Chapter 3
Affected Environment

3.0 AFFECTED ENVIRONMENT

In accordance with the Council on Environmental Quality's (CEQ) National Environmental Policy Act (NEPA) regulations (40 Code of Federal Regulations [CFR] Parts 1500 through 1508), this Versatile Test Reactor Environmental Impact Statement (VTR EIS) describes the resource areas that could be affected by the alternatives and options under consideration. The affected environment descriptions provide the context for understanding the environmental consequences described in Chapter 4 of this VTR EIS and serve as baselines from which any potential environmental impacts can be evaluated.

For this VTR EIS, each resource area that may be affected by the evaluated alternatives and options is described. The level of detail varies depending on the potential for impacts for each resource area. A number of site-specific and recent project-specific documents that are important sources of information for describing the existing environment are summarized and/or incorporated by reference in this chapter.

An important component in analyzing impacts is identifying or defining the region of influence (ROI) for each resource area. The ROIs are specific to the type of effect evaluated and encompass geographic areas within which potential impacts could be expected to occur. **Table 3–1** briefly describes the ROIs for each resource area evaluated in this VTR EIS. Definitions of the ROIs are further refined for each of the U.S. Department of Energy (DOE) sites included in the evaluations.

This chapter begins with descriptions of the affected environment for the Idaho National Laboratory (INL) in Section 3.1, followed by the Oak Ridge National Laboratory (ORNL) in Section 3.2, and the Savannah River Site (SRS) in Section 3.3.

Table 3–1. General Regions of Influence for Resource Areas

Resource Area	*Region of Influence*
Land Use and Aesthetics	INL, ORNL, and SRS and lands immediately adjacent, including county or counties where the site is located, neighboring communities, nearby tourist and recreation attractions, and other regional land uses that could be affected by the proposed action.
Geology and Soils	The boundaries of the INL, ORNL, and SRS.
Water Resources	INL, ORNL, and SRS surface waters where stormwater, industrial wastewater, or sanitary wastewater are discharged, including rivers, streams, tributaries, floodplains, swamps, lakes, ponds, bays, wetlands, and reservoirs; groundwater sources underlying the sites; and drinking water for the sites.
Air Quality	INL, ORNL, and SRS and nearby offsite areas within local air quality control regions and the transportation corridors that could be affected by air quality impacts from the proposed action.
Ecological Resources	INL, ORNL, and SRS and adjacent offsite areas where aquatic and terrestrial ecological communities exist, including non-sensitive and sensitive habitats and species that could be directly or indirectly affected by the proposed action.
Cultural and Paleontological Resources	INL, ORNL, and SRS and areas immediately adjacent to the sites where the proposed action would have the potential to affect cultural and paleontological resources
Infrastructure	INL, ORNL, and SRS power, fuel, and water supplies.
Noise	Proposed construction area at INL, ORNL, and SRS and 0.5-mile zone from the edge of the proposed construction areas.
Waste Management	INL, ORNL, and SRS waste treatment, storage, and disposal facilities.

Resource Area	Region of Influence
Human Health – Normal Operations	INL, ORNL, and SRS onsite project workers and the offsite public within 50 miles of the project location.
Human Health – Facility Accidents	INL, ORNL, and SRS noninvolved workers and the offsite public within 50 miles of the project location.
Traffic	INL, ORNL, and SRS onsite road systems, regional U.S. Interstate Highways, U.S. Highways, State Routes, major arterial roadways, and collector roads in the areas.
Socioeconomics	Counties where INL, ORNL, and SRS are located and surrounding counties
Environmental Justice	Minority and low-income populations within 50 miles of INL, ORNL, and SRS.

3.1 Idaho National Laboratory

3.1.1 Land Use and Aesthetics

The ROI for land use affected environment is composed of the INL Site and lands immediately adjacent, including portions of the five-county region where the INL Site is located. As the majority of the INL Site is located within Butte County, land use there, in neighboring communities, and nearby tourist and recreation attractions are generally described without a detailed account of specific land use in each respective area. Other regional land uses are described because they can be included in the ROI for other aspects of this affected environment. For example, areas potentially impacted by INL activities (e.g., Craters of the Moon National Monument and Preserve) are described as nearby land uses because these areas are considered in the ROI for aesthetics.

3.1.1.1 Land Use at Idaho National Laboratory

The INL Site is located on an 890-square mile parcel of land in the Eastern Snake River Plain (ESRP) in southeastern Idaho. The INL Site extends 39 miles from north to south and, at its broadest section, about 36 miles from east to west. INL's land holdings lie within five counties: Bingham, Bonneville, Butte, Clark, and Jefferson; however, the majority of the INL Site is located in Butte County. The INL Site is 45 miles northwest of the Fort Hall Indian Reservation, 132 miles southwest of Yellowstone National Park, 198 miles east of Boise, Idaho, and 234 miles north of Salt Lake City, Utah. The eastern boundary of the INL Site is 24 miles west of Idaho Falls, Idaho. INL also maintains a number of buildings within the city of Idaho Falls.

Congress authorized the Department of the Interior to "withdraw" public land to meet the needs of Federal agencies, such as DOE, using public land orders. The present-day boundary of the INL Site was created through several land transfers and land withdrawals beginning in the 1940s, resulting in the withdrawal of about 506,000 acres. INL lands were withdrawn from the public domain by way of Public Land Orders No. 318, 545, 637, and 1770. These public land orders have no specific time limitations. As such, DOE retains the authority to administer INL lands for the foreseeable future and is responsible for ensuring that future use and management of these lands are undertaken in accordance with these Public Land Orders. In addition to this federally withdrawn land, several parcels of land owned by the State of Idaho (21,308 acres) and private owners (43,275 acres) were transferred to the ownership of DOE's predecessor agencies from the 1940s to the 1960s. These transfers resulted in the completion of the intact land area of the current INL boundary (INL 2015c).

Approximately 94 percent of INL remains open and undeveloped. Pastures, foothills, and farmlands border much of the INL Site, with agricultural activity concentrated in areas to the northeast. The Bitterroot, Lemhi, and Lost River mountain ranges border the INL Site to the north and west; volcanic buttes and open plains are located near the southern boundary of the INL Site (INL 2017b). These surrounding mountain ranges are used for recreational activities and for livestock grazing; mining occurred in these mountains in the past, and the Bureau of Land Management (BLM) manages subsurface mineral rights on INL. At the INL Site, the Department of the Interior administers public land owned by the Federal government. As such, BLM has certain administrative responsibilities, including managing livestock grazing permits, granting utility rights-of-way across the land, and extracting materials (INL 2015c). INL's Fire Department provides wildland fire suppression services on the rangeland within the INL Site, as well as for a 1-mile perimeter outside the INL Site boundary (INL 2011b). Cooperative emergency policies and procedures have been established through agreements with Federal, State, local and Tribal agencies. The INL Emergency Plan/RCRA Contingency Plan defines agreements and communications links between the organizations in the event of emergencies (INL 2017e). Predator control at the INL Site is managed by the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service in coordination with other agencies. INL controls weeds and insects according to its Sitewide Noxious Weed Management Plan (INL 2013).

At the INL Site about 11,400 acres of the total land area has been developed at eight primary facility areas associated with energy research and waste management activities, which is surrounded by an about 45,000-acre security and safety buffer area. The developed area and buffer are located within an about 230,000-acre central core area of the INL Site. Another 34,000 acres at the INL Site have been developed for utility rights-of-way and public roads (DOE 2016k).

In 1975 the INL Site was designated a National Environmental Research Park (NERP) and is currently one of only seven in the United States. NERPs, which are situated on DOE land holdings, provide opportunities for researchers to study the compatibility of the environment with energy technology development. This designation opens the site to scientists from other government agencies, universities, and private foundations for use as a protected outdoor laboratory where long-term projects can be set up to answer questions about man's impact on the natural environment (SREL 2019).

In July 1999, the Secretary of Energy and representatives of the U.S. Fish and Wildlife Service (USFWS), BLM, and Idaho Department of Fish and Game designated a portion of the INL Site (then called the Idaho National Engineering and Environmental Laboratory) as a Sagebrush-Steppe Ecosystem Reserve. The reserve, located on 73,260 acres in the northwestern corner of the INL Site, was established to ensure this critically endangered ecosystem receives special consideration (DOE 2016k). A management plan for the INL Sagebrush-Steppe Ecosystem Reserve, prepared by the BLM and DOE, manages the reserve as a laboratory where all native ecosystem components, cultural resources, and Native American Tribal values are conserved in balance with opportunities for scientific investigation of the resources present on INL (INL 2015c).

Approximately 60 percent of the INL Site is available to livestock grazing (including on the Sagebrush-Steppe Ecosystem Reserve) with up to 340,000 acres leased for cattle and sheep grazing. However, grazing is not permitted within 0.5 miles of any primary facility boundary or within 2.0 miles of any nuclear facility. The U.S. Sheep Experiment Station uses about 900 acres of land at the junction of Idaho State Highways 28 and 33 as a winter feedlot for sheep.

The INL Site contains habitat suitable for big game. DOE cooperates with the Idaho Department of Fish and Game in allowing limited, controlled hunts for elk and antelope in a section of the northern half of the INL Site. These hunts, which are restricted to certain species and specific times and locations, are managed in accordance with an existing DOE/Idaho Department of Fish and Game memorandum of agreement. They are one of the few permitted public uses of the INL Site.

The INL Site is an administratively controlled area and in general, access to the INL Site and its facilities is permitted only on an official business basis. Public access is only allowed in rights-of-way associated with highways, the Big Lost River rest area, and at the Experimental Breeder Reactor-I (EBR-I) visitor center. There are no residential dwellings on INL property.

The INL Site is included within a large territory once inhabited by, and still of importance to, the Shoshone-Bannock Tribes. However, the INL Site does not lie within any of land boundaries established by the Fort Bridger Treaty of 1868. The Treaty provision that allows the Shoshone-Bannock Tribes to hunt on unoccupied lands of the United States does not apply to the INL lands because the entire site is considered to be occupied by DOE. DOE and the Shoshone-Bannock Tribes have an agreement-in-principle encouraging regular interactions between the DOE and the Tribes on issues of mutual concern. In addition, the Tribes have a memorandum of agreement that assures continued Tribal access to the Middle Butte Cave, which holds significant Tribal interest for ceremonial, cultural, and educational activities. For more information about the Fort Bridger Treaty and the Shoshone-Bannock Tribes, please refer to Section 3.1.6, Cultural and Paleontological Resources.

Land Use at Materials and Fuels Complex

The Materials and Fuels Complex (MFC) is located about 28 miles west of Idaho Falls and about 50 miles north of Pocatello, Idaho. U.S. Highway 20 is about 1.5 miles from MFC's southern boundary. MFC consists of a large developed area surrounded by an undeveloped security perimeter. Structures tend to be one- or two-story, block concrete buildings, with a handful of towers and other holding tank structures interspersed. The MFC operational area encompasses about 60 acres. MFC contains analytical laboratories and other facilities for nuclear research, including the Hot Fuel Examination Facility, the Irradiated Materials Characterization Laboratory, the Experimental Fuels Facility, the Fuel Conditioning Facility, and the decommissioned Zero Power Physics Reactor. Over the last few years, significant infrastructure investment has occurred and will continue in the next several years, including the construction of a Sample Preparation Laboratory (INL 2015c). The land outside the security fencing at MFC is similar to the other undeveloped land at INL.

Regional Land Use

Figure 3–1 depicts the regional location of INL and land ownership of surrounding areas. The INL Site is surrounded by a mixture of public and private land, about 75 percent of which is managed by the Federal government by way of BLM. Land uses in these federally administered areas include mineral and energy production, livestock grazing, and recreation. Approximately 1 percent of the adjacent land is owned by the State of Idaho and is used for the same purposes as the Federal land. The remaining 24 percent of the land adjacent to the INL Site is privately owned and primarily is used for grazing and crop production. In 2017, about 1,005,921 acres of total cropland was available for use, with 825,165 acres harvested within the 5-county area that encompasses INL (USDA 2019a).

Populated areas in proximity to the INL Site are relatively sparse, with the largest population centers of Idaho Falls and Pocatello to the east and south, respectively. Based on U.S. Census Bureau population estimates, total population of the 5-county area where the INL Site is situated is 195,952 with only 2,611 of those residing in Butte County (Census 2019a). The largest population centers within 50 miles of the INL Site include Idaho Falls (61,535), Pocatello (56,266), and Rexburg (28,687) (Census 2019a). Outside of such population centers, the remaining regional population resides in small towns and rural communities. There are no permanent residents on the INL Site.

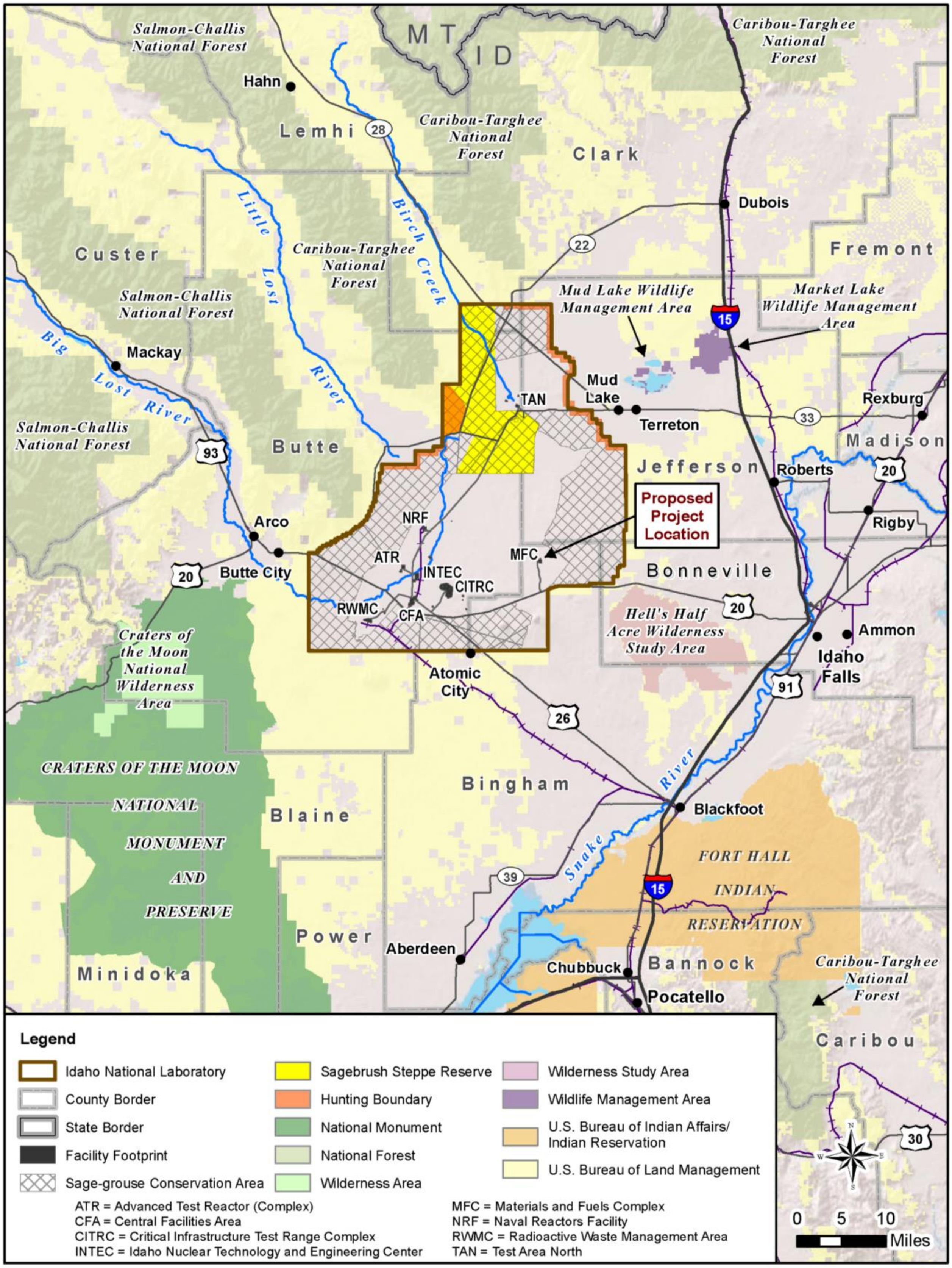


Figure 3–1. Idaho National Laboratory Regional Location and Land Ownership

The Idaho Local Land Use Planning Act of 1975 guided land-use planning in the State of Idaho. Currently, Idaho does not have a statewide land use agency or any State-based funding for cities and counties to carry out their land-use planning work. Therefore, the Idaho legislature requires that each county adopt its own land-use planning and zoning guidelines. At present, most of the counties around the INL Site have implemented guidelines to focus development adjacent to previously developed areas. Because of INL's remote location and existing adjacent land uses (BLM, U.S. Forest Service [USFS], private cultivated and non-cultivated land), areas near the site are not likely to experience residential and commercial development; however, increased recreational and agricultural use can be expected to increase in the surrounding area.

There are several areas adjacent to INL used for recreational purposes, including the Big Southern Butte and Hell's Half Acre Lava Field National Natural Landmark south of the INL Site border, and Mud Lake Wildlife Management Area and Market Lake Wildlife Management Area to the northeast of INL. Other tourist and recreational attractions in the vicinity of INL include Craters of the Moon National Monument and Preserve, Challis National Forest, Targhee National Forest, Beaverhead-Deerlodge National Forest, Camas National Wildlife Refuge, and Black Canyon Wilderness Study Area. Yellowstone National Park and Grand Teton National Park are within a few hours' drive east of the INL Site.

3.1.1.2 Aesthetics at Idaho National Laboratory

Aesthetics includes natural and manmade features that provide a particular landscape its character and aesthetic quality. The ROI for aesthetics are comprised of the INL Site, the ESRP, Fort Hall Reservation, the Bitterroot, Lemhi, and Lost River mountain ranges, the Big Southern Butte, East Butte, Middle Butte, Circular Butte, Antelope Butte, Hell's Half Acre National Natural Landmark, and Hell's Half Acre Wilderness Study Area.

The INL Site is located in a large, relatively undisturbed expanse of sagebrush steppe, but small volcanic buttes dot the natural landscape. Topographic features, such as volcanic cones, domes, and mountain ranges, are visible from most areas on the INL Site. Several mountain ranges (Bitterroot, Lemhi, and Lost River) are visible to the north and west of the INL Site. The Big Southern Butte, East Butte, and Middle Butte are visible from the southern boundary of the INL Site; Circular and Antelope Buttes are visible to the northeast. In general, the viewscape at the INL Site consists of sagebrush-dominated terrain with an understory of grasses. Juniper is common near the buttes and foothills of the Lemhi range; crested wheatgrass is scattered throughout the INL Site.

Features of the natural landscape at the INL Site have a special importance to the Shoshone-Bannock Tribes. Some prominent features of the INL Site landscape are within visual range of the Fort Hall Reservation, about 45 miles to the southeast.

There are eight primary facility areas present on the INL Site, each of which resembles a low-density commercial or industrial complex area. Structures generally range in height from 10 to 100 feet, some with emission stacks that tower up to 250 feet in height. While several facilities on the INL Site are visible from public highways (particularly U.S. Highways 20 and 26, and Idaho State Road 33), most buildings are located more than 0.5 mile from public roads.

Lands within and adjacent to the INL Site follow the BLM Visual Resource Management (VRM) guidelines. While the VRM system is officially applicable only to BLM land, it provides a useful tool for making inventory and managing visual resources on land owned by other agencies. This system relies on two main components: visual resource inventories and visual resource management. Visual resource inventories attempt to establish the visual qualities of an area, assess whether the public has any concerns related to scenic quality for a location, and determine if sensitivity exists at the location for visual intrusions. Sensitivity is evaluated by considering the types of users that would view the location (e.g., recreational users, commuters, or workers), the amount of use, public interest, and adjacent land uses. There are four levels of VRM rating, designated as VRM Classes I to IV, with Class I being the most restrictive and protective of the visual landscape and Class IV being the least restrictive (BLM 1986):

> *Class I* – Preserve the existing character of the landscape. This class provides for natural ecological changes and does not preclude limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.
>
> *Class II* – Retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
>
> *Class III* – Partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
>
> *Class IV* – Provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

Lands adjacent to the INL Site have been designated visual resource Class II areas; lands within the INL Site have been designated as Class III and Class IV.

In 2017, the International Dark-Sky Association (IDA) designated Craters of the Moon National Monument an International Dark Sky Park (IDA 2019). An International Dark Sky Park is a land area possessing an exceptional or distinguished quality of starry nights and a nocturnal environment specifically protected for its scientific, natural, educational, cultural heritage, and/or public enjoyment. The IDA only designates International Dark Sky Places following a rigorous application process requiring applicants to demonstrate robust community support for dark sky protection and a documentation of designation-specific program requirements. While Craters of the Moon National Monument is host to some of the darkest night skies of any national park unit, light pollution from far-off cities such as Idaho Falls and Twin Falls, Idaho, can influence views of the night sky. The park is considered to be located on the edge of one of the largest remaining pools of natural nighttime darkness in the lower 48 States, which serves as a natural defense against development that could bring significant new sources of artificial light (IDA 2019).

3.1.2 Geology and Soils

The ROI for geology and soils includes the INL Site and MFC. The INL Site is located on a relatively flat area along the northwestern edge of the ESRP Physiographic Province (DOE 2016b). The Snake River Plain (SRP) is about 50 to 62 miles wide and over 348 miles long and extends in a broad arc from the Yellowstone Plateau on the east to the Idaho-Oregon border on the west (INL 2010b). The ESRP extends from the Yellowstone Plateau to Shoshone, Idaho, and represents the track of volcanic activity associated with movement of the North American crustal plate over the Yellowstone hotspot (Hackett et al. 2002:462).

The land surface at the INL Site is gently sloping, with elevations ranging from 4,790 feet in the south to 5,912 feet in the northeast (Mattson et al. 2004). The INL Site is relatively flat but includes volcanic buttes jutting from the desert floor, uneven surfaced basalt flows, and flow vents and fissures. The INL Site is bordered on the north and west by mountain ranges of the geologic Basin and Range Province and on the south by volcanic buttes and open plain (INL 2010c).

3.1.2.1 Geology

Regional Geology

The surface of the ESRP is covered by basaltic lava, aged between 4 million and 2,100 years ago (DOE 2005b), and overlying older tertiary rhyolites. Most of the visible ESRP was shaped during the last 1.2 million years by volcanic eruptions that resulted in gentle sloping basaltic shield volcanoes and 3, steep-sided silicic domes (NRC 2004). Basaltic volcanic centers have been grouped into four volcanic rift zones, each with a northwestern trend that cut across the ESRP. Three of these volcanic rift zones cut across the INL Site. The volcanic rift zone orientations appear to be the result of basalt dikes, which primarily intruded perpendicular to the northeast-southwest direction of extension associated with the physiographic region of the Basin and Range province. The Axial Volcanic Zone extends along the axis of the ESRP and has a higher concentration of basaltic volcanic vents (DOE 2005b; Payne 2006).

