1. Site and Operations Overview

Setting

The Oak Ridge Reservation (ORR), a government-owned, contractor-operated facility, contains three major operating sites: the Y-12 National Security Complex, Oak Ridge National Laboratory, and East Tennessee Technology Park (formerly the K-25 Site). The ORR was established in the early 1940s as part of the Manhattan Project, a secret undertaking that produced the materials for the first atomic bombs. The reservation's role has evolved over the years, and it continues to adapt to meet the changing defense, energy, and research needs of the United States. Both the work carried out for the war effort and subsequent research, development, and production activities have involved (and continue to involve) radiological and hazardous materials.

Update

Both the *Oak Ridge Reservation Annual Site Environmental Report* and *Environmental Monitoring on the Oak Ridge Reservation: 2000 Results* are now available on the World Wide Web at http://www.ornl.gov/aser.

UT-Battelle, LLC, was awarded the contract to manage the Oak Ridge National Laboratory. UT-Battelle assumed responsibility on April 1, 2000. BWXT Y-12, LLC, was awarded the contract to manage the Y-12 National Security Complex. BWXT Y-12 assumed responsibility on November 1, 2000. The Community Reuse Organization of East Tennessee (CROET) leases portions of the East Tennessee Technology Park, and then subleases these federally owned properties to business and industry.

1.1 BACKGROUND

This document is prepared annually to summarize environmental activities, primarily environmental-monitoring activities, on the Oak Ridge Reservation (ORR) and within the ORR surroundings. The monitoring and documentation criteria are described within the U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program." The results summarized in this report are based on the data collected prior to and through 2000. The 2000 results are compiled in *Environmental Monitoring on the Oak Ridge Reservation: 2000 Results* (UT-Battelle 2001). This report is intended to fulfill the requirements of DOE Order 5400.1. The data and information found in this report were generated in accordance with the DOE-approved *Environmental Monitoring Plan for the Oak Ridge Reservation* (DOE 1998b). This report is not intended to provide the results of all sampling on the ORR. Additional data collected for other site purposes, such as environmental restoration remedial investigation reports and waste management characterization sampling, are presented in other documents that have been prepared in accordance with applicable DOE guidance and/or laws. Sampling results are captured in the Oak Ridge Environmental Information System (OREIS), which can be accessed at http://eimdb-web.bechteljacobs.org:8080/oreis/help/oreishome.html. This report is available on the World Wide Web at http://www.ornl.gov/aser or from the project director. Corrections to the ASER for the previous year are found in Appendix A.

Environmental monitoring on the ORR consists primarily of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring involves the collection and analysis of samples or measurements of liquid and gaseous effluents prior to release into the environment; these measurements allow the quantification and official reporting of contaminants, assessment of radiation and chemical exposures to the public, and demonstration of compliance with applicable standards and permit requirements. Environmental surveillance consists of the collection and analysis of environmental samples from the site and its environs; this provides direct measurement of contaminants in air, water, groundwater, soil, foods, biota, and other media subsequent to effluent release into the environment. Environmental surveillance data provide information as to the ORR's compliance status and, combined with data from effluent monitoring, allow the determination of chemical and radiation dose/exposure assessments of ORR operations and effects, if any, on the local environment.

1.2 DESCRIPTION OF SITE LOCALE

The city of Oak Ridge lies in a valley between the Cumberland and Blue Ridge mountain ranges and is bordered on two sides by the Clinch River. The Cumberland Mountains are 16 km (10 miles) to the northwest; the Blue Ridge Mountains, which include the Great Smoky Mountains National Park, are 51 km (32 miles) to the southeast (Fig. 1.1).

The ORR encompasses about 13,949 hectares (34,424 acres) of mostly contiguous land owned by DOE in the Oak Ridge area. The majority lies within the corporate limits of the city of Oak Ridge; 246.4 hectares (608 acres), west of the East Tennessee Technology Park (ETTP), is outside the city limits. The residential section of Oak Ridge forms the northern boundary of the reservation. The Tennessee Valley Authority's (TVA's) Melton Hill and Watts Bar reservoirs on the Clinch and Tennessee rivers form the southern and western boundaries (Fig. 1.2).

The population of the ten-county region surrounding the ORR is about 805,491, with 3.7% of its labor force employed on the reservation (Fig. 1.3). Other towns in close proximity to the reservation include Oliver Springs, Clinton, Karns, Lenoir City, Farragut, Kingston, and Harriman (Fig. 1.4).

Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 km (25 miles) to the east and has a population of about 173,890, as reported by the U.S. Census Bureau (*www.census.gov*). Except for the city of Oak Ridge, the land within 8 km (5 miles) of the ORR is semirural and is used primarily for residences, small farms, and cattle pasture. Fishing, boating, water skiing, and swimming are popular recreational activities in the area.

1.3 CLIMATE

The climate of the region may be broadly classified as humid continental. The Cumberland Mountains to the northwest help to shield the region from cold air masses that frequently penetrate far south over the plains and prairies in the central United States during the winter months.

During the summer, tropical air masses from the south provide warm and humid conditions that often produce thunderstorms; however, anticyclonic circulation around high-pressure systems centered in the western Gulf of Mexico can bring dry air from the southwestern United States into the region, leading to occasional periods of drought.

1.3.1 Temperature

The mean annual temperature for the Oak Ridge area is 14.7°C (57.7°F) (NOAA 1999). The coldest month is usually January, with temperatures averaging about 2.9°C (37.2°F) but once dipping as low as –31°C (–24°F). July is typically the hottest month of the year, with temperatures averaging 25.4°C (77.2°F) but occasionally peaking at over 37.8°C (100°F). In the course of a year, the difference between maximum and minimum daily temperatures averages 12.5°C (22.5°F). The 2000 average temperature as measured at the meteorological towers on the ORR was 14.2°C (57.5°F).

1.3.2 Winds

Winds in the Oak Ridge area are controlled in large part by the valley-and-ridge topography. Prevailing winds are either up-valley (northeasterly) daytime winds or down-valley (southwesterly) nighttime winds. Wind speeds are less than 11.9 km/hour (7.4 mph) 75% of the time; tornadoes and winds exceeding 30 km/hour (18.5 mph) are rare. The average wind speeds at 10 meters at the ORR meteorological towers was 3.6 mph. Air stagnation is relatively common in eastern Tennessee (about twice that of western Tennessee).

