

# 1. Introduction to the Oak Ridge Reservation

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The Oak Ridge Reservation (ORR) is a 13,560 ha (33,508-acre) federally owned site located in the counties of Anderson and Roane in eastern Tennessee. ORR is home to two major US Department of Energy (DOE) operating components, the Oak Ridge National Laboratory (ORNL) and the Y-12 National Security Complex (Y-12 Complex). A number of other facilities are located on ORR, including the East Tennessee Technology Park (ETTP), site of a former gaseous diffusion plant that is undergoing environmental cleanup and transition to a private sector business/industrial park; 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 cleanup; and the government-owned, government-operated Agent Operations Eastern Command (AOEC) of the National Nuclear Security Administration (NNSA) Office of Secure Transportation (OST).

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. ORR missions are continuing to evolve as it adapts to meet the changing basic and applied research and national security needs of the United States.

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 here as needed for specific calculations and comparisons.

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## 1.1 Background

The *Oak Ridge Reservation Annual Site Environmental Report* (ASER) 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 O 231.1B, *Environment, Safety and Health Reporting*, (DOE 2012) that an integrated annual site environmental report be prepared.

The results summarized in this report are based on data collected before and continuing through 2013. This report is not intended to, nor does it, present the results of all environmental monitoring associated with 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 here as appropriate. Appendix A contains a glossary of technical terms that may be useful for understanding the terminology used in this report.

Environmental monitoring on 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 public exposures to radiation and chemicals, 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 about 1,000 families inhabited the area.

In 1942, the area that was to become 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  $^{235}\text{U}$  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 the Y-12 Complex, 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 US 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 the three major ORR installations have continued to evolve and operations have 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 ORR, are described in Sect. 1.4 of this document.

## 1.3 Site Description

### 1.3.1 Location and Population

ORR lies within the Great Valley of East Tennessee between the Cumberland and Great Smoky Mountains and is bordered 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. ORR encompasses about 13,560 ha (33,508 acres) of mostly contiguous land owned by the federal government and under the management of DOE in Anderson and Roane counties (Fig. 1.2). The population of the 10-county region surrounding ORR is about 961,000, with less than 2% of its labor force employed on ORR. The population estimate for the official nine-county Knoxville Metropolitan Statistical Area is 848,350. Other municipalities within about 30 km (18.6 miles) of the reservation include Oliver Springs, Clinton, Lake City, Lenoir City, Farragut, Kingston, and Harriman.

Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 km (25 miles) to the east and has a population of about 181,000. Except for the city of Oak Ridge, the land within 8 km (5 miles) of 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.

ORNL 2010-G00435/chj

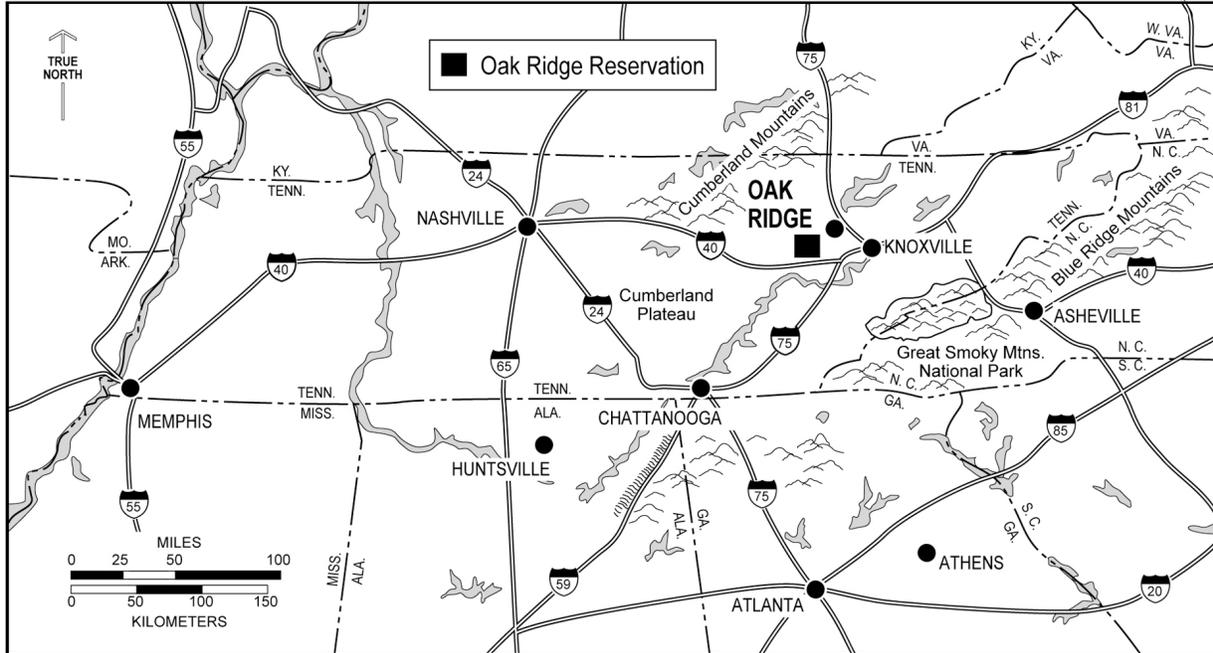


Fig. 1.1. Location of the city of Oak Ridge.

