

1. Introduction to the Oak Ridge Reservation

The Oak Ridge Reservation (ORR) is a 13,302 ha (32,869-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 or Y-12). 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.

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 2014. 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}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 13,302 ha (32,869 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 962,000, with about 2% of its labor force employed on ORR. The population estimate for the official nine-county Knoxville Metropolitan Statistical Area is 850,000. 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.



Fig. 1.1. Location of the Oak Ridge Reservation.

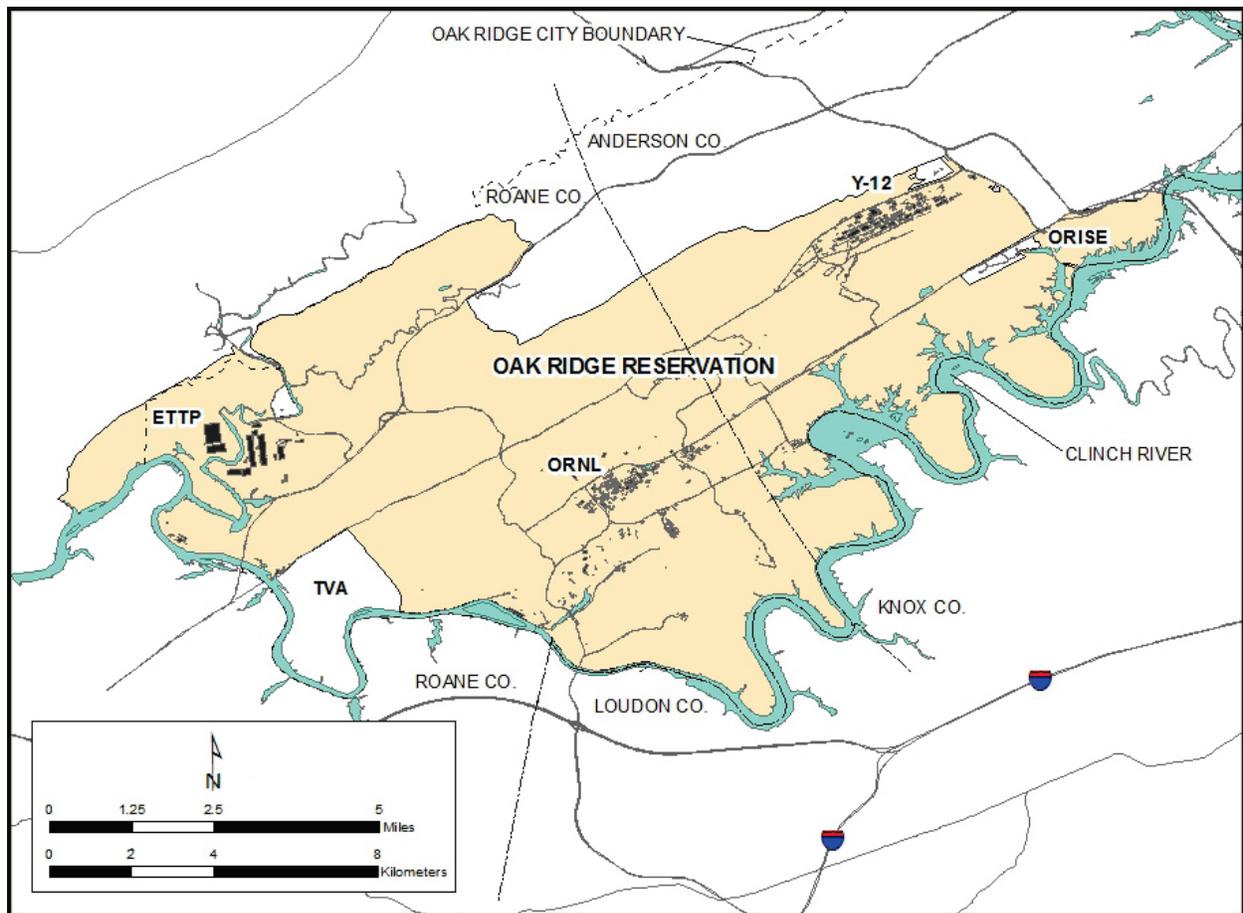


Fig. 1.2. The Oak Ridge Reservation.