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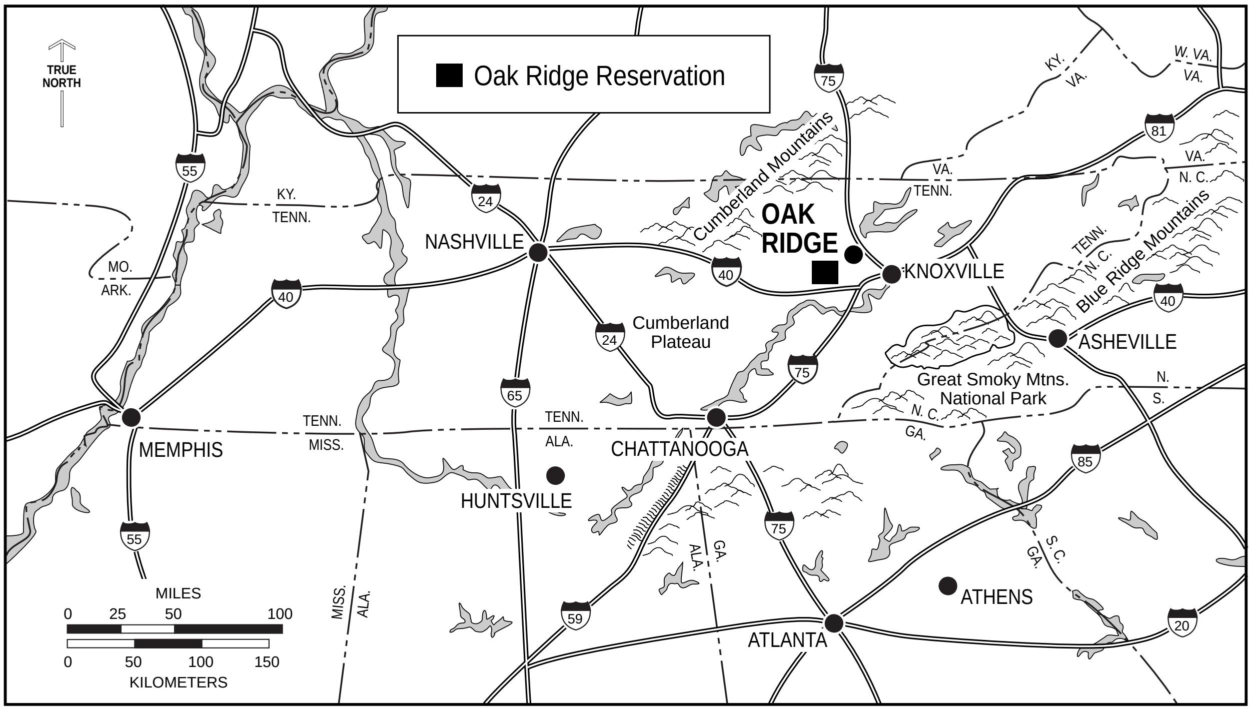

Fig. 1.1. Location of the city of Oak Ridge.

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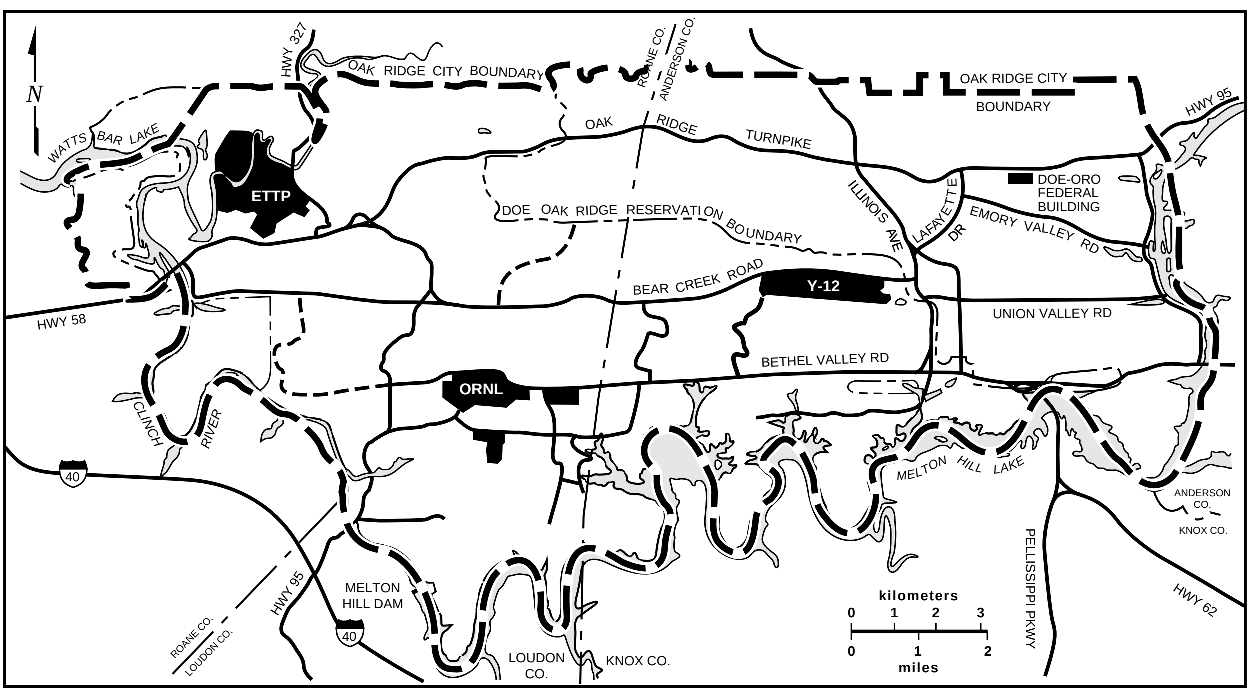

Fig. 1.2. The Oak Ridge Reservation.

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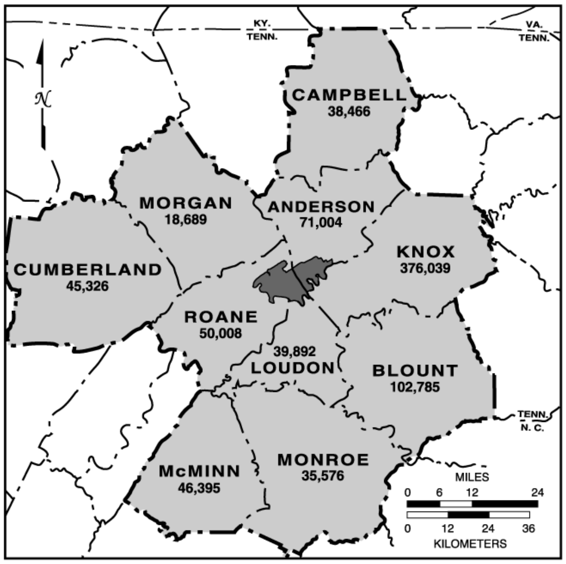

Fig. 1.3. The ten-county region surrounding the Oak Ridge Reservation. (*Source:* http://www.census.gov/populations/estimates/county/co-98-1/98c1-47.txt.)

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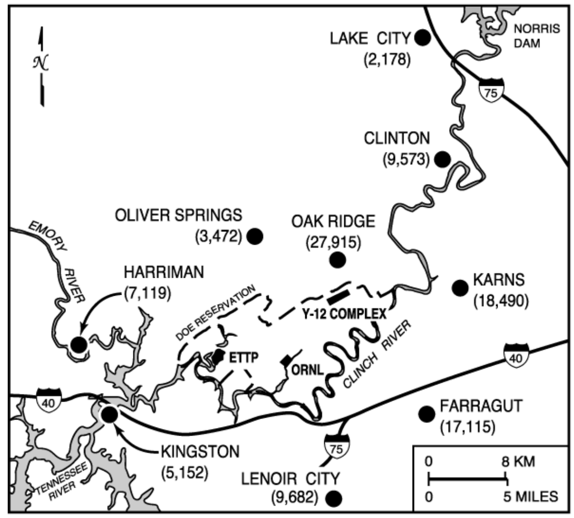

Fig. 1.4. Locations and populations of towns nearest to the Oak Ridge Reservation. (UTCBER 2000).

An average of about two multiple-day air stagna tion episodes occurs annually in eastern Tennessee, to cover an average of about 8 days per year. August, September, and October are the most likely months for air stagnation episodes.

1.3.3 Precipitation

The 30-year annual average precipitation is 137.4 cm (54.1 in.), including about 24.4 cm (9.6 in.) of snowfall (NOAA 1999). Average rainfall on the ORR in 2000 as measured at the meteorological towers was 135.3 cm (53.3 in.). Precipitation in the region is greatest in the winter months (December through February). Precipitation in the spring exceeds the summer rainfall, but the summer rainfall may be locally heavy because of thunderstorm activity. The driest periods generally occur during the fall months when high-pressure systems are most frequent.

