

1. Introduction to the Oak Ridge Reservation

The Oak Ridge Reservation (ORR) is a 13,574-ha (33,542-acre) federally owned site located in the counties of Anderson and Roane in eastern Tennessee. The ORR is home to two major U.S. Department of Energy (DOE) operating components, the Oak Ridge National Laboratory (ORNL) and the Y-12 National Security Complex (Y-12 Complex). Also located on the ORR are the East Tennessee Technology Park (ETTP), site of a former gaseous diffusion plant that is undergoing environmental restoration; the Oak Ridge Institute for Science and Education (ORISE) South Campus, which includes training facilities, laboratories, and support facilities; a variety of smaller government-owned, contractor-operated facilities involved in environmental restoration; and the government-owned, government-operated Agent Operations Eastern Command of the National Nuclear Security Administration Office of Secure Transportation.

The ORR was established in the early 1940s as part of the Manhattan Project for the purposes of enriching uranium and pioneering methods for producing and separating plutonium. The missions of the ORR have evolved over the years, as it continues to adapt to meet the changing basic and applied research and national security needs of the United States.

The *Oak Ridge Reservation Annual Site Environmental Report* and supporting data are available at http://www.ornl.gov/sci/env_rpt.

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

1.1 Background

The *Oak Ridge Reservation Annual Site Environmental Report* is prepared annually and presents summary environmental data to (1) characterize environmental performance, (2) summarize environmental occurrences reported during the year, (3) confirm compliance with environmental standards and requirements, and (4) highlight significant program activities. The report fulfills the requirement contained in DOE Order 231.1A, *Environment, Safety and Health Reporting* (DOE 2004) that an integrated annual site environmental report be prepared.

The results summarized in this report are based on data collected prior to and through 2010. This report is not intended to nor does it present the results of all environmental monitoring associated with the ORR. Data collected for other site and regulatory purposes, such as environmental restoration/remedial investigation reports, waste management characterization sampling data, and environmental permit compliance data, are presented in other documents that have been prepared in accordance with applicable DOE guidance and/or laws and are referenced herein as appropriate. Appendix A to this report identifies corrections to the 2009 report. Appendix B contains a glossary of technical terms that may be useful for understanding the terminology used in this document.

Environmental monitoring on the ORR consists primarily of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring involves the collection and analysis of samples or measurements of liquid and gaseous effluents at the points of release to the environment; these measurements allow the quantification and official reporting of contaminant levels, assessment of radiation and chemical exposures to the public, and demonstration of compliance with applicable standards and permit requirements. Environmental surveillance consists of direct measurements and collection and analysis of samples taken from the site and its environs exclusive of effluents; these activities provide information on contaminant concentrations in air, water, groundwater, soil, foods, biota, and other media. Environmental surveillance data support determinations regarding environmental

compliance and, when combined with data from effluent monitoring, support chemical and radiation dose and exposure assessments of the potential effects of ORR operations, if any, on the local environment.

1.2 History of the Oak Ridge Reservation

The ORR area was first occupied by Native Americans more than 10,000 years ago, and members of the Overhill Cherokee tribe still lived in the East Tennessee region when European settlers arrived in the late 1700s. These settlers lived on farms or in four small communities called Elza, Robertsville, Scarboro, and Wheat. All but Elza were founded shortly after the Revolutionary War. In the early 1940s approximately 1,000 families inhabited the area.

In 1942, the area that was to become the ORR was selected for use in the Manhattan Project because the Clinch River provided ample supplies of water, nearby Knoxville was a good source of labor, and the Tennessee Valley Authority (TVA) could supply the huge amounts of electricity needed. About 3,000 residents received court orders to vacate within weeks the homes and farms that their families had occupied for generations. The site's wartime name was "Clinton Engineering Works."

The workers' city, named Oak Ridge, was established on the reservation's northern edge. The city grew to a population of 75,000 and was the fifth largest in Tennessee; however, it was not shown on any map. At the Y-12 Complex, south of the city, an electromagnetic separation method was used to separate ^{235}U from natural uranium. A gaseous diffusion plant, later known as K-25, was built on the reservation's western edge. Near the reservation's southwest corner, about 16 km (10 miles) from Y-12, was a third facility, known as X-10 (or Clinton Laboratories), where the Graphite Reactor was built. The X-10 facility was a pilot plant for the larger plutonium production facilities built at Hanford, Washington. Two years after World War II ended, Oak Ridge was shifted to civilian control, under the authority of the U.S. Atomic Energy Commission. In 1959, the city was incorporated and a city manager and city council form of government was adopted by the community.

Since that time, the missions of these three major installations have continued to evolve and operations adapted to meet the changing defense, energy, and research needs of the United States. Their current missions, as well as the missions of several smaller DOE facilities/activities on the ORR, are described in Sect. 1.4 of this document.

1.3 Site Description

1.3.1 Location and Population

The ORR lies within the Great Valley of East Tennessee between the Cumberland and Great Smoky Mountains and is bordered on two sides by the Clinch River (Fig. 1.1). The Cumberland Mountains are 16 km (10 miles) to the northwest; the Great Smoky Mountains are 51 km (31.6 miles) to the southeast. The ORR encompasses about 13,574 ha (33,542 acres) of mostly contiguous land owned by the federal government and under the management of the DOE (Fig. 1.2). Most of it lies within the corporate limits of the city of Oak Ridge; some of the area west of ETTP lies outside the city limits. Approximately 4,667 ha (11,533 acres) of the ORR is situated in Anderson County, and approximately 8,906 ha (22,008 acres) is in Roane County. The population of the 10-county region surrounding the ORR is about 946,830 with less than 2% of its labor force employed on ORR (Fig. 1.3). Other municipalities within approximately 30 km (18.6 miles) of the reservation include Oliver Springs, Clinton, Lake City, Lenoir City, Farragut, Kingston, and Harriman (Fig. 1.4).

Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 km (25 miles) to the east and has a population of about 185,100. Except for the city of Oak Ridge, the land within 8 km (5 miles) of the ORR is semirural and is used primarily for residences, small farms, and cattle pasture. Fishing, hunting, boating, water skiing, and swimming are popular recreational activities in the area.

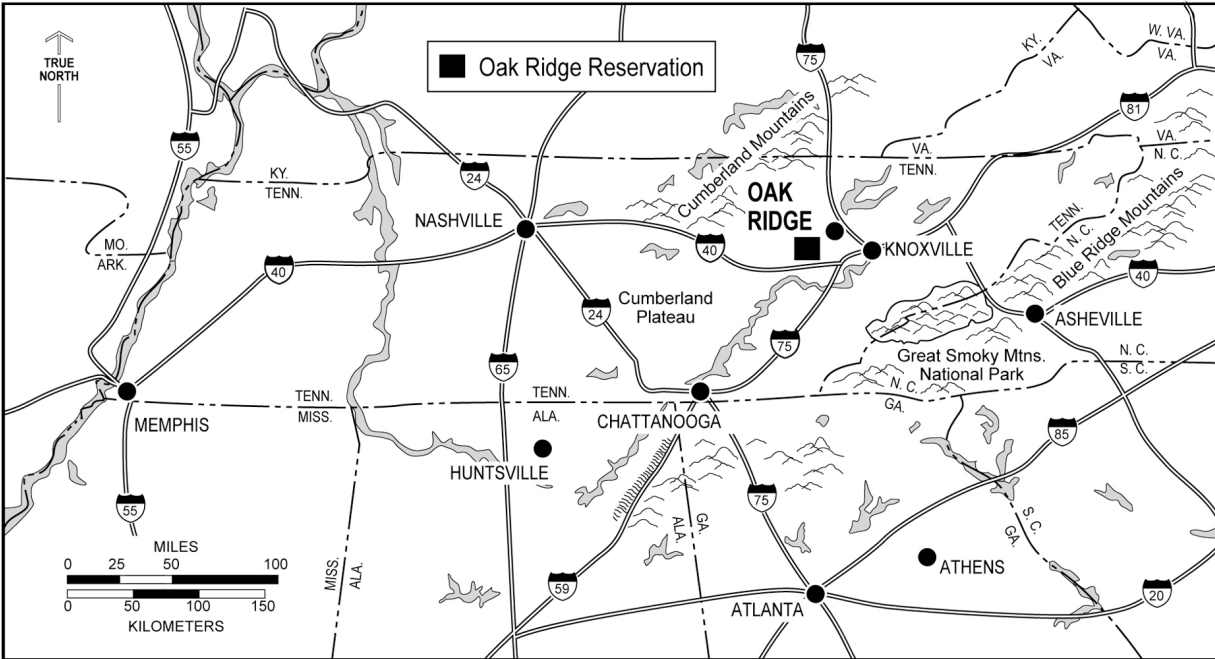


Fig. 1.1. Location of the city of Oak Ridge.