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 2014 was 14.7°C (58.5°F). The coldest month is usually January, with temperatures averaging about 3.2°C (37.7°F). During 2014, January temperatures were the coldest since 1985, averaging –0.6°C (30.9°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 2014 temperatures averaged 24.2°C (75.6°F), near the 30-year average but representing the coolest July average in the last 5 years.

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 2014 [measured at the Oak Ridge National Weather Service meteorological tower in Oak Ridge (KOQT)] was 1,338 mm (52.64 in.), just slightly above the 30-year average. Total 2014 snowfall was 25.4 cm (10.0 in.), above the 30-year average. Monthly summaries of precipitation averages, extremes, and 2014 values are provided in Appendix B, Table B.1.

In 2014, wind speeds at ORNL Tower C/D (MT2) measured at 15 m (49 ft) above ground level (AGL) averaged 1.2 m/s (2.8 mph). This value increased to about 2.3 m/s (5.1 mph) for winds at 60 m (198 ft) AGL (slightly below the height of the 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 2014 precipitation hours for the ORR towers may be reviewed at <http://www.ornl.gov/adm/fo/lp/orrm/page7.htm> under the header “2014 Annual Precipitation Wind Roses—Oak Ridge Reservation.”

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 is documented in “Wind Regimes in Complex Terrain in the Great Valley of Eastern Tennessee” (Birdwell, 2011) and may be reviewed online at http://www.ornl.gov/~das/met/MT/KRB_ORNL.pdf.

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 (SO₂), carbon monoxide (CO), nitrogen dioxide (NO₂), lead (Pb), ozone (O₃), particulate matter (PM) with an aerodynamic diameter less than or equal to 10 μm (PM₁₀), and fine PM 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 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) O₃ standard as part of the larger Knoxville 8 h basic O₃ nonattainment area, which encompasses several counties. In addition, EPA has designated Anderson, Knox, and Blount counties as a nonattainment area for the 2006 PM_{2.5} air quality standard. EPA also designated the portion of Roane County surrounding the Kingston Steam Plant as a nonattainment area for PM_{2.5}. EPA has established a newer 2012 PM_{2.5} standard. The attainment determination against the

2012 PM_{2.5} standard for the State of Tennessee has been deferred until after May 2015. 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 km² (136-mile²) 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 (WOC) drainage basin, which has an area of 16.5 km² (6.4 mile²). WOC 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 km² (1.47 mile²). The waters of WOC enter White Oak Lake, which is an impoundment formed by White Oak Dam (WOD). Water flowing over WOD enters the Clinch River after passing through the WOC 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.

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 2014, as part of the Uranium Processing Facility (UPF) project at the Y-12 Complex, construction of the Bear Creek Road bypass phase II and a haul road extension that modified wetlands on the north side of Bear Creek Road was completed. The work was performed under an approved US Army Corps of Engineers (USACE) Section 404 permit and an ARAP issued by TDEC. The wetland mitigation work performed under these permits will result in a more than 3 : 1 net increase in total wetland area when the multiyear project is complete. Monitoring mitigation in accordance with the permits has been initiated.

