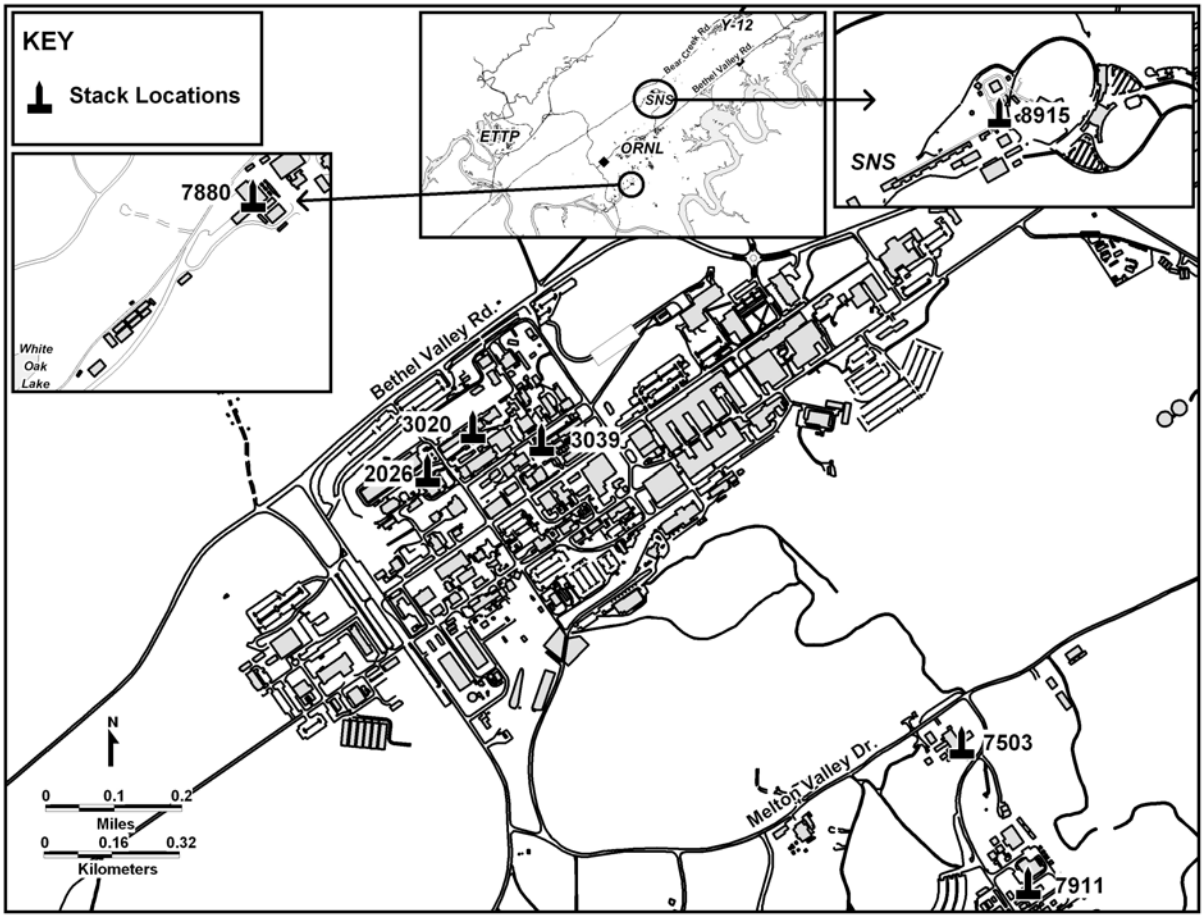



**Fig. 5.11. Locations of major stacks (radiological emission points) at Oak Ridge National Laboratory.**

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. 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 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 manufacturer's instrument test procedures. The stack sampler rotameter is calibrated at least quarterly against 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 ORNL Nuclear and Radiological Protection Division. A variety of methods are used to determine the emissions from the various minor sources. Methods used for minor source-emission calculations comply with EPA criteria. These 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 d 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. Compositing provides a better opportunity for quantification of the low-concentration isotopes. Silica-gel traps are used to capture tritium water vapor. 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 the rinsate is collected and submitted for isotopic analysis identical to that performed on the particulate filters. For 7880, the rinsate is submitted for analysis only if the field measurements of alpha, beta, or gamma contamination levels are above background screening levels. A probe-cleaning program has been determined unnecessary for 8915 since 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.

The data from the charcoal cartridges, silica gel, probe wash, and the 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 2007 are presented in Table 5.14. All data presented were determined to be statistically different from zero at the 95% confidence level. Any number not statistically different from zero was not included in the emission calculation. Because measuring a radionuclide requires counting random radioactive emissions from a sample, the same result may not be obtained if the sample is analyzed repeatedly. This deviation is referred to as the “counting uncertainty.” Statistical significance at the 95% confidence level means that there is a 5% chance that the results could be erroneous.

Historical trends for tritium and $^{131}$I are presented in Figs. 5.12 and 5.13, respectively. The tritium emissions for 2007 totaled approximately 54.1 Ci (Fig. 5.13), which is a decrease from 2006. The $^{131}$I emissions for 2007 totaled 0.09 Ci (Fig. 5.14), which is almost twice the amount for the past four years but is in line with historical releases. The major contributor to the off-site dose at ORNL historically has been $^{41}$Ar, which is emitted as a nonadsorbable gas from the 7911 Melton Valley complex stack. Emissions of $^{41}$Ar result from HFIR operations and research activities. However, from 2001–2006, $^{138}$Cs became the major contributor to the off-site ORNL plant dose since HFIR was down because of an extended maintenance period and the installation of the Cold Neutron Source. Emissions of $^{138}$Cs result from research activities in the Radiochemical Engineering Development Center, which also exhausts through the 7911 Melton Valley complex stack. In 2007, HFIR was in full operation completing several operating cycles, which resulted in $^{41}$Ar once again becoming the major off-site dose contributor to the ORNL plant dose (approximately 49%). Cesium-138 contributed approximately 21% of the ORNL plant dose. The $^{41}$Ar emissions for 2007 were 3581 Ci; $^{138}$Cs emissions were 886 Ci (Fig. 5.14). The calculated radiation dose to the maximally exposed off-site individual from all radiological airborne release points at

**Table 5.14. Radiological airborne emissions (Ci), Oak Ridge National Laboratory sources, 2007[a]**

| Isotope | Stack | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | X-2026 | X-3020 | X-3039 | X-7503 | X-7911 | X-7880 | X-8915 | Total minor sources | Total ORNL |
| $^{225}$Ac | | | | | | | | 1.20E–06 | 1.20E–06 |
| $^{228}$Ac | | | | | | | | 5.68E–08 | 5.68E–08 |
| $^{228}$Ac | | | | | | | | 7.49E–06 | 7.49E–06 |
| $^{110m}$Ag | | | | | | | | 1.61E–08 | 1.61E–08 |
| $^{110m}$Ag | | | | | | 2.06E–06 | | | 2.06E–06 |
| $^{241}$Am | 1.57E–07 | 1.44E–07 | 8.90E–07 | 4.01E–09 | 8.35E–09 | | | 3.77E–07 | 1.58E–06 |
| $^{241}$Am | | | | | | | | 8.01E–10 | 8.01E–10 |
| $^{243}$Am | | | | | | | | 2.54E–11 | 2.54E–11 |
| $^{41}$Ar | | | | | 3.58E+03 | | 4.26E–01 | 1.14E–01 | 3.58E+03 |
| $^{133}$Ba | | | | | | | | 7.36E–09 | 7.36E–09 |
| $^{137m}$Ba | | | | | | | | 1.54E–07 | 1.54E–07 |
| $^{139}$Ba | | | | | 2.05E–01 | | | | 2.05E–01 |
| $^{140}$Ba | | | | | 1.28E–04 | | | 4.90E–16 | 1.28E–04 |
| $^{140}$Ba | | | | | | 3.71E–05 | | | 3.71E–05 |
| $^{7}$Be | 4.76E–08 | 1.67E–07 | 9.82E–06 | 4.39E–08 | | | | 1.58E–05 | 2.59E–05 |
| $^{212}$Bi | | | | | | | | 7.77E–08 | 7.77E–08 |
| $^{213}$Bi | | | | | | | | 1.12E–05 | 1.12E–05 |
| $^{214}$Bi | | | | | | | | 2.64E–06 | 2.64E–06 |
| $^{11}$C | | | | | | | 1.78E+01 | | 1.78E+01 |
| $^{11}$C | | | | | | | | 1.52E–01 | 1.52E–01 |
| $^{14}$C | | | | | | | | 2.60E–10 | 2.60E–10 |
| $^{139}$Ce | | | | | | | | 2.08E–09 | 2.08E–09 |
| $^{141}$Ce | | | | | | | | 3.45E–08 | 3.45E–08 |
| $^{144}$Ce | | | | | | | | 1.51E–10 | 1.51E–10 |
| $^{249}$Cf | | | | | | | | 7.95E–14 | 7.95E–14 |
| $^{250}$Cf | | | | | | | | 3.37E–12 | 3.37E–12 |
| $^{251}$Cf | | | | | | | | 1.47E–14 | 1.47E–14 |
| $^{252}$Cf[b] | | | | | 5.06E–09 | | | 9.99E–08 | 1.05E–07 |
| $^{242}$Cm | | | | | | | | 5.65E–08 | 5.65E–08 |
| $^{243}$Cm | | | | | | | | 2.59E–11 | 2.59E–11 |
| $^{244}$Cm | 1.11E–06 | 1.86E–08 | 1.77E–07 | 3.47E–08 | 1.08E–08 | | | 5.94E–06 | 7.29E–06 |
| $^{245}$Cm | | | | | | | | 1.73E–09 | 1.73E–09 |
| $^{246}$Cm | | | | | | | | 1.79E–09 | 1.79E–09 |
| $^{248}$Cm[c] | | | | | | | | 1.66E–13 | 1.66E–13 |
| $^{56}$Co | | | | | | | | 9.93E–09 | 9.93E–09 |
| $^{57}$Co | | | | | | | | 2.09E–06 | 2.09E–06 |
| $^{58}$Co | | | | | | 2.82E–06 | | | 2.82E–06 |
| $^{58}$Co | | | | | | | | 4.60E–06 | 4.60E–06 |
| $^{60}$Co | | | 3.18E–05 | | | | | 2.63E–04 | 2.95E–04 |
| $^{60}$Co | | | | | | 2.61E–06 | | | 2.61E–06 |
| $^{51}$Cr | | | | | | | | 7.74E–05 | 7.74E–05 |

**Table 5.14** (continued)

| Isotope | Stack | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | X-2026 | X-3020 | X-3039 | X-7503 | X-7911 | X-7880 | X-8915 | Total minor sources | Total ORNL |
| $^{134}$Cs | | | | | | | | 1.67E–08 | 1.67E–08 |
| $^{134}$Cs | | | | | | 2.17E–06 | | | 2.17E–06 |
| $^{135}$Cs | | | | | | | | 2.18E–13 | 2.18E–13 |
| $^{136}$Cs | | | | | | | | 3.60E–16 | 3.60E–16 |
| $^{136}$Cs | | | | | | 6.54E–06 | | | 6.54E–06 |
| $^{137}$Cs | 2.16E–06 | 9.78E–07 | 2.53E–04 | 1.45E–08 | 2.68E–05 | | | 1.20E–03 | 1.48E–03 |
| $^{137}$Cs | | | | | | 2.99E–06 | | | 2.99E–06 |
| $^{138}$Cs | | | | | 8.86E+02 | | | | 8.86E+02 |
| $^{152}$Eu | | | | | | | | 3.19E–07 | 3.19E–07 |
| $^{154}$Eu | | | | | | | | 2.07E–07 | 2.07E–07 |
| $^{155}$Eu | | | | | | | | 2.66E–10 | 2.66E–10 |
| $^{55}$Fe | | | | | | | | 7.22E–05 | 7.22E–05 |
| $^{59}$Fe | | | | | | | | 1.32E–06 | 1.32E–06 |
| $^{59}$Fe | | | | | | 7.31E–06 | | | 7.31E–06 |
| $^{67}$Ga | | | | | | | | 1.82E–15 | 1.82E–15 |
| $^{153}$Gd | | | | | | | | 3.00E–09 | 3.00E–09 |
| $^{68}$Ge | | | | | | | | 3.75E–15 | 3.75E–15 |
| $^{3}$H | 1.11E+00 | | 2.41E+01 | 1.55E+00 | 2.48E+01 | | 1.54E+00 | 1.01E+00 | 5.41E+01 |
| $^{172}$Hf | | | | | | | | 6.85E–14 | 6.85E–14 |
| $^{175}$Hf | | | | | | | | 8.09E–13 | 8.09E–13 |
| $^{178m}$Hf | | | | | | | | 5.14E–15 | 5.14E–15 |
| $^{181}$Hf | | | | | | | | 3.51E–15 | 3.51E–15 |
| $^{203}$Hg | | | | | | | | 9.28E–07 | 9.28E–07 |
| $^{124}$I | | | | | | | | 6.92E–08 | 6.92E–08 |
| $^{125}$I | | | | | | | | 5.42E–06 | 5.42E–06 |
| $^{126}$I | | | | | | | | 4.92E–06 | 4.92E–06 |
| $^{129}$I | | | | | | | | 1.21E–03 | 1.21E–03 |
| $^{130}$I | | | | | | | | 1.96E–30 | 1.96E–30 |
| $^{131}$I | | | | | | | | 6.20E–02 | 6.20E–02 |
| $^{131}$I | | | | | | 3.86E–05 | | | 3.86E–05 |
| $^{131}$I | | | | | 3.16E–02 | | | | 3.16E–02 |
| $^{132}$I | | | | | 2.88E–01 | | | | 2.88E–01 |
| $^{133}$I | | | | | 1.63E–01 | | | | 1.63E–01 |
| $^{133}$I | | | 7.16E–05 | | | | | | 7.16E–05 |
| $^{134}$I | | | | | 4.56E–01 | | | | 4.56E–01 |
| $^{135}$I | | | | | 5.04E–01 | | | | 5.04E–01 |
| $^{192}$Ir | | | | | | | | 1.02E–06 | 1.02E–06 |
| $^{40}$K | | | | | | | | 3.60E–05 | 3.60E–05 |
| $^{40}$K | | | | | | 4.11E–05 | | | 4.11E–05 |
| $^{79}$Kr | | | | | | | | 1.50E–30 | 1.50E–30 |
| $^{81}$Kr | | | | | | | | 5.88E–12 | 5.88E–12 |
| $^{85}$Kr | | | | | 1.61E+03 | | | 1.00E–01 | 1.61E+03 |
| $^{85m}$Kr | | | | | 5.17E+00 | | 5.32E–01 | | 5.70E+00 |
| $^{87}$Kr | | | | | 8.19E+01 | | 4.01E–01 | | 8.23E+01 |
| $^{88}$Kr | | | | | 1.01E+02 | | 4.43E–02 | | 1.01E+02 |
| $^{89}$Kr[d] | | | | | 7.06E+01 | | | | 7.06E+01 |

**Table 5.14** (continued)

| Isotope | Stack | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | X-2026 | X-3020 | X-3039 | X-7503 | X-7911 | X-7880 | X-8915 | Total minor sources | Total ORNL |
| $^{140}$La | | | | | | 1.57E–05 | | | 1.57E–05 |
| $^{140}$La | | | | | 1.33E–05 | | | | 1.33E–05 |
| $^{173}$Lu | | | | | | | | 7.57E–13 | 7.57E–13 |
| $^{174}$Lu | | | | | | | | 1.60E–13 | 1.60E–13 |
| $^{177m}$Lu | | | | | | | | 1.34E–14 | 1.34E–14 |
| $^{54}$Mn | | | | | | | | 1.99E–07 | 1.99E–07 |
| $^{54}$Mn | | | | | | 2.48E–06 | | | 2.48E–06 |
| $^{93}$Mo | | | | | | | | 1.36E–07 | 1.36E–07 |
| $^{99}$Mo | | | | | | | | 1.03E–10 | 1.03E–10 |
| $^{99}$Mo | | | | | | 7.74E–03 | | | 7.74E–03 |
| $^{13}$N | | | | | | | 3.90E–01 | 5.73E–01 | 9.63E–01 |
| $^{22}$Na | | | | | | | | 4.53E–09 | 4.53E–09 |
| $^{92}$Nb[e] | | | | | | | | 6.24E–09 | 6.24E–09 |
| $^{93m}$Nb | | | | | | | | 1.43E–07 | 1.43E–07 |
| $^{94}$Nb | | | | | | 2.14E–06 | | | 2.14E–06 |
| $^{94}$Nb | | | | | | | | 2.20E–09 | 2.20E–09 |
| $^{95}$Nb | | | | | | | | 1.07E–07 | 1.07E–07 |
| $^{59}$Ni | | | | | | | | 4.44E–07 | 4.44E–07 |
| $^{63}$Ni | | | | | | | | 4.35E–05 | 4.35E–05 |
| $^{237}$Np | | | | | | | | 4.80E–11 | 4.80E–11 |
| $^{239}$Np | | | | | | | | 1.05E–11 | 1.05E–11 |
| $^{15}$O | | | | | | | 1.46E+00 | | 1.46E+00 |
| $^{185}$Os | | | | | | | | 1.43E–16 | 1.43E–16 |
| $^{191}$Os | | | 6.69E–04 | | | | | | 6.69E–04 |
| $^{33}$P | | | | | | | | 1.37E–07 | 1.37E–07 |
| $^{210}$Pb | | | | | | | | 1.11E–06 | 1.11E–06 |
| $^{212}$Pb | | | | | | | | 4.74E–03 | 4.74E–03 |
| $^{212}$Pb | 3.71E–01 | | 1.10E+00 | 8.37E–02 | 5.65E–02 | | | 4.59E–08 | 1.61E+00 |
| $^{214}$Pb | | | | | | | | 9.27E–09 | 9.27E–09 |
| $^{147}$Pm | | | | | | | | 9.35E–09 | 9.35E–09 |
| $^{209}$Po[f] | | | | | | | | 4.00E–06 | 4.00E–06 |
| $^{144}$Pr | | | | | | | | 7.58E–09 | 7.58E–09 |
| $^{238}$Pu | 5.79E–08 | 1.07E–08 | 6.14E–08 | 3.16E–09 | 4.75E–09 | | | 5.67E–07 | 7.05E–07 |
| $^{239}$Pu | 2.08E–07 | 1.20E–07 | 1.98E–06 | 1.17E–08 | 4.32E–09 | | | 2.08E–05 | 2.32E–05 |
| $^{240}$Pu | | | | | | | | 1.84E–09 | 1.84E–09 |
| $^{241}$Pu | | | | | | | | 1.80E–07 | 1.80E–07 |
| $^{242}$Pu | | | | | | | | 7.12E–13 | 7.12E–13 |
| $^{225}$Ra | | | | | | | | 1.00E–06 | 1.00E–06 |
| $^{226}$Ra | | | | | | 3.94E–05 | | | 3.94E–05 |
| $^{228}$Ra | | | | | | | | 7.53E–06 | 7.53E–06 |
| $^{228}$Ra | | | | | | | | 1.43E–08 | 1.43E–08 |
| $^{188}$Re | | | | | | | | 1.51E–05 | 1.51E–05 |
| $^{103}$Ru | | | | | | | | 1.06E–09 | 1.06E–09 |
| $^{106}$Ru | | | | | | | | 1.00E–05 | 1.00E–05 |
| $^{35}$S | | | | | | | | 5.00E–06 | 5.00E–06 |
| $^{124}$Sb | | | | | | | | 6.80E–07 | 6.80E–07 |

**Table 5.14** (continued)

| Isotope | Stack | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | X-2026 | X-3020 | X-3039 | X-7503 | X-7911 | X-7880 | X-8915 | Total minor sources | Total ORNL |
| $^{125}$Sb | | | | | | 5.40E–06 | | | 5.40E–06 |
| $^{125}$Sb | | | | | | | | 2.69E–07 | 2.69E–07 |
| $^{126}$Sb | | | | | | | | 1.90E–16 | 1.90E–16 |
| $^{46}$Sc | | | | | | | | 7.37E–11 | 7.37E–11 |
| $^{75}$Se | | | 1.04E–04 | | | | | 8.43E–07 | 1.05E–04 |
| $^{113}$Sn | | | | | | | | 1.70E–11 | 1.70E–11 |
| $^{119m}$Sn | | | | | | | | 1.25E–09 | 1.25E–09 |
| $^{85}$Sr | | | | | | | | 2.00E–09 | 2.00E–09 |
| $^{89}$Sr | | | | | | | | 2.78E–05 | 2.78E–05 |
| $^{90}$Sr | | | | | | | | 9.68E–04 | 9.68E–04 |
| $^{90}$Sr | 4.79E–07 | 6.65E–07 | 5.76E–05 | 2.93E–08 | 6.58E–06 | | | 5.30E–05 | 1.18E–04 |
| $^{90}$Sr | | | | | | 8.31E–06 | | | 8.31E–06 |
| $^{179}$Ta | | | | | | | | 9.49E–14 | 9.49E–14 |
| $^{182}$Ta | | | | | | | | 7.14E–05 | 7.14E–05 |
| $^{95m}$Tc | | | | | | | | 2.30E–14 | 2.30E–14 |
| $^{96}$Tc | | | | | | | | 1.97E–14 | 1.97E–14 |
| $^{99}$Tc | | | | | | | | 1.29E–10 | 1.29E–10 |
| $^{99}$Tc | | | | | | 2.78E–05 | | | 2.78E–05 |
| $^{99m}$Tc | | | | | | | | 1.20E–16 | 1.20E–16 |
| $^{125m}$Te | | | | | | | | 1.20E–06 | 1.20E–06 |
| $^{129}$Te | | | | | | | | 9.92E–12 | 9.92E–12 |
| $^{129m}$Te | | | | | | | | 3.76E–07 | 3.76E–07 |
| $^{228}$Th | 2.79E–08 | 4.22E–09 | 4.73E–09 | 6.46E–10 | | 1.66E–06 | | 1.06E–07 | 1.80E–06 |
| $^{229}$Th | | | | | | | | 1.02E–08 | 1.02E–08 |
| $^{230}$Th | 3.61E–10 | 3.94E–09 | 4.86E–09 | 1.38E–10 | 2.44E–09 | | | 1.35E–08 | 2.53E–08 |
| $^{232}$Th | | 1.08E–09 | 5.52E–09 | | 1.39E–09 | 9.13E–06 | | 7.12E–09 | 9.15E–06 |
| $^{234}$Th | | | | | | | | 3.52E–05 | 3.52E–05 |
| $^{170}$Tm | | | | | | | | 1.00E–09 | 1.00E–09 |
| $^{232}$U | | | | | | | | 8.07E–16 | 8.07E–16 |
| $^{233}$U | | | | | | | | 5.50E–10 | 5.50E–10 |
| $^{233}$U | | | | | | 1.05E–07 | | 6.40E–06 | 6.51E–06 |
| $^{234}$U | | | | | | | | 5.55E–10 | 5.55E–10 |
| $^{234}$U | 2.07E–07 | 6.91E–08 | 1.80E–07 | 1.21E–08 | 9.40E–08 | 1.05E–07 | | 6.92E–06 | 7.59E–06 |
| $^{235}$U | | | | | | | | 3.07E–10 | 3.07E–10 |
| $^{235}$U | 3.05E–08 | 1.69E–09 | 3.20E–08 | 9.49E–10 | 2.89E–08 | 1.30E–07 | | 9.70E–07 | 1.19E–06 |
| $^{236}$U | | | | | | | | 9.27E–07 | 9.27E–07 |
| $^{238}$U | | | | | | | | 7.06E–10 | 7.06E–10 |
| $^{238}$U | 1.99E–08 | 7.75E–09 | 4.58E–08 | 6.44E–10 | 2.67E–08 | 1.64E–07 | | 5.57E–05 | 5.59E–05 |
| $^{49}$V | | | | | | | | 8.74E–10 | 8.74E–10 |
| $^{181}$W | | | | | | | | 7.83E–10 | 7.83E–10 |
| $^{185}$W | | | | | | | | 2.09E–07 | 2.09E–07 |
| $^{188}$W | | | | | | | | 1.01E–05 | 1.01E–05 |
| $^{127}$Xe | | | | | | | | 2.97E–07 | 2.97E–07 |
| $^{129m}$Xe | | | | | | | | 8.70E–05 | 8.70E–05 |
| $^{131m}$Xe | | | | | 9.80E+01 | | | 1.10E–02 | 9.80E+01 |
| $^{133}$Xe | | | | | 2.47E+00 | | | 5.90E–01 | 3.06E+00 |

