Chapter 3
Affected Environment

In Chapter 3, the affected environment descriptions are presented to provide the context for understanding the environmental consequences described in Chapter 4. As such, they serve as a baseline from which any environmental changes that may be brought about by implementing the proposed action and alternatives can be identified and evaluated; the baseline conditions are the currently existing conditions. The affected environments at each site are described for the following impact areas: land resources, noise, air quality, water resources, geology and soils, ecological resources, cultural and paleontological resources, socioeconomics, existing human health risk, environmental justice, waste management, and spent nuclear fuel.

3.1 APPROACH TO DEFINING THE AFFECTED ENVIRONMENT

For this *Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (*Nuclear Infrastructure Programmatic Environmental Impact Statement* [NI PEIS]), the candidate sites for neptunium-237 storage, target fabrication, and irradiated target processing facilities to recover plutonium-238 are the Oak Ridge Reservation (ORR), the Idaho National Engineering and Environmental Laboratory (INEEL), and the Hanford Site (Hanford). As described in Chapter 2, the candidate facilities for neptunium-237 storage, target fabrication, and irradiated target processing are the Radiochemical Engineering Development Center (REDC) at ORR, Building 651 and the Fluorinel Dissolution Process Facility (FDPF) at INEEL, and the Fuels and Materials Examination Facility (FMEF) at Hanford. The facilities being considered for irradiation of the neptunium-237 targets are the High Flux Isotope Reactor (HFIR) at ORR, the Advanced Test Reactor (ATR) at INEEL, the Fast Flux Test Facility (FFTF) at Hanford, a generic commercial light water reactor (CLWR), and one or two new accelerators or a nuclear research reactor that would be located at an unspecified existing U.S. Department of Energy (DOE) site.

As described in Chapter 2, the candidate sites for target fabrication and irradiated target processing facilities for industrial and medical isotope production and for research and development are Hanford, and the unspecified DOE site, where one or two new accelerators or a research reactor would be located. The candidate facilities for these target fabrication and irradiated target processing activities would be FMEF in the Hanford 400 Area, other existing processing facilities in the Hanford 300 Area, and a new processing facility located at an existing DOE site where one or two new accelerators or research reactor would be constructed. The sites being considered for research and development irradiation activities and for irradiation of targets for the production of industrial and medical isotopes are Hanford, where FFTF is located, and an unspecified existing DOE site where one or two new accelerators or research reactor would be located.

The affected environment is described for the candidate sites for the following resource areas: land use, visual resources, noise, air quality, water resources, geology and soils, ecological resources, cultural and paleontological resources, socioeconomics, existing human health risk, environmental justice, waste management, and spent nuclear fuel management. No additional spent nuclear fuel would be generated by the operation of HFIR, ATR, or a generic CLWR for neptunium-237 target irradiation; as they would be operating, even if they were not irradiating targets discussed in this NI PEIS. Additional spent nuclear fuel would be generated by the operation of FFTF or a new reactor located on an existing DOE site. Operation of the existing HFIR, ATR, or generic CLWR would continue to generate spent nuclear fuel, which is managed under current planning. New spent nuclear fuel would be generated by the restart of FFTF or a new research reactor located on an existing DOE site. Accordingly, spent nuclear fuel management is addressed in this chapter only in the sections for Hanford and an existing DOE site where a new research reactor would be located.

DOE evaluated the environmental impacts of certain research and development activities, and of industrial isotope, medical isotope, and plutonium-238 production alternatives within defined regions of influence at each of the candidate sites and along potential transportation routes. The regions of influence are specific to the type of effect evaluated, and encompass geographic areas within which any significant impact would be expected to occur. For example, human health risks to the general public from exposure to airborne contaminant emissions were assessed for an area within an 80-kilometer (50-mile) radius of the proposed facilities. The human health risks of shipping materials between sites were evaluated for populations living along roadways linking the DOE sites. Economic effects such as job and income changes were evaluated within a socioeconomic region of influence that include the county in which the site is located, and nearby counties in which a substantial portion of the site's workforce reside. Brief descriptions of the regions of influence are given in **Table 3–1**. More detailed descriptions of the region of influence and the methods used to evaluate impacts are presented in Appendix G.

Table 3–1 General Regions of Influence for the Affected Environment

Environmental Resouces	Region of Influence
Land use and visual resources	The site and the areas immediately adjacent to the site
Noise	The site, nearby offsite areas, access routes to the sites, and the transportation corridors between the sites
Air quality	The site, nearby offsite areas within local air quality control regions, and the transportation corridors between the sites
Water resources	Onsite and adjacent surface water bodies and groundwater
Geology and soils	Geologic and soil resources within the site and nearby offsite areas
Ecological resources	The site and adjacent areas where ecological resources may be affected by construction and/or operation
Cultural and paleontological resources	The area within the site and adjacent to the site boundary
Socioeconomics	The counties where at least 90 percent of site employees reside
Existing human health risk	The site, nearby offsite areas (within 80 kilometers [50 miles] of the site, and the transportation corridors between the sites) where worker and general population radiation, radionuclide, and hazardous chemical exposures may occur
Environmental justice	The minority and low-income populations within 80 kilometers (50 miles) of the site, and along the transportation corridors between the sites
Waste management	Waste management facilities on the site
Spent fuel management	Spent fuel management facilities on the site

At each of the candidate sites, baseline conditions for each environmental resource area were determined for ongoing operations from information provided in previous environmental studies, relevant laws and regulations, and other government reports and data bases. More detailed information of the affected environment at the candidate sites can be found in annual site environmental reports and site National Environmental Policy Act (NEPA) documents.

3.2 OAK RIDGE RESERVATION

ORR, established in 1943 as one of the three original Manhattan Project sites, is located on 13,949 hectares (34,424 acres) in Oak Ridge, Tennessee, and includes the Oak Ridge National Laboratory (ORNL), the Y–12 Plant (Y–12), and the East Tennessee Technology Park. It extends over parts of Anderson and Roane counties. The primary focus of ORNL is to conduct basic and applied scientific research and technology development. Y–12 engages in national security activities and manufacturing outreach to U.S. industries. The mission of the East Tennessee Technology Park is to maintain the infrastructure until decommissioning activities have been completed.

ORNL is one of the country's largest multidisciplinary and multiprogram laboratories and research facilities. Its primary mission is to perform leading-edge nonweapons research and development in energy, health, and the environment. Other missions include production of radioactive and stable isotopes, not available from other production sources; fundamental and applied research and development in sciences and materials development; research involving hazardous and radioactive materials; environmental research; and radioactive waste disposal. These activities are primarily sponsored by various offices within DOE, including the Office of Science; Office of Environmental Management; Office of Environment, Safety and Health; and Office of Nuclear Energy, Science and Technology.

Activities at ORR that are sponsored by the DOE Office of Defense Programs are performed at Y–12, and include storage of uranium and lithium materials and weapons parts; maintenance of the capability to fabricate components for nuclear weapons; dismantlement of nuclear weapon components returned from the national stockpile; processing of special nuclear materials; and special production support to DOE design agencies and other DOE programs.

Environmental management activities are in progress at each of the major facilities within ORR. These activities consist of environmental remediation and restoration, decontamination and decommissioning of surplus facilities, and waste management.

Non-DOE activities conducted at ORR include National Oceanic and Atmospheric Administration missions and programs, which conducts meteorological and atmospheric diffusion research, sponsored by itself and DOE. This work is performed at the Atmospheric Turbulence and Diffusion Laboratory and at field sites on ORR. This laboratory also provides services to DOE contractors and operates the Weather Instrument Telemetering Monitoring System for DOE. ORR also provides support to other Federal agencies such as the U.S. Nuclear Regulatory Commission (NRC), U.S. Environmental Protection Agency (EPA), and others, and private industry in conducting basic scientific research, engineering technology development and transfer, and educational research in the areas of health, environment, and energy.

3.2.1 Land Resources

Land resources include land use and visual resources. Each of these resource areas is described for the site as a whole, as well as for the locations of the proposed activities.

3.2.1.1 Land Use

Land use may be characterized by its current use and potential for the location of human activities. Natural resource attributes and other environmental characteristics could make a site more suitable for some land uses than for others. Changes in land use may have both beneficial and adverse effects on other resources such as ecological, cultural, geological, aquatic, and atmospheric.

3.2.1.1.1 General Site Description

Land bordering ORR is predominantly rural and is used primarily for residences, small farms, forest land, and pasture land. The city of Oak Ridge has a typical urban mix of residential, public, commercial, and industrial land uses. It also includes almost all of ORR. There are four residential areas along the northern boundary of ORR, several of which have houses located within 30 meters (98 feet) of the site boundary.

Generalized land uses at ORR are shown in **Figure 3–1**. Land uses at the site include industrial, mixed industrial, institutional/research, institutional/environmental laboratory, and mixed research/future initiatives. Industrial and mixed industrial areas of the site include ORNL, Y–12, and the East Tennessee Technology Park. The institutional/research category applies to land occupied by central research facilities at ORNL and the Natural and Accelerated Bioremediation Field Research Center in Bear Creek Valley near Y–12. The institutional/environmental laboratory category includes the Oak Ridge Institute for Science and Education. Land within the mixed research/future initiative category includes land that is used or available for use in field research and land reserved for future DOE initiatives. Most mixed research and future initiatives areas are forested. Undeveloped forested lands on ORR are managed for multiple use and sustained yield of quality timber products. Although soils that would be identified as prime farmland occur on the site, that designation is waived because they are within the city of Oak Ridge (DOE 1999a). Only a small fraction of ORR has been disturbed by Federal activities, including the construction and operation of facilities, roadways, or other structures.

A large number of reservation-wide land uses overlay the primary land use categories and are officially designated as mixed uses. The largest mixed use is biological and ecological research in the Oak Ridge National Environmental Research Park, which is on 8,090 hectares (20,000 acres). The National Environmental Research Park, established in 1980, is used by the nation's scientific community as an outdoor laboratory for environmental science research on the impact of human activities on the eastern deciduous forest ecosystem (DOE 1996b; ORNL 1999). Recently, the Three Bend Scenic and Wildlife Management Refuge Area, on 1,215 hectares (3,000 acres), was set aside by DOE as a conservation and wildlife management area. The area is located in the ORR buffer zone, on Freels, Gallaher, and Solway Bends on the north shore of Melton Hill Lake (DOE 1999b). Additional details on land use plans at the site are provided in the *Oak Ridge National Laboratory Land and Facilities Plan* (LMER 1999).

Proposed short-range projects at ORR include the Composite Materials Laboratory; Laboratory for Comparative and Functional Genomics; Mixed Waste Treatment Facility; Transuranic Waste Treatment Project Facility; Recycle and Materials Processing Facility; Process Waste Treatment Facility; Industrial Landfill Expansion and Upgrades; and Steam Plant Waste Water Treatment Facility. The Spallation Neutron Source Project and the Environmental Management of Waste Management Facility are in early stages of development. DOE completed an environmental assessment for economic development leasing of 387 hectares (957 acres) of land located to the northeast of the East Tennessee Technology Park (DOE 1996a:S-1). The lease is for 40 years (DOE 2000e). The Community Reuse Organization of East Tennessee is currently developing the site as an industrial park. The locations of selected, planned, or proposed projects at ORR are shown in Figure 3–1.

Almost all of ORR lies within the city of Oak Ridge. A small portion of the northwest corner of the site lies outside the city in Roane County. The Oak Ridge Area Land Use Plan (city of Oak Ridge) designates ORR with the following land uses: residential, office/institutional, industrial, public, and undesignated. The city of Oak Ridge zoning ordinance classifies the entire ORR as a Forest, Agriculture, Industry, and Research District. The Roane County zoning ordinance does not classify ORR land; rather, it identifies ORR as a DOE Reservation.

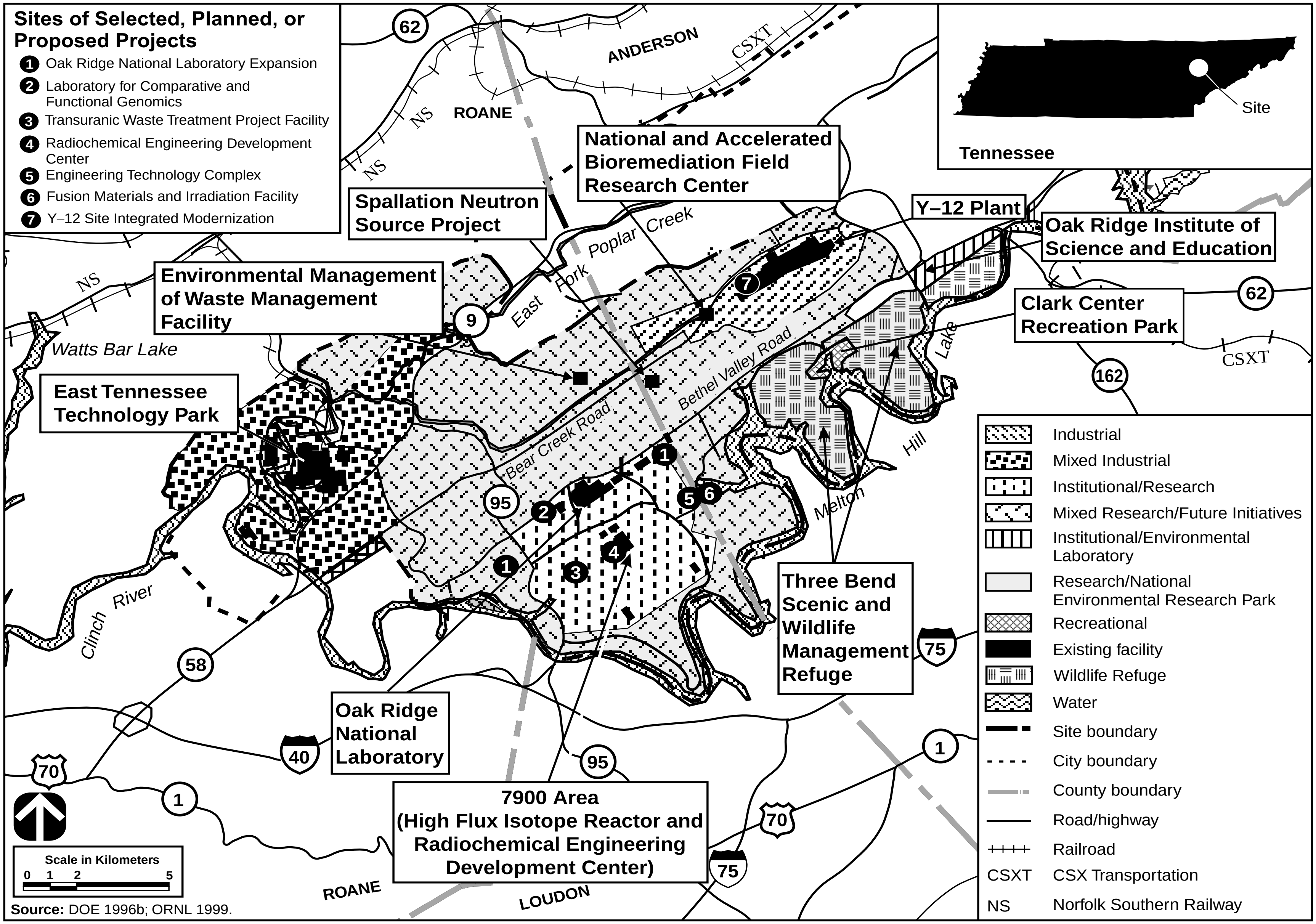

Figure 3–1 Generalized Land Use at Oak Ridge Reservation and Vicinity

3.2.1.1.2 Location of Proposed Activities

ORNL is primarily located within Bethel Valley between Haw and Chestnut Ridges, and covers 1,720 hectares (4,250 acres) of land (ORNL 1999). The site is classified as an industrial area that encompasses a number of facilities dedicated to energy research. REDC and HFIR are in the 7900 Area of ORNL. The 7900 Area is situated on a low ridge in Melton Valley, just to the southwest of Haw Ridge. The nearest public access to the 7900 Area, Bethel Valley Road, is located about 1,500 meters (4,920 feet) to the north, and the nearest residential area is about 4,100 meters (13,450 feet) to the southwest. Land surrounding ORNL is largely forested and is classified as mixed research/future initiatives.