1.3.4 Evapotranspiration

Regionally, annual evapotranspiration has been estimated to range from 81 to 89 cm (32 to 35 in.), or 60 to 65% of rainfall (Farnsworth et al. 1982). Evapotranspiration in the Oak Ridge area is 74 to 76 cm (29 to 30 in.), or 55 to 56% of annual precipitation (TVA 1972, Moore 1988, and Hatcher et al. 1989). Evapotranspiration is greatest in association with the growing season, which in the vicinity of the ORR is 220 days, from mid-March through mid-October. During this period, evapotranspiration often exceeds the rate of precipitation, resulting in soil moisture deficits.

1.3.5 Physiography

The ORR lies within the Valley and Ridge Physiographic Province. The Valley and Ridge Physiographic Province has developed on thick, folded beds of sedimentary rock deposited during the Paleozoic era. The long axes of the folded beds control the shapes and orientations of a series of long, narrow parallel ridges and intervening valleys. The differing degrees of resistance to erosion of the shales, sandstones, and carbonate rocks comprising the lithology determine local relief.

1.4 SURFACE WATER SETTING

Waters drained from the ORR eventually reach the Tennessee River via the Clinch River, which forms the southern and western boundaries of the ORR (Fig. 1.2). The ORR lies within the Valley and Ridge Physiographic Province, which is composed of a series of drainage basins or troughs containing many small streams feeding the Clinch River. Surface water at each of the major facilities of the ORR drains into a tributary or series of tributaries, streams, or creeks within different watersheds. Each of these watersheds drains into the Clinch River.

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

East Fork Poplar Creek (EFPC), which discharges into Poplar Creek east of the ETTP, originates within the Y-12 National Security Complex (Y-12 Complex) near the former S-3 Ponds and flows northeast along the south side of the Y-12 Complex. Various Y-12 Complex wastewater discharges to the upper reaches of EFPC from the late 1940s to the early 1980s left a legacy of contamination [e.g., mercury, polychlorinated biphenyls (PCBs), uranium] that has been the subject of water quality improvement initiatives over the past 10 to 15 years. Bear Creek also originates within the Y-12 Complex with headwaters near the former S-3 Ponds, where the creek flows southwest. Bear Creek is mostly affected by stormwater runoff, groundwater infiltration, and tributaries that drain former waste disposal sites in the Bear Creek Valley Burial Grounds Waste-Management Area.

Both the Bethel Valley and Melton Valley portions of Oak Ridge National Laboratory (ORNL) are in the White Oak Creek (WOC) drainage basin, which has an area of 16.5 square kilometers (6.37 square miles). WOC headwaters originate on Chestnut Ridge north of ORNL. At the ORNL site, the creek flows east along the southern boundary of the developed area, then flows southwesterly through a gap in Haw Ridge to the western portion of Melton Valley, where it collects the flow from Melton Branch. The waters of WOC enter White Oak Lake, which is an impoundment formed by White Oak Dam. Water flowing over White Oak Dam enters the Clinch River after passing through the WOC embayment area.

1.4.1 Surface Water Monitoring

Surface water is monitored at each of the sites as well as elsewhere on the ORR. Program details and results are given in the facility-specific chapters: Sect. 7.4 for the ORR, Sect. 4.4 for the ETTP, Sect. 5.8 for ORNL and Sect 6.5 for the Y-12 Complex.

1.5 GEOLOGICAL SETTING

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

Two geologic units on the ORR, designated as the Knox Group and the Maynardville Limestone of the Conasauga Group, both consisting of dolostone and limestone, constitute the Knox Aquifer. A combination of fractures and solution conduits in this aquifer control flow over substantial areas, and relatively large quantities of water may move relatively long distances. Active groundwater flow can occur at substantial depths in the Knox Aquifer [91.5 to 122 m (300 to 400 ft) deep]. The Knox Aquifer is the primary source of groundwater to many streams (base flow), and most large springs on the ORR receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits are reported to exceed 3784 L/min (1000 gal/min).

The remaining geologic units on the ORR (the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group) constitute the ORR Aquitards, which consist mainly of siltstone, shale, sandstone, and thinly bedded limestone of low to very low permeability (Fig. 1.5). Nearly all groundwater flow in the aquitards occurs through fractures. The typical yield of a well in the aquitards is less than 3.8 L/min (1 gal/min), and the base flows of streams draining areas underlain by the aquitards are poorly sustained because of such low flow rates.

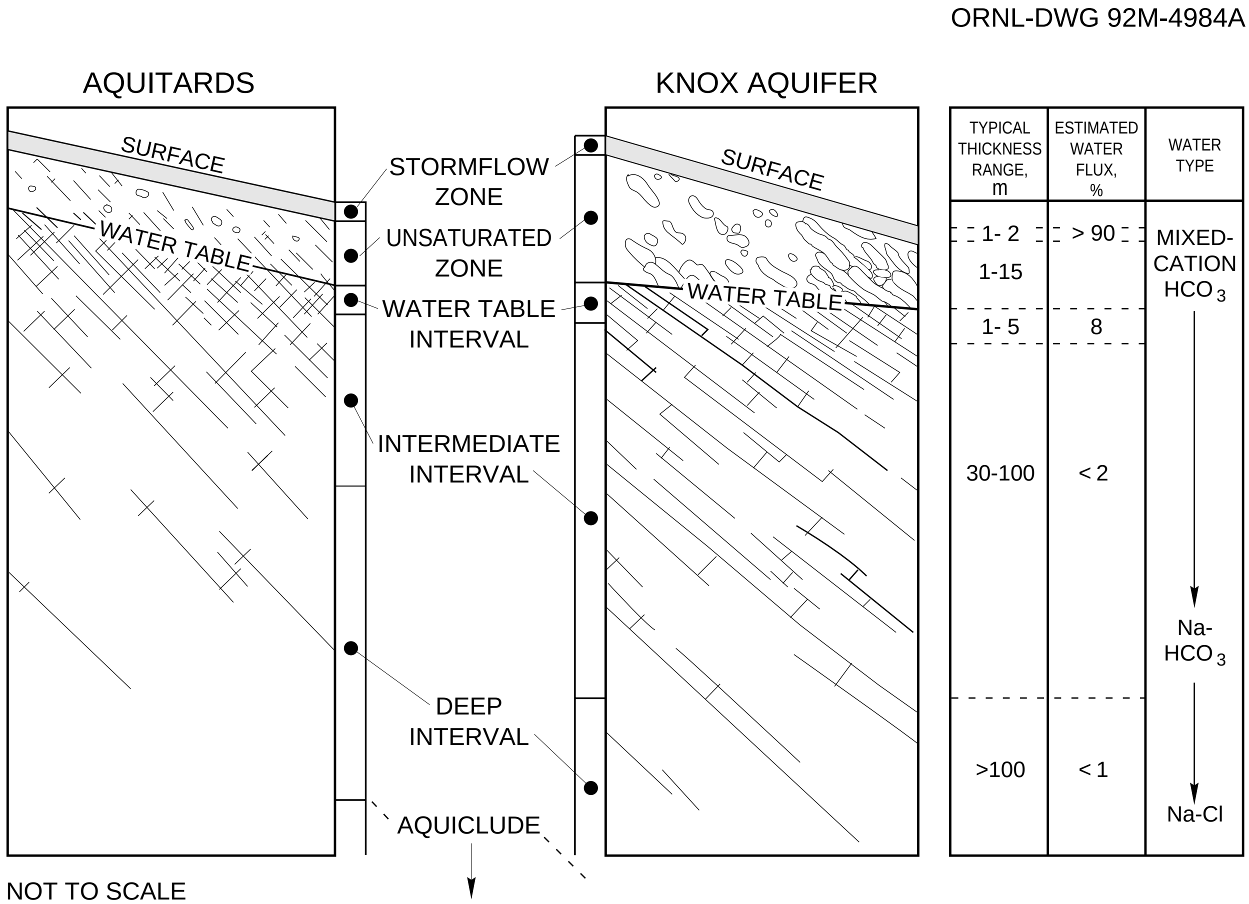

Fig. 1.5. Vertical relationships of flow zones of the ORR: estimated thicknesses, water flux, and water types.