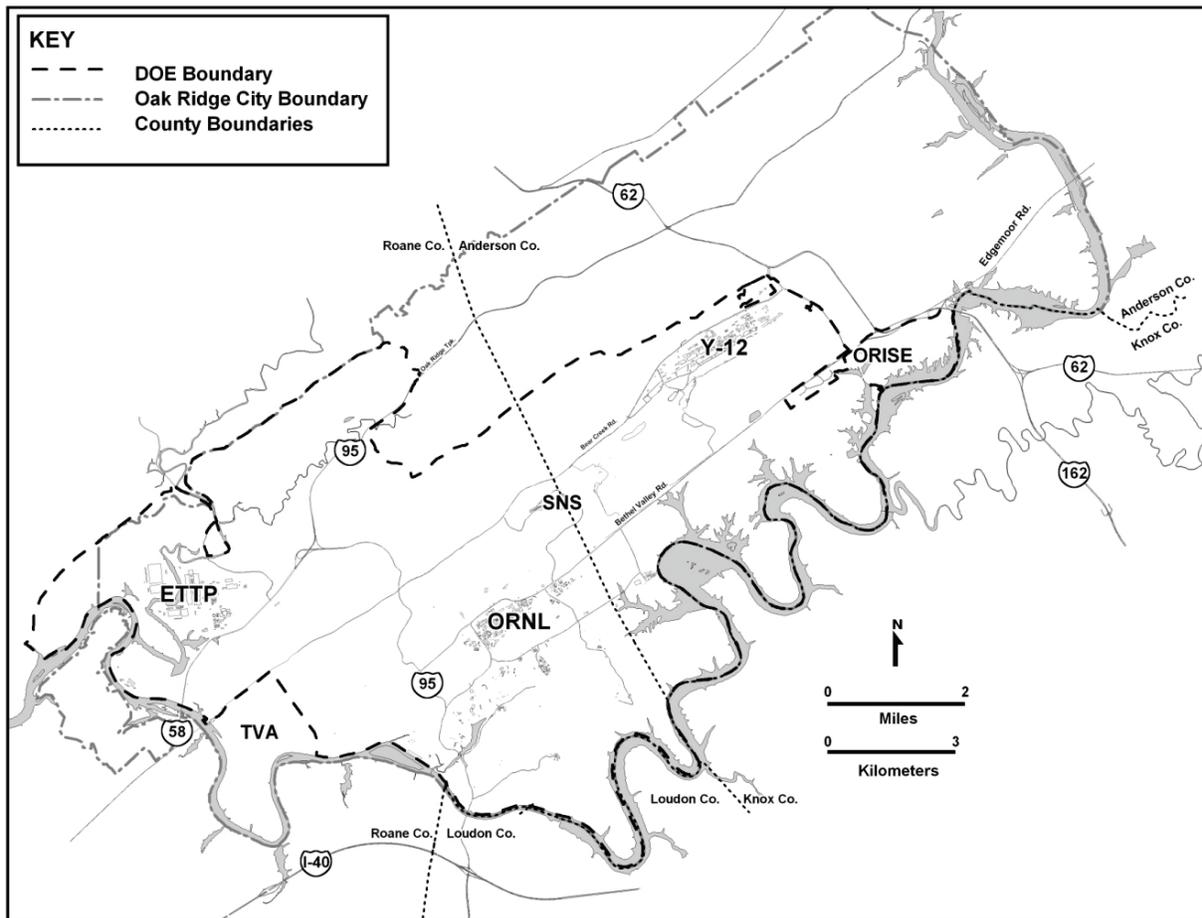


Fig. 1.2. The Oak Ridge Reservation.

### 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 1981–2010 was 14.9°C (58.8°F). The average temperature for the Oak Ridge area during 2013 was 14.8°C (58.7°F). The coldest month is usually January, with temperatures averaging about 3.2°C (37.7°F). During 2013, January temperatures were above normal at 5.6°C (42.0°F). July tends to be the warmest month, with average temperatures of 25.8°C (78.5°F). However during the 2000s, August temperatures were slightly warmer than July [25.7°C (78.3°F) vs. 25.4°C (77.7°F)]. July 2013 temperatures averaged 24.6°C (76.2°F), below the 30-year average.

Average annual precipitation in the Oak Ridge area for the 30-year period from 1981 to 2010 was 1,293.5 mm (50.91 in.), including about 21.3 cm (8.4 in.) of snowfall annually (NOAA 2011). Total precipitation during 2013 [measured at the Oak Ridge National Weather Service meteorological tower (MT)] was 1,712 mm (67.37 in.), 32% above the 30-year average. Total 2013 snowfall was 9.4 cm (3.7 in.), 60% below the 30-year average. Monthly summaries of precipitation averages, extremes, and 2013 values are provided in Appendix B, Table B.1.

In 2013, wind speeds at ORNL Tower C (MT2) measured at 10 m (32.8 ft) above ground level (AGL) averaged 1.1 m/s (2.5 mph). This value increased to about 2.9 m/s (6.4 mph) for winds at 100 m (328 ft) AGL (about the height of local ridgetops). The local ridge-and-valley terrain reduces average wind speeds at valley bottoms, resulting in frequent periods of calm or near calm conditions, particularly during clear early morning hours in weak synoptic weather environments. Wind direction frequencies with respect to 2013 precipitation hours for the ORR towers may be reviewed at <http://www.ornl.gov/adm/fo/lp/orrm/page7.htm>.

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 B of this document. A detailed analysis of wind patterns for ORR was conducted from 2009 to 2011 and may be reviewed online at [http://www.ornl.gov/~das/met/MT/KRB\\_ORNL.pdf](http://www.ornl.gov/~das/met/MT/KRB_ORNL.pdf) (Birdwell 2011).