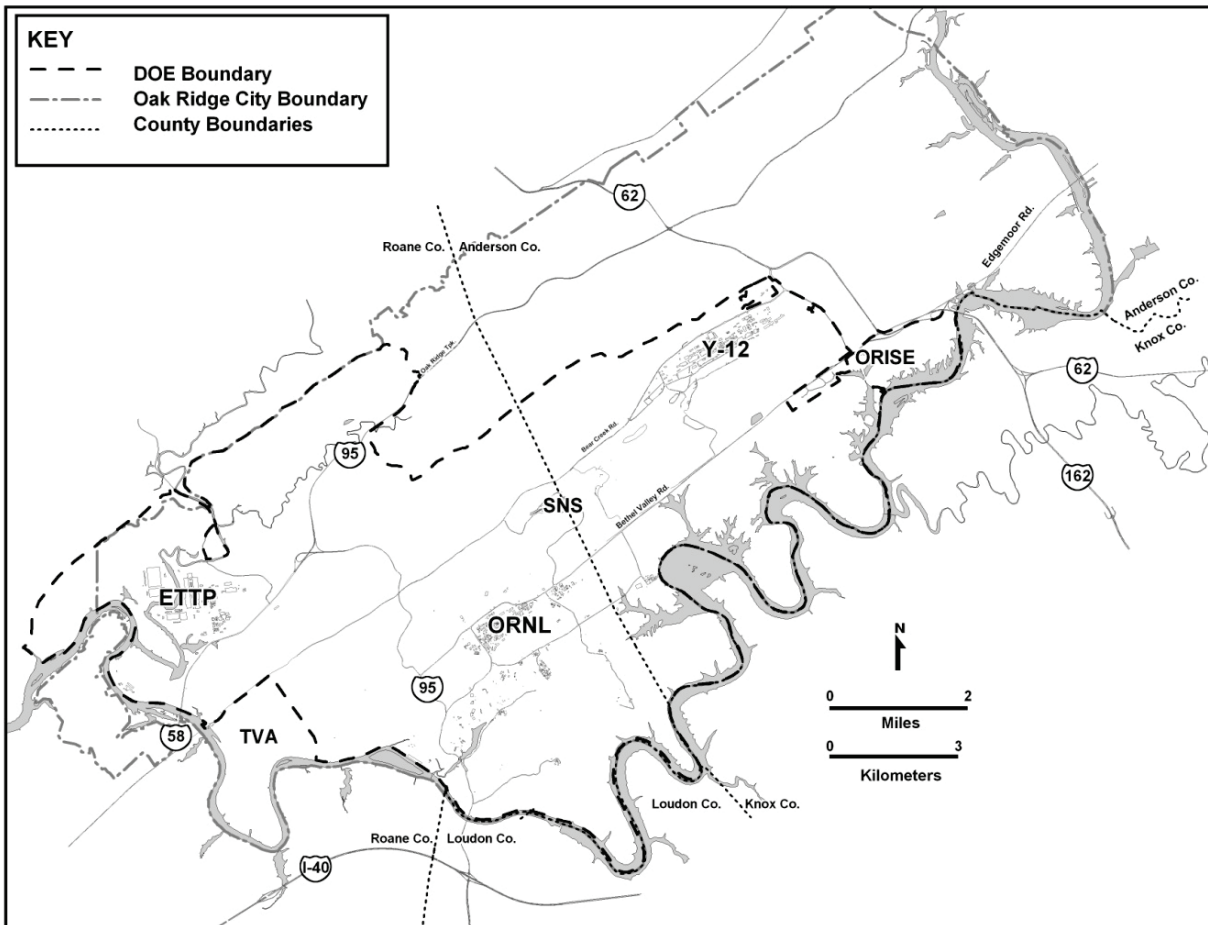


Fig. 1.2. The Oak Ridge Reservation.

Oak Ridge Reservation

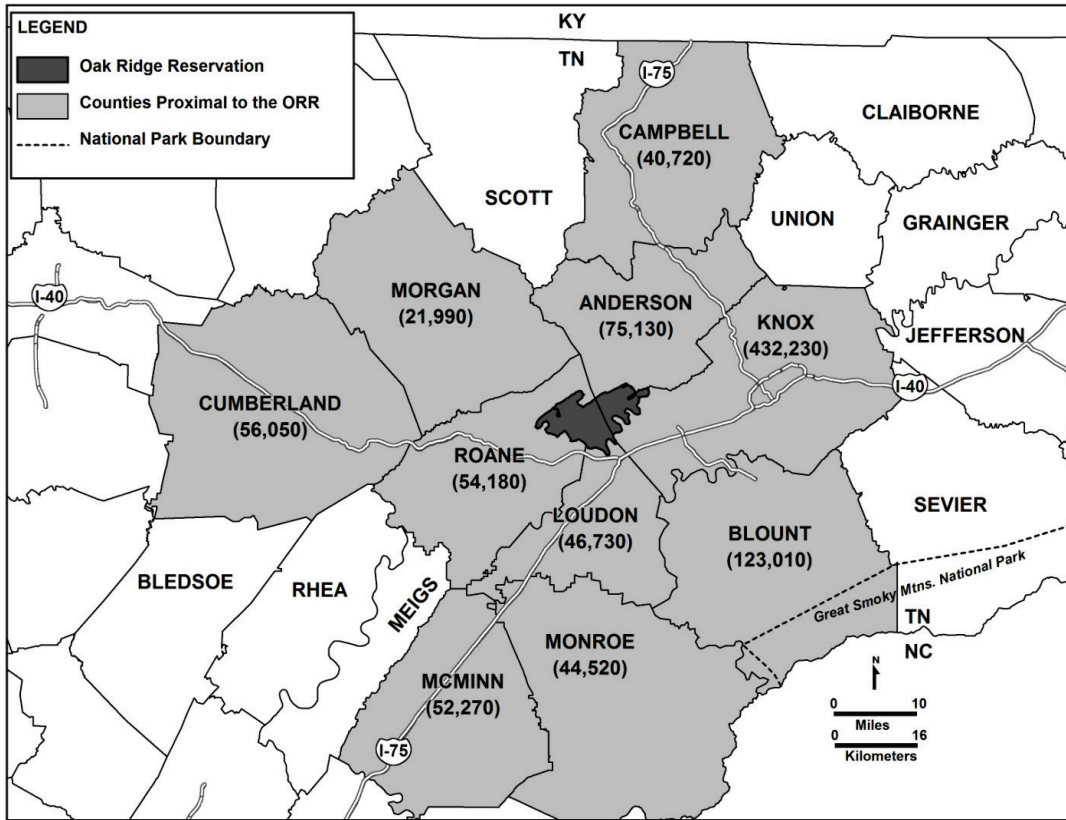


Fig. 1.3. Population by county in the 10-county region surrounding the Oak Ridge Reservation.

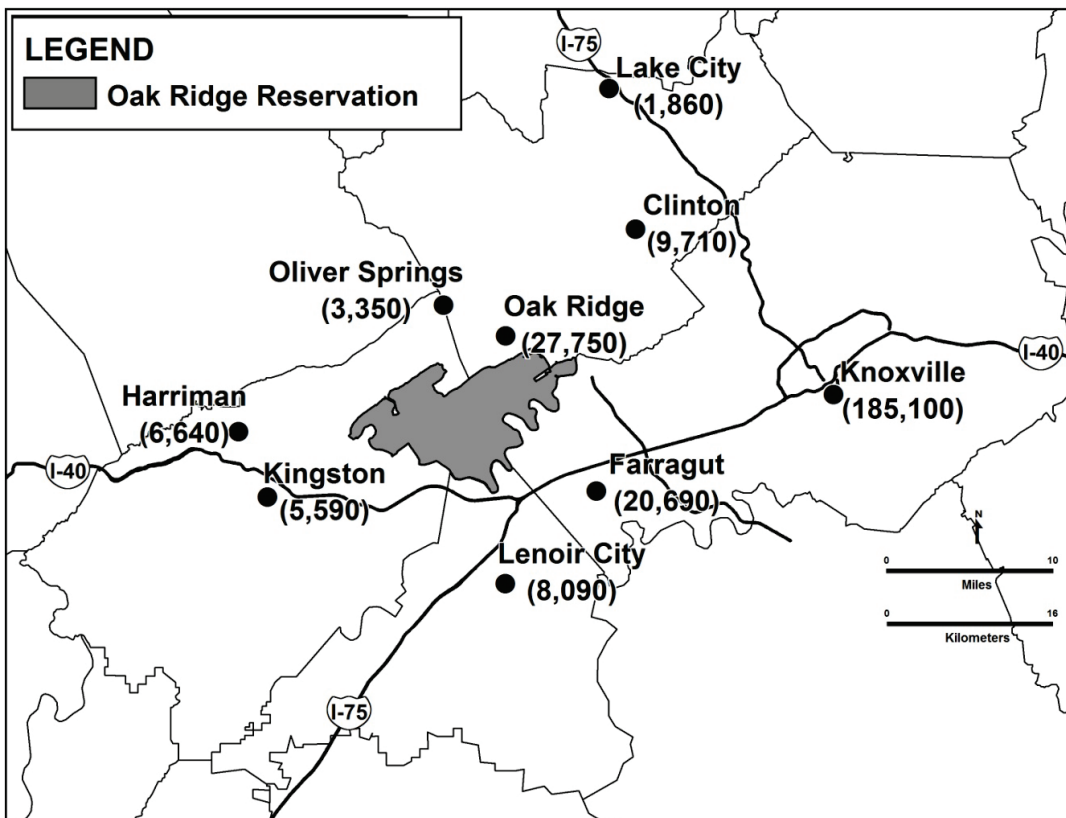


Fig. 1.4. Locations and populations of towns nearest to the Oak Ridge Reservation.