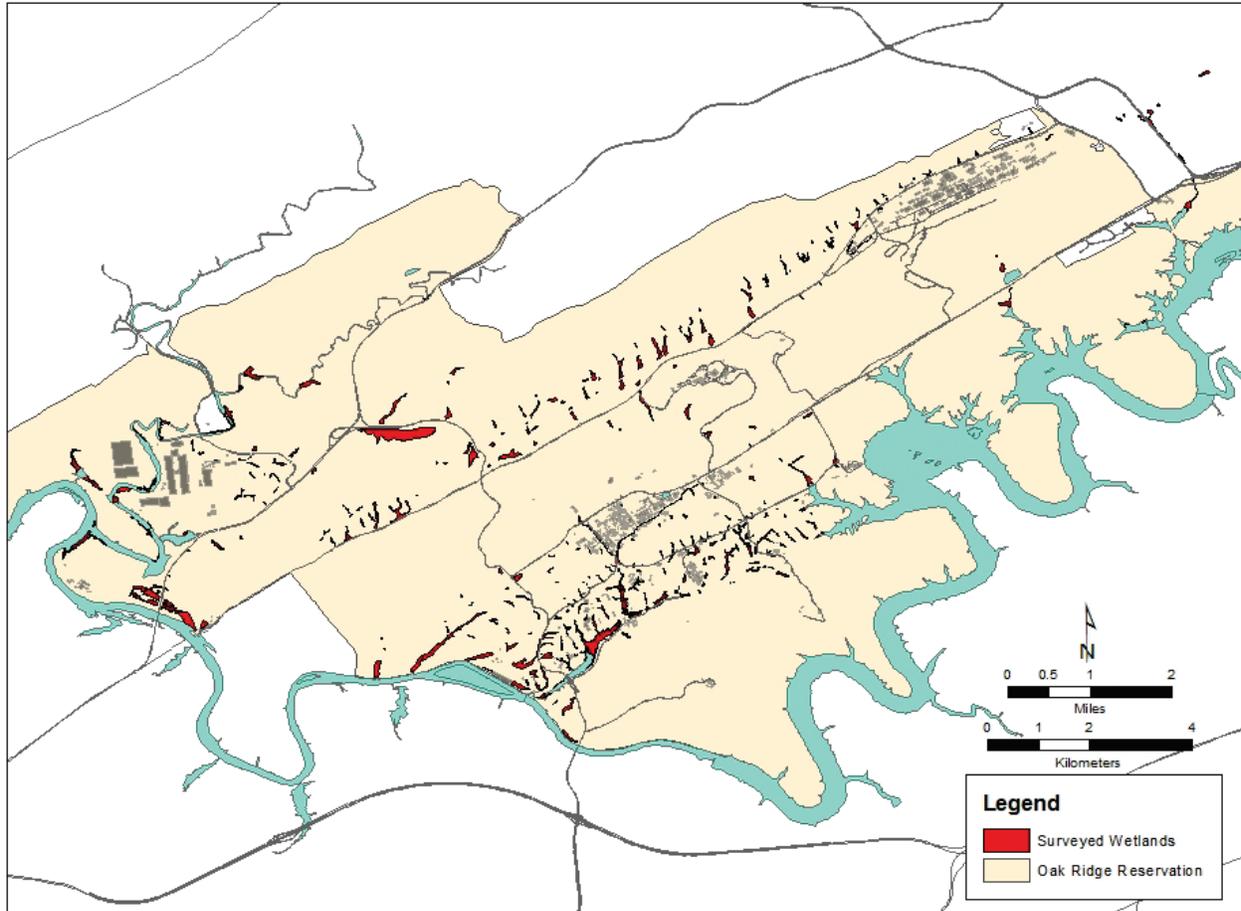


Fig. 1.3. Oak Ridge Reservation wetlands.

1.3.6.2 Wildlife/Endangered Species

Animals listed as species of concern by state, federal, or international organizations and known to have occurred 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 and southeastern shrew) are comparatively common and widespread on the reservation.

Table 1.1. Animal species of special concern reported on the Oak Ridge Reservation^a

Scientific name	Common name	Status ^b		
		Federal	State	PIF ^c
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>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	
Kites, Hawks, Eagles, and Allies				
<i>Haliaeetus leucocephalus</i>	Bald eagle	MC ^d	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
Falcons				
<i>Falco peregrinus</i>	Peregrine falcon	MC ^e	E	RI
<i>Falco sparverius</i>	American kestrel	MC		RI
Grouse, Turkey, and Quail				
<i>Bonasa umbellus</i>	Ruffed grouse			RI
<i>Colinus virginianus</i>	Northern bobwhite			RI
Rails, Gallinules, and Coots				
<i>Rallus limicola</i>	Virginia rail	MC		
<i>Porzana Carolina</i>	Sora	MC		
<i>Gallinula galeata</i>	Common gallinule		NM	
Owls				
<i>Aegolius acadicus</i>	Northern saw-whet owl	MC	T	RI
<i>Tyto alba</i>	Barn owl		NM	
Goatsuckers				
<i>Caprimulgus carolinensis</i>	Chuck-will's-widow	MC		RI
<i>Caprimulgus vociferus</i>	Eastern whip-poor-will			RI