### 1.3.3 Regional Air Quality

The US 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 (SO<sub>2</sub>), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), lead (Pb), ozone (O<sub>3</sub>), particulate matter (PM) with an aerodynamic diameter less than or equal to 10 μm (PM<sub>10</sub>), and fine PM with an aerodynamic diameter less than or equal to 2.5 μm (PM<sub>2.5</sub>). 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 NAAQS for a particular pollutant are classified as nonattainment areas for that pollutant.

ORR is located in Anderson and Roane counties. EPA has designated Anderson County as a basic nonattainment area for the 8-hour (h) O<sub>3</sub> standard as part of the larger Knoxville 8 h basic O<sub>3</sub> nonattainment area, which encompasses several counties. In addition, EPA has designated Anderson, Knox, and Blount counties as a nonattainment area for the PM<sub>2.5</sub> air quality standard. EPA also designated the portion of Roane County surrounding the Kingston Steam Plant as a nonattainment area for PM<sub>2.5</sub>. The greater Knoxville and Oak Ridge area is classified as an NAAQS attainment area for all other criteria pollutants for which EPA has made attainment designations.

### 1.3.4 Surface Water

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 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 km<sup>2</sup> (136-mile<sup>2</sup>) area, including the northwestern sector of ORR. It flows from northeast to southwest, roughly through the center of ETTP, and discharges directly into the Clinch River.

East Fork Poplar Creek (EFPC), which discharges into Poplar Creek east of 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 but 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 km<sup>2</sup> (6.4 mile<sup>2</sup>). 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 about 3.8 km<sup>2</sup> (1.47 mile<sup>2</sup>). 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

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 ORR, designated as the Knox Group and the Maynardville Limestone of the Upper Conasauga Group, consisting of dolostone and limestone, respectively, make up the most significant water-bearing hydrostratigraphic units in the Valley and Ridge Province (Zurawski 1978) and on 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 the 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 for 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 3,784 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 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 and the 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. Detailed information on ORR groundwater hydrology and flow is available in *Oak Ridge Reservation Physical Characteristics and Natural Resources* (Parr and Hughes 2006).

### 1.3.6 Natural, Cultural, and Historic Resources

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 ORR; most are classified as forested palustrine, scrub/shrub, and emergent wetlands. Wetlands occur across ORR at low elevations, primarily in riparian zones of headwater streams and receiving streams and in the Clinch River embayments (Fig. 1.3). Wetlands identified to date range in size from several square meters at small seeps and springs to about 10 ha (25 acres) at White Oak Lake. Surveys of wetland resources presented in *Identification and Characterization of Wetlands in the Bear Creek Watershed* (Rosensteel and Trettin 1993), *Wetland Survey of the X-10 Bethel Valley and Melton Valley Groundwater Operable Units at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (Rosensteel 1996), and *Wetland Survey of Selected Areas in the Oak Ridge Y-12 Plant Area of Responsibility, Oak Ridge, Tennessee* (Rosensteel 1997) serve as references to support wetland assessments for upcoming projects and activities. In addition, wetland maps have been developed for selected areas of ORR in response to project-specific requirements. These are also consulted, and verified by site inspections, when appropriate.