The INL Site is underlain by about 0.6 to 1.2 miles of Quaternary age basaltic lava flows interbedded with poorly consolidated sedimentary materials. Interbedded sediments consist of materials deposited by streams and the Big Lost River (silts, sands, and gravels), historic lakes (clays, silts, and sands), and wind (silts) that accumulated between volcanic events. The interbedded basalt flow and sediment sequences are collectively known as the Snake River Group (DOE 2005b). The Snake River Group is composed of sedimentary deposits of thicknesses up to 197 feet interbedded with basalts that are 16 to 82 feet in thickness (NRC 2011).

The Quaternary Yellowstone Group and Plateau Rhyolite, which is composed of rhyolite ash-flow tuff, ash and pumice beds, is found in some areas of the ESRP. Below the Snake River Group, in the northeast and southeast area of the ESRP, lies the upper part of the Idaho Group, which is in the Tertiary geologic period and consists of basalts and poorly consolidated sediment beds. The lower part of the Idaho Group (Tertiary) is composed of basalt exhibiting columnar jointing and is ubiquitous throughout the entire Snake River Plain. The Tertiary Idavada Volcanics are found in the northeast and southwest areas of the ESRP (NRC 2011).

The most recent basalt flow at the INL Site is the Cerro Grande flow, which occurred about 13,000 years ago and originated from a vent south of the INL Site (Kuntz et al. 1994). In contrast, the Hell’s Half-Acre flow immediately southeast of the INL Site is only about 5,200 years old and flows at the nearby Craters of the Moon National Monument and Preserve are as recent as 2,100 years old. The much older basalt lava flows characteristic of the southern portion of the INL Site are between 200,000 and 730,000 years old (Hackett and Smith 1992). Basalt on the northern portion of the INL Site is at least a million years old (INL 2015c).

Overlying the basalts are thin, discontinuous deposits of wind-blown sand (loess composed of calcareous silt), floodplain sediments, and riverbed and lake sediments (clays, silts, sands, and gravels) (NRC 2004). These surficial sediments range in thickness from 0 to over 310 feet (Anderson et al. 1996; DOE 2005b).

The subsurface geology beneath MFC is somewhat different from the rest of the INL Site because it is closer to basaltic volcanic vents and is isolated from receiving sediment deposits from the Big Lost River. Because of this difference, MFC lacks thick sedimentary interbeds. The sedimentary interbeds are discontinuous stringers, deposited in low areas on basalt surfaces from wind and localized drainages. They are generally composed of calcareous silt, sand, or cinders. Rubble layers between individual basalt flows are composed of sand and gravel to boulder-sized material. The interbeds range in thickness from less than 1 inch to 15 feet. The thickness and texture of individual basalt lava flows are quite variable and range in thickness from 10 to 100 feet. The upper surfaces of the basalt flows are often irregular and contain many fractures and joints that may be filled with sediment. The outer portions of a flow (both top and bottom) tend to be highly vesicular. The middle portions of the flow typically have few vesicles and are dominated by vertical fractures formed during cooling (INL 2010b).

3.1.2.2 Soils

Four basic soilscapes exist at the INL Site: river-transported sediments deposited on alluvial plains, fine-grained sediments deposited into lake or playa basins, colluvial sediments originating from bordering mountains, and windblown sediments (silt and sand) over lava flows. The alluvial deposits follow the courses of the modern Big Lost River and Birch Creek. The playa soils are found in the north-central part of the site; the colluvial sediments, along the western edge of the INL Site; and the windblown sediments, throughout the rest of the site (DOE 2002c).

Although a comprehensive survey of the soils at the INL Site has not been conducted, information from county surveys and other sources has been compiled (Olson et al. 1995). This compendium indicates that most soils at the INL Site are Aridisols, with Calciorthids being the most common great group; Entisols, namely Torriorthents and Torrifluvents; and Mollisols, including Calcixerolls and Haploxerolls (INL 2020f). No soils have been designated as prime farmland within the INL Site boundaries (DOE 2005b).

Soils in the MFC area generally consist of light, well-drained, brown-gray, silty loams to brown, extremely stony loams. Soils are highly disturbed within developed areas of MFC (DOE 2002c). The thickness of surficial soils and sediment near MFC range from 0.5 to 26 feet, with two locations in MFC that have deposits of 31.5 and 46 feet (INL 2006:56). The two primary types of soils at MFC are classified as 425-Bondfarm-Rock outcrop-Grassy Butte complex and 432-Maim-Bondfarm-Matheson complex (DOE-ID 1998). The permeability of these soils is moderately rapid to rapid. The hazard of erosion is slight or moderate (INL 2010b).

Radiological Monitoring

To determine the need for soil sampling, potential releases from INL Site facilities with significant air emissions in 2013 were modeled using CALPUFF, a non-steady state air dispersion model (Rood and Sondrup 2014) and estimated particulate deposition rates (INL 2016e). The results showed that for the onsite facilities only the Radioactive Waste Management Complex had the potential for soil accumulations to be detectable in less than a decade. Results for the other facilities, including MFC showed the potential for surface accumulations to be detectable only after hundreds to thousands of years (INL 2016e).

The INL contractor currently completes soil sampling on a 5-year rotation at the INL Site to evaluate long-term accumulation trends and to estimate environmental radionuclide inventories. Data from previous years of soil sampling and analysis on the INL Site show slowly declining concentrations of short-lived, manmade radionuclides (e.g., cesium-137), with no evidence of detectable concentrations depositing onto surface soil from ongoing INL releases. The Environmental Surveillance, Education, and Research (ESER) program contractor collects soil samples at offsite locations first established by Radiological and Environmental Sciences Laboratory (RESL) every 2 years (in even-numbered years). Results to date indicate that the source of detected radionuclides is not from INL operations and is most likely derived from worldwide fallout activity (DOE-ID 2014).

3.1.2.3 Geologic and Soil Resources

Mineral resources that are inside the INL Site boundary are limited to several quarries, or "borrow sources," which supply sand, gravel, pumice, silt, clay, and aggregate for road construction and maintenance; new facility construction and maintenance; waste burial activities; and landscaping on site. Onsite topsoil is a very limited commodity. The INL Site contains six active gravel/borrow pits that support onsite maintenance operations, new construction, and environmental restoration and waste management activities (DOE-ID 2019b). The Rye Grass Flats Borrow Source, the nearest borrow source to MFC, is about 11 miles to the southwest.

The geologic history of the ESRP makes the potential for petroleum production at the INL Site very low (NRC 2004). The potential for geothermal energy development exists at the INL Site; however, a study conducted in 1979 found no economic geothermal resources (Mitchell et al. 1980). Outside of the INL Site and within about 100 miles of the boundary, mineral resources include sand, gravel, pumice, phosphate, and base and precious metals (NRC 2004).

3.1.2.4 Geologic Hazards

Seismic Hazards

The seismic characteristics of the ESRP and the adjacent Basin and Range Province are different. The ESRP has historically experienced infrequent, small-magnitude earthquakes (DOE 2002a). In contrast, the majority of contemporary seismicity is associated with the major episode of Basin and Range Province faulting that began about 16 million years ago and continues today (Rodgers et al. 2002).

Most earthquakes with the potential to affect the INL Site occur along normal faults (type of fault associated with Basin and Range tectonics) in the Basin and Range Province. The faults closest to the INL Site are the Quaternary Lost River, Lemhi, and Beaverhead faults. They are normal faults located along the base of the mountains to the north and west of the INL Site (INL 2010a). The nearest capable faults to MFC are the southernmost segments along the Lost River and Lemhi faults. Their southernmost terminations are near the western and northwestern INL Site boundary about 20 miles from MFC. A capable fault is one that has had movement at or near the surface at least once within the past 35,000 years or recurrent movement within the past 500,000 years (10 CFR Part 100). **Figure 3–2** shows the locations of faults and volcanic rift zones near the INL Site (DOE 2016b: 3-11).

The mountains and valleys of southeastern Idaho lie within the Intermountain Seismic Belt and tectonic belts II and III of the Yellowstone Tectonic Parabola (INL 2020c). As shown in **Figure 3–3**, the compilation of seismicity from 1850 to 2014 from the INL seismic network and surrounding networks documents that earthquakes of magnitude 2.0 and greater occurred outside the ESRP with the exception of the 1905 Shoshone, Idaho earthquake.[1] During this time period, there were 23 documented earthquakes of magnitude 5.5 and greater within the parabolic zone of seismicity and nearby regions (Payne and Bockholt 2017). The closest large event (Borah Peak earthquake) occurred on October 28, 1983, with an epicenter about 68 miles northwest of MFC and an estimated moment magnitude of 6.9 (USGS 2019c).

The historical earthquake record shows the ESRP has a remarkably low rate of seismicity compared to the surrounding Basin and Range Province. The basalt layers interbedded with ancient stream and lakebed sediments under the INL Site may dampen or attenuate ground motions generated by earthquakes (Payne 2006). Due to the large distances from the INL Site, the 1959 Hebgen Lake earthquake (moment magnitude 7.3), 1983 Borah Peak earthquake (moment magnitude 6.9), and recent March 2020 Central Idaho earthquake (moment magnitude 6.5) were felt at MFC but did not cause any damage (BMPC 2011; DNFSB 2020). Earthquake-produced ground motion is expressed in units of percent g (acceleration relative to that of the Earth's gravity). The Borah Peak earthquake produced horizontal peak accelerations ranging from 0.022 g to 0.078 g across the INL Site (INEEL 2005; Jackson and Boatwright 1985). At MFC, recorded peak accelerations in the basement of two facilities ranged from 0.032 g to 0.048 g (Jackson and Boatwright 1985).

[1] With no instrumental recordings, the epicenter for the 1905 magnitude 5.7 earthquake was placed in the ESRP at Shoshone, Idaho; however, damage reports indicate the earthquake epicenter was south of the ESRP.

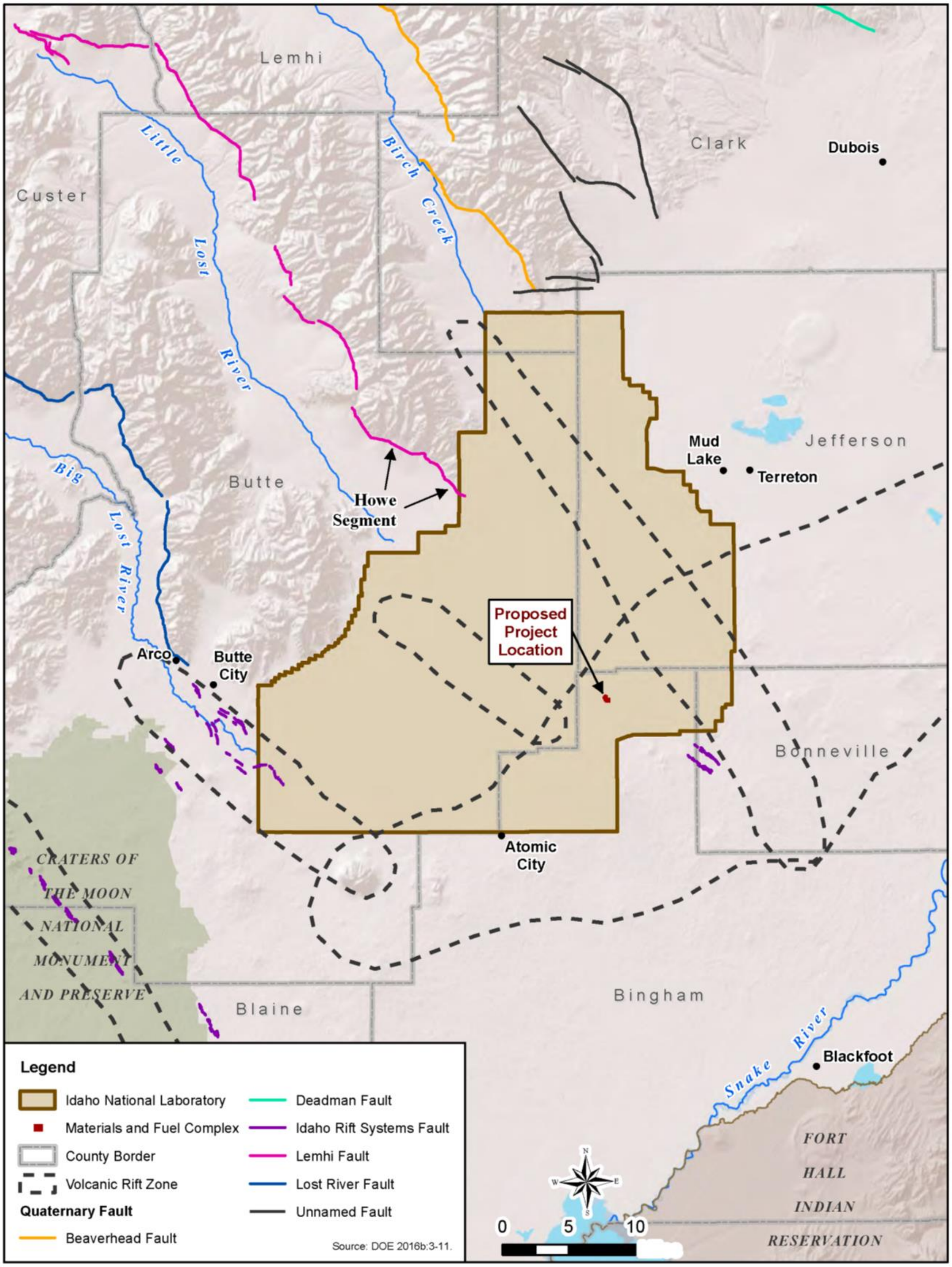
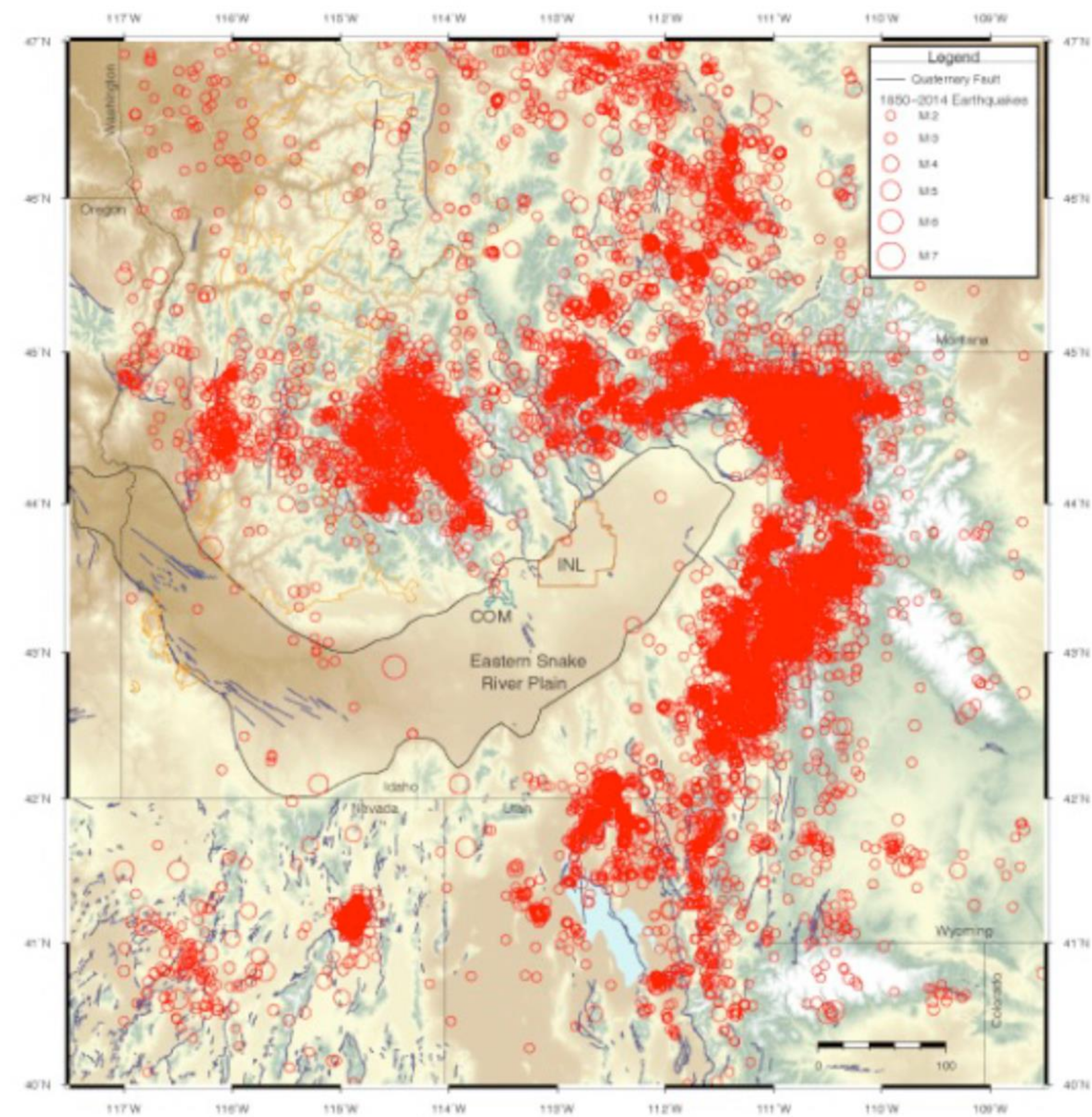


Figure 3–2. Locations of the Faults and Volcanic Zones



Source: Payne and Bockholt 2017.

Figure 3–3. Map Showing Epicenters of More than 20,000 Magnitudes 2.0 or Greater Earthquakes from 1850 to 2014 Form a Parabolic Distribution around the Eastern Snake River Plain

The INL Seismic Monitoring Program has 35 permanent seismic stations to determine the time, location, and size of earthquakes occurring near the INL Site. The program also operates 32 sites with accelerometers near and within INL facilities and at seismic stations to record strong ground motions from local moderate or major earthquakes. Seismic monitoring provides data for validating current ground motion models, and serves as an early detection system for future volcanism, because low-magnitude earthquake swarms typically accompany the upward movement of magma. Two permanent seismic stations with accelerometers are located at MFC (INL 2020c).

Seismic history and geologic conditions indicate that earthquakes with a magnitude of more than 5.5 and the associated strong ground shaking and surface rupture are more likely to occur in the Basin and Range

Province outside the ESRP. However, moderate to strong ground shaking from future large magnitude earthquakes in the Basin and Range Province could be felt at INL (DOE 2016a).

Volcanic Hazards

The potential for future volcanism and associated volcanic hazards at the INL Site are a consequence of the volcanic history of the ESRP. Eruptions of silica- and iron-rich (mafic) magmas have occurred in the ESRP as a result of the Yellowstone hotspot in conjunction with crustal thinning associated with Basin and Range Province extension of the crust. Explosive silica-rich, caldera-forming eruptions began about 16 million years ago, in association with the hotspot's initial position centered on the common borders of Idaho, Oregon, and Nevada. The hotspot is now located beneath the Yellowstone Plateau, which has had three major caldera eruptions over the last 2 million years. Following cessation of hotspot-related caldera-forming eruptions, mild effusive eruptions of predominantly iron-rich magmas from relatively recent basaltic volcanoes have covered the ESRP. Basaltic volcanic activity on the ESRP dates from 4 million years ago to as recently as 2,100 years ago (DOE 2011a). Recent eruptions produced basalt lava flows from 2,100 to 15,000 years ago at Craters of the Moon National Monument and Preserve (INL 2010a) and at other locations south of the INL Site.

Volcanic hazards at the INL Site have been evaluated for possible hazard phenomena associated with the different types of silica- and iron-rich eruptions. Hazards associated with explosive, silica-rich caldera-forming eruptions, similar to those that have occurred at the Yellowstone Plateau, are considered to be negligible for the INL Site since the locus of this activity is now in the Yellowstone Plateau. Volcanic ash-falls could occur at the INL Site from eruptions as far away as the Cascade Mountains. A 0.001 annual probability was calculated for a 0.4-inch thick ash deposit forming at the INL Site from a Cascade volcano eruption (NRC 2004). Rhyolite dome volcanoes, such as Big Southern Butte or East Butte, also have the potential to produce ash-fall deposits. The estimated recurrence of silicic volcanism within the volcanic axial zone is 4.5×10^{-6} per year (NRC 2011:3-42). In addition, eruptions from the Yellowstone Volcanic Zone could produce appreciable ash-fall deposits at the INL Site, in the unlikely event that regional winds were directed to the southwest during a potential small-volume eruption (INL 2010a) or the size of the eruption overwhelmed prevailing winds (Mastin et al. 2014).

Basaltic volcanism has occurred as recently as 2,100 years ago in the Great Rift, southwest of the INL Site. Other basaltic lava flows near the southern INL Site boundary erupted about 5,000 and 13,000 years ago (INL 2010a). Based on the probability analysis of the volcanic history in the Axial Volcanic Zone and volcanic rift zones, the conditional probabilities that MFC and the south-eastern INL Site would be affected by basaltic volcanism would be once in 16,000 and 40,000 years or longer, respectively (Hackett et al. 2002:Figure 4). The estimated probability of volcanic impact is less than once every million years or longer for the northern INL Site because past volcanism was older and less frequent (DOE 1995).

A recent study (Gallant et al. 2018) shows a 30 percent probability of partial inundation of the INL Site given an eruption on ESRP, with an annual inundation probability of 8.4×10^{-5} to 1.8×10^{-4}. An annual probability of 6.2×10^{-5} to 1.2×10^{-4} is estimated for the opening of a new eruptive center within the INL Site boundaries.

Slope Stability, Subsidence, and Liquefaction

No natural factors at MFC that would produce slope instability, subsidence, or liquefaction have been reported. As described in Section 3.1.2.2, slopes are very gradual and soils are generally thin.

3.1.3 Water Resources

The ROI for water resources includes surface waters of the INL Site where stormwater, industrial wastewater, or sanitary wastewater are discharged (e.g., Industrial Waste Pond and active sewage lagoons), and the Snake River Plain Aquifer (SRPA) beneath and downstream of the INL Site.

This section describes the INL Site's surface and groundwater resources in general and provides specific information regarding current levels of nonradiological and radiological contaminant concentrations in surface water effluent and groundwater due to operations at MFC. Wastewater, stormwater, and flooding potential are discussed.

The U.S. Environmental Protection Agency (EPA) has established, under authority of the Safe Drinking Water Act (SDWA), National Primary Drinking Water Regulations known as primary standards. Primary standards limit the levels of contaminants in drinking water. Maximum Contaminant Levels (MCLs), as contained in 40 CFR Part 141, are the highest levels of contaminants allowed in drinking water and are legally enforceable. National Secondary Drinking Water Regulations, or secondary standards, are non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects in drinking water (40 CFR Part 143). Idaho Administrative Procedures Act (IDAPA) 58.01.08 establishes State drinking water standards that are enforced by the Idaho Department of Environmental Quality (IDEQ).