Table 1.1 (continued)

Scientific name	Common name	Status ^b		
		Federal	State	PIF ^c
Swifts				
<i>Chaetura pelagica</i>	Chimney swift			RI
Kingfishers				
<i>Megaceryle alcyon</i>	Belted kingfisher			RI
Woodpeckers				
<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
Tyrant Flycatchers				
<i>Contopus cooperi</i>	Olive-sided flycatcher	MC	NM	RI
<i>Contopus virens</i>	Eastern wood-pewee			RI
<i>Empidonax vireescens</i>	Acadian flycatcher			RI
<i>Empidonax trailii</i>	Willow flycatcher			RI
Swallows				
<i>Progne subis</i>	Purple martin			RI
<i>Riparia riparia</i>	Bank swallow			RI
<i>Hirundo rustica</i>	Barn swallow			RI
Titmice and Chickadees				
<i>Poecile atricapillus</i>	Black-capped chickadee	MC	NM	
<i>Poecile carolinensis</i>	Carolina chickadee			RI
Nuthatches				
<i>Sitta pusilla</i>	Brown-headed nuthatch	MC		RI
Wrens				
<i>Troglodytes troglodytes</i>	Winter wren			RI
<i>Thryothorus ludovicianus</i>	Carolina wren			RI
Kinglets, Gnatcatchers, and Thrushes				
<i>Hylocichla mustelina</i>	Wood thrush	MC		RI
Thrashers and Mockingbirds				
<i>Toxostoma rufum</i>	Brown thrasher			RI
Waxwings				
<i>Bombycilla cedrorum</i>	Cedar waxwing			RI
Shrikes				
<i>Lanius ludovicianus</i>	Loggerhead shrike	MC	NM	RI
Vireos				
<i>Vireo flavifrons</i>	Yellow-throated vireo			RI
<i>Vireo solitaries</i>	Blue-headed vireo			RI
<i>Vireo griseus</i>	White-eyed 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 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
<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
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>Pooecetes gramineus</i>	Vesper sparrow		NM	
<i>Ammodramus henslowii</i>	Henslow's sparrow	MC	NM	RI
<i>Melospiza Georgiana</i>	Swamp sparrow			RI
Blackbirds and Allies				
<i>Dolichonyx oryzivorus</i>	Bobolink			RI
<i>Sturnella magna</i>	Eastern meadowlark			RI
Finches and Allies				
<i>Spinus tristis</i>	American goldfinch			RI

Table 1.1 (continued)

Scientific name	Common name	Status ^b		
		Federal	State	PIF ^c
<i>MAMMALS</i>				
<i>Myotis grisescens</i>	Gray bat	E	E	
<i>Myotis sodalists</i>	Indiana bat ^f	E	E	
<i>Myotis septentrionalis</i>	Northern long-eared bat	T		
<i>Sorex longirostris</i>	Southeastern shrew		NM	
<i>Sorex cinereus</i>	Masked shrew		NM	
<i>Zapus hudsonius</i>	Meadow jumping mouse		NM	

^aLand and surface waters of the Oak Ridge Reservation (ORR) exclusive of the Clinch River, which borders ORR.

^bStatus codes

E = endangered

T = threatened

PE = proposed endangered

MC = of management concern

NM = in need of management

RI = regional importance

^cPartners in Flight—an international organization devoted to conserving bird populations in the Western Hemisphere.

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

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

^fSingle 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. Nevertheless, the only federally listed animal species that have been observed on ORR in recent years have been mammals. Gray bats were observed over the Clinch River bordering ORR 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. Northern long-eared bats, recently federally listed as threatened, are known to be present on ORR: their calls have been identified in various acoustic surveys of the reservation, and in 2013 their presence was confirmed when a number were captured in mist nets (McCracken 2015).