1.5.1 Hydrogeological Setting

1.5.1.1 Groundwater Hydrology

When rain falls, a portion of the rainwater accumulates as groundwater by infiltrating into the subsurface. The accumulation of groundwater in pore spaces of sediments and bedrock creates sources of usable water; the water flows in response to external forces. Groundwater eventually reappears at the surface in springs, swamps, stream and river beds, and pumped wells. Thus, groundwater is a reservoir for which the primary input is recharge from infiltrating rainwater and whose output is discharge to springs, swamps, rivers, streams, and wells.

Groundwater hydrology at its simplest is a fairly technical subject requiring the use of some technical language for adequate explanations of groundwater distribution and movement. Since groundwater distribution and movement on the ORR is quite complex and is a key component of the pollution potential of the ORR, it is considered important to discuss here some of the technical essentials necessary for understanding the role of groundwater in the overall existence and movement of contaminants on the reservation. Appendix B contains a glossary of technical terms that may be useful for clarifying some of the language used in this section.

Groundwater on the ORR occurs both in the unsaturated zone as transient, shallow subsurface stormflow and within the deeper saturated zone. An unsaturated zone of variable thickness separates the stormflow zone and water table. Adjacent to surface water features or in valley floors, the water table is found at shallow depths, and the unsaturated zone is thin. Along the ridge tops or near other high topographic areas, the unsaturated zone is thick, and the water table often lies at considerable depth [15 to 50 m (50 to 175 ft) deep]. In low-lying areas where the water table occurs near the surface, the stormflow zone and saturated zone are indistinguishable.

As noted earlier, two broad hydrologic units are identified on the ORR: the Knox Aquifer and the ORR Aquitards, which consist of less permeable geologic units. Figure 1.6 is a generalized map showing surface distribution of the Knox Aquifer and the ORR Aquitards. Many waste areas on the ORR are located in areas underlain by the ORR Aquitards.

1.5.1.2 Unsaturated Zone Hydrology

In undisturbed, naturally vegetated areas on the ORR, about 90% of the infiltrating precipitation does not reach the water table but travels through the 1- to 2-m- (3- to 7-ft-) deep stormflow zone, which approximately corresponds to the root zone. Because of the permeability contrast between the stormflow zone and the underlying unsaturated zone, the stormflow zone partially or completely saturates during rainfall events, and then water flows laterally, following very short flow paths to adjacent streams. When the stormflow zone becomes completely saturated, flow of water over the land occurs. Between rainfall events, as the stormflow zone drains, flow rates decrease dramatically and water movement becomes nearly vertical toward the underlying water table.

The rate at which groundwater is transmitted through the stormflow zone is attributed to large pores (root channels, worm bores, and relict bedding planes and fractures). Stormflow is primarily a transport mechanism in undisturbed or vegetated areas, where it intersects shallow waste sources. Most buried wastes are below the stormflow zone; however, in some trenches a commonly observed condition known as “bathtubbing” can occur, in which the excavation fills with water and may overflow into the stormflow zone. All stormflow ultimately discharges to streams on the ORR.

1.5.1.3 Saturated Zone Hydrology

As shown in Fig. 1.5, the saturated zone on the ORR can be divided conceptually into four flow zones in a vertical cross section: an uppermost water table interval, an intermediate zone, a deep zone, and an aquiclude. The presence and thickness of any zone may vary across the ORR.

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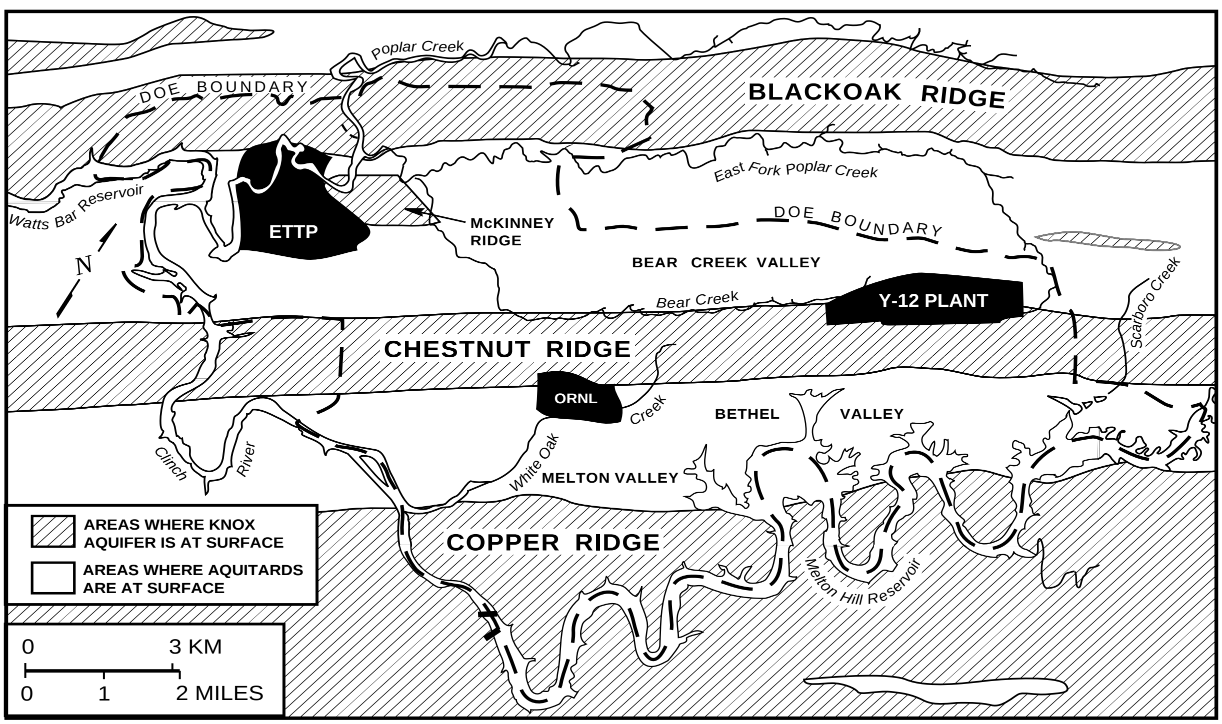

Fig. 1.6. The Knox Aquifer and the aquitards on the Oak Ridge Reservation.

Available evidence indicates that most water in the saturated zone in the aquitards is transmitted through a 1- to 6-m- (3- to 20-ft-) thick layer of closely spaced, well-connected fractures near the water table (the water table interval) as shown in Fig. 1.7.

As in the stormflow zone, the bulk of groundwater in the saturated zone resides within the pore spaces of the rock matrix. The rock matrix typically forms blocks that are bounded by fractures. Contaminants migrating from sources by way of the fractures typically occur in higher concentrations than in the matrix; thus, the contaminants tend to move (diffuse) into the matrix. This process, termed diffusive exchange or matrix diffusion, between water in matrix pores and water in adjacent fractures reduces the overall contaminant migration rates relative to groundwater flow velocities. For example, the leading edge of a geochemically nonreactive contaminant mass such as tritium (^3H) may migrate along fractures at a typical rate of 1 m/day (3 ft/day); however, the center of mass of a contaminant plume typically migrates at a rate less than 0.66 m/day (2 ft/day).

In the aquitards, chemical characteristics of groundwater change from a mixed-cation-HCO_3 water type at shallow depth to a Na-HCO_3 water type at deeper levels [30.5 m (about 100 ft)]. This transition, not marked by a distinct change in rock properties, serves as a useful marker and can be used to distinguish the more active water table and intermediate groundwater intervals from the sluggish flow of the deep interval. There is no evidence of similar change with depth in the chemical characteristics of water in the Knox Aquifer; virtually all wells are within the monitoring regime of Ca-Mg-HCO_3 type water. Although the mechanism responsible for this change in water types is not quantified, it most likely is related to the amount of time the water is in contact with a specific type of rock.