3.2.1.2 Visual Resources

Visual resources are natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape.

3.2.1.2.1 General Site Description

The ORR landscape is characterized by a series of ridges and valleys that trend in a northeast-to-southwest direction. The vegetation is dominated by deciduous forest mixed with some coniferous forest. Most of the original open field areas on the site have been planted in shortleaf and loblolly pine, although smaller areas have been planted in a variety of deciduous and coniferous trees. The DOE facilities are brightly lit at night, making them especially visible. The developed areas of ORR are consistent with the Bureau of Land Management's Visual Resource Management Class IV rating in which management activities dominate the view and are the focus of viewer attention (DOI 1986). The remainder of ORR ranges from a Visual Resource Management Class II to Class III rating. Management activities within these classes may be seen, but should not dominate the view.

The viewshed consists mainly of rural land. The city of Oak Ridge is the only adjoining urban area. Sensitive viewpoints affected by DOE facilities are primarily associated with Interstate 40, State Highways 58, 62, and 95, and Bethel Valley and Bear Creek Roads. The Clinch River/Melton Hill Lake, and the bluffs on the opposite side of the Clinch River also have views of ORR, but views of most of the existing DOE facilities are blocked by terrain and/or vegetation. Although only a small portion of State Highway 62 crosses ORR, it is a major route for traffic to and from Knoxville and other communities. The hilly terrain, heavy vegetation, and generally hazy atmospheric conditions limit views. Partial views of the city of Oak Ridge water treatment plant can be seen from the urban areas of the city of Oak Ridge.

3.2.1.2.2 Location of Proposed Activities

ORNL is one of several highly developed areas of ORR. As noted above, such areas are consistent with the Bureau of Land Management Visual Resource Management Class IV rating. While a large part of ORNL is visible from Bethel Valley Road, it is not visible to persons in offsite locations because of the presence of the Haw and Chestnut Ridges. The 7900 Area, which is located to the south of the main ORNL complex, is not visible from any public area.

3.2.2 Noise

Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities or diminish the quality of the environment.

3.2.2.1 General Site Description

Major noise emission sources within ORR include various industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). Most ORR industrial facilities are a sufficient distance from the site boundary that noise levels at the boundary from these sources are not measurable, or are barely distinguishable from background noise levels (DOE 1996b:3-192).

Sound level measurements have been recorded at various locations within and near ORR in the process of testing sirens and preparing support documentation for the Atomic Vapor Laser Isotope Separation site. The acoustic environment along the ORR site boundary in rural areas and at nearby residences away from traffic noise is typical of a rural location, with average day-night sound levels in the range of 35 to 50 decibels A-weighted (dBA). Areas near the site within Oak Ridge are typical of a suburban area, with the average day-night sound levels in the range of 53 to 62 dBA. Traffic is the primary source of noise at the site boundary and at residences located near roads. During peak hours, the plant traffic is a major contributor to traffic noise levels in the area (DOE 1996b:3-192).

The State of Tennessee has not established specific community noise standards applicable to ORR. The city of Oak Ridge has specific acceptable sound levels at property lines (City of Oak Ridge 1999). EPA guidelines for environmental noise protection recommend a day-night average sound level of 55 dBA as sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974:29). Land use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses (14 CFR Part 150). These guidelines further indicate that noise levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures. It is expected that for most residences near ORR, the day-night average sound level is less than 65 dBA, and is compatible with the residential land use, although for some residences along major roadways noise levels may be higher.

3.2.2.2 Location of Proposed Activities

No distinguishing noise characteristics within ORNL have been identified. The ORNL 7900 Area is 2.5 kilometers (1.6 miles) from the site boundary; thus, the noise levels at the site boundary from these sources are barely distinguishable from background noise levels.

3.2.3 Air Quality

Air pollution refers to the introduction, directly or indirectly, of any substance into the air that could endanger human health, harm living sources and ecosystems and material property, and impair or interfere with the comfortable enjoyment of life or other legitimate uses of the environment. Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

3.2.3.1 General Site Description

The climate at ORR may be classified as humid continental, but is moderated by the influence of the Cumberland and Great Smoky Mountains. Winters are mild and summers are warm, with no noticeable extremes in precipitation, temperature, or winds (DOE 1996b:3-192). The average annual temperature is 13.7 °C (56.6 °F); average monthly temperatures range from a minimum of 2.2 °C (36 °F) in January to a maximum of 24.9 °C (76.8 °F) in July. The average annual precipitation is 138.5 centimeters (54.5 inches).

Prevailing winds at ORR generally follow the valley, up the valley from the southwest daytime, or down the valley from the northeast nighttime. The wind speed is less than 11.9 kilometers per hour (7.4 miles per hour) 75 percent of the time; tornadoes and winds exceeding 30 kilometers per hour (18 miles per hour) are rare (Hamilton et al. 1999:1-4).

ORR is located in the Eastern Tennessee and Southwestern Virginia Interstate Air Quality Control Region #207. The areas within this Air Quality Control Region are in attainment with respect to the National Ambient Air Quality Standards (NAAQS) for criteria pollutants (40 CFR Section 81.343). Applicable NAAQS and Tennessee State ambient air quality standards are presented in **Table 3–2**.

Table 3–2 Comparison of Modeled Ambient Air Concentrations from Oak Ridge Reservation Sources with Most Stringent Applicable Standards or Guidelines, 1998

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meters)[a]	ORR Concentration (micrograms per cubic meters)
Criteria pollutants			
Carbon monoxide	8 hours	10,000[b]	8.05
	1 hour	40,000[b]	27.1
Nitrogen dioxide	Annual	100[b]	1.58
Ozone	1 hour	235[c]	(d)
PM_{10}	Annual	50[b]	1.6
	24 hours	150[b]	12.7
Sulfur dioxide	Annual	80[b]	4.86
	24 hours	365[b]	35.7
	3 hours	1,300[b]	112.0
Other regulated pollutants			
Total suspended particulates	24 hours	150[e]	2[f]

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.
b. Federal and state standard.
c. Federal 8-hour standard is currently under litigation.
d. Not directly emitted or monitored by the site.
e. State standard.
f. Based on stack emissions of particulate matter only.

Note: Emissions of hazardous air pollutants not listed here have been identified at ORR, but are not associated with any alternative evaluated. EPA revised the ambient air quality standards for particulate matter and ozone in 1997 (62 FR 38856, 62 FR 38652); however, these standards are under litigation, but could become enforceable during the life of this project.
Source: 40 CFR Part 50; Hamilton et al. 1999; TDEC 1999a; modeled site boundary concentrations using 1998 meteorological data and 1998 emissions data.

One Prevention of Significant Deterioration Class I area can be found in the vicinity of ORR. A Class I area is one in which very little increase in pollution is allowed due to the pristine nature of the area. This area, the Great Smoky Mountains, is located 48.3 kilometers (30 miles) southeast of ORR. ORR and its vicinity are classified as a Class II area in which more moderate increases in pollution are allowed. Since the creation of the Prevention of Significant Deterioration program in 1977, no Prevention of Significant Deterioration permits have been issued for any emission source at ORR (DOE 1996b:3-192).

The primary sources of criteria air pollutants at ORR are the steam plants at ORNL, Y–12, and the East Tennessee Technology Park. Other emission sources include the Toxic Substances Control Act incinerator;

various process sources; vehicles, temporary emissions from construction activities; and fugitive particulate emissions from coal piles (DOE 1996b:3-192; Hamilton et al. 1999).

The existing ambient air pollutant concentrations attributable to sources at ORR are presented in Table 3–2. These concentrations are based on dispersion modeling, using emissions for the year 1998 (Hamilton et al. 1999). Only those pollutants that would be emitted by any of the alternatives evaluated in this NI PEIS are presented. As shown in Table 3–2, modeled concentrations associated with ORR emission sources represent a small percentage of the ambient air quality standard.

The closest offsite monitors are operated by the Tennessee Department of Environment and Conservation in Anderson County and the city of Knoxville. In 1999, these monitors reported a maximum 8-hour average carbon monoxide concentration of 4,466 micrograms per cubic meter and maximum 1-hour average concentration of 12,712 micrograms per cubic meter. An annual average particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) concentration of 30.0 micrograms per cubic meter and a maximum 24-hour average concentration of 71 micrograms per cubic meter were reported. Annual, 24-hour, and 3-hour average sulfur dioxide maximum concentrations of 7.9 micrograms per cubic meter, 78.5 micrograms per cubic meter, and 293 micrograms per cubic meter, respectively, were also reported in 1999 (EPA 2000).

Because ORR sources are limited or background concentrations of criteria pollutants are well below ambient standards, ORR emissions should not result in air pollutant concentrations that violate the ambient air quality standards.

3.2.3.2 Location of Proposed Activities

HFIR and REDC are located in the 7900 Area of ORNL. The 7900 Area is situated in Melton Valley, south of the main portion of ORNL, between the Cumberland Mountains to the northwest, and the Great Smoky Mountains to the southeast. Terrain generally consists of ridges and valleys oriented southwest-northeast. The prevailing winds tend to follow this flow (LMER 1998:2.3-1, 2.3-2).

Current nonradiological emissions from the HFIR/REDC facilities are minimal, and result from wet chemistry and laboratory scale activities located at the facility. Additional nonradiological emissions result from maintenance activities inside the facility and in a small shop located adjacent to HFIR/REDC and testing of emergency diesel generators. Current Tennessee Department of Environment and Conservation air pollution control rules do not require that these emissions be permitted or quantified (Smith 2000). The existing ambient air pollutant concentrations attributable to sources at HFIR and REDC are presented in **Table 3–3**. These concentrations are estimated using SCREEN3 and are expected to over estimate the contribution to site boundary concentrations.

The primary sources of nonradiological air pollutants at ORNL include the facility steam plant, discussed in Section 3.2.3.1, and two small oil-fired boilers, which account for 98 percent of all allowable emissions. ORNL has 21 air permits covering 201 air emission sources. In 1998, the Tennessee Department of Environment and Conservation inspected all permitted sources and found them to be in compliance (Hamilton et al. 1999:2-23).

Table 3–3 Comparison of Modeled Ambient Air Concentrations from Sources at HFIR and REDC with Most Stringent Applicable Standards or Guidelines

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meters)[a]	HFIR/REDC Concentration (micrograms per cubic meters)
Criteria pollutants			
Carbon monoxide	8 hours	10,000[b]	31.5
	1 hour	40,000[b]	45.1
Nitrogen dioxide	Annual	100[b]	0.0072
Ozone	1 hour	235[c]	(d)
PM_{10}	Annual	50[b]	0.0005
	24 hours	150[b]	5.96
Sulfur dioxide	Annual	80[b]	0.0005
	24 hours	365[b]	5.51
	3 hours	1,300[b]	12.4
Other regulated pollutants			
Total suspended particulates	24 hours	150[e]	5.96

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.
b. Federal and state standard.
c. Federal 8-hour standard is currently under litigation.
d. Not directly emitted or monitored by the site.
e. State standard.

Source: 40 CFR Part 50; Hamilton et al.1999; TDEC 1999a; modeled concentrations using SCREEN3 and emissions estimate for periodic testing of diesel generators.

3.2.4 Water Resources

Water resources include all forms of surface water and subsurface groundwater.

3.2.4.1 Surface Water

Surface water includes marine or freshwater bodies that occur above the ground surface, including rivers, streams, lakes, ponds, rainwater catchments, embayments, and oceans.

3.2.4.1.1 General Site Description

The major surface water feature in the immediate vicinity of ORR is the Clinch River, which borders the site to the south and west. There are four major sub-drainage basins on ORR that flow into the Clinch River and are affected by site operations: Poplar Creek, East Fork Poplar Creek, Bear Creek, and White Oak Creek. Several smaller drainage basins, including Ish Creek, Grassy Creek, Bearden Creek, McCoy Branch, Kerr Hollow Branch, and Raccoon Creek, drain directly to the Clinch River (**Figure 3–2**). Each drainage basin takes the name of the major stream flowing through the area. The three major facilities at ORR each affect

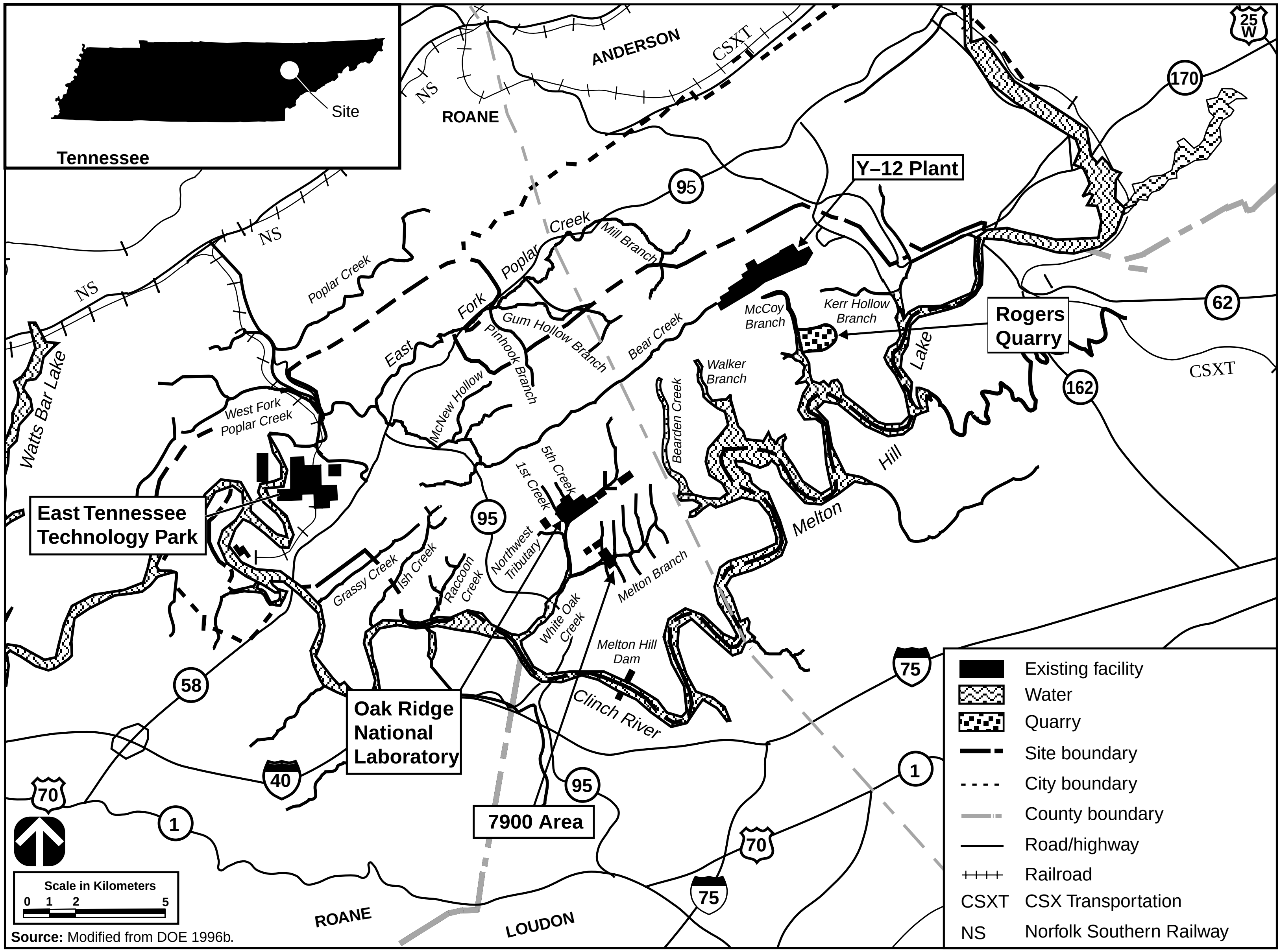

Figure 3–2 Surface Water Features at Oak Ridge Reservation

different basins of the Clinch River. Drainage from Y–12 enters both Bear Creek and East Fork Poplar Creek; the East Tennessee Technology Park drains mainly into Poplar Creek; and ORNL drains into White Oak Creek (DOE 1996b:3-194).