1.3.2 Climate

The climate of the Oak Ridge region may be broadly classified as humid subtropical and is characterized by significant temperature changes between summer and winter. The 30-year mean temperature for the period of 1981–2010 is 14.7°C (58.5°F). The average temperature for the Oak Ridge area during 2010 was 14.9°C (58.8°F). The coldest month is usually January, with temperatures averaging about 3.1°C (37.5°F). During 2010, January temperatures averaged below normal at 1.2°C (34.1°F). July tends to be the warmest month, with average temperatures of 25.7°C (78.1°F). July 2010 temperatures averaged 27.2°C (81°F), above the 30-year mean.

Average annual precipitation in the Oak Ridge area for the 30-year period from 1981 to 2010 was 1,342.7 mm (52.85 in.), including about 17 cm (6.7 in.) of snowfall annually (NOAA 2010). Total rainfall during 2010 (measured at the Oak Ridge National Weather Service meteorological tower) was 1,391 mm (54.76 in.), and total 2010 snowfall was 28.2 cm (11.1 in.). Precipitation during 2010 was near the 30-year average, but snowfall was above average. Monthly summaries of precipitation averages, extremes, and 2010 values are provided in Appendix C, Table C.1.

In 2010, wind speeds at ORNL Tower C (MT2) measured at 10 m (32.8 ft) above ground level averaged 1.1 m/s (3.7 ft/s). This value increased to about 2.8 m/s (9.1 ft/s) for winds at 100 m (328 ft) above the ground (about the height of local ridgetops). The local ridge-and-valley terrain reduces average wind speeds at valley bottoms, resulting in frequent periods of nearly calm conditions, particularly during clear, early morning hours. Wind direction and speed frequencies for the ORR towers during 2010 and during precipitation events over the 10-year representative period from 1998–2007 can be viewed at <http://www.ornl.gov/~das/web/page6.cfm>.

More detailed information on the climate of the Oak Ridge area is available in *Oak Ridge Reservation Physical Characteristics and Natural Resources* (Parr and Hughes 2006) and in Appendix C of this document.

1.3.3 Regional Air Quality

The Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards (NAAQS) for key principal pollutants, which are called “criteria” pollutants. These pollutants are sulfur dioxide (SO₂), carbon monoxide (CO), carbon dioxide (CO₂), nitrogen dioxide (NO₂), lead (Pb), ozone (O₃), particles with an aerodynamic diameter less than or equal to 10 µm (PM₁₀), and fine particulate matter with an aerodynamic diameter less than or equal to 2.5 µm (PM_{2.5}). EPA evaluates NAAQS based on ambient (outdoor) levels of the criteria pollutants. Areas that satisfy NAAQS are classified as attainment areas, whereas areas that exceed the NAAQS for a particular pollutant are classified as nonattainment areas for that pollutant.

The ORR is located in Anderson and Roane counties. The EPA has designated Anderson County as a basic nonattainment area for the 8-hour (h) O₃ standard as part of the larger Knoxville 8-h basic O₃ nonattainment area, which encompasses several counties. In addition, the EPA has designated Anderson, Knox, and Blount counties as a nonattainment area for the PM_{2.5} air quality standard. EPA designated the portion of Roane County surrounding the Kingston Steam Plant as a nonattainment area for PM_{2.5} as well. Air quality in the greater Knoxville and Oak Ridge area is classified as an attainment area with the NAAQS for all other criteria pollutants for which EPA has made attainment designations.

1.3.4 Surface Water

The ORR lies within the Valley and Ridge Physiographic Province, which is composed of a series of drainage basins or troughs containing many small streams feeding the Clinch River. Surface water on the ORR drains into a tributary or series of tributaries, streams, or creeks within different watersheds. Each of these watersheds drains into the Clinch River that, in turn, flows into the Tennessee River.

The largest of the drainage basins is Poplar Creek, which receives drainage from a 352 km² (136 mile²) area, including the northwestern sector of the ORR. It flows from northeast to southwest, approximately through the center of the ETPP, and discharges directly into the Clinch River.

East Fork Poplar Creek, which discharges into Poplar Creek east of the ETTP, originates within the Y-12 Complex and flows northeast along the south side of the Y-12 Complex. Bear Creek also originates within the Y-12 Complex and flows southwest. Bear Creek is mostly affected by storm water runoff, groundwater infiltration, and tributaries that drain former waste disposal sites in the Bear Creek Valley Burial Grounds Waste Management Area and the current Environmental Management Waste Management Facility (EMWMF).

Both the Bethel Valley and Melton Valley portions of ORNL are in the White Oak Creek drainage basin, which has an area of 16.5 km² (6.4 mile²). White Oak Creek headwaters originate on Chestnut Ridge, north of ORNL, near the Spallation Neutron Source (SNS) site. At the ORNL site, the creek flows west along the southern boundary of the developed area and then flows southwesterly through a gap in Haw Ridge to the western portion of Melton Valley, where it forms a confluence with Melton Branch. The headwaters of Melton Branch originate in Melton Valley east of the High Flux Isotope Reactor (HFIR) Complex. It has a drainage basin area of approximately 3.8 km² (1.47 mile²). The waters of White Oak Creek enter White Oak Lake, which is an impoundment formed by White Oak Dam. Water flowing over White Oak Dam enters the Clinch River after passing through the White Oak Creek embayment area.

1.3.5 Geological Setting

The ORR is located in the Tennessee portion of the Valley and Ridge Physiographic Province, which is part of the southern Appalachian fold-and-thrust belt. As a result of thrust faulting and differential erosion rates, a series of parallel valleys and ridges have formed that trend southwest–northeast.

Two geologic units on the ORR, designated as the Knox Group and the Maynardville Limestone of the Upper Conasauga Group, consisting of dolostone and limestone, respectively, comprise the most significant water-bearing hydrostratigraphic unit in the Valley and Ridge Province (Zurawski 1978) as well as on the ORR. Being composed of fairly soluble minerals, these bedrock formations are prone to dissolution as slightly acidic rainwater and percolating recharge water come in contact with mineral surfaces. This dissolution increases fracture apertures and can form caverns and extensive solution conduit networks under some circumstances. This hydrostratigraphic unit is referred to locally as the “Knox Aquifer.” A combination of fractures and solution conduits in the aquifer control flow over substantial areas, and large quantities of water may move long distances. Active groundwater flow can occur at substantial depths in the Knox Aquifer [91.5 to 122 m (300 to 400 ft) deep]. The Knox Aquifer is the primary source of groundwater to many streams (base flow), and most large springs on the ORR receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits are reported to exceed 3,784 L/min (1,000 gal/min). The high productivity of the Knox Aquifer is attributed to the combination of its abundant and sometimes large solution conduit systems and frequently thick overburden soils that promote recharge and storage of groundwater.

The remaining geologic units on the ORR (the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group) are composed predominantly of shales, siltstones, and sandstones with a subordinate and locally variable amount of carbonate bedrock. These formations are predominantly composed of insoluble minerals such as clays and quartz that were derived from ancient continental erosion. Groundwater occurs and moves through fractures in those bedrock units. Groundwater availability in such settings is dependent on the abundance and interconnectedness of fractures as well as connection of fractures to sources of recharge, such as alluvial soils along streams that can provide some sustained infiltration. The shale and sandstone formations are the poorest aquifers in the Valley and Ridge Province (Zurawski 1978). Well yields are generally low in the Rome, Conasauga, and Chickamauga bedrock formations except in very localized areas, where carbonate beds may provide greater groundwater storage than adjacent clastic bedrock (Fig. 1.5). Detailed information on ORR groundwater hydrology and flow is available in *Oak Ridge Reservation Physical Characteristics and Natural Resources* (Parr and Hughes 2006).