Most groundwater flow in the saturated zone occurs within the water table interval. Most flow is through weathered, permeable fractures and matrix rock and within solution conduits in the Knox Aquifer. The range of seasonal fluctuations of water table depth and rates of groundwater flow vary significantly across the reservation. In areas underlain by the Knox Aquifer, seasonal fluctuations in water levels average 5.3 m (17 ft), and mean discharge from the active groundwater zone

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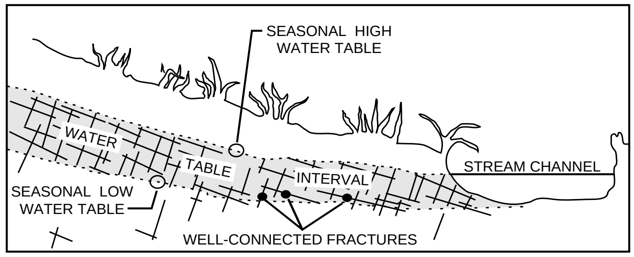

Fig. 1.7. Water table interval.

is typically 322 L/min (85 gal/min) per square mile. In the aquitards of Bear Creek Valley (BCV), Melton Valley, East Fork Valley, and Bethel Valley, seasonal fluctuations in water levels average 1.5 m (5 ft), and typical mean discharge is 98 L/min (26 gal/min) per square mile.

In the intermediate interval, groundwater flow paths are a product of fracture density and orientation. In this interval, groundwater movement occurs primarily in permeable fractures that are poorly connected. In the Knox Aquifer, a few cavity systems and fractures control groundwater movement in this zone, but in the aquitards, the bulk of flow is through fractures, along which permeability may be increased by weathering.

The deep interval of the saturated zone is delineated by a change to a Na-Cl water type. Hydrologically active fractures in the deep interval are significantly fewer in number and shorter in length than in the other intervals, and the spacing is greater. Wells finished in the deep interval of the ORR aquitards typically yield less than 1.1 L/min (0.3 gal/min) and thus are barely adequate for water supply.

In the aquitards, saline water characterized by total dissolved solids ranging up to 275,000 mg/L and chlorides generally in excess of 50,000 mg/L (ranging up to 163,000 mg/L) lies beneath the deep interval of the groundwater zone, delineating an aquiclude. Chemically, this water resembles brines typical of major sedimentary basins, which originated from an evaporating water body. The brines are thought to have been pushed westward and trapped by overthrusting rock during the formation of the Appalachian Mountains (approximately 250 million years ago). The chemistry suggests extremely long residence times (i.e., very low flow rates); however, some mixing with shallow groundwater has been observed (Nativ et al. 1997).

The aquiclude has been encountered at depths of 122 and 244 m (400 and 800 ft) in Melton and Bethel Valleys, respectively (near ORNL), and it is believed to approach 305 m (1000 ft) in portions of BCV (near the Y-12 Complex) underlain by aquitard formations. Depth to the aquiclude in areas of the Knox Aquifer is not known but is believed to be greater than 366 m (1200 ft); depth to the aquiclude has not been established in the vicinity of the ETTP.

1.5.2 Groundwater Flow

Many factors influence groundwater flow on the ORR. Topography, surface cover, geologic structure, and rock type exhibit especially strong influences on the hydrogeology. Variations in these features result in variations of the total amount of groundwater moving through the system (flux). (Average flux ratios for the aquitards and the Knox Aquifer formations are shown in Fig. 1.5.) As an example, the overall decrease in open fracture density with depth results in a decreased groundwater flux with depth.

Topographic relief on the ORR is such that most active subsurface groundwater flow occurs at shallow depths. U.S. Geological Survey modeling (Tucci 1992) suggests that 95% of all groundwater flow occurs in the upper 15 to 30 m (50 to 100 ft) of the saturated zone in the aquitards. As a result, flow paths in the active-flow zones (particularly in the aquitards) are relatively short, and nearly all groundwater discharges to local surface water drainages on the ORR. Conversely, in the Knox Aquifer it is believed that solution conduit flow paths may be considerably longer, perhaps as much as 1.6 km (1 mile) long in the along-strike direction. No evidence at this time substantiates the existence of any deep, regional flow off the ORR or between basins within the ORR in either the Knox Aquifer or the aquitards. Data collected in the calendar years (CYs) 1994 and 1995, however, have demonstrated that groundwater flow and contaminant transport occur off the ORR in the intermediate interval of the Knox Aquifer, near the east end of the Y-12 Complex.

Migration rates of contaminants transported in groundwater are strongly influenced by natural chemical and physical processes in the subsurface (including diffusion and adsorption). Peak concentrations of solutes, including contaminants such as tritium moving from a waste area, for instance, can be delayed for several to many decades in the aquitards, even along flow paths as short as a few hundred feet. The processes that naturally retard contaminant migration and store contaminants in the subsurface are less effective in the Knox Aquifer than in the aquitards because rapid flow along solution features allows minimal time for diffusion to occur.

1.5.3 Groundwater Monitoring Considerations

The groundwater monitoring programs at the ORR were designed to gather information to determine the effects of DOE operations on groundwater quality. However, because of the complexity of the hydrogeologic framework on the ORR, groundwater flow and, therefore, contaminant transport are difficult to predict on a local scale. Consequently, individual plume delineation is not always feasible on the ORR. Stormflow and most groundwater discharge to ORR surface water drainages. For that reason, monitoring springs, seeps, and surface water quality is one of the best ways to assess the extent to which groundwater from a large portion of the ORR transports contaminants; however, contaminant transport may occur at depth as well [e.g., the center of mass of the contaminant plume east of the Y-12 Complex lies at a depth of 91.5 m (300 ft)].

1.5.3.1 Groundwater Monitoring Programs on the ORR

Groundwater monitoring programs at each of the major ORR facilities are discussed in the facility-specific chapters: Sect. 4.11 for the ETTP, Sect. 5.9 for ORNL, and Sect. 6.10 for the Y-12 Complex. The Water Resources Restoration Program (WRRP), successor to the Integrated Water Quality Program (IWQP) (Sect. 3.11), has been established to track and prioritize Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) monitoring across the ORR.

1.6 DESCRIPTION OF SITE FACILITIES AND OPERATIONS

The facilities on the ORR began operating in 1942 as part of the Manhattan Project, producing components for the first nuclear weapons. The ORR remains government-owned, although the nature of the work at the facility has changed. The primary missions of the three sites have evolved during the past 58 years and continue to adapt to meet the changing defense, energy, and research needs of the United States. The reservation contains three major DOE installations: the Y-12 Complex, ORNL, and the ETTP.

These are the primary DOE activities conducted outside of the three installation sites:

- American Museum of Science and Energy;
- Atmospheric Turbulence and Diffusion Division—National Oceanic and Atmospheric Administration (ATDD-NOAA) Facility;
- Building 2714;
- Central Training Facility;
- checking stations (gatehouses);
- Clark Center Recreation Park;
- Federal Office Building;
- George Jones Memorial Baptist Church;
- National Transportation Research Center (NTRC),
- Office of Scientific and Technical Information (OSTI);
- Parcel ED-1;
- Parcel ED-2;
- Transportation Safeguards Division Firing Range;
- Transportation Safeguards Maintenance Facility;
- 55 Jefferson; and
- Union Valley Sample Preparation Facility.

