

1. Introduction to the Oak Ridge Reservation

It was not shown on any maps. No visitors were allowed without special approval. US Army guards were posted at the entrances to the city, and all residents were required to wear badges at all times outside their homes. Thus, Oak Ridge existed for seven years, from 1942 to 1949, as a truly secret city. It was here and in supporting locations that humankind made the leap from candlepower to nuclear power in a single generation. The engineering marvel that materialized in the Secret City changed the world, helped bring an end to World War II, and launched diagnostic tools such as magnetic resonance imaging and nuclear medicine that save thousands of lives from cancer and other maladies. Today the revealed Secret City exists in two parts: the City of Oak Ridge and the Oak Ridge Reservation (ORR).

ORR covers 52 square miles of land in Anderson and Roane counties and 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). Other ORR facilities include the East Tennessee Technology Park (ETTP), site of a former gaseous diffusion plant that has undergone significant environmental cleanup and transitioned to a private sector business and industrial park; the Oak Ridge Institute for Science and Education (ORISE) South Campus, which includes training facilities, laboratories, and support facilities; several smaller, government-owned, contractor-operated entities 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). Some things have not changed; personnel seeking entrance to ORR must have proper credentials in accordance with current access security requirements.

President Franklin D. Roosevelt received the famous Einstein-Szilard letter in 1939 informing him that German scientists were working on a nuclear weapon. In utmost secrecy, he formed the agencies leading up to the Manhattan Project. Then, on June 28, 1941, five months and nine days prior to the Japanese attack on Pearl Harbor, he signed Executive Order 8807 which funded the Manhattan Project. The super-secret code name Manhattan Project gave no indication of the classified activities it concealed. So named because its original headquarters were established in June 1942 in New York City's Manhattan district in an office building at 270 Broadway, in the summer of 1943 the project moved to Oak Ridge, where construction of America's first full-scale gaseous diffusion plant was underway. Here scientists began using the gaseous diffusion process to enrich uranium using Graham's Law of Diffusion.

Graham's Law was formulated by Scottish physical chemist Thomas Graham in 1848. He found experimentally that the rate of diffusion of a gas is inversely proportional to the square root of its molecular weight. Thus, if the molecular weight of one gas is four times that of another, it will diffuse through a porous plug or escape through a small pinhole in a vessel at half the rate of the lighter gas. In other words, heavier gases diffuse more slowly. Graham's Law provides a basis for separating isotopes by diffusion—the method that played a crucial role in the development of the atomic bomb 100 years after Graham's discovery. Today ORR's mission continues to evolve as it adapts to meet the changing basic and applied research and national security needs of the United States.

Due to different permit reporting requirements and instrument capabilities, this report uses various units of measurement. The lists of units of measure and conversion factors on pages xxvii and xxviii are included to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

1.1 Background

The ORR Annual Site Environmental Report (ASER) is a summary of environmental data that characterizes environmental performance, lists environmental occurrences reported during the year, confirms compliance with environmental standards and requirements, and highlights significant environmental program activities. The ASER meets the requirements of DOE Order 231.1B, Environment, Safety, and Health Reporting, and its Attachments 1, 2, 3, 4, and 5 (DOE 2012) regarding the preparation of an integrated annual site environmental report.

Summary results in this report are based on data collected before and continuing through 2019. Not all results of the environmental monitoring associated with ORR are reported here, and this is not intended to be a comprehensive monitoring report. Data collected for other site and regulatory purposes, such as environmental restoration and 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 laws, regulations, policies, and guidance. These data are referenced herein as appropriate.

Environmental monitoring of ORR activities consists primarily of 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 their release to the environment. These measurements allow quantification and official reporting of contaminant levels, assessment of public exposures to radiation (see Appendix E) and chemicals (see Appendix F), and demonstration of compliance with applicable standards and permit requirements. Environmental surveillance consists of direct measurement, collection, and analysis of samples taken from the site and its environs, exclusive of effluents. These surveillance activities provide information on contaminant concentrations in air, water, groundwater, soil, foods, biota, and other media. Other environmental surveillance data support environmental compliance and, when combined with data from effluent monitoring, also 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 Area around the Oak Ridge Reservation

Native Americans first inhabited the ORR area during the Woodland Period (c. 1000 BC to AD 1000). Descendants of these early dwellers, whose ancestors were Neolithic and Stone Age people, still lived in the East Tennessee region when European settlers arrived in the late 1700s. The Cherokee people were dominant in the area following wars with the Shawnee and Creek. The early European settlers of the ORR area lived on farms or in four small communities named Elza, Robertsville, Scarborough, and Wheat. All but Elza were founded shortly after the Revolutionary War. About a thousand families inhabited the area in the early 1940s.

The area that became ORR was selected in 1942 for the Manhattan Project, in part, because the Clinch River provided abundant water and the terrain's linear and partitioned ridges offered separation and protection that, in the words of General Leslie Groves, "prevented them from blowing up like firecrackers on a string." Nearby Knoxville was a good source of labor, and the Tennessee Valley Authority could supply ample amounts of needed electricity. Families that had occupied homes and farms for generations received orders to vacate within just a few weeks. The federal government's acquisition of property under the right of eminent domain immediately affected more than three thousand individuals. According to data from the US Department of Agriculture's National Agricultural Statistics Service, the average farm real estate value in 1942 for the 48 contiguous states was \$34 per acre. Some property owners were paid this amount for their land, and others were paid less. Many felt they were poorly compensated, especially for their homes.

The site's wartime name was Clinton Engineering Works. Although it was not shown on any map, the workers' city on the reservation's northern edge, named Oak Ridge, quickly grew to a population of 75,000, becoming the fifth largest city in Tennessee. To the south of the residential area at the Y-12 Complex, an electromagnetic method separated uranium-235 from natural uranium. The K-25 gaseous diffusion plant was built on the reservation's western edge. Near the reservation's southwest corner, about 16 km (10 mi) from the Y-12 Complex, a third facility—known as X-10 or Clinton Laboratories—housed the experimental graphite reactor. X-10 served as a pilot scale facility for the larger plutonium production facilities built at Hanford, Washington.

Two years after World War II ended, Oak Ridge shifted to civilian control under the authority of the US Atomic Energy Commission. In 1959 the city was incorporated and the community adopted a city manager and city council form of government. The missions of the three major ORR installations have continued to evolve and operations have adapted to meet America's changing defense, energy, and research needs. Section 1.4 describes their current missions, as well as the missions of several smaller DOE facilities and activities on ORR.

1.3 Site Description

1.3.1 Location and Population

Situated in the Great Valley of East Tennessee between the Cumberland and Great Smoky Mountains, as shown in Figure 1.1, ORR borders the Clinch River (see Figure 1.2). The Cumberland Mountains are 16 km (10 mi) to the northwest and the Great Smoky Mountains are 51 km (31.6 mi) to the southeast. ORR encompasses about 13,055 hectares (33,866.54 acres) of mostly contiguous, federally owned land in Anderson and Roane Counties, and is under the management of DOE.



Figure 1.1. Location of the Oak Ridge Reservation in Tennessee

As reported in *US Department of Energy FY 2017 Economic Impact in Tennessee* (East Tennessee Economic Council 2017), ORR employs about 35,000 members of the region's labor force. The July 1, 2019 US Census population estimate for the Knoxville Metropolitan Statistical Area, which includes Oak Ridge, was 869,046. The combined 2019 US Census population estimates for the ten counties surrounding ORR (Anderson, Blount, Campbell, Cumberland, Knox, Loudon, McMinn, Monroe, Morgan, and Roane) was 1,009,993. Knoxville, the major city nearest to Oak Ridge, is about 40 km (25 mi) to the east and had a population of about 187,603, according to the 2019 US census population estimate. Other municipalities within about 30 km (18.6 mi) of ORR include Oliver Springs, Clinton, Rocky Top, Lenoir City, Farragut, Kingston, and Harriman. Except for the city of Oak Ridge, the land within 8 km (5 mi) 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.