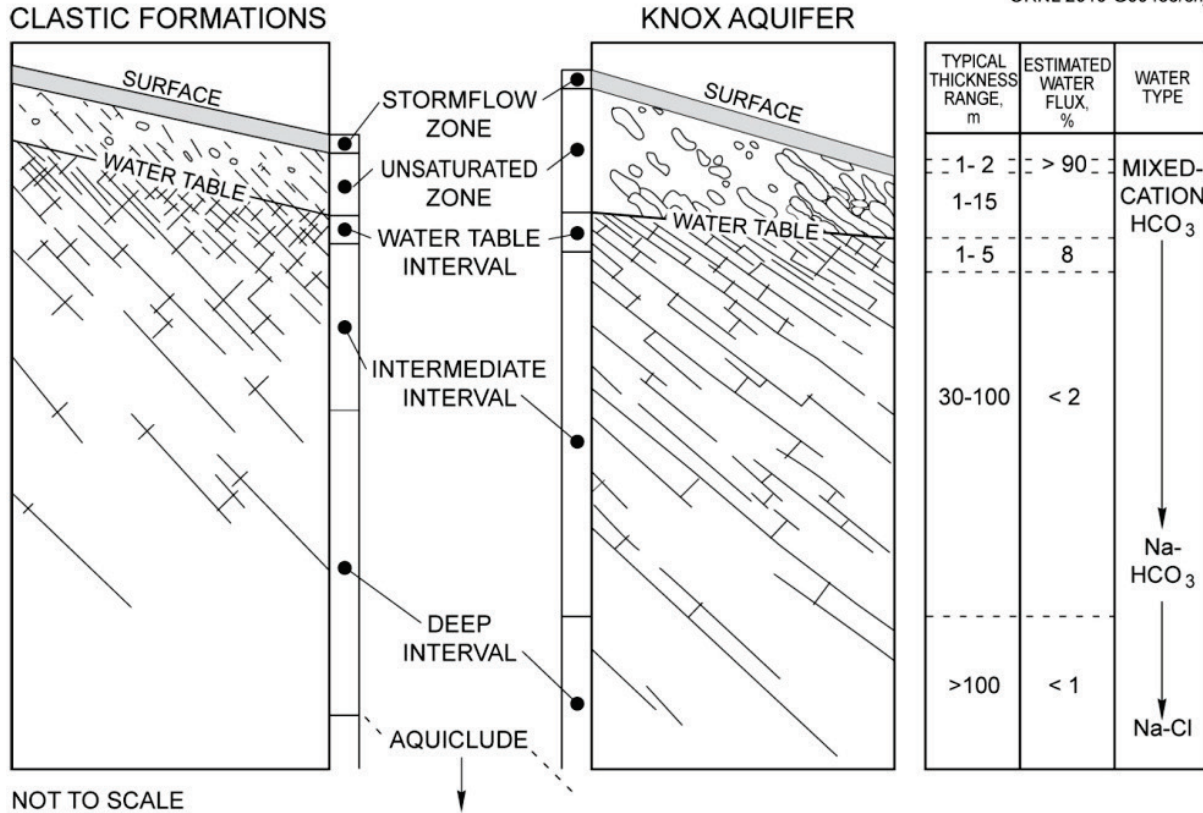


Fig. 1.5. Vertical relationships of flow zones of the Oak Ridge Reservation: estimated thicknesses, water flux, and water types.

1.3.6 Natural, Cultural, and Historic Resources

The ORR contains a unique variety of natural, cultural, and historic resources. Ongoing efforts continue to focus on preserving the rich diversity of these resources.

1.3.6.1 Wetlands

About 243 ha (600 acres) of wetlands have been identified on the ORR, most are classified as forested palustrine, scrub/shrub, and emergent wetlands. Wetlands occur across the ORR at low elevations, primarily in riparian zones of headwater streams and receiving streams as well as in the Clinch River embayments (Fig. 1.6). Wetlands identified to date range in size from several square meters at small seeps and springs to approximately 10 ha (25 acres) at White Oak Lake. Surveys of wetlands resources presented in *Identification and Characterization of Wetlands in the Bear Creek Watershed* (MMES 1993), *Wetland Survey of Selected Areas in the Oak Ridge Y-12 Plant Area of Responsibility, Oak Ridge, Tennessee* (LMES 1997), and *Wetland Survey of the X-10 Bethel Valley and Melton Valley Groundwater Operable Units at Oak Ridge National Laboratory* (Rosensteel 1996) serve as references to support wetlands assessments for upcoming projects and activities. In addition, wetlands maps have been developed for selected areas of the ORR in response to project-specific requirements. These are also consulted, and verified by site inspections, when appropriate.

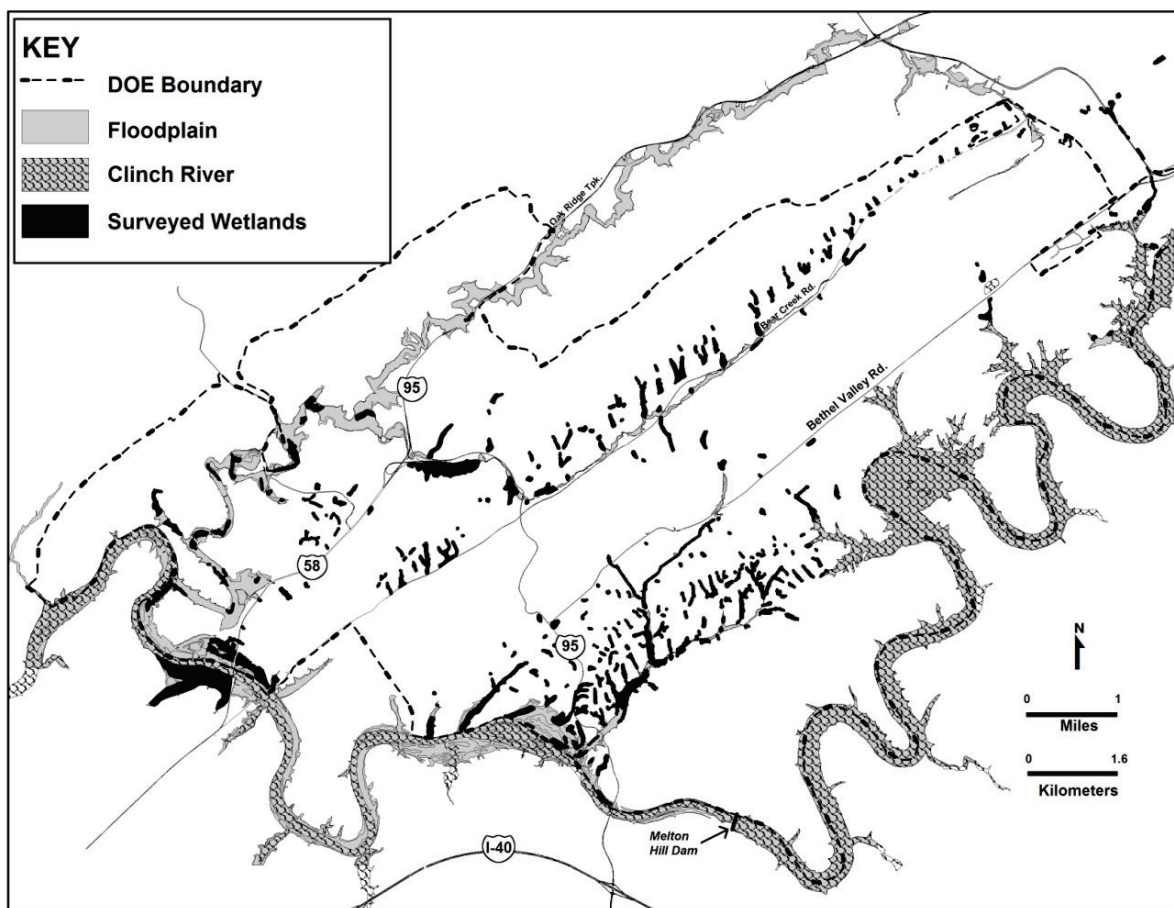


Fig. 1.6. Oak Ridge Reservation wetlands.