**Table 5.14** (continued)

| Isotope | Stack | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | X-2026 | X-3020 | X-3039 | X-7503 | X-7911 | X-7880 | X-8915 | Total minor sources | Total ORNL |
| $^{133m}$Xe | | | | | 1.76E+01 | | | 6.10E–01 | 1.82E+01 |
| $^{135}$Xe | | | | | 3.85E+01 | | | | 3.85E+01 |
| $^{135m}$Xe | | | | | 1.74E+01 | | | | 1.74E+01 |
| $^{137}$Xe$^{g}$ | | | | | 7.61E+01 | | | | 7.61E+01 |
| $^{138}$Xe | | | | | 9.64E+01 | | | | 9.64E+01 |
| $^{87}$Y | | | | | | | | 1.90E–16 | 1.90E–16 |
| $^{88}$Y | | | | | | | | 8.34E–09 | 8.34E–09 |
| $^{88}$Y | | | | | | 1.61E–06 | | | 1.61E–06 |
| $^{90}$Y | | | | | | | | 2.99E–11 | 2.99E–11 |
| $^{91}$Y | | | | | | | | 1.60E–08 | 1.60E–08 |
| $^{65}$Zn | | | | | | | | 7.08E–09 | 7.08E–09 |
| $^{65}$Zn | | | | | | 5.56E–06 | | | 5.56E–06 |
| $^{88}$Zr | | | | | | | | 8.15E–08 | 8.15E–08 |
| $^{95}$Zr | | | | | | 4.88E–06 | | | 4.88E–06 |
| $^{95}$Zr | | | | | | | | 1.06E–07 | 1.06E–07 |

[a]1 Ci = 3.7E+10 Bq.
[b]Californium-248 was used as a surrogate for $^{252}$Cf.
[c]Curium-245 was used as a surrogate for $^{248}$Cm.
[d]Krypton-88 was used as a surrogate for $^{89}$Kr.
[e]Niobium-94 was used as a surrogate for $^{92}$Nb.
[f]Polonium-210 was used as a surrogate for $^{209}$Po.
[g]Xenon-135 was used as a surrogate for $^{137}$Xe.

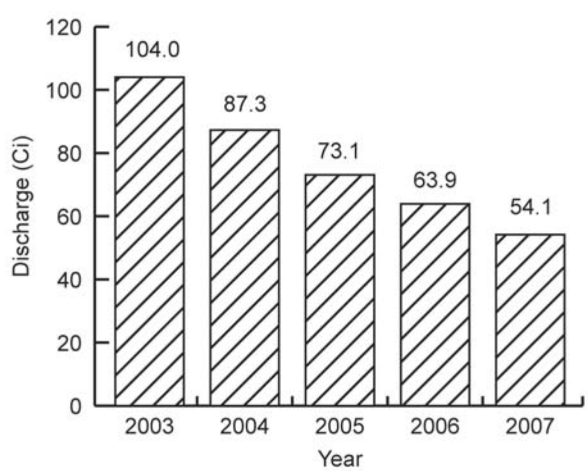



**Fig. 5.12. Total discharges of $^{3}$H from Oak Ridge National Laboratory to the atmosphere, 2003–2007.**

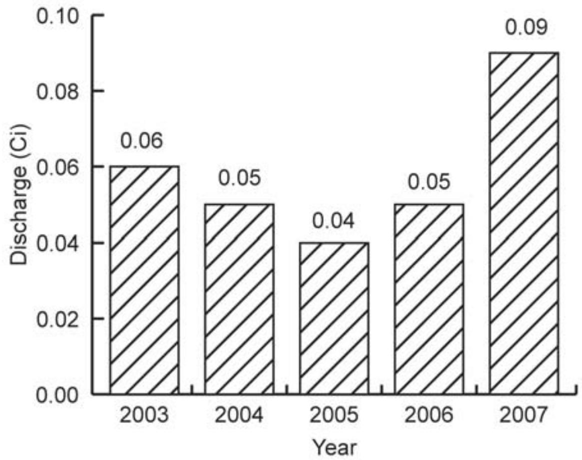



**Fig. 5.13. Total discharges of $^{131}I$ from Oak Ridge National Laboratory to the atmosphere, 2003–2007.**

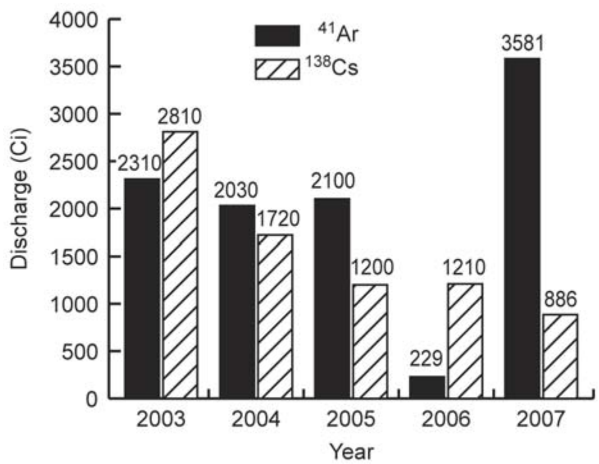



**Fig. 5.14. Total discharges of $^{41}Ar$ and $^{138}Cs$ from Oak Ridge National Laboratory to the atmosphere, 2003–2007.**

ORNL during 2007 was 0.26 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.09 % of the 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.)

### 5.4.4 Stratospheric Ozone Protection

As required by Title VI of the CAA Amendments of 1990, actions have been implemented to comply with the prohibition against releasing ozone-depleting substances 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 ozone-depleting substances. All critical applications of Class I ozone-depleting substances have been eliminated, replaced, or retrofitted with other materials. Work is progressing as funding becomes available for noncritical applications with no disruption of service.

## 5.4.5 Ambient Air

The objectives of the ORNL ambient air monitoring program are to collect samples at perimeter air monitoring (PAM) stations most likely to show impacts of airborne emissions from the operation of ORNL and to provide for emergency response capability. Four stations, identified as Stations 1, 2, 3, and 7 (Fig. 5.15) make up the ORNL PAM network. Sampling is conducted at each ORNL station to quantify levels of tritium; adsorbable gases (e.g., iodine); and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.15).

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. Following the filter is a charcoal cartridge that collects adsorbable gases and is collected and analyzed bi-weekly. A silica-gel column is used for collection of tritium as tritiated water. These samples are collected biweekly or weekly and composited quarterly for tritium analysis.

### 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 5.15) are compared with the derived concentration guides (DCGs) for air established by DOE as reference values for conducting radiological environmental protection programs at DOE sites. (DCGs are listed in DOE Order 5400.5.) Average radionuclide concentrations measured for the ORNL network were less than 1% of the applicable DCG in all cases.

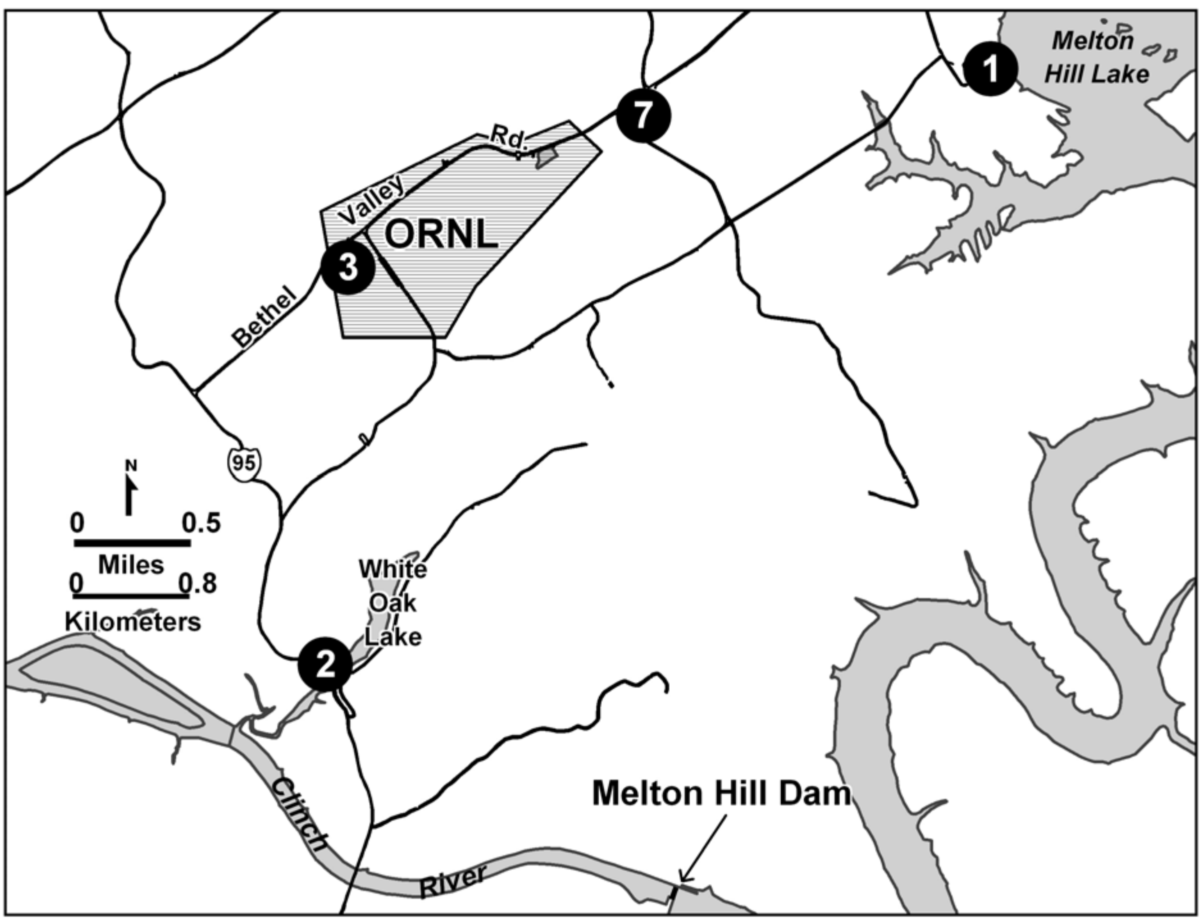



**Fig. 5.15. Locations of ambient air monitoring stations at Oak Ridge National Laboratory.**

**Table 5.15. Radionuclide concentrations (pCi/mL)[a] measured at Oak Ridge National Laboratory perimeter air monitoring stations, 2007**

| Parameter | No. detected/sampled | Concentration | | |
|---|---|---|---|---|
| | | Average | Minimum | Maximum |
| | | **Station 1** | | |
| Alpha | 1/1 | 6.28E–09 | [b] | [b] |
| $^{7}$Be | 1/1 | 2.53E–08 | [b] | [b] |
| Beta | 1/1 | 1.83E–08 | [b] | [b] |
| $^{3}$H | 0/4 | 1.66E–08 | –1.71E–06 | 2.91E–06 |
| $^{40}$K | 26/26 | 3.12E–07 | 1.48E–07 | 4.67E–07 |
| $^{234}$U | 1/1 | 8.96E–12 | [b] | [b] |
| $^{235}$U | 0/1 | –3.20E–13 | [b] | [b] |
| $^{238}$U | 1/1 | 9.49E–12 | [b] | [b] |
| Total uranium | 1/1 | 1.81E–11 | [b] | [b] |
| | | **Station 2** | | |
| Alpha | 1/1 | 1.15E–09 | [b] | [b] |
| $^{7}$Be | 1/1 | 2.48E–08 | [b] | [b] |
| Beta | 1/1 | 1.88E–08 | [b] | [b] |
| $^{3}$H | 3/4 | 5.69E–06 | 1.82E–06 | 9.80E–06 |
| $^{40}$K | 26/26 | 3.24E–07 | 1.06E–07 | 5.93E–07 |
| $^{234}$U | 1/1 | 8.15E–12 | [b] | [b] |
| $^{235}$U | 0/1 | 9.19E–13 | [b] | [b] |
| $^{238}$U | 1/1 | 1.40E–11 | [b] | [b] |
| Total uranium | 1/1 | 2.31E–11 | [b] | [b] |
| | | **Station 3** | | |
| Alpha | 1/1 | 1.52E–09 | [b] | [b] |
| $^{7}$Be | 1/1 | 1.62E–08 | [b] | [b] |
| Beta | 1/1 | 1.40E–08 | [b] | [b] |
| $^{3}$H | 0/4 | 1.00E–09 | –7.51E–07 | 6.96E–07 |
| $^{40}$K | 26/26 | 2.94E–07 | 1.45E–07 | 4.80E–07 |
| $^{234}$U | 1/1 | 6.75E–12 | [b] | [b] |
| $^{235}$U | 0/1 | 1.14E–12 | [b] | [b] |
| $^{238}$U | 1/1 | 9.41E–12 | [b] | [b] |
| Total uranium | 1/1 | 1.73E–11 | [b] | [b] |
| | | **Station 7** | | |
| Alpha | 1/1 | 1.14E–09 | [b] | [b] |
| $^{7}$Be | 1/1 | 2.62E–08 | [b] | [b] |
| Beta | 1/1 | 1.84E–08 | [b] | [b] |
| $^{3}$H | 1/4 | 4.04E–06 | 2.32E–06 | 6.29E–06 |
| $^{40}$K | 26/26 | 3.38E–07 | 1.80E–07 | 5.42E–07 |
| $^{234}$U | 1/1 | 1.39E–11 | [b] | [b] |
| $^{235}$U | 0/1 | 1.43E–13 | [b] | [b] |
| $^{238}$U | 1/1 | 1.14E–11 | [b] | [b] |
| Total uranium | 1/1 | 2.54E–11 | [b] | [b] |

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

# 5.5 Water Quality Program

## 5.5.1 NPDES/Surface Water

### 5.5.1.1 NPDES Permit Monitoring

ORNL's wastewater discharges are monitored and regulated under NPDES Permit TN0002941, which went into effect on February 3, 1997, and was renewed by TDEC on December 6, 1996. The permit includes 164 separate outfalls and monitoring points. Data collected to meet the requirements of the permit are submitted to the state of Tennessee in the monthly NPDES Discharge Monitoring Report.

The ORNL NPDES Permit requires sampling of point-source outfalls before their discharge into receiving waters or before being mixed with any other wastewater stream (see Fig. 5.16). Under the existing permit, there are numeric and narrative effluent limits applied at the following locations:

- X01—Sewage Treatment Plant;
- X02—Coal Yard Runoff Treatment Facility (CYRTF);
- X12—Process Waste Treatment Complex (PWTC);
- X13—Melton Branch (MB1);
- X14—White Oak Creek (WOC);
- X15—White Oak Dam (WOD);
- instream chlorine monitoring points (X16–X26);
- steam condensate outfalls;
- groundwater from building foundation drains;
- Category I outfalls (storm drains, water discharged under best management practices, groundwater, steam, and water condensate);
- Category II outfalls (storm drains, water discharged under best management practices, groundwater, steam, and water condensate);
- Category III outfalls (storm drains, water discharged under best management practices, groundwater, steam, water condensate, cooling water, and cooling tower blowdown);
- Category IV outfalls (storm drains, water discharged under best management practices, groundwater, steam, water condensate, cooling water, and cooling tower blowdown); and
- cooling systems (cooling water and cooling tower blowdown).

Permit limits and compliance statistics are shown in Table 5.16. Instream data collection points X-13, X-14, and X-15 are not included in the table because only flow measurements and narrative conditions are required at these three points.

The current permit also requires ORNL to conduct detailed characterization of numerous storm water outfalls, develop and implement a radiological monitoring plan, develop and implement a storm water pollution prevention plan, implement a revised Biological Monitoring and Abatement Program (BMAP) plan, and develop and implement a chlorine-control strategy. These programs are discussed in the following sections.

On November 3, 2003, the TDEC Division of Water Pollution Control issued NPDES permit TN0077895 for wastewater discharges at the SNS site. This permit became effective on December 1, 2003, and authorized DOE to discharge cooling tower blowdown and heating, ventilation, and air-conditioning condensate water from the SNS to a storm water detention pond that discharges to WOC at approximate stream mile 4.2 through outfall 435. The SNS Permit also includes the pond emergency spillway, designated as outfall 437, which discharges in large storm runoff situations to mile 0.6 of a tributary to WOC. The SNS began discharging blowdown waters to the retention pond in December 2003. Since then, UT-Battelle has been fully compliant with all permit limits established for the SNS (see Table 5.17). The current NPDES permit expired on October 31, 2006. An application for renewal was

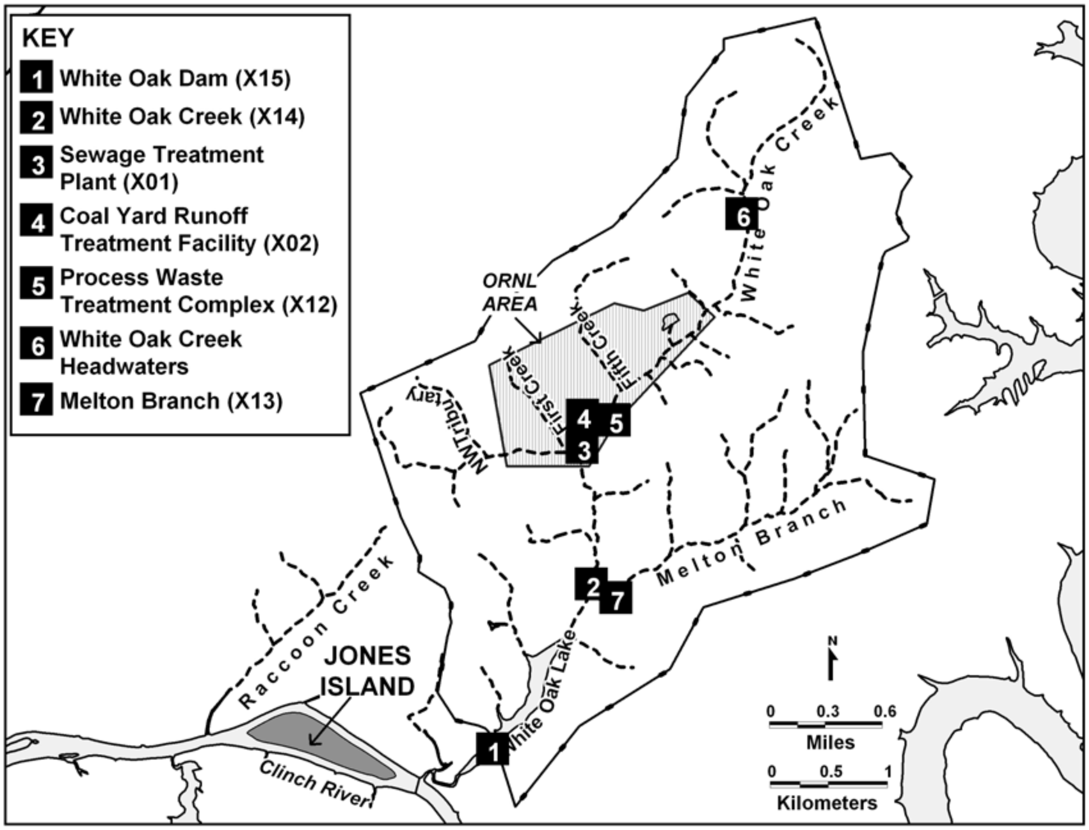



**Fig. 5.16. Oak Ridge National Laboratory surface water, National Pollutant Discharge Elimination System, and reference sampling locations.**

submitted to and received by the TDEC on April 19, 2006. When the overall NPDES permit for the ORNL site is renewed, the SNS outfalls will be included into the site permit, and the separate SNS NPDES permit will be cancelled.

### 5.5.1.2 Chlorine Control Strategy

The NPDES permit regulates the discharge of chlorinated water at ORNL by setting either total residual chlorine concentration limits or total residual oxidant mass-loading action levels, depending on outfall location and the volume of discharge. At ORNL, total residual oxidant measurements may include both chlorine and bromine residuals. Most outfalls with total residual oxidant mass-loading action levels are monitored semiannually; the rest are monitored either weekly, semimonthly, or quarterly. Numerous outfalls with no dry-weather total residual oxidant discharges were dropped from the Chlorine Control Strategy during the duration of the NPDES permit. Outfalls included in the Chlorine Control Strategy have a mass-loading action level for total residual oxidants that requires ORNL to reduce or eliminate total residual oxidants in the discharge if they exceed the action level. The 1.2-g/d action level is calculated by multiplying the instantaneously measured concentration by the instantaneous flow rate of the outfall.

ORNL monitored 145 measurable dry-weather discharges during 2007 at 24 outfalls. The action level was exceeded eight times at four outfalls. A report detailing monitoring results, corrective actions, and proposed modifications is submitted to TDEC annually.