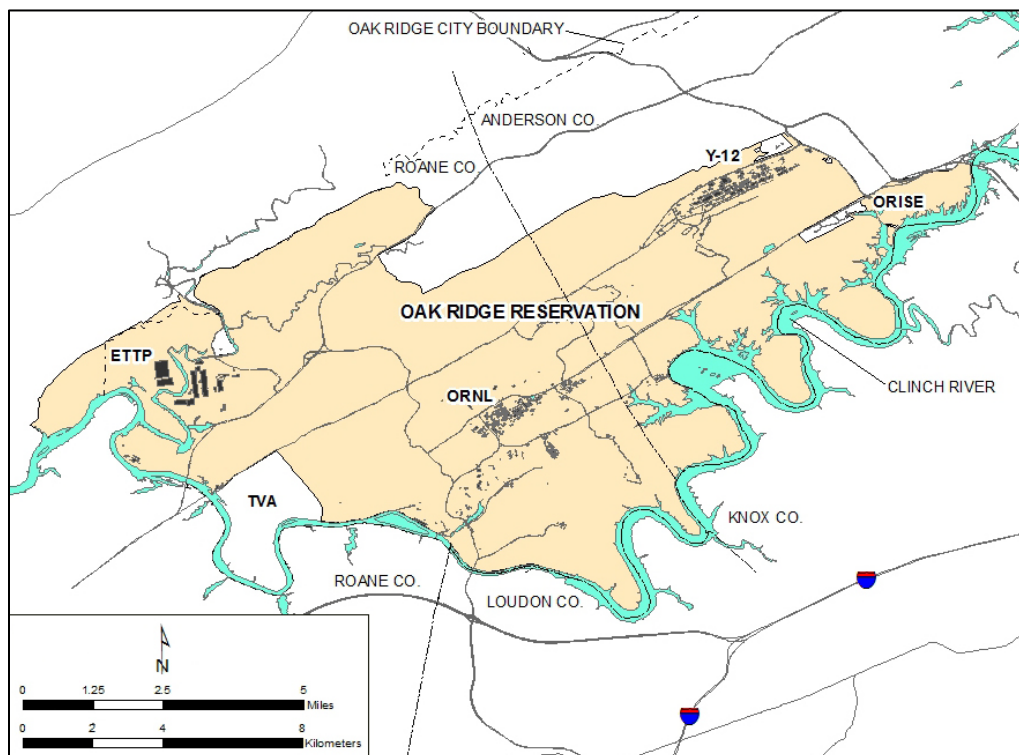


Figure 1.2. Map of the Oak Ridge Reservation

1.3.2 Climate

Although it features significant temperature changes between summer and winter, the climate of the Oak Ridge region qualifies as humid subtropical. The 30-year average temperature for 1981–2010 was 14.7°C (58.5°F). The average high temperature for the Oak Ridge area in 2019 was 21.5°C (70.8°F). January temperatures were coldest in 2019, averaging 0.4°C (32.7°F). July was the warmest month, with average temperatures of 24.5°C (76.1°F). Monthly summaries of temperature averages, extremes, and 2019 values are provided in Appendix B, Table B.1.

Average annual precipitation in the Oak Ridge area for the 30-year period from 1981 to 2010 was 1,337.5 mm (52.64 in.), including about 21.3 cm (8.4 in.) of snowfall (NOAA 2011). Total precipitation during 2019 as measured at meteorological tower (MT)2 was 1,847.7 mm (72.74 in.), which is 38 percent above the 30-year average. Monthly summaries of precipitation averages, extremes, and 2019 values can also be found in Appendix B, Table B.1.

The average annual wind data recovery rates (a measure of acceptable data) across locations used for modeling during 2019 were greater than 99.6 percent for wind sensors at the ORNL sites (towers MT2, MT3, MT4, MT10, and MT12). All other (MT6, MT9, and MT11) instrument recoveries were above 98 percent for both quarterly and annual values.

In 2019 wind speeds at ORNL Tower A (MT4), measured at 15 m (49 ft) above ground level, averaged 0.94 meters per second (2.1 mph). This value remained unchanged for winds at 60 m (198 ft) above ground level. 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 precipitation hours for the ORR towers may be reviewed [here](#) under the heading 2019 Annual Precipitation Wind Roses—Oak Ridge Reservation.

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 report. An in-depth analysis of wind patterns for ORR conducted from 2009 to 2011 and documented in *Wind Regimes in Complex Terrain in the Great Valley of Eastern Tennessee* (Birdwell 2011) is available online [here](#).

1.3.3 Regional Air Quality

The US Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards set national ambient air quality standards (NAAQS) for key principal pollutants, also known as criteria pollutants. These key pollutants are sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, ozone, particulate matter with an aerodynamic diameter less than or equal to 10 μm (PM_{10}), and fine particulate matter with an aerodynamic diameter less than or equal to 2.5 μm ($\text{PM}_{2.5}$). EPA evaluates NAAQS based on ambient, or outdoor, levels of the criteria pollutants. Areas that satisfy NAAQS are classified as attainment areas, and areas that exceed NAAQS for a particular pollutant are considered non-attainment areas for that pollutant.

ORR is located in Anderson and Roane Counties. As of August 30, 2017, EPA designated Anderson, Knox, Blount, and Roane Counties as attainment areas for the $\text{PM}_{2.5}$ air quality standard. The greater Knoxville and Oak Ridge area is a NAAQS attainment area for all other criteria pollutants for which EPA has made attainment designations.

1.3.4 Surface Water

The ORR area comprises a series of drainage basins or troughs containing numerous small streams that feed the Clinch River. Surface water on ORR drains into a series of tributaries, streams, or creeks in different watersheds. Each of these watersheds drains into the Clinch River, which in turn flows into the Tennessee River. On December 31, 2018, the Tennessee Valley Authority declared 2018 the wettest year on record for the Tennessee Valley region with 67.02 inches of precipitation, surpassing a previous record of 65.1 inches set in 1973. With 66.5 inches of rainfall, 2019 was the second wettest year on record. This conclusion is based on more than 100 years of collected weather data.

The largest of the ORR drainage basins is Poplar Creek, which receives drainage from a 352 km^2 (136 mi^2) area including the northwestern sector of ORR. Flow is from northeast to southwest, roughly through the center of ETTP, and the creek discharges directly into the Clinch River.

East Fork Poplar Creek, which discharges into Poplar Creek east of ETTP, originates within the Y-12 Complex and flows northeast along the south side of the complex. Bear Creek also originates within the Y-12 Complex and flows southwest. Bear Creek is 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 covers 16.5 km^2 (6.4 mi^2). The headwaters of White Oak Creek originate on Chestnut Ridge, north of ORNL and near the Spallation Neutron Source site. The creek flows west along the southern boundary of the developed area of the ORNL site, then flows southwest through a gap in Haw Ridge to the western

portion of Melton Valley, forming a confluence with Melton Branch. The headwaters of Melton Branch originate in Melton Valley east of the High Flux Isotope Reactor complex, and the area of the drainage basin is about 3.8 km² (1.47 mi²). The waters of White Oak Creek enter White Oak Lake, 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 in the Tennessee portion of the Valley and Ridge Physiographic Province, which is part of the southern Appalachian fold-and-thrust belt. Thrust faulting, associated fracturing of the rock, and differential erosion rates created a series of parallel valleys and ridges that trend southwest to northeast.