Wetlands that have been created at the former ORNL Emergency Waste Basin solid waste storage area (SWSA 6) and the former ORNL Intermediate Holding Pond (SWSA 4) were evaluated in June–September 2010 to determine if these areas have maintained characteristics of jurisdictional and other ORR wetlands. These wetlands were created to provide mitigation for impacts to several small wetlands in the Melton Valley due to construction activities. The created wetlands were flagged to determine acreage and were evaluated for the presence of hydrology, hydrophytic vegetation, and hydric soils. Biological conditions within the wetlands were further evaluated by surveying certain indicator wildlife populations (i.e., birds, reptiles, and amphibians). Both wetlands were found to exhibit characteristics that meet the Army Corps of Engineers (ACOE) wetlands criteria very strongly for vegetation and hydrology; however, the nature of these recently created wetland has not allowed enough time for development of classic wetland soils. Proper landscape positioning and contour design has resulted in successful wetland creations. Both sites provide a self-perpetuating hydro period that supports a diversity of wetland plants and is used by a number of wetland fauna species. Successful seeding, planting, and colonization have resulted in the establishment of sites dominated by wetland plants. The encroachment of *sericea lespedeza*, a highly invasive non-native plant, was noted at both sites. Eurasian water-milfoil was noted in the pond at the Emergency Waste Basin site. This highly aggressive green sunfish was plentiful in the pond at the southern end of the Intermediate Holding Pond site.

Instability and erosion evaluations were conducted along two relocated streams in the vicinity of the SWSA 5 cap at ORNL in June–September 2010. A portion of Melton Branch was relocated to facilitate construction of the southwestern corner of the cap and to optimize the location of a downgradient groundwater collection trench in that area. Two reaches of the Homogeneous Reactor Experiment (HRE) tributary on the east side of SWSA 5 were also relocated in areas where they infringed upon the cap boundary. The Melton Branch relocation was evaluated using habitat metrics collected as part of the

Biological Monitoring and Abatement Program (BMAP) fish and benthic community monitoring of Melton Branch, along with additional data collected on the use of riparian habitat by wildlife (mainly birds). The HRE tributary was evaluated by visual surveys of stream instability and erosion features, habitat parameter measurements, and data collected on wildlife (mainly birds) using the riparian habitat. Both the Melton Branch and HRE tributary reaches maintain “non-impaired” status, based on the habitat assessments conducted. The Melton Branch reach successfully provides habitat for epifaunal colonization and fish cover. This reach also provides favorable and diverse substrate for benthic macroinvertebrates, with conditions more favorable than most in the White Oak Creek watershed. The site provides suitable habitat for fish populations with similar fish species diversity and higher densities and biomass than several other ORR tributaries. Adjacent riparian zones are generally of sufficient width and habitat quality to support a number of bird species, including two species specifically dependent on riparian zone habitat. The narrowness of the riparian zone on the north side of the reach has an impact on habitat quality and creates some runoff and erosion issues. The presence of steep unvegetated banks is impacting habitat quality in certain portions of the reach. The HRE tributary also successfully provides habitat for epifaunal colonization and fish cover. Bank stability and vegetative cover are good along most of this reach, enhancing the quality of habitat in the tributary. Although habitat is fragmented in the area, the riparian zone is being utilized by a number of bird species, including one species known specifically for riparian habitats. The presence of steep unvegetated banks in the area of the initial stream diversion at this site is impacting the habitat quality at that specific location. The presence of deep pools along this reach would further enhance habitat quality in the tributary. The narrowness of the riparian zone on both sides of the tributary has some impact on habitat quality and creates some runoff and erosion issues.

A wetland assessment was also conducted in 2010 on the ORNL White Oak Creek floodplain just north of the existing Transuranic (TRU) Waste Processing Center (TWPC) facility. The assessment was conducted to determine the presence of jurisdictional wetlands in an area that may be impacted by the expansion of the TWPC facility. The area was evaluated for hydrology, wetland soils, and wetland vegetation. The general area that included the proposed site for the TWPC expansion contained a large area that satisfies soils, hydrologic, and vegetation criteria of the ACOE wetland protocols. The site contained numerous seeps and varying densities of wetland vegetation. Areas were broadly flagged to encompass these sensitive areas. In addition to the delineation of large wetland areas on the floodplain, a smaller bermed wetland area was also flagged on the site. Based on these wetland delineations, Wastren Advantage Inc. (WAI) began the development of a plan that would minimize impacts to wetlands and the floodplain. The limits of clearing for the current project are outside delineated wetland boundaries and the 500-year and 100-year floodplains. The current project also provides a buffer from Melton Branch. However, the project will result in the loss of some second growth bottomland forest, which could result in some impacts to forest wildlife. Additional bottomland forest exists to the north and west of the site.

A wetland assessment was conducted at sites associated with the proposed Uranium Processing Facility (UPF) at the Y-12 National Security Complex in early FY 2010. The assessment was conducted to determine if jurisdictional wetlands were present in the area of the proposed UPF project. The area was evaluated for hydrology, wetland soils, and wetland vegetation. A total of nine wetlands that satisfied soils, hydrologic, and vegetation criteria of the ACOE wetland protocols were identified at the proposed UPF site. The total acreage of wetlands delineated was 1.43 acres. The wetland evaluation was also used to successfully identify and design 3.02 acres of wetland mitigation off-set acreage for the project.

1.3.6.2 Wildlife/Endangered Species

Animals listed as species of concern known to be present on the reservation (excluding the Clinch River bordering the reservation) are listed along with their status in Table 1.1. The list illustrates the diversity of avian species on the ORR, which is also habitat for many unlisted species, some of which are in decline nationally or regionally. Some of these (e.g., anhinga) have been seen only once or a few times; others (e.g., sharp-shinned hawk, southeastern shrew) are comparatively common and widespread on the reservation. Other listed species may also be present, although they have not been observed recently (in the past 20 years). These include several species of mollusks (such as the spiny river snail), amphibians (such as the hellbender), birds (such as Bachman’s sparrow), and mammals (such as the smoky shrew).

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Table 1.1. Animal species of concern reported from and sensitive wildlife species recently found on the Oak Ridge Reservation^a

| Scientific name | Common name | Status ^b | | |
|---|-------------------------------|---------------------|-------|------------------|
| | | Federal | State | PIF ^c |
| MAMMALS | | | | |
| <i>Myotis grisescens</i> | Gray bat | E | E | |
| <i>Sorex longirostris</i> | Southeastern shrew | | NM | |
| <i>Zapus hudsonius</i> | Meadow jumping mouse | | NM | |
| FISH | | | | |
| <i>Phoxinus tennesseensis</i> | Tennessee dace | | NM | |
| AMPHIBIANS AND REPTILES | | | | |
| <i>Cryptobranchus alleganiensis</i> | Hellbender | MC | NM | |
| <i>Hemidactylium scutatum</i> | Four-toed salamander | | NM | |
| BIRDS | | | | |
| Darters | | | | |
| <i>Anhinga anhinga</i> | Anhinga | | NM | |
| Bitterns and Herons | | | | |
| <i>Ardea alba</i> | Great egret | | NM | |
| <i>Egretta caerulea</i> | Little blue heron | | NM | |
| <i>Egretta thula</i> | Snowy egret | | NM | |
| Kites, Hawks, Eagles, and Allies | | | | |
| <i>Haliaeetus leucocephalus</i> | Bald eagle ^d | | NM | |
| <i>Circus cyaneus</i> | Northern harrier | | NM | |
| <i>Accipiter striatus</i> | Sharp-shinned hawk | | NM | |
| <i>Buteo platypterus</i> | Broad-winged hawk | | | RI |
| Falcons | | | | |
| <i>Falco peregrines</i> | Peregrine falcon ^e | | E | RI |
| Grouse, Turkey, and Quail | | | | |
| <i>Bonasa umbellus</i> | Ruffed grouse | | | RI |
| <i>Colinus virginianus</i> | Northern bobwhite | | | RI |
| Rails, Gallinules, and Coots | | | | |
| <i>Gallinula chloropus</i> | Common moorhen | | NM | |
| Owls | | | | |
| <i>Aegolius acadicus</i> | Northern saw-whet owl | MC | T | RI |
| <i>Tyto alba</i> | Barn owl | | NM | |

Table 1.1 (continued)

| Scientific name | Common name | Status ^b | | |
|---|--------------------------|---------------------|-------|------------------|
| | | Federal | State | PIF ^c |
| Goatsuckers | | | | |
| <i>Caprimulgus carolinensis</i> | Chuck-will's-widow | | | RI |
| <i>Caprimulgus vociferous</i> | Whip-poor-will | | | RI |
| Swifts | | | | |
| <i>Chaetura pelagic</i> | Chimney swift | | | RI |
| Kingfishers | | | | |
| <i>Megaceryle alcyon</i> | Belted kingfisher | | | RI |
| Woodpeckers | | | | |
| <i>Melanerpes erythrocephalus</i> | Red-headed woodpecker | | | RI |
| <i>Sphyrapicus varius</i> | Yellow-bellied sapsucker | MC | NM | |
| <i>Picoides pubescens</i> | Downy woodpecker | | | RI |
| <i>Colaptes auratus</i> | Northern flicker | | | RI |
| Tyrant Flycatchers | | | | |
| <i>Contopus cooperi</i> | Olive-sided flycatcher | | NM | RI |
| <i>Contopus virens</i> | Eastern wood-pewee | | | RI |
| <i>Empidonax traillii</i> | Willow flycatcher | | | RI |
| <i>Empidonax vireescens</i> | Acadian flycatcher | | | RI |
| Swallows | | | | |
| <i>Progne subis</i> | Purple martin | | | RI |
| Titmice and Chickadees | | | | |
| <i>Poecile carolinensis</i> | Carolina chickadee | | | RI |
| Nuthatches | | | | |
| <i>Sitta pusilla</i> | Brown-headed nuthatch | | | RI |
| Kinglets, Gnatcatchers, and Thrushes | | | | |
| <i>Hylocichla mustelina</i> | Wood thrush | | | RI |
| Thrashers and Mockingbirds | | | | |
| <i>Toxostoma rufum</i> | Brown thrasher | | | RI |
| Shrikes | | | | |
| <i>Lanius ludovicianus</i> | Loggerhead shrike | MC | NM | RI |
| Vireos | | | | |
| <i>Vireo flavifrons</i> | Yellow-throated vireo | | | RI |