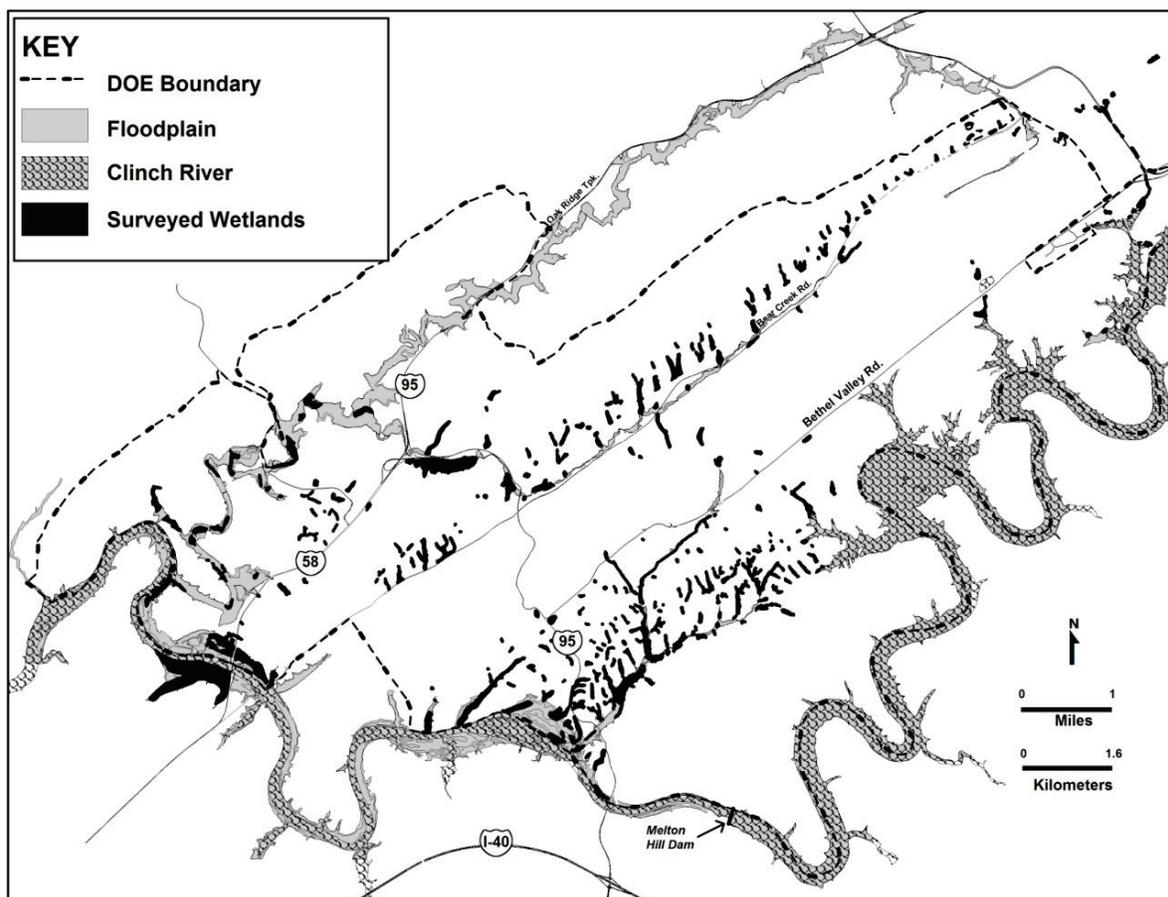


Fig. 1.3. Oak Ridge Reservation wetlands.

Monitoring restored or created mitigation sites for 5 years is a standard requirement of the Tennessee Department of Environment and Conservation's (TDEC's) wetland mitigation Aquatic Resource Alteration Permits (ARAPs) required by Section 401 of the Clean Water Act (CWA).

In 2013, as part of the Uranium Processing Facility (UPF) project at the Y-12 Complex, work was begun on the Bear Creek Road by-pass phase II and a haul road extension project that modified wetlands on the north side of Bear Creek Road. The work was performed under an approved US Army Corps of Engineers (USACE) Section 404 permit. The wetland mitigation work performed under the permit will result in a more than 3 : 1 net increase in total wetland area when the multiyear project is complete.

### 1.3.6.2 Wildlife/Endangered Species

Animals listed as species of concern by state, federal, or international organizations and known to be present on the reservation (excluding the Clinch River bordering the reservation) are listed along with their status in Table 1.1. 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.

**Table 1.1. Animal species of special concern reported on the Oak Ridge Reservation<sup>a</sup>**

Scientific name	Common name	Status <sup>b</sup>		
		Federal	State	PIF <sup>c</sup>
<b>FISH</b>				
<i>Phoxinus tennesseensis</i>	Tennessee dace		NM	
<b>AMPHIBIANS AND REPTILES</b>				
<i>Cryptobranchus alleganiensis</i>	Hellbender	MC	NM	
<i>Hemidactylium scutatum</i>	Four-toed salamander		NM	
<b>BIRDS</b>				
<b>Darters</b>				
<i>Anhinga anhinga</i>	Anhinga		NM	
<b>Bitterns and Herons</b>				
<i>Ixobrychus exilis</i>	Least bittern	MC	NM	
<i>Ardea alba</i>	Great egret		NM	
<i>Egretta caerulea</i>	Little blue heron	MC	NM	
<i>Egretta thula</i>	Snowy egret	MC	NM	
<b>Kites, Hawks, Eagles, and Allies</b>				
<i>Haliaeetus leucocephalus</i>	Bald eagle	MC <sup>d</sup>	NM	
<i>Circus cyaneus</i>	Northern harrier		NM	
<i>Accipiter striatus</i>	Sharp-shinned hawk	MC	NM	
<i>Buteo lineatus</i>	Red-shouldered hawk			RI
<i>Buteo platypterus</i>	Broad-winged hawk			RI
<b>Falcons</b>				
<i>Falco peregrinus</i>	Peregrine falcon	MC <sup>e</sup>	E	RI
<i>Falco sparverius</i>	American kestrel	MC		RI
<b>Grouse, Turkey, and Quail</b>				
<i>Bonasa umbellus</i>	Ruffed grouse			RI
<i>Colinus virginianus</i>	Northern bobwhite			RI
<b>Rails, Gallinules, and Coots</b>				
<i>Gallinula galeata</i>	Common gallinule		NM	
<b>Owls</b>				
<i>Aegolius acadicus</i>	Northern saw-whet owl	MC	T	RI
<i>Tyto alba</i>	Barn owl		NM	
<b>Goatsuckers</b>				
<i>Caprimulgus carolinensis</i>	Chuck-will's-widow	MC		RI
<i>Caprimulgus vociferus</i>	Eastern whip-poor-will			RI
<b>Swifts</b>				
<i>Chaetura pelagica</i>	Chimney swift			RI

Table 1.1. (continued)