The State of Idaho has established primary and secondary constituent standards for groundwater per IDAPA 58.01.11. These standards essentially mirror the Federal primary and secondary standards established by EPA for drinking water and apply to any activity with the potential to substantially degrade groundwater (aquifer) quality. Unlike the Federal secondary standards, State secondary constituent standards may be enforced.

3.1.3.1 Surface Water

3.1.3.1.1 Natural Water Features

The INL Site is in the Mud Lake – Lost River Drainage Basin. This is a closed basin that includes the Big Lost River, Little Lost River, and Birch Creek. IDEQ regulates protection of bodies of water in Idaho for existing or designated uses. Big Lost River, Little Lost River, and Birch Creek have been designated for cold-water aquatic communities, salmonid spawning, and primary recreation (IDAPA 58.01.02). The Big Lost River channel and sinks and lowermost Birch Creek are classified for domestic water supply and as special resource waters. In general, Big Lost River, Little Lost River, and Birch Creek are similar with respect to water quality. Chemical compositions reflect the carbonate mineral compositions of the mountain ranges drained by the streams and the quality of irrigation water return flows. None of the rivers or streams on or near the INL Site has been classified as wild and scenic per the Wild and Scenic Rivers Act, 16 *United States Code* (U.S.C.) Section 1274. Surface waters are not used for drinking water at the INL Site, nor are effluents discharged directly to them; therefore, no surface water rights are issued to INL.

The Big Lost River, Little Lost River, and Birch Creek are intermittent on the INL Site. During the summer months, most flow from these streams is diverted for irrigation before it reaches the INL Site's boundaries. During fall and winter, seasonal changes in climate (e.g., precipitation and temperature) reduce stream flow enough that streams do not generally reach the INL Site. Big Lost River, Little Lost River, and Birch Creek flow year-round off the INL Site and drain the mountain areas to the north and west of the site. Flow that reaches the INL Site seeps into the ground surface along the length of the streambeds and in the Big Lost River spreading areas and sinks. The spreading areas are natural, low elevation, closed basins associated with the INL Site's diversion dam. The sinks are the lowest elevation in the closed drainage basin where the Big Lost River terminates in a series of playas where seasonal wetlands have formed.

Surface water on the INL Site that does not infiltrate the ground surface is lost from the system through evapotranspiration processes. No surface water flows off the INL Site.

The Big Lost River flows southeast from Mackay Dam, past Arco, and onto the Snake River Plain. The INL Site's diversion dam, near the southwestern boundary, prevents flooding of downstream areas during periods of heavy runoff by diverting water to a series of natural depressions or spreading areas. During periods of high flow or low irrigation demand, the Big Lost River continues to the northeast past the diversion dam, passes between the Idaho Nuclear Technology and Engineering Center (INTEC) and the Advanced Test Reactor (ATR) Complex, and ends in a series of playas, where the water infiltrates the ground surface.

National Wetland Inventory maps prepared by the USFWS indicate wetland areas are associated with the Big Lost River, the Big Lost River spreading areas, and the Big Lost River Sinks. These wetlands are classified as riverine/intermittent, indicating a defined stream channel with flowing water during only part of the year. The only U.S. Army Corps of Engineers jurisdictional wetlands are the Big Lost River Sinks.

Materials and Fuels Complex

MFC's watershed contains natural drainage channels, which can concentrate overland water flow during periods of high precipitation or heavy spring runoff. However, the watershed contains no perennial, natural surface water features. The Transient Reactor Test (TREAT) Facility is located in an adjacent local topographically closed watershed, which also contains no identifiable perennial, natural surface water features.

The closest natural surface water feature to MFC is an unnamed intermittent stream located about 7.8 miles to the south. This about 12-mile-long waterway extends west before sinking into the ground about 1.6 miles northeast of the intersection of U.S. Routes 20 and 26. At its most proximate point, the Big Lost River is located 16 miles west of MFC.

3.1.3.1.2 Surface Water Quality

Surface water locations outside of the INL Site's boundaries are sampled quarterly. When the Big Lost River is flowing, locations along this surface water within the INL Site are also sampled for gross alpha activity, gross beta activity, tritium, and cesium-137. The Big Lost River was flowing enough to collect samples in April and June of 2018. Samples were collected at five locations, plus one control sample from Birch Creek. During the June 2018 sampling event, gross alpha activity was detected in four of these samples (the highest concentration was 3.6 picocuries per liter (pCi/L) found in the samples collected from INTEC and the Experimental Field Station in June). Gross beta activity was detected in all five (the highest concentration was 9.1 pCi/L found at INTEC and the Experimental Field Station). Tritium was also detected in five samples, with the highest concentration being 119 pCi/L at the rest area (ESER 2019b). For reference, the EPA MCL for gross alpha is 15 pCi/L, the EPA screening level for gross beta activity is 50 pCi/L, and the EPA MCL for tritium is 20,000 pCi/L. Thus, all concentrations detected in June 2018 fell well below regulatory levels. All concentrations detected this quarter were similar to those found in atmospheric moisture and precipitation samples and were consistent with the findings from sampling events occurring in prior years. No manmade, gamma-emitting radionuclides (e.g., cesium-137) were found during this sampling effort (ESER 2019b).

3.1.3.1.3 Wastewater

Other surface water bodies on the INL Site include manmade percolation and evaporation ponds, sewage lagoons, and industrial waste ditches. These ponds, lagoons, and ditches are used for wastewater management at the INL Site and include the INTEC New Percolation Ponds, Test Area North/Technical Support Facility Sewage Treatment Plant Disposal Pond, ATR Complex Code Waste Pond, MFC Industrial

Waste Pond, MFC Sanitary Lagoons, and the Naval Reactors Facility Industrial Waste Ditch. The Naval Reactors Facility also has sewage lagoons.

INL Wastewater Discharge

Discharge of industrial wastewater to the land surface at the INL Site is regulated by IDAPA 58.01.16 and IDAPA 58.01.17 and may require an industrial reuse permit (referred to in general terms as a wastewater reuse permit throughout the rest of this section). Wastewater reuse permits specify annual discharge volumes, application rates, and effluent primary and secondary constituent standards. Monitoring of nonradioactive parameters is required to demonstrate compliance with the permits. Annual reports are prepared and submitted to IDEQ, as required, and IDEQ inspects facilities for permit compliance on a regular basis. Some facilities also monitor specified radiological parameters for surveillance purposes, even though this may not be required by the different wastewater reuse permits. Compliance with Idaho groundwater quality primary constituent standards and secondary constituent standards in specified groundwater monitoring wells is generally required.

Currently, permitted INL facilities include the ATR Complex Cold Waste Pond, INTEC New Percolation Ponds, and MFC Industrial Waste Pond. These facilities were sampled for parameters required by facility-specific permits, and no limits were exceeded in 2017 (INL 2018a).

Materials and Fuels Complex

Wastewater features within the MFC boundary include an Industrial Waste Pond and new evaporative sewage lagoons (constructed in 2012). The Industrial Waste Pond has a design capacity of 285 million gallons and receives wastewater from the industrial waste pipeline and stormwater runoff (INL 2018a). The Industrial Waste Pond appears in the USFWS National Wetland Inventory and is classified as PUBHx. PUBHx means the pond is a palustrine, permanently flooded wetland with an unconsolidated bottom that was excavated by humans (USFWS 2019b).

Effluent carried through the industrial waste pipeline includes non-contact cooling water, boiler blowdown, cooling tower blowdown and drain, air wash flows, steam condensate, intermittent reverse osmosis effluent, and laboratory sink discharge from the MFC-768 Power Plant. Effluent discharged to the Industrial Waste Pond from the industrial waste pipeline is sampled monthly in accordance with Reuse Permit I-160-02, issued January 26, 2017 and modified March 7, 2017. In 2017, gross alpha, gross beta, potassium-40, and uranium isotopes were detected at levels below applicable derived concentration standards (INL 2018a). **Figure 3–4** illustrates wastewater and groundwater sampling locations at MFC.

3.1.3.1.4 Stormwater

Stormwater from onsite INL facilities, including MFC, is generally discharged to industrial waste ditches, sewage lagoons, or infiltration ponds. Stormwater may result in minor overland flow that infiltrates into the ground. Stormwater that is discharged to sewage lagoons is contained, and stormwater discharged to infiltration ponds or trenches evaporates or infiltrates the ground surface. Because stormwater from INL facilities is not discharged to regulated waters (i.e., the Big Lost River), the National Pollutant Discharge Elimination System (NPDES) permit provisions for discharges into regulated surface waters do not apply to MFC operations.

For construction stormwater discharges, INL facilities maintain compliance with INL's NPDES General Permit for Discharges from Construction Activities, updated June 2019, initially issued by EPA in June 1993. INL contractors obtain coverage under the general permit and develop stormwater pollution prevention plans for individual construction projects if it is determined there is reasonable potential to discharge pollutants to regulated surface waters. The general permit and plan provide best management practices to prevent pollution of stormwater from construction activities at the INL Site.

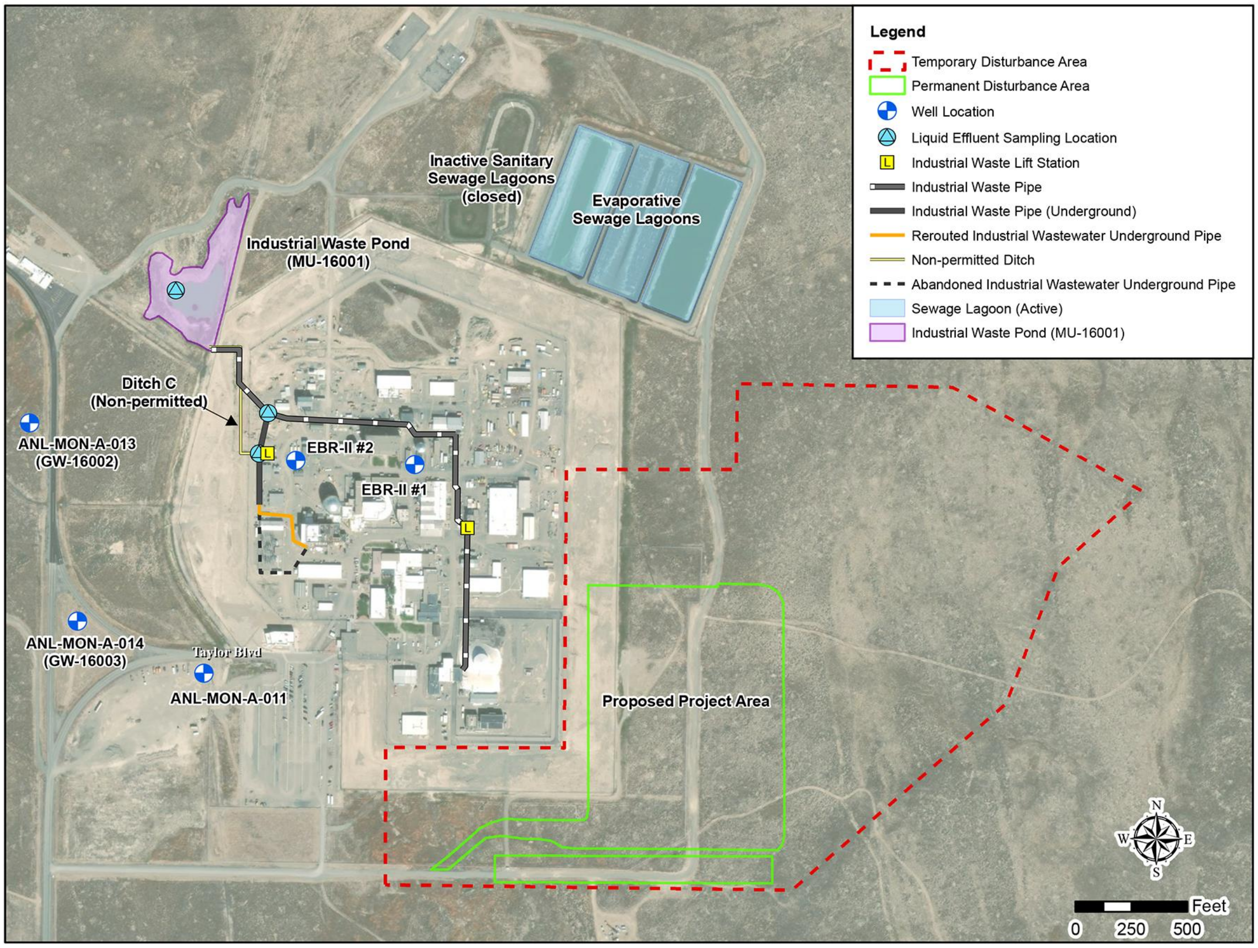


Figure 3–4. Wastewater and Groundwater Sampling Locations at the Materials and Fuels Complex

3.1.3.1.5 Floodplains

Flood frequency is typically characterized by the recurrence interval of a flood. The recurrence interval is the average period of time that elapses between floods of a given size. Larger floods are less frequent and, therefore, have a greater recurrence interval. Recurrence intervals are calculated based on historical measurements of flow and on geologic evidence of flooding. The 100-year flood does not necessarily occur once every 100 years, but rather has a 1 in 100 (1 percent) probability of occurring in any given year. The 500-year flood may occur more or less than once in a 500-year period but has only a 1 in 500 (0.2 percent) probability of occurring in any given year. A probable maximum flood is a hypothetical flow scenario that is used to place an upper bound on the impacts of flooding and is usually several times larger than the maximum-recorded flood. Probable maximum flood is not assigned a probability, but it is intended to represent the combination of events (snowmelt, precipitation, and dam failure) that could lead to maximum streamflow.

The INL Site's diversion dam, constructed in 1958 and enlarged in 1984, was designed to secure that portion of the INL Site located on the Big Lost River floodplain from the 300-year flood of the Big Lost River by directing flow through a diversion channel into four spreading areas. The estimated flood hazard area for a probable maximum flood due to a failure of the Mackay Dam includes the west-central portion of the INL Site along the Big Lost River drainage. Because the ground surface at the INL Site is relatively flat, floodwaters outside the banks of the Big Lost River would spread over a large area and pond in the lower lying areas. Although predicted flood velocities would be relatively slow with shallow water depths, some facilities could be impacted. However, MFC is not located within the probable maximum flood hazard area.

A flood control system was constructed for MFC around 1963. This system, which has been improved over time, now consists of drainage ditches, culverts, an interceptor canal, a diversion dam, and the Industrial Waste Pond. The flood control system is intended to "control and collect water from intermittent surface water runoff events" (Sehlke and Wichlacz 2010). The interceptor canal is located along the western side of MFC and transports water into the Industrial Waste Pond. MFC's diversion dam was constructed in 1968 in response to a flood event and is located 0.5 mile south of MFC. During a flood, the dam's gate can be closed and water diverted into a drainage channel toward the interceptor canal and the Industrial Waste Pond (Sehlke and Wichlacz 2010).

According to the Federal Emergency Management Agency (FEMA), MFC is located within an area designated as Zone C, or an area of minimal flooding. While the only potential source of this minimal flooding is anticipated to be from intermittent overland flow, flood events have occurred at MFC in the past, including 1963, 1969, and 1995. All three of these past flood events involved precipitation or snowmelt over frozen ground (Sehlke and Wichlacz 2010).

Figure 3–5 illustrates flood hazard areas, wetlands, and other surface water features near the INL Site.

3.1.3.2 Groundwater

3.1.3.2.1 Local Hydrology

Snake River Plain Aquifer

Groundwater in the ESRP is contained primarily in one major unit known as the SRPA. The SRPA underlies about 9,600 square miles in southeastern Idaho, including the INL Site. Aquifer boundaries are formed by contact of the aquifer with less-permeable rocks at the margins of the ESRP. These boundaries correspond to the mountains on the west and north and the Snake River on the east.

The SRPA is the major source of drinking water and crop irrigation for southeastern Idaho and has been designated a Sole Source Aquifer by EPA (EPA 2019a). Water storage in the uppermost 500 feet of the aquifer is estimated to equal that of Lake Erie, or about 200 to 300 million acre-feet (De Grey and Link 2020; Idaho Conservation League 2019). The aquifer is composed of numerous relatively thin basalt flows with interbedded sediments extending to depths of more than 5,000 feet. The interbeds accumulated over time, as some basalt flows were exposed at the surface long enough to collect sediment. The fractured basalt allows for the flow of groundwater (De Grey and Link 2020; Idaho Conservation League 2019).

Transmissivity is a measure of the rate at which water is transmitted through a unit width of aquifer to hydraulically downgradient areas and to pumping wells. Transmissivity in the SRPA ranges from about 1.1 to 760,000 square feet per day and averages about 93,000 square feet per day. Groundwater flow rates in the aquifer have been reported to range from about 2 to 20 feet per day (INL 2011a). Regionally, water in the aquifer moves horizontally, mainly through fractures in the basalts and basalt interflow zones. Interflow zones are comprised of highly permeable rubble zones between basalt flows. Groundwater flow in the SRPA is primarily toward the southwest.

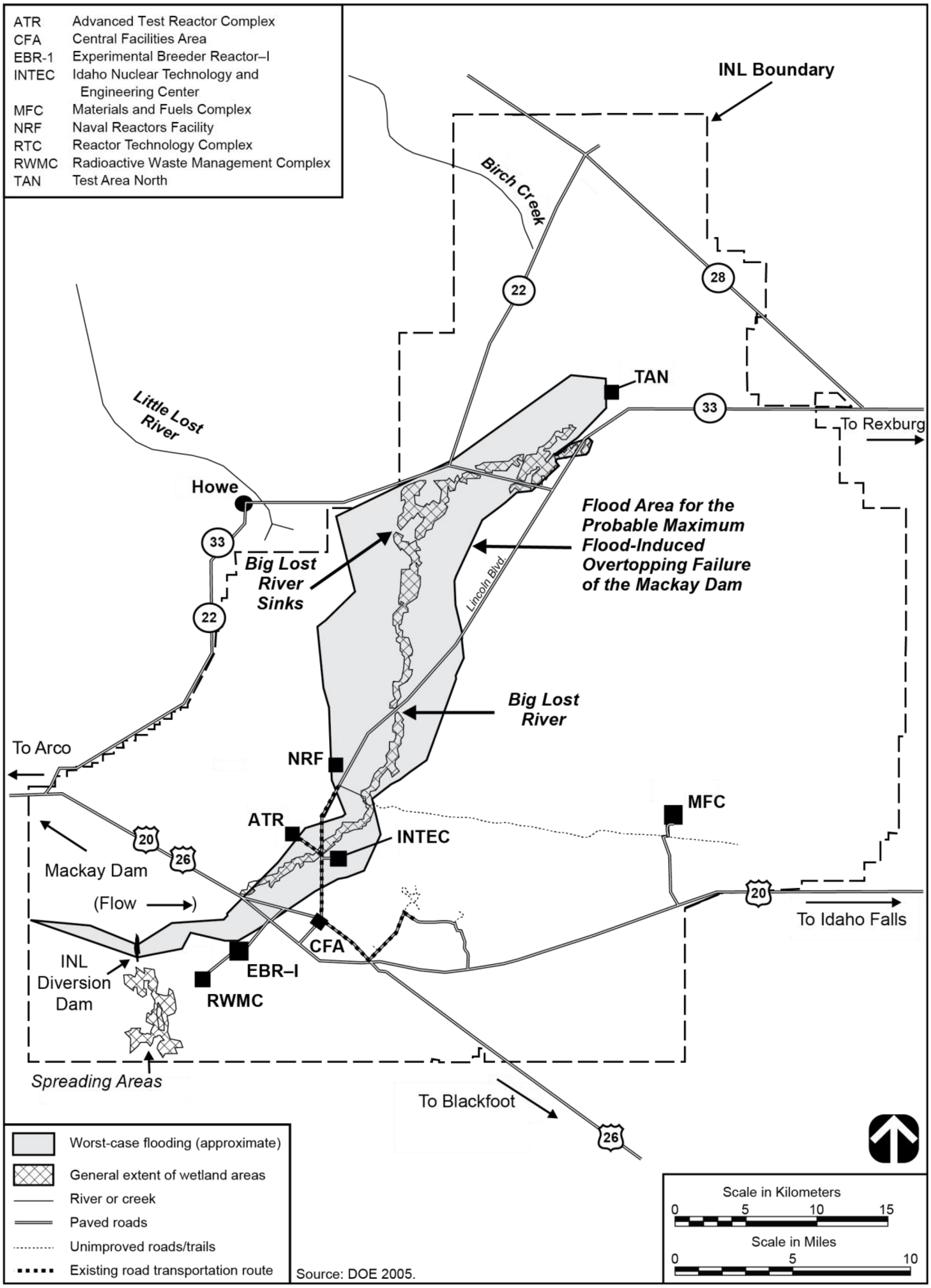


Figure 3–5. Surface Water Features, Wetlands, and Flood Hazard Areas at the Idaho National Laboratory Site

The Big Lost River, Little Lost River, and Birch Creek terminate at sinks on or near the INL Site and recharge the aquifer (when flow is present). Recharge occurs when water infiltrates through the surface of the ESRP from flow in the channel of the Big Lost River, the sinks, Little Lost River, Birch Creek, and Mud Lake. Additionally, recharge may occur from melting of local snowpacks, during years in which snowfall accumulates on the ESRP, and from local agricultural irrigation activities. Valley underflow from the mountains to the north and northeast of the ESRP has been cited as a source of recharge. Water is discharged from the SRPA through large springs to the Snake River at locations near American Falls, Idaho and Hagerman, Idaho. The aquifer discharges about 311 billion cubic feet of water annually to springs and rivers.

The USGS estimates that the thickness of the active portion of the SRPA at the INL Site ranges from 250 to 820 feet. Depth to the water table ranges from about 200 feet below land surface in the northern part of the INL Site to about 1,000 feet in the southern part. At MFC, the distance to the water table was measured at three locations in September 2016 and ranged between 649 to 662 feet below land surface (INL 2017a). From these findings, the direction of groundwater flow was estimated to be from the northeast to the southwest.

3.1.3.2.2 Subsurface Water Quality

Groundwater Monitoring Network

The USGS INL Project Office and INL contractors perform groundwater monitoring, analyses, and studies of the SRPA under and adjacent to the INL Site. Groundwater monitoring is required by a variety of permits and by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Records of Decision (RODs) related to remedial action requirements for Waste Area Groups (WAGs) established on the INL Site. The INL Site has an extensive groundwater quality monitoring network maintained by the USGS and INL contractors. This network includes monitoring or production wells in the SRPA, from which samples are collected and analyzed for selected organic, inorganic, and radioactive constituents. The specific number of wells sampled each year varies. However, between 1949 and 2017, 143 wells have been sampled for water quality and water levels have been monitored at 213 wells (USGS 2017).

CERCLA activities at the INL Site are divided into 10 WAGs. Each WAG monitors specific groundwater contaminants associated with remedial actions implemented according to the requirements of the associated ROD (INL 2011a). DOE has designated WAG 10 as INL-wide and addresses the combined impact of the individual contaminant plumes. MFC is covered by WAG 9.