**Table 5.16. National Pollutant Discharge Elimination System (NPDES) compliance at Oak Ridge National Laboratory, 2007**

NPDES permit effective February 3, 1997

| Effluent parameters[a] | Permit limits | | | | | Permit compliance | | |
|---|---|---|---|---|---|---|---|---|
| | Monthly average (kg/d) | Daily max. (kg/d) | Monthly average (mg/L) | Daily max. (mg/L) | Daily min. (mg/L) | Number of noncompliances | Number of samples | Percentage of compliance[b] |
| **X01 (Sewage Treatment Plant)** | | | | | | | | |
| $LC_{50}$ for *Ceriodaphnia* (%) | | | | | 41.1 | 0 | 4 | 100 |
| $LC_{50}$ for fathead minnows (%) | | | | | 41.1 | 0 | 4 | 100 |
| Ammonia, as N (summer) | 2.84 | 4.26 | 2.5 | 3.75 | | 0 | 80 | 100 |
| Ammonia, as N (winter) | 5.96 | 8.97 | 5.25 | 7.9 | | 0 | 76 | 100 |
| Carbonaceous BOD | 8.7 | 13.1 | 10 | 15 | | 0 | 156 | 100 |
| Dissolved oxygen | | | | | 6 | 0 | 156 | 100 |
| Fecal coliform (col/100 mL) | | | 1000 | 5000 | | 0 | 156 | 100 |
| NOEC for *Ceriodaphnia* (%) | | | | | 12.3 | 0 | 4 | 100 |
| NOEC for fathead minnows (%) | | | | | 12.3 | 0 | 4 | 100 |
| Oil and grease | 8.7 | 13.1 | 10 | 15 | | 0 | 156 | 100 |
| pH (std. units) | | | | 9 | 6 | 0 | 156 | 100 |
| Total residual chlorine | | | 0.038 | 0.066 | | 0 | 156 | 100 |
| Total suspended solids | 26.2 | 39.2 | 30 | 45 | | 0 | 156 | 100 |
| **X02 (Coal Yard Runoff Treatment Facility)** | | | | | | | | |
| $LC_{50}$ for *Ceriodaphnia* (%) | | | | | 4.2 | 0 | 4 | 100 |
| $LC_{50}$ for fathead minnows (%) | | | | | 4.2 | 0 | 4 | 100 |
| Copper, total | | | 0.07 | 0.11 | | 0 | 24 | 100 |
| Iron, total | | | 1.0 | 1.0 | | 2[c] | 24 | 91.7 |
| NOEC for *Ceriodaphnia* (%) | | | | | 1.3 | 0 | 0[d] | 100 |
| NOEC for fathead minnows (%) | | | | | 1.3 | 0 | 0[d] | 100 |
| Oil and grease | | | 10 | 15 | | 0 | 52 | 100 |
| pH (std. units) | | | | 9.0 | 6 | 0 | 52 | 100 |
| Selenium, total | | | 0.22 | 0.95 | | 0 | 24 | 100 |
| Silver, total | | | | 0.008 | | 0 | 24 | 100 |
| Total suspended solids | | | | 50 | | 0 | 52 | 100 |
| Zinc, total | | | 0.87 | 0.95 | | 0 | 24 | 100 |

**Table 5.16** (continued)

| Effluent parameters[a] | Permit limits | | | | | Permit compliance | | |
|---|---|---|---|---|---|---|---|---|
| | Monthly average (kg/d) | Daily max (kg/d) | Monthly average (mg/L) | Daily max (mg/L) | Daily min (mg/L) | Number of noncompliances | Number of samples | Percentage of compliance[b] |
| **X12 (Process Waste Treatment Complex)** | | | | | | | | |
| $LC_{50}$ for *Ceriodaphnia* (%) | | | | | 100 | 0 | 4 | 100 |
| $LC_{50}$ for fathead minnows (%) | | | | | 100 | 0 | 4 | 100 |
| Cadmium, total | 0.79 | 2.09 | 0.008 | 0.034 | | 0 | 52 | 100 |
| Chromium, total | 5.18 | 8.39 | 0.22 | 0.44 | | 0 | 52 | 100 |
| Copper, total | 6.27 | 10.24 | 0.07 | 0.11 | | 0 | 52 | 100 |
| Cyanide, total | 1.97 | 3.64 | 0.008 | 0.046 | | 0 | 4 | 100 |
| Lead, total | 1.3 | 2.09 | 0.028 | 0.69 | | 0 | 52 | 100 |
| Nickel, total | 7.21 | 12.06 | 0.87 | 3.98 | | 0 | 52 | 100 |
| NOEC for *Ceriodaphnia* (%) | | | | | 30.9 | 0 | 4 | 100 |
| NOEC for fathead minnows (%) | | | | | 30.9 | 0 | 4 | 100 |
| Oil and grease | 30.3 | 45.4 | 10 | 15 | | 0 | 52 | 100 |
| pH (std. units) | | | | 9.0 | 6.0 | 0 | 156 | 100 |
| Silver, total | 0.73 | 1.3 | | 0.008 | | 0 | 52 | 100 |
| Temperature (ºC) | | | | 30.5 | | 0 | 156 | 100 |
| Total toxic organics | | 6.45 | | 2.13 | | 0 | 12 | 100 |
| Zinc, total | 4.48 | 7.91 | 0.87 | 0.95 | | 0 | 52 | 100 |
| **Instream chlorine monitoring points** | | | | | | | | |
| Total residual oxidant | | | 0.011 | 0.019 | | 0 | 264 | 100 |
| **Steam condensate outfalls** | | | | | | | | |
| pH (std. units) | | | | 9.0/8.5 | 6.0/6.5 | 0 | 16 | 100 |
| **Groundwater/pumpwater outfalls** | | | | | | | | |
| pH (std. units) | | | | 9.0/8.5 | 6.0/6.5 | 0 | 6 | 100 |
| **Cooling tower blowdown outfalls** | | | | | | | | |
| pH (std. units) | | | | 9.0 | 6.0 | 0 | 4 | 100 |
| **Category I outfalls** | | | | | | | | |
| pH (std. units) | | | | 9.0 | 6.0 | 0 | 16 | 100 |
| **Category II outfalls** | | | | | | | | |
| pH (std. units) | | | | 9.0 | 6.0 | 0 | 18 | 100 |
| **Category III outfalls** | | | | | | | | |
| pH (std. units) | | | | 9.0 | 6.0 | 0 | 53 | 100 |
| **Category IV outfalls** | | | | | | | | |
| pH (std. units) | | | | 9.0 | 6.0 | 0 | 335 | 100 |

**Table 5.16** (continued)

| Effluent parameters[a] | Permit limits | | | | | Permit compliance | | |
|---|---|---|---|---|---|---|---|---|
| | Monthly average (kg/d) | Daily max (kg/d) | Monthly average (mg/L) | Daily max (mg/L) | Daily min (mg/L) | Number of noncompliances | Number of samples | Percentage of compliance[b] |
| **Cooling tower blowdown/cooling water outfalls** | | | | | | | | |
| pH (std. units) | | | | 9.0 | 6.0 | 0 | 49 | 100 |
| Total residual oxidant | | | 0.011 | 0.019 | | 0 | 49 | 100 |

[a]Abbreviatons:

$LC_{50}$ = the concentration (as a percentage of full-strength wastewater) that kills 50% of the test species in 96 h.

BOD=biological oxygen demand.

NOEC = no-observed-effect concentration; the concentration as a percentage of full-strength wastewater that caused no reduction in Ceriodaphnia survival or reproduction or fathead minnow survival or growth.

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

[c]The iron measurement from January 11, 2007, resulted in a daily max. concentration exceedance and an average monthly concentration exceedance.

[d]Insufficient discharge for chronic test and determination of no-observed-effect concentration for each of the quarterly tests.

**Table 5.17. National Pollutant Discharge Elimination System (NPDES) compliance at Spallation Neutron Source, 2007**
NPDES permit effective December 1, 2003

| Effluent parameters | Permit limits | | | | | Permit compliance | | |
|---|---|---|---|---|---|---|---|---|
| | Monthly average (kg/d) | Daily max. (kg/d) | Monthly average (mg/L) | Daily max. (mg/L) | Daily min. (mg/L) | Number of noncompliances | Number of samples | Percentage of compliance[a] |
| pH (std. units) | | | | 9 | 6.5 | 0 | 105 | 100 |
| Total residual chlorine | | | 0.011 | 0.019 | | 0 | 105 | 100 |

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

### 5.5.1.3 Storm Water Pollution Prevention

The ORNL NPDES Permit requires an SWP3 to document existing material management practices and to evaluate the vulnerability of those practices in contributing pollutants to area streams via storm water runoff. The plan consists of four major components:

- assessment and mapping of outdoor material storage/handling at ORNL,
- characterization of storm water runoff by monitoring,
- training of employees, and
- implementation of measures to minimize storm water pollution in areas of ORNL that may be vulnerable.

These four components of the plan were initiated in 1997 and are reviewed and updated by the facility at least annually. The SWP3 was last revised in August 2007. The document is available to personnel on the ORNL internal web.

For sampling purposes, storm water outfalls are grouped into four broad categories based on common land uses or pollutant sources and storm water pollutant potential. These four groups are further subdivided based on permit categorizations that have different monitoring schedule requirements. The permit requires that Category I and II outfalls be characterized over a 5-year period and that Category III and IV outfalls be characterized over a 3-year period. The outfalls chosen to be sampled are thought to be representative of the group or were thought to be more vulnerable to runoff pollution. Other factors considered in selecting representative outfalls from each group include interest in a particular runoff quality at an outfall and ease of obtaining a representative sample. A rotation of representative outfalls occurs each sampling period as directed by the permit. The results of the storm water outfall effluent sampling are provided in Attachment 5.0 of the storm water pollution prevention plan. Various water-quality reference values are used to compare to ORNL storm water data collected under this SWP3 program for purposes of better characterizing outfalls and for targeting additional actions such as focused investigations into storm water pollution sources, monitoring, or best management practices. One such reference includes report levels adopted by the TDEC Multi-Sector General Storm Water Permit for Industrial Activities, which are developed specific to “sectors” or classifications of industrial activity. ORNL storm water data have been consistently lower than TDEC report levels for applicable sectors.

Reference values also include a summary of typical concentrations of pollutants compiled in a published study that undertook an international literature search of all storm water research that had been published in the 25 years prior to 1995 and that identified and quantified contaminant parameters. Although ORNL is an industrial setting, many attributes of its watersheds are comparable to urban watersheds such as its green spaces, traffic areas, large parking lots, office buildings, and a wide variety of potential storm water pollutants. ORNL’s storm water data generally lie in between but toward the lower end of the broad concentration ranges published in the study.

Qualitative observations from a comparison between outfall storm water data collected to date show that grab samples generally have higher concentrations of analytes than flow-proportional composite samples. This is expected since grab samples are designed to collect and characterize the “first-flush” runoff from a watershed.

The EPA Nationwide Urban Runoff Program was developed to expand the understanding of urban runoff pollution by instituting data collection and applied research projects in U.S. urban areas. Urban storm-water runoff pollutant-loading factors for 10 standard water quality constituents, called “event mean concentrations” (EMCs), were developed for the 1983 program’s final report. Program findings were updated in 1999 by using results of storm water data collected by the U.S. Geological Survey and the NPDES Storm Water Program to refine the EMCs. A formal National Storm Water Quality Database (Version 1.1) was published in February 2004. This latest publication includes industrial median values that target land use components typical of industry.

In a comparison of ORNL storm water data with data from the Nationwide Storm Water Quality Database, most values for the conventional storm water quality constituents measured are well below the Industrial EMCs. Patterns of values exceeding the industrial EMCs can be generalized by exceedances of copper, nitrate/nitrite, or zinc. Copper is natural in the soils and could also occur from coal-burning activities or corrosion of copper pipes. Nitrate is an inorganic form of nitrogen in water solution that can be attributed to the breakdown of many nitrogen-bearing sources (e.g., fertilizers, organic decay). Zinc can be attributed to vehicular degradation. There were also a few exceedances of suspended solids that can probably be attributed to the numerous construction projects in and around the main ORNL campus.

### 5.5.1.4 Radiological Monitoring Plan

ORNL monitors radioactivity at NPDES outfalls that have the potential to discharge radioactivity and at instream monitoring stations under a radiological monitoring plan required by Part III, Sect. J, of the ORNL NPDES permit. The current version of the plan was implemented on November 1, 1999. Table 5.18 details the monitoring frequency and target analyses for 27 category outfalls (dry-weather component of discharge), 3 treatment facility outfalls, and 3 instream monitoring locations.

Category outfalls are outfalls that discharge effluents with relatively minor constituents that receive little or no treatment prior to discharge. Dry-weather discharges from category outfalls are primarily cooling water, groundwater, and condensate. In 2007, dry-weather grab samples were collected at 20 of the 27 category outfalls. The remaining seven outfalls were not sampled, either because they are no longer in service, there was no discharge, or they were otherwise unable to be sampled during sampling attempts.

**Table 5.18. Oak Ridge National Laboratory National Pollutant Discharge Elimination System Radiological Monitoring Plan**

| Location | Frequency | Gross alpha[a] | Gross beta[a] | Gamma scan | Tritium | Total rad Sr | Isotopic uranium | Carbon 14 |
|---|---|---|---|---|---|---|---|---|
| Outfall 001 | Annually | X | | | | | | |
| Outfall 080 | Monthly | X | X | X | X | X | | |
| Outfall 081 | Annually | | X | | | | | |
| Outfall 085 | Quarterly | X | X | | | X | X | |
| Outfall 086[b] | When discharges | | X | | X | | | |
| Outfall 087 | Annually | | X | X | | | | |
| Outfall 203 | Annually | | X | | | | | |
| Outfall 204 | Quarterly | X | X | | | X | | |
| Outfall 205 | Annually | | X | | | | | |
| Outfall 207 | Quarterly | X | X | X | | X | | |
| Outfall 211 | Quarterly | | X | | | X | | |
| Outfall 217 | Annually | | X | | | | | |
| Outfall 219 | Annually | | X | | | | | |
| Outfall 234 | Annually | X | | | | | | |
| Outfall 241[c] | Annually | | X | | | | | |
| Outfall 265 | Annually | | X | X | | | | |
| Outfall 281 | Quarterly | X | X | X | X | | | |
| Outfall 282 | Quarterly | X | X | | | | | |
| Outfall 284[c] | Annually | | X | | | | | |
| Outfall 290[c] | Annually | | | X | | | | |
| Outfall 302 | Monthly | X | X | X | X | X | | |
| Outfall 304 | Monthly | X | X | X | X | X | | |
| Outfall 365 | Quarterly | X | X | | | | | |
| Outfall 368 | Quarterly | X | X | X | | | | |
| Outfall 381[d] | Quarterly | | X | X | X | | | |
| Outfall 382[e] | Annually | | X | X | | | | |
| Outfall 383 | Annually | | X | | X | | | |
| Sewage Treatment Plant (X01) | Monthly | X | X | | X[f] | X | | X[f] |
| Coal Yard Runoff Treatment Facility (X02) | Monthly | X | X | | | | | |
| Process Waste Treatment Complex (X12) | Monthly | X | X | X | X | X | X | |
| Melton Branch 1 (X13) | Monthly | X | X | X | X | X | | |
| WOC (X14) | Monthly | X | X | X | X | X | | |
| WOD (X15) | Monthly | X | X | X | X | X | | |

[a]Isotopic analyses are performed to identify contributors to gross activities when results exceed screening criteria described in the *Radiological Monitoring Plan*, June 1999.

[b]Outfall no longer exists.

[c]No discharge present.

[d]Physically removed in late 2004; eliminated as part of the HFIR ponds remediation project.

[e]No longer discharges (plugged).

[f]Added to the plan in January 2006.

The three treatment facilities included in the ORNL radiological monitoring plan are the Sewage Treatment Plant (STP), the CYRTF, and the PWTC. Three instream monitoring locations are: X13 on Melton Branch, X14 on WOC, and X15 at WOD (Fig. 5.16). At each of these treatment facilities and instream monitoring stations, monthly flow-proportional composite samples are collected using dedicated automatic water samplers.

Expressing radioactivity concentrations as percentage of the DOE DCG values is used in this section as a means of comparing effluent points with different radioisotope signatures. Annual average concentrations were compared with DCG concentrations where applicable (there are no DCGs for gross alpha and gross beta activities) and when at least one individual measurement indicated detectable activity (i.e., at least one individual measurement had a concentration greater than or equal to the measurement's minimum detectable activity [MDA]). For analyses that cannot differentiate between two radioisotopes (e.g., $^{89/90}$Sr), and for radioisotopes that have more than one DCG for different gastrointestinal tract absorption factors, the most restrictive (lowest) DCG was used in the comparisons. DCGs are not intended to be thresholds for instream values as they are for effluents, but are nonetheless useful as a frame of reference. Effluents and instream concentrations are compared to DCGs that were calculated for exposures to humans by ingesting water, but their use in this section does not imply that ORNL effluents or ambient waters are sources of drinking water.

In 2007, measured annual average concentrations of radioactivity equaling or exceeding 100% of DCG concentrations were measured at outfall 080. Weekly sampling attempts were made at this outfall, but due to the intermittent nature of the discharge, effluent was found on only two sample occasions. The average of two measurements of $^{243/244}$Cm at outfall 080 was 250 pCi/L (4.2 times the DCG for $^{244}$Cm or 5 times the DCG for $^{243}$Cm). Although the analytical test does not differentiate between $^{243}$Cm and $^{244}$Cm, it is believed that most of the activity is from the $^{244}$Cm isotope. In 2007, the average $^{243/244}$Cm concentration was down considerably from the 2006 average concentration of 1,100 pCi/L. In addition to $^{243/244}$Cm, the average concentrations of $^{241}$Am, $^{239/240}$Pu, and $^{89/90}$Sr were also notable: 21%, 11%, and 12% of their respective DCGs. The flow rates at outfall 080 during both 2007 sample collections were 0.1 gal/min. Therefore, no significant changes in contaminant concentrations have been detected in downstream monitoring. It was reported in the previous ASER that in 2006, when concentrations were higher, the contamination was within the target human health risk range for the Record of Decision for Interim Actions in Melton Valley. It was also reported that the increase in contaminant concentrations at outfall 080 was thought to be caused by a previously unknown release from a nearby remediation activity—the grouting of an abandoned waste pipeline. That is still thought to be true. In 2007, concentrations of radioactivity in the outfall 080 effluent declined notably from 2006 levels, consistent with the theory of a one-time short-duration release.

In addition to outfall 080, the annual average concentration of at least one radionuclide exceeded 4% of the relevant DCG concentration in dry-weather discharges from seven other NPDES outfalls (X01, X02, X12, 085, 204, 302, and 304) and at instream sampling locations X13 and X15 (Fig. 5.17). Four percent of the DCG is roughly equivalent to the 4-mrem dose limit on which the EPA radionuclide drinking water standards are based (4% of a DCG is a convenient comparison point, but it should not be concluded that ORNL effluents or ambient waters are direct sources of drinking water). The annual average concentration of $^{89/90}$Sr in the ORNL STP Discharge (outfall X01) was 9.7% of the DCG. In CYRTF effluent (outfall X02), $^{40}$K was present at 5.6% of its DCG, and $^{89/90}$Sr was present at 12% of its DCG. Concentrations of three radionuclides measured in the discharge from the PWTC (outfall X12) were greater than 4% of the DCG: $^{137}$Cs (13%), $^{89/90}$Sr (5.2%), and tritium (15%). In addition to outfall 080 (discussed in the paragraph above), four category outfalls had measured concentrations of a parameter greater than 4% of a DCG: outfall 085 ($^{89/90}$Sr, 11%), outfall 204 ($^{89/90}$Sr, 6.9%), outfall 302 ($^{89/90}$Sr, 14%), and outfall 304 ($^{89/90}$Sr, 25%). At the instream monitoring station on Melton Branch (Location X13), $^{89/90}$Sr was measured at 4.4% of the DCG, and at the X15 monitoring station at WOD, $^{89/90}$Sr was measured at 4.9% of the DCG.

The amounts of radioactivity in stream water passing WOD, the final monitoring point on WOC before the stream flow leaves ORNL, were calculated from concentration and flow. The total annual

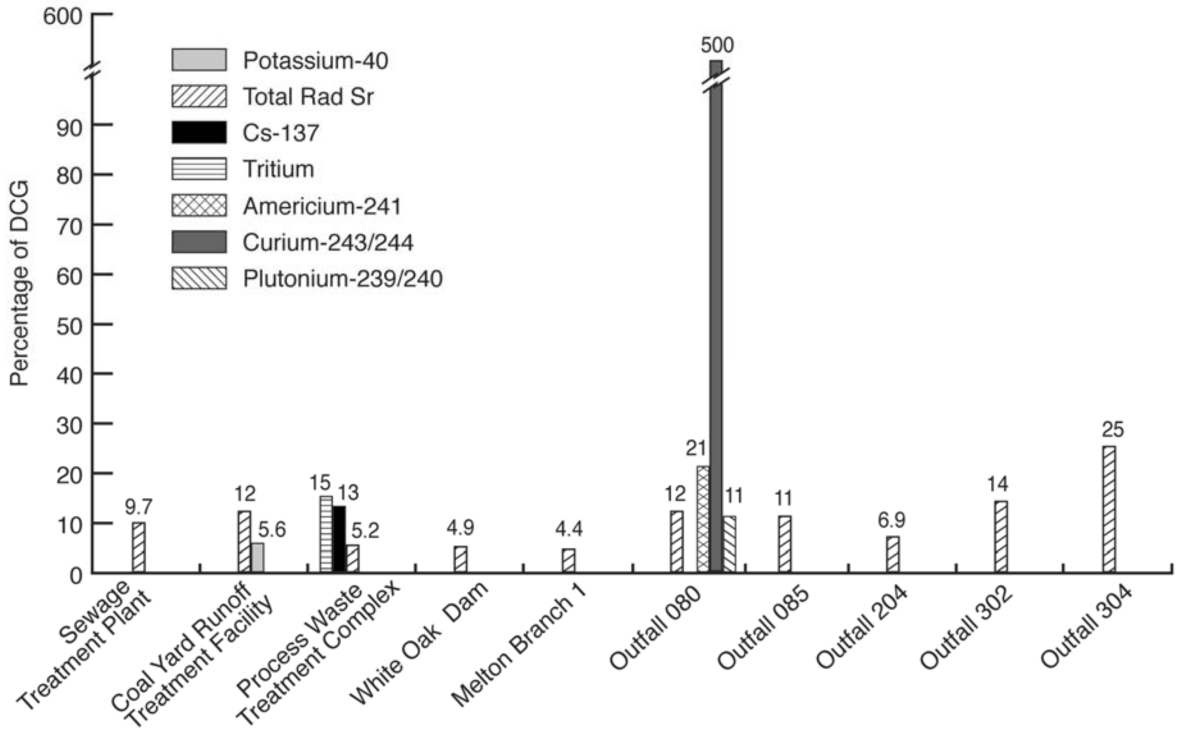



**Fig. 5.17. Radionuclides at Oak Ridge National Laboratory sampling sites having average concentrations greater than 4% of the relevant derived concentration guides in 2007.**

discharges (or amounts) of radioactivity released at WOD during each of the past 5 years are shown in Figs. 5.18 through 5.22. The amounts of radioactivity passing this monitoring station in 2007 show a general decrease in comparison to previous years. The reductions presumably result from the completion of waste area caps in Melton Valley.