Two-hundred twenty-nine species of birds have been recorded on ORR and its boundary waters. These are the 228 species documented by Roy et al. (2014) and the cackling goose (*Branta hutchinsii*), which was recorded in [eBird](#) (Sullivan et al. 2009) at the ORNL Swan Pond in November 2014. Most of these species are afforded protection under the Migratory Bird Treaty Act and Executive Order (EO) 13186 (*Responsibilities of Federal Agencies to Protect Migratory Birds*). DOE's 2013 updated memorandum of understanding on migratory birds with the US Fish and Wildlife Service (FWS) strengthens migratory bird conservation on ORR through enhanced collaborations between DOE and FWS (DOE-FWS 2013). Breeding bird surveys were conducted at 79 points along nine routes on ORR in 2014 for the Partners in Flight Program. Two public bird walks were held on ORR in 2014 in addition to a third walk for Earth Day that was conducted for employees. ORR work on early succession habitat was selected to represent DOE in the 2015 Presidential Migratory Bird Federal Stewardship Award nominations. All known ORR bird records since 1950, as well as population trends for 32 species of birds, were documented in the technical manuscript *Oak Ridge Reservation Bird Records and Population Trends* (Roy et al. 2014).

Several state-listed bird species such as the anhinga, olive-sided flycatcher, and little blue heron are uncommon migrants or visitors to the reservation. The cerulean warbler, listed by the state as “in need of

management,” has been recorded during the breeding season on ORR but is currently listed as a potential breeding bird on ORR (Roy et al. 2014) as its actual breeding status is still uncertain. The bald eagle (Fig. 1.4), also listed by the state as in need of management, is a year-round resident in Tennessee, though it can be difficult to find on the reservation from September through November. One bald eagle nest was confirmed on the reservation in 2011, and this pair nested again in 2012, 2013, and 2014. A second bald eagle nest, with an eaglet, was discovered in 2013. Observations were made of adult eagles at this nest in 2014, but it is not known whether any young were fledged that year. 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 (May 1998) on the reservation, as has the Lincoln’s sparrow (*Melospiza lincolni*, May 2014, no listed status). 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.]

With many northern lakes freezing solid during the winter of 2013–2014, white-winged scoters (*Melanitta fusca*) and red-necked grebes (*Podiceps grisegena*) made rare appearances in East Tennessee in February and March of 2014, though they were only recorded locally on boundary waters of the reservation. Other uncommon birds for the ORR have been recorded in recent years, including several species associated with wetland habitats. The sora, least bittern, and Virginia rail (Fig. 1.5) were all observed at the K1007 P1 pond at ETP in 2013, 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 throughout Tennessee, but it is seldom 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. The Virginia rail, most recently observed in October 2013, was previously known only from historic (early 1950s) records on the ORR (Roy et al. 2014). All three species (Fig. 1.5) have been listed by FWS as “of management concern,” and the least bittern is also deemed in need of management by the State of Tennessee (Table 1.1).

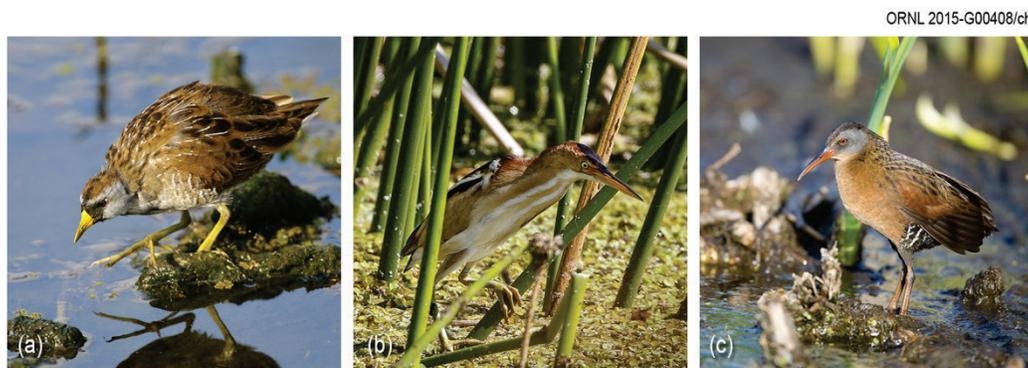


Fig. 1.5. Interesting bird species sighted on the Oak Ridge Reservation in recent years: (a) sora, (b) least bittern, and (c) Virginia rail. [Source: Stock images courtesy of iStock.]