Groundwater Quality

Localized areas of radiochemical and chemical contamination are present in the SRPA beneath the INL Site. These areas, or plumes, are considered to be the result of past disposal practices. Of principal concern at the INL Site over the years has been the movement of the tritium, strontium-90, and iodine-129 plumes. Groundwater monitoring has generally shown long-term trends of decreasing concentrations for these radionuclides and current concentrations are near or below EPA MCLs for drinking water (INL 2018a). The decreases in concentrations are attributed to discontinued disposal to the aquifer, radioactive decay, and dilution within the aquifer.

USGS collects samples annually from select wells at the INL Site for analysis of gross alpha activity, gross beta activity, gramma spectroscopy, and plutonium and americium isotopes. Between 2012 and 2015, sampled wells showed exceedances of reporting levels for gross alpha activity, gross beta activity, and cesium-137 in at least one sampling location (INL 2018a).

USGS also collects samples annually from select wells at the INL Site for analysis of chloride, sulfate, sodium, fluoride, nitrate, chromium, selected other trace elements, total organic carbon, and volatile organic compounds (VOCs). Concentrations of chloride, nitrate, sodium, and sulfate historically have been above background concentrations in many wells at the INL Site, but concentrations were below established MCLs or secondary MCLs in all wells during 2015 (INL 2018a).

In 2017, samples from 26 groundwater monitoring wells across the INL Site were analyzed for 61 VOCs; 10 of these compounds were detected above the minimum detection limit of 0.2 or 0.1 microgram per liter (µg/L), depending on the compound, in at least one well (INL 2018a).

In 2017, samples at five wells in WAG-9 (which encompasses MFC) were collected and tested for radionuclides, metals, anions, cations, and other water quality parameters. Per the 2017 Annual Site Environmental Report, "Overall, the data show no discernable impacts [to groundwater quality] from activities at the MFC" (INL 2018a).

3.1.3.3 Drinking Water

Drinking water at the INL Site is routinely monitored to ensure it is safe for human consumption and to demonstrate that it meets Federal and State regulations. Drinking water parameters are regulated by the State of Idaho under authority of the SDWA. Parameters with primary MCLs must be monitored at least once every 3 years. Parameters with secondary MCLs are monitored every 3 years based on a recommendation by EPA. Sampling is generally more frequent when establishing a baseline, and subsequent sampling parameters/frequency are determined from the baseline result. Currently, the INL Site has 11 drinking water systems. Drinking water samples collected from these systems in 2017 were well below drinking water limits for all regulatory parameters. Specifically regarding MFC, concentrations of gross alpha activity, gross beta activity, nitrate, total trihalomethanes (TTHM), lead, and copper were detected, but all at levels well below the applicable MCL (INL 2018a).

3.1.3.4 Water Use and Rights

The SRPA is the only source of water for INL facilities. The INL's Federal Reserved Water Right permits a maximum water consumption of 11.4 billion gallons per year from the SRPA. In 2019, the INL Site's production well system withdrew a total of about 755 million gallons of water, which represents about 6.6 percent of the Federal Reserved Water Right for the INL Site (Nelson 2020).

3.1.4 Air Quality

This section describes the existing air quality and climate change conditions of the INL Site. The following five counties that encompass the INL Site comprise the immediate ROI for the project air quality analysis: Bingham, Bonneville, Butte, Clark, and Jefferson.

3.1.4.1 Meteorology and Climatology

The altitude, latitude, and intermountain setting of the INL Site combine to produce a continental and semi-arid climate for the region. This climate is characterized by relatively low precipitation, warm summers, cold winters, and wide fluctuations in diurnal and seasonal temperatures.

A prevailing westerly flow transports Polar storm systems and moisture from the Pacific Ocean into the INL region for much of the year. The Cascade Mountains, Coastal Ranges, and northern extension of Sierra Nevada mountain range block much of this moisture flow, which produces a rain shadow effect in the region and contributes to its aridity. This westerly flow regime provides the majority of annual precipitation to the region. From roughly July through September, weak westerly flow can be replaced by southerly flow that is part of the North American monsoon. This regime produces widely scattered rain shower and thunderstorm activity.

Climate and meteorological data collected at the Central Facilities Area (CFA) (14 miles west-southwest of MFC) and MFC are used to describe the climatic conditions of the INL Site and the MFC location (NOAA 2018). The average high and low temperatures at the INL Site in July are about 88 and 50 degrees Fahrenheit, respectively. January's average high and low temperatures are about 28 and 5 degrees Fahrenheit, respectively. Annual precipitation averages about 8.4 inches per year. The wettest and driest seasons are spring and summer, respectively. An average of 26 inches of snow falls annually at the INL Site. Thunderstorms occur mainly during the warmest months of the year and peak monthly activities occur in August.

Figure 3–6 shows a graphic of wind speed and wind direction data (wind rose) recorded at MFC for years 1994 through 2015. These data show that winds at MFC prevail from the southwest and northeast quadrants. This wind direction pattern is largely due to the regional geography, which frequently forces winds to flow up and down the southwest to northeast axis of the ESRP. The annual average wind speed is 9.4 miles per hour. May and June are the windiest months, when wind speeds average 11 miles per hour.

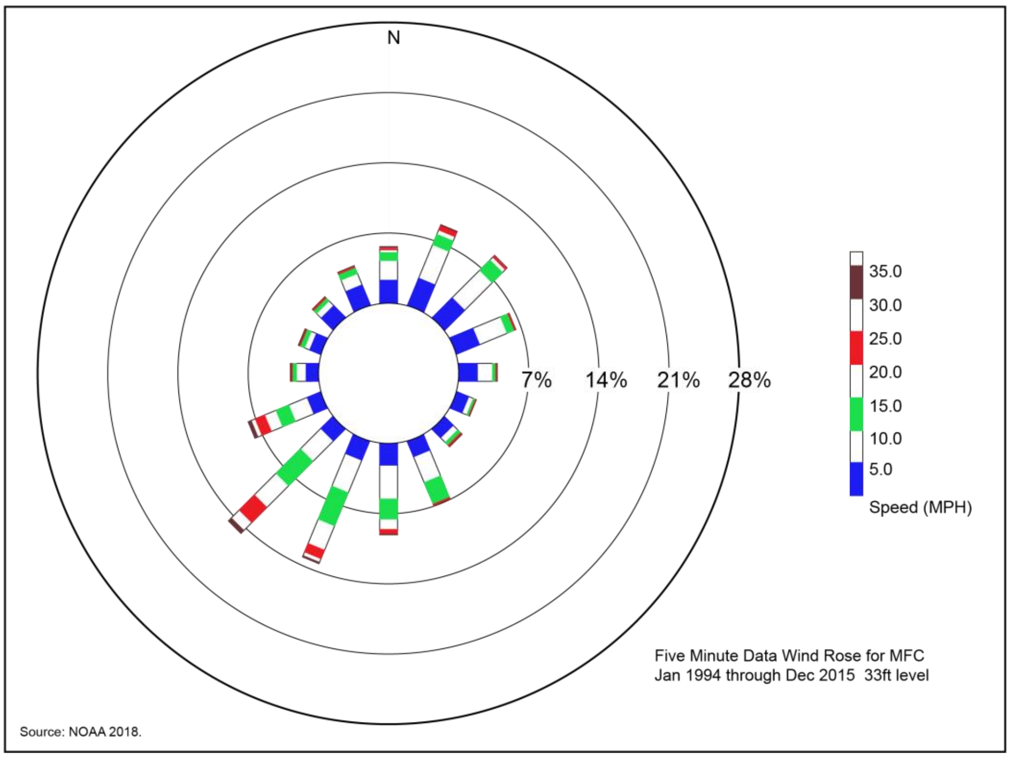


Figure 3–6. Wind Rose for the Materials and Fuels Complex – Years 1994 through 2015

3.1.4.2 Air Quality Standards and Regulations

The Clean Air Act (CAA) and its subsequent amendments establish air quality regulations and the National Ambient Air Quality Standards (NAAQS). In Idaho, the EPA has delegated authority to the IDEQ to enforce air quality regulations. The CAA establishes air quality planning processes and requires States to develop a State Implementation Plan that details how they will maintain the NAAQS or attain a standard in nonattainment within mandated timeframes. The requirements and compliance dates for attainment are based on the severity of the nonattainment classification of the area. The following summarizes the air quality rules and regulations that apply to the proposed action at the INL Site.

3.1.4.2.1 Nonradiological Air Emission Standards

Air quality at a given location can be described by the concentrations of various air pollutants in the atmosphere. Air pollutants are defined as two general types: (1) criteria pollutants and (2) hazardous air pollutants (HAPs). EPA establishes the NAAQS to regulate the following criteria pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than or equal to 10 microns in diameter (PM_{10}), particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), and lead. These standards represent atmospheric concentrations to protect public health and welfare and include a reasonable margin of safety to protect the most sensitive individuals in the population. The IDEQ implements the NAAQS and a State ambient standard for fluoride for purposes of regulating air quality in Idaho. The NAAQS are shown in **Table 3–2**.

Table 3–2. National Ambient Air Quality Standards

Pollutant	Averaging Time	National Standards [a]	
		Primary [b]	Secondary [c]
O_3	8-hour	0.070 ppm (137 μg/m³)	Same as primary
CO	8-hour	9 ppm (10 mg/m³)	Not applicable
	1-hour	35 ppm (40 mg/m³)	Not applicable
NO_2	Annual	0.053 ppm (100 μg/m³)	Same as primary
	1-hour	0.10 ppm (188 μg/m³)	Not applicable
SO_2	3-hour	Not applicable	0.5 ppm (1,300 μg/m³)
	1-hour	0.075 ppm (196 μg/m³)	Not applicable
PM_{10}	24-hour	150 μg/m³	Same as primary
$PM_{2.5}$	Annual	12 μg/m³	15 μg/m³
	24-hour	35 μg/m³	Same as primary
Lead	Rolling 3-month period	0.15 μg/m³	Same as primary

ppm = parts per million; μg/m³ = micrograms per cubic meter.
[a] Concentrations are expressed first in units in which they were promulgated. Equivalent units are included in parentheses.
[b] Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.
[c] Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.
Source: EPA 2016.

Ozone is formed in the atmosphere by photochemical reactions of previously emitted pollutants called precursors. Ozone precursors are mainly nitrogen oxides and photochemically reactive VOCs. In the presence of sunlight, the maximum effect of precursor emissions on ozone levels usually occurs several hours after they have been emitted and many miles from their source. Ozone concentrations are highest during the warmer months of the year and coincide with the period of maximum exposure to sun rays. Inert pollutants, such as carbon monoxide, tend to have the highest concentrations during the colder months of the year when light winds and nighttime/early morning surface-based temperature inversions inhibit atmospheric dispersion. Maximum inert pollutant concentrations usually are found near an emission source. Maximum PM_{10} concentrations in the vicinity of the INL Site occur in combination with fugitive dust generated by ground-disturbing activities (such as the operation of vehicles on unpaved surfaces and agricultural activities) and high wind events.

EPA designates all areas of the United States as having air quality better than (attainment) or worse than (nonattainment) the NAAQS. Former nonattainment areas that have attained the NAAQS are designated as maintenance areas. Presently, EPA categorizes the five counties that encompass the INL Site as in attainment of all NAAQS. The nonattainment area nearest to the INL Site is the Fort Hall Indian Reservation PM_{10} nonattainment area, which is in northeastern Power County and northwestern Bannock

County. Directly east of this area and centered in Pocatello is the Portneuf Valley PM_{10} maintenance area, which is the nearest maintenance area to the INL Site.

EPA also regulates HAPs that are known or are suspected to cause serious health effects or adverse environmental effects. The CAA identifies 187 substances as HAPs (e.g., benzene, formaldehyde, mercury, and toluene). HAPs are emitted from a range of industrial facilities and vehicles. EPA sets Federal regulations to reduce HAP emissions from stationary sources in the National Emission Standards for Hazardous Air Pollutants (NESHAP). A "major" source of HAPs is defined as any stationary facility or source that directly emits or has the potential to emit 10 tons per year or more of any HAP or 25 tons per year or more of combined HAPs. In Idaho, the IDEQ regulates HAPs and about 350 toxic air pollutants (TAPs), as the Idaho TAP program preceded the Federal program. Both programs set ambient levels of concern for HAPs and TAPs.

As part of the Prevention of Significant Deterioration (PSD) Regulation, the CAA provides special protection for air quality and air quality-related values (including visibility and pollutant deposition) in select National Parks, National Wilderness Areas, and National Monuments in the United States. These Class I areas are areas in which any appreciable deterioration of air quality is considered significant. In 1999, EPA promulgated a regional haze regulation that requires States to establish goals and emission reduction strategies to make initial improvements in visibility within their respective Class I areas. Visibility impairment is defined as a reduction in the visual range and atmospheric discoloration. Criteria to determine the significance of air quality impacts in Class I areas usually pertain to stationary emission sources, because mobile sources are generally exempt from permit review by regulatory agencies. However, Section 169A of the CAA states the national goal of prevention of any future impairment of visibility within Class I areas from manmade sources of air pollution. Craters of the Moon National Monument and Preserve is the closest PSD Class I area to the INL Site. Its nearest border is about 45 miles southwest of MFC. Therefore, this EIS provides qualitative analyses of the potential for emissions generated by the project alternatives to affect visibility within this pristine area.

The IDEQ Air Quality Division (AQD) is responsible for enforcing air pollution regulations in Idaho. The AQD enforces the NAAQS by monitoring air quality, developing rules to regulate and to permit stationary sources of air emissions, and managing the air quality attainment planning processes in Idaho. The IDEQ air quality regulations, "Rules for the Control of Air Pollution in Idaho," are found in the IDAPA Section 58.01.01 (IDEQ 2019). The operation of the INL Site includes sources that emit criteria and hazardous air pollutants and require a permit to construct (PTC), as outlined in IDAPA 58.01.01.200 through 228. These sources currently operate under a PTC (PTC #P-2015.0023) with a facility emissions cap. This PTC limits facility-wide emissions to below levels that would require a Title V operating permit and it rescinds the previous Title V permit that regulated emission sources at the INL Site (IDEQ 2018).

3.1.4.2.2 Greenhouse Gases and Climate Change

It is well documented that the Earth's climate has fluctuated throughout its history. However, recent scientific evidence indicates a correlation between increasing global temperatures over the past century and the worldwide proliferation of greenhouse gas (GHG) emissions by mankind. Climate change associated with global warming is predicted to produce negative environmental, economic, and social consequences across the globe.

GHGs are gases that trap heat in the atmosphere by absorbing infrared radiation. GHG emissions occur from natural processes and human activities. Water vapor is the most important and abundant GHG in the atmosphere. The most common GHGs emitted from natural processes and human activities include carbon dioxide (CO_2), methane, and nitrous oxide. The main source of GHGs from human activities is the combustion of fossil fuels, such as natural gas, crude oil (including gasoline, diesel fuel, and heating oil), and coal. Examples of GHGs created and emitted primarily through human activities include fluorinated gases (hydrofluorocarbons and perfluorocarbons) and sulfur hexafluoride. The main sources of manmade GHGs include refrigerants and electrical transformers.

Each GHG is assigned a global warming potential (GWP). The GWP is the ability of a gas or aerosol to trap heat in the atmosphere over a given period of time. The GWP rating system is normalized to CO_2, which has a value of one. For example, methane has a GWP of 28 over 100 years, which means that it has a global warming effect 28 times greater than CO_2 on an equal-mass basis (IPCC 2014). To simplify GHG analyses, total GHG emissions from a source are often expressed as a CO_2 equivalent (CO_2e), which is calculated by multiplying the emissions of each GHG by its GWP and adding the results together to produce a single, combined emission rate representing all GHGs. While methane and nitrous oxide have much higher GWPs than CO_2, CO_2 is emitted in such greater quantities that it is the overwhelming contributor to global CO_2e emissions from both natural processes and human activities.

Numerous studies document the recent trend of rising atmospheric concentrations of CO_2. The longest continuous record of CO_2 monitoring extends back to 1958 (Keeling 1960; Scripps Institution of Oceanography 2019). These data show that atmospheric CO_2 levels have risen an average of 1.6 parts per million per year over the last 60 years (NOAA 2019). As of 2018, CO_2 levels are about 40 percent higher than the highest levels estimated for the 800,000 years preceding the industrial revolution, as determined from CO_2 concentrations analyzed from air bubbles in Antarctic ice core samples (USGCRP 2018).

This section defines GHGs and the concept of CO_2e and discusses the link between the worldwide proliferation of GHG emissions by humankind and global warming. Global climate change has already had observable negative effects on the environment (IPCC 2014; USGCRP 2018). The potential future effects of global climate change include more worldwide environmental, economic, and social consequences. Predictions of long-term negative environmental impacts due to global warming include an increase in the rate of sea level rise; changing weather patterns, including increases in the severity of storms and droughts; changes to local and regional ecosystems, including the potential loss of species; and a substantial reduction in winter snowpack. In Idaho, the USGCRP predicts that annual average temperatures will increase between four and eight degrees Fahrenheit by 2100, based on both low and high global GHG emission scenarios (USGCRP 2018). In addition, average winter precipitation will increase over the long-term, but with an increase in annual variability. Predictions of the impacts of these changes to Idaho include (1) an increase in flooding, drought, and heat waves; (2) compromises to water supplies and hydropower; (3) an increase in wild fires; (4) damage to aquatic and terrestrial ecosystems; (5) an increase in the incidence of infectious diseases and other human health problems; and (6) stresses to agricultural productivity.

Federal agencies address emissions of GHGs by reporting and meeting reductions mandated in Federal laws, Executive orders, and agency policies. Some of these requirements include Executive Order 13834 and EPA *Final Mandatory Reporting of Greenhouse Gases Rule*. Executive Order 13834 identifies requirements for Federal agencies to increase efficiency and to report GHG emissions. Under the *Mandatory Reporting of Greenhouse Gases Rule*, stationary sources that emit 25,000 metric tons or more per year of CO_2e are required to report their annual GHG emissions to EPA. The INL Site emitted greater than 25,000 metric tons CO_2e emissions from stationary combustion sources in 2010 and therefore was subject to the mandatory reporting requirements. INL developed a GHG monitoring plan for stationary combustion and other regulated sources to meet the mandatory reporting requirements (DOE 2010a). From 2011 through 2015, the INL Site emitted less than 25,000 metric tons CO_2e emissions and is no longer subject to the mandatory reporting requirements.

The potential effects of GHG emissions from the project alternatives are by nature global and cumulative. Given the global nature of climate change and the current state of the science, it is not useful at this time to attempt to link the emissions quantified for local actions to any specific climatological change or resulting environmental impact. Nonetheless, GHG emissions from the project alternatives are quantified in this EIS for use as indicators of their potential cumulative contributions to climate change effects and for making reasoned choices among alternatives.

3.1.4.2.3 Radiological Air Emission Standards

Facilities at the INL Site have the potential to emit radioactive materials and, therefore, are subject to NESHAP, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." This regulation limits the radionuclide dose to a member of the public to 10 millirem per year. Subpart H also establishes requirements for monitoring emissions from facility operations and analyzing and reporting of radionuclide doses. Airborne radiological effluents are monitored at individual facilities at the INL Site (including MFC) to comply with the requirements of NESHAP and DOE Order 458.1, "Radiation Protection of the Public and the Environment."

3.1.4.3 Nonradiological Air Emissions

Sources of nonradiological air emissions at the INL Site include oil-fired boilers, diesel engines, emergency diesel generators; small gasoline, diesel, and propane combustion sources; and chemical and solvent usages. Boilers generate steam for heating facilities and are the main source of nonradiological air emissions at the INL Site. Diesel engines are mainly used to generate electricity for facility operations. All facilities at the INL Site use emergency diesel generators for emergency electrical power and emissions from these sources occur from periodic testing. Miscellaneous non-vehicle sources include small portable generators, air compressors, and welders. The main combustive sources at MFC are emergency diesel generators and diesel-powered emergency firewater pumps.

Table 3–3 presents a summary of the nonradiological air emissions that occurred in 2018 from stationary sources at the INL Site (including MFC) that are regulated under PTC P-2015.0023 (INL 2019a). These data show that regulated emissions in 2018 were below the facility emissions cap (FEC) limits. INL has applied to the AQD to modify PTC, and most of the FEC limits identified in Table 3–3 would change because of this process.

Table 3–3. Idaho National Laboratory Facility-Wide Emissions – Calendar Year 2018

Source	***Air Pollutant (tons per year)***							
	VOC	***CO***	***NO_x***	***SO_2***	***PM_{10}***	***$PM_{2.5}$***	***Single HAP***	***Total HAPS***
INL Facility Wide	2.66	11.58	35.65	2.16	3.51	3.51	1.26	1.49
FEC Emission Limits [a]	**3.7**	**17.7**	**95.0**	**16.9**	**5.6**	**5.6**	**10**	**25**

CO = carbon monoxide; FEC = facility emissions cap; HAP = hazardous air pollutant (Single HAP = hydrochloric acid); NOx = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] IDEQ 2018.

Source: INL 2019a.

3.1.4.4 Radiological Air Emissions

Radionuclide emissions at the INL Site occur from (1) point sources, such as process stacks and vents; and (2) fugitive sources, such as waste ponds, buried waste, contaminated soil areas, and decontamination and decommissioning (D&D) operations. During 2018, an estimated 1,477 curies of radioactivity were released to the atmosphere from all INL Site sources (INL 2019c). This level of release is within the range of releases from recent years and is consistent with the general downward trend observed over the past 10 years. For example, reported releases for 2010 and 2015 were 4,320 curies and 1,870 curies, respectively.

Radiological air emissions from MFC primarily occur from spent fuel treatment at the Fuel Conditioning Facility, waste characterization and fuel research and development at the Hot Fuel Examination Facility, fuel research and development at the Fuel Manufacturing Facility, and post-irradiation examination at the Irradiated Materials Characterization Laboratory. These facilities are equipped with continuous emission monitoring (CEM) systems and all radionuclide sources are controlled with high-efficiency particulate air (HEPA) filters. MFC released about 93 curies in 2018, which equate to about 12.9 percent of total the INL Site source term (INL 2019c).

For calendar year 2018, the effective dose equivalent from combined INL Site emissions to the maximally exposed individual (MEI) member of the public was 0.01 millirem per year, which is 0.1 percent of the 10 millirem-per-year standard (INL 2019c). Subpart H defines the MEI as any member of the public at any offsite location where there is a residence, school, business, or office. Radionuclide emissions from MFC contributed to about 18.7 percent of this impact. See Section 3.1.10 Human Health – Normal Operations, for additional discussion of the radiological impacts from site operations.

3.1.5 Ecological Resources

Ecological resources include the plant and animal species, habitats, and ecological relationships of the land and water areas within the ROI, which is the area directly or indirectly affected by the proposed action. Particular consideration is given in the ROI to sensitive species, which are those species protected under Federal or State law, including threatened and endangered species, migratory birds, and bald and golden eagles. For the purposes of this EIS, sensitive and protected ecological resources include plant and animal species that are federally (USFWS) or State- (Idaho Department of Fish and Game [IDFG]) listed for protection.