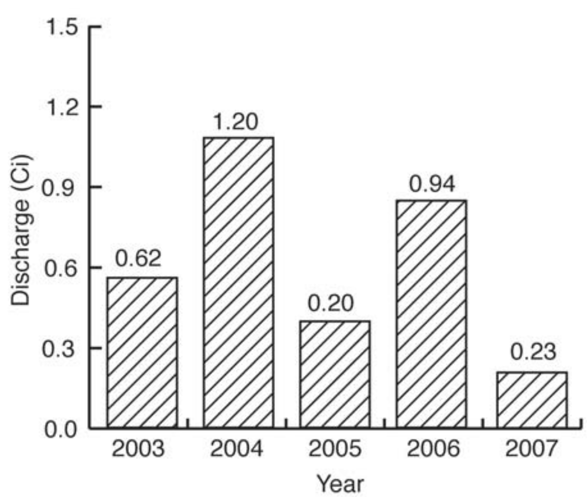



**Fig. 5.18. Cesium-137 discharges at White Oak Dam, 2003–2007.**

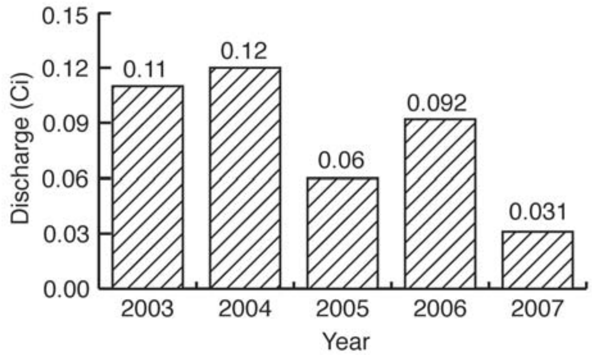



**Fig. 5.19. Gross alpha discharges at White Oak Dam, 2003–2007.**

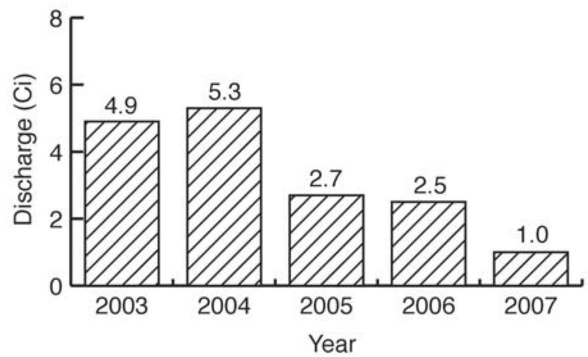



**Fig. 5.20. Gross beta discharges at White Oak Dam, 2003–2007.**

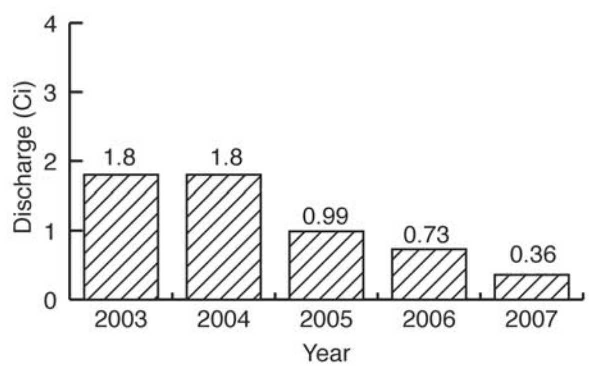



**Fig. 5.21. Total radioactive strontium discharges at White Oak Dam, 2003–2007.**

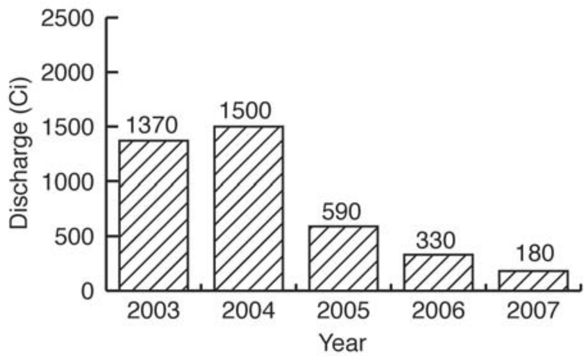



**Fig. 5.22. Tritium discharges at White Oak Dam, 2003–2007.**

The ORNL Radiological Monitoring Plan also includes monitoring of radioactivity at category outfalls during storm runoff conditions. A total of 20 storm water outfalls were monitored in CY 2007. Storm water samples are analyzed for gross alpha, gross beta, and tritium activities. A gamma scan is also routinely performed. Additional analyses are added when there is enough gross alpha and/or gross beta activity in an outfall's discharges to indicate that DCG levels may be exceeded. In 2007, additional analyses were performed on samples from one outfall—outfall 302—in an attempt to identify the radioisotopes contributing to the gross alpha activities in the sample. The gross alpha activity in this storm water sample was found to be from uranium isotopes, particularly $^{233/234}$U, which is consistent with dry weather monitoring results.

Of the 105 individual storm water sample results collected in 2007, 89 (85%) showed no detectable activity (measured activities were less than the MDAs of the tests). Concentrations of radioactivity in storm water discharges were compared with DCGs if a DCG existed for that parameter (there are no DCGs for gross alpha and gross beta activities) and if the concentration was greater than or equal to the MDA for the measurement. One outfall had a measurement of radionuclide concentrations in storm water that was greater than 4% of DCG levels: at outfall 302, $^{89/90}$Sr was measured at 76% of the DCG.

### 5.5.1.5 Biomonitoring

Under the NPDES permit, wastewaters from the STP, the Steam Plant Wastewater Treatment Facility (SPWTF), and the PWTC were evaluated for toxicity during 2007. The results of the toxicity tests of wastewaters from the three treatment facilities are given in Table 5.19, which provides, for each wastewater location, the month the test was conducted, the wastewater's no-observed-effect concentration (NOEC), and the concentration that kills 50% of the test organisms ($LC_{50}$) for fathead minnows (*Pimephales promelas*) and daphnia (*Ceriodaphnia dubia*). The NOEC is the highest concentration tested that does not significantly reduce survival or growth of fathead minnows or survival or reproduction of *Ceriodaphnia*. The 96-h $LC_{50}$ is the concentration of wastewater that kills 50% of the test organisms in 96 h. The NPDES permit defines the limits for the biomonitoring tests. For the outfall X01 (STP) discharge, toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 h in 41.1% effluent or if the NOEC is less than 12.3%. For the outfall X02 discharge (SPWTF), toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 h in 4.2% effluent or if the NOEC is less than 1.3%. Because of the batch mode of discharge at the SPWTF, the limit for the NOEC applies only if the facility discharges for a sufficient length of time. For the outfall X12 discharge (PWTC), toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 h in 100% effluent ($LC_{50}$) or if the NOEC is less than 30.9%.

During 2007, the STP, SPWTF, and PWTC were each tested four times. Numeric biomonitoring limits in the NPDES permit were met in all cases.

**Table 5.19. Toxicity test results of Oak Ridge National Laboratory wastewaters, 2007**

| Test date | Test species | NOEC[a] | $LC_{50}$[b] |
|---|---|---|---|
| **Sewage Treatment Plant (outfall X01)** | | | |
| January | *Ceriodaphnia* | 41.1 | >41.1 |
| | Fathead minnow | 41.1 | >41.1 |
| May | *Ceriodaphnia* | 32.9 | >41.1 |
| | Fathead minnow | 41.1 | >41.1 |
| July | *Ceriodaphnia* | 41.1 | >41.1 |
| | Fathead minnow | 41.1 | >41.1 |
| November | *Ceriodaphnia* | 41.1 | >41.1 |
| | Fathead minnow | 41.1 | >41.1 |
| **Steam Plant Wastewater Treatment Facility (outfall X02)** | | | |
| January | *Ceriodaphnia* | NA[c] | >4.2[d] |
| | Fathead minnow | NA[c] | >4.2[d] |
| May | *Ceriodaphnia* | NA[c] | >4.2[d] |
| | Fathead minnow | NA[c] | >4.2[d] |
| July | *Ceriodaphnia* | NA[c] | >4.2[d] |
| | Fathead minnow | NA[c] | >4.2[d] |
| November | *Ceriodaphnia* | NA[c] | >4.2 |
| | Fathead minnow | NA[c] | >4.2 |
| **Process Waste Treatment Complex (outfall X12)** | | | |
| January | *Ceriodaphnia* | 100 | >100 |
| | Fathead minnow | 100 | >100 |
| May | *Ceriodaphnia* | 100 | >100 |
| | Fathead minnow | 100 | >100 |
| July | *Ceriodaphnia* | 80 | >100 |
| | Fathead minnow | 100 | >100 |
| November | *Ceriodaphnia* | 100 | >100 |
| | Fathead minnow | 100 | >100 |

[a]NOEC = no-observed-effect concentration; the concentration (as percentage of full-strength wastewater) that caused no reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth.

[b]$LC_{50}$ = the concentration (as percentage of full-strength wastewater) that kills 50% of the test species in 96 h.

[c]Insufficient duration of discharge for chronic test and determination of NOEC.

[d]48-h $LC_{50}$.

## 5.5.1.6 Biological Monitoring and Abatement Program

The BMAP is a requirement of the NPDES Permit to assess the condition of aquatic life in WOC, the northwest tributary of WOC, Melton Branch, Fifth Creek, and First Creek. The results for bioaccumulation and macroinvertebrate and fish community studies in the WOC watershed for the BMAP in 2007 are summarized in the following sections.

### 5.5.1.6.1 Bioaccumulation Studies

The bioaccumulation task for the BMAP addresses two NPDES permit requirements at ORNL: (1) evaluate whether mercury (Hg) at the site is contributing to a stream so that it will impact fish and aquatic life or violate the recreational criteria (instream water analyses for mercury should be part of this activity), and (2) monitor the status of PCB contamination in fish tissue in the WOC watershed.

### 5.5.1.6.1.1 Mercury in Water

In continuation of a monitoring effort initiated in 1997, bimonthly water samples were collected from WOC at four sites in 2007. Stream conditions were selected to be representative of seasonal base-flow conditions (dry weather, clear flow) based on historical results that indicated higher mercury concentrations under these conditions.

Highest mercury concentrations (108 ± 33 ng/L, mean ± SD) were consistently observed at WCK 4.1, a short distance downstream from the Building 4500 complex at ORNL. Dilution reduced waterborne mercury to 49 ± 23 ng/L at WCK 3.4 (the upper limit of the BMAP fish bioaccumulation site in WOC). Average mercury concentration in the White Oak Lake (WOL) discharge was 45 ± 17 ng/L in 2007. Long-term trends in waterborne mercury concentrations in the WOC system show little change over the past 7 years (Fig. 5.23), but the recent (December 2007) reroute of a highly contaminated sump discharge to a treatment plant is expected to result in a decrease in waterborne mercury throughout the system in 2008.

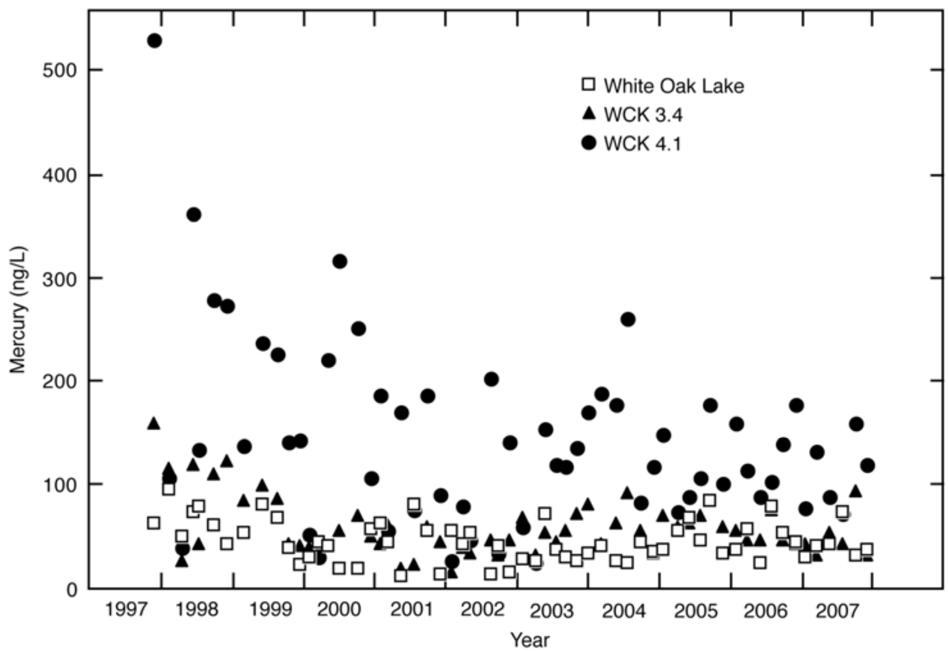



**Fig. 5.23. Total aqueous mercury concentrations at sites in White Oak Creek downstream from Oak Ridge National Laboratory, 1998–2007.** (WCK = White Oak Creek kilometer)

### 5.5.1.6.1.2 Bioaccumulation in Fish

In order to provide data directly applicable to assessing human health concerns, redbreast sunfish (*Lepomis auritus*) are collected annually from WCK 2.9, and bluegill sunfish (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) from WOL (WCK 1.5). Collections were restricted to fish of a size large enough to be kept by sport fishermen (>50 g for sunfish, and >500 g for bass). Muscle tissue fillets were taken from six individual fish of each species for both Hg and PCB analysis. The stoneroller minnow (*Campostoma oligolepis*) is a forage species that readily accumulates particle-associated contaminants such as PCBs. Specimens were collected at WCK 3.9 to provide a measure of the possible exposure of fish-eating wildlife to PCBs. For stonerollers, ten whole-body fish comprised each of three composite samples.

**Mercury.** Mean total Hg concentrations in WOC fish collected in 2007 are reported in Table 5.20. Average Hg concentrations in redbreast sunfish from WCK 2.9 (0.43 ± 0.17 µg/g) were approximately five-fold higher than in redbreast sunfish from Hinds Creek (0.07 ± 0.02 µg/g). Concentrations of Hg in bluegill collected further downstream in WOL were far lower than at the upstream site, with Hg concentrations (0.12 ± 0.02 µg/g) approaching those at the reference stream. Relatively greater concentrations of Hg in largemouth bass from WOL, averaging 0.23 ± 0.05 µg/g, reflected their higher position in the food chain.

**Table 5.20. Total mercury and polychlorinated biphenyl (Aroclor 1254 + 1260) concentrations in fish (mean ± SE; range in parentheses) from sites in White Oak Creek and a reference stream, Hinds Creek, April/May 2007[a, b]**

| Site | Species[c] | Mercury (µg/g) | PCBs (µg/g) |
|---|---|---|---|
| WCK 3.5 | Stoneroller | Not analyzed | 2.1 ± 0.13 |
| WCK 2.9 | Redbreast sunfish | 0.43 ± 0.17<br>(0.18–0.67) | 0.17 ± 0.06<br>(0.09–0.26) |
| WOL | Bluegill | 0.12 ± 0.02<br>(0.08–0.23) | 0.69 ± 0.26<br>(0.42–1.18) |
| WOL | Largemouth bass | 0.23 ± 0.05<br>(0.19–0.33) | 2.36 ± 1.02<br>(1.10–3.47) |
| Hinds Creek | Redbreast sunfish | 0.07 ± 0.02<br>(0.05–0.15) | < 0.01 |
| Hinds Creek | Stoneroller | Not analyzed | <0.01 |

[a]N = 6 fish for each site/species combination; samples are of fillet tissue only. Stoneroller samples are mean ± SE of three ten-fish composites.

[b]Abbreviations;
WCK = White Oak Creek kilometer.
PCB = polychlorinated biphenyl.
WOL = White Oak Lake.

[c]Largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), redbreast sunfish (*Lepomis auritus*), and stoneroller (*Campostoma oligolepis*).

Temporal trends in mercury bioaccumulation are shown in Fig. 5.24. Mercury in sunfish from WCK 2.9 remained elevated above the Tennessee fish tissue-based water quality criterion (0.3 µg/g), although mercury in both bass and sunfish in WOL fell below that standard in 2007. Response of mercury in fish in 2008 and 2009 to reduced waterborne mercury inputs from upstream sources will provide critical data for assessing the potential effectiveness of mercury source-control actions at other sites on the ORR.

**PCBs.** Mean PCB concentrations in WOC fish collected in 2007 are reported in Table 5.20 Mean PCB concentrations in sunfish from WCK 2.9 and WOL were 0.17 ± 0.06 µg/g and 0.69 ± 0.26 µg/g, respectively. Such levels of PCBs are relatively high for short-lived, lipid-poor fish such as sunfish. Largemouth bass from WOL typically have substantially higher levels of PCBs, and averaged 2.36 ± 01.02 µg/g in 2007. Reference site sunfish analyzed concurrently had average PCB concentrations of <0.01 µg/g. PCB concentrations in stonerollers collected near the main ORNL Campus averaged 2.10 ± 0.13 µg/g. Higher PCB concentrations in fish from WOL than in WOC indicate that contaminated lake sediments are a likely source of PCBs. However, the presence of high concentrations of PCBs in stonerollers in WOC near ORNL suggests that continuing inputs to the stream probably occur in the vicinity of the ORNL main campus.

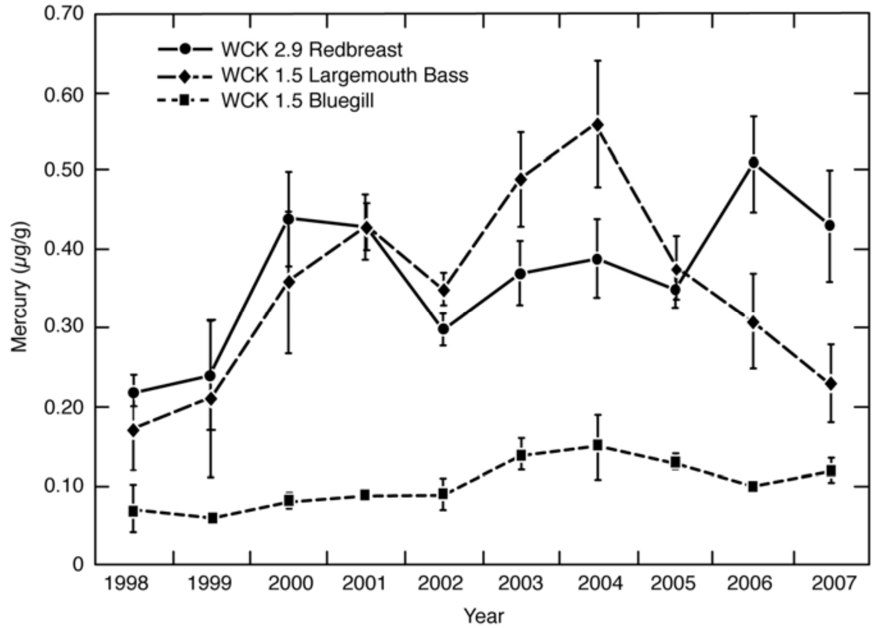



**Fig. 5.24. Mean total mercury concentrations (µg/g, ± SE) in fish muscle fillets collected from the White Oak Creek watershed, 1998–2007.** (WCK = White Oak Creek kilometer)

Mean PCB concentrations in 2007 were well within historical ranges (Fig. 5.25). While year-to-year fluctuations are both large and typical, the 10-year pattern suggests little actual change in PCB inputs over time.

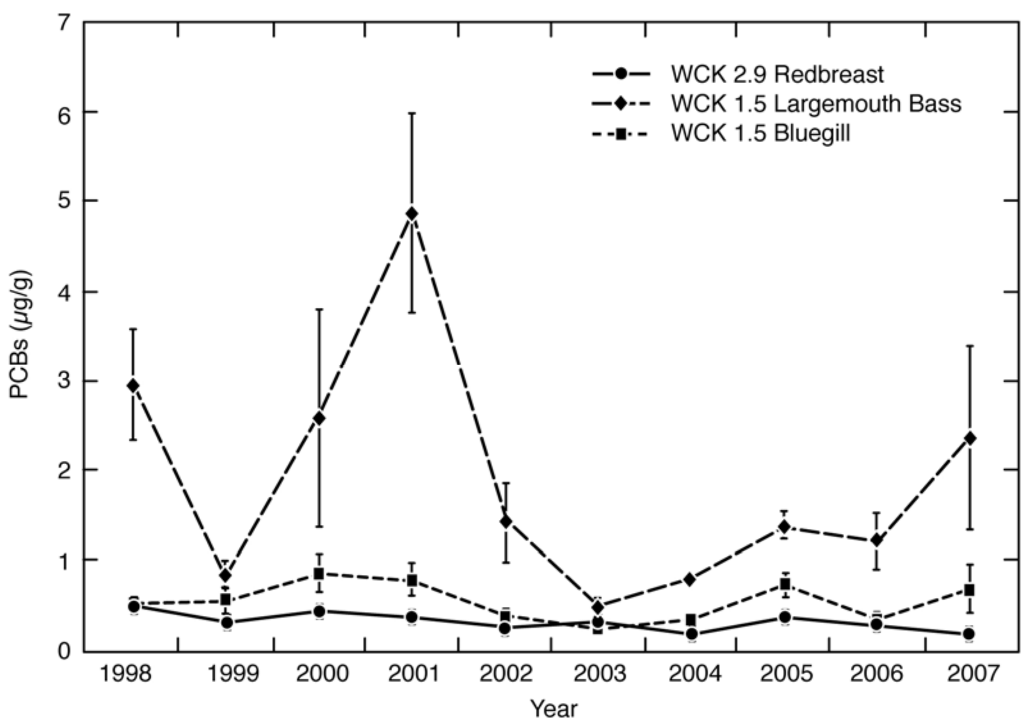



**Fig. 5.25. Mean total PCB concentrations (µg/g, ± SE) in largemouth bass and sunfish muscle fillets collected from the White Oak Creek watershed, 1998–2007.** (WCK = White Oak Creek kilometer)

#### 5.5.1.6.1.3 Benthic Macroinvertebrate Communities

Monitoring of the benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2007. Benthic macroinvertebrate samples are collected at sites upstream and downstream of the influence of ORNL operations. These sites include impacted and unimpacted (reference site) locations. The objectives of this activity are to (1) help assess ORNL's compliance with the current NPDES permit requirements and (2) evaluate and verify the effectiveness of pollution abatement and remedial actions taken at ORNL.