In 1975, the American Museum of Science and Energy was moved from its original facility (55–59 Jefferson Circle) to a 17-acre site contiguous to the Oak Ridge Associated Universities (ORAU) campus, on South Tulane Avenue in Oak Ridge. The masonry structure contains about 55,400 ft^2 (33,932 for exhibition space and 21,468 ft^2 for offices and related space). This facility contains the energy house, which is licensed to the city of Oak Ridge for use by the Convention and Visitors' Bureau. The building is considered adequate for its current use. The museum also has warehouse space in OSTI's Building 1916T-2 complex. The museum is managed by ORNL.

The ATDD-NOAA Facility is composed of a wood-frame building built in the 1940s and several smaller buildings at 456 South Illinois Avenue in Oak Ridge. ATDD conducts meteorological and atmospheric diffusion research that is jointly supported by DOE and NOAA. It also provides services to other DOE contractors and operates the Weather Instrument Telemetering Monitoring System for DOE.

Building 2714 is a DOE-owned facility that DOE shares with Oak Ridge Institute of Science and Education (ORISE) (referred to as the "Laboratory Road Facility"). The facility comprises approximately 18,000 ft^2 and is located in Oak Ridge immediately south of the Federal Office Building.

The Central Training Facility is used primarily by security forces and consists of a small office building, an indoor firing range, a classroom/storage trailer, another storage trailer, onsite parking, fitness facilities (an outdoor track), and numerous outdoor firing ranges. The site, including a buffer area, is south of Bear Creek Road, less than 1 mile southeast of ETTP, and currently consists of about 150 acres.

Checking stations (gatehouses) are historic structures located on Oak Ridge Turnpike (Turnpike Checking Station), Scarboro Road (Midway Checking Station, also known as Bear Creek Road Checking Station), and Bethel Valley Road (Bethel Valley Road Checking Station, a small building south of Bethel Valley Road). DOE manages these historic facilities.

Clark Center Recreation Park is an 80-acre public park. It consists of a building containing offices and rest rooms, three shelters, a boat ramp, improved parking areas, two softball fields, an unguarded swimming area, and a paved access road. The park is currently operated by the Corporate and Community Affairs Office of the Recreation Department.

The Federal Office Building is owned by the General Services Administration and is maintained by DOE. DOE Oak Ridge Operations Office (DOE-ORO) offices occupy the vast majority of space in the building, which consists of 113,000 ft^2 and is located in Oak Ridge.

George Jones Memorial Baptist Church, located within the ETTP, predates World War II and is included in the *National Register of Historic Places*.

The NTRC is a collaborative effort among DOE, ORNL, the University of Tennessee (UT), and the Development Corporation of Knox County, located on a 6-acre site in the Pellissippi Corporate Center and leased to ORNL and UT separately by Pellissippi Investors LLC.

OSTI is located in two masonry buildings constructed as warehouses in the 1940s: Buildings 1916T-1 and 1916T-2. Building 1916T-1 houses the main OSTI functions as well as other occupants. Portions of this building were converted to office space in the 1950s, and additional bays were added in the 1950s and 1960s. Currently, the building has one office bay and seven other bays for a total space of 135,000 ft^2. Building 1916T-2 houses OSTI's subcontractor in charge of distribution and storage. The two OSTI buildings are located on a 7-acre tract that parallels the Oak Ridge Turnpike about 2 miles east of the Federal Office Building. Because of their age and configuration, they are classified as Class B buildings (i.e., semipermanent buildings, constructed primarily of wood, which may need to be renewed, renovated, or rehabilitated in the near future) but are deemed adequate for current functions.

Parcel ED-1 comprises 957 acres leased to the Community Reuse Organization of East Tennessee (CROET) (effective April 28, 1998). CROET is authorized to lease facilities from DOE and to sublease to the private sector for purposes of economic development. The lease is for a period of 10 years and contains an option for an additional 30-year period. CROET is responsible for the protection and maintenance of all portions of the property at all times and reports directly to DOE.

Parcel ED-2 consists of a barge facility and an adjacent 15-acre area located in the K-700 area west of the main ETTP site. ED-2 and the barge facility have already been leased to CROET, which intends to offer the barge facility to the business community on a fee basis. Present CROET plans are to develop the facility, in conjunction with adjacent rail service and interstate corridor, as a mini-port authority. The balance of ED-2, also leased to CROET, includes two subleased portions and another portion proposed for use as a laydown area supporting the barge facility.

The Transportation Safeguards Division Firing Range is located to the east of the Central Training Facility and is operated by the DOE Albuquerque Operations Office (DOE-ALO).

The surface danger zones for the Central Training Facility and the Transportation Safeguards Division Firing Range overlap and together comprise about 2,500 acres.

The Transportation Safeguards Maintenance Facility is the former Stone & Webster (OS-3) warehouse, located about 1 mile east of ETTP, on the south side of State Route 58 (Oak Ridge Turnpike), near the intersection with Blair Road. The building is situated on a 20-acre site and has undergone major modifications, including the addition of security fencing, paved parking, and paved access around the building. Additional expansions include a target range with a safety buffer zone, a fitness facility, and the eventual relocation of office facilities from the Y-12 Complex. The total site area constitutes about 100 acres. The maintenance facility is operated and maintained by the Y-12 Complex's Facilities Management Organization and is funded by DOE-ALO.

The facility at 55 Jefferson is a DOE-owned facility comprising approximately 46,000 ft^2 on a 3-acre site located on Jefferson Circle along the Oak Ridge Turnpike in Oak Ridge. The primary facility use is DOE Environmental Management (DOE-EM). The building is a temporary wood-frame structure constructed in the 1940s.

The Union Valley Sample Preparation Facility is located on Union Valley Road. This facility houses laboratories that provide sample analysis for the three sites.

The Water Intake Station, located at Solway Bend, was transferred to the city of Oak Ridge on April 1, 2000.

The Water Treatment Plant, located on Pine Ridge just north of the Y-12 Complex, can process an estimated 28 Mgd. The sanitary (treated) water is stored in four reservoirs that have a combined capacity of 10 million gal. From the reservoirs, water is supplied by gravity flow to the Y-12 Complex, ORNL, the ORISE Scarboro Operations Site, and the city of Oak Ridge. The water treatment plant was transferred from DOE to the city of Oak Ridge on April 1, 2000.

1.6.1 Y-12 Complex

Until 1992, the primary mission of the Y-12 Complex (Fig. 1.8) was the production and fabrication of nuclear weapon components. Activities associated with these functions included production of lithium compounds, recovery of enriched uranium from scrap material, and fabrication of uranium and other materials into finished parts. Fabrication operations included vacuum casting, arc melting, powder compaction, rolling, forming, heat treating, machining, inspecting, and testing.

Current assignments in the Y-12 Complex Defense Programs include dismantling nuclear weapon components returned from the national arsenal, serving as the nation's storehouse of special nuclear materials, and providing special production support to DOE programs. Another mission of long standing is the support of other federal agencies through the Work for Others Program. In addition, the technology transfer mission has as its goal applying its unique expertise, initially developed for highly specialized military purposes, to a wide range of manufacturing problems to support the capabilities of the U.S. industrial base. The all-inclusive expertise at the Y-12 Complex includes proceeding from concept, through detailed design and specification, to building prototypes and configuring integrated manufacturing processes. For more information, visit the Y-12 Complex home page on the World Wide Web (http://www.y12.doe.gov/bwxt/y12.html).

The Oak Ridge Centers for Manufacturing Technology (ORCMT), located on the Y-12 Complex, apply skills, capabilities, and facilities developed during the 58-year history of the Oak Ridge complex to a variety of peacetime missions. Major programs at the Y-12 Complex include metrology (measurement science), machine tool technology, technology applications, manufactur-

Y-12 PHOTO 306208

Fig. 1.8. The Y-12 National Security Complex.

ing operations, and gear and thread technology. More than 15 centers are solving manufacturing problems and deploying technology. Oak Ridge has already helped nearly 4,000 companies from 49 of the 50 states solve manufacturing problems, resulting in millions of dollars of savings and growth to industry.