Ecological resources at the INL Site are monitored by the ESER Program. The program implements comprehensive species monitoring via routine plant and animal inventories. These include focused surveys (including, but not limited to, sensitive species, breeding birds, pygmy rabbits, greater sage-grouse, and bats), and vegetation classification efforts. Revegetation and weed management are also supervised through the program as needed. Historical reports and further information on ecological resources available on the INL Site are identified on the Idaho ESER website (INL 2019b).

3.1.5.1 Vegetation

The INL Site covers about 569,135 acres (or about 890 square miles), supports over 420 plant species, and occupies one of the largest tracts of relatively undisturbed sagebrush steppe habitat (INL 2020e). Vegetation communities within the site are dominated by various sagebrush species (*Artemisia* spp.). A diversity of other native shrubs, grasses, and herbaceous plants also thrive there. The INL sagebrush communities are dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), basin big sagebrush (*Artemisia tridentate* ssp. *tridentat*a), or a combination of both. Prevailing shrubs in non-big sagebrush communities may include green rabbitbrush (*Chrysothamnus viscidiflorus*), sickle saltbush (*Atriplex falcata*), black sagebrush (*Artemisia nova*), three-tip sagebrush (*Artemisia tripartita*), low sagebrush (*Artemisia arbuscul*a), spiny hopsage (*Grayia spinosa*), and shadscale (*Atriplex confertifolia*) (ESER 2019a).

BLM and DOE work in partnership to manage sagebrush resources at the INL Site. Together the agencies employ the INL Sagebrush-Steppe Ecosystem Reserve plan with input from IDFG, USFWS, and Native American Tribes. The Sagebrush-Steppe Ecosystem Reserve, which covers about 115 square miles (73,600 acres) in the northwest corner of the INL Site, was designated to ensure that this portion of the ecosystem receives special consideration and remains undisturbed (INL 2020e).

Vegetation communities within the 100-acre proposed project area were assessed during three field survey days in 2019 and 2020 to confirm the vascular plant resources within the area (Veolia 2019; VNSFS 2020). A total of 73 species and 5 vegetation communities were documented within the proposed project area. **Table 3–4** presents these communities. Nearly 60 percent of vegetation within the proposed project area is comprised of shrublands, 38 percent is disturbed, and 1 percent is grasslands. Vegetation class distribution within the proposed project area is also presented in **Figure 3–7**.

Table 3–4. Vegetation Communities within the Proposed Project Area

Vegetation Community	*Acres within the Proposed Project Area*
Crested Wheatgrass Ruderal Grassland	0.07 acres
Cheatgrass Ruderal Grassland	1.14 acres
Green Rabbitbrush/Thickspike Wheatgrass Shrub Grassland and Needle and Thread Grassland	24.9 acres
Big Sagebrush – Green Rabbitbrush (Threetip Sagebrush) Shrubland	35.0 acres
Previously disturbed/facilities	38.4 acres
	Total: ~100 acres

Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: Veolia 2019; VNSFS 2020.

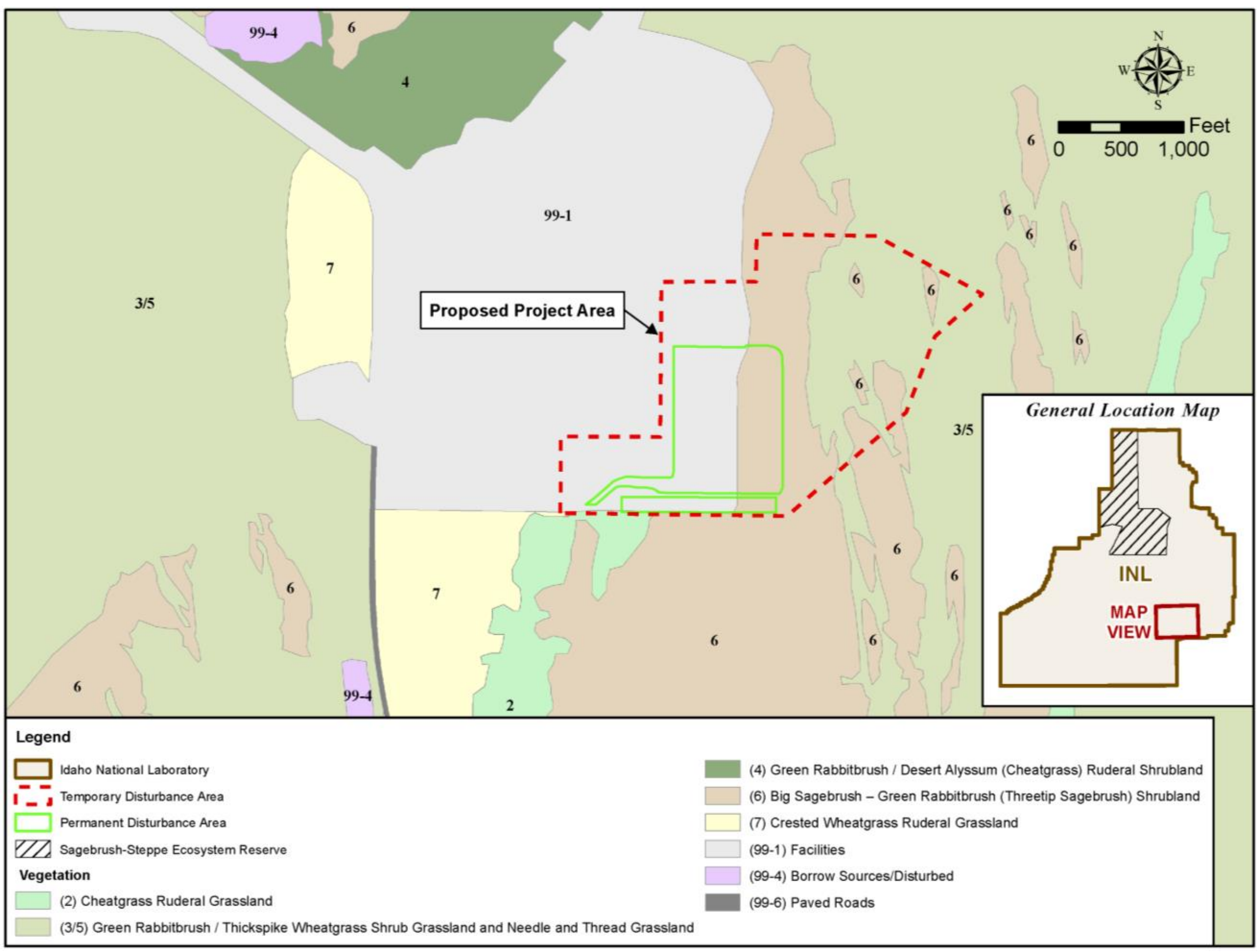


Figure 3–7. INL Vegetation Class Distribution within the Proposed Project Area

3.1.5.2 Invasive Plant Species

Invasive plants are those species whose introduction does or is likely to cause economic or environmental harm or harm to human health. Per the *Invasive Species Executive Order 13112*, the Idaho Department of Agriculture mandates the official noxious weed list of introduced, invasive, and harmful plants. At the INL Site, invasive species management and noxious weed control is monitored and managed throughout the site. According to *Weeds of the Idaho National Engineering and Environmental Laboratory* report, a total of 13 Idaho invasive weeds have been identified on the INL Site (INL 2020e). Battelle Energy Alliance (BEA) administers invasive plant species control, with support from the ESER program.

Within the proposed project area, field surveys documented 16 non-native species and 4 Idaho State-listed noxious weeds, including whitetop (*Cardaria draba*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), and bull thistle (*Carduus nutans*) (VNSFS 2020; USDA 2020). These species are relatively sparse in intact vegetation communities but become more frequent in highly disturbed areas, such as along fence lines and roadways (VNSFS 2020).

3.1.5.3 Wildlife

Sagebrush steppe ecosystems provide habitat for a variety of terrestrial wildlife species. Common small mammals observed at the INL Site include bushy-tailed woodrat (*Neotoma cinerea*), black-tail jackrabbit (*Lepus californicus*), mountain cottontail (*Sylvilagus nuttallii*), sagebrush voles (*Lemmiscus curtatus*), North American deer mice (*Peromyscus maniculatus*), Merriam's shrew (*Sorex merriami*), and American badgers (*Taxidea taxus*). Large mammal species include coyote (*Canis latrans*), bobcat (*Lynx rufus*), pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), moose (*Alces americanus*), mountain lion (*Puma concolor*), and elk (*Cervus canadensis*) (INL 2020e). A complete list of mammal species documented on the INL Site in 2001 is available on the ESER website (INL 2001).

Additionally, the sagebrush steppe ecosystem provides foraging and roosting habitat for a variety of resident and transient bat species. Eleven bat species have been recorded on the INL Site, including several species with heightened conservation concern (refer to *Special Status Species* below) (INL 2018c). Bats are known to frequent the proposed project area to forage and roost, and there is a potential for maternity roosts to occur within close proximity because there are caves distributed around the INL Site (Veolia 2019). For additional information on bats' use of the INL Site, refer to the *Idaho National Laboratory Bat Protection Plan* (2018) (DOE-ID 2018).

Common reptiles observed at the INL Site include the Great Basin spadefoot toad (*Spea intermontana*), sagebrush lizard (*Sceloporus graciosus*), short-horned lizard (*Phrynosoma douglassii*), Great Basin rattlesnake (*Crotalus oreganus lutosus*), western terrestrial garter snake (*Thamnophis elegans*), and gopher snake (*Pituophis catenifer*) (INL 2020e; VNSFS 2020). Fish species reported on the INL Site are limited to the Big Lost River during years when water flow is sufficient. However, there is no aquatic habitat to support fish species within the proposed project area.

In an effort to monitor bird populations on the INL Site, breeding bird surveys have been conducted almost annually since 1985. Surveys occur along five breeding bird survey (BBS) routes that are part of a nationwide survey administered by the U.S. Geological Survey and eight additional routes near INL Site facilities (ESER 2019c). In 2018, about 2,840 birds representing 53 species were documented during the BBSs across the INL Site. The most commonly identified bird species observed were horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), sage thrasher (*Oreoscoptes montanus*), sagebrush sparrow (*Artemisiospiza nevadensis*), Brewer's sparrow (*Spizella breweri*), common raven (*Corvus corax*), and mourning dove (*Zenaida macroura*) (ESER 2019c). The 2018 breeding bird surveyors observed eight species considered by the IDFG to be Species of Greatest Conservation Need (SGCN) on the INL Site. These birds are the sage thrasher, sagebrush sparrow, Franklin's gull (*Larus pipixcan*), common nighthawk (*Chordeiles minor*), ferruginous hawk (*Buteo regalis*), grasshopper sparrow (*Ammodramus savannarum*), burrowing owl (*Athene cunicularia*), and long-billed curlew (*Numenius americanus*) (ESER 2019c). Within the proposed project area, field surveys conducted in May 2020 documented a bobolink (*Dolichonyx oryzivorus*), which is also listed as a SGCN (VNSFS 2020). Additionally, one BBS INL facility route, Route M, occurs within the proposed project area (see **Figure 3–8**).

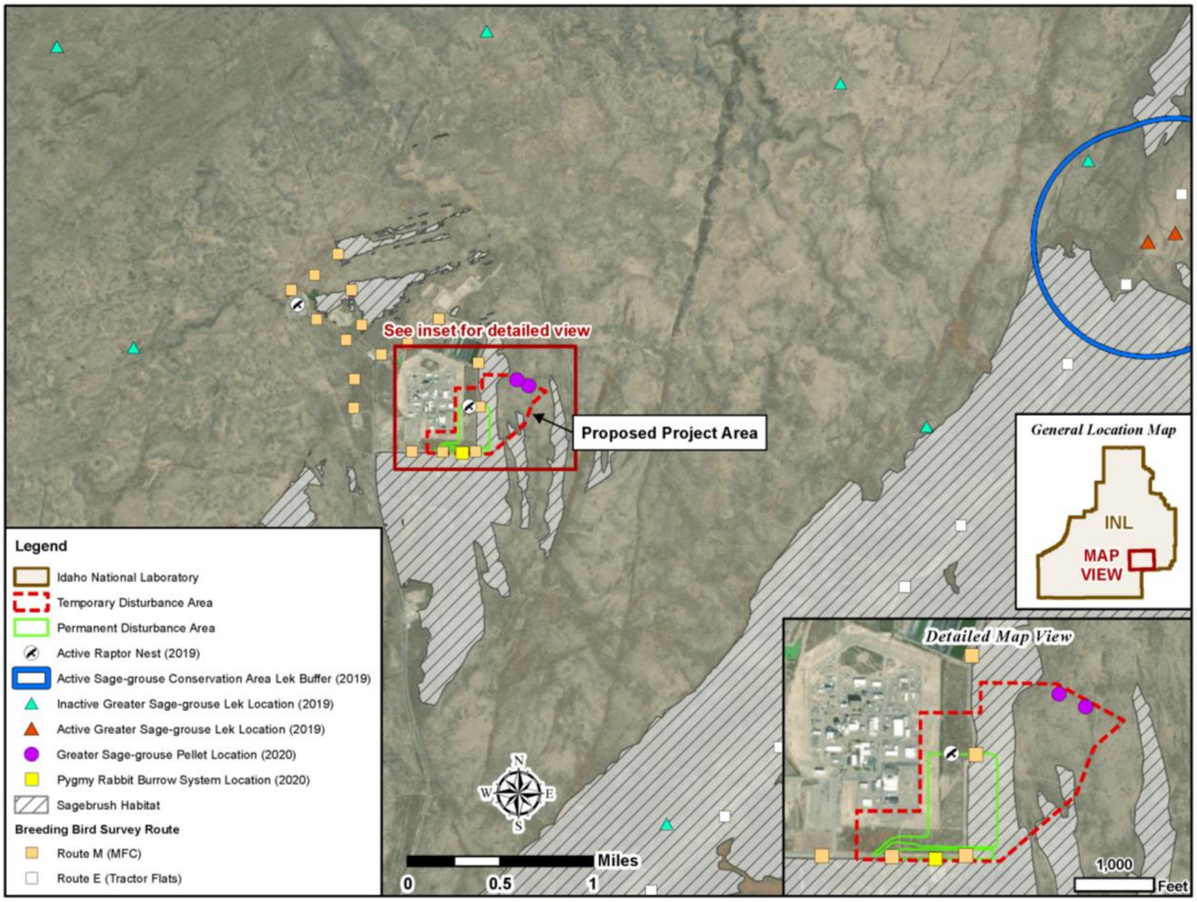


Figure 3–8. Sensitive Species Occurrences and/or Known Habitat Distribution within the Proposed Project Area

3.1.5.4 Special Status Species

Special status species include federally listed (USFWS) threatened, endangered, and State-designated (IDFG) sensitive species and their habitats. Applicable laws include the Endangered Species Act (ESA) (16 U.S.C. 1532 et seq.), the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-712), the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c), and the Idaho Fish and Game statutes (Title 36).

The USFWS's Information for Planning and Consultation (IPaC) online system was accessed to identify current USFWS trust resources with potential to occur within the proposed project area. On January 23, 2020, the Idaho Fish and Wildlife Office provided an automated Official Species List via Section 7 letter (USFWS 2019a). No federally listed species under the ESA have been observed or documented within the INL Site, and there is no designated critical habitat. According to the USFWS IPaC report, no federally listed species were identified as known to occur or have potential to occur within the proposed project area (USFWS 2020a).

The INL Site has no documented federally listed plant species. However, there are five rare and/or sensitive species (i.e., those that have a global or State ranking identified by the Idaho Natural Heritage Program) that are known to occur and 29 species have the potential to occur. Within the proposed project area, no sensitive plant species were recorded during the vegetation surveys. However, focused surveys that target peak identification periods have not been conducted (Veolia 2019; VNSFS 2020).

The IDFG *Idaho State Wildlife Action Plan* (SWAP) (IDFG 2017) prioritizes SGCN by three tiers (1, 2, and 3) based on relative conservation priority. Tier 1 SGCN are species of the highest priority for the SWAP and represent species with the most critical conservation needs. The plan includes an early warning list of taxa that have a highest probability of being listed under ESA in the near future. Tier 2 SGCN are species with high conservation needs and longer-term vulnerabilities or patterns suggesting management intervention is needed, but the species is not necessarily facing imminent extinction or having the highest management profile. Tier 3 SGCN are relatively common, yet long-term monitoring surveys indicate they are rapidly declining throughout the species' range. Sensitive species occurrences and known habitat distribution within the proposed project area is presented in Figure 3–8.

A number of SGCN wildlife have been reported on the INL Site. One SGCN Tier 1 bird (greater sage-grouse [*Centrocercus urophasianus]*), two SGCN Tier 2 bats (the hoary bat [*Lasiurus cinereus*] and silver-haired bat [*Lasionycteris noctivagans*]), and three SGCN Tier 3 bats (Townsend's big-eared bat [*Corynorhinus townsendii*], western small-footed myotis [*Myotis ciliolabrum*], and little brown myotis [*M. lucifugus]*) are known to occur on the INL Site (IDFG 2017). Habitat for these species includes lava tube caves, fractured rock outcrops, talus-flanked buttes, and juniper uplands (INL 2018c). Bats are known to use the proposed project area, and MFC provides an abundance of roost sites and foraging habitat (VNSFS 2020). Additionally, pygmy rabbits (*Brachylagus idahoensis*), a SGCN Tier 2, have been observed throughout the INL Site as well as within the proposed project area (ESER 2007). An active burrow system was identified on the southern boundary of the proposed project area during recent ecological surveys and several positive pygmy rabbit sightings were caught on wildlife cameras, confirming their presence within the site (see Figure 3–8) (VNSFS 2020). Pygmy rabbits are dependent on sagebrush for food and shelter throughout the year. They use the dense stands of big sagebrush growing in deep loose soils to dig burrows (NatureServe 2019).

The greater sage-grouse is a widespread, sagebrush-obligate species that has become an icon and symbol for conserving sagebrush across the western United States. Sage-grouse is known to occupy various areas at the INL Site (ESER 2019d). In 2014, DOE voluntarily entered into a *Candidate Conservation Agreement* with USFWS to protect the greater sage-grouse and its habitats on the INL Site, while allowing DOE flexibility in conducting its current and future missions (DOE-ID & USFWS 2014). Although the sage-grouse does not warrant protection under the ESA, DOE, and USFWS continue to collaborate on sage-grouse protection at the INL Site.

The INL Site establishes a Sage-grouse Conservation Area (SGCA) that limits infrastructure development and human disturbance in remaining sagebrush-dominated communities. The INL Site conservation framework protects lands within a 0.6-mile radius of all known active leks (sage-grouse communal breeding ground). Leks are categorized as historical, active, or inactive. Historical leks have not been surveyed since 2009. Active leks are part of established IDFG survey route or have been surveyed elsewhere using the protocol from the IDFG guidelines. (Guidelines require a lek survey to be conducted at least four times per year.) Inactive leks were not found to have an active breeding ground for at least 4 years within a 5-year period. (No sage-grouse activity was observed within the survey period [DOE-ID & USFWS 2014].) The INL Site sage-grouse population is assessed according to baseline conditions from 2011. As of 2019, 40 active leks were recorded (VNSFS 2020).

The proposed project area is not within the established SGCA, and there are no documented active or inactive leks. The closest known documented lek site is categorized as inactive, and it is located about 1.7 miles northwest. The closest active lek is located about 2.7 miles east of the proposed project area. During recent 2020 surveys sage-grouse signs (fecal pellets) were observed at two separate locations, indicating current sage-grouse use of the proposed project area (Figure 3–8) (VNSFS 2020). The proposed project area is subject to DOE's no net loss of sagebrush habitat policy on the INL Site.

Additionally, several species identified as Birds of Conservation Concern (BCCs) under the MBTA or as SGCN under State of Idaho regulations occur at the INL Site. The USFWS maintains a regional list of designated migratory birds known to occur in the United States. BCCs are a subset of MBTA-protected species identified by the USFWS as those in the greatest need of additional conservation action to avoid future listing under the ESA. BCCs have been identified at three geographic scales: National, USFWS Regions, and Bird Conservation Regions (BCRs). The INL Site is located within BCR 9 (Great Basin) and there are 28 BCCs listed (USFWS 2008). Additionally, the USFWS IPaC system identified five migratory bird species with potential to occur in the proposed project area: bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), Brewer's sparrow, sage thrasher, and willow flycatcher (*Empidonax traillii*) (USFWS 2020a). SGCN on the INL Site include bald eagle, golden eagle, Brewer's sparrow, burrowing owl, common nighthawk, grasshopper sparrow, greater sage-grouse, long-billed curlew, ferruginous hawk, Franklin's gull, loggerhead shrike (*Lanius ludovicianus*), peregrine falcon (*Falco mexicanus*), sage thrasher, sagebrush sparrow, and short-eared owl (*Asio flammeus*) (ESER 2019c).

3.1.5.5 Aquatic Resources

The nearest aquatic resources are within 1 mile of the proposed project area and include manmade ponds and sporadic riverine wetlands (see Figure 3–5). Riverine wetlands in Idaho typically occur in broad valleys and have fine-textured sediments, deposited by peak flows in the spring and early summer (IIFA 1999). In general, water flow patterns are typically intermittent within the shallow creeks. The sagebrush steppe terrain is typically flat or gently rolling (NWL 2019). There are no aquatic resources located within the proposed project area (VNSFS 2020).

3.1.5.6 Wildfire

Wildfire in Idaho is fairly common due to the landscape's arid conditions and dry vegetation. Wildland fire management is employed at the INL Site to prevent the loss of big sagebrush habitat and to protect sensitive species unique to the area (ESER 2019a). Fires on the INL Site pose heightened risks because of the potential to burn through radiologically contaminated areas. Restrictions are in place to minimize the potential for human-caused fires when vegetation is most susceptible to fire (INL 2020e). For more information on recent wildfires and past fire scars, refer to the *Wildfire Recovery Reports* available on the ESER website (INL 2001).

Decade old fire scars cover about 13.5 acres of the proposed project area. These fires have resulted in the loss of sagebrush habitat and increased the abundance of other native shrublands (such as green rabbitbrush) and native grasses (bluebunch wheatgrass [*Pseudoroegneria spicata*], bottlebrush squirreltail [*Elymus elymoides*], and Sandberg bluegrass [*Poa secunda*]) (Veolia 2019).

3.1.6 Cultural and Paleontological Resources

The area of potential effect (APE) was determined by the scope of the current undertaking, including all potential direct and indirect impacts associated with project activities. The project area encompasses about 100 acres east of MFC and extends east and south into currently undeveloped areas. Development in the far western section of the project area, a new Spent Fuel Storage Area (SFSA), will occur within the existing MFC security fence within an area already disturbed by MFC activities. Accounting for this disturbance, the APE was established as a 200-foot buffer surrounding all but the western perimeter of the project area to allow for new building construction, laydown areas, defensible security buffers, and egress during construction. The APE for new construction totals 138 acres.