Scientific name	Common name	Status <sup>b</sup>		
		Federal	State	PIF <sup>c</sup>
<b>Kingfishers</b>				
<i>Megaceryle alcyon</i>	Belted kingfisher			RI
<b>Woodpeckers</b>				
<i>Melanerpes erythrocephalus</i>	Red-headed woodpecker	MC		RI
<i>Sphyrapicus varius</i>	Yellow-bellied sapsucker	MC	NM	
<i>Picoides pubescens</i>	Downy woodpecker			RI
<i>Colaptes auratus</i>	Northern flicker			RI
<b>Tyrant Flycatchers</b>				
<i>Contopus cooperi</i>	Olive-sided flycatcher	MC	NM	RI
<i>Contopus virens</i>	Eastern wood-pewee			RI
<i>Empidonax virescens</i>	Acadian flycatcher			RI
<i>Empidonax trailii</i>	Willow flycatcher			RI
<b>Swallows</b>				
<i>Progne subis</i>	Purple martin			RI
<i>Riparia riparia</i>	Bank swallow			RI
<i>Hirundo rustica</i>	Barn swallow			RI
<b>Titmice and Chickadees</b>				
<i>Poecile atricapillus</i>	Black-capped chickadee	MC	NM	
<i>Poecile carolinensis</i>	Carolina chickadee			RI
<b>Nuthatches</b>				
<i>Sitta pusilla</i>	Brown-headed nuthatch	MC		RI
<b>Wrens</b>				
<i>Troglodytes troglodytes</i>	Winter wren			RI
<i>Thryothorus ludovicianus</i>	Carolina wren			RI
<b>Kinglets, Gnatcatchers, and Thrushes</b>				
<i>Hylocichla mustelina</i>	Wood thrush	MC		RI
<b>Thrashers and Mockingbirds</b>				
<i>Toxostoma rufum</i>	Brown thrasher			RI
<b>Waxwings</b>				
<i>Bombycilla cedrorum</i>	Cedar waxwing			RI
<b>Shrikes</b>				
<i>Lanius ludovicianus</i>	Loggerhead shrike	MC	NM	RI
<b>Vireos</b>				
<i>Vireo flavifrons</i>	Yellow-throated vireo			RI
<i>Vireo solitarius</i>	Blue-headed vireo			RI
<i>Vireo griseus</i>	White-eyed vireo			RI
<b>Wood Warblers</b>				
<i>Vermivora chrysoptera</i>	Golden-winged warbler	MC	NM	RI
<i>Vermivora cyanoptera</i>	Blue-winged warbler	MC		RI
<i>Setophaga cerulea</i>	Cerulean warbler	MC	NM	RI
<i>Setophaga discolor</i>	Prairie warbler	MC		RI
<i>Setophaga dominica</i>	Yellow-throated warbler			RI
<i>Mniotilta varia</i>	Black-and-white warbler			RI
<i>Helmitheros vermivorum</i>	Worm-eating warbler	MC		RI
<i>Parkesia motacilla</i>	Louisiana waterthrush	MC		RI
<i>Protonotaria citrea</i>	Prothonotary warbler	MC		RI
<i>Geothlypis formosa</i>	Kentucky warbler	MC		RI
<i>Cardellina canadensis</i>	Canada warbler	MC		RI
<i>Setophaga citrina</i>	Hooded warbler			RI

Table 1.1. (continued)

Scientific name	Common name	Status <sup>b</sup>		
		Federal	State	PIF <sup>c</sup>
<i>Icteria virens</i>	Yellow-breasted chat			RI
<i>Setophaga pinus</i>	Pine warbler			RI
<i>Cardellina pusilla</i>	Wilson's warbler			RI
<i>Setophaga magnolia</i>	Magnolia warbler			RI
<i>Setophaga fusca</i>	Blackburnian warbler			RI
<i>Setophaga pennsylvanica</i>	Chestnut-sided warbler			RI
<i>Setophaga virens</i>	Black-throated green warbler			RI
<b>Tanagers</b>				
<i>Piranga olivacea</i>	Scarlet tanager			RI
<i>Piranga rubra</i>	Summer tanager			RI
<b>Cardinals, Grosbeaks, and Allies</b>				
<i>Passerina cyanea</i>	Indigo bunting			RI
<b>Towhees, Sparrows, and Allies</b>				
<i>Pipilo erythrophthalmus</i>	Eastern towhee			RI
<i>Spizella pusilla</i>	Field sparrow			RI
<i>Ammodramus savannarum</i>	Grasshopper sparrow			RI
<i>Pooecetes gramineus</i>	Vesper sparrow		NM	
<i>Ammodramus henslowii</i>	Henslow's sparrow	MC	NM	RI
<i>Melospiza Georgiana</i>	Swamp sparrow			RI
<b>Blackbirds and Allies</b>				
<i>Dolichonyx oryzivorus</i>	Bobolink			RI
<i>Sturnella magna</i>	Eastern meadowlark			RI
<b>Finches and Allies</b>				
<i>Spinus tristis</i>	American goldfinch			RI
<b>MAMMALS</b>				
<i>Myotis grisescens</i>	Gray bat	E	E	
<i>Myotis sodalis</i>	Indiana bat <sup>f</sup>	E	E	
<i>Myotis septentrionalis</i>	Northern long-eared bat	PE		
<i>Sorex longirostris</i>	Southeastern shrew		NM	
<i>Sorex cinereus</i>	Masked shrew		NM	
<i>Zapus hudsonius</i>	Meadow jumping mouse		NM	

<sup>a</sup>Land and surface waters of the Oak Ridge Reservation (ORR) exclusive of the Clinch River, which borders ORR.

<sup>b</sup>Status codes

E = endangered

T = threatened

PE = proposed endangered

MC = of management concern

NM = in need of management

RI = regional importance

<sup>c</sup>Partners in Flight—an international organization devoted to conserving bird populations in the Western Hemisphere.

<sup>d</sup>The bald eagle was federally delisted effective August 8, 2007.

<sup>e</sup>The peregrine falcon was federally delisted effective August 25, 1999.

<sup>f</sup>Single specimen captured in mist net bordering the Clinch River, June 2013.