Two geologic units on ORR, the Knox Group and the Maynardville Limestone of the Upper Conasauga Group, consist of dolostone and limestone, respectively, and make up the most significant water-bearing hydrostratigraphic units in the Valley and Ridge Province (Zurawski 1978) and on ORR. Composed of moderately 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, under some circumstances, form caverns and extensive solution conduit networks. This hydrostratigraphic unit is locally known 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 (91.5 to 122 m, or 300 to 400 ft) in the Knox Aquifer. The Knox Aquifer is the primary source of groundwater (base flow) for many streams, and most large springs on ORR receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits exceed 3,785.4 liters per minute (1,000 gallons per minute). The high productivity of the Knox Aquifer results from 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 shale, siltstones, and sandstones with a subordinate and locally variable amount of carbonate bedrock. These formations are primarily composed of insoluble minerals such as clays and quartz that were derived from ancient continental erosion. Groundwater occurs in and moves through fractures in these bedrock units. Groundwater availability in such settings depends on the abundance and interconnectedness of fractures and the connection of fractures to sources of recharge, such as alluvial soils along streams, which 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 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 has an exceptional 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

Wetlands occur across ORR at low elevations, primarily in riparian zones of headwater streams and receiving streams and in the Clinch River embayments, as shown in Figure 1.3. 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.

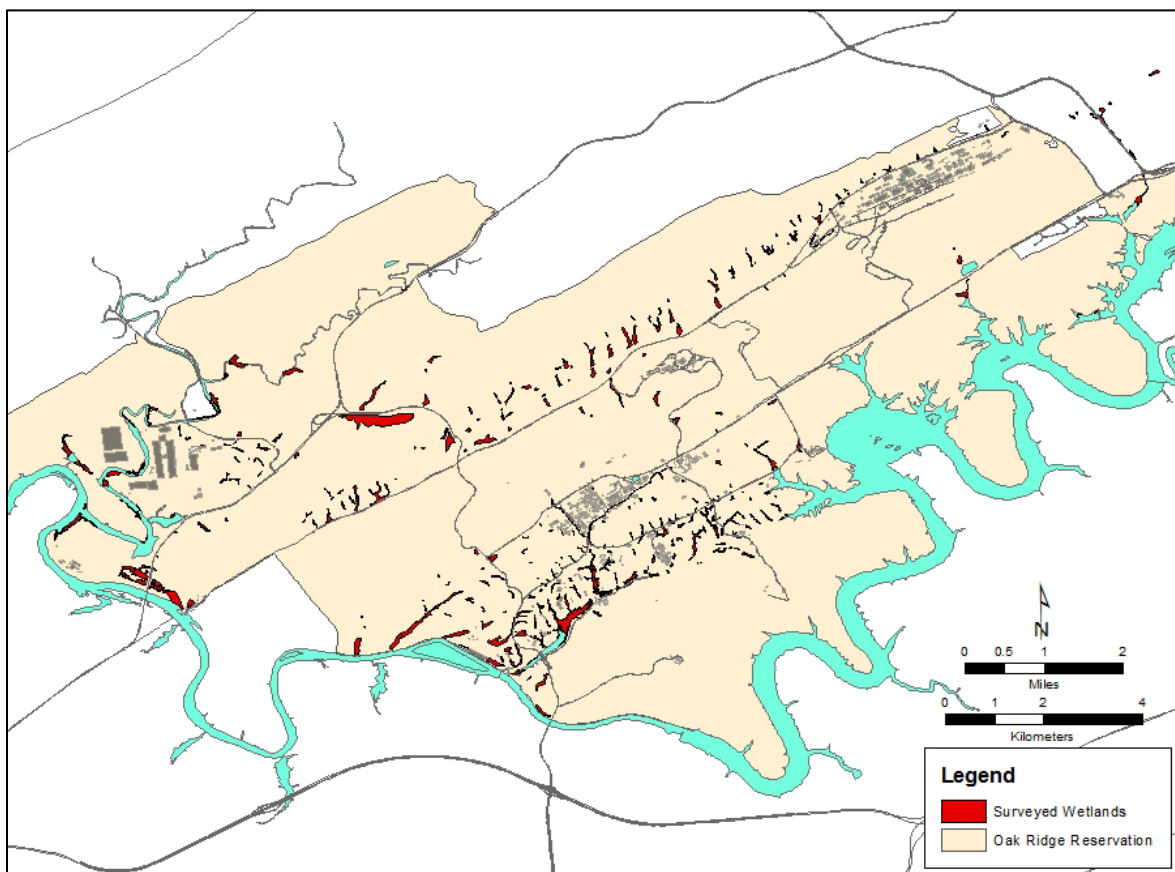


Figure 1.3. Location of Oak Ridge Reservation wetlands

About 243 hectares (600 acres) of wetlands have been identified on ORR; most are classified as forested palustrine, scrub/shrub, and emergent wetlands. Wetlands identified to date range from several square meters at small seeps and springs to about 10 hectares (25 acres) at White Oak Lake. In 2017, wetlands were delineated in the Copper Ridge Borrow Area and 294 Power Line Area. The Tennessee Department of Environment and Conservation's wetland mitigation aquatic resource alteration permits, required by Section 401 of the Clean Water Act, entail monitoring restored or created wetland mitigation sites for five years. Activities and conditions in and around ORNL wetlands are verified by site inspections when appropriate (see Chapter 5, Section 5.3.12).

A haul road constructed as part of the Uranium Processing Facility project inside Y-12 caused the loss of some wetlands that required mitigation, including creating and expanding wetlands in the Bear Creek watershed. Details of this activity are provided in Chapter 4, Section 4.5.8.4. The work was performed under an approved US Army Corps of Engineers Section 404 permit and an aquatic resource alteration permit issued by the Tennessee Department of Environment and Conservation. Monitoring in accordance with these permits began following the completion of mitigation activities. The wetland mitigation carried

out under these permits resulted in a more than 3:1 net increase in total wetland area. In all, 3.51 acres of wetlands will be constructed to compensate for the removal of one acre. The compensation ratios are intended to ensure there is no net loss of wetland resource value. Annual monitoring of the remediated wetland sites through 2019 revealed that, in general, the wetlands are responding as intended and have shown remarkable wetland plant coverage over the past few years. The five remediated wetlands had the hydrologic, vegetative, and soil characteristics to be considered wetlands in 2019. The wetlands have responded as intended; minimal alterations were required in two of the wetlands. Data from Wetlands 1 and 7 had shown a trend of decreasing plant coverage as water levels increased. To remedy this, 1,500 plants representing a dozen species were planted in Wetlands 1 and 7 in 2019. The monitoring conducted in 2019 marks the end of wetland monitoring for this project.

1.3.6.2 Wildlife and 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, such as hellbender, have been seen only once or a few times; others, including wood thrush, are comparatively common and widespread on ORR. As of July 2016, Tennessee had 93 species listed under the federal Endangered Species Act (75 endangered and 18 threatened). The complete Tennessee Threatened and Endangered List—New Rules is found [here](#).