In determining the APE, consideration was given to visual, auditory, and atmospheric effects that may be imposed by the proposed undertaking on architectural properties within the MFC facility. MFC consists of a 90-acre developed area, which includes an undeveloped security perimeter. Structures include analytical laboratories and other facilities that tend to be one- or two-story, block concrete buildings with towers and holding tank structures interspersed.

3.1.6.1 Ethnographic Resources

The Shoshone-Bannock Tribes have a long and traditional association with the area of the proposed action, as detailed in the following sections.

Native American Cultures

Native American cultural resources have been identified within the 138-acre APE that encompasses the proposed VTR facility construction area. Coupled with numerous recorded and yet to be identified properties within MFC and across the INL Site, the Shoshone-Bannock Tribes document the past, long-term use of the area. Representatives from the Shoshone-Bannock Tribes Heritage Tribal Office have indicated to DOE that pre-contact archaeological sites, native plants and animals, water, and other natural landscape features across the INL Site continue to fill important roles in Tribal heritage and ongoing cultural traditions.

Pre-contact sites, located throughout the INL Site, and oral histories establish the importance of the area in the seasonal round of the Shoshone and Bannock people. Much of the area now encompassing the INL Site served as a travel route within their traditional territory, providing access to the Birch Creek and Little Lost River valleys as well as the Camas Prairie and beyond. The Big Lost River, Big Southern Butte, and Howe Point served as seasonal base camps providing fresh water, food, and obsidian (volcanic glass) for tool making and trade. The Shoshone and Bannock people depended on a variety of plants and animals for food, medicines, clothing, tools, and building materials (NRC 2004).

The importance of plants, animals, water, air, and land resources on the ESRP to the Shoshone and Bannock peoples is reflected in the sacred reverence in which they hold the resources. Specific places in the ESRP have sacred and traditional importance to the Shoshone and Bannock people, including buttes, caves, and other natural landforms on or near the INL Site (NRC 2004).

Native American and Euro-American Interactions

The influence of Euro-American culture and loss of aboriginal territory and reservation land severely impacted the aboriginal subsistence cultures of the Shoshone and Bannock people. Settlers began establishing homesteads in the valleys of southeastern Idaho in the 1860s, increasing the conflicts with aboriginal people and providing the motivation for treaty-making by the Federal government. The Fort Bridger Treaty of 1868 and associated Executive orders designated the Fort Hall Reservation for mixed bands of Shoshone and Bannock people. A separate reservation established for the Lemhi Shoshone was closed in 1907, and the Native Americans were forced to migrate to the Fort Hall Reservation across the area now occupied by the INL Site.

The original Fort Hall Reservation, consisting of 1.8 million acres, has been reduced to about 544,000 acres through a series of cessions to accommodate the Union Pacific Railroad and the growing city of Pocatello. Other developments, including the flooding of portions of the Snake River bottoms by the construction of the American Falls Reservoir, have also reduced the Shoshone-Bannock Tribes' land base.

The creation of the INL Site had an impact on the Shoshone and Bannock subsistence culture. Land withdrawals initiated by the U.S. Navy during World War II and continued by the Atomic Energy Commission during the Cold War restricted access to authorized personnel. In addition, initial construction of facilities on the INL Site may have impacted cultural resources of importance to the Tribes, including traditional and sacred areas and artifacts (NRC 2004).

Contemporary Cultural Practices and Resource Management

The efforts of the Shoshone-Bannock Tribes to maintain and revitalize their traditional cultures are dependent on having continual access to aboriginal lands, including some areas on the INL Site. DOE accommodates Tribal member access to areas on the INL Site for subsistence and religious uses. Also, Tribal members continue to hunt big game, gather plant materials, and practice religious ceremonies in traditional areas that are accessible on public lands adjacent to the INL Site. The historical record described in the *INL Cultural Resources Management Plan* (INL 2016f) supports the conclusion that the INL Site is located within a large, traditional territory of the Shoshone and Bannock people and there are archaeological and other cultural resources that reflect the importance of the INL Site area to the Tribes. DOE recognizes the unique interest the Shoshone-Bannock Tribes have in the management of resources on the INL Site and continues to consult with the Tribes concerning Federal undertakings and management of cultural and natural resources.

The maintenance of pristine environmental conditions, including native plant communities and habitats, natural topography, and undisturbed vistas, is critical to continued viability of the Shoshone and Bannock culture. Contamination from past and ongoing operations at the INL Site has the potential to affect plants, animals, and other resources that Tribal members continue to use and deem significant (NRC 2004). Due to the lack of nearby permanent water sources, the archaeological evidence within the proposed VTR construction location is limited to single, short-term events. The area has been disturbed by fire and the subsequent planting of crested wheatgrass, a non-native bunchgrass that occurs on the INL Site and was planted in areas around MFC that were burned by wildland fires. It is unlikely that any sensitive Tribal resources are present within the project area (Lee 2020).

3.1.6.2 Cultural Resources

The INL Site and surrounding areas are rich in cultural resources, including pre-contact and early historic archaeological artifacts and features left by the Shoshone and Bannock people, as well as artifacts and features left by early pioneers, homesteaders, and ranchers who also frequented the area. Historic uses of the area include attempts at homesteading and as a route for cattle drives and settlers traveling west. The most recent use of the area facilitated the nuclear technology age with research and development of nuclear power. Descendants of pioneers who crossed the INL Site on Goodale's Cutoff or homesteaders who attempted to scrape an existence from the desert soils or employees who participated in the initial operations on the INL Site retain a special connection to the land.

To date, numerous cultural resource surveys have been conducted at the INL Site. These surveys have identified many archaeological properties and properties associated with the historic built environment. The archaeological record on the INL Site represents nearly 13,500 years of human occupation and land use. Many archaeological sites, buildings, and structures are significant and are either potentially eligible for or eligible for listing on the National Register of Historic Places (NRHP).

Archaeological Resources

Archaeological resources encompass Native American occupation sites and late 19th and early 20th century Euro-American cultural resources associated with mining, canal and railroad construction, emigration and homesteading, agriculture, and ranching. Archaeological surveys and investigations conducted in southeastern Idaho have provided evidence of human use of the ESRP for at least 12,500 years, which is supported by radiocarbon dates on excavated materials from Owl Cave at the Wasden site located on private land near the INL Site. Numerous collapsed lava tubes and caves on the INL Site provide evidence of pre-contact occupation. Recognizing the importance of these resources, Aviator's Cave was listed on the NRHP in 2010.

Southeastern Idaho is also rich with cultural resources that reflect the settlement and development of the region by Euro-American explorers and settlers. As the westward expansion entered the region, artifacts and features were left behind that provide a record of historic uses and development of the area. Many of these cultural resources exist within the INL Site boundaries. The region is etched with historic trails used by emigrants on their way to Oregon and California, prospectors headed to the gold fields, and settlers who attempted to homestead the area. Many of these trails were also used for cattle drives and, in the late 1800s, as stage and freight routes, to support mining towns in central Idaho. Encouraged by the Carey Act, homesteaders attempted to settle and farm the area along the Big Lost River in the late 1800s and early 1900s, but irrigation efforts in the high desert climate failed. Subsequently, homesteads were abandoned, and Euro-American settlement and development of the region ceased (DOE 2002a).

The area of the proposed VTR facility construction was subject to intensive pedestrian archaeological survey. The investigation identified five pre-contact cultural resources, but none of the resources were determined to meet the threshold of significance to be recommended as eligible for listing on the NRHP (Lee 2020).

Historic Resources

Resources within the built environment consist of modern roads, railroad tracks, irrigation canals, and transmission and telephone lines, along with buildings and landscape features associated with the Arco Naval Proving Ground and the National Reactor Testing Station's nuclear energy research beginning in 1949. MFC was initially established as Argonne National Laboratory – West (ANL-W) and was operated by the University of Chicago from 1949 to 2005. Prior to the development of the second Experimental Breeder Reactor (EBR-II) at ANL-W, researchers and operators successfully demonstrated the creation of usable quantities of electricity at EBR-I for the Atomic Energy Commission (AEC). EBR-I, located over 18 miles west of MFC, was designated as a National Historic Landmark by President Lyndon B. Johnson in 1966 for its outstanding historical significance in reactor development and design. Following decontamination, in 1975 the Reactor Building and associated Office Annex were opened as a public Visitor Center.

MFC, which is located about 38 miles west of Idaho Falls in Bingham County, is in the southeastern corner of the INL Site. MFC is about 100 acres (inside the MFC fence) and about 2.7 miles from the southern INL Site boundary. MFC is engaged in advanced nuclear power research and development, spent fuel and waste treatment technologies, national security programs, and projects to support space exploration. Since it was established in 1949, MFC's primary mission has been to take nuclear power systems through the steps from design to demonstration.

Five buildings within MFC have been proposed for modification to support fabrication of VTR driver fuel: the Hot Fuels Examination Facility (HFEF), the Irradiated Materials Characterization Laboratory (IMCL), the Fuel Conditioning Facility (FCF), the Zero Power Physics Reactor (ZPPR), and the Fuel Manufacturing Facility (FMF). Internal reconfiguration activities within these existing MFC facilities, in which additional equipment would be installed for proposed post-irradiation testing, spent fuel treatment, and fuel fabrication, are exempt from cultural resource review by agreement among the INL Site, the Idaho State Historic Preservation Officer, the Advisory Council on Historic Preservation, and the Shoshone-Bannock Tribes (INL 2016f:51). Construction of the SFSA will require the removal of the existing guardhouse, MFC-

1741. The guardhouse was constructed in 2016 and does not meet the standard 50-year age requirement for historic significance. Another facility, the Experimental Fuels Facility may also be used for testing VTR Fuel cladding. However, no modifications are anticipated.

Table 3–5 lists the NRHP status of the seven existing facilities within the MFC that are proposed for use or removal in operations of the VTR, including post-irradiation testing and spent fuel treatment.

Table 3–5. Materials and Fuels Complex Facilities Proposed for Use in Operations of the VTR

Facility Name	*Facility Number*	*Year Built*	*NRHP Eligibility*	*Proposed Action*
Fuel Manufacturing Facility (FMF)	MFC-704	1986	Not Eligible	Internal Modification
Fuel Conditioning Facility (FCF)	MFC-765	1963	Eligible	Internal Modification
Zero Power Physics Reactor (ZPPR)	MFC-776	1968	Eligible	Internal Modification
Hot Fuels Examination Facility (HFEF)	MFC-785	1972	Eligible	Internal Modification
Experimental Fuel Facility (EFF)	MFC-794	1975	Not Eligible	No Modification [a]
Irradiated Materials Characterization Laboratory (IMCL)	MFC-1729	2012	Not Eligible	Internal Modification
Guardhouse	MFC-1741	2016	Not Eligible	Demolition

[a] The Experimental Fuels Facility may be used for testing VTR Fuel cladding but no modifications are anticipated.
Source: INL 2016f.

3.1.6.3 Paleontological Resources

Paleontological resources are fossils of plants or animals from a former geologic age used to investigate prehistoric biology and ecology. Survey and evaluation for paleontological remains within the INL Site boundaries have identified several fossils that suggest that the region contains varied paleontological resources. Analyses of these materials and site locations suggest that these types of resources are found in areas of basalt flows, particularly in sedimentary interbeds or lava tubes within local lava flows, and in some wind and sand deposits. Other and more specific areas in which these resources are likely to occur are in the deposits of the Big Lost River, Little Lost River, Birch Creek, and Lake Terreton and playas. Vertebrate and invertebrate animals, pollen, and plant fossils have been discovered in caves, in lake sediments, and in alluvial gravels along the Big Lost River. Twenty-four paleontological localities have been identified in published data. Vertebrate fossils include mammoth and camel remains, and a horse fossil identified in a borrow source near the CFA (NRC 2004). Paleontological resources are not governed by the same set of laws that apply to cultural resources, but are managed in the same way under the *INL Cultural Resources Management Plan* (INL 2016f).

3.1.7 Infrastructure

Site infrastructure includes those basic resources and services required to support planned construction and operations activities and the continued operations of existing facilities. For the purposes of this EIS, infrastructure is defined as electricity, fuel, water, and sewage. The ROI for infrastructure includes those items at MFC. Waste management and transportation infrastructure are addressed separately in Sections 3.1.9 and 3.1.12, respectively.

Capacities and characteristics of INL's utility infrastructure are summarized in **Table 3–6**. Section 3.1.12, Traffic, addresses local and regional transportation, infrastructure, and waste and material shipments.

Table 3–6. Idaho National Laboratory Site-Wide Infrastructure Characteristics

Resource	*Site Usage*	*Site Capacity*
Electricity		
Energy Consumption (megawatt-hours per year)	186,255	481,800 [a]
Peak Load (megawatts)	36	55
Fuel		
Natural Gas (cubic feet per year)	902,001	Not applicable
Fuel Oil for Heating (gallons per year)	571,028	Not limited [b]
Diesel Fuel (gallons per year)	262,909	Not limited [b]
Gasoline (gallons per year)	627,007	Not limited [b]
Propane (gallons per year)	754,699,070	Not limited [b]
Water (gallons per year)	902,001	11.400,000,000 [c]

[a] Limited by contract with the Idaho Power Company.
[b] Capacity is limited only by the ability to ship resources to the site.
[c] Water right allocation.
Source: Nelson 2020.

3.1.7.1 Electricity

Commercial electric power is delivered by contract with Idaho Power Company to supply the operating areas of the INL Site by way of an extensive power transmission and distribution system (see **Figure 3–9**). Offsite power feeds into the INL Site power transmission system through the Scoville substation. Power to the Scoville substation and the INL Site is provided via two 230-kilovolt (kV) transmission lines from Rocky Mountain Power's Antelope substation. At the Antelope substation, the voltage is stepped down to 138 kV, then transmitted to the DOE-owned Scoville substation via two redundant feeders. The Antelope substation feeds the Scoville substation via three different transformers, a pair of 161kV-138kV transformers, and a single 230kV-161kV transformer, fed from three local utilities. The Scoville substation is the end and the beginning of the 138kV INL loop (Nelson 2020).

The current contract allows for a total power demand of up to 50,000 kilowatts (50 megawatts [MW]), but can be increased to 55,000 kilowatts (55 MW) if advance notice is provided to Idaho Power. Power demand above this transmission would need to be negotiated with Idaho Power.

The INL Site power system consists of eight substations, with two more under construction, and nearly 70 miles of aboveground 138-kV-rated high-voltage transmission lines. Much of the system is looped, which provides a reliable and redundant source of power (Wayment et al. 2019). A separate 6.2-mile, 138-kV line feeds the INL Radioactive Waste Management Complex with capacity in excess of 20 MW. The distribution system ranges in voltage from 13.8 to 2.4 kV and is composed of about 60 miles of overhead lines and several miles of underground lines. The transmission loop capacity is 50 MW.

Electrical energy available to the INL Site is about 481,800 MW-hours per year based on the contract load limit of 55,000 kilowatts (55 MWs) for 8,760 hours per year. Current electrical energy consumption at the INL Site is 186,255 MW-hours annually. The recorded peak load was about 39 MWs; current electrical usage at MFC is about 28,700 MW-hours per year (Nelson 2020).

The current power transmission system is over 50 years old and is limited by available contractual supply capacity and voltage-drop problems directly related to the location where loads are applied on the loop. The current system can only support an approximate increase in peak demand of 20 MW to 30 MW and still maintain acceptable power quality (Wayment et al. 2019).

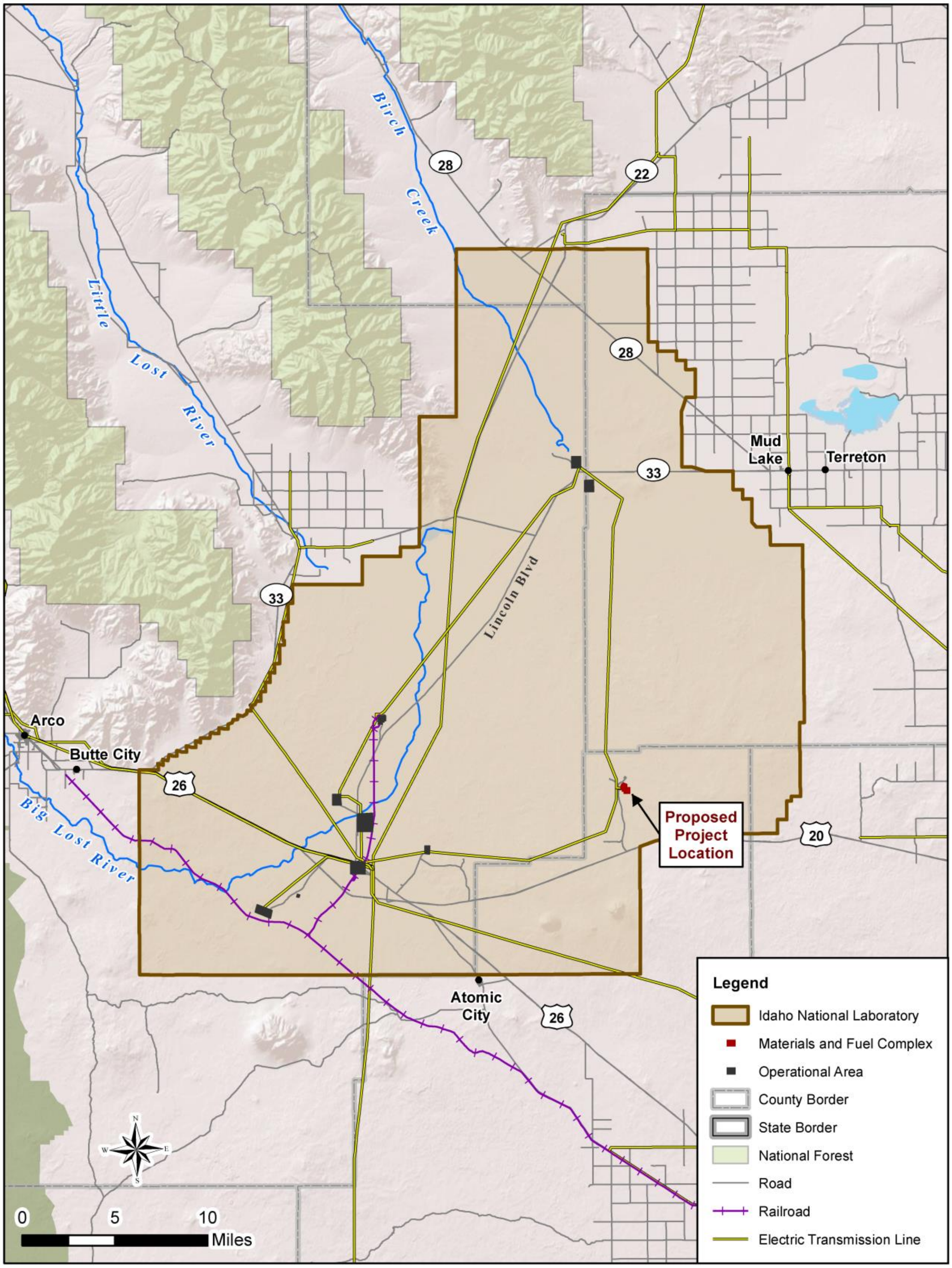


Figure 3–9. Idaho National Laboratory Infrastructure (includes electrical distribution, roads, and rail lines)

Electricity at MFC is supplied by the INL Site's transmission loop system. Annual electric consumption at MFC is just over 35.4 megawatt-hours (MWh). Annual electric usage for selected facilities at MFC is indicated in **Table 3–7**.

Table 3–7. Electrical Usage for Facilities on the Materials and Fuels Complex (kilowatt-hour)

Building Number	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	Average
MFC-704 Fuel Manufacturing Facility	697,566	812,552	833,029	769,870	835,376	789,679
MFC-765 Fuel Conditioning Facility	NA	NA	NA	2,071,180	2,064,979	2,068,080
MFC-768 Power Plant	1,996,422	1,423,303	106,363	1,200,155	1,303,763	1,206,001
MFC-774 Electron Microscopy Laboratory	NA	984,247	1,182,244	1,068,566	933,242	1,042,075
MFC-784 Advanced Fuels Facility	68,707	87,448	119,504	103,902	99,299	95,772
MFC-785 Hot Fuel Examination Facility (HFEF)	NA	2,542,919	2,607,832	2,219,233	2,365,578	2,433,891

NA = data not available.
Source: Nelson 2020.

3.1.7.2 Fuel

Fuel consumed at INL includes natural gas, fuel oil (for heating), diesel fuel, gasoline, and propane. All fuels are transported to the site for use and storage. There are no gas or oil lines on the INL Site, although individual facilities may have propane or fuel storage tanks (INL 2015b). Fuel storage is provided for each facility and inventories are restocked as needed. INL site-wide fuel oil consumption was about 902,000 gallons in 2019 (Nelson 2020). In 2019, natural gas consumption was about 3,149,200 cubic feet, total diesel fuel consumption was about 571,000 gallons, total gasoline consumption was about 262,900 gallons, and total propane consumption was about 627,000 gallons (see Table 3–5) (Nelson 2020).

3.1.7.3 Water

The SRPA supplies all water used at the INL Site. Water is provided to the INL Site by a system of about 30 wells, pumps, and storage tanks. DOE holds the Federal Reserved Water Right of 11.4 billion gallons per year for the site. In 2019, INL's production well system withdrew a total of about 755 million gallons of water, which represents about 6.6 percent of the Federal Reserved Water Right for the INL Site (Nelson 2020).

The MFC water supply and distribution system is a combination fire-protection, potable, and service water supplied from an underground aquifer via two onsite deep production wells. The two deep wells (EBR-II #1 and EBR-II #2) have a pumping capacity of 800 gallons per minute or 420 million gallons annually. These wells can be connected with control valves to either a storage tank or directly to the distribution system, as necessary. The two wells at MFC withdrew 26,754,578 gallons, or about 3.5 percent of the total water withdrawn across INL (INL 2018b). Typically, well water is pumped to a 400,000-gallon primary storage tank and then through the distribution system for potable, service, and fire-protection use. A second 400,000-gallon water storage tank, reserved for fire protection, is maintained at full capacity. Currently, MFC water demand and usage from its two production wells is about 48 million gallons annually. Accurate potable water flow information is difficult to determine. MFC's water supply demands average 50-60 gallons per minute and the system flows from 20-225 gallons per minute throughout the year. Water demand spikes are most likely due to fire water testing (INL 2019h).

The existing firewater supply system for MFC consists of a looped network of buried 6-, 8-, 10-, 12-, and 14-inch diameter fire mains. The lead-ins to the buildings are typically 6 inches in diameter. Piping materials differ depending on the era of installation and includes cast iron, ductile iron, cement-lined ductile iron, and polyvinyl chloride. The system is designed so that if any segment of the firewater main is isolated, water can be supplied through an alternate flow path (INL 2019h).