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 lake sturgeon (*Acipenser fulvescens*), state-listed as endangered, 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 the Bear Creek watershed, tributaries to the 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). Other plant populations are currently under study on ORR, which may lead to additions to the table below.

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, 2014

Species	Common name	Habitat on ORR	Status code ^a
Currently known to be or previously reported on 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>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	T
<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
Rare plants that occur near and could be present on ORR			
<i>Agalinis auriculata</i>	Earleaf false foxglove	Calcareous barren	FSC, E
<i>Allium burdickii</i> or <i>A. tricoccom</i> ^b	Ramps	Moist woods	S, CE
<i>Lathyrus palustris</i>	Marsh pea	Moist meadows	S
<i>Liatris cylindracea</i>	Slender blazing star	Calcareous barren	T
<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	S
<i>Pseudognaphalium helleri</i>	Heller's catfoot	Dry woodland edge	S
<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.

^bRamps 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 the result of 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 ETTP 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 ETTP and of the communities that were displaced during the construction of the site. Details are provided in Chapter 3, Sections 3.3.4 and 3.8.2.6.

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.

After completing an evaluation of the structural integrity of the K-25 building and interpretative approaches for the site, DOE distributed a preferred mitigation plan in October 2011. The DOE final mitigation plan, addressing comments submitted by consulting parties in November 2011, permitted demolition of the entire K-25 building and called for, among other mitigation measures, the designation of a commemorative area around the building's perimeter from which future surface development would largely be restricted; the retention, if possible, of the entire concrete slab or the demarcation of the building's footprint; the construction of a viewing tower and of a structure for equipment display; and the development of a history center within the ETTP Fire Station. A final MOA was signed in August 2012, finalizing the aspects set forth in the mitigation plan. During 2013, a request for proposal was issued for a "Professional Design Team and Museum Professional" as specified in the MOA. Nine firms were prequalified, and the selection and award were executed April 1, 2014. The procurement process for the K-25 "virtual museum" web design firm was also begun in 2013 and awarded September 2, 2014.

On December 14, 2014, Congress authorized the establishment of the Manhattan Project Historical Park to commemorate the history of the Manhattan Project. It will comprise the three major sites, Los Alamos, New Mexico; Oak Ridge, Tennessee; and Hanford, Washington, that were dedicated to accomplishing the Manhattan Project's mission.

1.4 Oak Ridge Sites

1.4.1 Oak Ridge National Laboratory

ORNL, managed for DOE by UT-Battelle, LLC, a partnership of the University of Tennessee and Battelle Memorial Institute, is the largest science and energy national laboratory in the DOE system (Fig. 1.6), conducting basic and applied research to deliver transformative solutions to compelling problems in energy and 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.

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. Today there are about 4,400 workers at ORNL, and 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}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.

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}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. On July 1, 2014, Consolidated Nuclear Security, LLC (CNS), assumed responsibility for management and operation of both the Y-12 Complex, Oak Ridge, Tennessee, and the Pantex Plant, Amarillo, Texas. CNS replaces Babcock & Wilcox Technical Services Y-12, LLC (B&W Y-12; formerly called BWXT Y-12), which had operated Y-12 since 2000, and B&W Pantex, which had operated Pantex since 2000. The contract includes a total annual operating budget of \$1.5 billion and employment of about 8,000 in Tennessee and Texas. CNS is a partnership of Bechtel National, Inc.; Lockheed Martin Services, Inc.; ATK Launch Systems, Inc.; and SOC LLC, with Booz Allen Hamilton, Inc., as a teaming subcontractor.

Oversight of the new contract is the responsibility of the NNSA Production Office (NPO). In June 2012, the Pantex and Y-12 Site Offices were merged into NPO in anticipation of the award of a single management and operating contract for the operation of both Pantex and Y-12.