The benthic macroinvertebrate communities in First Creek, Fifth Creek, and WOC downstream of effluent discharges have recovered significantly since 1987, but community characteristics indicate that ecological impairment continues (Figs. 5.26, 5.27, and 5.28). Total taxonomic richness and richness of the pollution-intolerant taxa (i.e., mayflies, stoneflies, and caddisflies or Ephemeroptera, Plecoptera, and Trichoptera [EPT] richness) continue to be lower at sites adjacent to and downstream of the main ORNL campus than at their respective reference sites. Over the past 6 to 7 years, annual changes in total and EPT taxa richness at downstream sites have either been minimal (FFK 0.2) or generally similar to those at the reference sites (FCK 0.1, WCK 2.3, WCK 3.9), suggesting that no unusual changes have occurred due to environmental conditions. In contrast to these streams, the benthic macroinvertebrate community in lower Melton Branch (MEK 0.6), which was marginally impaired from 1987 through 1997 (Fig. 5.29), has exhibited no discernible evidence of degradation based on total and EPT richness metrics since sampling was reinstated in 2006.

#### 5.5.1.6.1.4 Fish Communities

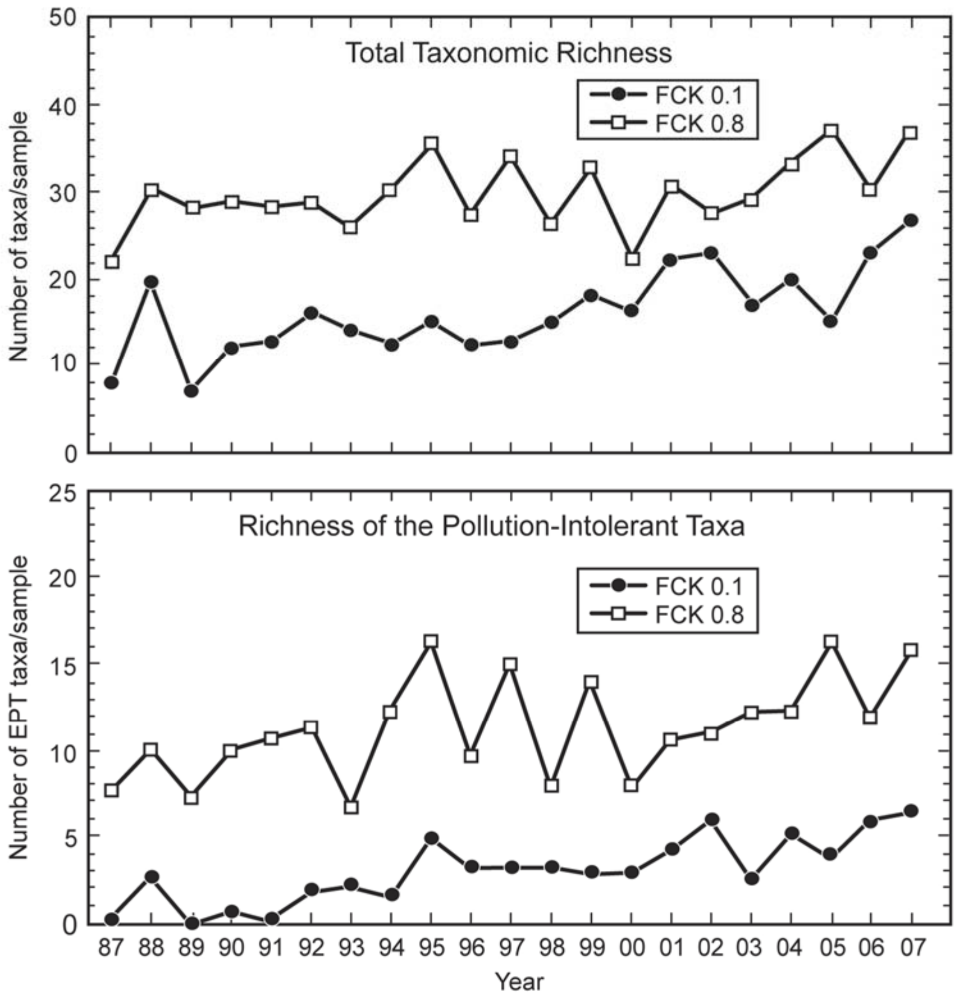
Monitoring of the fish communities in WOC and its major tributaries continued in 2007. Samples were taken at 11 sites in WOC watershed in the spring and fall. Mill Branch, a stream located on the north side of Pine Ridge within the city of Oak Ridge, was also sampled as a reference site.

In WOC, the fish community continued to display characteristics of degraded conditions, 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. After decreasing in the early 2000s, densities at WOC sites have generally stabilized over the past couple of years, although at most sites they remain ~2 times higher than at the respective reference site (Fig. 5.30). The fish communities in 2007 showed a general increase in density during the fall sample. In the past, these sites had very high densities (~14–17 fish/$m^2$) that were at least tenfold higher than at reference sites. Often in recovering streams, as fish density declines, species richness will increase, reflecting an overall improvement. However, in WOC, there has not been a corresponding increase in species richness as density has decreased. The low species richness seen in WOC watershed, relative to off-site reference locations, is partially a result of barriers that limit immigration of new species from the Clinch River drainage. A project to introduce some of these missing species into the watershed will be initiated in 2008.

Generally, the fish communities in tributary sites adjacent to and downstream of ORNL outfalls remained somewhat impacted in 2007 relative to reference streams or upstream sites. Species richness of fish in tributaries to WOC remained slightly lower in 2007 relative to reference streams not in the WOC watershed. The primary difference between these tributaries and their reference streams is the absence of pollution-sensitive species, such as darters, from the tributaries. The density of fish communities in First Creek (Fig. 5.31), in Fifth Creek (Fig. 5.32), and in Melton Branch (Fig. 5.33) all showed increases in fall 2007. Because 2007 was greatly influenced by drought conditions, the apparent increase in density may reflect smaller stream sizes that concentrated fish rather than an actual increase in absolute numbers of fish.

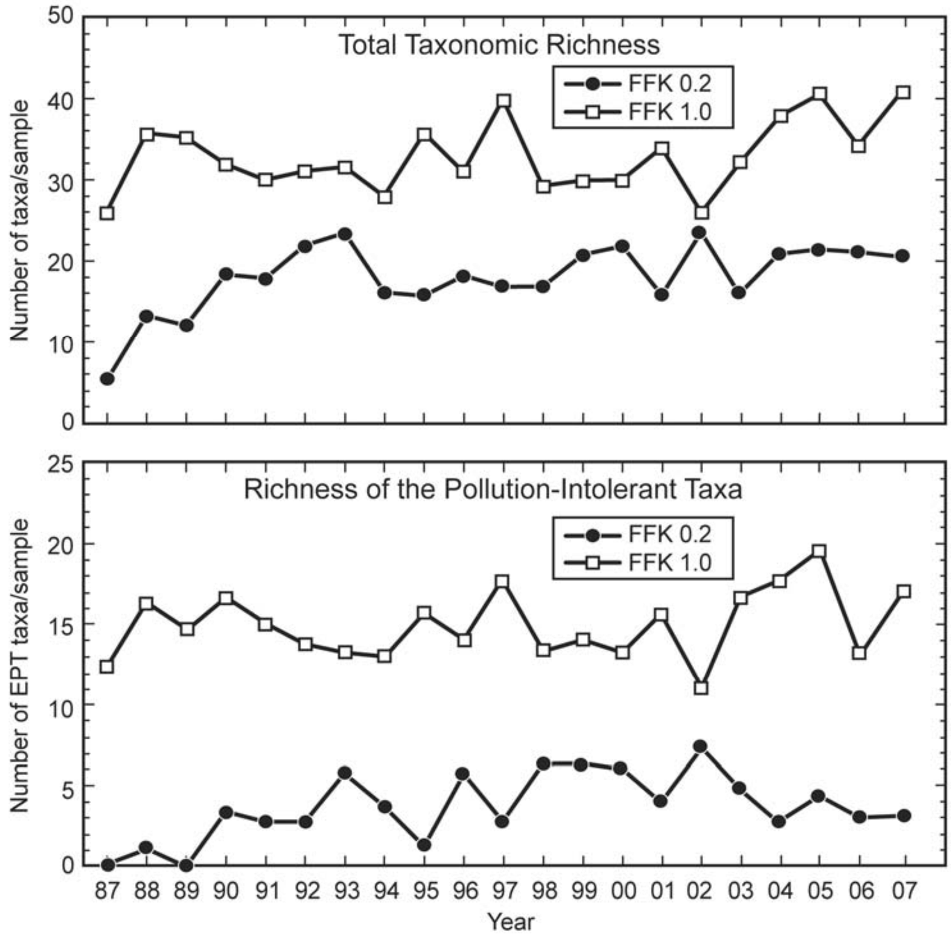
### 5.5.2 Surface Water Monitoring at NPDES Reference Location

WOC headwaters were monitored in 2007 as a reference location for ORNL NPDES surface water monitoring.




*FCK - First Creek kilometer*
*EPT - Ephemeroptera, Plecoptera, and Trichoptera*

**Fig. 5.26. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate community in First Creek, April sampling periods, 1987−2007.** FCK 0.8 = First Creek kilometer reference site.




*FFK - Fifth Creek kilometer*
*EPT - Ephemeroptera, Plecoptera, and Trichoptera*

**Fig. 5.27. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate community in Fifth Creek, April sampling periods, 1987−2007.** (FFK 1.0 = Fifth Creek kilometer reference site)

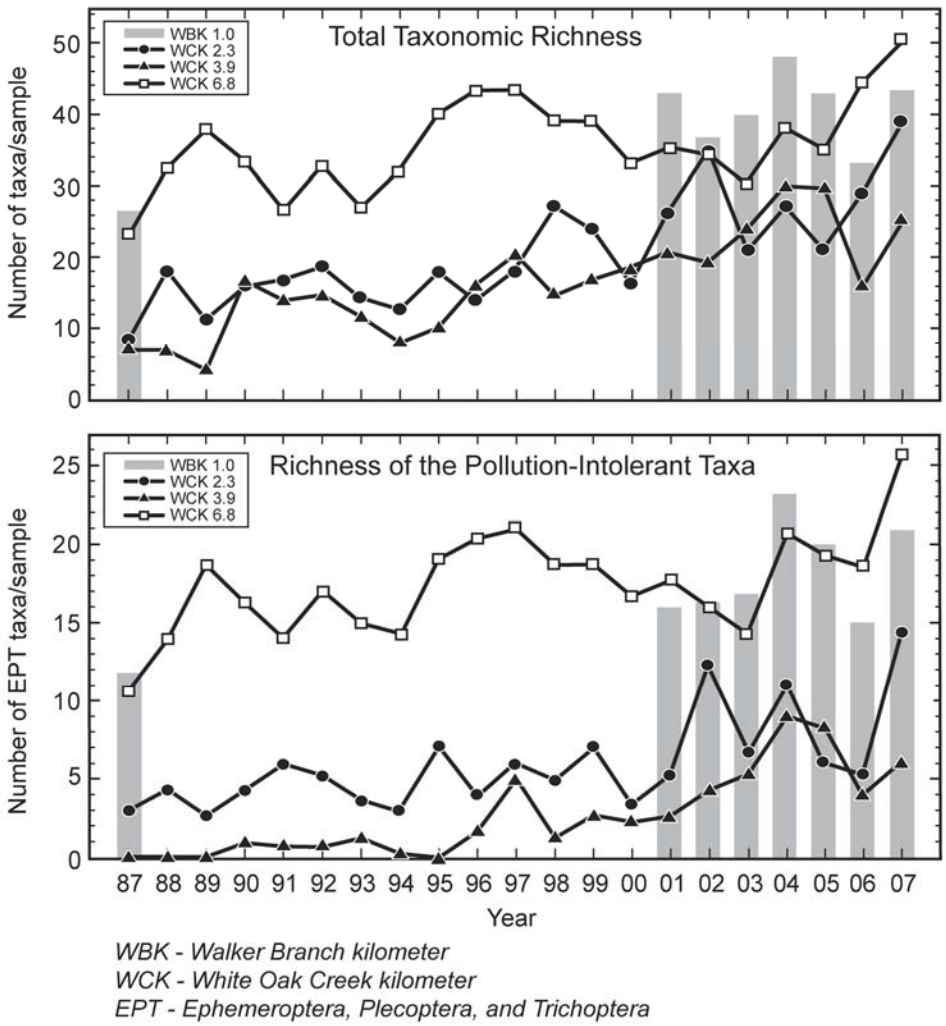



**Fig. 5.28. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate communities in White Oak Creek, April sampling periods, 1987−2007.** (WBK 1.0 = Walker Branch kilometer reference site)

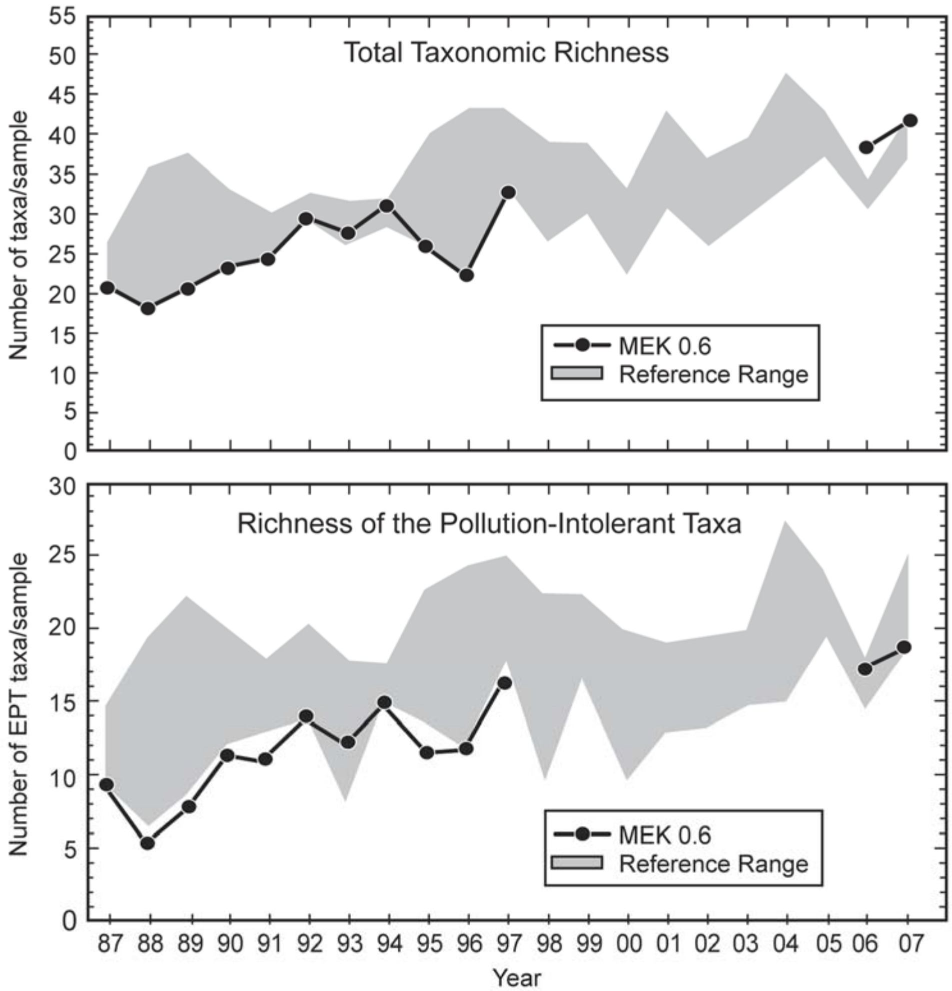



**Fig. 5.29. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate community in lower Melton Branch, April sampling periods, 1987−2007.** MEK 0.6 = Melton Branch kilometer reference site, EPT = Ephemeroptera, Plecoptera, and Trichoptera, reference range = minimum and maximum values for Oak Ridge National Laboratory Biological Monitoring and Abatement Program reference sites on First Creek, Fifth Creek, and Melton Branch (1987–1997); Walker Branch (2001–2007); and White Oak Creek (1987–2000).

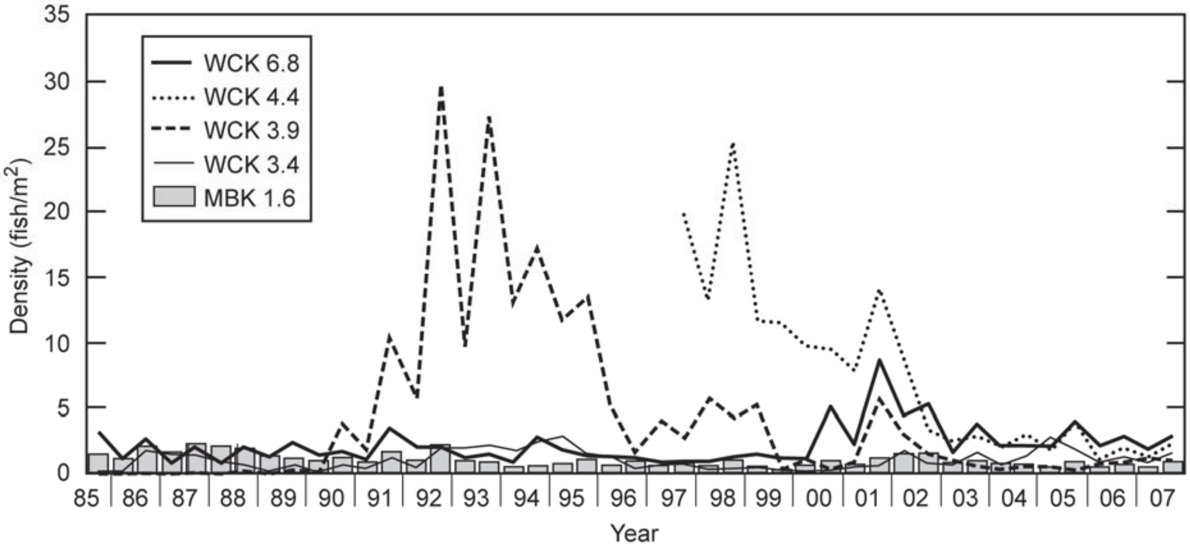



**Fig. 5.30. Density (fish/m$^2$) estimates for fish in spring and fall samples from upper White Oak Creek and from a reference site on Mill Branch (MBK 1.6), 1985–2007.** (WCK = White Oak Creek kilometer, MBK = Mill Branch kilometer)

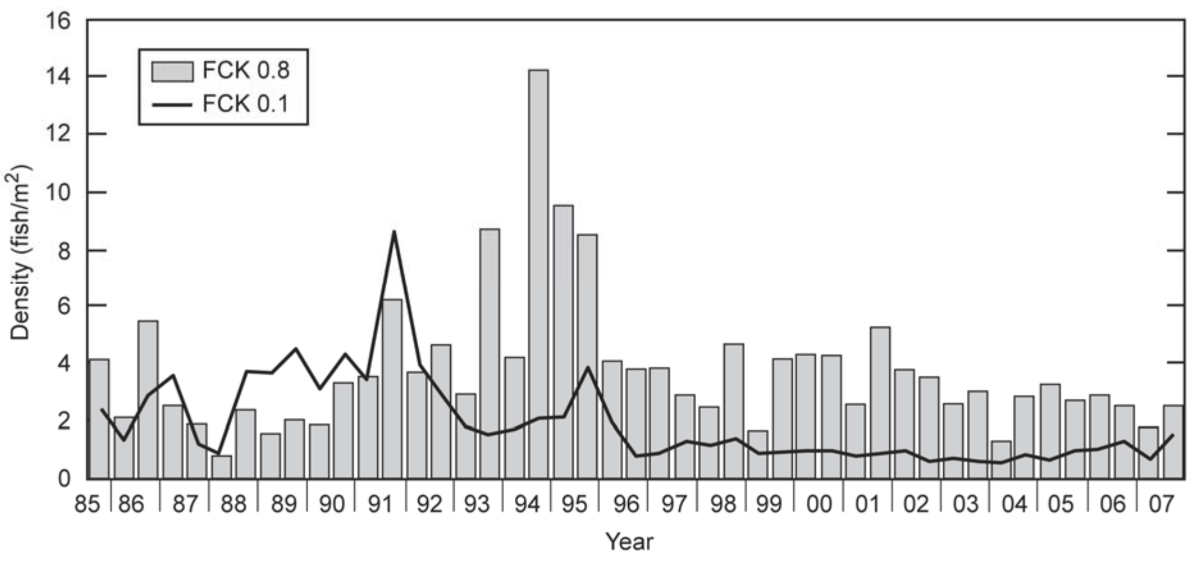



**Fig. 5.31. Density (fish/m$^2$) estimates for fish in spring and fall samples from First Creek, 1985–2007.** (FCK = First Creek kilometer 0.8 reference site)

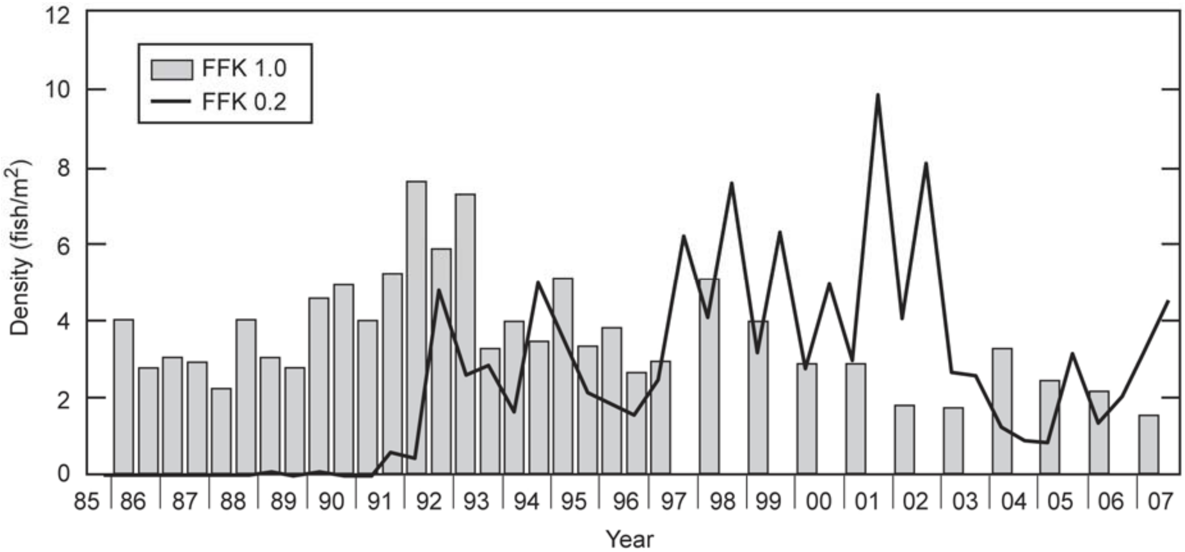



**Fig. 5.32. Density (fish/m$^2$) estimates for fish in spring and fall samples from Fifth Creek, 1985–2006.** (FFK 1.0 = Fifth Creek kilometer reference site)