3.1.7.4 Sanitary Sewer

MFC has an existing sanitary sewer system to collect and treat domestic wastewater from the facilities. The majority of the facilities are served by a collection system consisting of gravity sewers and several lift stations and force mains. Collected wastewater is conveyed to one of two lift stations that pump the wastewater through a 4-inch high-density polyethylene force main to three total containment sewage lagoons for final disposal and evaporation. Some small areas of MFC are served by local onsite subsurface disposal systems and are independent from the primary collection system. The existing MFC wastewater lagoons were designed for flows of about 14,950 gallons per day. Based on information provided by MFC staff in 2017, the average daily flow to the lagoons was about 7,840 gallons per day (INL 2019h).

3.1.7.5 Industrial Wastewater

MFC industrial wastewater operates using a collection system consisting of gravity pipelines, ditches, and structures located throughout the MFC site. Collected wastewater is conveyed to an industrial wastewater pond, permitted by IDEQ, located outside the perimeter security fence near the northwest corner of the facility. MFC currently generates 7 to 8 million gallons of industrial wastewater per year; the permit from the IDEQ for the existing industrial wastewater pond allows 17 million gallons per year (INL 2019h).

3.1.7.6 Telecommunications

MFC uses existing INL Site telecommunications services for telephone and business and research data network needs. Services are provided to buildings via fiber optic and copper cabling from MFC-1728 where telephone, INL Site data network, Private Facility Controls Network, security systems, and life safety systems are housed. The existing MFC telecommunications infrastructure system is comprised of a main dial room, an auxiliary dial room, and telecommunications manhole/duct system (INL 2019h).

3.1.8 Noise and Vibration

The ROI for noise extends 0.5 mile from the edge of the construction area, and is the area that could be susceptible to noise impacts.

This EIS considers the following data sources for characterizing the noise environment and vibration:

- Aerial photography to identify potential noise-sensitive receptors near the project area, including the Google Earth™ imagery for counties within the project area.
- The 2018 U.S. Department of Transportation (DOT) Federal Transit Administration Transit Noise and Vibration Impact Assessment methodology to estimate ambient, construction, and operational noise levels and to evaluate general noise and vibration concepts (DOT 2018).
- EPA methodology for noise concepts and limits (EPA 1978).
- 2018 Idaho National Laboratory Site Environmental Report (INL 2019c).

3.1.8.1 Noise and Vibration Overview

Sound is a physical phenomenon consisting of vibrations that travel through a medium, such as air, and are sensed by the human ear. Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise intrusive. Human response to noise varies, depending on the type and characteristics of the noise, distance between noise source and receptor, receptor sensitivity, and time of day. Noise is often generated by activities essential to a community's quality of life, such as construction or vehicular traffic.

Sound varies by both intensity and frequency. Sound also can be quantified in terms of its amplitude (loudness) and frequency (pitch). The physical intensity or loudness level of noise is expressed quantitatively as the sound pressure level. Sound pressure levels are defined in terms of decibels (dB), which are measured on a logarithmic scale. Frequency is measured in hertz, which is the number of cycles per second. The typical human ear can hear frequencies ranging from about 20 hertz to 20,000 hertz. Typically, the human ear is most sensitive to sounds in the middle frequencies where speech is found and is less sensitive to sounds in the low and high frequencies.

> **Sound** is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air. The human ear experiences sound as a result of these pressure variations in the air.
>
> **Noise** is defined as any unwanted sound.

Because the human ear cannot perceive all pitches or frequencies equally, measured noise levels in dB will not reflect the actual human perception of the loudness of the noise. Thus, the sound measures can be adjusted or weighted to correspond to a scale appropriate for human hearing. The common sound descriptors used to evaluate the way the human ear interprets dB from various sources are as follows:

- **Decibel (dB)**: Sound intensity is measured by sound pressure in levels known as decibels. The decibel is a logarithmic unit that expresses the ratio of a sound pressure level to a standard reference level.
- **A-Weighted Decibel Scale (dBA):** Often used to describe the sound pressure levels that account for how the human ear responds to different frequencies and perceives sound.
- **Hertz**: Measurement of frequency or pitch.
- **Equivalent Sound Level (L_{eq}):** The L_{eq} represents the average sound energy over a given period, presented in decibels.
- **Day-Night Average Sound Level (L_{dn}):** The L_{dn} is the 24-hour L_{eq}, but with a 10-dB penalty added to nighttime noise levels (10 p.m. to 7 a.m.) to reflect the greater intrusiveness of noise experienced during this time.
- **Sensitive Receptors**: Locations or land uses associated with indoor or outdoor areas inhabited by humans that may be subject to significant interference from noise (i.e., nearby residences, schools, hospitals, nursing home facilities, and recreational areas).

Table 3–8 presents a list of sounds encountered in daily life and their approximate levels in dBA. **Table 3–9** presents the typical sound levels associated with residential communities.

Table 3–8. Examples of Common Sound Levels

Noise Level (dBA)	*Description*	*Typical Sources*
140	Threshold of pain	–
120	Uncomfortably loud	Jet aircraft
100	Very loud	Diesel truck
80	Moderately loud	Motor bus
60	Moderate	Low conversation
40	Quiet	Quiet room
20	Very quiet	Leaves rustling

dBA = A-weighted decibel.
Source: Liu and Lipták 1997.

Table 3–9. Typical L_{90} Sound Levels in Residential Communities

Description	*Typical Range (dBA)*	*Average (dBA)*
Very Quiet Rural or Remote Area	26 to 30	28
Very Quiet Suburban or Rural Area	31 to 35	33
Quiet Suburban Residential	36 to 40	38
Normal Suburban Residential	41 to 45	43
Urban Residential	46 to 50	48
Noisy Urban Residential	51 to 55	53
Very Noisy Urban Residential	56 to 60	58

dBA = A-weighted decibel.
Note: L_{90} is the level exceeded for 90 percent of the time. For 90 percent of the time, the noise level is above this level. It is generally considered to be representing the background or ambient level of a noise environment.
Source: EPA 1974.

Ambient or background noise is a combination of various sources heard simultaneously. Calculating noise levels for combinations of sounds does not involve simple addition, but instead uses a logarithmic scale (HUD 1985). As a result, the addition of two noises, such as a garbage truck (100 dBA) and a lawn mower (95 dBA) would result in a cumulative sound level of 101.2 dBA, not 195 dBA.

Noise levels decrease (attenuate) with distance from the source. The decrease in sound level from any single noise source normally follows the “inverse square law.” That is, the sound level change is inversely proportional to the square of the distance from the sound source (DOT 2018). Barriers, both manmade (e.g., sound walls, buildings) and natural (e.g., forested areas, hills) may reduce noise levels, as may other natural factors, such as temperature, humidity, and wind direction (EPA 1978). Persistent and escalating sources of sound are often considered annoyances and can interfere with normal activities, such as sleeping or conversation, so that these sounds could disrupt or diminish quality of life.

Vibration refers to the oscillations or rapid linear motion of parts of a fluid or elastic solid. Vibration is often expressed in terms of the peak particle velocity, as inches per second or millimeters per second, when used to evaluate human annoyance and building damage impacts. Common sources of ground-borne vibration are trains, heavy construction machinery, and groundbreaking construction activities such as blasting, drilling, and operating heavy earth-moving equipment. The impacts of ground-borne vibration include perceptible movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In severe cases, the vibration can cause damage to buildings (DOT 2018).

While there are no Federal standards for vibration, various researchers and organizations have published guidelines. The human response to vibration involves barely perceptible vibration levels (in peak particle velocity) of 0.01 inches per second, distinctly perceptible levels of 0.04 inches per second, and strongly perceptible levels of 0.10 inches per second (Jones and Stokes 2004). Continuous, frequent, or intermittent vibration sources are typical of construction activities. Additionally, 0.2 inches per second is the threshold at which there is a risk of architectural damage to normal structures, such as dwellings (Jones and Stokes 2004).

3.1.8.2 Noise Regulations

The Noise Control Act of 1972 (42 U.S.C. 4901) directs Federal agencies to comply with applicable Federal, State, interstate, and local noise control regulations. The primary responsibility of addressing noise pollution has shifted to State and local governments. In 1974, EPA published its document entitled *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, which evaluated the effects of environmental noise with respect to health and safety (EPA 1974). The document provides information for State and local agencies to use in developing their ambient noise standards. As set forth in the publication, an L_{dn} of 55 dBA outdoors and 45 dBA indoors is the threshold above which noise could cause interference or annoyance (EPA 1974).

Aside from the Noise Control Act of 1972, the noise levels associated with the construction and operation of VTR would be regulated by 40 CFR Part 204, Noise Emissions Standards for Construction Equipment.

Except for the prohibition of nuisance noise, neither the State of Idaho nor local governments have established any regulations that specify acceptable community noise levels applicable to the INL Site. In the absence of standardized criteria for a detailed assessment of construction noise, the Federal Transit Administration recommends construction noise levels for the sensitive receptor in residential areas should not exceed the following levels:

- An 8-hour L_{eq} of 80 dBA during daytime (7 a.m. to 10 p.m.),
- An 8-hour L_{eq} of 70 dBA during nighttime (10 p.m. to 7 a.m.), or
- A 30-day average L_{dn} of 75 dBA (DOT 2018).

3.1.8.3 Existing Noise Environment

The major noise sources within the INL Site include industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, intercom paging systems, construction and materials-handling equipment, and vehicles). Most INL industrial facilities are far enough from the site boundary that noise levels from these sources are not measurable or are barely distinguishable from background levels at the boundary.

The primary existing noise at the INL Site results from transportation-related activities including transportation of people and materials to and from the site and in-town facilities via buses, trucks, private vehicles, and freight trains. During a typical workweek, the majority of the employees are transported to various work areas at the INL Site by buses covering about 70 routes. Approximately 1,200 private vehicles also travel to and from the INL Site daily. Rail transport for the INL Site typically occurs no more than one train per day and usually less than one train per week (NRC 2004). Homeland Security's occasional explosive tests at the INL Site and detonation of unexploded ordnance also contribute to the noise at the INL Site.

The proposed VTR site would be located on the east side of MFC, which includes a number of noise-generating sources such as industrial heating, ventilation, and air conditioning equipment, blowers, moving equipment, and forklifts. Nearly all of this equipment is housed inside existing buildings. Noise measurements were obtained in Spring 2020 at 23 different locations outside existing facilities that could provide support for VTR operations, fuel fabrication, and post-irradiation examination. Noise readings ranged from 42.3 dBA to 65.9 dBA and are relatively consistent throughout the day.

Historical noise measurement data obtained from sites within 50 feet of U.S. Highway 20 indicate traffic noise ranges from about 64 to 86 dBA, with buses identified as the primary source, contributing from 71 to 80 dBA (NRC 2011). Buses operate off the INL Site but are part of the normal levels of traffic noise in the community. Industrial activities (i.e., shredding paper documents) at the CFA produce the highest noise levels measured at 104 dBA. Noise generated at the INL Site is not detectable off site because all existing primary facilities are at least 3 miles from site boundaries. In addition, previous studies on effects of noise on wildlife indicate that even high intermittent noise levels at the INL Site (more than 100 dBA) would not affect wildlife productivity (NRC 2004).

The proposed VTR site is about 2.9 miles from the INL Site boundary. The Bingham County parcel data identified the land directly adjacent to this portion of the INL Site border as zoned as a natural resource area and owned by the State of Idaho and BLM. The closest noise-sensitive receptor is an agricultural homestead that is about 5.0 miles from the VTR site and about 1.9 miles from U.S. Highway 20, which is expected to be the primary noise at this location.

The existing noise levels in a particular area are generally based on its proximity to nearby major roadways or railroads or on population density (DOT 2018). The land surrounding the proposed VTR site and existing MFC is uninhabited and the location of the closest sensitive receptor is rural. U.S. Highway 20 accounts for the majority of potential noise for the closest sensitive receptor, but since it is more than 800 feet away, it is not considered a major source. Therefore, ambient noise levels were estimated based on the population density of the affected county using the methodology described in the DOT *Transit Noise and Vibration Impact Assessment* (DOT 2018).

According to the U.S. Census Bureau, the population density of the Bingham County is about 22 people per square mile (Census 2010a). As a result, the existing L_{dn} in the vicinity of the proposed VTR site is estimated to be 35 dBA, and the existing ambient equivalent continuous sound levels (in L_{eq}) during daytime and nighttime are estimated to be about 35 and 25 dBA, respectively (DOT 2018). Ambient (background) noise levels could occur from roadway traffic, farm machinery, pets, and various other household noises. The closest Federal and State parks to the proposed VTR site are Craters of the Moon National Monument and Preserve, Harriman State Park, and Massacre Rocks State Park, which are about 40 miles southwest, 62 miles northeast, and 67 miles southwest of the proposed VTR site, respectively. Other nearby recreation areas include the Hells Half Acre Lava Field, about 10 miles southeast, and Middle Butte, about 7.5 miles southwest of the proposed VTR site. The INL Site is designated as a NERP to provide protected lands that act as buffers around DOE facilities and provide environmental research and education (see Section 3.1.1.1 for additional details).

3.1.9 Waste and Spent Nuclear Fuel Management

This section describes the current average annual "baseline" generation rates and management practices for the waste categories that will be generated if the VTR alternative and a fuel fabrication scenario are implemented at the INL Site (INL 2020a). The ROI for waste management activities includes everything within the INL Site boundaries. Offsite locations (together with other DOE and commercial facilities) are not included in the waste management ROI. The potential impacts at these non-INL Site disposition facilities were considered as part of the licensing/permitting/approval process for these sites and are not detailed in this document. There would be no additional impacts, including exposure to the offsite public or onsite workers. All waste disposition actions would comply with the licenses, permits, and/or approvals applicable to the facilities described in this document. Those waste categories are: (1) low-level radioactive waste (LLW), mixed low-level radioactive waste (MLLW), and transuranic (TRU) waste, (2) Resource Conservation and Recovery Act (RCRA) Hazardous and Toxic Substances Control Act (TSCA) wastes, (3) and nonhazardous solid waste and recyclable materials. High-level radioactive waste (HLW) is also managed at the INL Site; however, no HLW would be generated under the VTR alternative or the fuel fabrication scenario and therefore will not be discussed further in the section. Additionally, while not a waste, spent nuclear fuel also would be generated and is discussed in this section. **Table 3–10** presents the latest available 5-year annual generation by waste category.

Table 3–10. 5-Year Annual "Baseline" Generation by Waste Category in Cubic Meters

	2015		*2016*		*2017*		*2018*		*2019*		*Average*	
Waste Type	***INL***	***MFC***	***INL***	***MFC***	***INL***	***MFC***	***INL***	***MFC***	***INL***	***MFC***	***INL***	***MFC***
LLW	9,900	460	12,000	710	4,300	400	6,900	720	10,000	800	8,600	620
MLLW	2,800	20	3,300	36	8,700	47	4,700	19	3,700	38	4,600	32
TRU	1,700	0.18	1,600	0	870	0	740	0	650	9.0	1,100	1.8
Hazardous and TSCA	59	22	35	9.0	13	8.3	35	9.3	83	32	45	16
C&D	520	53	310	8.5	650	33	670	14	790	10	590	24

C&D = construction and demolition and industrial waste; INL = Idaho National Laboratory; LLW = low-level radioactive waste; MFC = Materials and Fuels Complex; MLLW = mixed low-level radioactive waste; TRU = transuranic waste.
Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.
Source: INL 2020a.

3.1.9.1 Low-Level Waste, Mixed Low-Level Waste, and Transuranic Waste

Low-Level Waste

DOE Order 435.1, "Radioactive Waste Management" was issued to ensure that all DOE radioactive waste is managed in a manner that protects the environment, worker, public safety, and health. This order, effective July 1, 1999, includes the requirements that must be met by DOE in managing radioactive waste. LLW is generated as a result of current routine and D&D activities. LLW is transported to the INL Site's Radioactive Waste Management Complex (RWMC) where it is characterized and packaged consistent with the applicable waste acceptance criteria and shipped in accordance with DOT requirements. LLW scrap from the Naval Reactor Facility (NRF) is placed in the subsurface disposal area at the RWMC. Newly generated remote-handled LLW is disposed of at the Remote Handled Low-Level Waste Facility near the ATR Complex. Other LLW is sent off site.

Mixed Low-Level Waste

The Federal Facilities Compliance Act (FFCA) requires the preparation of site treatment plans for the treatment of mixed waste stored or generated at DOE facilities. Mixed waste contains both hazardous and radioactive components. The INL Site's FFCA Site Treatment Plan was signed by the State of Idaho on November 1, 1995, and is updated annually. This plan outlines DOE's proposed treatment strategy for the INL Site's mixed-waste streams. The Mixed Waste Management Plan specifies the requirements for management of MLLW in accordance with the State of Idaho requirements for RCRA hazardous constituents and DOE requirements for the radiological constituents. MLLW is transported to the INL Site's RWMC where it is characterized and packaged consistent with the applicable waste acceptance criteria and shipped in accordance with DOT requirements. MLLW is shipped off site for disposal at the Nevada National Security Site (NNSS) or treatment, disposal, or both through commercial waste processing vendors.

Transuranic Waste

On October 16, 1995, DOE, the U.S. Navy, and the State of Idaho entered into an agreement (the Idaho Settlement Agreement) that guides management of spent nuclear fuel and radioactive waste at the INL Site (DOE/Navy/ID 1995). The Agreement limits shipments of DOE and Naval spent nuclear fuel into the State and sets milestones for shipments of spent nuclear fuel and radioactive waste out of the State. The FFCA Site Treatment Plan and the Idaho Settlement Agreement require DOE to process and ship all waste stored as TRU waste on the INL Site in 1995. When the agreements were signed, all of these wastes were to be shipped out of Idaho by December 31, 2018. In February 2014, the shipment of TRU waste was curtailed due to the suspension of the Waste Isolation Pilot Plant (WIPP) operations in Carlsbad, New Mexico. However, during that time INL continued to characterize and package TRU waste for shipment and disposal. In April of 2017, shipments resumed to the WIPP facility. The Idaho Cleanup Project Core manages and operates a number of projects to facilitate the disposition of radioactive waste as required by the Idaho Settlement Agreement and Site Treatment Plan. The Idaho Cleanup Project performs retrieval, characterization, treatment, packaging, and shipment of TRU waste currently stored at the INL Site. The vast majority of the waste processed at the INL Site resulted from the manufacture of nuclear components at DOE's Rocky Flats Plant in Colorado. This waste is contaminated with TRU radioactive elements (primarily plutonium).

3.1.9.2 Resource Conservation and Recovery Act Hazardous and Toxic Substances Control Act/Mixed Toxic Substances Control Act Wastes

Resource Conservation and Recovery Act Hazardous Wastes

RCRA established regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste. The IDEQ is authorized by EPA to regulate hazardous waste and the hazardous components of mixed waste at the INL Site. Mixed waste contains both radioactive and hazardous materials. The Atomic Energy Act, as administered through DOE orders, regulates radioactive wastes and the radioactive part of mixed wastes. Radioactive waste management is discussed above in Section 3.1.9.1. The INL Site's RCRA hazardous waste permit contains two parts: Part A and Part B. The INL Site currently has two RCRA Part A permit volumes and seven Part B permit volumes. Parts A and B are considered a single RCRA permit that comprises several volumes. As required by the State of Idaho, the INL Site annually submits the Hazardous Waste Generator Annual Report on the types and quantities of hazardous wastes generated, shipped for treatment and disposal, and remaining in storage. The predominant source of RCRA hazardous wastes are from D&D activities. RCRA hazardous waste is treated and disposed at offsite facilities and transported by a commercial transport contractor.

Toxic Substance Control Act Wastes/Mixed Toxic Substance Control Act Wastes

The TSCA, which is administered by EPA, requires regulation of the production, use, and/or disposal of chemicals. TSCA supplements sections of the CAA, the Clean Water Act, and the Occupational Safety and Health Act. Because the INL Site does not produce chemicals, compliance with the TSCA is primarily directed toward use and management of certain chemicals, particularly polychlorinated biphenyls. For example, polychlorinated biphenyls-containing light ballasts are being removed at buildings undergoing demolition. The ballasts are disposed of off the INL Site at a TSCA-approved disposal facility. TSCA/mixed TSCA wastes are treated and disposed at offsite facilities and transported by a commercial transport contractor.

3.1.9.3 Nonhazardous Solid Waste and Recyclable Materials

Nonhazardous solid waste and recyclable materials are routinely generated as a result of current routine and D&D activities. Nonhazardous solid waste is primarily disposed of at the INL Site's CFA Landfill

Complex. The INL Site's CFA Landfill Complex is operated in accordance with State of Idaho regulations. The remaining capacity of the INL Site's CFA Landfill Complex is about 3.4 million cubic meters. Nonhazardous solid waste items that cannot be disposed at the INL Site's CFA Landfill Complex are sent off site to a commercial disposer. As much as possible, recyclable materials are segregated from the solid waste stream in accordance with waste minimization and pollution prevention protocols. Most solid metal waste is accumulated and sold to a scrap salvage vendor. In addition, batteries, plastic and aluminum beverage containers, tin cans, paper, and cardboard materials are collected for recycling. Scrap wood is sent to the INL Site's CFA Landfill Complex to be chipped and reused for mulch.

3.1.9.4 Spent Nuclear Fuel

Spent nuclear fuel is nuclear fuel that has been withdrawn from a nuclear reactor following irradiation and the constituent elements have not been separated. Spent nuclear fuel contains unreacted uranium and radioactive fission products. Because of its radioactivity (primarily from gamma rays), it must be properly shielded. DOE's inventory of spent nuclear fuel is from development of nuclear energy technology (including foreign and domestic research reactors), national defense, and other programmatic missions. At the INL Site, spent nuclear fuel is managed by Fluor Idaho, the Idaho Cleanup Project Core contractor at INTEC, the Naval Nuclear Propulsion Program at the Naval Reactors Facility, and BEA, the INL Site's contractor at the ATR Complex and MFC. The 1995 Idaho Settlement Agreement (DOE/Navy/ID 1995) put into place milestones for the management of radioactive waste and spent nuclear fuel at the INL Site.

In order to resume shipments of spent nuclear fuel to Idaho, including spent nuclear fuel rods for research purposes from the Byron Nuclear Generating Station in Illinois, DOE and the State of Idaho developed the 2019 Supplemental Agreement (DOE-ID & Idaho 2019) to the 1995 Settlement Agreement.

To resolve uncertainty about how commitments made in the 1995 Settlement Agreement to eliminate wet storage of spent nuclear fuel apply to operations of ATR, DOE and the State of Idaho entered into the 2020 Advanced Test Reactor Spent Nuclear Fuel Agreement (DOE-ID & Idaho 2020).

3.1.10 Human Health – Normal Operations

The impact on human health during normal facility operations addresses the potential impacts from exposure to ionizing radiation and chemicals. Potential human health impacts from exposure to radiation from normal operational conditions is considered for both an individual and the population as a whole for both the public and site workers; this constitutes the ROI. For the existing environment, the public population is considered to be all people living within 50 miles of the operational areas at the INL Site. The maximally exposed individual is considered to be a hypothetical person who could receive the maximum possible dose from releases at the INL Site. In addition, for workers the potential human health impacts associated with exposure to workplace chemicals are considered.