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		T	
<i>Hemidactylium scutatum</i>	Four-toed salamander		NM	
BIRDS				
Swans, Geese, and Ducks				
<i>Branta canadensis</i>	Canada goose	MCOB	NM	
<i>Aix sponsa</i>	Wood duck	MC		
<i>Anas strepera</i>	Gadwall	MC		
<i>Anas americana</i>	American wigeon	MC		
<i>Anas rubripes</i>	American black duck	MC		RC
<i>Anas platyrhynchos</i>	Mallard	MC		
<i>Anas discors</i>	Blue-winged teal	MC		
<i>Anas crecca</i>	Green-winged teal	MC		
<i>Anas clypeata</i>	Northern shovler	MC		
<i>Anas acuta</i>	Northern pintail	MC		
<i>Aythya valisineria</i>	Canvasback	MC		
<i>Aythya americana</i>	Redhead	MC		
<i>Aythya collaris</i>	Ring-necked duck	MC		
<i>Aythya affinis</i>	Lesser scaup	MC*		

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

Scientific name	Common name	Status ^b		
		Federal	State	PIF ^c
Grebes				
<i>Podilymbus podiceps</i>	Pie-billed grebe	MC		
<i>Podiceps auritus</i>	Horned grebe	MC		
Frigatebirds, Boobies, Cormorants				
<i>Phalacrocorax auritus</i>	Double-breasted cormorant	MCOB		
Bitterns and Herons				
<i>Ixobrychus exilis</i>	Least bittern		NM	
<i>Egretta caerulea</i>	Little blue heron		NM	
<i>Nycticorax nycticorax</i>	Black-crowned night heron		NM	
<i>Mycteria americana</i>	Wood stork	T		
Kites, Hawks, Eagles, and Allies				
<i>Haliaeetus leucocephalus</i>	Bald eagle	MC ^d		
Rails, Gallinules, and Coots				
<i>Rallus limicola</i>	Virginia rail	MC		
<i>Porzana carolina</i>	Sora	MC		
<i>Fulica americana</i>	American coot	MC		
<i>Actitis macularius</i>	Spotted sandpiper	MC		
<i>Tringa solitaria</i>	Solitary sandpiper	MC		
<i>Tringa flavipes</i>	Lesser yellowlegs	MC		
<i>Scolopax minor</i>	American woodcock	MC*		
Grouse, Turkey, and Quail				
<i>Bonasa umbellus</i>	Ruffed grouse			RC
<i>Colinus virginianus</i>	Northern bobwhite	MC		RC
Pigeons and Doves				
<i>Zenaida macroura</i>	Mourning dove	MC		
Goatsuckers				
<i>Caprimulgus carolinensis</i>	Chuck-will's-widow			RC
<i>Caprimulgus vociferus</i>	Eastern whip-poor-will			RC
Swifts				
<i>Chaetura pelagica</i>	Chimney swift			RC
Kingfishers				
<i>Megaceryle alcyon</i>	Belted kingfisher			RC
Woodpeckers				
<i>Melanerpes erythrocephalus</i>	Red-headed woodpecker			RC
<i>Colaptes auratus</i>	Northern flicker			RC

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

Scientific name	Common name	Status ^b		
		Federal	State	PIF ^c
Tyrant Flycatchers				
<i>Contopus virens</i>	Eastern wood-pewee			RC
<i>Empidonax virescens</i>	Acadian flycatcher			RC
<i>Contopus cooperi</i>	Olive-sided flycatcher			
<i>Empidonax trailii</i>	Willow flycatcher	MC		
Swallows				
<i>Progne subis</i>	Purple martin			RC
<i>Hirundo rustica</i>	Barn swallow			RC
Kinglets, Gnatcatchers, and Thrushes				
<i>Hylocichla mustelina</i>	Wood thrush		NM	RC
Shrikes				
<i>Lanius ludovicianus</i>	Loggerhead shrike		NM	
Wood Warblers				
<i>Vermivora chrysoptera</i>	Golden-winged warbler		T	RC
<i>Setophaga cerulea</i>	Cerulean warbler		NM	RC
<i>Setophaga discolor</i>	Prairie warbler			RC
<i>Mniotilta varia</i>	Black-and-white warbler			RC
<i>Protonotaria citrea</i>	Prothonotary warbler			RC
<i>Geothlypis formosa</i>	Kentucky warbler			RC
<i>Cardellina canadensis</i>	Canada warbler			RC
<i>Icteria virens</i>	Yellow-breasted chat			RC
Tanagers				
<i>Piranga rubra</i>	Summer tanager			RC
Towhees, Sparrows, and Allies				
<i>Pipilo erythrophthalmus</i>	Eastern towhee			RC
<i>Spizella pusilla</i>	Field sparrow			RC
<i>Ammodramus savannarum</i>	Grasshopper sparrow			RC
<i>Ammodramus henslowii</i>	Henslow's sparrow		T	RC
<i>Melospiza Georgiana</i>	Swamp sparrow			RC
Finches and Allies				
<i>Spinus tristis</i>	American goldfinch			RC
MAMMALS				
<i>Myotis grisescens</i>	Gray bat	E	E	
<i>Myotis lucifugus</i>	Little brown bat		T	
<i>Myotis sodalist</i>	Indiana bat ^e	E	E	
<i>Myotis septentrionalis</i>	Northern long-eared bat	T		
<i>Myotis leibii</i>	Eastern small-footed bat		NM	

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

Scientific name	Common name	Status ^b		
		Federal	State	PIF ^c
<i>Perimyotis subflavus</i>	Tri-colored bat		T	
<i>Corynorhinus rafinesquii</i>	Rafinesque's Big-eared bat		NM	
<i>Sorex dispar</i>	Long-tailed shrew		NM	

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

^b Status codes:

E = endangered

FS = Federal Focal species

T = threatened

MC = of management concern

NM = in need of management

OB = overly abundant

RC = regional concern

UR = under federal review

^c Partners in Flight (PIF) is an international organization devoted to conserving bird populations in the Western Hemisphere.

^d The bald eagle was federally delisted effective August 9, 2007.

^e A single specimen was captured in a mist net bordering the Clinch River in June 2013.

Birds, fish, and aquatic invertebrates are the most thoroughly surveyed animal groups on ORR. Nevertheless, the only federally listed animal species observed on ORR in recent years are mammals. Gray bats were seen 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 caught in mist nets bordering the Clinch River in June and 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 et al. 2015).

Birds recorded on ORR and its boundary waters include the 228 species documented by Roy et al. (2014) plus the cackling goose (*Branta hutchinsii*), purple gallinule (*Porphyrio martinicus*), American bittern (*Botaurus lentiginosus*) and federally threatened wood stork (*Mycteria Americana*) for a total of 232 species. Most of these species are protected under the Migratory Bird Treaty Act and Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. DOE's updated memorandum of understanding on migratory birds with the US Fish and Wildlife Service (FWS) (DOE-FWS 2013) strengthens migratory bird conservation on ORR through enhanced collaboration between DOE and FWS.

Breeding bird surveys conducted along varying numbers of up to 10 routes on ORR provide data for the Partners in Flight Program. Five public nature walks were held on ORR during 2019. Topics included American woodcock and birds of prey, birds, frog calls, a reptiles and amphibians inventory, and history of ORR. In past years ORR has been nominated for the Presidential Migratory Bird Federal Stewardship Award. A technical manuscript, *Oak Ridge Reservation Bird Records and Population Trends* (Roy et al. 2014), documents all known ORR bird records since 1950, as well as population trends for 32 species of birds.

Several state-listed bird species such as the golden-winged warbler, cerulean warbler, and little blue heron are uncommon migrants or visitors to the reservation. The cerulean warbler, listed by the state as in need of management, often appears during the breeding season on ORR but is currently listed as a potential breeding bird on the reservation (Roy et al. 2014) as its actual breeding status is still uncertain. The bald

eagle (shown in Figure 1.4), which was removed from the federal list of threatened and endangered species on August 9, 2007, 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 2019. This nest was first observed in 2011 and has remained active every year since.