ORNL 2012-G00348/chj



Fig. 1.7. Y-12 National Security Complex.

1.4.3 East Tennessee Technology Park

What is now known as ETPP (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.

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, ETPP landlord contractor functions and the majority of the ETPP cleanup program actions were managed by UCOR.



Fig. 1.8. East Tennessee Technology Park.

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 m³ (1.7 million yd³) disposal facility. The approved capacity was subsequently increased to 1.8 million m³ (2.4 million yd³) 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.

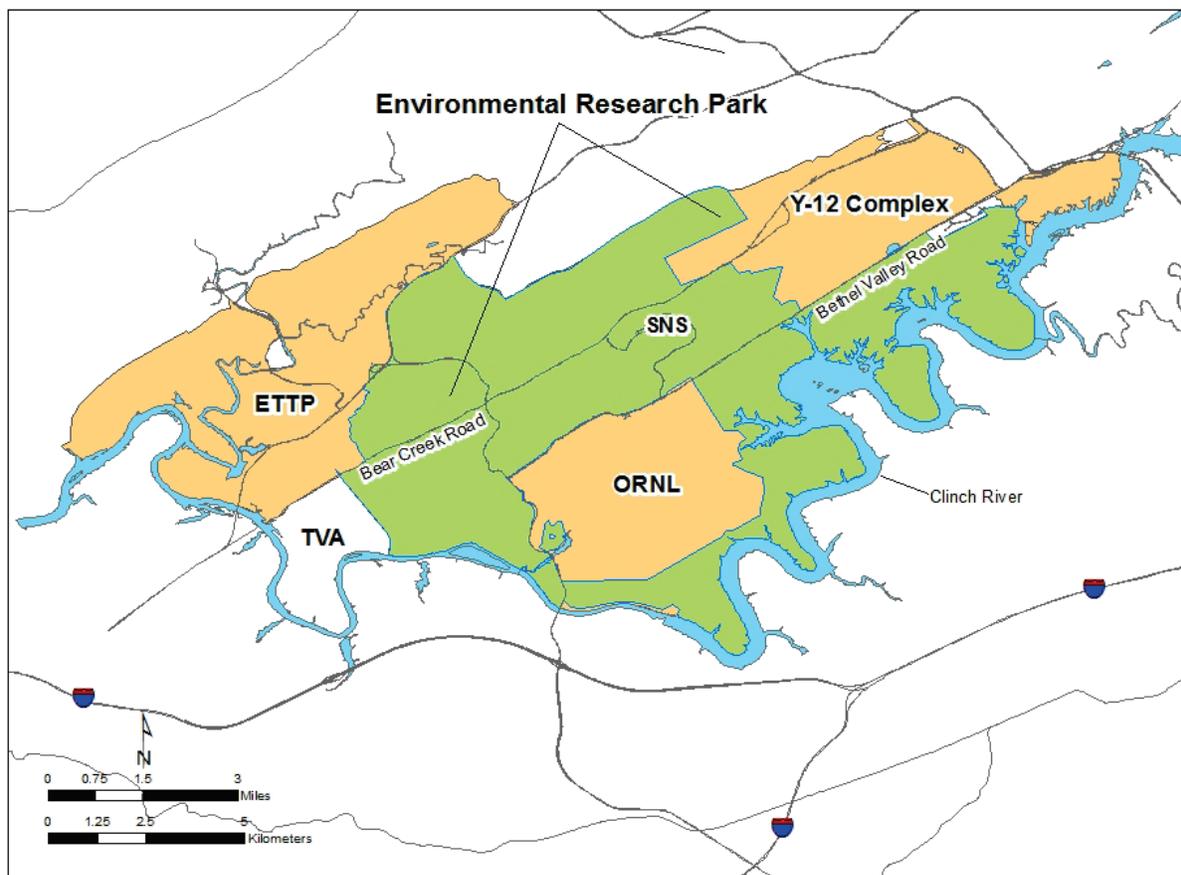


Fig. 1.9. The Oak Ridge Environmental Research Park.

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 723 ha (1,786 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.

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