Manufacturers nationwide can access information and services at the Y-12 Complex through a toll-free telephone service (1-800-356-4USA) that is a direct link to scientists, engineers, and other technical experts in the full range of manufacturing technologies. For more information on ORCMT, visit the Web site at http://www.y12.doe.gov/bwxt/y12/y12-orcmt.html.

1.6.2 East Tennessee Technology Park

The ETTP was built as the home of the Oak Ridge Gaseous Diffusion Plant (ORGDP) (Fig. 1.9). Construction of ORGDP began in the 1940s as part of the U.S. Army's Manhattan Project. The plant's mission was production of highly enriched uranium for nuclear weapons.

Enrichment was initially carried out in two process buildings, K-25 and K-27. Later, the K-29, K-31, and K-33 buildings were built to increase the production capacity of the original facilities by raising the assay of the feed material entering K-27. After military production of highly enriched uranium was concluded in 1964, the two original process buildings were shut down. For the next 20 years, the plant's primary missions were production of only slightly enriched uranium to be fabricated into fuel elements for nuclear reactors and the recycling of fuel elements from nuclear reactors. Other missions during the latter part of this 20-year period included development and testing of the gas centrifuge method of uranium enrichment and the research and development (R&D) of laser isotope separation.

By 1985, demand for enriched uranium had declined, and the gaseous diffusion cascades at ORGDP were placed in standby mode. That same year, the gas centrifuge program was canceled. The decision to permanently shut down the diffusion cascades was announced in late 1987, and actions necessary to implement that decision were initiated soon thereafter. Because of the termination of the original and primary missions, ORGDP

DOE ORO 89-1063

Fig. 1.9. The East Tennessee Technology Park.

was renamed the Oak Ridge K-25 Site in 1990. In 1997, the K-25 Site was renamed the East Tennessee Technology Park (ETTP).

CROET leases portions of ETTP, and then subleases these federally owned properties to business and industry. The ETTP mission is to reindustrialize and reuse site assets through leasing of vacated facilities and incorporation of commercial industrial organizations as partners in the ongoing environmental restoration (ER), decontamination and decommissioning (D&D), waste treatment and disposal, and diffusion technology development activities.

1.6.3 Oak Ridge National Laboratory

ORNL was the smallest of three facilities built in 1942 and 1943 on the newly acquired 58,575-acre federal reservation (now 34,424 acres) in Oak Ridge, Tennessee (Fig. 1.10). From its modest beginning as a wartime pilot plant, ORNL has grown to become one of the world's premier scientific research centers and DOE's largest and most diversified multiprogram national laboratory.

The management of ORNL includes the management and planning for ORNL facilities and for most of the ORR's undeveloped land area. This responsibility includes planning for approximately 18,000 acres of undeveloped and developed land. As a multiprogram national laboratory, ORNL carries out R&D in support of all four of DOE's major missions: science and technology, energy resources, environmental quality, and national security.

1.6.3.1 Oak Ridge National Environmental Research Park

The Oak Ridge National Environmental Research Park is an approximately 8,100-hectare (20,000-acre) "outdoor laboratory" with relatively undisturbed ecosystems (Fig. 1.11). The Research Park provides a protected, biologically diverse land area for environmental research and education. It represents the eastern deciduous forest, with more than 1,100 species of vascular plants, some of which are state-listed rare plants, and 315 wildlife species, some of which are state-listed or federally listed rare wildlife species (see Chap. 2, Tables 2.8 and 2.9 for listings). The park

DOE ORO 89-1216

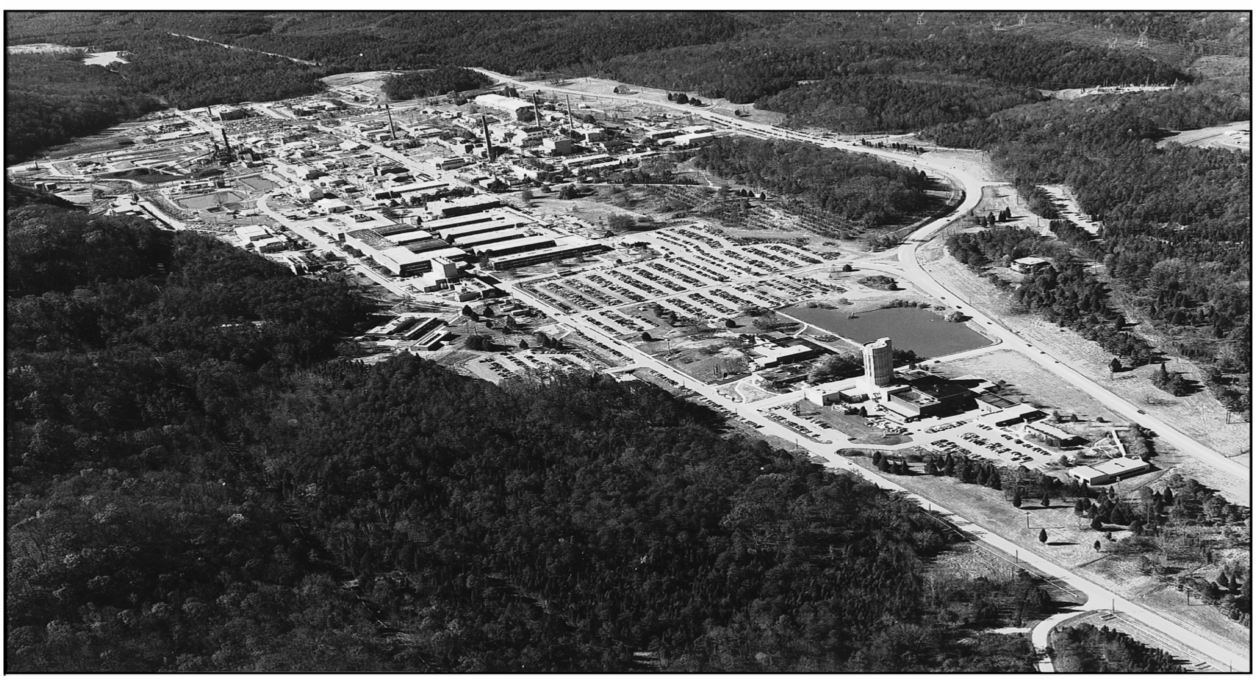

Fig. 1.10. The Oak Ridge National Laboratory.