Source: Jason Richards, ORNL photographer

Figure 1.4. Bald eagle nest on the Oak Ridge Reservation

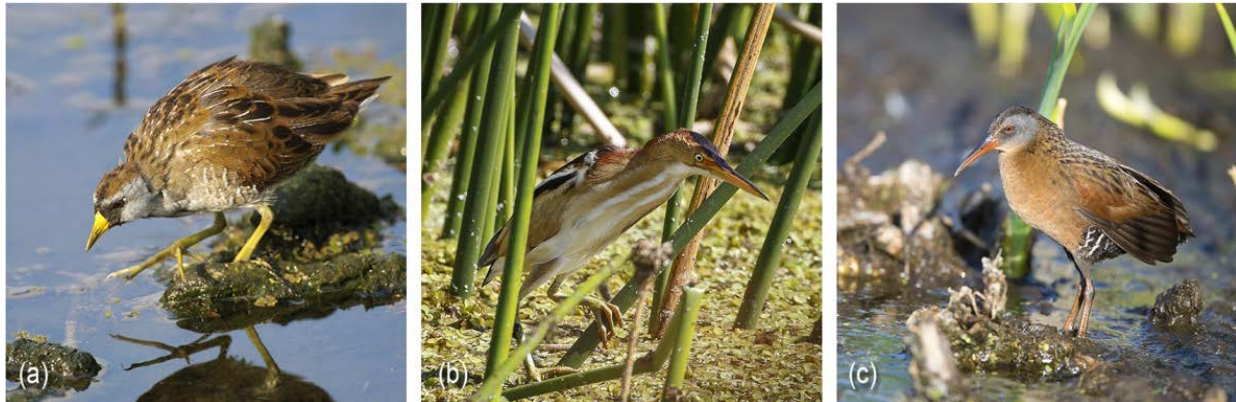
More than two dozen eaglets fledged in East Tennessee during 2017, according to bald eagle information published by the East Tennessee State University College of Arts and Sciences Biological Sciences department. More than 50 sightings in Roane and Anderson counties were reported to eBird (described in Sullivan et al. 2009) during calendar year 2019.

Other species such as the wood thrush and barn swallow are migrants and are known to nest on the reservation. The golden-winged warbler (*Vermivora chrysoptera*), listed by the state as threatened, was sighted once, in May 1998, on the reservation, as was the Lincoln's sparrow (*Melospiza lincolnii*) (no listed status) in May 2014. Barn owls were documented nesting on the reservation in 2019.

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 recorded locally only on boundary waters of the reservation. Other uncommon birds for ORR recorded in recent years include several species associated with wetland habitats. The sora, least bittern, and Virginia rail, shown in Figure 1.5, were observed at the K1007 P1 pond at ETPP in 2013 and were likely attracted to high quality wildlife habitat established through recent restoration efforts. The sora, seen as recently as December 2016, is a fairly common migrant throughout Tennessee but is seldom seen on ORR. The least bittern is an uncommon migrant and summer resident in Tennessee. The Virginia rail, most recently observed in October 2013, was previously known on ORR only through historic records from the early 1950s (Roy et al. 2014). FWS lists all three of these species as of management concern. The least bittern is also deemed in need of management by the State of Tennessee, as shown in Table 1.1.

One fish species, 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 in need of management, appears in the Bear Creek watershed, tributaries to the lower East Fork watershed, and Ish Creek. The Tennessee dace also occurs in some sections of Grassy Creek upstream of Scientific Ecology Group, Inc. and International Technology Corporation at Clinch River kilometer 23, south of west Bear Creek Road near Grassy Creek sampling point 1.9.



Source: Stock images courtesy of iStock.

Figure 1.5. Interesting bird species sighted on the Oak Ridge Reservation in recent years: (a) sora, (b) least bittern, and (c) Virginia rail

1.3.6.3 Threatened and Endangered Plants

Four plant species 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 previously listed under the C2 candidate designation. FWS now informally refers to these as special concern species.

The State of Tennessee lists 17 plant species occurring on ORR as endangered, threatened, or of special concern; these are included in Table 1.2. Appalachian bugbane is no longer listed by Tennessee and does not have official federal status; therefore, it does not appear in Table 1.2. An additional 10 threatened, endangered, or special concern species occur in the area and, although currently unconfirmed on ORR, may be present. These are also included in Table 1.2. Other plant populations currently under study on ORR may be added to the table in future years.

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

Species	Common name	Habitat on ORR	Status code ^a
<i>Currently known to be or previously reported on ORR</i>			
<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

Table 1.2. Vascular plant species listed by state or federal agencies and sighted/reported on or near the Oak Ridge Reservation (continued)

Species	Common name	Habitat on ORR	Status code ^a
<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 var. herbiola</i>	Tubercled 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

^a 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

^b 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 the result of planting. Both species of ramps have the same state status.

Acronym: ORR = Oak Ridge Reservation

The latest Tennessee Rare Plant List was published in October 2016. The 2012 Tennessee Rare Plant List reduced the number of state-protected species on ORR by six, and the 2016 Tennessee Rare Plant List reduced this number by an additional two species: the Tennessee coneflower (*Echinacea tennesseensis*) and Egget's sunflower (*Helianthus eggertii*).

1.3.6.4 Historical and Cultural Resources

Efforts continue to preserve ORR's rich prehistoric and historic cultural resources. Compliance with the National Historic Preservation Act is maintained in conjunction with National Environmental Policy Act (NEPA) compliance. The scope of proposed actions is reviewed in accordance with the *Cultural Resource Management Plan, DOE Oak Ridge Reservation, Anderson and Roane Counties, Tennessee* (DOE 2001). ORR has several facilities that were eligible for inclusion on the National Register of Historic Places (NRHP), a National Park Service program to identify, evaluate, and protect historic and archeological resources in the US, as well as numerous facilities that were not eligible for NHRP inclusion. Artifacts of historical or cultural significance are identified prior to demolition and catalogued in a database to aid in historic interpretation. The reservation contains more than 44 known prehistoric sites (primarily

archeological evidence of former structures), 254 historic pre-World War II structures, 32 cemeteries, and several historically significant structures from the Manhattan Project era.

The National Defense Authorization Act of 2015, passed by Congress and signed into law on December 19, 2014, included provisions authorizing the Manhattan Project National Historical Park. An agreement by the Secretaries of Energy and Interior established the Manhattan Project National Historical Park on November 10, 2015. The Park includes facilities and lands in Los Alamos, New Mexico and Hanford, Washington, as well as Oak Ridge. On ORR, the National Park includes the X-10 Graphite Reactor, Buildings 9731 and 9204-3 at the Y-12 Complex and the K-25 Building Site at ETTP.

The X-10 Graphite Reactor building has been a National Historic Landmark since 1966, and has been open for public access in various ways since that time. Enhancing access and improving the visitor experience are important DOE objectives as it moves forward in implementing the National Park.

Although Buildings 9731 and 9204-3 at the Y-12 Complex are eligible for listing on the NRHP, at present neither is available for regular public access. Occasional public access to both facilities last occurred on Nov. 12, 2015, when DOE facilitated public tours of both buildings to celebrate the establishment of the National Park. By developing the National Park, DOE aims to enhance safe access to these buildings while protecting the agency's mission capabilities.

DOE will fulfill the objective of enabling safe access to the former site of the K-25 Building. The National Park Service will aid in historic interpretation of the site, although the K-25 Building site is already undergoing extensive historic interpretation activities separate and independent from the National Park. DOE launched the K-25 Virtual Museum as part of the activities to establish the Park. The online exhibit, which details the history of the K-25 Gaseous Diffusion Plant through narrative and photographs, can be viewed [here](#). The initial phase of the K-25 History Center was under construction in 2019 and was expected to open in early 2020.