Table 1.1 (continued)

| Scientific name | Common name | Status ^b | | |
|---|-------------------------|---------------------|-------|------------------|
| | | Federal | State | PIF ^c |
| Wood Warblers | | | | |
| <i>Vermivora chrysoptera</i> | Golden-winged warbler | MC | NM | RI |
| <i>Vermivora pinus</i> | Blue-winged warbler | | | RI |
| <i>Dendroica cerulean</i> | Cerulean warbler | | NM | RI |
| <i>Dendroica discolor</i> | Prairie warbler | | | RI |
| <i>Dendroica fusca</i> | Blackburnian warbler | | | RI |
| <i>Mniotilta varia</i> | Black-and-white warbler | | | RI |
| <i>Helmitheros vermivorum</i> | Worm-eating warbler | | | RI |
| <i>Seiurus motacilla</i> | Louisiana waterthrush | | | RI |
| <i>Oporornis formosus</i> | Kentucky warbler | | | RI |
| <i>Wilsonia Canadensis</i> | Canada warbler | | | RI |
| <i>Wilsonia citrine</i> | Hooded warbler | | | RI |
| <i>Icteria virens</i> | Yellow-breasted chat | | | RI |
| Tanagers | | | | |
| <i>Piranga olivacea</i> | Scarlet tanager | | | RI |
| <i>Piranga rubra</i> | Summer tanager | | | RI |
| Cardinals, Grosbeaks, and Allies | | | | |
| <i>Passerina cyanea</i> | Indigo bunting | | | RI |
| Towhees, Sparrows, and Allies | | | | |
| <i>Pipilo erythrophthalmus</i> | Eastern towhee | | | RI |
| <i>Spizella pusilla</i> | Field sparrow | | | RI |
| <i>Ammodramus savannarum</i> | Grasshopper sparrow | | | RI |
| <i>Poocetes gramineus</i> | Vesper sparrow | | NM | |
| Blackbirds and Allies | | | | |
| <i>Sturnella magna</i> | Eastern meadowlark | | | RI |

^aLand and surface waters of the ORR exclusive of the Clinch River, which borders the ORR

^bStatus codes

E = endangered

T = threatened

MC = species of management concern

NM = in need of management

RI = regional importance

^cPartners in Flight was launched in 1990 in response to growing concerns about declines in the populations of many land bird species, and to emphasize the conservation of birds not covered by existing conservation initiatives.

^dThe bald eagle was federally delisted effective August 8, 2007.

^eThe peregrine falcon was federally delisted effective August 25, 1999.

Birds, fish, and aquatic invertebrates are the most thoroughly surveyed animal groups on the ORR. The only federally listed animal species that has been observed on the ORR in recent years is the gray bat, which was observed over water bordering the ORR (the Clinch River) in 2003 and over a pond on the ORR in 2004. Three gray bats were mist-netted outside a cave on the ORR in 2006. The peregrine falcon, listed by the state of Tennessee as endangered, and the northern saw-whet owl, listed by the state as threatened, are only very rare transients on the site (Fig. 1.7). Similarly, several state-listed bird species, such as the anhinga, olive-sided flycatcher, and little blue heron, are uncommon migrants or visitors to the reservation; however, the little blue heron is believed to be increasing in numbers. The cerulean warbler, listed by the state as in need of management, has been recorded during the breeding season; however, this species is not actually known to breed on the reservation. The bald eagle, also listed by the state as in need of management, is increasingly seen at all times of the year, and one nest was confirmed on the reservation in 2011. Others, such as the northern harrier, great egret, and yellow-bellied sapsucker, are migrants or winter residents that do not nest on the reservation. The golden-winged warbler, listed by the state as in need of management, has been sighted once on the reservation. Barn owls have been known to nest on the reservation in the past.

One species of fish, the spotfin chub (*Erimonax monacha*), which is listed as threatened by both the state and the federal government, has been sighted and collected in the city of Oak Ridge and may be present on the ORR. The Tennessee dace, listed by the state as being in need of management, has been found in Bear Creek watershed, tributaries to lower East Fork watershed, and Ish Creek and may occur in some sections of Grassy Creek (upstream of Scientific Ecology Group, Inc., and International Technology Corporation at Clinch River Kilometer 23) [(e.g., south of west Bear Creek Road near Grassy Creek (GSK) sampling point 1.9)].

1.3.6.3 Threatened and Endangered Plants

Four species (spreading false-foxglove, Appalachian bugbane, tall larkspur, and butternut) have been under review for listing at the federal level and were listed under the formerly used “C2” candidate designation. These species are now informally referred to as “special concern” species by the U.S. Fish and Wildlife Service.

The most recent addition (2009) to the ORR list of state-protected plants (Table 1.2) is American barberry, which is listed as a species of special concern by the state. Also early in 2011 butternut was confirmed to be currently extant on the ORR.

The Tennessee Heritage Program scientific advisory committee met in 2009 to revise the state list, but its changes to the state list are not yet official. These changes are expected to add one species to the ORR list while deleting two. In addition, the ORR list (Table 1.2) reflects changes made by the state to the scientific names used for plants.

1.3.6.4 Historical and Cultural Resources

Efforts continue to preserve the rich prehistoric and historic cultural resources of the ORR. The reservation contains more than 45 known prehistoric sites (primarily burial mounds and archeological evidence of former structures), more than 250 historic pre-World War II structures, 31 cemeteries, and several historically significant Manhattan Project-era structures. Six historic ORR properties are individually listed in the *National Register of Historic Places*:

- Freels Bend Cabin,
- Graphite Reactor,
- New Bethel Baptist Church and Cemetery,
- Oak Ridge Turnpike Checking Station,
- George Jones Memorial Baptist Church and Cemetery, and
- Scarboro Road Checking Station.

Although not yet listed in the *National Register*, an area known as the Wheat Community African Burial Grounds was dedicated in June 2000, and a memorial monument was erected.

ORR Record

Peregrine Falcon (E)
 Bachman's Sparrow (E)



ORR (1950-1953)

Northern Saw-Whet Owl (T)
 Bewick's Wren (E)



No ORR Record

Least Tern (E)
 Golden Eagle (T)
 Common Raven (T)
 Lark Sparrow (T)



Fig. 1.7. Tennessee birds—threatened and endangered.

Table 1.2. Vascular plant species listed by state or federal agencies, 2011

| Species | Common name | Habitat on ORR | Status code ^a |
|--|---------------------------|-----------------------|--------------------------|
| Currently known or previously reported from the ORR | | | |
| <i>Aureolaria patula</i> | Spreading false-foxglove | River bluff | FSC, S |
| <i>Berberis Canadensis</i> | American barberry | Rocky bluff | S |
| <i>Bolboschoenus fluviatilis</i> | River bulrush | Wetland | S |
| <i>Carex gravid</i> | Heavy sedge | Forest | S |
| <i>Carex oxylepis var. pubescens^b</i> | Hairy sharp-scaled sedge | Shaded wetlands | S |
| <i>Cimicifuga rubifolia</i> | Appalachian bugbane | Forested River slope | FSC, T |
| <i>Cypripedium acaule</i> | Pink lady's-slipper | Dry to rich woods | S-CE |
| <i>Delphinium exaltatum</i> | Tall larkspur | Barrens and woodlands | FSC, E |
| <i>Diervilla lonicera</i> | Northern bush-honeysuckle | Rocky River bluff | T |
| <i>Draba ramosissima</i> | Branching whitlow-grass | Limestone cliff | S |
| <i>Elodea nuttallii</i> | Nuttall waterweed | Pond, embayment | S |
| <i>Fothergilla major</i> | Mountain witch-alder | Woods | T |
| <i>Helianthus occidentalis</i> | Naked-stem sunflower | Barrens | S |
| <i>Hydrastis Canadensis</i> | Golden seal | Rich woods | S-CE |
| <i>Juglans cinerea</i> | Butternut | Lake shore | FSC, T |
| <i>Juncus brachycephalus</i> | Small-head rush | Open wetland | S |
| <i>Lilium canadense</i> | Canada lily | Moist woods | T |
| <i>Lilium michiganense^c</i> | Michigan lily | Moist woods | T |
| <i>Liparis loeselii</i> | Fen orchid | Forested wetland | E |
| <i>Panax quinquefolius</i> | Ginseng | Rich woods | S-CE |