ORNL 97-100684B/gss

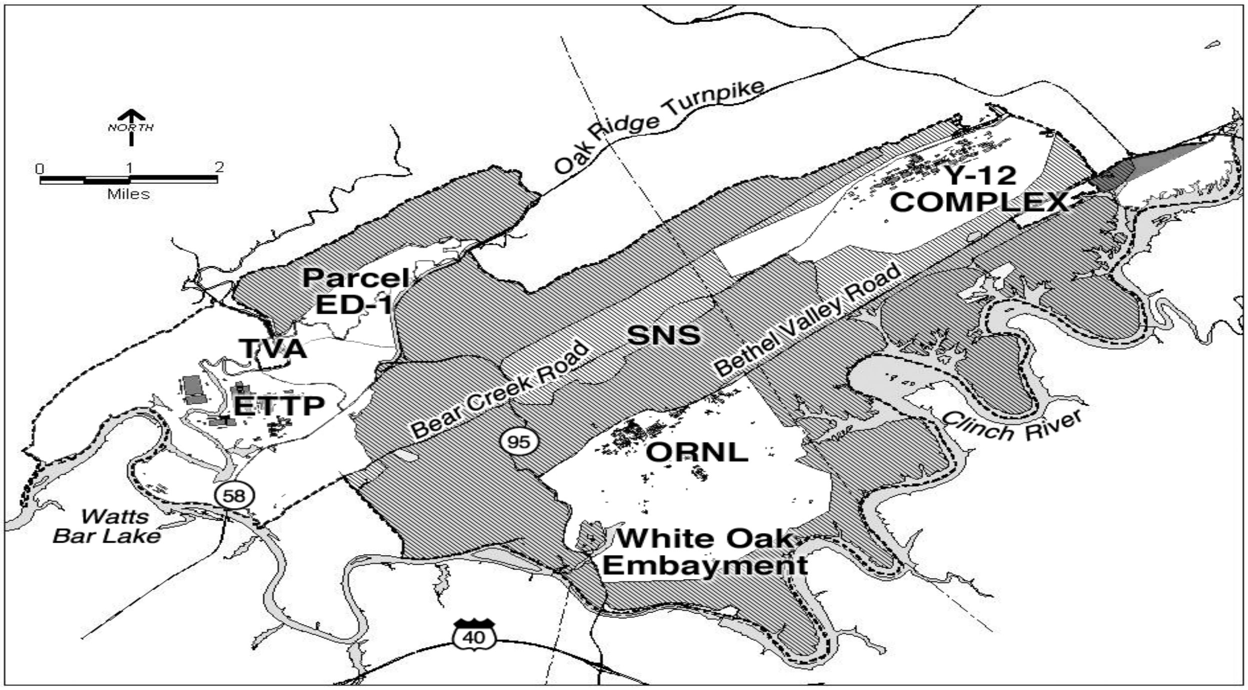

Fig. 1.11. The Oak Ridge National Environmental Research Park covers approximately 20,000 acres on the reservation.

is a biosphere reserve; an ORNL user facility; a site that contains seven registered State Natural Areas; an area that plays a significant role in the nesting and migration of breeding birds; and the location of two National Historic Landmarks, Freel's Cabin and the Graphite Reactor.

In June 1999, Secretary of Energy Richardson set aside 1,215 hectares (3,000 acres) of the ORR at Freels, Gallaher, and Solway bends as the "Three Bend Scenic and Wildlife Refuge" to be cooperatively managed by Tennessee Wildlife Resources Agency (TWRA) and DOE for preservation purposes.

The biological diversity of the Oak Ridge National Environmental Research Park serves as a foundation for ecological research into how the development and use of energy as well as other issues of national importance affect the environment. More than 700 individuals have performed research in the Oak Ridge National Environmental Research Park User Facility during the last 5 years. Users include students and faculty from more than 75 colleges and universities as well as participants from ORNL and other state and federal agencies. Field research facilities occur across the reservation and include Walker Branch Watershed, the Global Change Field Research Facility, Melton Branch Watershed, and the Bear Creek Valley Hydrology Field Sites.

The National Environmental Research Park has supported research in the following areas.

- **Ecosystems dynamics and biodiversity.** The large, unfragmented land provides a base for investigations into biogeochemical cycling, climate-change impacts, air quality, and biotechnology and offers opportunities for wildlife restoration.
- **Environmental characterization.** As the most hydrologically and geologically complex of all DOE sites, the Oak Ridge National Environmental Research Park provides opportunities for hydrogeologic and geophysical investigations, contaminant transport and fate studies, tracers for fractured media, microbial ecology, wetland surveys, and flora/fauna species/communities characterization.

1.6.3.2 Spallation Neutron Source

DOE prepared and issued a final environmental impact statement (FEIS) (SNS 1999a, 1999b, and 1999c) and a record of decision (ROD) to construct and operate the Spallation Neutron Source (SNS). This state-of-the-art, pulsed neutron facility is under construction on Chestnut Ridge at ORNL. A mitigation action plan was developed to document the goals and objectives by which the potential environmental impacts from construction and operation identified in the FEIS will be mitigated. An annual update on the progress toward implementing the identified mitigation actions will be provided until all actions are complete.

Potential adverse impacts of SNS construction and operations were identified for wetlands, protected species, cultural resources, transportation infrastructure, and research projects in the Walker Branch Watershed. Mitigation measures were identified for each of the potential subjects, and this update documents the status of the measures.

Construction of the SNS access roads affected wetlands. By evaluating routes, improving the Chestnut Ridge Road was selected as the action affecting the smallest area of wetlands. Construction affected 0.055 acres, and careful attention to erosion control and equipment movement limited impacts to other nearby wetland areas. The SNS developed a wetlands mitigation plan to compensate for the impacts to the 0.055 acres by restoring 0.138 acres (a mitigation ratio of 2.511) of wetlands located in the same watershed. The wetlands mitigation plan was accepted by the Tennessee Department of Environment and Conservation (TDEC) on June 29, 2000, and the 0.138 acres of wetlands were restored in August 2000. This mitigation action is complete, and the restored areas will be routinely monitored to ensure the survival rate of the indigenous shrubs and vegetation planted in the restored area.

No federally listed or proposed threatened or endangered species were identified in the site surveys of the SNS. However, construction and operation of the SNS could affect protected species that were not identified during the site surveys. Definitive surveys were conducted during three seasons (spring, summer, and fall) in 1999 to ensure that any protected species, including those that can be identified only during flowering, would be noted. No protected species were identified during these surveys, and this mitigation action is complete.

No prehistoric or historic sites listed on or eligible for inclusion on the *National Register of Historic Places* were identified on the SNS site. A survey of cultural resources was conducted for the access road rights-of-way, and no significant cultural resources were located or disturbed. This mitigation action is complete for the SNS roads and utility corridors. The TVA powerline upgrades associated with the SNS will be evaluated for cultural resources when TVA determines the appropriate route.

Increased traffic due to SNS construction and operation on local roads was evaluated by SNS. Traffic issues were also coordinated with other activities on the ORR. Improvements to Bethel Valley Road, including acceleration and deceleration lanes, marked turn lanes, lighting, and traffic signals have been identified to reduce the effects on traffic flow in the vicinity of the SNS. Improvements to the roads, including widening and lane marking, will be made in the spring of 2001. Traffic signals and lighting will be installed in 2001. This mitigation action is on schedule.

Emissions of water vapor and CO_2 during construction and operation of the SNS could impact the research activities at the Walker Branch Watershed, located approximately 0.75 miles (1.2 km) east of the SNS on Chestnut Ridge. The emissions would affect a small amount of the data collected at Walker Branch Watershed, and a committee was established in 1999 to evaluate the impacts of the SNS. The committee reviewed the impacts and potential mitigation measures, and determined that establishing a satellite monitoring location in an area not affected by SNS was the preferred solution. The satellite tower will be established before SNS operates to allow development of statistical correlations between the locations, thereby preserving the quality of the data. The location of the satellite tower was identified in FY 2001, and plans to develop the site are under way. Incorporating superconducting accelerator technology at SNS was evaluated in a supplement to the FEIS in 2000. The impacts of the technology on the Walker Branch Watershed were evaluated and were found to be not significant; the change to superconducting was determined to have no significant environmental impacts.

1.6.4 Oak Ridge Institute for Science and Education

ORISE is managed for DOE by ORAU, a nonprofit consortium of 86 colleges and universities. ORISE includes 94.3 hectares (233 acres) on the southeastern border of the ORR that from the late 1940s to the mid-1980s was part of an agricultural experiment station owned by the federal government and, until 1981, was operated by the University of Tennessee.

The ORISE Scarboro Operations Site (formerly the South Campus) lies immediately southeast of the intersection of Bethel Valley Road and Pumphouse Road. It houses offices, laboratories, and storage areas for ORISE's program offices and support departments, and the site is being developed for other productive uses.

For more information, visit the ORAU home page at http://www.orau.org and the ORISE home page at http://www.orau.gov/orise.htm.