Birds, fish, and aquatic invertebrates are the most thoroughly surveyed animal groups on ORR. The only federally listed animal species that have been observed on ORR in recent years have both been bats. Gray bats were observed over water bordering ORR (the Clinch River) in 2003 and over a pond on ORR in 2004. Three gray bats were mist-netted outside a cave on ORR in 2006. Several gray bats and one Indiana bat were also captured in mist nets bordering the Clinch River in June–July 2013. 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 (Fig. 1.4), also listed by the state as in need of management, is increasingly seen at all times of the year. One nest was confirmed on the reservation in 2011, and the pair nested again in 2012 and 2013. A second bald eagle nest was discovered in 2013. Other species, such as the northern harrier, great egret, and yellow-bellied sapsucker, are migrants, winter residents, or casual visitors and are not known to 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 and are still occasionally seen on the reservation.



**Fig. 1.4. Bald eagle nest on the Oak Ridge Reservation.** [Source: Jason Richards, ORNL photographer.]

Some interesting birds uncommon for ORR were recorded in 2013. These included the sora and least bittern (Fig. 1.5). Both sightings were at the K1007 P1 Pond at ETTP, where high quality wildlife habitat has been established as a result of recent restoration efforts. The sora, seen as recently as December 2013, is considered to be a fairly common migrant through Tennessee, but it is not often seen on ORR. The least bittern, heard in July 2012 and then again in May and July of 2013, is an uncommon migrant and summer resident in Tennessee and is on the state “in need of management” list.



**Fig. 1.5. Other interesting birds sighted on the Oak Ridge Reservation during 2013: (a) sora and (b) least bittern.** [Source: Neil Giffen.]

One species of fish, the spotfin chub (*Erimonax monachus*), 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 ORR. The tangerine darter (*Percina aurantiaca*), a species listed by the state as “in need of management,” has also been recorded in close proximity to ORR. The state-endangered lake sturgeon (*Acipenser fulvescens*) is known to inhabit the adjacent Clinch River. 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 (CRK) 23 (e.g., south of west Bear Creek Road near Grassy Creek sampling point 1.9).

### 1.3.6.3 Threatened and Endangered Plants

Four species currently known to be on ORR, 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 US Fish and Wildlife Service. (Note: Appalachian bugbane is no longer listed by Tennessee and does not have official federal status; therefore, it does not appear in Table 1.2.)

Seventeen plant species occurring on ORR are listed by the state as endangered, threatened, or of special concern. An additional 10 threatened, endangered, or special concern species are known to occur in the area and although currently unconfirmed on ORR have the potential to be present (Table 1.2).

The Tennessee Heritage Program scientific advisory committee met in 2012 to revise the state’s Rare Plant List. Those changes are now official. This has reduced the number of state-protected species on ORR by six. The protection of these six species on ORR was a factor in their delisting.

**Table 1.2. Vascular plant species listed by state or federal agencies and sighted/reported on or near the Oak Ridge Reservation, 2013**

Species	Common name	Habitat on ORR	Status code <sup>a</sup>
<b>Currently known to be or previously reported on ORR</b>			
<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>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>Eupatorium godfreyanum</i>	Godfrey’s thoroughwort	Dry woods edge	S
<i>Fothergilla major</i>	Mountain witch-alder	Woods	T
<i>Helianthus occidentalis</i>	Naked-stem sunflower	Barrens	S
<i>Juglans cinerea</i>	Butternut	Lake shore	FSC, T
<i>Juncus brachycephalus</i>	Small-head rush	Open wetland	S
<i>Liparis loeselii</i>	Fen orchid	Forested wetland	E
<i>Panax quinquefolius</i>	American ginseng	Rich woods	S-CE
<i>Platanthera flava</i> var. <i>herbiola</i>	Tuberculed rein-orchid	Forested wetland	T
<i>Spiranthes lucida</i>	Shining ladies’-tresses	Boggy wetland	T
<i>Thuja occidentalis</i>	Northern white cedar	Rocky river bluffs	S
<b>Rare plants that occur near and could be present on ORR</b>			
<i>Agalinis auriculata</i>	Earleaf false foxglove	Calcareous barren	FSC, E
<i>Allium burdickii</i> or <i>A. tricoccom</i> <sup>b</sup>	Ramps	Moist woods	S, CE

Table 1.2. (continued)

Species	Common name	Habitat on ORR	Status code <sup>a</sup>
<i>Pseudognaphalium helleri</i>	Heller's catfoot	Dry woodland edge	S
<i>Lathyrus palustris</i>	Marsh pea	Moist meadows	S
<i>Liatris cylindracea</i>	Slender blazing star	Calcareous barren	E
<i>Lonicera dioica</i>	Mountain honeysuckle	Rocky river bluff	S
<i>Meehania cordata</i>	Heartleaf meehania	Moist calcareous woods	T
<i>Pedicularis lanceolata</i>	Swamp lousewort	Calcareous wet meadow	S
<i>Pycnanthemum torrei</i>	Torrey's mountain-mint	Calcareous barren edge	S
<i>Solidago ptarmicoides</i>	Prairie goldenrod	Calcareous barren	E

<sup>a</sup>Status 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.

<sup>b</sup>Ramps have been reported near ORR, but there is not sufficient information to determine which of the two species is present or whether the occurrence may have been introduced by planting. Both species of ramps have the same state status.

**Acronyms**

ORR = Oak Ridge Reservation

### 1.3.6.4 Historical and Cultural Resources

Efforts continue to preserve ORR's rich prehistoric and historic cultural resources. 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, 32 cemeteries, and several historically significant Manhattan Project-era structures. Seven historic ORR properties are individually listed in the National Register of Historic Places (NRHP):

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

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

The DOE Oak Ridge Office (ORO) cultural resource management plan (Souza et al. 2001) was developed to identify, assess, and document historic and cultural resources on ORR and establish a management strategy.