The Graphite Reactor is a National Historic Landmark, and six additional historic ORR properties are listed individually in the NRHP:

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

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

A memorandum of agreement signed in 2012 between DOE Oak Ridge Office, the State Historic Preservation Officer, the Advisory Council on Historic Preservation, the City of Oak Ridge, and the East Tennessee Preservation Alliance ensures consistent interpretation of site historic properties at ETTP. The memorandum of agreement is being implemented through planning for a History Center that will highlight the historic aspects of ETTP and of the communities that were displaced during the construction of the site.

Three site-wide programmatic agreements among the DOE Oak Ridge Office, the State Historic Preservation Officer, and the Advisory Council on Historic Preservation concerning management of

historical and cultural properties on ORR, at ORNL, and at Y-12 have been enforced since their respective approvals.

1.4 Oak Ridge Sites

ORR includes a number of sites critical to the mission of DOE. Eight of these sites are described in this section: ORNL, the Y-12 Complex, ETTP, EMWMF, the Oak Ridge Environmental Research Park, ORISE, NNSA OST AOEC, and the Transuranic Waste Processing Center (TWPC) Sludge Buildout Facility.

1.4.1 Oak Ridge National Laboratory

ORNL (shown in Figure 1.6) is managed for DOE by UT-Battelle, LLC, a partnership between the University of Tennessee and Battelle Memorial Institute. The largest science and energy national laboratory in the DOE system, ORNL conducts 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 the Spallation Neutron Source and the High Flux Isotope Reactor. ORNL hosts a DOE leadership computing facility, home of the Summit supercomputer; one of DOE's nanoscience centers, the Center for Nanophase Materials Sciences; one of DOE's energy research centers; and the Bio-Energy Science Center. UT-Battelle, LLC also manages the US ITER project (formerly the International Thermonuclear Experimental Reactor project) for DOE.

Formerly known as X-10, 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 portfolio broadened to include programs supporting DOE missions in scientific discovery and innovation, clean energy, and nuclear security. Today ORNL employs about 4,400 workers, and the laboratory's extensive capabilities in scientific discovery and innovation are applied to the delivery of mission outcomes for DOE and other sponsors.

During fiscal year (FY) 2019, DOE remained focused on disposing of a significant inventory of uranium-233 stored in Building 3019 at ORNL. This special nuclear material requires strict safeguards and security controls to protect against access. The objectives of the Uranium-233 Project are to address safeguards and security requirements, eliminate safety and nuclear criticality concerns, and safely dispose of the material. DOE has successfully resolved the concerns associated with the disposition of the Consolidated Edison Uranium Solidification Project material, which originated from a 1960s research and development test of thorium and uranium fuel at Consolidated Edison's Indian Point 1 Nuclear Plant in New York. Isotek Systems, LLC manages activities at the Building 3019 complex for DOE and is responsible for activities associated with processing, down-blending, and packaging the DOE inventory of uranium-233 stored in the complex.

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 UCOR activities include groundwater monitoring, transuranic waste storage, and operation of the liquid low-level and process waste systems and the off-gas collection and treatment system.



Figure 1.6. Aerial view of the Oak Ridge National Laboratory

1.4.2 Y-12 National Security Complex

The Y-12 Complex (shown in Figure 1.7) was originally constructed as part of the World War II Manhattan Project and began operations in November 1943. The first site mission was the separation of uranium-235 from natural uranium by an electromagnetic separation process. At its peak in 1945, more than 22,000 workers were employed at the Y-12 site.

Today, as part of the NNSA Nuclear Security Enterprise, the Y-12 Complex is 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 the nation's supply of enriched uranium. The Y-12 Complex also supports efforts to reduce the risk of nuclear proliferation and performs complementary work for other government agencies.

Outfall 200 Mercury Treatment Facility

In December 2017, UCOR (the cleanup contractor for ORR) issued the *Construction Execution/Management Plan, Outfall 200 Mercury Treatment Facility at the Y-12 Nuclear Security Complex, Oak Ridge, Tennessee* (UCOR 2017). The goal of the Mercury Treatment Facility is to reduce the mercury concentration in water exiting the Y-12 Complex. The west end Y-12 storm drain system discharges to Upper East Fork Poplar Creek at Outfall 200, and mercury from historic operations is present at Outfall 200 where storm water enters Poplar Creek.

Three lines of investigation were developed for East Fork Poplar Creek: to examine potential downstream sources such as bank soil and sediment control, to study the ecology and investigate how differences in food chain processes may influence the uptake of mercury in fish, and to investigate the water chemistry

and flow characteristics of the creek and their influence. In support of mercury cleanup efforts, research and technology development activities focused on the major factors influencing the accumulation of mercury in fish, which are the major route of both human and wildlife exposure. The *Mercury Remediation Technology Development for Lower East Fork Poplar Creek—2017 Progress Report* (ORNL 2018) provided details of each study area and findings.



Figure 1.7. Aerial view of the Y-12 National Security Complex

Construction of the Mercury Treatment Facility at Outfall 200 continued in 2019. OREM completed early site preparation activities, which included constructing utilities necessary for the treatment facility, installing secant pile walls near East Fork Poplar Creek, and relocating and demolishing existing infrastructure and structures to prepare the site.

The Mercury Treatment Facility is designed to treat up to 3,000 gallons of storm water per minute. It includes a 2-million-gallon storage tank to collect storm water during peak flow conditions of up to 40,000 gallons per minute. The stored water can then be treated after storm flow subsides. Captured storm water will be piped to a treatment facility located on an available site east of Outfall 200. Mercury treatment will be accomplished using chemical precipitation, clarification, and media filtration. Treated water will be discharged back into Upper East Fork Poplar Creek.

At the end of FY 2019, the Y-12 Complex had achieved seven of nine established environmental targets, and the remaining targets were carried into future years. Highlights include the following; further details and additional successes are presented in other sections of this report.

- **Clean Air:** The Y-12 Complex finalized modification of the Title V air permit to include the calciner operations.

- **Energy Efficiency:** Y-12 completed a project to replace the Building 9117 computer room air conditioner.
- **Hazardous Materials:** A project to disposition and ship legacy mixed waste per Site Treatment Plan milestones was completed in 2019, and FY 2019 priorities for unneeded materials and chemicals were completed to disposition unneeded production equipment in Building 9201-5N. Asbestos abatement and material removal in the Biology Complex also began in 2019.
- **Land, Water, and Natural Resources:** Reroofing projects for seven buildings were completed to reduce risks to storm and surface water. In addition, Phase 1 of a project to improve protection of the sanitary sewer drainage system from infill and infiltration was completed. Smoke testing and camera inspection of four lateral lines around Alpha-3 was completed to determine what future improvements are required.
- **Mercury Removal:** More than 4.6 tons of mercury have been removed from column exchange equipment at Alpha-4, and 22 tanks were characterized for disposal.

In FY 2019, the Y-12 Complex implemented 97 pollution prevention initiatives resulting in a reduction of more than 68.6 million lb of waste and projected cost efficiencies of more than \$19.6 million. Also in 2019, the Y-12 Complex diverted 52.7 percent (2.6 million lb) of municipal and 38.6 percent (65.5 million lb) of construction and demolition waste from landfill disposal through reuse and recycling. Also in FY 2019, more than 1,000 lb of waste generation prevention was realized by transferring materials for on-site reuse, and more than 3.29 million lb of materials were diverted from landfills into viable recycle processes.