The Clinch River and connected waterways supply the raw water for ORR. The Clinch River has an average flow rate of 132 cubic meters (4,647 cubic feet) per second, as measured at the downstream side of Melton Hill Dam. The average flow rates of Grassy, Ish, and Bear Creeks in the ORR area are 0.08 cubic meters (2.8 cubic feet) per second, 0.05 cubic meters (1.8 cubic feet) per second, and 0.11 cubic meters (3.9 cubic feet) per second, respectively. The average flow rate at East Fork Poplar Creek is 1.46 cubic meters (51.4 cubic feet) per second. Y–12 uses 7,530 million liters (1,989 million gallons) per year of water, and ORR uses 14,210 million liters (3,754 million gallons) per year (DOE 1996b:3-194). The ORR water supply system, which includes the city of Oak Ridge treatment facility (formerly the DOE treatment facility) and the East Tennessee Technology Park treatment facility, has a capacity of 90.8 to 121.5 million liters (24 to 32.1 million gallons) per day (DOE 1996b:3-194; LMER 1999:3-24).

The Clinch River water levels in the vicinity of ORR are regulated by a system of dams operated by the Tennessee Valley Authority. Melton Hill Dam controls the flow of the Clinch River along the northeast and southeast sides of ORR. Watts Bar Dam on the Tennessee River near the lower end of the Clinch River controls the flow of the Clinch River along the southwest side of ORR (DOE 1996b:3-194).

The surface streams of Tennessee are classified by the Tennessee Department of Environmental Conservation according to the Use Classifications for Surface Waters. Classifications are based on water quality, beneficial uses, and resident aquatic biota. The Clinch River is the only surface water body on or near ORR classified for domestic water supply. Unless otherwise specified in these rules, all streams in Tennessee are classified for use for fish and aquatic life, recreation, irrigation, and for livestock watering and wildlife. In addition, the Clinch River and a short segment of Poplar Creek from its confluence with the Clinch River are also classified for industrial water supply use. White Oak Creek and Melton Branch are the only streams on ORR not classified for irrigation (TDEC 1999b). East Fork Poplar Creek is posted by the State of Tennessee with warnings against fishing and contact recreation (O'Donnell 2000).

Wastewater treatment facilities are located throughout ORR, including six treatment facilities at Y–12 that discharge to East Fork Poplar Creek, and three treatment facilities at ORNL that discharge into White Oak Creek Basin. These discharge points are included in existing National Pollutant Discharge Elimination System (NPDES) permits. Y–12 also has a permit to discharge wastewater to the city of Oak Ridge Treatment Facility. The East Tennessee Technology Park operates one sanitary sewage system discharging to Poplar Creek (DOE 1996b:3-196).

There are more than 400 NPDES-permitted outfalls at ORR associated with the three major facilities (Y–12 Plant, East Tennessee Technology Park, and ORNL); many of these are storm water outfalls. ORNL is currently operating under NPDES Permit TN0002941, which was renewed by the Tennessee Department of Environmental Conservation on December 6, 1996, and went into effect on February 3, 1997. This permit lists 164 point-source discharges that require compliance monitoring. Approximately 100 of these are storm drains, roof drains, and parking lot drains. Compliance was determined by approximately 6,500 laboratory analyses and measurements in 1998, in addition to numerous field observations by ORNL field technicians. The NPDES permit compliance rate was nearly 100 percent with only three permit exceedances. The NPDES permit limit compliance rate for all discharge points for the three major facilities in 1998 was over 99 percent (Hamilton et al. 1999:2-18, 2-19).

Compared with the previous permit, the new ORNL NPDES permit includes more stringent limits based on water quality criteria at a number of outfalls. The new permit also requires ORNL to conduct detailed characterization of numerous storm water outfalls, conduct an assessment and evaluation for the modification of the Radiological Monitoring Plan, develop and implement a Storm Water Pollution Prevention Plan, implement a revised Biological Monitoring and Abatement Program Plan, and develop and implement a Chlorine Control Strategy (Hamilton et al. 1999:2-19).

At ORR, water samples are collected and analyzed from 22 locations around the reservation to assess the impact of past and current DOE operations on the quality of local surface water. Sampling locations include streams, both upstream and downstream of ORR waste sources, and public water intakes. Samples are collected and analyzed for general water quality parameters at all locations, and are screened for radioactivity and analyzed for specific radionuclides, when appropriate. Based on 1998 sampling data, radionuclides were detected at all but two surface water locations, which were dry when sampling was attempted. High levels of radioactivity (gross alpha, gross beta, and total radioactive strontium) relative to applicable standards or criteria detected at First Creek within ORNL are attributed to leakage to backfill and soil from underground waste storage Tank W-1A at ORNL. Uranium isotopes were determined to be the primary alpha emitters. Excluding the First Creek site, the highest levels of gross beta, total radioactive strontium and tritium were detected at White Oak Creek at White Oak Dam and at White Oak Creek and Melton Branch, both downstream from ORNL. These data are consistent with historical data and with process or legacy activities nearby or upstream from these sites. Elevated levels of gross beta and total radioactive strontium have also been detected at Raccoon Creek and Northwest Tributary. Locations that were checked for volatile organic compounds showed either low or undetectable levels. Polychlorinated biphenyls were not detected at either of the two sites sampled. Except for lead in 1 sample, and zinc in 3 samples out of 12 respectively, at the Clinch River upstream from all DOE inputs, no metals of human health concern were detected (Hamilton et al. 1999:7-6, 7-10, 7-11, D-5, D-8, D-11, D-13, D-14).

In Tennessee, the state's water right laws are established under the Water Quality Control Act. In effect, water rights are similar to riparian rights, in that designated usages of a water body cannot be impaired. Before withdrawing water from available supplies, a U.S. Army Corps of Engineers permit to construct intake structures would need to be obtained (DOE 1996b:3-196). In addition, projects and activities with the potential to affect aquatic resources could require permits from the Tennessee Department of Environment and Conservation and the Tennessee Valley Authority (Hamilton et al. 1999:2-20).

The Tennessee Valley Authority has conducted flood studies along the Clinch River, Bear Creek, and East Fork Poplar Creek. Portions of Y–12 lie within the 100- and 500-year floodplain boundaries of East Fork Poplar Creek. Studies have not been performed to delineate the 100- or 500-year floodplain boundaries of Grassy, Ish, and Bear Creeks in the western half of the site (DOE 1996b:3-194).

The Tennessee Valley Authority has performed probable maximum flood studies along the Clinch River. The probable maximum flood is the flood that can be expected from the most severe combination of critical hydrometeorological conditions that are reasonably possible over the entire watershed. The probable maximum flood level along the Clinch River at the mouth of Bearden Creek occurred at elevation 248.3 meters (814.7 feet), while the probable maximum flood level at the mouth of White Oak Creek occurred at elevation 237.5 meters (779.3 feet). Based on the studies, most of ORR is above the probable maximum flood elevation along the Clinch River (LMER 1999:2-8).

3.2.4.1.2 Location of Proposed Activities

HFIR and REDC are in the 7900 Area on a low ridge in Melton Valley. HFIR overlooks Melton Branch, a tributary of White Oak Creek, with the REDC complex (Buildings 7920 and 7930) just north and upslope of HFIR (LMER 1998:2.4-1). Two reservoir systems supply water to ORNL facilities in Melton Valley and the 7900 Area, in particular, and also to facilities in Bethel Valley. The first is to the north of the 7900 Area on

Chestnut Ridge and consists of a concrete storage reservoir with a capacity of 11.4 million liters (3 million gallons). A project to construct a second 3.8-million-liter (1-million-gallon) storage reservoir adjacent to the existing one is planned. The second system is on Haw Ridge and consists of two steel reservoir tanks, each with a storage capacity of 5.7 million liters (1.5 million gallons). These tanks are designated to provide reserve capacity for HFIR, REDC, and other facilities in Melton Valley. Water usage by ORNL Melton Valley facilities ranges from 9.5 million liters (2.5 million gallons) per day in the winter to a maximum of 18.9 million liters (5 million gallons) per day in the summer. The reservoir distribution system can supply 26.5 million liters (7 million gallons) per day (LMER 1999:3-25). These reservoirs are supplied by the city of Oak Ridge water treatment plant, which receives its water from the Melton Hill Reservoir via a pumping station upstream from HFIR. Either of the two reservoirs is capable of supplying the normal 3,785 liters (1,000 gallons) per minute cooling water requirements of HFIR (Building 7900) (LMER 1998:2.4-1). Based on the most recent water use survey, the HFIR complex (i.e., Buildings 7900–7903, 7910, and 7916) uses a total of approximately 6.1 million liters (1.6 million gallons) of water per day or about 2.23 billion liters (589 million gallons) annually. REDC (Buildings 7920 and 7930) uses approximately 294,000 liters (77,800 gallons) of water per day or 107 million liters (28.4 million gallons) per year (Wham 2000c). The major water demand by both HFIR and REDC is for cooling purposes.

Sanitary wastewater from the 7900 Area is conveyed to the ORNL Sewage Treatment Plant, which provides primary, secondary, and tertiary sewage treatment. The Sewage Treatment Plant has a treatment capacity of 1.1 million liters (300,000 gallons) per day. Since 1997, treated flows have ranged from about 685,000 to 821,000 liters (181,000 to 217,000 gallons) per day (LMER 1999:3-62, 3-63). Specifically, the HFIR complex is estimated to generate about 7.3 million liters (1.93 million gallons) of sanitary wastewater per year with REDC generating an additional 3.1 million liters (828,000 gallons) annually (Wham 2000a).

Process wastewater from HFIR and REDC is collected and conveyed to storage tanks prior to processing in the Process Waste Treatment Complex. Continuous monitoring of the wastewater in the collection system is used to route the wastewater to the appropriate treatment process. The Process Waste Treatment Complex consists of two facilities, Buildings 3544 and 3608, which provide both nonradiological and radiological effluent treatment. Treatment in Building 3608 consists of precipitation, filtration, air stripping, and neutralization to remove particulates, heavy metals, and organics, and to control pH before discharge. A clarifier is also used to perform process wastewater softening prior to transfer to Building 3544 for further treatment. Treatment capacity is 4.2 million liters (1.1 million gallons) per day. Treatment in Building 3544 consists of precipitation, filtration, and ion exchange. The maximum treatment capacity is about 1.9 million liters (504,000 gallons) per day (LMER 1999:3-64, 3-65).

All wastewater treated at Buildings 3544 and 3608 is ultimately discharged to White Oak Creek through a single NPDES-permitted outfall (Outfall X12). The flow rate from this outfall averages about 2.08 million liters (550,000 gallons) per day, of which approximately 66,245 liters (17,500 gallons) per day are attributable to process wastewater from HFIR and REDC. The treated effluent from Outfall X12 meets NPDES water quality–based limits for metals and organics and DOE Derived Concentration Guides (DOE Order 5400.5), and is not toxic to aquatic species based on NPDES-required toxicity testing. HFIR and REDC also discharge dechlorinated cooling water and cooling tower blowdown to Melton Branch through NPDES-permitted outfalls 081 and 281. Discharge from Outfall 281, which is predominantly HFIR cooling tower blowdown, averages about 378,500 liters (100,000 gallons) per day in the warm months. The discharge rate from Outfall 081 averages approximately 265,000 liters (70,000 gallons) per day during the warm months and consists primarily of REDC cooling water (Valentine 2000). Waste management activities and facilities are discussed in greater detail under Section 3.2.11.

Melton Branch, the primary stream in the immediate vicinity of HFIR and REDC, was analyzed to assess the potential for flooding from a locally intense storm, based on probable maximum precipitation events. The analysis determined that the relatively high elevation of the terrain and slope of the 7900 Area ensures that locally intense precipitation would not cause the Melton Branch to flood equipment at the HFIR site and vicinity. Likewise, the occurrence of a probable maximum flood at the mouth of White Oak Creek or along Melton Branch due to probable maximum precipitation events would not inundate the HFIR and vicinity. Surface runoff and facility drainage flows to either of two headwater tributaries of Melton Branch on the east and west sides, respectively, of the 7900 Area (LMER 1998:2.4-6, 2.4-7).

3.2.4.2 Groundwater

Aquifers are classified by Federal and state authorities according to use and quality. The Federal classifications include Classes I, II, and III groundwater. Class I groundwater is either the sole source of drinking water, or is ecologically vital. Classes IIA and IIB are current or potential sources of drinking water (or other beneficial use), respectively. Class III is not considered a potential source of drinking water and is of limited beneficial use.

3.2.4.2.1 General Site Description

ORR is in an area of sedimentary rocks of widely varying hydrologic character. Groundwater flow occurs at shallow depths with discharge to nearby surface waters. Depth to groundwater is generally 5 to 9 meters (16 to 30 feet), but may be as little as 1.5 meters (5 feet). All aquifers are considered Class II (DOE 1996b:3-196).

Two broad hydrologic regimes have been characterized at ORR, each having fundamentally different hydrologic characteristics. The Knox Group and the Maynardville Limestone of the Conasauga Group constitute the Knox aquifer, in which flow is dominated by solution conduits formed along fractures and bedding planes. The less permeable ORR aquitard units constitute the second regime, in which flow is dominated by fractures (DOE 1999a:4-12; Hamilton et al. 1999:1-5, 1-6). These hydrologic groupings and the geologic units comprising them are illustrated in **Figure 3–3**. The combination of fractures and solution conduits in the dolostones and limestones of the Knox aquifer control flow over substantial areas, and rather large quantities of water may move relatively long distances. The Knox aquifer is the primary source of groundwater to many streams (base-flow), and most large springs on ORR receive discharge from the Knox aquifer. Yields of some wells penetrating larger solution conduits are reported to exceed 3,785 liters (1,000 gallons) per minute. Units at ORR constituting the ORR aquitards include the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group, and consist mainly of siltstone, shale, sandstone, and thinly bedded limestone of low to very low permeability. The typical yield of a well in the aquitards is less than 3.8 liters (1 gallon) per minute, and the base flows of streams draining areas underlain by the aquitards are poorly sustained because of such low flow rates (Hamilton et al. 1999:1-5).

Subsurface flow in both the Knox aquifer and in the aquitards is recharged mainly on ridges and is discharged into lakes, streams, springs, and seeps (DOE 1999a:4-12). Within ORR, the Knox aquifer underlies some of the major ridges (e.g., Chestnut and Copper Ridge) and aquitard units predominate under the valleys (e.g., Bear Creek, Bethel, and Melton valley) (Hamilton et al. 1999:1-7, 1-8) (**Figure 3–4**). Because of the abundance of surface water and its proximity to the points of use, very little groundwater is used at ORR. Only one water supply well exists on ORR; it provides a supplemental water supply to an ORNL aquatic biology laboratory during extended droughts (DOE 1996b:3-196).