A memorandum of agreement (MOA) for the interpretation of historical properties at ETPP was signed in 2012 by DOE ORO, the State Historic Preservation Officer, the Advisory Council on Historic Preservation (ACHP), the City of Oak Ridge, and the East Tennessee Preservation Alliance. The MOA is being implemented through planning for a museum that will highlight the historic aspects of the ETPP and of the communities that were displaced during the construction of the site. Details are provided in Chapter 3, Section 3.3.4.

A sitewide programmatic agreement among DOE ORO, NNSA, Tennessee State Historic Preservation Office (SHPO), and ACHP concerning management of historical and cultural properties at the Y-12 Complex has been enforced since its approval on August 25, 2003.

A sitewide programmatic agreement among DOE ORO, SHPO, and ACHP concerning management of historical and cultural properties at ORNL has been enforced since its approval on February, 23, 2005.

## 1.4 Oak Ridge Sites

### 1.4.1 Oak Ridge National Laboratory

ORNL is the largest science and energy national laboratory in the DOE system (Fig. 1.6). ORNL's scientific programs focus on materials, neutron science, energy, high-performance computing, systems biology, and national security. The laboratory is home to several of the world's top supercomputers and is a leading neutron science and nuclear energy research facility that includes SNS and HFIR. ORNL hosts a DOE leadership computing facility—home of the Titan supercomputer—one of DOE's nanoscience centers, the Center for Nanophase Materials Sciences; one of DOE's energy research centers, the BioEnergy Science Center; and a DOE innovation hub, the Consortium for Advanced Simulation of Light-Water Reactors. UT-Battelle also manages the US ITER project for DOE.



**Fig. 1.6. The Oak Ridge National Laboratory.**

Managed by UT-Battelle, LLC, a partnership of the University of Tennessee and Battelle Memorial Institute, ORNL was established in 1943 to support the Manhattan Project. From an early focus on chemical technology and reactor development, ORNL's research and development (R&D) portfolio broadened to include programs supporting DOE missions in scientific discovery and innovation, clean energy, and nuclear security.

There are about 4,400 workers at ORNL and the annual budget exceeds \$1.6 billion. The laboratory's extensive capabilities for scientific discovery and innovation are applied to the delivery of mission outcomes for DOE and other sponsors.

The Transuranic Waste Processing Center (TWPC) is located on a tract of land about 10.5 ha (26 acres) in size in the Melton Valley area of ORNL about 120 ft west of the existing Melton Valley Storage Tanks. TWPC is managed by Wastren Advantage, Inc. (WAI), for DOE. TWPC's mission is to receive transuranic (TRU) waste 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 (NNSS) or another 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  $^{233}\text{U}$  stored in the Building 3019 complex.

URS | CH2M Oak Ridge LLC (UCOR) is the DOE ORR "cleanup contractor." The scope of UCOR activities at ORNL includes long-term surveillance, maintenance, and management of inactive waste disposal sites, structures, and buildings such as former reactors and isotope production facilities. Other activities include groundwater monitoring, TRU waste storage, and operation of the liquid low-level and process waste systems and the off-gas collection and treatment system.

About 5 ha (12 acres) in the central portion of 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). ORSTP provides space for private companies doing research at ORNL, partner universities, start-up companies built around ORNL technologies, and ORNL contractors to conduct business within a short distance of ORNL researchers and DOE user facilities such as SNS, the Center for Nanophase Materials Sciences, and HFIR. Construction of the first ORSTP facility, Pro2Serve's 115,000 ft<sup>2</sup> National Security Engineering Center, was completed in 2009, and the company is now well-established in the building. In addition, the former Building 2033, also leased to Halcyon, LLC, is now known as the Halcyon Commercialization Center (HCC) and continues to attract tenants. HCC's largest tenant is Roane State Community College, which is offering job training classes on-site in the areas of carbon fiber manufacturing and solar energy technology. Other HCC tenants include a construction management firm and a carbon fiber manufacturer that is partnering with ORNL for materials research. There may be potential to expand ORSTP as more environmental cleanup in ORNL's central campus is completed.

As of the date of this report, no construction was occurring within ORSTP.

#### **1.4.2 The Y-12 National Security Complex**

The original Y-12 Complex 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  $^{235}\text{U}$  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, the Y-12 Complex (Fig. 1.7) serves as the nation's only source of enriched uranium nuclear weapons components and provides enriched uranium for the US Navy. The Y-12 Complex is a leader in materials science and precision manufacturing and serves as the main storage facility for enriched uranium. The Y-12 Complex also supports efforts to reduce the risk of nuclear proliferation and performs complementary work for other government agencies. Since November 2000 Babcock & Wilcox Technical Services Y-12, LLC (B&W Y-12; formerly called BWXT Y-12), a partnership of Babcock and Wilcox Company and Bechtel National Inc., has served as the management and operations contractor for the Y-12 Complex.

ORNL 2012-G00348/chj



**Fig. 1.7. Y-12 National Security Complex.**

### **1.4.3 East Tennessee Technology Park**

What is now known as ETTP (Fig. 1.8) was originally named the K-25 Site, where the nation's first gaseous diffusion plant for enriching uranium, as part of the Manhattan Project, was located.