The Y-12 Complex has achieved a 47 percent reduction in energy intensity as of FY 2019. Specific initiatives that helped reduce energy consumption at the Y-12 Complex include the following:

- Completing a new, more-efficient Air Compressor Plant at the end of FY 2016
- Upgrading light fixtures with T-8 fluorescent lighting and light-emitting diodes
- Replacing steam with natural gas
- Upgrading chillers with new high-efficiency variable speed modes; retrofitting existing chillers with efficient controls; replacing constant-speed chilled water pumps with a variable-speed type; and replacing tower pumps, steam controls, and control valves
- Replacing cooling towers

Sustainability goals and performance status for the Y-12 Complex are listed in Chapter 4, Table 4.1.

1.4.3 East Tennessee Technology Park

ETTP (see Figure 1.8), originally named K-25, is the site of the nation's first gaseous diffusion uranium enrichment plant. It was established as part of the World War II Manhattan Project. Additional uranium enrichment facilities K-29, K-31, and K-33 were built adjacent to K-25 during the Cold War, and these facilities formed a complex officially known as the Oak Ridge Gaseous Diffusion Plant. Uranium enrichment operations at the site ceased in 1986, and restoration and decontamination and decommissioning 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. Today restoration of the environment, decontamination and decommissioning of facilities, disposition of wastes, and reindustrialization are the major activities at the site.



Figure 1.8. Aerial view of East Tennessee Technology Park

In 2019, ETTP landlord contractor functions and the majority of the ETTP cleanup program actions were managed by UCOR. Decontamination and demolition of K-1423 was completed on October 30, 2019. Samples collected during rainfall events at demolition sites did not exhibit any screening level exceedances. Based on total greenhouse gas emissions from all ETTP stationary sources during 2019, the threshold limit was not exceeded. Greenhouse gas emissions totaled 50 metric tons of carbon dioxide, which is 0.2 percent of the yearly threshold for reporting.

In 2017, a proposed plan to build an airport on the ETTP site reached a major milestone with the completion of a master plan, which was submitted to the Federal Aviation Administration for approval. Metropolitan Knoxville Airport Authority is leading the project. The Federal Aviation Administration granted conditional approval of the airport layout plan in 2019, and the Metropolitan Knoxville Airport Authority is proceeding with final design work. The airport would serve primarily corporate planes such as the Beechcraft King Air 350, Cessna 500, and Cirrus SF-50 Vision Jet.

1.4.4 Environmental Management Waste Management Facility

The EMWMF (shown in Figure 1.9) is located in eastern Bear Creek Valley near the Y-12 Complex and is managed by UCOR. EMWMF was built for the disposal of waste resulting from Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) cleanup actions on ORR. The original design was for the construction, operation, and closure of a projected 1.3 million cubic meter (1.7 million cubic yard) disposal facility. The approved capacity was subsequently increased to 1.8 million cubic meters (2.4 million cubic yards) to maximize use of the footprint designated in a 1999 record of decision. The facility currently consists of six disposal cells.



Figure 1.9. Aerial view of the Environmental Management Waste Management Facility

EMWMF is an engineered landfill that accepts low-level, mixed low-level, and hazardous wastes from CERCLA cleanup activities on ORR 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. In FY 2019 the facility collected, analyzed, and disposed of approximately 4.5 million gallons of leachate. The leachate is treated at the ORNL Liquids and Gaseous Treatment Facility, which is also operated by UCOR. ORR landfills disposed of 123,376 cubic yards of waste during 2019.

During FY 2019 the EMWMF received 10,555 waste shipments, accounting for 75,074 tons, from cleanup projects at ETTP, ORNL, and Y-12. EMWMF will reach its capacity before OREM completes its cleanup at Y-12 and ORNL. Planning continued throughout FY 2019 for a new facility, the Environmental Management Disposal Facility, which will provide the additional disposal capacity needed to complete the cleanup at Oak Ridge.

1.4.5 Oak Ridge Environmental Research Park

DOE established the Oak Ridge Environmental Research Park (see Figure 1.10) in 1980. Managed for DOE by UT-Battelle, LLC, the research park serves as an outdoor laboratory to evaluate the environmental consequences of energy use and development and strategies to mitigate those effects. Its large blocks of forest and diverse communities of vegetation 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. 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.

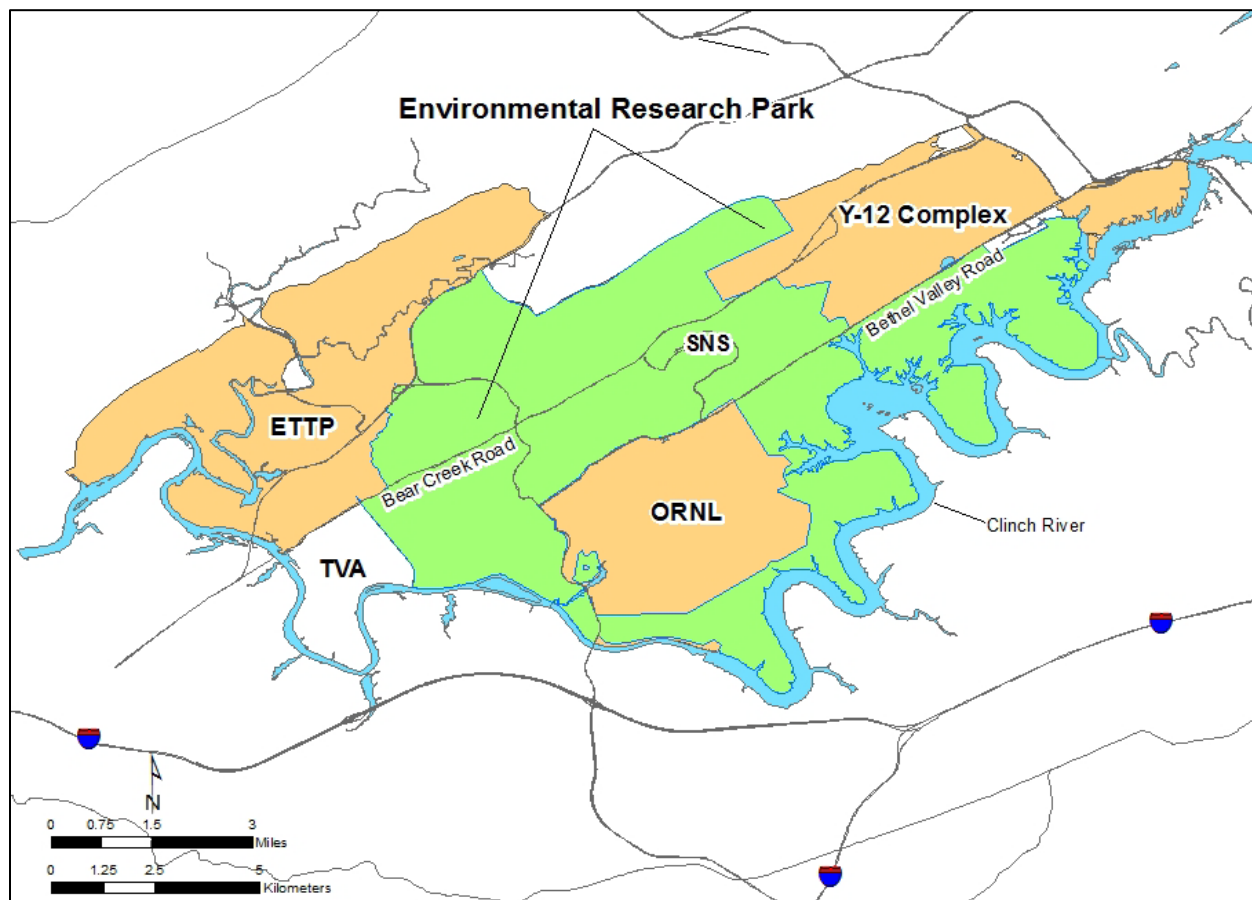


Figure 1.10. Location of the Oak Ridge Environmental Research Park

National recognition of the research park's value has led to its use in both regional- and continental-scale research projects. 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.