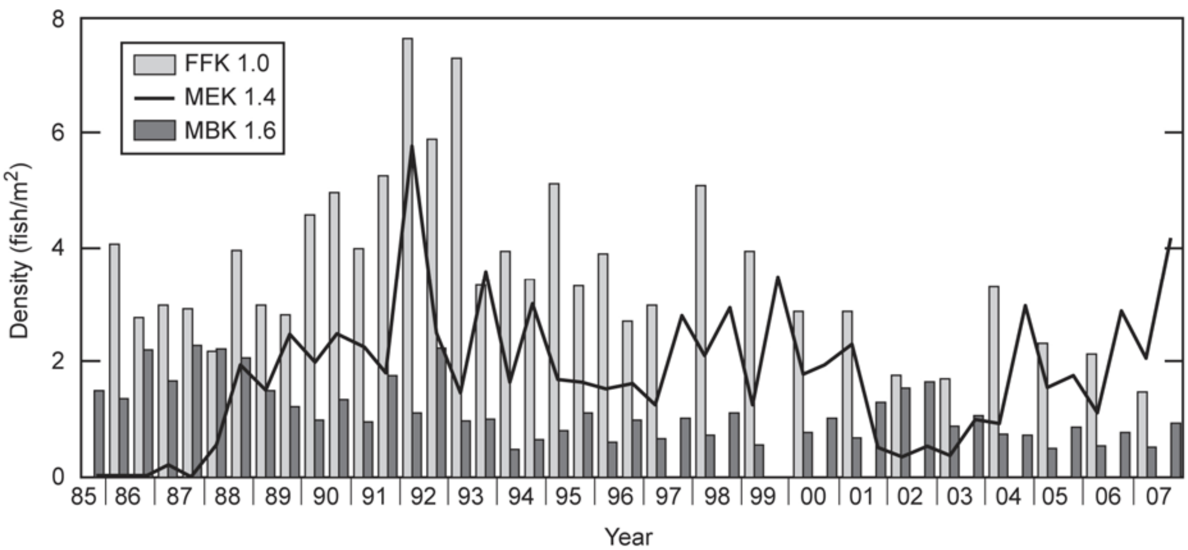



**Fig. 5.33. Density (fish/m$^2$) estimates for fish in spring and fall samples from Melton Branch, 1985–2007.** (MEK 1.4 = Melton Branch kilometer reference site, FFK 1.0 = Upper Fifth Creek kilometer reference site, and MBK 1.6 = Mill Branch kilometer reference sites)

In an effort to provide a basis for evaluation of analytical results and for assessment of nonradiological surface water quality, Tennessee general water quality criteria (TDEC 2004) have been used as reference values. The criteria for fish and aquatic life have been used at WOC headwaters. [See Appendix D, Table D.2, for Tennessee General Water Quality Criteria for all parameters in water. See Tables 2.3 and 3.4 in *Environmental Monitoring on the Oak Ridge Reservation: 2007 Results* (DOE 2007b) for surface water analyses.]

### 5.5.3 Sanitary Wastewater

At ORNL, sanitary wastewater is collected, treated, and discharged separately from other liquid wastewater streams through an on-site sewage treatment plant. Wastewater discharged into the system is regulated by means of internally administered waste-acceptance criteria based on the plant's NPDES operating permit parameters. Wastewater streams currently processed through the plant include sanitary sewage from facilities in Bethel and Melton valleys, area runoff of rainwater that infiltrates the system, and specifically approved nonhazardous biodegradable wastes, such as scintillation fluids. The effluent stream from the sewage treatment plant is ultimately discharged into WOC through an NPDES-permitted outfall (X-01). In 1998, ORNL's sewage sludge was accepted into the city of Oak Ridge's Biosolids Land Application Program. ORNL transported no sewage sludge to the Oak Ridge sewage treatment plant in 2007 because the plant was undergoing an expansion project. During 2007, ORNL's sewage sludge was dried and handled as solid low-level waste (LLW). Shipments of sludge to the city of Oak Ridge may resume in 2008.

TWPC holds a state operating permit for sewage holding tanks, which are emptied and the sanitary wastewater taken for processing at an off-site sewage treatment plant.

### 5.5.4 Storm Water Protection Permits

Storm water discharges associated with construction activities that disturb 0.4 ha or more of land must be NPDES-permitted. Coverage under a general permit is typically approved for a construction project if the proper notice of intent is filed.

In 2007, ORNL had five construction projects covered by the Tennessee General Permit for Storm Water Runoff Associated with Construction Activity. These included the SNS project, the ORNL Research Support Center, the ORNL 24-Inch Water Line Replacement Project, a project to decommission and demolish specific excess buildings, and the West Campus Improvement project. The TWPC also had a construction project covered by the Tennessee General Permit for Storm Water Runoff Associated with Construction Activity.

### 5.5.5 Aquatic Resources Protection

The Army Corps of Engineers, TVA, and TDEC conduct permitting programs for projects and activities that could affect aquatic resources, including navigable waters, surface waters (including tributaries), and wetlands. These are the Corps of Engineers Sect. 404 dredge-and-fill permits, TDEC aquatic resource alternative permits (ARAPs), and TVA 26A approvals.

ORNL had one ARAP that was active in 2007. Construction of a new section of 24-in. water line resulted in temporary disturbance to a small tributary channel. The work was conducted under TDEC's General Permit for Utility Line Crossings. The stream crossing was substantially completed in 2006, but the ARAP remained in effect until May 2007. An Army Corps of Engineers permit (Nationwide Permit No. 18, "Minor Discharges") was issued to ORNL in 2006 to allow fill material to be placed in an abandoned boathouse foundation located on the Freels Bend area of Melton Hill Reservoir. Work was completed in 2006, but the permit remained in effect until March 2007.

### 5.5.6 Oil Pollution Prevention

Section 311 of the CWA regulates the discharge of oils or petroleum products to waters of the United States and requires the development and implementation of a spill prevention, control, and countermeasure plan to minimize the potential for oil discharges. Currently, each facility on the ORR implements a site-specific plan. This section of the CWA was significantly amended by the Oil Pollution Act of 1990, which has as its primary objective the improvement of responses to oil spills. On July 17, 2002, EPA issued the new final rule for 40 CFR Part 112, "Oil Pollution Prevention and Response; Non-Transportation-Related Onshore and Offshore Facilities," in the *Federal Register*. The rule contains significant changes in the requirements for SPCCs, including how the plans are prepared, reviewed, and certified and the information that must be included in the plans. The ORNL SPCC was revised in September 2007, including incorporation of the new EPA requirements.

### 5.5.7 ORNL Surface Water Surveillance Monitoring

The ORNL surface water monitoring program includes sample collection and analysis from 15 locations at ORNL and around the ORR. This program is conducted in conjunction with the ORR surface water monitoring activities discussed in Sect. 6.4 to enable assessing the impacts of past and current DOE operations on the quality of local surface water. Sampling locations include streams downstream of ORNL waste sources, reference points on streams and reservoirs upstream of waste sources, and public water intakes (see Fig. 5.34).

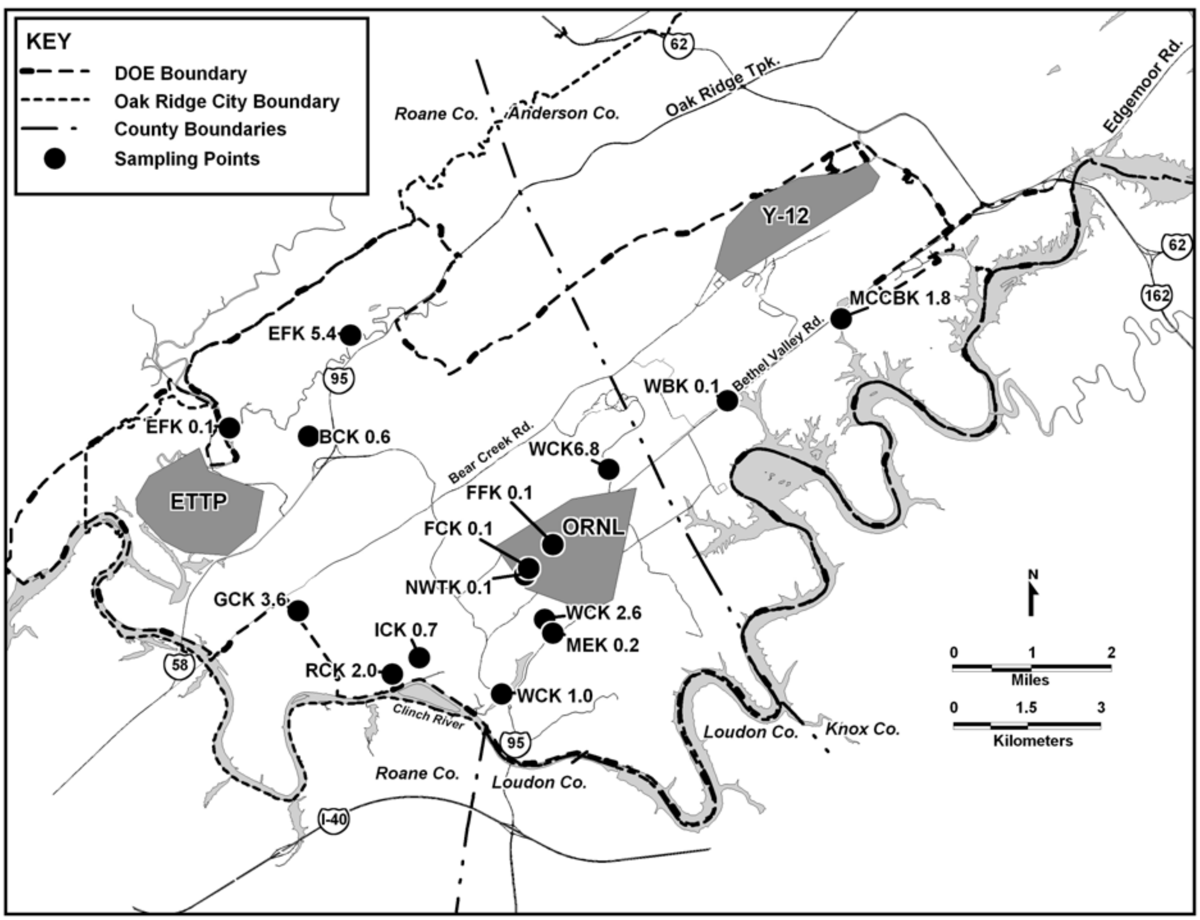



**Fig. 5.34. Oak Ridge National Laboratory surface water sampling locations.**

In 2007 several changes to this program resulted from modifications to the *Environmental Monitoring Plan for the Oak Ridge Reservation*, (DOE 2007c), which was reissued in October 2007. Three sites (CRK 32, CRK 58, and CRK 66) which were previously included in this program are now incorporated into monitoring activities for the ORR, and monitoring was discontinued at three other locations (BCK

0.6, EFK 0.1 and EFK 5.4) which were previously sampled in a biannual basis. One sampling event for the three discontinued locations was conducted prior to the implementation of the program modifications.

Sampling frequency and parameters vary by site. Grab samples are collected and analyzed for general water quality parameters at all locations and all are screened for radioactivity and analyzed for specific radionuclides when appropriate. Samples from WOL at WOD are also checked for VOCs, PCBs, and metals. Table 5.21 lists the specific locations and their sampling frequencies and parameters.

**Table 5.21. Oak Ridge National Laboratory surface water sampling locations, frequencies, and parameters, 2007**

| Location[a] | Description | Frequency | Parameters |
|---|---|---|---|
| BCK 0.6[b] | Bear Creek downstream from DOE inputs | Semiannually (April, Oct.) | Gross alpha, gross beta, gamma scan, field measurements[c] |
| EFK 0.1[b] | East Fork Poplar Creek prior to entering Poplar Creek | Semiannually (April, Oct.) | Gross alpha, gross beta, gamma scan, field measurements[c] |
| EFK 5.4[b] | East Fork Poplar Creek downstream from floodplain | Semiannually (April, Oct.) | Gross alpha, gross beta, gamma scan, field measurements[c] |
| MEK 0.2 | Melton Branch downstream from ORNL | Bimonthly (Jan., March, May, July, Sept., Nov.) | Gross alpha, gross beta, gamma scan, total radioactive strontium, $^{3}H$, field measurements[c] |
| WCK 1.0 | White Oak Lake at White Oak Dam | Monthly | Volatiles, metals, PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, $^{3}H$, field measurements[c] |
| WCK 2.6 | White Oak Creek (WOC) downstream from ORNL | Bimonthly (Jan., March, May, July, Sept., Nov.) | Gross alpha, gross beta, gamma scan, total radioactive strontium, $^{3}H$, field measurements[c] |
| WCK 6.8 | WOC upstream from ORNL | Quarterly (Feb., May, Aug., Nov.) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[c] |
| WBK 0.1 | Walker Branch prior to entering CRK 53.4 | Semiannually (April, Oct.) | Gross alpha, gross beta, gamma scan, field measurements[c] |
| GCK 3.6 | Grassy Creek upstream of SEG and IT Corp. at CRK 23 | Semiannually (April, Oct.) | Lead, gross alpha, gross beta, gamma scan, field measurements[c] |
| ICK 0.7 | Ish Creek prior to entering CRK 30.8 | Semiannually (April, Oct.) | Gross alpha, gross beta, gamma scan, field measurements[c] |
| MCCBK 1.8 | McCoy Branch prior to entering CRK 60.3 | Semiannually (April, Oct.) | Gross alpha, gross beta, gamma scan, field measurement[c] |
| RCK 2.0 | Raccoon Creek sampling station prior to entering CRK 31 | Semiannually (April, Oct.) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[c] |
| NWTK 0.1 | Northwest Tributary prior to the confluence with First Creek | Semiannually (April, Oct.) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[c] |
| FCK 0.1 | First Creek prior to the confluence with Northwest Tributary | Semiannually (April, Oct.) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[c] |

**Table 5.21 (continued)**

| Location[a] | Description | Frequency | Parameters |
|---|---|---|---|
| FFK 0.1 | Fifth Creek just upstream of WOC (ORNL) | Semiannually (April, Oct.) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^3$H, field measurements[c] |

[a]Locations identify bodies of water and locations on them (e.g., WCK 1.0 = 1.0 km upstream from the confluence of White Oak Lake and the Clinch River).

[b]Locations dropped from sampling plan effective October 1, 2007; consequently, only sampled one time in 2007 (during April).

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

Seven of the 15 sampling locations are classified by the state of Tennessee for freshwater fish and aquatic life. Tennessee water quality criteria associated with these classifications are used as references where applicable (TDEC 2004). The Tennessee water quality criteria do not include criteria for radionuclides. Four percent of the DOE DCG 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.

### 5.5.7.1 Results

Radionuclides were detected above MDAs at 11 of the 15 surface water locations in 2007. The locations with the highest levels of radionuclides are in the ORNL main plant area and at locations downstream of the main plant. Locations in the main plant area are near CERCLA sites, and downstream locations are impacted by contamination from upstream sources. Over the past few years, several remedial actions have been completed within the main plant area which have resulted in observed decreases in radionuclide concentrations in surface water samples; future remedial actions in these areas are planned and, until completion, little change in surface water contaminant conditions is expected (DOE 2008). The results from 2007 sampling at these locations are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations. These patterns are expected to continue until remediation efforts are completed.

The VOCs chloroform and common laboratory contaminants acetone and methylene chloride were detected at WOC at WOD in 2007, all at low estimated levels.

Samples collected from Raccoon Creek (Raccoon Creek kilometer [RCK] 2.0) showed gross beta and total radioactive strontium detections in April. Historically, results at RCK 2.0 have a seasonal pattern with results from the fall sampling being noticeably higher than in the spring; however, this location was dry when sampled in the fall. Raccoon Creek is impacted by contaminated groundwater from Solid Waste Storage Area (SWSA) 3. Future remedial actions should decrease these levels of radionuclides.

## 5.5.8 ORNL Sediment

Stream and lake sediments act as a record of some aspects of water quality by concentrating and storing certain contaminants. Sampling sites for sediment are the Clinch River downstream from all DOE inputs (Clinch River kilometer [CRK] 16), the Clinch River downstream from ORNL (CRK 32), and the Clinch River at the Solway Bridge, upstream from all DOE inputs (CRK 70) (Fig. 5.35). The locations are sampled annually, and gamma scans are performed on the samples.

In addition, each year, two samples containing settleable solids are collected in conjunction with a heavy rain event to characterize sediments that exit ORNL during a storm event. The sampling locations are Melton Branch upstream from ORNL (MEK 2.1), White Oak Lake at White Oak Dam (WCK 1.0), WOC downstream from ORNL (WCK 2.6), and WOC Headwaters as a reference location (Fig. 5.35). These samples are filtered, and the residue (settleable solids) is analyzed for gross alpha, gross beta, and gamma emitters.

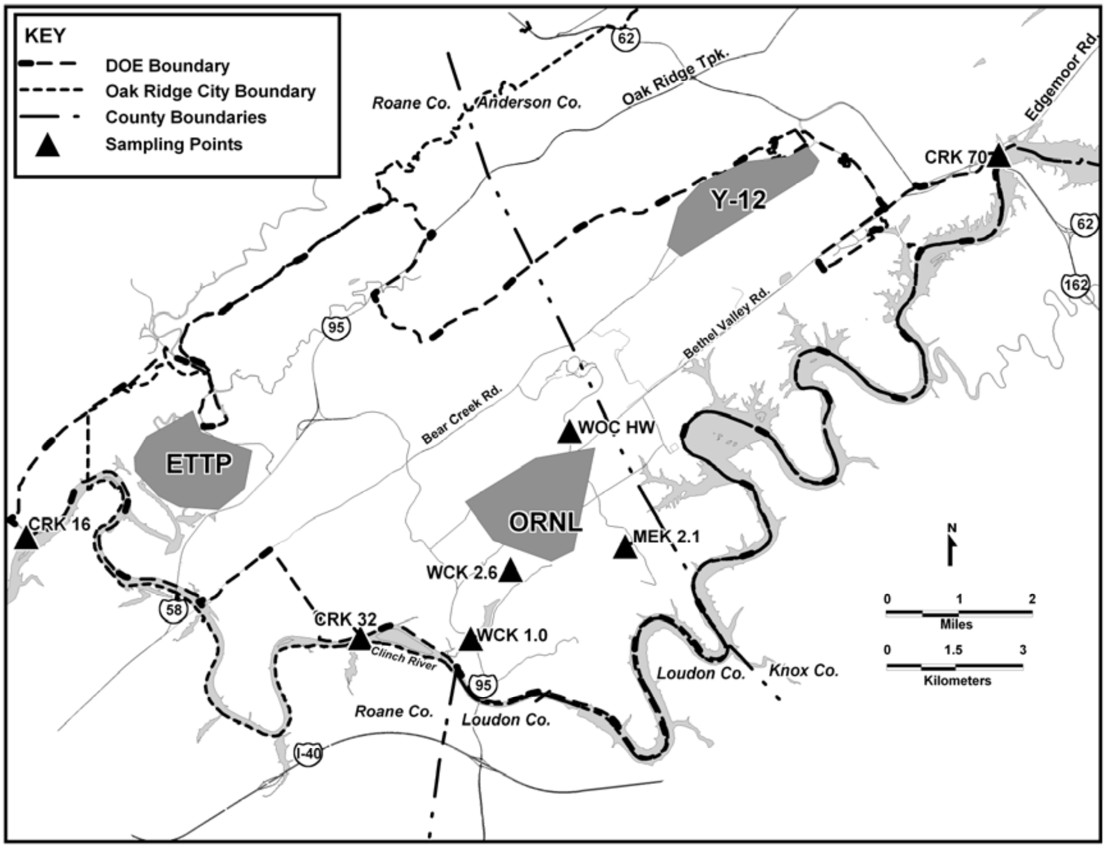



**Fig. 5.35. ORNL sediment sampling locations.**

Potassium-40, a naturally occurring radionuclide, was detected in sediments at all three locations. Cesium-137 was also detected in the samples collected at CRK 16 and CRK 32. Cesium-137 concentrations at these locations have declined slightly between 2004 and 2007.

Heavy rain event sampling took place in September and December 2007. Radionuclide concentrations for all parameters were higher at the downstream locations than those observed at the upstream reference location.

During September 2007, gross alpha concentrations at all sampling points, including the upstream reference location, were higher than levels observed over the past several years. However, in December 2007 all alpha results returned to lower levels which are consistent with historical sampling information.

Beta concentrations at all four locations, including the upstream reference location, exhibited a pattern similar to that observed for gross alpha results with increased levels during the September 2007 event, and general returns to lower levels in December 2007. The beta result at the WOC headwaters reference location remained elevated over levels observed for the past several years in December 2007.

The $^{137}$Cs results from the September 2007 settleable solids sampling event were also higher at the White Oak Creek locations, followed by lower results in December 2007. The $^{137}$Cs levels at MEK 2.1 for September 2007 did not increase, and remained at levels below detection limits.

Since sampling began, there has been no indication of significant trends in alpha, beta or $^{137}$Cs concentrations at any of the locations.

### 5.5.8.1 Results

Potassium-40, a naturally occurring radionuclide, was detected in sediments at all three locations. Cesium-137 was also detected in the samples collected at CRK 16 and CRK 32. These radionuclide detections are consistent with historical detections in Clinch River sediment sampling programs.

Heavy-rain-event sampling took place in September and December 2007. The concentrations of radionuclides associated with each of these rain events are higher at the locations downstream of ORNL than at the upstream locations.