Groundwater samples are collected quarterly from representative wells selected from more than 1,000 monitoring wells throughout ORR. Samples collected from monitoring wells are analyzed for a standard set of parameters, including trace metals, volatile organic compounds, radioactive materials, and acidity/basicity. Background groundwater quality at ORR is generally good in the near-surface aquifer zones, and poor in the bedrock aquifer at depths greater than 305 meters (1,000 feet), due to high total dissolved

Age		Group	Formation		Thickness, meters	Hydrologic Unit
Ordovician	Upper	Chickamauga Group	Moccasin Formation		100–170	Aquitard
			Witten Formation		105–110	
			Bowen Formation		5–10	
	Middle		Benbolt/Wardell Formation		110–115	Aquifer
			Rockdell Formation		80–85	
			Hogskin Member Fleanor Shale Member	Lincolnshire Formation	75–80	Aquitard
			Eidson Member		70–80	
			Blackford Formation			
	Lower	Knox Group	Mascot Dolomite		75–150	Knox Aquifer
			Kingsport Formation		90–150	
			Longview Dolomite		40–60	
			Chepultepec Dolomite		152–213	
Cambrian	Upper		Copper Ridge Dolomite		244–335	
		Conasauga Group	Maynardville Limestone		100–110	Aquitard
	Middle		Nolichucky Shale		150–180	
			Dismal Gap Formation (Formerly Maryville Limestone)		98–125	
			Rogersville Shale		25–34	
			Friendship Formation (Formerly Rutledge Limestone)		31–37	
			Pumpkin Valley Shale		56–70	
	Lower		Rome Formation		122–183	

Source: Modified from DOE 1999a. **Note:** To convert meters to feet multiply by 3.281.

Figure 3–3 Stratigraphic Column for the Oak Ridge Reservation

solids (DOE 1996b:3-197). Information on more recent groundwater monitoring and chemical analysis is presented in the annual site environmental report (Hamilton et al. 1999).

Groundwater in the Bear Creek Valley near Y–12 and in the ORNL and East Tennessee Technology Park areas has been locally contaminated by hazardous chemicals and radionuclides from past process activities. The contaminated sites include past waste disposal sites, waste storage tanks, spill sites, and contaminated inactive facilities (DOE 1996b:3-197).

Industrial and drinking water supplies are primarily taken from surface water sources. However, single-family wells are common in adjacent rural areas not served by the public water supply system. Most of the residential wells in the immediate vicinity of ORR are south of the Clinch River (DOE 1996b:3-197).

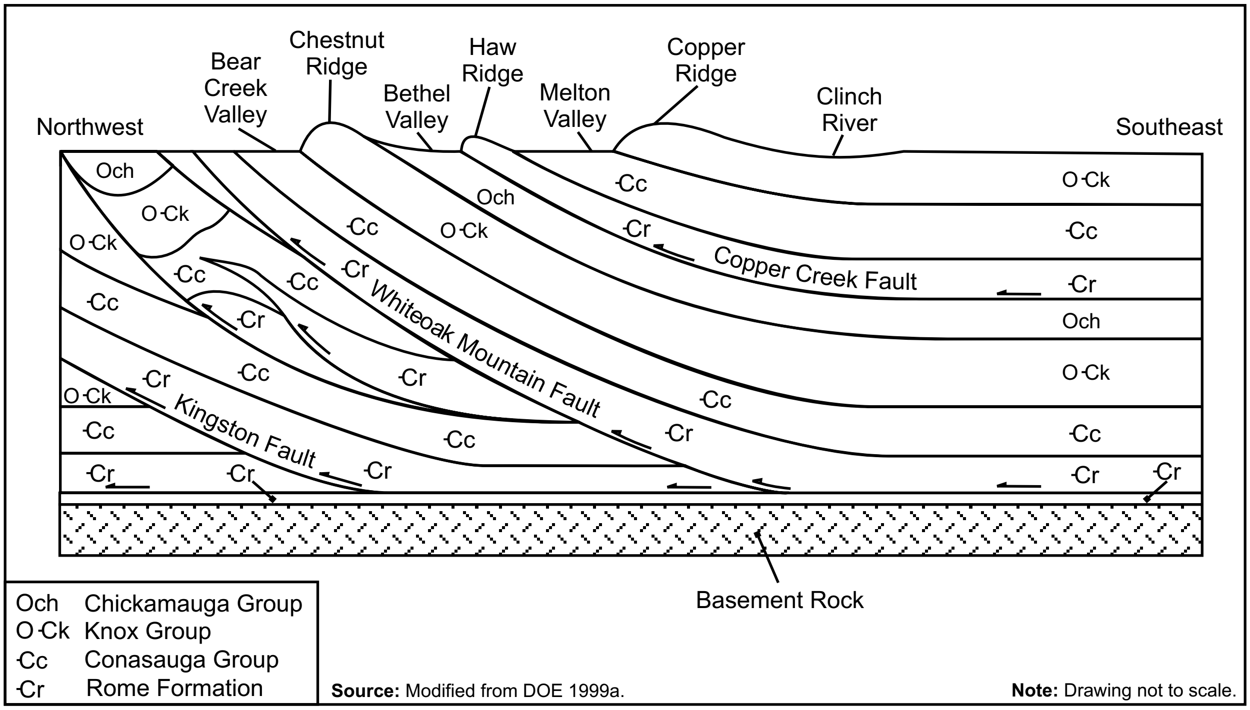

Figure 3–4 Geologic Cross Section of the Oak Ridge Reservation

Groundwater rights in the State of Tennessee are traditionally associated with the Reasonable Use Doctrine. Under this doctrine, landowners can withdraw groundwater as long as they exercise their rights reasonably in relation to the rights of others (DOE 1996b:3-199).

3.2.4.2.2 Location of Proposed Activities

Groundwater sampling performed in 1998 at 11 monitoring wells located in waste area groupings 8 and 9 in Melton Valley, encompassing HFIR and REDC, showed evidence of radioactivity attributable to former effluent-handling practices in the 7900 Area (Smith 2000). Two of the sampled wells exceeded Federal drinking water standards: one well for tritium contamination, and a second well for gross beta activity and total radioactive strontium contamination. Gross alpha activity ranged from undetectable to 6.7 picocuries per liter; the drinking water standard is 15 picocuries per liter. Gross beta activity ranged from undetectable to 1,400 picocuries per liter; the drinking water standard is 50 picocuries per liter. Total radioactive strontium ranged from undetectable to 630 picocuries per liter; the drinking water standard is 8 picocuries per liter. Tritium ranged from undetectable to 53,000 picocuries per liter; the drinking water standard is 20,000 picocuries per liter (Hamilton et al. 1999:5-27, 5-33). Note that groundwater is not used for drinking water at ORNL (Hamilton et al. 1999:5-28). In general, contaminant plumes in groundwater at ORNL and elsewhere at ORR are relatively small in areal extent as contaminant sources are discretely located, and flow paths to surface water outlets are short (Hamilton et al. 1999:1-9, 5-28, 5-30).

3.2.5 Geology and Soils

Geologic resources are consolidated or unconsolidated earth materials, including ore and aggregate materials, fossil fuels, and significant landforms. Soil resources are the loose surface materials of the earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts.

3.2.5.1 General Site Description

ORR is in the southwestern portion of the Valley and Ridge physiographic province in east-central Tennessee. The topography consists of alternating valleys and ridges that have a southwest-northeast trend, with most ORR facilities occupying the valleys (DOE 1996b:3-200). The topography reflects the underlying geology, which consists of a sequence of sedimentary rocks deformed by a series of major southeast-dipping thrust faults (Figures 3–3 and 3–4). The ridges are underlain by relatively erosion-resistant rocks, while weaker rock strata underlie the valleys (DOE 1999a:4-1, 4-3). Y–12 is in Bear Creek Valley between Pine and Chestnut Ridges, East Tennessee Technology Park is located along Poplar Creek between McKinney and Pine Ridges, and the ORNL main site is in Bethel Valley between Haw and Chestnut Ridges. The 7900 Area of ORNL is on a low ridge in Melton Valley, south of Haw Ridge. ORNL and the East Tennessee Technology Park are underlain primarily by calcareous siltstones and silty to clean limestone of the Chickamauga Group of upper and middle Ordovician age (about 440 to 480 million years old). The Conasauga Group underlies Y–12 and the 7900 Area; it is comprised of shales, calcareous siltstones, and silty-to-clean limestones of upper and middle Cambrian age (about 505 to less than 550 million years old). Pine Ridge and Haw Ridge are underlain by the Rome Formation, which consists of sandstone with thin shale interbeds. Chestnut Ridge is underlain by the cherty dolomite of the Knox Group. The Knox Group typically has well-developed karst features such as sinkholes, large solution cavities, and caves (DOE 1996b:3-200; 1999a:4-3–4-5). Structurally, two major thrust faults factor into the subsurface geology of ORR. Chestnut Ridge and Bethel Valley are underlain by the Whiteoak Mountain thrust fault. Haw Ridge and Melton Valley are underlain by the Copper Creek thrust fault (Figure 3–4). These faults formed during the Permian-Pennsylvanian periods (occurring about 245 to 320 million years ago) but have not been historically active (DOE 1999a:4-3–4-5). The present topography of the valleys is a result of stream action preferentially eroding the softer shales and limestones; the ridges are composed of relatively more resistant sandstones and dolomites. With the exception of strata suited to hard-rock quarrying for stone and aggregate (e.g., limestone, shale), no economically viable geologic resources have been identified at ORR (DOE 1996b:3-200).

There is no evidence of capable faults in the Valley and Ridge physiographic province, or within the rocks comprising the Appalachian Basin structural feature, where ORR is located. A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years (10 CFR Part 100, Appendix A). The nearest capable faults are approximately 480 kilometers (298 miles) northwest in the New Madrid (Reelfoot rift) fault zone. Historical earthquakes occurring in the Valley and Ridge are not attributable to fault structures in underlying sedimentary rocks, but rather occur at depth in basement rock (DOE 1999a:4-9; LMER 1998:2.5-19, 2.5-20).

The historical seismicity of the southeastern United States relative to ORR has been extensively reviewed in recent years. Since the New Madrid earthquakes of 1811-1812, at least 27 other earthquakes with a Modified Mercalli Intensity of III to VI (**Table 3–4**) have been felt in the Oak Ridge area (DOE 1996b:3-200; LMER 1998:2.5-16, 2.5-17, 2.5-29, 2.5-30). Second to the New Madrid earthquakes in intensity, the Charleston, South Carolina, earthquake of 1886, located about 515 kilometers (320 miles) from ORR, is estimated to have produced effects at ORR equivalent to Modified Mercalli Intensity VI (LMER 1998:2.5-29). One of closest and most intense seismic events occurred in 1930, approximately 8 kilometers (5 miles) from ORR, and had a Modified Mercalli Intensity of V at the site. The largest most recent earthquake in eastern Tennessee registered 4.6 on the Richter scale and occurred on November 30, 1973, in Maryville, Tennessee, about 32 kilometers (20 miles) southeast of ORR. This earthquake produced a Modified Mercalli Intensity of V to VI at ORR (as estimated at HFIR) (DOE 1996b:3-200; LMER 1998: 2.5-17, 2.5-30). The region has continued to be seismically active, with 42 earthquakes recorded within a radius of 90 kilometers (56 miles) of ORNL since 1973. In 1987, a magnitude 4.2 earthquake occurred about 38 kilometers (24 miles) from ORR producing a Modified Mercalli Intensity of VI at its epicenter. Since 1995, two earthquakes with a reported

Table 3–4 The Modified Mercalli Intensity Scale of 1931, with Approximate Correlations to Richter Scale and Maximum Ground Acceleration[a]

Modified Mercalli Intensity[b]	Observed Effects of Earthquake	Approximate Richter Magnitude[c]	Maximum Ground Acceleration[d](g)
I	Usually not felt	Less than 2	Negligible
II	Felt by persons at rest on upper floors or favorably placed	2 to 3	Less than 0.003
III	Felt indoors; hanging objects swing; vibration like passing of light truck occurs; might not be recognized as earthquake	3	0.003 to 0.007
IV	Felt noticeably by persons indoors, especially in upper floors; vibration occurs like passing of heavy truck; jolting sensation; standing automobiles rock; windows, dishes, and doors rattle; wooden walls and frames may creak	4	0.007 to 0.015
V	Felt by nearly everyone; sleepers awaken; liquids disturbed and may spill; some dishes break; small unstable objects are displaced or upset; doors swing; shutters and pictures move; pendulum clocks stop or start	Between 4 and 5	0.015 to 0.03
VI	Felt by all; many are frightened; persons walk unsteadily; windows and dishes break; objects fall off shelves, pictures fall off shelves and walls; furniture moves or overturns; weak masonry cracks; small bells ring; trees and bushes shake	5	0.03 to 0.09
VII	Difficult to stand; noticed by car drivers; furniture breaks; damage moderate in well built ordinary structures; poor quality masonry cracks and breaks; chimneys break at roof line; loose bricks, stones, and tiles fall; waves appear on ponds and water is turbid with mud; small earthslides; large bells ring	6	0.07 to 0.22
VIII	Automobile's steering affected; some walls fall; twisting and falling of chimneys, stacks, and towers; frame houses shift if on unsecured foundations; damage slight in specially designed structures, considerable in ordinary substantial buildings; changes in flow of wells or springs; cracks appear in wet ground and steep slopes	Between 6 and 7	0.15 to 0.3
IX	General panic; masonry heavily damaged or destroyed; foundations damaged; serious damage to frame structures, dams and reservoirs; underground pipes break; conspicuous ground cracks	7	0.03 to 0.7
X	Most masonry and frame structures destroyed; some well built wooden structures and bridges destroyed; serious damage to dams and dikes; large landslides; rails bent	8	0.45 to 1.5
XI	Rails bent greatly; underground pipelines completely out of service	Between 8 and 9	0.5 to 3
XII	Damage nearly total; large rock masses displaced; objects thrown into air; lines of sight distorted	9	0.5 to 7

a. This table illustrates the approximate correlation between the Modified Mercalli Intensity scale, the Richter scale, and maximum ground acceleration.
b. Intensity is a unitless expression of observed effects.
c. Magnitude is an exponential function of seismic wave amplitude, related to the energy released.
d. Acceleration is expressed in relation to the earth's gravitational acceleration (g).
Source: DOE 1996b:3-39.

Modified Mercalli Intensity of at least III and two with a Modified Mercalli Intensity of V have occurred within approximately 90 kilometers (56 miles) of ORR. The most recent of those events occurred on June 17, 1998, with an epicenter within ORR near the East Tennessee Technology Park, registering a magnitude 3.6 (USGS 2000a, 2000c). Based on historical observations, the maximum earthquake for ORR would be a Modified Mercalli Intensity VIII event, having an epicenter at ORR (DOE 1999a:4-9, 4-10). Numerous studies have been conducted as part of establishing the design-basis earthquake for evaluating and designing new ORR facilities. For this purpose, an earthquake producing an effective peak-ground acceleration of 0.15g has been established and calculated to have an annual probability of occurrence of about 1 in 1,000

(LMER 1998:2.5-18, 2.5-59). For comparison, an earthquake with a peak acceleration of 0.32g has an annual probability of occurrence of 1 in 5,000 (Barghusen and Feit 1995:2.8-14).

Measures of peak (ground) acceleration are indicative of what an object on the ground would experience during an earthquake. This motion is customarily expressed in units of g (percent of gravity). While peak acceleration is generally adequate to approximate what a short structure would experience in terms of horizontal force during an earthquake, it does not account for the range of energies experienced by a building during an earthquake, particularly for taller buildings. Thus, building design based on peak acceleration alone does not provide a uniform margin against collapse. However, the U.S. Geological Survey (USGS) has developed new seismic hazard maps as part of the National Seismic Hazard Mapping Project that are based on response spectral acceleration.