1.4.6 Oak Ridge Institute for Science and Education

ORISE is managed for DOE by Oak Ridge Associated Universities. The ORISE mission is to develop people and solutions to strengthen our nation's competitive advantage in science. ORISE accomplishes its mission by recruiting and preparing the next generation of our nation's scientific workforce; promoting sound scientific and technical investment decisions through independent peer reviews; facilitating and preparing for the medical management of radiation incidents in the US and abroad; evaluating health outcomes in workers exposed to chemical and radiological hazards on the job; and ensuring public confidence in environmental cleanup through independent environmental assessments. ORISE creates opportunities for collaboration through partnerships with other DOE facilities, federal agencies, academia, and industry consistent with DOE objectives and the ORISE mission.

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

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

Beginning in 1947, DOE and its predecessor agencies moved nuclear weapons, weapons components, special nuclear materials, and other important national security assets by commercial and government modes of transportation. 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. Modified and redesigned transport equipment was created to incorporate features that more effectively enhance self-protection and 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 responsible for this mission within DOE NNSA is the Office of Secure Transportation, or OST.

The NNSA OST AOEC Secure Transportation Center and Training Facility is located on ORR. Situated on about 723 ha (1,786 acres), it operates under a user permit agreement with DOE Oak Ridge Office. NNSA OST AOEC implements its assigned mission transportation operations, maintains applicable fleet and escort vehicles, and continues extensive training activities for its federal agents.

1.4.8 Transuranic Waste Processing Center

TWPC is located on an approximately 10.5-hectare (26-acre) tract of land in the Melton Valley area of ORNL about 120 feet west of the existing Melton Valley Storage Tanks. North Wind Solutions, LLC manages TWPC for DOE. TWPC's mission is to receive transuranic waste for processing, treatment, repackaging, and shipment to DOE's Waste Isolation Pilot Plant near Carlsbad, New Mexico.

Transuranic waste consists of materials and debris that are contaminated with elements that have a higher atomic mass and are listed after uranium on the periodic table. The majority of Oak Ridge's inventory of transuranic materials originated from previous research and isotope production missions at ORNL. Waste determined to be non-transuranic (e.g., low-level radioactive waste or mixed low-level waste) is shipped to the Nevada National Security Site or other approved facilities. TWPC has processed approximately 98 percent of the contact-handled transuranic waste and 98 percent of the remote-handled transuranic waste, and has also completed key regulatory Site Treatment Plan milestones on schedule.

Key progress for the project during FY 2019 included the following actions:

- In 2019, 85 shipments containing 2,739 drums of contact-handled transuranic waste were sent to the Waste Isolation Pilot Plant.
- Construction permit 974744 was issued November 19, 2018 to implement proposed modifications to the Title V operating permit, and significant modification No. 1 to the Title V operating permit, incorporating the proposed modifications, was issued on April 15, 2019.
- Design work continued on the Sludge Mobilization System and the Slurry Mixing and Characterization Tank.
- Testing of the mobilization measurement instrumentation was initiated.

- Sludge Processing Facility Build-out technical basis documents were updated, including the safety design strategy, integrated system test plan, waste certification strategy, flowsheet and material balance, and revised simulant strategy.
- A contract change proposal for extending utilities to the Sludge Test Area site was submitted to DOE for review and approval. The Sludge Test Area construction subcontractor submitted a worker safety and health plan and construction waste management and disposal plans for approval; a draft memorandum of understanding with UCOR was sent for review; and site preparation began at the Sludge Test Area site in preparation for the concrete slab to be poured in 2020.
- Quarterly Safety Design Integration Team meetings were conducted.

1.5 References

- Birdwell 2011/ Birdwell, Kevin Ray, “Wind Regimes in Complex Terrain of the Great Valley of Eastern Tennessee.” PhD dissertation, University of Tennessee, May.
- DOE 2001. *Cultural Resource Management Plan, DOE Oak Ridge Reservation, Anderson and Roane Counties, Tennessee*. DOE/ORO-2085, US Department of Energy Oak Ridge Operations Office, Oak Ridge, TN, July.
- DOE 2012. *Environment, Safety, and Health Reporting*. DOE Order 231.1B, approved 06-27-11, US Department of Energy, Washington, DC.
- DOE-FWS 2013. “Memorandum of Understanding between the United States Department of Energy and the United States Fish and Wildlife Service Regarding Implementation of Executive Order 13186, ‘Responsibilities of Federal Agencies to Protect Migratory Birds’.” US Department of Energy and US Fish and Wildlife Service, Washington, DC; available online at <http://energy.gov/sites/prod/files/2013/10/f3/Final%20DOE-FWS%20Migratory%20Bird%20MOU.pdf>.
- East Tennessee Economic Council 2017. *US Department of Energy FY 2017 Economic Impact in Tennessee*. Oak Ridge, TN, May.
- McCracken et al. 2015. McCracken, M.K., N.R. Giffen, A.M. Haines, and J.W. Evans, *Bat Species Distribution on the Oak Ridge Reservation*. ORNL/TM-2015/248, Oak Ridge National Laboratory, Oak Ridge, Tennessee. (Note: Draft report; contact author for access.)
- NOAA 2011. *Annual 2011 Local Climatological Data Report for Oak Ridge, Tennessee (Site KOQT)*. Published by the National Oceanic and Atmospheric Administration National Climatic Data Center, Asheville, North Carolina.
- ORNL 2018. *Mercury Remediation Technology Development for Lower East Fork Poplar Creek—2017 Update*. ORNL/TM-2017/480, Oak Ridge National Laboratory, Oak Ridge, Tennessee, July.
- Parr and Hughes 2006. Parr, P.D. and J.F. Hughes, *Oak Ridge Reservation Physical Characteristics and Natural Resources*. ORNL/TM-2006/110, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Rosensteel 1996. Rosensteel, Barbara A., *Wetland Survey of the X-10 Bethel Valley and Melton Valley Groundwater Operable Units at Oak Ridge National Laboratory, Oak Ridge, Tennessee*. ORNL/ER-350, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Rosensteel 1997. Rosensteel, Barbara A., *Wetland Survey of Selected Areas in the Oak Ridge Y-12 Plant Area of Responsibility, Oak Ridge, Tennessee*. Y/ER-279, Y-12 National Security Complex, Oak Ridge, Tennessee.
- Rosensteel and Trettin 1993. Rosensteel, Barbara A. and Carl C. Trettin, *Identification and Characterization of Wetlands in the Bear Creek Watershed*. Y/TS-1016, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

- Roy et al. 2014. Roy, W.K., N.R. Giffen, M.C. Wade, A.M. Haines, J.W. Evans, and R.T. Jett, *Oak Ridge Reservation Bird Records and Population Trends*. ORNL/TM-2014/109, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Sullivan et al. 2009. Sullivan, B.L., C.L. Wood, M.J. Iliff, R.E. Bonney, D. Fink, and S. Kelling, “eBird: A Citizen-Based Bird Observation Network in the Biological Sciences.” *Biological Conservation* 142, 2282–2292.
- UCOR 2017. *Construction Execution/Management Plan, Outfall 200 Mercury Treatment Facility at the Y-12 Nuclear Security Complex, Oak Ridge, Tennessee*. UCOR-4972/R1, UCOR, Oak Ridge, Tennessee, November 29.
- Zurawski 1978. Zurawski, A., “Summary Appraisals of the Nation’s Ground-Water Resources—Tennessee Region.” US Geological Survey Professional Paper 813-L.