## 5.6 U.S. Department of Agriculture/Tennessee Department of Agriculture

In 2007, ORNL researchers had 12 domestic soil agreements for receipt of or movement of quarantined soils and four soil permits for receipt of or movement of non-domestic soils (from outside the continental United States). Three other researchers held permits or approvals for receipt of other material regulated by the U.S. Department of Agriculture (USDA), such as animal or plant viruses or genetically engineered organisms. The domestic soil agreements are jointly issued by the USDA and the Tennessee Department of Agriculture, whereas permits are issued by the USDA.

## 5.7 Groundwater Protection Program

Groundwater monitoring at ORNL was conducted under two programmatic components in 2007: DOE Environmental Management and Enrichment Facilities (EMEF) monitoring and DOE Office of Science (OS) surveillance monitoring. The EMEF groundwater monitoring program was conducted by cleanup contractor BJC while the OS groundwater monitoring surveillance program was performed by UT-Battelle.

### 5.7.1 Environmental Management and Enrichment Facilities Groundwater Monitoring

Under the EMEF program, monitoring was performed as part of an on-going comprehensive cleanup effort in Bethel and Melton Valleys at ORNL, the two watersheds defined by the Water Resources Restoration Program (WRRP). The WRRP has been managed by BJC for the EMEF program since its inception and is the vehicle for DOE to carry out the monitoring requirements outlined in the Federal Facility Agreement. With the exception of monitoring at Waste Area Grouping (WAG) 6, the scope of the EMEF monitoring has dealt with remediation effectiveness monitoring at contaminated sites undergoing cleanup. For several years EMEF monitoring results have been reported in annual Remediation Effectiveness Reports.

WAG 6 has been regulated under both RCRA and CERCLA from the mid-1990s, and, for a number of years, specific monitoring results and interpretations required by RCRA have been reported in the annual Groundwater Quality Assessment Report for Solid Waste Storage Area 6 (GWQAR). A RCRA postclosure permit application (PCPA) was submitted to TDEC in 2002 with updates to the PCPA submitted in 2005. In late 2006, official notification was made by DOE to the TDEC, Division of Solid Waste Management, that RCRA closure of Solid Waste Storage Area 6 had been completed. At that time DOE submitted a copy of the *Final Phase Construction Completion Report for the Hydraulic Isolation at Solid Waste Storage Area 6 at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, (DOE 2006b), which provided details of the closure of the unit. Postclosure monitoring of the unit is being conducted consistent with the PCPA. SWSA 6 groundwater monitoring results are reported to TDEC in an annual groundwater monitoring report. All EMEF monitoring results for 2007 are presented in the *Remediation Effectiveness Report* (DOE 2008) and are not discussed in this ASER.

### 5.7.2 Office of Science Groundwater Monitoring

The OS monitoring effort has two functions: exit pathway groundwater surveillance and “active sites” groundwater surveillance monitoring. Groundwater surveillance monitoring is reported herein and is the focus of the remainder of this section.

Through 2004, the WAG concept was used as the basis of the OS groundwater monitoring program at ORNL. A WAG consisted of multiple contaminated sites that are geographically contiguous and/or that occur within hydrologically defined areas. At ORNL, 20 WAGs were identified by the RCRA Facility Assessment conducted in 1987. The WAG concept was developed to facilitate evaluation of potential sources of releases to the environment. Discussion of past WAG-based monitoring results can be found in previous editions of this document.

The former groundwater monitoring approach was reviewed in 2004 and revised to meet DOE Order 450.1A requirements and UT-Battelle management objectives. DOE Order 450.1A is the primary contractual requirement document specifying the implementation of a site-wide groundwater protection program at ORNL. As part of the site-wide groundwater protection program, and to be consistent with UT-Battelle management objectives, a groundwater surveillance monitoring strategy was developed to enable groundwater exit pathways and UT-Battelle facilities potentially posing risk to groundwater resources at ORNL ("active sites") to be assessed and monitored. The changes to the OS groundwater monitoring strategy were documented in the *Data Quality Objectives for the UT-Battelle Groundwater Surveillance Monitoring Program at ORNL* (Bonine 2004).

The exit pathway and active sites groundwater surveillance monitoring points sampled during 2007 included selected seep/spring and surface water monitoring locations as well as groundwater surveillance monitoring wells. Seep/spring and surface water monitoring locations were used in the absence of monitoring wells located in appropriately selected 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 with which to compare sampling results. In an effort to provide a basis for evaluation of analytical results and for assessment of groundwater quality monitored by UT-Battelle for the OS, federal drinking water standards and Tennessee water quality criteria for domestic water supplies (TDEC 2004) are used as reference values in the following discussions. Four percent of the DOE DCGs were used for comparison if no federal or state standards have been established for a radionuclide. Although drinking water standards and DOE DCGs 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.

Monitoring conducted by BJC and the exit pathway and active sites monitoring approach used by UT-Battelle comprise the site-wide monitoring program for ORNL. The combination of both monitoring programs meets the DOE Order 450.1A requirement of a comprehensive site-wide groundwater protection program.

### 5.7.2.1 Exit Pathway Monitoring

During 2007, exit pathway groundwater surveillance monitoring was performed under the guidance of *UT-Battelle Sampling and Analysis Plan for Surveillance Monitoring of Exit Pathway Groundwater at Oak Ridge National Laboratory* (Bonine 2007) (Exit Pathway SAP). Groundwater exit pathways at ORNL include watersheds or portions of watersheds (sub-watersheds) 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 intervals (for wells), and locations relative to discharge areas proximal to the ORNL main campus. The groundwater exit pathways at ORNL include four discharge zones identified by the groundwater data quality objectives process. In addition, one of the original exit pathway zones was split into two zones for the sake of geographic expediency. The five zones include (1) the WOC Discharge Area Exit Pathway (wells 857, 858, 1190, 1191, and 1239), (2) the 7000/Bearden Creek Watershed Discharge Area Exit Pathway (wells 1198 and 1199 and Spring BC-01), (3) the East End Discharge Area Exit Pathway (well 923 and Springs/Surface Water Monitoring Points EE-01 and EE-02), (4) the Northwestern Discharge Area Exit Pathway [wells 531, 535, and 4579 (see RER for 4579 results)], and (5) the Southern Discharge Area Exit Pathway (Springs/Surface Water Monitoring Points S-01 and S-02). The Southern Discharge Area Exit Pathway was carved from the East End Discharge Area Exit Pathway. Figure 5.36 shows the locations of the exit pathway monitoring points sampled in 2007. Note that East End Discharge Area Exit Pathway monitoring point EE-02 was moved approximately 2750 ft southeast of its original location because EE-02 was dry at all times during the 2006 monitoring period.

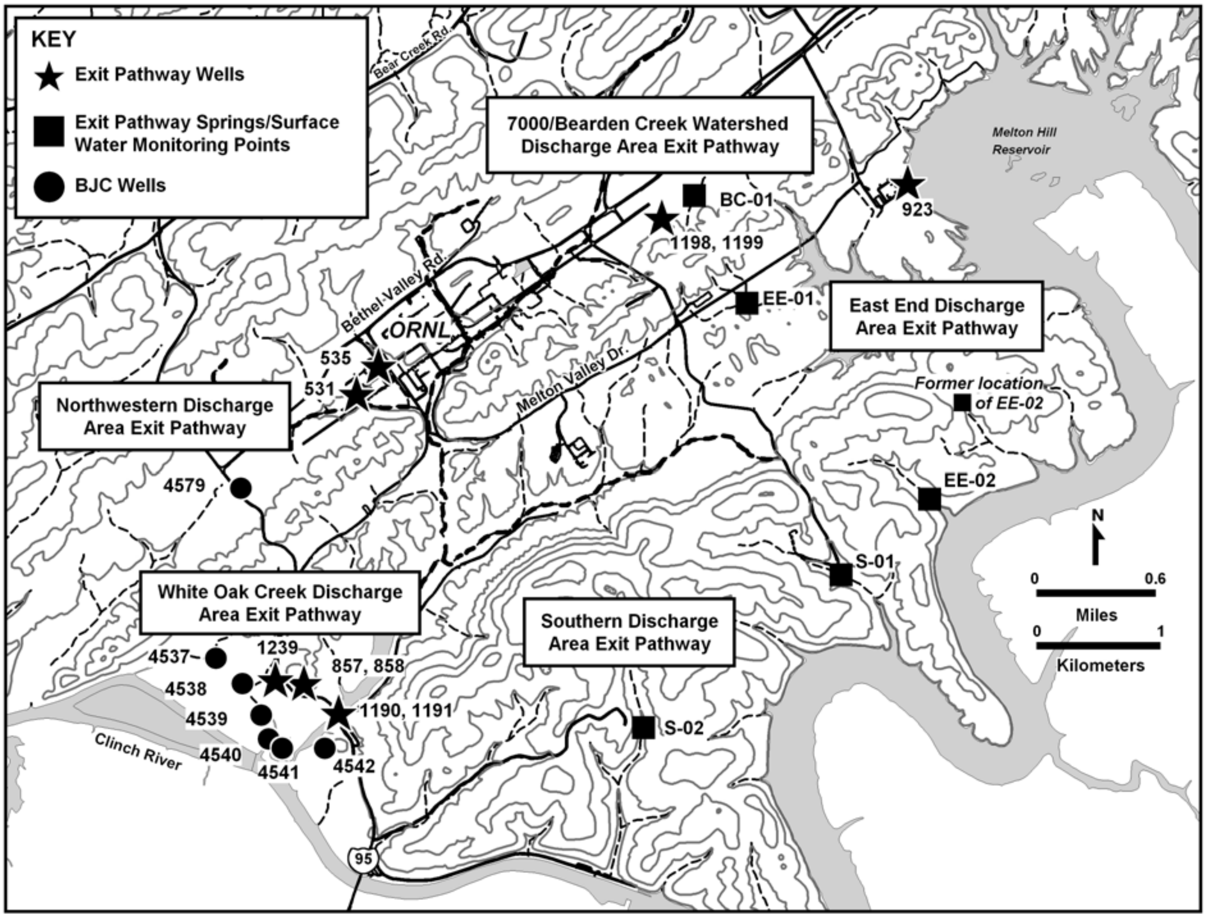



**Fig. 5.36. UT-Battelle exit pathway groundwater monitoring locations at Oak Ridge National Laboratory, 2007.**

Samples were collected during 2007 from seven multiport monitoring wells (BJC wells 4537, 4538, 4539, 4540, 4541, 4542, and 4579) installed west of the main campus of ORNL by BJC. Multi-port wells enable multiple shallow to deep water-bearing strata to be monitored. Sampling data generated by these wells were used to supplement the data generated by the WOC Discharge Area Exit Pathway. These data were reviewed by UT-Battelle, but are not reported herein. The multi-port monitoring well analytical data are reported in the annual RER as well as the Oak Ridge Environmental Information System (OREIS).

Samples collected from the UT-Battelle exit pathway groundwater surveillance monitoring points in 2007 were analyzed for VOCs, semivolatile organic compounds, metals (including mercury), and radionuclides (including gross alpha/gross beta activity, gamma emitters, total radioactive strontium, and tritium). Under the monitoring strategy in place per the Exit Pathway SAP, samples were collected semiannually during wet and dry seasons in 2007.

### 5.7.2.2 Active Sites Monitoring–HFIR and SNS

Active sites groundwater surveillance monitoring was performed in 2007 at the HFIR and SNS sites. These UT-Battelle–managed facilities were monitored based on known releases of contaminants to the subsurface (HFIR) or the potential for adverse impact on groundwater resources at ORNL should a release occur (SNS).

The HFIR monitoring activities were initiated by UT-Battelle's Research Reactors Division (RRD) following the discovery in the autumn of 2000 of a tritium release to the subsurface (the tritium release sites were repaired in 2001). During 2007 HFIR monitoring was performed under the *Annual Monitoring*

*Plan for the High Flux Isotope Reactor Site: Monitoring Period 2006–2007*. Sampling under the Annual Monitoring Plan began in December 2006 and was completed in December 2007.

Monitoring at the SNS site was performed in 2007 under the draft, biennial (2006–2008) *Operational Groundwater Monitoring Plan for the Spallation Neutron Source Site* (Bonine, Ketelle, and Trotter, 2007). Operational monitoring was initiated after a two year (2004–2006) baseline monitoring program at SNS. Operational monitoring will continue during SNS operations.

Monitoring continued at the HFIR and SNS sites during 2007 under the *HFIR Annual Monitoring Plan* and the *SNS Operational Monitoring Plan*, respectively. Monitoring was performed by UT-Battelle at both sites.

Observations of recent and historical tritium concentration behavior were made by trending concentration data accumulated under the *2006–2007 Annual Monitoring Plan* and archived data collected during previous monitoring periods. Of particular interest are monitoring points in the pathway of the main tritium plume migration (i.e., monitoring point J-1 and wells 658, and 892) in addition to monitoring points catch basin manhole (CBMH) and outfall 383. Changes in the monitoring strategy at HFIR (i.e., changes in points monitored and sampling frequency) instituted over the years necessitated the use of subsets of the data possessing sufficient data density to perform the statistical trend analysis.

Monitoring point J-1 is the closest rapid-flow system monitoring point to the tritium release area, whereas well 658 is the closest slow-flow system monitoring point to the release area. Monitoring points CBMH and outfall 383 are part of the rapid-flow monitoring system and are located south of the tritium release area. Well 892 is part of the slow-flow monitoring system and is located beneath Building 7972 (the well was integrated into the construction of the building) and is southeast of the release area. The locations of these monitoring points are shown on Fig. 5.37. Action levels (Action Level 1—40,000 pCi/L and Action Level 2—80,000 pCi/L) established for J-1 in past Annual Monitoring Plans continued to be used during the 2006–2007 monitoring period as the basis for contingent actions to be taken in the event of an observed abrupt increase in tritium concentration.

As with the exit pathway data sets, comparison of baseline SNS data to reference values was performed. Statistical trending of data was not performed on SNS data sets.

### 5.7.2.2.1 HFIR Monitoring

The HFIR site is located in Melton Valley about one-half mile south of the main ORNL facilities, which are located in Bethel Valley. The site slopes to the southeast, and small stream valleys lie to the east and west of the HFIR complex. Surface water drainage from the site flows into Melton Branch via these small streams or through storm drains. Melton Branch is located south of the HFIR site and flows west into WOC. WOC ultimately discharges into the Clinch River.

The water table surface in Melton Valley is typically a subdued replica of surface topography. The dry season water table typically occurs at or slightly above the top of bedrock. Groundwater data gathered before the tritium release indicate a water table high to the north of HFIR and a general gradient toward the adjacent streams. Estimates of groundwater flow directions are based on the generally observed tendency for groundwater to flow parallel to geologic strike (parallel to the orientation of the rock beds). Extensive historic investigations performed at Oak Ridge over several decades indicate that 90% or more of infiltrating precipitation (groundwater recharge) flows directly to the nearest stream. Because of this, in small watersheds, groundwater contaminants not subject to geochemical transport retardation, such as tritium, are readily detected in surface water samples.

The tritium release sites were on the southwest side of the HFIR Building. The releases occurred in two sections of the HFIR process waste drain (PWD) system, external to the HFIR Building.

Two interrelated flow regimes exist within the upper portion of the aquifer underlying the HFIR complex. A rapid-flow pathway is associated with the shallowest groundwater flow into subsurface piping traces (the HFIR building foundation drain and auxiliary piping to the south), and a slow-flow pathway is associated with deeper groundwater flow beneath the site.

The HFIR Building foundation drain and auxiliary waste piping system gravity-feed into Melton Branch and this piping system forms a capture zone beneath and around the building. Tritium releases

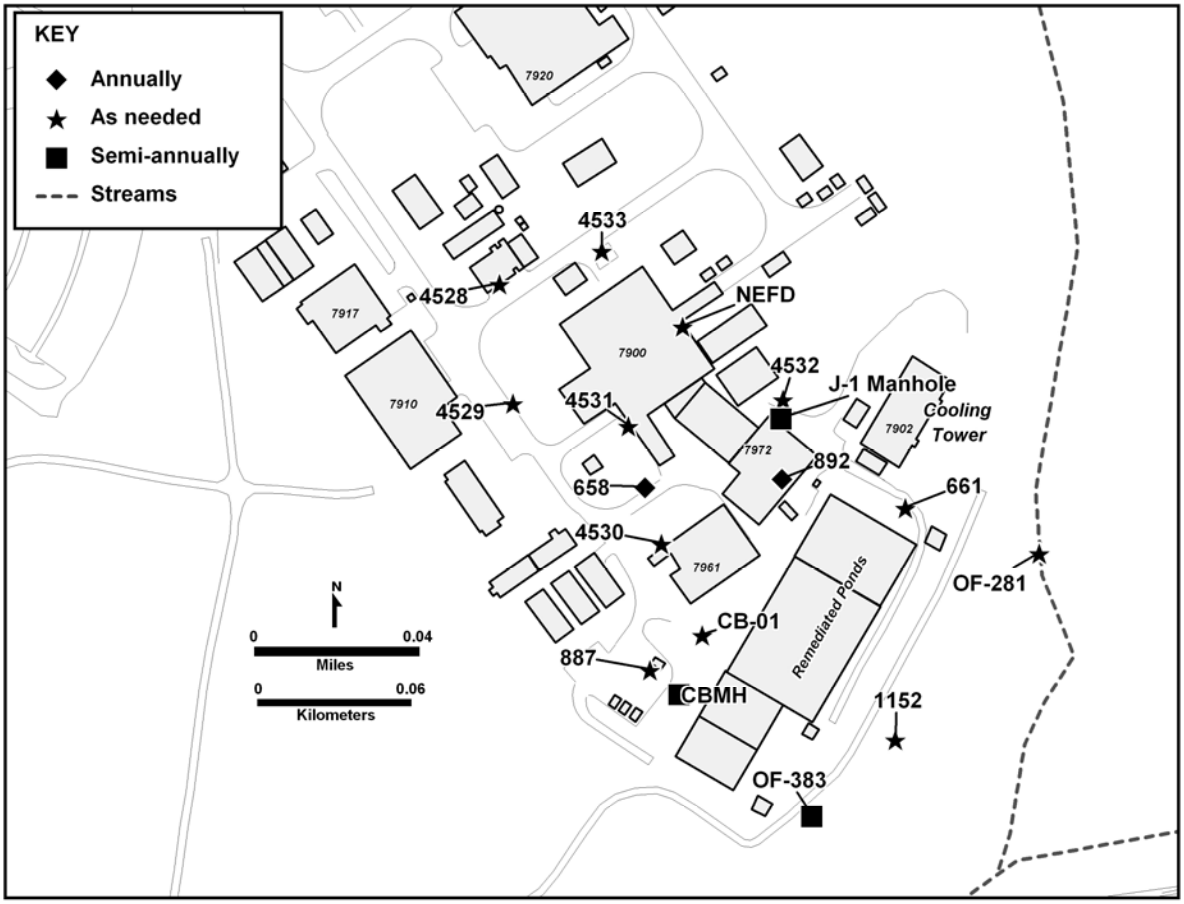



**Fig. 5.37. Groundwater monitoring locations at the High Flux Isotope Reactor, 2007.**

from the PWD system seeped into the foundation drain system and waste piping ditch lines, resulting in flow to the southeast and south ultimately discharging through NPDES outfalls. The piping systems induce groundwater flow through in-leakage and/or ditch lines, allowing a direct and rapid transport of groundwater to either the unnamed tributary to Melton Branch or to Melton Branch itself. The east foundation drain (EFD) intercepts the rapid-flow pathway and has been monitored at J-1, a monitoring point proximal to the HFIR, for several years. Likewise, waste piping ditch lines associated with the HFIR intercept the rapid-flow pathway and have been monitored regularly for several years at NPDES outfall 383. Both J-1 and outfall 383 were sampled by RRD on a routine basis during 2007 (outfall 383 was also sampled under the aegis of the NPDES *Radiological Monitoring Plan for the Oak Ridge National Laboratory*. CBMH, a manhole connected to piping that conveys intercepted groundwater from the western portion of the HFIR site to outfall 383, was also sampled during 2007.

Saturated zone groundwater flow is predominantly through secondary porosity features, such as fractures and joints. This saturated zone fracture flow represents the slow-flow pathway regime at depth beneath the HFIR site. Secondary porosity features diminish in frequency and interconnectivity with depth at the HFIR site due to overburden and vertical and lateral earth pressures. The shallow portion of the aquifer lying below HFIR (within the saprolite and upper portion of bedrock) has been of concern because tritium releases caused by operational activities or system failures are likely to find their way from the shallow rapid-flow portion of the aquifer into deeper subsurface flow. Consequently, monitoring of the slow-flow zone has been a priority since the tritium release was discovered. Past monitoring of up-gradient wells revealed no up-gradient sources of tritium, therefore monitoring of up-gradient wells was discontinued prior to sampling activities outlined in the 2006–2007 *Annual Monitoring Plan*. Additionally, monitoring of wells located on the periphery of the tritium plume was discontinued as the focus of the 2006–2007 Annual Monitoring Plan was to provide (1) detection of releases to groundwater from HFIR operational activities or system failures and (2) continued tracking the main mass of the tritium plume in the vicinity of HFIR. wells 658 and 892 are in the known discharge pathway of the tritium plume and are screened within the upper portion of the slow-flow pathway. These wells were used to track the mass of the tritium plume and were the only HFIR wells that were sampled in 2007.

Figure 5.37 shows the locations of the monitoring point locations sampled in 2007. Tritium has been the contaminant of concern throughout the history of the multi-year monitoring effort at HFIR and remained the contaminant of concern during 2007.

### 5.7.2.2.1.1 HFIR Site Results

The following is a summary of trend analyses performed on data produced by the 2006–2007 Annual Monitoring Plan. Also included are results of trend analyses performed on historical data collected from 2000 through 2007.

**East Foundation Drain (J-1).** No exceedances of the AL 1 threshold occurred during the 2006–2007 monitoring period at J-1. Trend analysis performed on recent (2006–2007) tritium monitoring data shows the presence of a statistically significant downward trend in tritium concentrations. Trend analysis of J-1 historical tritium data indicates the presence of a statistically significant downward trend.

**CBMH.** Given that CBMH was not sampled from September 2003 through February 2007 and that this monitoring point was sampled only twice during the 2007–2007 monitoring period, there were insufficient data available to perform the statistical analyses outlined above for the 2006–2007 monitoring period. However, analysis of historical data indicates the presence of a statistically significant downward tritium concentration trend at CBMH.

**Outfall 383.** Trend analysis performed on 2006–2007 tritium monitoring data shows the presence of a slight, statistically insignificant upward trend in tritium concentrations. Trend analysis of historical data indicates the presence of a statistically significant downward tritium concentration trend.

**Well 658.** A statistically significant downward trend in tritium concentration is present in the recent data set (because well 658 was sampled on an annual basis per the 2006–2007 Annual Monitoring Plan, data for November 2004 to April 2007 time period were used in trend analysis). Likewise, a trend analysis of the historical data set reveals a statistically significant downward trend in tritium concentration.