Spectral acceleration maps account for the natural period of vibration of structures (i.e., short buildings have short natural periods [up to 0.6 second] and taller buildings longer periods [less than or equal to 0.7 second]) (USGS 2000b). These maps have been adapted for use in the new *International Building Code* (ICC 2000) (Figures 1615(1) and 1615(2) in the code) and depict maximum considered earthquake ground motion of 0.2- and 1.0-second spectral response acceleration, respectively, based on a 2 percent probability of exceedance in 50 years. This corresponds to an annual recurrence interval of about 1 in 2,500. ORR lies within the 0.50g to 0.60g mapping contours for a 0.2-second spectral response acceleration and the 0.10g to 0.15g contours for a 1.0-second spectral response acceleration.

There is no volcanic hazard at ORR. The area has not experienced volcanic activity within the last 230 million years (DOE 1996b:3-200).

Four general soil map units occur on ORR. These are described based on the Anderson County soil survey (Moneymaker 1981:5-7). The soil survey for Roane County has not been updated since 1942 (Swann et al. 1942) and does not specifically identify general soil map units. The four soil map units of ORR are Fullerton-Claiborne-Bodine; Collegedale-Gladeville-Rock outcrop; Lehew-Armuchee-Muskingum; and Armuchee-Montevallo-Hamblen units. Soils of the Fullerton-Claiborne-Bodine unit may be described as deep, rolling-to-steep, well-drained cherty and noncherty soils underlain by dolomite. They occur on rolling ridgetops and on all aspects of steep side slopes. The Collegedale-Gladeville-Rock outcrop soil unit consists of deep and shallow, rolling and hilly well-drained soils that are underlain by limestone and have many outcrops of limestone. Soils of this group occur on uplands. Soils of the Lehew-Armuchee-Muskingum unit are moderately deep, steep, well-drained soils underlain by multicolored shale, siltstone, and sandstone. This unit is found on high winding ridges. The Armuchee-Montevallo-Hamblen soil unit is made up of shallow-to-deep, steep to nearly level, well-drained and moderately well-drained soils underlain by shale. This unit occurs on uplands and bottomlands.

Prime farmland is land with the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is available for these uses. While there are soils that would be classified as prime farmland on ORR, that designation is waived within the city limits of Oak Ridge and ORR (DOE 1999a:4-7).

3.2.5.2 Location of Proposed Activities

There are no capable faults on or near ORR. As noted above, the ORNL main site is underlain primarily by calcareous siltstones and silty-to-clean limestone of the Chickamauga Group. Melton Valley, and the 7900 Area in particular, are underlain by the interbedded limestones and shales of the Conasauga Group. Most of the 7900 Area is mapped as underlain by the Maryville Limestone with the southern limits of the site bordering the Nolichucky Shale (DOE 1999a:4-4, 4-5; LMER 1998:2.5-48) (Figures 3–3 and 3–4). In particular, the bedrock beneath the HFIR complex is described as a dark-gray, calcareous clay shale overlain by up to 6 meters (20 feet) of saprolite (weathered bedrock) with only a thin topsoil (LMER 1998:2.5-16). Karst features are less developed in the Chickamauga Group than in the Knox Group. Cavities encountered are smaller and often clay-filled, and caves are sparse and typically small, with the same observation expected for the Conasauga Group (LMER 1999:2-8). Soils of ORNL, including the 7900 Area, are highly disturbed and would be classified as Urban Land. Urban Land includes areas where more than 80 percent of the surface is covered with industrial plants, paved parking lots, and other impervious surfaces (Moneymaker 1981:44).

3.2.6 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species.

3.2.6.1 Terrestrial Resources

This section addresses the plant and animal communities of ORR and includes a plant community map of the site. Terrestrial resources are described for the site as a whole, as well as the proposed facility locations.

3.2.6.1.1 General Site Description

Plant communities at ORR are characteristic of the intermountain regions of central and southern Appalachia. Only a small fraction of ORR has been disturbed by Federal activities; the remainder of the site has reverted to or been planted with natural vegetation. The vegetation of ORR has been categorized into seven plant communities (**Figure 3–5**). Pine and pine-hardwood forest is the most extensive plant community on the site. Another abundant community is the oak-hickory forest, which is commonly found on ridges throughout ORR. Northern hardwood forest and hemlock-white pine-hardwood forest are the least common forest community types on the site. Forest resources on ORR are managed for multiple use and sustained yield of quality timber products (DOE 1996b). Over 1,100 vascular plants species are found on ORR (LMER 1999).

Animal species found on ORR include 59 amphibians and reptiles, 260 birds, and 38 mammals (LMER 1999). Animals commonly found on the site include the American toad, eastern garter snake, Carolina chickadee, northern cardinal, white-footed mouse, and raccoon. Most of ORR is within the Oak Ridge Wildlife Management Area. Wildlife management is carried out by the Tennessee Wildlife Resources Agency in cooperation with ORNL's Environmental Sciences Division. The whitetail deer and wild turkey are the only species hunted on site; however, other game animals are also present (LMER 1999). Raptors, such as the northern harrier and great horned owl, and carnivores, such as the gray fox and mink, are ecologically important groups on ORR. A variety of migratory birds have been found at ORR.

3.2.6.1.2 Location of Proposed Activities

Vegetative communities in the vicinity of the 7900 Area are typical of ORR as a whole, with pine, pine-hardwood forests, cedar, cedar-pine, cedar hardwood, and oak-hickory forests being the predominant community types (Figure 3–5). Fauna of the area are similar to that found throughout ORR. The 7900 Area itself is highly developed and provides minimal wildlife habitat.

3.2.6.2 Wetlands

Wetlands include "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation

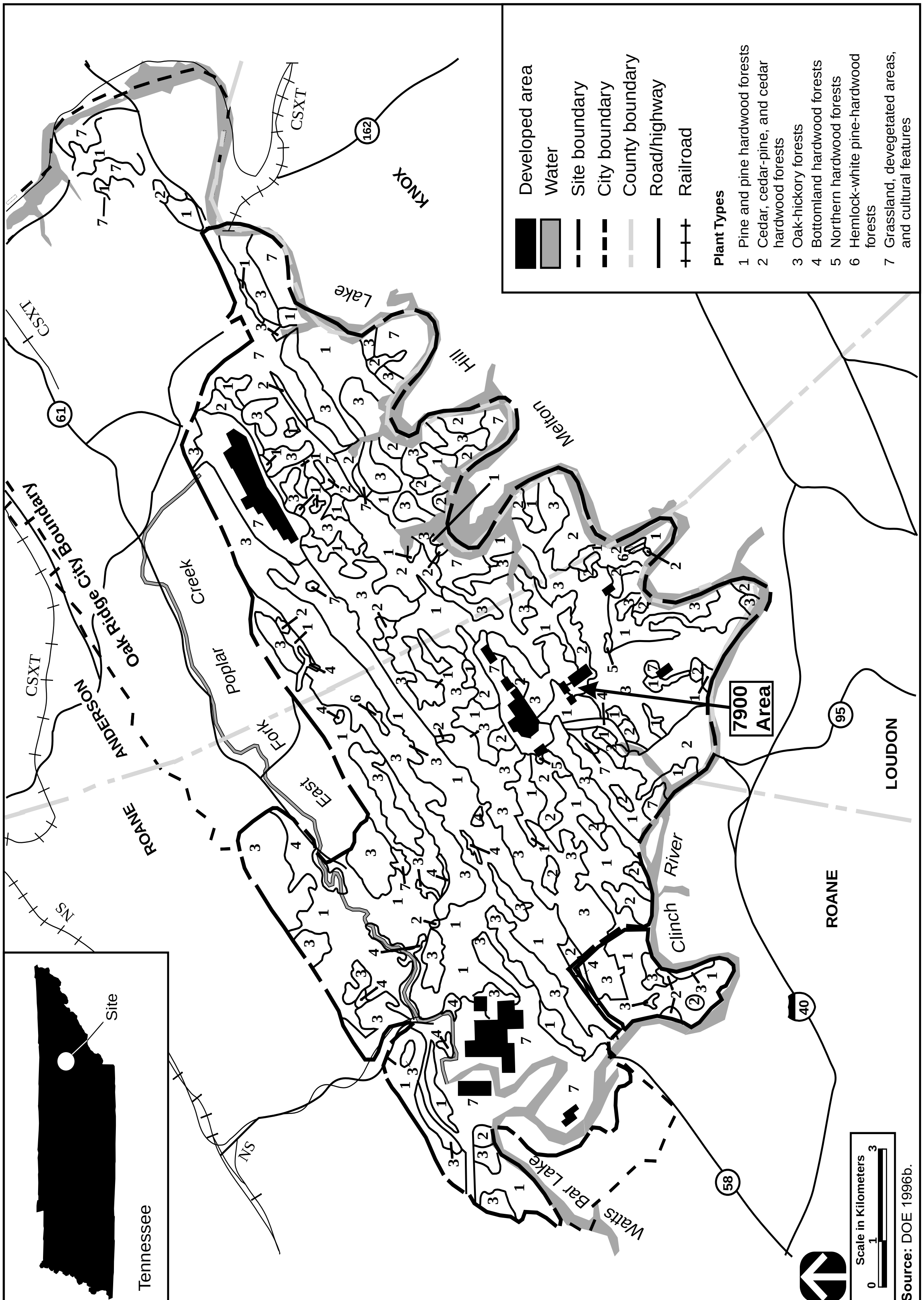

Figure 3–5 Distribution of Plant Communities at the Oak Ridge Reservation

typically adapted for life in saturated soil conditions" (33 CFR Section 328.3). Wetlands are described for ORR as a whole, as well as for the proposed facility locations.

3.2.6.2.1 General Site Description

Approximately 235 hectares (580 acres) of wetlands occur on ORR (LMER 1999). These include emergent, scrub and shrub, and forested wetlands associated with bays (embayments) of the Melton Hill and Watts Bar Lake, areas bordering major streams and their tributaries (riparian), old farm ponds, and groundwater seeps. Well-developed communities of emergent wetland plants in the shallow embayments of the two reservoirs typically intergrade into forested wetland plant communities, which extend upstream through riparian areas associated with streams and their tributaries. Old farm ponds on ORR vary in size and support diverse plant communities and fauna. Although most riparian wetlands on ORR are forested, areas within utility rights-of way, such as those in Bear Creek and Melton Valley, support emergent wetland vegetation.

3.2.6.2.2 Location of Proposed Activities

There are six wetlands in the vicinity of the 7900 Area, including one small, unclassified wetland (Rosensteel 1996:25, 42); however, none are within the developed area. These wetlands, which were identified using the criteria and methods set forth in the *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987), are generally classified as palustrine forested broad-leaved deciduous wetlands, although one also includes areas of emergent vegetation. Not including the unclassified wetland, the size of these areas range from 0.14 hectare (0.3 acre) to 1.23 hectares (3.0 acres). Mowing routinely disturbs two of the six wetlands.

3.2.6.3 Aquatic Resources

Aquatic resources at ORR are described for the site as a whole, as well as for the proposed facility locations.

3.2.6.3.1 General Site Description

Aquatic habitat on or adjacent to ORR ranges from small, free flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction. These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small perennial streams. Aquatic areas in ORR also include seasonal and intermittent streams and old farm ponds.

Sixty-three fish species have been collected on ORR (LMER 1999). The minnow family has the largest number of species and is numerically dominant in most streams. Fish species representative of the Clinch River in the vicinity of ORR are shad, herring, common carp, catfish, bluegill, crappie, and freshwater drum. The most important fish species taken commercially in the ORR area are common carp and catfish. Commercial fishing is permitted on the Clinch River downstream from Melton Hill Dam. Area recreational species consist of crappie, largemouth bass, sauger, sunfish, and catfish. Sport fishing is not permitted within ORR.

3.2.6.3.2 Location of Proposed Activities

ORNL is drained by White Oak Creek. The upper portion of the creek is similar to the upper reaches of other streams originating on Chestnut Ridge. These streams typically have alternating riffle and pool habitats. The stoneroller and blacknose dace are the fish species most commonly collected; 24 taxa of macroinvertebrates are present. Historically, operations at ORNL have had an adverse ecological effect on White Oak Creek. For example, the influence of ORNL is reflected in the fact that benthic macroinvertebrate populations are less diverse downstream of the site than upstream (DOE 1999a).

There are three Aquatic Reference Areas and one Reference Area in the ORNL area: Aquatic Reference Areas 3, 4, and 5, and Reference Area 28 (Pounds, Parr, and Ryon 1993:5,15-17). Reference Areas are areas that are representative of the communities of the southern Appalachian region or that possess unique biotic features. Aquatic Reference Area 3, Northwest Tributary, is a second-order, frequently intermittent stream that flows along the wooded base of Haw Ridge, but with mowed fields, parking lots, and experimental ponds on the opposite bank. Aquatic Reference Area 4, First Creek, and Aquatic Reference Area 5, Fifth Creek, are first-order, spring-fed streams that flow out of Chestnut Ridge. Each area has rich benthic fauna, but is somewhat more limited with regard to the number of fish species present. Reference Area 28, Spring Pond, is a small spring-fed pond with unusually clear water for ponds on ORR; it is dominated by Nutall waterweed.

3.2.6.4 Threatened and Endangered Species

Endangered species are those plants and animals in danger of extinction throughout all or a large portion of their range. Threatened species are those species likely to become endangered within the foreseeable future. Threatened and endangered species are described for ORR as a whole, as well as for the proposed facility locations.

3.2.6.4.1 General Site Description

Forty Federal and state-listed threatened, endangered, and other special status species have been found on ORR; additional species that occur near the site may also be present (ORNL 2000). The gray bat (endangered) and bald eagle (threatened, but proposed to be delisted) are the only federally listed threatened or endangered species observed on or near ORR. The bald eagle has been seen on Melton Hill and Watts Bar Lakes (DOE 1996b). A dead gray bat was found several years ago at Y–12 (Barclay 1999). The Indiana bat (endangered) has not been reported from the site (Mitchell et al. 1996a; ORNL 2000). State-listed threatened or endangered species observed on ORR include the gray bat, bald eagle, peregrine falcon, osprey, and 10 plant species. No critical habitat for threatened or endangered species, as defined in the Endangered Species Act, exists on ORR or adjacent lakes. Consultation to comply with Section 7 of the Endangered Species Act was conducted with the U.S. Fish and Wildlife Service. Consultation was also conducted with the state. The results of these consultations are presented in Chapter 4.

3.2.6.4.2 Location of Proposed Activities

No threatened, endangered, or sensitive plant or animal species have been recorded at or in the vicinity of the 7900 Area. Further, there is no potential habitat for such species confirmed in close proximity to the area (Parr 1999).

3.2.7 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. The three general categories of cultural resources addressed in this section are prehistoric, historic, and Native American. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age, and may be sources of information on paleoenvironments and the evolutionary development of plants and animals.

3.2.7.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records.