Table 1.2 (continued)

| Species | Common name | Habitat on ORR | Status code ^a |
|--|------------------------|------------------------|--------------------------|
| Currently known or previously reported from the ORR (cont) | | | |
| <i>Platanthera flava</i> var. <i>herbiola</i> | Tuberculed rein-orchid | Forested wetland | T |
| <i>Ruellia purshiana</i> | Pursh's wild-petunia | Dry, open woods | S |
| <i>Spiranthes lucida</i> | Shining ladies-tresses | Boggy wetland | T |
| <i>Thuja occidentalis</i> | Northern white cedar | Rocky river bluffs | S |
| <i>Viola tripartite</i> var. <i>tripartite</i> | Three-parted violet | Rocky woods | S |
| Rare plants that occur near and could be present on the ORR | | | |
| <i>Agalinis auriculata</i> | Earleaf false foxglove | Calcareous barren | FSC, E |
| <i>Allium burdickii</i> or <i>A. tricoccom</i> ^d | Ramps | Moist woods | S, CE |
| <i>Pseudognaphalium helleri</i> | Heller's catfoot | Dry woodland edge | S |
| <i>Lathyrus palustris</i> | A vetch | Moist meadows | S |
| <i>Liatris cylindracea</i> | Slender blazing star | Calcareous barren | E |
| <i>Lonicera dioica</i> | Mountain honeysuckle | Rocky river bluff | S |
| <i>Meehanian cordata</i> | Heartleaf meehania | Moist calcareous woods | T |
| <i>Pedicularis lanceolata</i> | Swamp lousewort | Calcareous wet meadow | T |
| <i>Pycnanthemum torrei</i> | Torrey's mountain-mint | Calcareous barren edge | S |
| <i>Solidago ptarmicoides</i> | Prairie goldenrod | Calcareous barren | E |

^aStatus codes:

CE = Status due to commercial exploitation.

E = Endangered in Tennessee.

FSC = Federal Special Concern; formerly designated as C2. See *Federal Register*, February 28, 1996.

S = Special concern in Tennessee.

T = Threatened in Tennessee.

^b*Carex oxylepis* var. *pubescens* has not been observed during recent surveys.

^c*Lilium michiganense* is believed to have been extirpated from the ORR by the impoundment at Melton Hill.

^dRamps have been reported near the ORR, but there is not sufficient information to determine which of the two species is present or if the occurrence may have been introduced by planting. Both species of ramps have the same state status.

The DOE Oak Ridge Office (ORO) *Cultural Resource Management Plan* (DOE 2001) was developed to identify, assess, and document historic and cultural resources on the ORR and establish a management strategy.

1.4 DOE Offices and Sites

1.4.1 The DOE Oak Ridge Office

The ORR is home to a world-leading research and manufacturing park, with major federal programs in the areas of science, environmental management, nuclear fuel supply, and national security. The DOE-ORO oversees and manages these programs at three primary sites: ORNL, ETPP, and ORISE.

The DOE presence in Oak Ridge has a major financial impact on the area as well; it serves as an economic engine, driving local, regional, and statewide development. DOE is credited with providing a \$3.6 billion increase in the gross state product. It supports some 44,889 full-time jobs statewide, results in \$76.9 million in state and local sales tax, and is the fourth-largest employer in Tennessee.

With a federal and contractor workforce in Oak Ridge of more than 12,000 people, DOE is committed to continuing its strong ties to the communities in East Tennessee. The support of local communities has enabled ORO to undertake some of the most complex work in the department, and there is more to come as ORO advances public and private-sector growth in the areas of science, manufacturing, national security, and reindustrialization.

1.4.2 The National Nuclear Security Administration Y-12 Site Office

The National Nuclear Security Administration (NNSA) is a semiautonomous agency within DOE that works in partnership with the U.S. Department of Defense and the other components of the national security enterprise to perform routine maintenance and repair of nuclear weapons components, dismantlement of retired nuclear weapons, and refurbishment of nuclear warheads and to maintain the capability to design, manufacture, and certify new nuclear warheads.

The NNSA Y-12 Site Office (YSO), located on the Y-12 Complex, is responsible for operation of the Y-12 Complex. YSO employees perform contract and program management oversight, contract and administrative management, and technical evaluation and assessment.

1.4.3 Oak Ridge National Laboratory

Oak Ridge National Laboratory is DOE's largest science and energy laboratory (Fig. 1.8). Managed since April 2000 by UT-Battelle, LLC, a partnership between the University of Tennessee and Battelle Memorial Institute, ORNL was established in 1943 as a part of the Manhattan Project to pioneer a method for producing and separating plutonium. During the 1950s and 1960s, ORNL became an international center for the study of nuclear energy and related research in the physical and life sciences. With the creation of DOE in the 1970s, ORNL's mission broadened to include a variety of energy technologies and strategies. Today the laboratory supports the nation with a peacetime science and technology mission.



Fig. 1.8. The Oak Ridge National Laboratory.

As an international leader in a range of scientific areas that support DOE's mission, ORNL has six major mission roles: neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale, and national security. ORNL's leadership role in the nation's energy future includes hosting the U.S. project office for the ITER fusion experiment and the BioEnergy Science Center, which is sponsored by the DOE Office of Science.

The TWPC is managed by Wastren Advantage, Inc. (WAI) for DOE. The mission of TWPC is to receive TRU wastes from ORNL for processing, treatment, repackaging, and shipment to designated facilities for final disposal. Processed TRU waste is shipped to the Waste Isolation Pilot Plant (WIPP) for disposal. Waste that is determined to be non-TRU (e.g., low-level radioactive waste, mixed low-level waste) is shipped to the Nevada National Security Site or other approved facility.

Isotek Systems LLC (Isotek) manages activities at ORNL's Building 3019 Complex for DOE and is responsible for activities associated with processing, down-blending, and packaging the DOE inventory of ^{233}U stored in the Building 3019 Complex.

Approximately 5 ha (15 acres) in the central portion of the ORNL has been leased to Halcyon, LLC, a subsidiary of the Community Reuse Organization of East Tennessee (CROET) for development into the Oak Ridge Science and Technology Park (ORSTP). The ORSTP will provide space for private companies doing research at ORNL, partner universities, start-up companies built around ORNL technologies, and ORNL contractors to conduct business within a short distance of ORNL researchers and DOE user facilities such as the SNS, the Center for Nanophase Materials Sciences, and the HFIR. Construction of the first ORSTP facility, Pro2Serve's 115,000-ft² National Security Engineering Center, was completed in 2009, and the company has moved into the building. In addition, the former Building 2033, which has been leased to Halcyon, LLC, and is now known as the Halcyon Commercialization Center (HCC), continues to attract tenants. Currently, the largest tenant in the HCC is Roane State Community College, which is offering job training classes on site in the areas of carbon fiber and solar energy. Other tenants in the HCC include several consulting firms and a carbon fiber manufacturer that is partnering with ORNL for research. Expansion of the ORSTP will continue as more environmental cleanup in ORNL's central campus is completed.

There is currently no construction occurring within the ORSTP.

1.4.4 The Y-12 National Security Complex

The original Y-12 Complex (Fig. 1.9) was constructed as part of the World War II Manhattan Project and began operations in November 1943. The first site mission was the separation of ^{235}U from natural uranium by an electromagnetic separation process. At its peak in 1945, more than 22,000 workers were employed at the site.

Today, as part of the NNSA Nuclear Security Enterprise, Y-12 performs critical roles in strengthening national security and reducing the global threat from weapons of mass destruction through work in support of the nation's nuclear weapons stockpile, nuclear nonproliferation, and naval reactors. Y-12 also provides unique and highly specialized manufacturing and software technologies to other federal agencies through the DOE Work for Others program.



Fig. 1.9. Y-12 National Security Complex.

1.4.5 East Tennessee Technology Park

What is now known as the ETTP site was originally named the K-25 site, on which was located the nation's first gaseous diffusion plant for enriching uranium (Fig. 1.10), as part of the Manhattan Project.