ORNL 2010-G00441/chj



**Fig. 1.8. East Tennessee Technology Park.**

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, and restoration and decontamination and decommissioning (D&D) activities began soon after in preparation for ultimate conversion of the site to a private-sector industrial park to be called the Heritage Center. Reindustrialization of the site began in 1996 when it was renamed the East Tennessee Technology Park. Restoration of the environment, D&D of facilities, disposition of wastes, and reindustrialization are the major activities at the site. During 2013, ETTP landlord contractor functions and the majority of the ETTP cleanup program actions were managed by UCOR.

#### **1.4.4 Environmental Management Waste Management Facility**

EMWMF is located in eastern Bear Creek Valley near the Y-12 Complex and is managed by UCOR. EMWMF was built for disposal of waste resulting from CERCLA cleanup actions on ORR. The original design was for the construction, operation, and closure of a projected 1.3 million m<sup>3</sup> (1.7 million yd<sup>3</sup>) disposal facility. The approved capacity was subsequently increased to 1.8 million m<sup>3</sup> (2.4 million yd<sup>3</sup>) to maximize use of the footprint designated in a 1999 record of decision (ROD). The facility currently consists of six disposal cells.

EMWMF is an engineered landfill that accepts low-level, mixed low-level, and hazardous wastes from DOE ORR sites that meet specific waste acceptance criteria developed in accordance with agreements with state and federal regulators. Waste types that qualify for disposal include soil, dried sludge and sediment, solidified waste, stabilized waste, building debris, scrap equipment, and secondary waste such as personal protective equipment, all of which must meet 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, which is operated by UCOR.

#### **1.4.5 Oak Ridge Environmental Research Park**

In 1980, DOE established the Oak Ridge Environmental Research Park (Fig. 1.9). The research park serves as an outdoor laboratory to evaluate the environmental consequences of energy use and development and 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.

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, wetland mitigation, and forest and wildlife management.

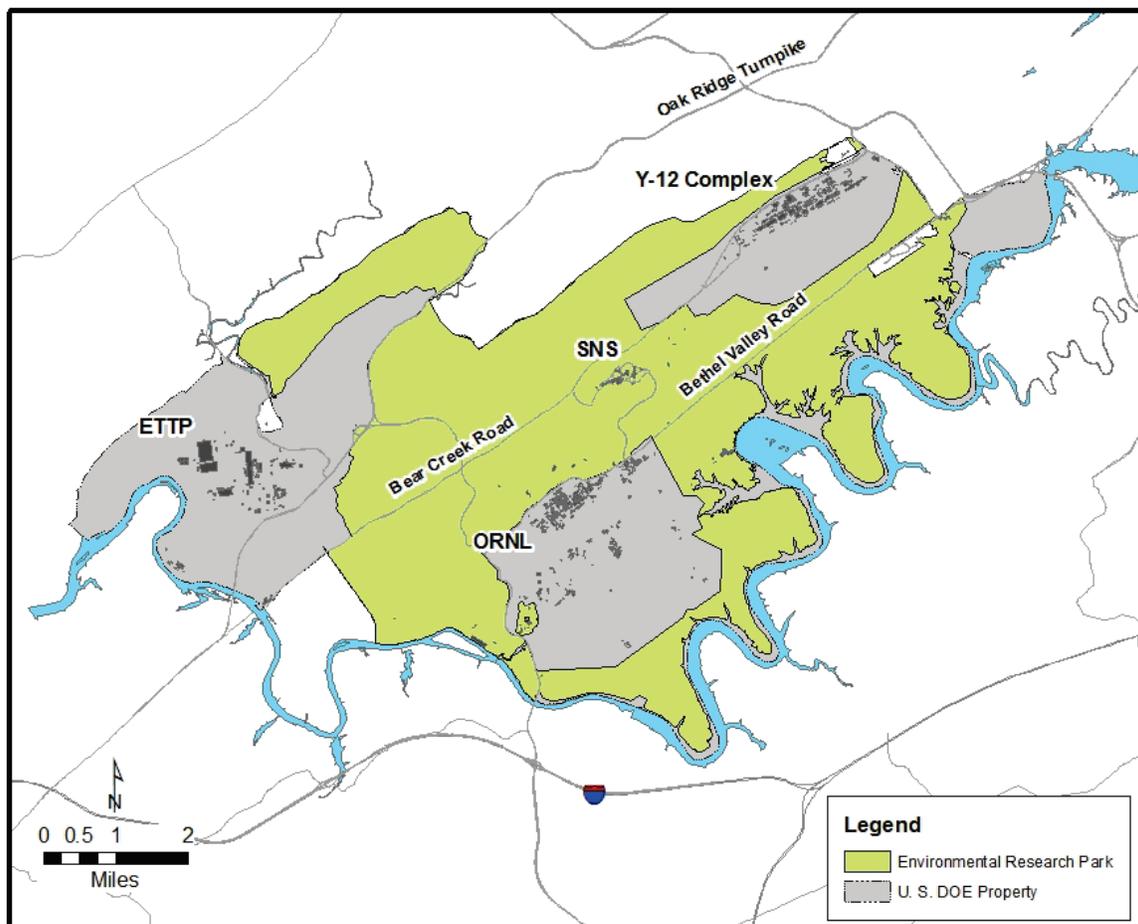


Fig. 1.9. The Oak Ridge Environmental Research Park.

#### 1.4.6 Oak Ridge Institute for Science and Education

ORISE is a DOE institute 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 is located on an area on the southeastern border of 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, operated by the University of Tennessee. The site houses offices, laboratories, and storage areas for the ORISE program offices and support departments.

#### 1.4.7 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 (SNMs), 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 was created to incorporate features that more

effectively enhance self-protection and that deny unauthorized access to the materials. 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 OST.

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

## 1.5 References

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