3.2.7.1.1 General Site Description

More than 20 cultural resources surveys have been conducted at ORR. About 90 percent of ORR has received at least some preliminary walkover or archival-level study, but less than 5 percent has been intensively surveyed. Most cultural resources studies have occurred along the Clinch River and adjacent tributaries. Prehistoric sites recorded at ORR include villages, potential burial mounds, camps, quarries, a chipping station, limited activity locations, and shell scatters. More than 45 prehistoric sites have been recorded at ORR to date. At least 13 prehistoric sites are considered potentially eligible for the National Registry of Historic Places, but most of these sites have not yet been evaluated. Additional prehistoric sites may be anticipated in the unsurveyed portions of ORR. In 1994, a Programmatic Agreement concerning the management of historic and cultural properties at ORR was executed among the DOE Oak Ridge Operation Office, the Tennessee State Historic Preservation Officer, and the Advisory Council on Historic Preservation. This agreement was executed to satisfy DOE's responsibilities regarding Sections 106 and 110 of the National Historic Preservation Act, and resulted in DOE preparing a cultural resources management plan for ORR (Souza, DuVall, and Tinker 1997).

3.2.7.1.2 Location of Proposed Activities

No prehistoric properties have been located within or immediately adjacent to the 7900 Area (Souza, DuVall, and Tinker 1997:F-5).

3.2.7.2 Historic Resources

Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date no earlier than 1492.

3.2.7.2.1 General Site Description

Several historic resources surveys have been conducted at ORR. Historic resources identified at ORR include both archaeological remains and standing structures. Documented log, wood frame, or fieldstone structures include cabins, barns, churches, gravehouses, springhouses, storage sheds, smokehouses, log cribs, privies, henhouses, and garages. Archaeological remains consist primarily of foundations, roads, and trash scatters. A total of 32 cemeteries are located within the present boundaries of ORR (Souza, DuVall, and Tinker 1997). More than 240 historic resources have been recorded at ORR, and 38 of those sites may be considered potentially eligible for listing on the National Registry of Historic Places. Freel's Cabin and two church structures, George Jones Memorial Baptist Church and the New Bethel Baptist Church, are listed on the National Registry. These structures date from before the establishment of the Manhattan Project. National Registry sites associated with the Manhattan Project include the Graphite Reactor at ORNL, listed on the National Registry of Historic Places as a National Historic Landmark, and three traffic checkpoints, Bear Creek Road, Bethel Valley Road, and Oak Ridge Turnpike Checking Stations (DOE 1999a). Many other buildings and facilities at ORR are associated with the Manhattan Project and are eligible for the National Registry. Historic building surveys have been completed for the Oak Ridge Townsite, ORNL, Y–12, the East Tennessee Technology Park, and the Oak Ridge Institute for Science and Education (Souza, DuVall, and Tinker 1997). Additional historic sites may be anticipated in the unsurveyed portions of ORR. Consultation to comply with Section 106 of the National Historic Preservation Act was initiated with the State Historic Preservation Office. The results of this consultation are presented in Chapter 4.

3.2.7.2.2 Location of Proposed Activities

A survey was conducted in 1993 to identify properties at ORNL that are included or are eligible for inclusion in the National Register of Historic Places. Eligible properties include the ORNL Historic District; Buildings 7001 and 7002 in the ORNL East Support Area; the Molten Salt Reactor Experiment Facility (Building 7503, previously known as the Aircraft Reactor Experiment Building); the Tower Shielding Facility; and White Oak Lake and Dam. Of these structures, the Molten Salt Reactor Experiment Facility is the closest eligible property to the 7900 Area. It is located about 0.4 kilometer (0.25 mile) to the north of REDC and HFIR (Souza, DuVall, and Tinker 1997:3-70).

3.2.7.3 Native American Resources

Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. In addition, cultural values are placed on natural resources such as plants, which have multiple purposes within various Native American groups. Concepts of sacred space that create the potential for land use conflicts are of primary concern.

3.2.7.3.1 General Site Description

The Overhill Cherokee Tribe occupied portions of the Tennessee, Hiwassee, Clinch, and Little Tennessee River Valleys in the 1700s. Overhill Cherokee villages consisted of a large townhouse, a summer pavilion, and a plaza, and residences had both summer and winter structures. Subsistence was based on hunting, gathering, and horticulture. The Cherokee were relocated to the Oklahoma territory in 1838, although some individuals refused to be moved and some Cherokee later returned to the area from Oklahoma. Resources that may be sensitive to Native American groups include remains of prehistoric and historic villages, ceremonial lodges, cemeteries, burials, and traditional plant gathering areas. Apart from prehistoric archaeological sites, to date no Native American resources have been identified at ORR.

3.2.7.3.2 Location of Proposed Activities

No Native American sacred sites or cultural items have been located within or immediately adjacent to the 7900 Area (Souza, DuVall, and Tinker 1997:3-66, 3-69, F-5).

3.2.7.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. Paleontological remains consist of fossils and their associated geological information.

3.2.7.4.1 General Site Description

The majority of geological units with surface exposures at ORR contain paleontological materials. Paleontological materials consist primarily of invertebrate remains, and these have relatively low research potential.

3.2.7.4.2 Location of Proposed Activities

Paleontological resources at ORNL would not be expected to differ from those found elsewhere on ORR.

3.2.8 Socioeconomics

Statistics for employment and regional economy are presented for the regional economic area, as defined in Appendix G.8, which encompasses 15 counties around ORR in Tennessee. Statistics for population, housing, community services, and local transportation are presented for the region of influence, a four-county area in which 89.9 percent of all ORR employees reside (**Table 3–5**). In 1998, ORR employed 14,215 persons (about 3.4 percent of the regional economic area civilian labor force) (DOE 1999c).

Table 3–5 Distribution of Employees by Place of Residence in the ORR Region of Influence, 1998

County	Number of Employees	Total Site Employment (percent)
Anderson	4,061	28.6
Knox	5,615	39.5
Loudon	828	5.8
Roane	2,275	16.0
Region of influence total	12,779	89.9

Source: DOE 1999c.

3.2.8.1 Regional Economic Characteristics

Between 1990 and 1998, the civilian labor force in the ORR regional economic area increased 17.6 percent to the 1998 level of 484,774. In 1998, the unemployment rate in the regional economic area was 4.1 percent, which was slightly less than the unemployment rate for Tennessee (4.2 percent) (DOL 2000).

In 1993, services represented the largest sector of employment in the regional economic area (26 percent), followed by retail (19 percent), and manufacturing (18 percent). In Tennessee, the services sector comprised 26 percent of total employment, followed by manufacturing (19 percent), and retail (17 percent) (DOE 1996b).

3.2.8.2 Population and Housing

In 1998, the ORR region of influence population totaled 528,017. From 1990 to 1998, the region of influence population grew by 9.4 percent, compared to 10.9 percent growth in Tennessee (Forstall 1995; DOC 1999). Between 1980 and 1990, the number of housing units in the region of influence increased by about 13.8 percent, nearly 2 percent less than the increase for the entire State of Tennessee. In 1998, the total number of owner and rental housing units within the region of influence was 225,636. In 1990, the homeowner and rental vacancy rates for the region of influence were 1.7 percent, compared to the state's rate of 8.5 percent (DOE 1996b; State of Tennessee 2000; DOC 1992).

3.2.8.3 Community Services

3.2.8.3.1 Education

School districts providing public education in the ORR region of influence operated at capacities ranging from 74.7 to 100 percent. Total student enrollment in the region of influence in 2000 was 70,493. The average student-to-teacher ratio was 16.7:1 (Davis 2000; Garza 2000; Groover 2000; McKinney 2000; Pierce 2000).

3.2.8.3.2 Public Safety

In 1999, a total of 1,501 sworn police officers served the four-county region of influence. The average officer-to-population ratio was 2.8 officers per 1,000 persons (HPI 1999). In 1998, 1,293 paid and volunteer firefighters provided fire protection services in the ORR region of influence. The average firefighter-to-population ratio was 2.4 firefighters per 1,000 persons (State of Tennessee 1998).

3.2.8.3.3 Health Care

In 1995, a total of 1,525 physicians served the ORR region of influence, with the majority practicing in Knox County (Randolph, Seidman, and Pasko, 1995). The average physician-to-population ratio was 3.0 physicians per 1,000 persons. In 1994, there were 13 hospitals serving the region of influence with a total of 2,833 beds (AHA 1995).

3.2.8.4 Local Transportation

Vehicles access ORR via three state routes. State Route 95 forms an interchange with Interstate 40, and enters the reservation from the south. State Route 58 enters the reservation from the west, and passes just south of the East Tennessee Technology Park. State Route 162 extends from Interstate 75 and Interstate 40 just west of Knoxville, and provides eastern access to ORR (Figure 3–1).

Within ORR, several routes are used to transfer traffic from the state routes to the main plant areas. Bear Creek Road, north of Y–12, flows in an east-west direction and connects Scarboro Road on the east end of the plant with State Road 95 and State Road 58. Bear Creek Road has restricted access around Y–12, and is not a public thoroughfare. Bethel Valley Road, a public roadway, provides access to ORNL, and extends from the east end of ORR at State Road 62 to the west end at State Route 95. Access to the 7900 Area is provided by secondary roads with controlled access: First Street, which runs north-south from Bethel Valley Road, and Melton Valley Road, which runs east-west and passes the 7900 Area entry road (McGee 2000).

Two main branches provide rail service for ORR. The CSX Transportation line at Elza (just east of Oak Ridge) serves Y–12 and the Office of Science and Technological Information in east Oak Ridge. The Norfolk and Southern main line from Blair provides easy access to the East Tennessee Technology Park. The Clinch River has a barge facility located on the west end of ORR near the East Tennessee Technology Park and is occasionally used to receive shipments that are too large or too heavy to be transported by rail or truck. McGhee Tyson Airport, 37 kilometers (23 miles) from ORR, is the nearest airport serving the region, with major carriers providing passenger and cargo service. A private airport, Atomic Airport, Inc., is the closest air transportation facility to Oak Ridge. Oak Ridge has a part-time public transportation system (DOE 1996b).

3.2.9 Existing Human Health Risk

Existing human health risk issues include the determination of potentially adverse effects on human health that result from acute and chronic exposures to ionizing radiation and hazardous chemicals.

3.2.9.1 Radiation Exposure and Risk

3.2.9.1.1 General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of ORR are shown in **Table 3–6**. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population, in terms of person-rem, changes as the population size changes. Background radiation doses are unrelated to ORR operations.

Table 3–6 Sources of Radiation Exposure to Individuals in the ORR Vicinity Unrelated to ORR Operations

Source	Effective Dose Equivalent (millirem per year)
Natural background radiation[a]	
Cosmic radiation	36
External terrestrial radiation	51
Internal terrestrial radiation	39
Radon in homes (inhaled)	200
Other background radiation[b]	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	Less than 1
Air travel	1
Consumer and industrial products	10
Total	390

a. Hamilton et al. 1999.
b. NCRP 1987.
Note: Value of radon is an average for the United States.

Releases of radionuclides to the environment from ORR operations provide another source of radiation exposure to individuals in the vicinity of ORR. Types and quantities of radionuclides released from ORR normal operations in 1998 are listed in the *Oak Ridge Reservation Annual Site Environmental Report for 1998* (Hamilton et al. 1999). The doses to the public resulting from these releases are presented in **Table 3–7**. These doses fall within radiological limits per DOE Order 5400.5 and are much lower than those of background radiation.

Table 3–7 Radiation Doses to the Public from ORR Normal Operations in 1998 (Total Effective Dose Equivalent)

Members of the Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual	Standard[a]	Actual
Maximally exposed individual (millirem)	10	0.73	4	2.6[b]	100	4.4[c]
Population within 80 kilometers (person-rem)[d]	None	12.3	None	48	100	60.3
Average individual within 80 kilometers (millirem)[e]	None	0.014	None	0.055	None	0.069

a. The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10-millirem-per-year limit from airborne emissions is required by the Clean Air Act, and the 4-millirem-per-year limit is required by the Safe Drinking Water Act; for this NI PEIS, the 4-millirem-per-year value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. The total dose of 100 millirem per year is the limit from all pathways combined. The 100-person-rem value for the population is given in proposed 10 CFR Part 834, as published in 58 FR 16268. If the potential total dose exceeds the 100-person-rem value, it is required that the contractor operating the facility notify DOE.
b. These doses are mainly from drinking water (approximately 0.35 millirem) and eating fish from the Clinch River section of Poplar Creek.
c. This total dose includes a conservative value of 1 millirem per year from direct radiation exposure to a cesium field near the Clinch River.
d. Based on a population of about 880,000 in 1998.
e. Obtained by dividing the population dose by the number of people living within 80 kilometers (50 miles) of the site.
Source: Hamilton et al. 1999.

Using a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Appendix H), the risk of a latent cancer fatality to the maximally exposed member of the public due to radiological releases from ORR operations in 1998 is estimated to be 2.2×10^{-6}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of ORR operations is approximately 2 in 1 million, as it takes several to many years from the time of radiation exposure for a cancer to manifest itself.

According to the same risk estimator, 0.030 excess latent cancer fatality is projected in the population living within 80 kilometers (50 miles) of ORR from normal operations in 1998. To place this number in perspective, it may be compared with the number of cancer fatalities expected in the same population from all causes. The 1997 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Famighetti 1998:964). Based on this mortality rate, the number of cancer fatalities expected during 1998 from all causes in the population living within 80 kilometers (50 miles) of ORR was 1,760, which was much higher than the 0.030 latent cancer fatality estimated from ORR operations in 1998.

ORR workers receive the same doses as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. The average dose to the individual worker and the cumulative dose to all workers at ORR from operations in 1998 are presented in **Table 3–8**. These doses fall within the radiological regulatory limits of 10 CFR Part 835. According to a risk estimator of 400 cancer fatalities per 1 million person-rem among workers (Appendix H), the number of projected latent cancer fatalities among ORR workers from normal operations in 1998 is 0.041.

Table 3–8 Radiation Doses to Workers from ORR Normal Operations in 1998 (Total Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average radiation worker (millirem)	None[b]	47
Total workers (person-rem)[c]	None	103

a. The radiological limit for an individual worker is 5,000 millirem per year. However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. It has therefore established the Administrative Control Level of 2,000 millirem per year; the site must make reasonable attempts to maintain individual worker doses below this level.
b. No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."
c. Based on a worker population of 2,187 with measurable doses in 1998.
Source: 10 CFR Section 835.202; DOE 1999p.

A more detailed presentation on the radiation environment, including background exposures and radiological releases and doses, is presented in the *Oak Ridge Reservation Annual Site Environmental Report for 1998* (Hamilton et al. 1999). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on and off site) are also presented in the report.

3.2.9.1.2 Location of Proposed Activities

Radiological health effects resulting from the release of radionuclides from the stack that serves HFIR and REDC are shown in **Table 3–9**. Estimates shown in the table are based on the 1997 through 1999 release data discussed in Appendix H. Doses listed in Table 3–9 show that the risk of a latent cancer fatality to the maximally exposed member of the public due to emissions from HFIR and REDC would be 2.3×10^{-7}. The risk of an excess cancer fatality among the public residing within 80 kilometers (50 miles) of ATR would be 0.0042.

Table 3–9 Radiation Doses to the Public from Normal Operations at HFIR and REDC in 1999 (Total Effective Dose Equivalent)

Members of the Public	Atmospheric Releases		Liquid Releases		Total	
	Standard	Actual	Standard	Actual	Standard	Actual
Maximally exposed individual (millirem)	10	0.46	4	0	100	0.46
Population within 80 kilometers (person-rem)	None	8.4	None	0	100	8.4
Average individual within 80 kilometers (millirem)[a]	None	7.4×10^{-3}	None	0.00	None	7.4×10^{-3}

a. For an affected population of 1,134,000.

Table 3–10 lists average annual radiation doses to HFIR and REDC workers for the years 1998 and 1999. The average risk of an excess cancer fatality among workers at HFIR and REDC due to onsite releases and direct radiation for each of the two years would be 1.5×10^{-5} and 6.6×10^{-5}, respectively.