**Well 892.** A statistically significant downward trend in tritium concentration is present in the recent data set (because well 658 was sampled on an annual basis per the 2006–2007 Annual Monitoring Plan, data for November 2004 to April 2007 time period were used in trend analysis). Historical data indicate the presence of a statistically significant increasing tritium concentration trend at well 892. This is largely a function of the trend model and the distribution of tritium concentrations in time series.

A summary of tritium concentration behavior in groundwater at HFIR is found in the report, *Summary of Groundwater Monitoring Activities at the High Flux Isotope Reactor Site: Final Report* (Bonine 2008).

Monitoring efforts during the 2006–2007 monitoring period revealed no surprises regarding the expected tritium plume behavior at the HFIR site. No exceedances of action-level thresholds were observed at the rapid-flow pathway monitoring point J-1. Tritium concentrations generally trended downward at all monitoring points sampled during the most recent monitoring period. The main mass of the tritium plume continued in its movement from the release area to the south-southeast toward Melton Branch. The smaller mass of tritium that moved southward from the release area has all but dissipated. That observation notwithstanding, the CERCLA remedial action involving the removal of the wastewater holding basins located south of the HFIR building appears to have influenced groundwater flow down-gradient of HFIR. Although groundwater flow is still to the south-southeast, the removal of the wastewater holding basins appears to have created a flow path more to the south.

The absence of an active release of tritium from HFIR systems, the nearly 4-year absence of any exceedances of ALs established for monitoring point J-1, observations of statistically significant downward historical (2000–2007) tritium concentration trends observed at wells 658, 892, J-1, and outfall 383 suggests that the tritium concentrations should continue to decrease over time, although there is a possibility of additional precipitation-driven concentration spikes or drought-induced tritium concentration stagnation events. In addition, review of historical tritium concentrations at wells 661 and 1152, located several hundred feet down-gradient and south of the HFIR Building, show that tritium concentrations reached their apex and are on the decline, suggesting the main mass of the tritium plume is moving toward Melton Branch.

RRD plans to cease monitoring under an annual monitoring plan scenario. RRD staff will, in turn, review monitoring results for outfall 281 and outfall 383 collected under the NPDES RMP. Both of these monitoring points are physically connected to piping systems that intercept the rapid-flow groundwater pathway. Both monitoring points are located strategically—outfall 383 is south of the HFIR building and outfall 281 is south-southeast of HFIR, and the logic for the locations of these monitoring points is reinforced by the appearance of a slight change in groundwater flow to the south due to the CERCLA remediation of the wastewater holding basins. Given the tritium source term available for release into the subsurface from the HFIR systems most likely to fail, it is very likely that a release from the HFIR would be conveyed to both monitoring points and be detected by the Radiological Monitoring Plan monitoring effort.

### 5.7.2.2.2 SNS Monitoring

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 into 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 which breakout 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 inducing 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 confounded by uncertainties presented by hydraulic conductivity differences exhibited by earth materials found at depth, the distribution of water bearing zones, the fate and transport characteristics of neutron activation products produced, diffusion and advection, the presence of karst geomorphic features found on the SNS site, etc. These uncertainties necessitated the initiation of a groundwater surveillance monitoring program at the SNS site. Groundwater surveillance monitoring started as a baseline monitoring program. The baseline monitoring program was initiated in April 2004 and ceased in April 2006, prior to start-up of the SNS. Concurrent with the initiation of operational testing and the completion of baseline monitoring, operational monitoring began under the biennial *Operational Monitoring Plan* (April 2006–March 2008). Objectives of the groundwater monitoring program outlined in the *Operational Monitoring Plan* include (1) determination of compliance with applicable environmental quality standards and public exposure limits outlined in DOE Orders 450.1A and 5400.5, respectively and (2) provide uninterrupted monitoring of the SNS site. Operational monitoring will continue during the operation of the SNS facility.

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 during the operational monitoring period. The locations of the SNS monitoring points were chosen based on hydrogeological factors and proximity to the beam line. Sampling locations were within the seeps/springs or in surface water bodies immediately adjacent to, and downstream of, these features. Figure 5.38 shows the loc

ations of the specific monitoring points sampled during 2007.

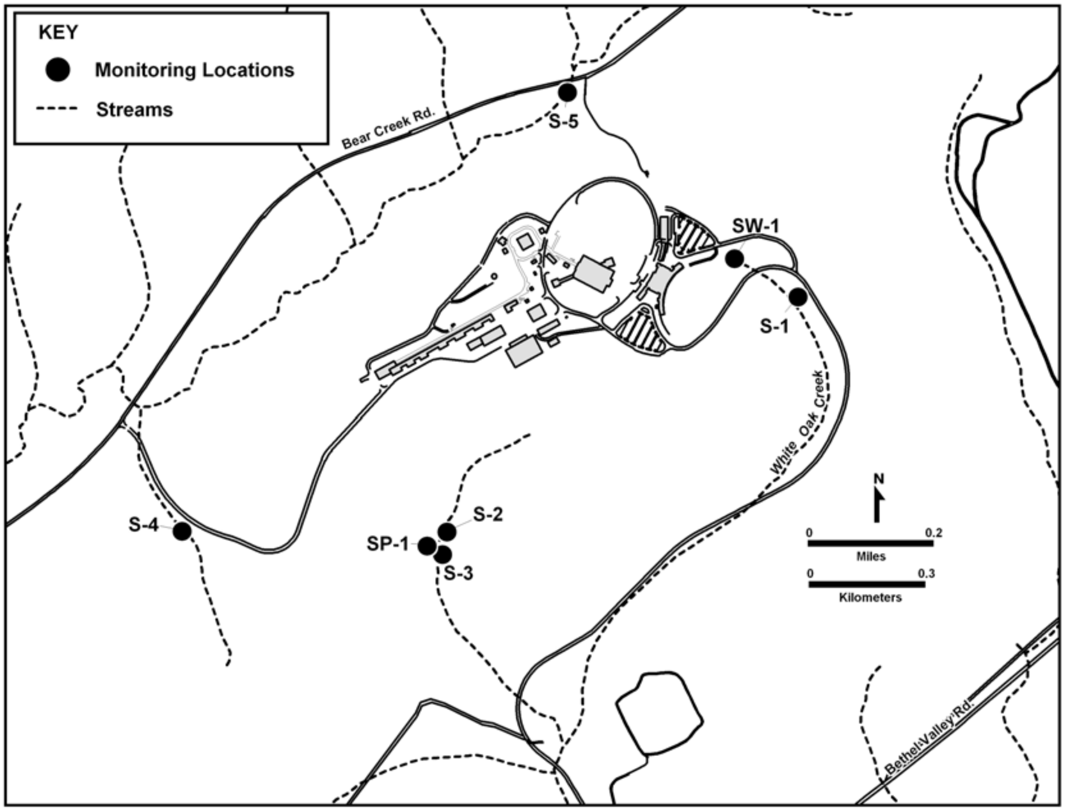



**Fig. 5.38. Groundwater monitoring locations at the Spallation Neutron Source, 2007.**

Because of the presence of karst geomorphic features at the SNS site, sampling of the seeps/springs was performed to characterize water quality throughout the expected range of flow observed at the selected monitoring locations. Three grab samples were collected from each seep/spring: one sample representing base flow and two samples representing higher stage/flow rates (i.e., one representing the rising limb of the storm hydrograph and one representing the recession [falling] limb of the storm hydrograph). Each monitoring point was sampled during base flow and higher stage flows on a quarterly basis under the *Operational Monitoring Plan*. Based on observations made during baseline monitoring, sampling frequency changes in the parameters of interest were made. From an operational standpoint, tritium and $^{14}C$ are the principal groundwater constituents of concern at the SNS site given their fate and transport characteristics. In 2007, samples were collected on a quarterly basis for tritium and $^{14}C$ analyses. Additionally, samples were collected annually during wet season base flow conditions for gross activity (alpha and beta) and selected gamma spectroscopic analyses. Samples were analyzed using EPA analytical methods by a certified laboratory.

### 5.7.2.2.2.1 SNS Site Results

Gross alpha activity was detected in the February 2007 base flow sampling event at monitoring point S-5. Moreover, the gross alpha concentration exceeded its reference value. No other radionuclide exceeded its reference value during the monitoring period. Gross beta activity was detected in samples collected during the February 2007 sampling event during base flow conditions at S-2, S-3, and S-5. No $^{14}C$ was detected in samples collected at any SNS monitoring points during the 2007 monitoring period. Tritium was detected in a quality assurance duplicate sample collected at monitoring point S-5 during falling limb flow conditions in June 2007. Nonetheless, the concentration of tritium was 2 orders of magnitude below its reference value.

Review and analysis of the data collected under the *Operational Monitoring Plan* will be performed periodically and modifications to the monitoring protocol will be made as needed. SNS staff are committed to performing groundwater monitoring throughout the duration of its operations.

## 5.8 Monitoring Results

### 5.8.1 2007 Exit Pathway Groundwater Surveillance Monitoring

Trend analyses were performed on exit pathway monitoring data of interest that exceeded reference values in 2007. Historical time series data collected from the late 1980s through 2007 were used as the bases for the trend analyses. Where there was insufficient data density to perform statistical trend analysis, trending was not performed. Concentrations of naturally occurring metals (e.g., aluminum, iron, manganese, zinc, magnesium) that exceeded reference values were not subjected to trend analysis because these constituents are relatively common in the soil and rock composing the Valley and Ridge Physiographic Province and are regularly found in groundwater samples collected from wells at ORNL. Moreover, trend analyses were not performed on 2007 monitoring data which were reported undetected by the laboratory, but their minimum detection limits exceeded reference values (i.e., semi-volatile organic compounds atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol).

Due to dry conditions encountered, samples were not collected at BC-01, S-01, and EE-02 during the dry season because of the climatic-based moisture deficit effecting East Tennessee during 2007.

As stated above, results of EMEF Program monitoring at Bechtel Jacobs well locations proximal to the WOC Discharge Area Exit Pathway exit pathway are summarized in the 2007 *Remediation Effectiveness Report* (DOE 2008) and in OREIS.

### 5.8.2 WOC Discharge Area Exit Pathway Results

Monitoring wells 857, 858, 1190, 1191, and 1239 were sampled in May and July/August 2007 by UT-Battelle. Three radiological constituents were found in two wells at concentrations greater than the reference values used for comparison. The three radiological constituents that exceeded reference values were tritium in well 1190 and gross beta activity, total radioactive strontium, and tritium in well 1191. A statistically significant downward trend exists for all three radiological constituents at both sampling locations. Gross alpha activity and $^{214}$Pb were detected in well 1191 but did not exceed their respective reference values. Tritium and gross beta activity were detected in samples collected from wells 857 and 858, respectively, but these constituents did not exceed their reference values in 2007. The presence of the radiological constituents in these wells is related to continued discharges of legacy contamination associated with past waste disposal activities within Melton Valley (gross beta activity, tritium and total radioactive strontium), or are associated with decay of naturally occurring radionuclides. One metal of interest (lead) exceeded its reference value in well 857 in samples collected during 2007. Trend analysis of lead data indicates the presence of a statistically significant downward trend for lead in well 857. Several other metals exceeded their reference values during 2007, but these metals (aluminum, iron, and manganese) are routinely found in the soil, rock, and groundwater at ORNL.

As mentioned above, detection limits for several undetected semi-volatile organic compounds exceeded their reference values in samples collected from WOC Discharge Area monitoring points. No other organic compounds were present above their reference values in samples collected from WOC Discharge Area monitoring point, however a common plasticizer [bis(2-ethylhexyl) phthalate] was detected at low concentrations in wells 1190 and 1239 (this plasticizer was also found in these wells in 2006). Bis(2-ethylhexyl) phthalate was also detected at low, estimated concentrations in well 857. Diethyl phthalate was also detected in low, estimated concentrations in samples collected from well 1239 in 2007. Methylene chloride was found at low, estimated concentrations in laboratory blank samples collected from wells 857 and 858. It was also found at a low, estimated concentration in a sample collected from well 1191.

### 5.8.2.1 7000/Bearden Creek Watershed Discharge Area Exit Pathway Results

Wells 1198 and 1199 were sampled by UT-Battelle in April and August 2007. BC-01 was sampled in May 2007 but no dry season sample was collected because the spring was dry. Tritium was detected at levels below its reference values in samples collected at wells 1198, 1199, and BC-01. Gross beta activity was detected in well 1199 but at a concentration below its reference value. Two metal constituents (aluminum and iron) exceeded their respective reference values at wells 1198 and BC-01, but these metals are common in groundwater at ORNL.

As noted in Sect. 5.10.1, detection limits for several undetected semi-volatile organic compounds exceeded their reference values. No other organic compounds were present above their reference values in samples collected however tetrachloroethene, toluene, and benzene were detected at low, estimated concentrations in well 1199. Toluene was also detected at a low, estimated concentration in well 1198. Follow up sampling will be performed in 2008 to determine if these contaminants are, in fact, present in these wells. Methylene chloride was also found at a low, estimated concentration in a laboratory blank sample collected from 1199. Plasticizers bis(2-ethylhexyl) phthalate and diethyl phthalate were detected at low, estimated concentrations in well 1198 and diethyl phthalate was detected at a low, estimated concentration in well 1199.

### 5.8.2.2 East End Discharge Area Exit Pathway Results

Well 923 was sampled in May and July 2007. EE-01 was sampled in April and July 2007. EE-02 was sampled during the wet season in 2007 (April) because there was no flow at this monitoring point during the dry season. No radiological constituents were present above reference values in samples collected from East End Discharge Area monitoring points, however low concentrations of tritium were detected in the samples collected from EE-01 in 2007. Aluminum, iron, and manganese exceeded reference values in EE-01 and EE-02 and iron exceeded its reference value in well 923, but these metals are relatively common in the soil, rock, and groundwater at ORNL.

As mentioned above, detection limits for several undetected semi-volatile organic compounds exceeded their reference values. No other organic compounds were detected in samples collected from East End Discharge Area monitoring points.

### 5.8.2.3 Northwestern Discharge Area Exit Pathway Results

Wells 531 and 535 were sampled in May and August 2007 by UT-Battelle. No radiological constituents were present above reference values in samples collected from wells 531 and 535; however, low levels of gross beta activity and tritium were detected in the samples collected in wells 531 and 535, respectively. The concentration of lead exceeded its reference value in the May 2007 sample collected from well 535 (lead exhibits a statistically insignificant upward trend in this well). Lead was reported exceeding its reference value in well 536 in 2006. Aluminum, iron, and manganese exceeded reference values, but as stated previously, these metals are common in groundwater at ORNL.

As mentioned previously, detection limits for several undetected semi-volatile organic compounds exceeded their reference values. No other organic compounds were present above reference levels in samples collected from Northwestern Discharge Area monitoring points. Toluene, benzene, and xylene were detected at low, estimated concentrations in well 531. The very low concentrations of toluene, benzene, and xylene detected in well 531 may be related to runoff from the parking lot located up-gradient of the well. Benzoic acid was detected in low, estimated concentrations in wells 531 and 535. Plasticizer diethyl phthalate was detected at low, estimated levels in wells 531 and 535 in 2007 and bis(2-ethylhexyl) phthalate was found in low, estimated levels in well 531. These plasticizers were found in samples collected from both wells in 2006. Plastic well casing materials used in the construction of both wells explain the presence of the phthalates in the samples.

#### 5.8.2.4 Southern Discharge Area Exit Pathway Results

Monitoring point S-01 was sampled by UT-Battelle in April 2007 but no samples were collected during the dry season sampling event because the monitoring point was dry. Monitoring point S-02 was sampled in April and August 2007. Aluminum and iron exceeded their reference values in S-01in 2007 whereas aluminum, iron, manganese, and lead exceeded their reference values at S-02. Lead exhibits a statistically insignificant upward trend in S-02. As stated above, these metals are common constituents of earth materials at ORNL. No radiological constituents or organic compounds were present above their detection limits in samples collected from Southern Discharge Area monitoring points, however, low levels of tritium and gross beta activity were detected in S-01 and S-02, respectively in 2007. As mentioned above, detection limits for several undetected semi-volatile organic compounds exceeded their reference values.

## 5.9 Quality Assurance Program

The application of quality assurance/quality control programs for environmental monitoring activities on the 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 utilizes the SBMS to provide a systematic approach to integrating quality assurance, 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 their work. SBMS translates laws, orders, directives, policies, and best management practices into Laboratory-wide subject areas and procedures.

### 5.9.1 Work/Project Planning and Control

UT-Battelle's Work/Project Planning and Control Management System establishes 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,
- work planning: analyzing hazards and defining controls,
- work execution, and
- provide feedback.

In addition, EP&WSD has approved project specific standard operating procedures (SOP) for all activities which are controlled and maintained through the ORNL Integrated Document Management System (IDMS).

Environmental sampling SOPs developed for ORNL 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.

### 5.9.2 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.

### 5.9.3 Equipment and Instrumentation

#### 5.9.3.1 Calibration

The UT-Battelle Quality Management System includes subject area directives that require all ORNL staff to use equipment of known accuracy based on appropriate calibration requirements that are traceable to an authority standard. The UT-Battelle Facilities and Operations Instrumentation and Control Technical Support tracks all equipment used in ORR environmental monitoring programs through a maintenance recall program to ensure 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.

#### 5.9.3.2 Standardization

EP&WSD sampling procedures, maintained on IDMS, include requirements and instructions for the proper standardization and usage of monitoring equipment. These 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. Sampling SOPs also include instructions for designating nonconforming instruments as “out-of-service” and initiating requests maintenance.

#### 5.9.3.3 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.

### 5.9.4 Assessment

Independent audits, surveillance, and internal management assessments are performed to verify that requirements have been accurately specified and that activities performed conform to expectations and requirements. External assessments are scheduled based on requests from auditing agencies. EP&WSD also conducts internal management assessments of ORNL 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 Assessment and Commitment Tracking System.

### 5.9.5 Analytical Quality Assurance

The contract laboratories that perform analyses of environmental samples from the ORR environmental monitoring programs are required to have documented Quality Assurance (QA)/Quality Control (QC) programs, trained and qualified staff, appropriately maintained equipment and facilities, and applicable certifications. A competitive award system is used by UT-Battelle to select laboratories that are contracted under Basic Ordering Agreements to perform analytical work to characterize ORNL environmental samples. Oversight of subcontracted commercial laboratories is performed by the DOE Environmental Management Consolidated Audit Program. 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 which monitor the performance of all subcontracted laboratories and verifies 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.

### 5.9.6 Data Management and Reporting

ORNL environmental surveillance and monitoring data management is accomplished using the Environmental Surveillance System (ESS), a web interface data management tool A software quality assurance 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 compliance screening is performed to ensure all required analyses were performed, appropriate analytical methods were employed, holding times were met, and specified detection levels were achieved.

Following the compliance screening, a series of checks is performed to determine if 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.

### 5.9.7 Records Management

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

## 5.10 Environmental Management Activities

EM is the largest DOE program in Oak Ridge, with cleanup programs under way to correct the legacies remaining from several years of energy research and weapons production.

Because of past practices, portions of land and facilities on the ORR are contaminated with radioactive elements, mercury, asbestos, polychlorinated biphenyls, and industrial wastes. The ORR is on the NPL and is being cleaned up under a federal facility agreement with the EPA and the state of Tennessee.

Progress on 2007 EM cleanup efforts at ORNL are summarized in the following sections. More detailed information is available in the Clean Up Progress Report for 2007.

### 5.10.1 Melton Valley Project Completion

More than 50 years of operation, production, and research activities at ORNL produced a legacy of contaminated inactive facilities and waste disposal areas. Many of the wastes and facilities are located in Melton Valley, which occupies approximately 405 ha in the southern portion of ORNL. Wastes in Melton Valley reside at a variety of locations, including trenches, tanks, landfills, pipelines, surface structures, and impoundments. The *Melton Valley Remedial Action Report*, which documents remediation activity completion, was approved in September 2007. This project involved capping 59 ha of waste sites, demolishing and disposing of 6,000 $ft^2$ of various buildings, and excavating 50,000 $yd^3$ of soil. The site is now subject to routine monitoring and maintenance to ensure the remediation actions remain effective.

### 5.10.2 Remediation Resumes at Molten Salt Reactor Salt Experiment Facility

After successful completion of a contractor operational readiness review, fuel removal at the Molten Salt Reactor Experiment (MSRE) facility resumed in October 2007. The MSRE facility operated from 1965 to 1969 to test the molten salt concept and was fueled by molten salt that flowed through the reactor chamber, where the nuclear chain reaction produced heat. When the reactor was shut down, the molten salt and the flush salt were drained into three fuel storage tanks located in an underground, concrete-shielded drain tank cell adjacent to the reactor cell. The current forecast to complete the fuel removal activities from the tanks is FY 2008.

### 5.10.3 3019 Project to Resolve Safety, Security Issues

The goal of the Building 3019 Project at ORNL is to resolve legacy safety and security issues associated with $^{233}$U stored the building. In FY 2007, an environmental assessment for the project was completed and a Finding of No Significant Impact under the NEPA process was issued. In May 2007 a proposal outlining the project baseline and plans for the procurement of long-lead items was approved.

## 5.11 ORNL Waste Management

### 5.11.1 ORNL Wastewater Treatment

Approximately 118 million gal of wastewater were treated and released at the PWTC in 2007. In addition, 92,000 gal of liquid LLW were treated at ORNL LLW evaporator, and 2.3 billion cubic meters of gaseous waste were treated at the ORNL 3039 Stack Facility in 2007. These waste treatment activities supported both EM and OS mission activities.

### 5.11.2 Transuranic Waste Processing Center

TRU waste processing activities carried out for DOE by EnergX addresses the three remaining waste streams stored at ORNL—contact-handled (CH) solids/debris, remote-handled (RH) solids/debris and RH sludge—and involves processing, treatment, repackaging, and off-site transportation and disposal at either the Nevada Test Site or the Waste Isolation Pilot Plant in New Mexico.

The TWPC was designed and constructed to treat and dispose 900 m$^3$ of RH sludge, 550 m$^3$ of RH-TRU/alpha LLW solids, 1,600 m$^3$ of RH LLW supernate, and 1,000 m$^3$ of CH TRU/alpha LLW solids currently stored in Melton Valley. The forecast for waste quantities to be processed at the TWPC has been updated to include the latest estimates: 2,000 m$^3$ of RH sludge, 700 m$^3$ of RH-TRU solids, and 1,500 m$^3$ of contact-handled CH-TRU solids. CH-TRU processing started December 2005. By September 30, 2007, approximately 200 m$^3$ had been processed.