In the postwar years, additional uranium enrichment facilities were built adjacent to K-25, forming a complex officially known as the Oak Ridge Gaseous Diffusion Plant. Uranium enrichment operations at the site ceased in 1987. The site was renamed the East Tennessee Technology Park in 1996 and began undergoing cleanup for ultimate conversion to a private-sector industrial park called the Heritage Center. Restoration of the environment, decontamination, and decommissioning of facilities, disposition of wastes, and reindustrialization are the major activities at the site. During the CY 2010 period covered by this report, ETTP landlord contractor functions and the majority of the ETTP cleanup program actions were managed by Bechtel Jacobs, Inc., LLC (BJC). In August 2011, the BJC work scope at ETTP transitioned to UCOR, a newly formed partnership between URS and CH2M Hill.

ORNL 2010-G00441/chj



Fig. 1.10. East Tennessee Technology Park.

1.4.6. Environmental Management Waste Management Facility

The EMWMF is located in eastern Bear Creek Valley near the Y-12 Complex and, during the period covered by this report, was managed by Bechtel Jacobs, Inc., LLC. In August 2011, management transitioned from Bechtel Jacobs to UCOR, a newly formed partnership between URS and CH2M Hill. The EMWMF was built for disposal of waste resulting from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup actions on the ORR. The original design was for the construction, operation, and closure of a projected 1.3 million m³ (1.7 million yd³) disposal facility. The approved capacity was subsequently increased to 1.8 million m³ (2.4 million yd³) to maximize utilization of the footprint designated in a 1999 record of decision. The facility currently consists of six disposal cells. A fifth cell was completed in 2010 and is awaiting final regulatory approval for use. Construction began on a sixth cell in May 2010.

EMWMF is an engineered landfill that accepts low-level, mixed low-level, and hazardous wastes from DOE sites on the ORR that meet specific waste acceptance criteria developed in accordance with the

agreements with state and federal regulators. Waste types that qualify for disposal include soil, dried sludge and sediment, solidified wastes, stabilized waste, building debris, scrap equipment, and secondary waste such as personal protective equipment, all of which must meet the land disposal restrictions. In addition to the solid waste disposal facility, EMWMF operates a leachate collection system. The leachate is treated at the ORNL Liquids and Gaseous Treatment Facility (LGTF), which is operated by UT-Battelle.

1.4.7 Oak Ridge National Environmental Research Park

In 1980, DOE established the Oak Ridge National Environmental Research Park (Fig. 1.11). Consisting of about 8,000 ha (19,760 acres), the Research Park serves as an outdoor laboratory to evaluate the environmental consequences of energy use and development as well as the strategies to mitigate those effects. It contains large blocks of forest and diverse communities of vegetation that offer unparalleled resources for ecosystem-level and large-scale research. Major national and international collaborative research initiatives use it to address issues such as multiple stress interactions, biodiversity, sustainable development, tropospheric air quality, global climate change, innovative power conductors, solar radiation monitoring, ecological recovery, and monitoring and remediation.

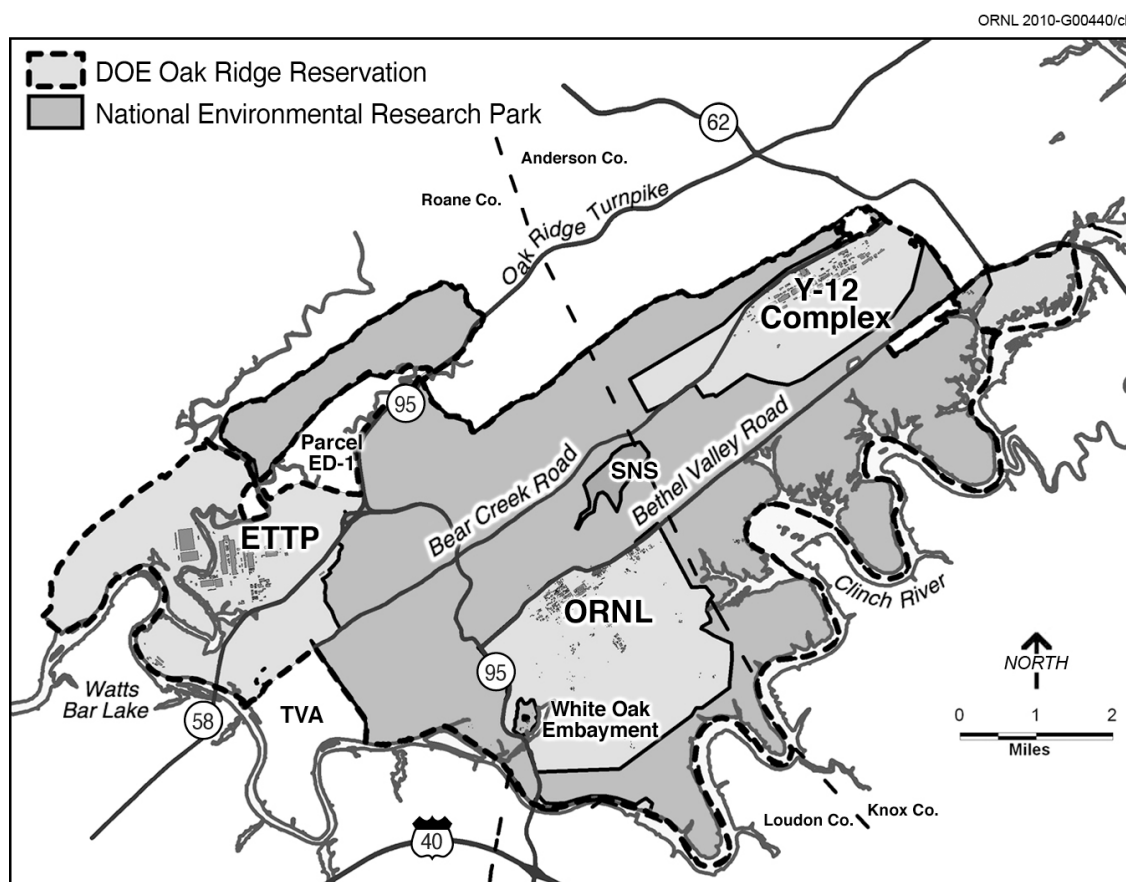


Fig. 1.11. The Oak Ridge National Environmental Research Park covers about 8000 hectares (19,760 acres) on the reservation.

Field sites at the Research Park provide maintenance and support facilities that permit sophisticated and well-instrumented environmental experiments. These facilities include elaborate monitoring systems that enable users to precisely and accurately measure environmental factors for extended periods of time. Because the park is under the jurisdiction of the federal government, public access is restricted, and experimental sites and associated equipment are, therefore, not disturbed.

National recognition of the value of the Research Park has led to its use as a component of both regional- and continental-scale research projects. Various Research Park sites offer opportunities for

aquatic and terrestrial ecosystem analyses of topics such as biogeochemical cycling of pollutants resulting from energy production, landscape alterations, ecosystem restoration, wetlands mitigation, and forest and wildlife management.

1.4.8 Oak Ridge Institute for Science and Education

The Oak Ridge Institute for Science and Education (ORISE) is a DOE institute, which is managed by Oak Ridge Associated Universities (ORAU). ORISE addresses national needs in assessing and analyzing environmental and health effects of radiation, beryllium, and other hazardous materials; developing and operating medical and national security radiation emergency management and response capabilities; and managing education programs to help ensure a robust supply of scientists, engineers, and technicians to meet future science and technology needs. ORISE creates opportunities for collaboration through partnerships with other DOE facilities, federal agencies, academia, and industry in a manner consistent with DOE objectives and the ORISE mission.

ORISE includes a 94-ha (232-acre) area on the southeastern border of the ORR that from the late 1940s to the mid-1980s was part of an agricultural experiment station owned by the federal government and, until 1981, was operated by the University of Tennessee. The site houses offices, laboratories, and storage areas for the ORISE program offices and support departments.

1.4.9 The National Nuclear Security Administration Office of Secure Transportation, Agent Operations Eastern Command

Since 1947, DOE and its predecessor agencies have moved nuclear weapons, weapons components, special nuclear materials, and other important national security assets by commercial and government transportation modes. In the late 1960s, worldwide terrorism and acts of violence prompted a review of procedures for safeguarding these materials. As a result, a comprehensive new series of regulations and equipment was developed to enhance the safety and security of these materials in transit. Thus, modified and redesigned transport equipment to incorporate features that more effectively enhance self-protection and that deny unauthorized access to the materials was established. Also during this time, the use of commercial transportation systems was abandoned, and a totally federal operation was implemented. The organization within DOE/NNSA responsible for this mission is the Office of Secure Transportation (OST).

The NNSA OST Agent Operations Eastern Command (AOEC) Secure Transportation Center and Training Facility is located on the ORR. The NNSA OST AOEC is situated on approximately 485 ha (1,198 acres) on the ORR and operates under a user permit agreement with DOE ORO. The NNSA OST AOEC implements its assigned mission transportation operations, maintains applicable fleet and escort vehicles, and continues extensive training activities for its federal agents.

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