Table 3–10 Radiation Doses to Workers from HFIR and REDC Normal Operations (Total Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual (1998 through 1999 average)
Average HFIR worker (millirem)	None[b]	38
Average REDC worker (millirem)	None[b]	165

a. The radiological limit for an individual worker is 5,000 millirem per year. However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. It has therefore established the Administrative Control Level of 2,000 millirem per year; the site must make reasonable attempts to maintain individual worker doses below this level.
b. No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."
Source: Boyd 2000a; Wham 2000d.

3.2.9.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media through which people may come in contact with hazardous chemicals (e.g., surface water during swimming, soil through direct contact, or food). Hazardous chemicals can cause cancer and other adverse health effects.

Carcinogenic Effects. Health effects in this case are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. This could be incremental or excess individual lifetime cancer risk.

Noncarcinogenic Effects. Health effects in this case are determined by the ratio between the calculated, or measured concentration of the chemical in the air and the reference concentration or dose. This ratio is known as the Hazard Quotient. Hazard Quotients for noncarcinogens are summed to obtain the Hazard Index. If the Hazard Index is less than 1, no adverse health effects would be expected.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emissions and NPDES permit requirements) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts on the public may occur by inhaling air containing hazardous chemicals released to the atmosphere during normal ORR operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are lower than those via the inhalation pathway.

Baseline concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed from normal operations at ORR. These concentrations are in compliance with applicable guidelines and regulations. Information on estimating the health impacts of hazardous chemicals is presented in Appendix H.

Exposure pathways to ORR workers during normal operation may include inhaling contaminants in the workplace atmosphere and through direct contact with hazardous materials. The potential for health impacts varies among facilities and workers, and available information is insufficient for a meaningful estimate of impacts. However, workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, substitution, and engineering and management controls. ORR workers are also protected by adherence to Occupational Safety and Health Administration (OSHA) and EPA standards that limit the workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals used in the operational processes ensure that these standards are not exceeded. Additionally, DOE requires that conditions in the workplace be as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm.

3.2.9.3 Health Effects Studies

Two epidemiologic studies were conducted to determine whether ORR contributed to any excess cancers in communities surrounding the facility. One study found no excess cancer mortality in the population living in counties surrounding ORR, when compared to the control populations in other nearby counties and elsewhere in the United States. The other study found slight excess cancer incidences of several types in the counties near ORR, but less than the number of expected cancers incidences for other types of cancers.

A pilot study on mercury contamination conducted by the Tennessee Department of Health and Environment showed no difference in urine or hair mercury levels between individuals with potentially high mercury exposures compared to those with little potential for exposure. However, soil analysis showed that the mercury in soil is inorganic, which decreases the likelihood of a toxic accumlation in living tissue (bioaccumulation) and adverse health effects. Studies are continuing on the long-term effects of exposure to mercury and other hazardous chemicals.

More epidemiologic studies have been conducted to assess health effects on the population working at ORR than any other site reviewed for this document. Excess cancer mortalities have been reported and linked to specific job categories, age, and length of employment, as well as to the levels of exposure to radiation.

For a more detailed description of the epidemiologic studies, refer to Appendix M.4.6 of the *Storage and Disposition PEIS* (DOE 1996b:M-235 to M-242).

3.2.9.4 Accident History

There have been no safety-related accidents causing significant injury or harm to workers, or posing any sort of harm to the offsite public, at HFIR or REDC during their operational lifetimes (DOE 1999e).

In addition, there have been no accidents with a measurable impact on offsite population during nearly 50 years of Y–12 operations at ORR. The most noteworthy accident in Y–12's history was a 1958 criticality accident, which resulted in temporary radiation sickness for a few ORR employees. In 1989, there was a one-time accidental release of xylene into the ORR sewer system with no offsite impacts. Accidental releases of anhydrous hydrogen fluoride occurred in 1986, 1988, and 1992, with little onsite and negligible offsite impacts. The hydrogen fluoride system where these accidents occurred is being modified to reduce the probability of future releases, and to minimize the potential consequences if a release does occur.

3.2.9.5 Emergency Preparedness

Each DOE site has established an emergency management program that would be activated in the event of an incident that threatens the health and safety of workers and the public. This program has been developed and maintained to ensure adequate response to most incident conditions and to provide response efforts for incidents not specifically considered. The emergency management program includes emergency planning, preparedness, and response.

DOE has overall responsibility for emergency planning and operations at ORR. However, DOE has delegated primary authority for event response to the operating contractor. Although the contractor's primary response responsibility is on site, the contractor does provide offsite assistance, if requested, under the terms of existing mutual aid agreements. If a hazardous materials event with offsite impacts occurs at a DOE facility, elected officials and local governments are responsible for the state's response efforts. The Tennessee Emergency Management Agency is the established agency responsible for coordinating state emergency services. When a hazardous materials event occurring at DOE facilities is beyond the capability of local government and assistance is requested, the Tennessee Emergency Management Agency Director may direct state agencies to provide assistance to the local governments. To accomplish this task and ensure prompt initiation of emergency response actions, the Director may cause the state Emergency Operations Center and Field Coordination Center to be activated. City or county officials may activate local Emergency Operations Centers in accordance with existing emergency plans.

DOE has specified actions to be taken at all DOE sites to implement lessons learned from the emergency response to an accidental explosion at Hanford in May 1997.

3.2.10 Environmental Justice

Under Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, Federal agencies are responsible for identifying and addressing the possibility of disproportionately high and adverse health, economic, and environmental impacts of programs and activities on minority and low-income populations in potentially affected areas. Minority populations refer to persons of any race self-designated as Asian, Black, Native American, or Hispanic. Low-income populations refer to households with incomes below the Federal poverty thresholds. In the case of ORR, the potentially affected area includes parts of Tennessee, North Carolina, and Kentucky.

The potentially affected area surrounding ORNL is defined by a circle with an 80-kilometer (50-mile) radius centered at HFIR/REDC (latitude 35° 55'8" N, longitude 84° 18'14" W). The total population residing within that area in 1990 was 881,987, while the minority population was 6.1 percent of that (DOC 1992). In 1990, approximately one-fourth of the total national population was comprised of persons self-designated as members of a minority group. Percentage minority populations residing in the States of Tennessee, North Carolina, and Kentucky were 17.4 percent, 25.0 percent, and 8.3 percent, respectively.

At the time of the 1990 census, Blacks were the largest minority group within the potentially affected area, constituting 4.7 percent of the total population. Asians made up 0.5 percent, Hispanics, 0.5 percent, and Native Americans made up 0.4 percent of the population (DOC 1992).

In 1990, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 137,708 persons (16 percent of the total population) residing within the potentially affected area around ORNL reported incomes below that threshold (DOC 1992). Data obtained during the 1990 census show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold. Percentages for those below the poverty threshold in Tennessee, North Carolina, and Kentucky were 19.0 percent, 13.1 percent, and 15.7 percent, respectively.

A more detailed description of the environmental justice analysis is given in Appendix K.

3.2.11 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. The waste is managed using appropriate treatment, storage and disposal technologies and in compliance with all Federal and state statutes and DOE orders. Disposal and management of previously generated ORR waste, known as legacy waste, is the responsibility of DOE's environmental management contractor, which is working to repackage, remove, and dispose of the existing legacy waste and newly generated wastes. The strategy is to dispose of current inventories of all waste types and close many of the existing storage facilities. The long-range strategy is to rely on a combination of onsite and offsite facilities to dispose of newly generated waste.

3.2.11.1 Waste Inventories and Activities

ORR manages the following types of waste: transuranic, mixed transuranic, low-level radioactive, mixed low-level radioactive, hazardous, and nonhazardous. Waste generation rates and the inventory of stored waste from activities at ORR are provided in **Table 3–11**. Waste generation rates specifically for HFIR and REDC activities are provided in **Table 3–12.** ORR waste management capabilities are summarized in **Table 3–13**. More detailed descriptions of the waste management system capabilities at ORR are included in the *Storage and Disposition PEIS* (DOE 1996b:3-219, E-63).

DOE is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at ORR. DOE is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed-upon milestones.

EPA placed ORR on the National Priorities List, which identifies sites for possible long-term remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), on November 21, 1989. DOE, EPA Region IV, and the Tennessee Department of Environment and Conservation completed a Federal Facility Agreement, effective January 1, 1992. This agreement coordinates ORR inactive site assessment and remedial actions. Portions of the Federal Facility Agreement are applicable to operating waste management systems. Existing actions are conducted under the Resource Conservation and Recovery Act (RCRA) and applicable state laws that minimize duplication, expedite response actions, and achieve a comprehensive remediation of the site. More information on regulatory requirements for waste disposal is provided in Chapter 5.

Table 3–11 Waste Generation Rates and Inventories at ORR and ORNL

Waste Type	Generation Rates (cubic meters per year)		Inventory (cubic meters)	
	ORR[a]	ORNL	ORR[a]	ORNL
Transuranic				
Contact handled	12	12	1,000	1,000
Remotely handled	10	10	550	550
Remotely handled sludge (tank waste)	1.5	1.5	900	900
Low-level radioactive				
Liquid[b]	12,500 (total)	1,200	20,000[c] (total)	1,600
Solid		2,400		3,614
Process waste	283,900	283,900	0[d]	0[d]
Mixed low-level radioactive				
Liquid	(e)	(e)	(e)	(e)
Solid	1,600	475	26,000	3,000
Hazardous	36,000 kg/yr	–	1,689	–
Nonhazardous				
Liquid	269,000	60,600	NA[f]	NA[f]
Solid	29,500	5,700	NA[f]	NA[f]

a. Represents entire waste generated or managed at ORR, including ORNL.
b. Liquid low-level radioactive waste is processed through an evaporator for volume reduction, and the evaporator bottoms are stored as a concentrated solution.
c. Excludes waste from DOE environmental restoration activities.
d. This inventory is zero because the process waste is treated and discharged.
e. Mixed liquid low-level radioactive waste is reported as low-level radioactive waste. Certain contents are mixed-permit-by-rule.
f. Generally, this waste is not held in long-term storage.

Note: To convert from cubic meters to cubic yards, multiply by 1.308. To convert from kilograms to pounds, multiply by 2.2.
Key: kg/yr, kilograms per year; NA, not applicable.
Source: Brunson 1999; DOE 1997a; Wham 1999.

Table 3–12 Waste Generation Rates at HFIR and REDC

Waste Type	HFIR (cubic meters per year)	REDC (cubic meters per year)
Transuranic		
Contact handled	0	16
Remotely handled	0	9
Low-level radioactive		
Liquid	0	52
Solid	48	65
Process waste	19,700	0
Mixed low-level radioactive	0	<1
Hazardous	0	13,200 kg
Nonhazardous		
Liquid	138,200	96,700
Sanitary wastewater	7,310	3,130
Solid	0	294

Note: To convert from cubic meters to cubic yards, multiply by 1.308. To convert from kilograms to pounds, multiply by 2.2.
Key: kg, kilograms.
Source: Boyd 2000b; Valentine 2000; Wham 2000a, 2000b.

Table 3–13 Waste Management Capabilities at ORR

Facility Name/ Description	Capacity	Status	Applicable Waste Type					
			TRU	**Mixed TRU**	**LLW**	**Mixed LLW**	**Haz**	**Non-Haz**
Y–12: Treatment Facility (cubic meters per year except as otherwise specified)								
West End Treatment Facility, Building 9616-7	10,221	Online			X	X	X	X
Central Pollution Control Facility	10,200	Online			X	X	X	
Acid Neutralization and Recovery Facility, Building 9818	2,100	Online				X		
Uranium Chip Oxidizer Facility	Classified	Online			X			
Cyanide Treatment Facility	185	Online				X	X	
Plating Rinsewater Treatment Facility (Building 9623)	30,283	Online					X	X
Steam Plant Wastewater Facility	177,914	Online					X	X
Oak Ridge Sewage Treatment Plant (offsite) cubic meters per day	5,300	Online						X
Building 9720-25 Baler Facility	41,700	Online						X
Waste Coolant Processing Facility, Building 9983-78	1,363	Online			X	X		
Organic Handling Unit, Building 9815 (gallons per day)	500	Online			X	X		
Uranium Recovery Operations, Building 9212	2,100	Online				X		
Y–12: Storage Facility (cubic meters)								
Aboveground Storage Pads (Building 9830-2 through 7)	7,130	Online			X			
Buildings 9206 and 9212, Container Storage Areas	30	Online			X	X		
Building 9720-12, Container Storage Facility	123	Online			X	X		
Contaminated Scrap Metal Storage Yard	4,740	Online			X			X
Cyanide Treatment Facility (Building 9201-5N)	8	Online				X	X	
Liquid Organic Waste Storage Facility (Building 9720-45, OD-10)	198	Online				X	X	
Liquid Storage Facility (Building 9416-35)	416	Online				X	X	
PCB and RCRA Hazardous Drum Storage Facility (Building 9720-9)	1,404	Online				X	X	
RCRA and PCB Container Storage Area (Building 9720-58)	1,130	Online				X	X	
RCRA Staging and Storage Facility (Building 9720-31)	170	Online				X	X	
RCRA Storage Facility (Building 9811-1, OD-8)	723	Online			X	X	X	
Waste Oil/Solvent Storage Facility (Building 9811-8, OD-9)	790	Online			X	X	X	
Tank Farm, Building 9212	151	Planned				X		

Facility Name/ Description	Capacity	Status	Applicable Waste Type					
			TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Container Storage Area/Production Waste Storage Facility, Building 9720-32	2,335	Online					X	
Low Level Waste Storage Pad, Building 9720-44	Not specified	Online			X			
Classified Waste (Container) Storage Area, Building 9720-59	1,090	Online			X	X		
Organic Handling Unit, Building 9815	8	Online					X	
Depleted Uranium Storage Vaults I and II (Building 9825-1 and 2 oxide vaults) and Building 9809	1,020	Online			X			
West Tank Farm	10,600	Online			X	X		
Y–12: Disposal Facility (cubic meters)								
Industrial and Sanitary Landfill V[a]	1,100,000[a]	Online						X
Construction Demolition Landfill VI[a]	119,000[a]	Online						X
Oak Ridge National Laboratory: Treatment Facility (cubic meters per year)								
Process Waste Treatment Plant	280,000	Online			X			
Melton Valley Low-Level Waste Immobilization Facility and Liquid Low-Level Waste Evaporation Facility	110,000	Online			X			
Waste Compaction Facility (Building 7831)	11,300	Online			X			
Sanitary Waste Water Treatment Facility (design capacity)	414,000	Online						X
Nonradiological Wastewater Treatment Facility	1,510,000	Online					X	
Oak Ridge National Laboratory: Storage Facility (cubic meters)								
Buildings 7826, 7834, 7842, 7878, 7879, and 7934	1,760	Online	X	X				
Bunker and Earthen Trenches (SWSA 5N Building 7855 and SWSA7 Building 7883)	1085	Online	X		X			
Liquid Low-Level Radioactive Waste Systems	3,230	Online			X			
Onsite tanks	7,850	Online			X			
Buildings 7507W, 7654, 7823, and Tank 7830a	393	Online Tank 7830a (standby)				X		
Hazardous Waste Storage Facility (Buildings 7507 and 7652) and Buildings 7651 and 7653	130	Online					X	
Interim Waste Management Facility	5,365 (1,730)[b]	Online			X			

Facility Name/ Description	Capacity	Status	Applicable Waste Type					
			TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Oak Ridge National Laboratory: Disposal Facility (cubic meters)								
Shared Landfills V and VI	(Refer to footnote a)	Online						X
TRU Waste Treatment Facility (low-temperature drying) (five year capacity)	4,050	Planned (2002)	X	X	X	X		
East Tennessee Technology Park: Treatment Facility (cubic meters per year)								
TSCA Incinerator (Building K-1435)	15,700	Online			X	X		
Central Neutralization Facility (permitted operating capacity)	221,000	Online				X		
Sewage Treatment Plant (Building K-1203)	829,000	Online						X
East Tennessee Technology Park: Storage Facility (cubic meters)								
Building K-25, outside areas, K-1313 A and K-33	44,000	Online			X			
Current permitted container (solids/sludges/liquid wastes) and tank (liquids) storage capacity	97,000	Online				X		
Total current permitted waste pile unit storage capacity	120,000	Online				X		
Stockpiled at scrap yard	Not specified	Online						X
East Tennessee Technology Park: Disposal Facility (cubic meters)								
Shared Landfills V and VI	(Refer to footnote a)	Online						X

a. Industrial and Sanitary Landfill V and Construction Demolition Landfill VI serve all three sites for disposal of solid nonhazardous waste. Their disposal capacities are 1,100,000 cubic meters and 119,000 cubic meters, respectively.
b. Available as of June 1999.
Note: To convert from cubic meters to cubic yards, multiply by 1.308.
Key: Haz, hazardous; LLW, low-level waste; PCB, polychlorinated biphenyl; RCRA, Resource Conservation and Recovery Act; TRU, transuranic; TSCA, Toxic Substances Control Act.
Source: DOE 1996b:3-200–3-225; 2000c:2-14; PAI Corporation 1996; Rathke 2000; Wham 1999.

3.2.11.2 High-Level Radioactive Waste

ORR does not manage high-level radioactive waste at the site.

3.2.11.3 Transuranic Waste

Although ORNL is the only current generator of transuranic wastes on ORR, other sites at ORR have produced small quantities of transuranic wastes in the past and are likely to do so again during decontamination and decommissioning activities. Transuranic waste includes contact-handled transuranic and remotely handled transuranic. Normally, contact-handled transuranic waste consists primarily of miscellaneous waste from glovebox operations (e.g., paper, glassware, plastic, shoe covers, and wipes), discarded high-efficiency particulate air filters, and discarded equipment (e.g., gloveboxes and processing equipment). Contact-handled transuranic waste has a surface dose rate that does not exceed 200 millirem per hour. Generally, contact-handled transuranic waste is contained within polyethylene bags inside 208-liter (55-gallon) stainless steel drums. Metal paint cans, plastic buckets, and other similar containers are also used to package waste inside the drums.

Remotely handled transuranic waste consists primarily of miscellaneous hot cell waste (e.g., paper, glass, plastic tubing, and wipes), high efficiency particulate air filters, and discarded equipment (e.g., processing racks, vacuum pumps, and furnaces). Unshielded remotely handled transuranic waste packages typically have radiation levels that measure between 10 and 2,000 rem per hour; however, most are below 100 rem per hour. Shielding generally reduces the levels at the surface of the container to approximately 1 rem per hour. Remotely handled transuranic waste contains activation and fission products that decay and emit neutron and gamma radiation on the surface of the packaging that exceeds 200 millirem per hour. The activation materials are transuranium radionuclides ranging from plutonium-238 to californium-252, but are usually dominated by curium-244 which contributes to the neutron dose from spontaneous fission and alpha-n reactions. The alpha-n reactions contribute to the external dose rate measured at the surface of a container for both the contact-handled transuranic and remotely handled transuranic solid waste.

Remotely handled transuranic wastes are usually contained in concrete casks (1.4 meters [4.5 feet] in diameter by 2.3 meters [7.5 feet] high). The wall thicknesses of the casks are currently either 15 centimeters (6 inches) or 30.5 centimeters (12 inches) thick, depending on the radiation level of the contents. A large polyethylene bag is placed inside the cask for additional contamination control prior to use. Most remotely handled transuranic wastes inside the concrete casks are also contained inside polyethylene bags. Smaller waste packages such as 11-liter (2.9-gallon) plastic buckets, 3.7-liter (0.98-gallon) paint cans, and 18.9-liter (5.0-gallon) metal cans are packaged within the polyethylene bags. Fiber drums and carbon and steel drums have also been used to package waste inside the concrete cask. Intermediate-sized items that will not fit in the previously mentioned packages are generally placed in vinyl bags, then placed inside the lined waste cask. Large cask items may be placed directly in the cask.

As of January 1999, approximately 1,000 cubic meters (1,310 cubic yards) of contact-handled transuranic waste was in retrievable drum storage in the Bunker and Earthen Trenches. The amount of remotely handled transuranic waste was about 550 cubic meters (719 cubic yards) (64 FR 4079). Current activities center around certification of contact-handled waste, designing of a repackaging and certification facility for remote-handled wastes, and planning for shipment of waste to the Waste Isolation Pilot Plant (WIPP) or another suitable geologic repository for disposal.

3.2.11.4 Low-Level Radioactive Waste

Solid low-level radioactive waste is compactible radioactive waste such as paper, plastic, cloth, glass, cardboard, filters, floor sweepings, styrofoam, clothing, ceiling tile, and miscellaneous radioactively contaminated trash. The waste may include up to 20 percent lightweight or non-smeltable metal items. The solid low-level radioactive waste normally generated at ORNL consists primarily of radioactively contaminated personnel protection equipment, paper debris, trapping media, and process equipment. The Interim Waste Management Facility at ORNL only accepts low-level radioactive waste generated at ORNL. However, the Interim Waste Management Facility is at two-thirds of capacity, and access to this facility for the proposed plutonium-238 production, new medical and industrial isotope production, or new nuclear reasearch and development activities is not expected. Solid low-level radioactive waste is being stored at the East Tennessee Technology Park and Y–12 for future disposal. Contaminated scrap metal is stored above ground at the K-770 scrap metal facility, the old salvage yard at Y–12, and at ORNL which is being managed by the DOE scrap metal program until further disposal methods are evaluated.

The basic low-level radioactive waste strategy is to:

1. Use the Interim Waste Management Facility for legacy waste until it is filled to capacity.

2. Stage low-level radioactive waste at all sites, with emphasis on storage at the East Tennessee Technology Park until a disposal site is available.

3. Ship waste to the Nevada Test Site, Hanford, or a commercial disposal site as access is approved, and according to site-specific waste acceptance criteria.

3.2.11.5 Mixed Low-Level Radioactive Waste

RCRA mixed low-level radioactive waste is in storage at Y–12, East Tennessee Technology Park, and ORNL. Because prolonged storage of these wastes exceeded the one-year limit imposed by RCRA, ORR entered into a Federal Facility Compliance Agreement for RCRA Land Disposal Restriction wastes with EPA on June 12, 1992. This agreement was terminated with the issuance of the Tennessee Department of Environmental Conservation Commissioner's Order, effective October 1, 1995, which requires DOE to comply with the Site Treatment Plan prepared by ORR. The plan contains milestones and target dates for DOE to characterize and treat its inventory of mixed wastes at ORR. Sludges contaminated with low-level radioactivity are generated by settling and scrubbing operations, and in the past were stored in K-1407-C ponds at the East Tennessee Technology Park.

Sludges have been removed from these ponds and a portion has been fixed in concrete at the K–1419 Sludge Treatment Facility, and stored at the K–33 building. The concreted sludges are being shipped off site for disposal. The raw sludges are stored in the K–1065 building, pending further treatment. Mixed waste sludges are also generated at Y–12 in the treatment of nitrate waste from purification and recycling of uranium and in the treatment of plating shop waste.

The primary facility generator of liquid mixed waste is the K–1435 Toxic Substances Control Act Incinerator from the wet scrubber blowdown. This waste is currently being treated at the Central Neutralization Facility, which provides pH adjustment and chemical precipitation. Treated effluents are discharged through a NPDES outfall. The contaminated sludges are stored as mixed waste at the East Tennessee Technology Park.

The East Tennessee Technology Park Toxic Substances Control Act Incinerator has a design capacity to incinerate 909 kilograms (2,000 pounds) per hour of mixed liquid waste and up to 455 kilograms (1,000 pounds) per hour of solids and sludge (91 kilograms [200 pounds] per hour maximum sludge content). The Toxic Substances Control Act Incinerator is capable of incineration of both Toxic Substances Control Act- and RCRA-mixed wastes. The Toxic Substances Control Act Incinerator capacity utilization for incinerable solids is limited to ORR wastes to support the completion of enforceable milestones required by the ORR Site Treatment Plan. Because of permit limits (Toxic Substances Control Act, RCRA, State of Tennessee), the incinerator is not running at full capacity. In 1994, approximately 2,590 cubic meters (683,000 gallons) of mixed liquid waste was incinerated (DOE 1996b:3-226).

The major type of mixed waste generated at ORNL is mixed waste oils. Mixed waste oils are generated when oils are removed from systems that have operated in radiation environments. Radiation levels in these oils are typically low (less than or equal to 10 millirem per hour). Generally, these wastes consist of vacuum pump oil, axle oil, refrigeration oil, mineral oil, or oil/water mixtures. The principal components of scintillation fluids are toluene and/or xylene, culture medium, and miscellaneous organics. Other mixed wastes generated at ORNL include organic wastes, carcinogenic wastes, mercury-contaminated solid waste, waste solvents, corrosives, poisons, and other process waste. Because of the diversity of the mixed waste generated at ORNL, quantities are usually small.

Radioactive wastes contaminated with polychlorinated biphenyl are being stored because of lack of treatment and disposal capacities. DOE and EPA signed a Federal Facility Compliance Agreement, effective

December 16, 1996, to bring East Tennessee Technology Park into compliance with Toxic Substances Control Act regulations for use, storage, and disposal of polychlorinated biphenyls. It also addressed the approximately 10,000 pieces of nonradioactive polychlorinated biphenyls-containing dielectric equipment used in the shutdown of diffusion plant operations.

3.2.11.6 Hazardous Waste

RCRA-regulated wastes are generated by ORR in laboratory research, electroplating operations, painting operations, descaling, demineralizer regeneration, and photographic processes. Certain other wastes (e.g., spent photographic processing solutions) are processed on site into a nonhazardous state. Those wastes that are safe to transport, and have been certified as having no radioactivity added, are shipped off site to RCRA-permitted commercial treatment and disposal facilities. Small amounts of reactive chemical explosives that would be dangerous to transport off site, such as aged picric acid, are processed on site in the Chemical Detonation Facility at ORNL.

3.2.11.7 Nonhazardous Waste

Nonhazardous wastes are generated from numerous ORR activities. For example, the steam plant produces nonhazardous sludge. Scrap metals are discarded from maintenance and renovation activities and are recycled when appropriate. Construction and demolition projects produce nonhazardous industrial wastes. Other nonhazardous wastes include paper, plastic, glass, can, cafeteria wastes, and general trash. All nonradioactive medical wastes are autoclaved to render them noninfectious and are sent to the Y–12 Sanitary Landfill. Remedial action projects also produce wastes requiring proper management. The State of Tennessee permitted landfill (Construction Demolition Landfill VI) receives nonhazardous industrial materials such as fly ash and construction debris. Asbestos and general refuse are managed in Industrial and Sanitary Landfill V located at Y–12.

3.2.11.8 Waste Minimization

The DOE Oak Ridge Operations Office has an active waste minimization and pollution prevention program to reduce the total amount of waste generated and disposed of at ORR. This is accomplished by eliminating waste through source reduction or material substitution; recycling potential waste materials that cannot be minimized or eliminated; and treating waste generated to reduce its volume, toxicity, or mobility prior to storage or disposal. Implementing pollution prevention projects reduced the amount of waste generated at ORR in 1998 by approximately 64,900 cubic meters (84,000 cubic yards). Examples of pollution prevention projects completed in 1998 at the Oak Ridge Operations Office include: reducing cleanup/stabilization of low-level radioactive waste by approximately 395 cubic meters (517 cubic yards), mixed low-level radioactive waste by approximately 119 cubic meters (156 cubic yards), and hazardous waste by approximately 83 metric tons (91 tons) by providing incentives in contracts for projects to turn over vacant and decontaminated buildings to the DOE Oak Ridge Operation Office; reducing routine operations mixed low-level radioactive waste by approximately 693 cubic meters (906 cubic yards) by selling various scrap metals (including clean and contaminated carbon steel and copper) to an outside vendor for cleaning and recycling; and reducing transuranic waste generation by less than 1 cubic meter (1.3 cubic yards) per year by replacing three oil-lubricated vacuum pumps with dry pumps, which eliminated the transuranic-contaminated waste oil stream and associated waste (DOE 1999f:56).

3.2.11.9 Waste Management PEIS Records of Decision

The *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (*Waste Management PEIS*) Records of Decision affecting ORR are shown in **Table 3–14** for the waste types analyzed in this NI PEIS. Decisions on the various waste types are being announced in a series of Records of Decision that have been issued on the *Waste Management PEIS*. The transuranic waste Record of Decision was issued on January 20, 1998 (63 FR 3629); the hazardous waste Record of Decision was issued on August 5, 1998 (63 FR 41810); the high-level radioactive waste Record of Decision was issued on August 12, 1999 (64 FR 46661); and the low-level radioactive waste and mixed low-level radioactive waste Record of Decision was issued on February 18, 2000 (65 FR 10061). The transuranic waste Record of Decision states that DOE will develop and operate mobile and fixed facilities to characterize and prepare transuranic waste for disposal at WIPP. Each DOE site that has or will generate transuranic waste will, as needed, prepare and store its transuranic waste on site. The hazardous waste Record of Decision states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, with ORR and the Savannah River Site (SRS) continuing to treat some of their own nonwastewater hazardous waste on site in existing facilities, where this is economically favorable. The high-level radioactive waste Record of Decision states that immobilized high-level radioactive waste will be stored at the site of generation until transfer to a geologic repository. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision states that for the management of low-level radioactive waste, minimal treatment will be performed at all sites and disposal will continue, to the extent practicable, on site at INEEL, Los Alamos National Laboratory (LANL), ORR, and SRS. In addition, Hanford and the Nevada Test Site will be available to all DOE sites for low-level radioactive waste disposal. Mixed low-level radioactive waste will be treated at Hanford, INEEL, ORR, and SRS and disposed of at Hanford and the Nevada Test Site. More detailed information concerning DOE's preferred alternatives for the future configuration of waste management facilities at ORR is presented in the *Waste Management PEIS* and the high-level radioactive waste, transuranic waste, hazardous waste, and low-level radioactive and mixed low-level radioactive waste Records of Decision.

Table 3–14 Waste Management PEIS Records of Decision Affecting ORR

Waste Type	Preferred Action
High-level radioactive	ORR does not currently manage high-level radioactive waste.[a]
Transuranic and mixed transuranic	DOE has decided that ORR should prepare and store its transuranic waste on site pending disposal at WIPP[b] or another suitable geologic repository.
Low-level radioactive	DOE has decided to treat ORR's liquid low-level radioactive waste on site.[c] Separate from the *Waste Management PEIS*, DOE prefers offsite management of ORR's solid low-level radioactive waste after temporary onsite storage.
Mixed low-level radioactive	DOE has decided to regionalize treatment of mixed low-level radioactive waste at ORR.[c] This includes the onsite treatment of ORR's waste and could include treatment of some mixed low-level radioactive waste generated at other sites.
Hazardous	DOE has decided to use commercial and onsite ORR facilities for treatment of ORR nonwastewater hazardous waste. DOE will also continue to use onsite facilities for wastewater hazardous waste.[d]

a. From the Record of Decision for high-level radioactive waste (64 FR 46661).
b. From the Record of Decision for transuranic waste (63 FR 3629).
c. From the Record of Decision for low-level radioactive and mixed low-level radioactive waste (65 FR 10061).
d. From the Record of Decision for hazardous waste (63 FR 41810).
Source: 63 FR 3629; 63 FR 41810; 64 FR 46661; 65 FR 10061.