3.1.10.1 Radiation Exposure and Risk

DOE monitors radiation in the environment and exposure of workers and calculates the radiation doses of members of the offsite general public and onsite workers from operation at the INL Site. **Table 3–11** presents data on radiation doses to the public for the years 2014 through 2018. The maximum radiation dose to an offsite member of the public during this period as a result of onsite facility operations was estimated to be 0.53 millirem per year (INL 2016b). The risk of developing a latent cancer fatality (LCF) from this dose is extremely small, much less than 1 in a million. The calculation of this total dose considers the maximum dose to an individual from air emissions and from the consumption of wildlife harvested in the vicinity of the INL Site. The maximum dose to an offsite individual does not include a contribution from drinking water. Although tritium has been detected in three USGS monitoring wells along the southern INL Site boundary, there are no drinking water wells near this location. This groundwater contamination does not contribute to a public dose, either individually or collectively. The average annual dose to an individual from INL Site operations is much less than one percent of the average dose of 383 millirem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for someone living on the Snake River Plain (INL 2018a).

There are two dose limits relevant to the exposure of an individual member of the public near a DOE site. As shown in Table 3–11, all of the doses to the maximally exposed individual from the operations at the INL Site are well below the DOE dose limit for a member the general public, which is 100 millirem per year from all pathways, as prescribed in DOE Order 458.1 (DOE 2011b). The table also shows that the dose from the air pathway is well below the NESHAPs dose limit for emissions from DOE facilities of 10 millirem per year (40 CFR Part 61, Subpart H).

Table 3–11. Annual Radiation Doses to the Public from Idaho National Laboratory Operations 2014–2018

	Maximally Exposed Individual				*Population*		
	Dose (millirem per year)			*LCF Risk*	*Estimated Population Dose (person-rem)*	*LCFs* [b]	*Estimated Dose from Background (person-rem)*
Year	*Airborne Radionuclides* [a]	*Consumption of Waterfowl*	*Total*	*Total* [b]			
2018	0.01	0.016	0.026	c	0.0075	0 (5×10^{-6})	129,000
2017	0.008	0.046	0.054	c	0.011	0 (7×10^{-6})	127,000
2016	0.014	NA [d]	0.014	c	0.044	0 (3×10^{-5})	126,000
2015	0.033	0.49	0.53	c	0.61	0 (4×10^{-4})	125,000
2014	0.037	0.032	0.069	c	0.61	0 (4×10^{-4})	124,000
Average	**0.022**	**0.15** [e]	**0.17** [e]	c	f	f	

LCF = latent cancer fatality; NA = not available.

[a] DOE (DOE 2011b) and the EPA (40 CFR Part 61 Subpart H) limit the dose to a member of the public from airborne radionuclides to 10 millirem per year.

[b] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem.

[c] The probability of this individual contracting a fatal cancer is less than 1 in a million.

[d] No data was collected for waterfowl in 2016.

[e] The average is calculated without year 2016 data because consumption of waterfowl was not included in that year.

[f] An average is not presented because the results for individual years are not all calculated on the same basis.

Notes:

The population within 50 miles of the INL Site was assumed to be 314,069 in 2013, increasing to 332,665 in 2017.

Due to rounding, sums and products may not equal those calculated from table entries.

Sources: INL 2015a, 2016b, 2017b, 2018a, 2019c.

The population dose is the sum of average individual doses to the entire population within 50 miles of the INL Site. Table 3–11 shows that over the years 2014 through 2018, the population dose from operations at the INL Site ranged from 0.011 to 0.61 person-rem. No latent cancer fatalities would be expected from these doses. The decrease in population dose between 2015 and 2016 is primarily due to a change in the way population doses were estimated. Prior to 2016, the highest dose to an individual within an area (a census division) was applied to all individuals within the area. From 2016 on, the average dose to a person within an area was applied to the total population of the area. Population doses from background sources of radiation are also presented in Table 3–11. The doses from INL Site operations are a small fraction of the background doses. Changes in the estimated dose from background are the result of the population growth within 50 miles of the INL Site, from an estimated 318,528 in 2014 to 337,643 in 2018 (INL 2015a, 2019c).

Worker doses at the INL Site result from:

- Maintenance activities,
- Routine test reactor operations,
- Research and development activities,
- Waste handling, treatment, and storage,
- Fuel handling,
- Benchtop analyses,
- Decontamination work, and
- Radiography operations.

Of the workers at the INL Site (6,836 in April of 2020), about 20 percent received a measurable (detectable) dose during the period of 2014 through 2018 (DOE 2015g, 2018b, 2019g). The average collective worker dose during this time was 93.5 person-rem per year with no LCFs expected (calculated value of 0.06). Considering only the workers who received a measurable dose (on average 1,265 per year and ranging between 1,114 and 1,368 workers each year), the average annual dose to a worker was 74 millirem. No single worker received a dose greater than 750 millirem during this period (DOE 2015g, 2016j, 2017g, 2018b, 2019g). To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year (DOE 2017f), and maintained as low as reasonably achievable. **Table 3–12** presents the INL Site worker dose information for the years 2014 to 2018.

Table 3–12. Annual Radiation Doses to Idaho National Laboratory Workers from Operations 2014–2018

Year	*Collective Dose (person-rem)*	*Workers with a Measurable Dose*	*Exposed Worker Population LCF Risk* [a]	*Average Dose Among Workers with a Dose (rem)*
2018	86.3	1,368	0 (0.05)	0.063
2017	78.9	1,177	0 (0.05)	0.067
2016	92.7	1,273	0 (0.06)	0.073
2015	123.2	1,331	0 (0.07)	0.093
2014	86.2	1,174	0 (0.05)	0.073
Average	**93.5**	**1,265**	**0 (0.06)**	**0.074**

LCF = latent cancer fatality, rem = roentgen equivalent man.

[a] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem. Values in parentheses are calculated values. A value of less than 0.5 is considered to result in no LCFs.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: DOE 2015g, 2018b, 2019g.

Some INL Site workers potentially receive a dose from consumption of drinking water from wells supporting the CFA. These wells are contaminated from past wastewater injection directly into the aquifer. Each of the 500 CFA workers served by these wells could receive a dose of 0.154 millirem (INL 2017b), which is well below the EPA standard of 4 millirem per year from drinking water systems.

3.1.10.2 Nonradiological Health and Safety

Nonradiological exposures at the INL Site are controlled through programs intended to protect workers from normal industrial hazards. These programs are controlled by the safety and health regulations for DOE contractor workers governed by 10 CFR Part 851, which establishes requirements for worker safety and health programs to ensure that DOE contractor workers have a safe work environment. Included are provisions to protect against occupational injuries and illnesses, accidents, and hazardous chemicals.

DOE monitors worker safety through the Computerized Accident Incident Reporting System (CAIRS). The CAIRS is a computerized database used to collect and analyze DOE reports of injuries, illnesses, and accidents that occur during facility operations. Two metrics generated for the tracking of injury, illness, and accident rates are the Days Away, Restricted or on-the-job Transfer (DART) rate and the Total Reportable Cases (TRC) rate. The DART rate is an indication of the instances of injuries, illnesses, and accidents that result in, at worst, lost work days or days lost due to transfer or worker job restrictions. The TRC rate is an indication of the total number of work-related injuries or illnesses that resulted in death, days away from work, job transfer or restriction, or recordable case as identified in the Occupational Safety and Health Administration Form 300. For the years 2015 through 2019 the INL DART and TRC rates (incidents per 200,000 work hours or the equivalent of 100 full-time workers) were 0.54 and 1.08, respectively. For the years 2015 through 2019, the DART and TRC rates for all DOE facilities combined average 0.39 and 0.86, respectively (DOE 2019a).

3.1.10.3 Regional Cancer Rates

The National Cancer Institute publishes national, State, and county incidence rates of various types of cancer (NCI 2018). However, the published information does not provide an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–13** presents incidence rates for the United States, Idaho, and the counties that account for most of the population within 50 miles of the INL Site. Additional information about cancer profiles in the vicinity of the INL Site is available in State Cancer Profiles, Incidence Rates Tables (NCI 2018). Not all types of cancer are presented in this table; totals for individual cancers will not sum to the all cancer values.

Table 3–13. Cancer Incidence Rates for the United States, Idaho, and Counties Adjacent to Idaho National Laboratory, 2012–2016

	Cancer Incidence Rates [a]						
Region	***All Cancers***	***Thyroid***	***Breast (female)***	***Lung and Bronchus***	***Leukemia***	***Prostate***	***Colon and Rectum***
United States	448.0	14.5	125.2	59.2	14.1	104.1	38.7
Idaho	440.5	15.9	124.2	50.3	16.2	105.7	35.5
Bannock County	368.5	11.1	105	36.1	14.6	92.5	29.6
Bingham County b	403.2	28.6	115.7	35.6	12.1	97.3	41
Blaine County	421.8	(c)	139.7	31.7	19.6	122	19.5
Bonneville County b	426.5	30.9	107.5	34.8	16.2	115.4	35.2
Butte County b	456.6	(c)	(c)	(c)	(c)	(c)	(c)
Clark County b	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Jefferson County b	405.1	28.9	85.1	35	14.3	123.3	36.2
Madison County	358	29.3	81.4	(c)	19.2	101.1	36.7
Power	363	(c)	117.6	41.2	(c)	84.8	(c)

[a] Age-adjusted incidence rates; cases per 100,000 persons per year.

[b] Portions of the INL Site are located in Bingham, Bonneville, Butte, Clark, and Jefferson Counties. MFC is in Bingham County.

[c] Data have been suppressed by the National Cancer Institute to ensure the confidentiality and stability of rate estimates when the annual average count is three or fewer cases.

Source: NCI 2018.

3.1.11 Human Health – Emergency Preparedness

Every site in the DOE complex has an established emergency management program that is activated in the event of an accident. These programs have been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. Emergency management programs address emergency planning, training, preparedness, and response for both on- and offsite personnel.

DOE Order 151.1D, *Comprehensive Emergency Management System,* (DOE 2016i) describes detailed requirements for emergency management that all DOE sites must implement. Each DOE site, facility, and activity, including the INL Site, establishes and maintains a documented emergency management program that implements the requirements of applicable Federal, State, and local laws, regulations, and ordinances for fundamental worker safety programs (e.g., fire, safety, and security). This is the Emergency Management Core Program. In addition, each DOE site, facility, and activity containing hazardous materials, such as radioactive materials or certain chemicals that do not fall under the purview of fundamental worker safety programs, establishes and maintains an Emergency Management Hazardous Materials Program. Finally, each site that receives or initiates shipments managed by the Office of Secure Transportation must be prepared to manage an emergency involving such a shipment, should that emergency occur on site.

These programs involve providing specialized training and equipment for local fire departments and hospitals, State public safety organizations, and other government entities that may participate in response actions, as well as specialized assistance teams. These programs also provide for notification of local governments whose constituencies could be threatened in the event of an accident. Broad ranges of drills and exercises are conducted to ensure the systems are working properly, from facility-specific exercises to regional responses. In addition, there are internal and external audits. Lessons learned from exercises and audits are used to continuously strengthen INL's emergency management program – see, for example, *Idaho National Laboratory Emergency Readiness Assurance Plan-Fiscal Year 2016* (INL 2016d) and the Office of Enterprise Assessments January 2018 *Assessment of the Emergency Management Exercise Program at the Idaho Site* (DOE 2018h).

A recent example of an exercise is INL's 2019 annual emergency exercise (INL 2019f). This exercise simulated a crash between a dump truck and a bus. The simulation tested the effectiveness of the response and coordination between numerous entities: INL fire department; INL Emergency Operations Center in Idaho Falls; INL heavy equipment operators; three helicopter ambulances from three separate outside agencies; Butte County coroner and dispatch; a local towing company; DOE-Idaho Operations Office; Idaho State Emergency Medical Services communications center (known as StateComm); and Eastern Idaho Regional Medical Center. The INL Site also made offsite notifications to all contiguous counties, Federal agencies, State of Idaho agencies, and Tribal authorities. This emergency exercise successfully tested and verified communication among all parties.

In summary, the emergency management system at the INL Site includes emergency response facilities and equipment, trained staff, and effective interface and integration with offsite emergency response authorities and organizations. INL personnel maintain the necessary apparatus, equipment, and a state-of-the-art Emergency Operations Center in Idaho Falls to respond effectively to virtually any type of emergency, not only at the INL Site, but throughout the local community.

3.1.12 Traffic

3.1.12.1 Transportation Infrastructure

The ROI for the transportation infrastructure includes two U.S. Interstate Highways, two U.S. Routes, three Idaho State Highways, and the INL onsite road systems.

Road performance is measured using level of service (LOS) ratings. LOSs are qualitative measures used to relate the quality of motor vehicle traffic services. LOS analyzes roadways and intersections by categorizing traffic flow and assigning quality levels of traffic based on performance measures like vehicle speed, density, and congestion. LOS ratings range from "A" to "F," with "A" being the best travel conditions and "F" being the worst. For example, U.S. Highways consider the following conditions when determining LOS:

- *A*: Traffic flows freely at or above the posted speed limit and motorists have complete mobility between lanes. Motorists have a high level of physical and psychological comfort. The effects of incidents or point breakdowns are easily absorbed. A rating of LOS A generally occurs late at night in urban areas and frequently in rural areas.
- *B*: Traffic flows freely. Speeds are maintained, maneuverability within the traffic stream is slightly restricted. Motorists still have a high level of physical and psychological comfort.
- *C*: Traffic flow is stable, at or near free flow. Ability to maneuver through lanes is noticeably restricted and lane changes require more driver awareness. Most experienced drivers are comfortable, roads remain safely below but efficiently close to capacity, and posted speed is maintained. Minor incidents may still have no effect, but localized service will have noticeable effects and traffic delays will form behind the incident. A rating of LOS C is considered acceptable for local roads and highways.
- *D*: Traffic flow is approaching unstable. Speeds slightly decrease as traffic volumes slightly increase. Freedom to maneuver within the traffic stream is much more limited and driver comfort levels decrease. Minor incidents create delays. A rating of LOS D is commonly considered acceptable for urban streets during peak hours since societal impacts and costs of construction (bypasses and lane additions) to attain a LOS C rating would be prohibitive.
- *E*: Traffic flow is unstable and operating at capacity. Flow becomes irregular, speeds vary rapidly, and there are virtually no usable gaps to maneuver in the traffic stream. Speeds rarely reach the posted limit. Any disruption to traffic flow, such as merging ramp traffic or lane changes, will create a shock wave affecting traffic upstream. Any incident will create serious delays. Drivers' level of comfort becomes poor. A rating of LOS E is a common standard in larger urban areas, where some roadway congestion is inevitable.
- *F*: Traffic is forced or there is a breakdown in flow. Every vehicle moves in lockstep with the vehicle in front of it. Frequent slowing is required. Travel time cannot be predicted, with generally more demand than capacity. A road in a constant traffic jam is at this LOS.

LOS is an average or typical service rather than a constant state. For example, a highway might be at LOS D for the AM peak hour, but have traffic consistent with LOS C some days, LOS E or F others, and come to a halt once every few weeks (Papacostas and Prevedouros 2001).

Regional

- U.S. Interstate 15, a north-south route connects several cities along the Snake River and is located about 25 miles east of the INL Site.
- U.S. Interstate 86 intersects Interstate 15 about 40 miles south of the INL Site and provides a primary linkage from Interstate 15 to points west.
- U.S. Route 20 is one of two main access routes to the southern portion of the INL Site and MFC.
- U.S. Route 26 is the second of two main access routes to the southern portion of the INL Site.
- Idaho State Highways 22, 28, and 33 pass through the northern portion of INL, with State Route 33 providing access to the northern INL Site facilities (DOE 2016b).

The majority of road segments in the vicinity of the INL Site operate at LOS D or better. However, the I-15 and US-20 interchange and a portion of US-26 (north of E Street in Idaho Falls) exceed LOS D threshold at certain times.

INL Onsite Road Systems

The INL Site contains an onsite road system of about 170 miles of paved roads. The onsite road system also includes 18 miles of service roads that are closed to the public. Some of the paved roads are highways that pass through the INL Site and are used by the public; however, security personnel and fencing strictly control public access to facilities at the INL Site. Most of the roads are adequate for the current level of normal transportation activity and could handle an increase in traffic volume.

The Multipurpose Haul Road is a 13-mile-long nonpublic road connecting MFC and other developed areas at the INL Site. It provides a road for limited year-round use with the ability for trucks traveling in opposite directions to pass.

The INL Site contains an onsite railroad system of about 22 miles of rail. Union Pacific Railroad's main line to the Pacific Northwest follows the Snake River across southern Idaho. This line handles as many as 30 trains per day. Union Pacific Railroad provides service to the INL Site from Blackfoot into the southern portion of the INL Site where it terminates. This branch connects with a DOE-owned spur line that extends to the CRF and the NRF (DOE 2016b). The rail does not extend to MFC. Rail shipments to and from the INL Site are usually limited to bulk commodities, Naval spent nuclear fuel, and radioactive waste.

MFC, where the proposed action would be located, is in the southeastern corner of the INL Site, about 38 miles west of Idaho Falls in Bingham County. MFC is about 2.7 miles from the southern INL Site boundary and is accessed via Taylor Boulevard from U.S. Highway 20 (INL 2015b).

Table 3–14 provides average daily traffic data for selected segments of routes in the vicinity of the INL Site. The daily weighted average of each route is the annual average daily traffic on the route. Each route is made up of segments that vary in distance and annual average daily traffic. The weighted average of each route is calculated by taking each segment of road from the beginning to the end (the total mileage of the segment) and dividing it by the total mileage of the total route.

Table 3–14. Annual Average Daily Traffic on Routes in the Vicinity of Idaho National Laboratory

Route	*Daily Traffic Number of Vehicles (weighted average)*
U.S. Highway 20 – Idaho Falls to the INL Site	2,500
U.S. Highway 26 – Blackfoot to the INL Site	1,200
State Route 33 – West from Mud Lake	1,600

Source: ITD 2020.

3.1.12.2 Waste and Material Shipments

The INL Site manages the following types of waste: HLW, TRU, LLW, MLLW, TSCA-regulated, RCRA-regulated hazardous, and industrial nonhazardous solid waste. See Section 3.1.9 for a detailed discussion of Waste and Spent Nuclear Fuel Management.

Average Shipments to and from the Materials and Fuels Complex

RCRA hazardous waste (including nonradioactive TSCA waste), recyclable material, LLW, MLLW, and radioactive TSCA wastes are transported from MFC to offsite facilities. Nonhazardous waste is typically shipped to the INL CFA Landfill Complex, while solid LLW is shipped to either the Radioactive Waste Management Complex at the INL Site or to offsite facilities. RCRA hazardous waste, radioactive TSCA waste, and MLLW are shipped on average 1.4 times per month, while routine solid[2]LLW is shipped 24.7 times on average per year. Nonhazardous waste is shipped less than once per year, on average.

The frequency of material shipments necessary to support MFC operations ranges from about one shipment per day to one shipment per week, depending on the amount of supplies ordered across MFC.

Traffic

The most recent employment data at the INL Site, as of Spring 2020, is 6,836 workers, including 4,998 at BEA and 1,838 at Fluor (DOE 2020c); these include full-time, part-time, and temporary employees. During a typical workweek, the majority of employees take buses to various work areas at the INL Site, covering about 70 bus routes. For MFC, about 13 percent of employees commute via carpool, while slightly less than 30 percent report taking the bus.

Approximately 1,200 private vehicles also travel to and from the INL Site daily, including an average of 250 to 300 to and from MFC. Rail transport for the INL Site typically occurs no more than one train per day and usually less than one train per week (NRC 2004).

3.1.13 Socioeconomics

This section describes current socioeconomic conditions and local community services within the seven-county ROI (or region) associated with the INL Site: Bannock, Bingham, Bonneville, Butte, Clark, Jefferson, and Madison Counties. Five of these counties border the INL Site: Bingham, Bonneville, Butte, Clark, and Jefferson. Also included are the Fort Hall Reservation and Off-Reservation Trust Land, home of the Shoshone Bannock Tribes, which lie largely within Bingham and Bannock Counties. Bannock County also includes Pocatello, one of the two largest cities within 50 miles of the INL Site; the other is Idaho Falls, located in Bonneville County. Because most of the population surrounding the INL Site lies to the east, including Madison County where nearly 2 percent of the INL Site workforce resides, this county is also included in the ROI. Figure 3–1 shows the counties in the ROI, surrounding towns, and major transportation routes.

3.1.13.1 Population and Housing

The main population surrounding the INL Site lies to the east, along Interstate Highway I-15 and U.S. Highway 20 corridors, which generally run north and south. Most of the population is concentrated in communities to the east and southeast. Idaho Falls with a population of about 61,535, and Pocatello with a population of about 56,266 are the 2 largest cities in the ROI and located about 40 and 50 miles, respectively, from MFC (Census 2020c).

[2] The Integrated Waste Tracking System data did not consistently include information regarding solid, liquid, or mixed solid and liquid shipments. To ensure a bounding calculation of the number of shipments, all shipments were counted as solid.

From 2000 to 2010, State population grew by 21.2 percent, compared to the ROI population growth of 20.7 percent or an average of 2.1 percent per year for both the ROI and the State (Census 2011). Population growth in the region between 2000 and 2018 was slightly lower than the State average, with growth rates for the region and State at 7.4 percent and 11.9 percent, respectively.

Table 3–15 contains population estimates from the U.S. Census Bureau for 2018 and actual census results for 2000 and 2010. U.S. Census Bureau estimates are not certain due to variability in times of birth and death, emigration and immigration rates, and other unanticipated factors in the region. Population projections were also developed for 2050 (lifetime of proposed project), based on an extrapolation of a 1.1 percent annual growth rate projected for the State out to 2026 (Idaho Department of Labor 2020); and for an extrapolation of the growth rate from 2010 to 2018 for each individual county).

Table 3–15. Population of the Idaho National Laboratory Region of Influence and Idaho: 2000–2018

County	*Year*				*Projected Population 2050*
	2000	*2010*	*2018*	*Population Change 2010-2018 (percent)*	
Bannock	75,565	82,839	87,138	5.2	105,263
Bingham	41,735	45,607	46,236	1.4	48,825
Bonneville	82,522	104,234	116,854	12	172,944
Butte	2,899	2,891	2,611	-9.7	1,598
Clark	1,092	982	852	-13.2	402
Jefferson	19,155	26,140	29,439	12.6	44,276
Madison	27,467	37,536	39,304	4.7	46,693
ROI	**250,434**	**300,229**	**322,434**	**7.4**	**420,001**
Idaho	1,293,953	1,567,582	1,754,208	11.9	2,371,689

ROI = region of influence
Source: Census 2020a, 2020b, 2020c, 2020d; Idaho Department of Labor 2020.

Housing

The most recent housing stock statistics from the Census report estimated 2017 housing occupancy by type (owned or rented) (Census 2017c). Of interest for impact analysis is the capacity of the ROI to absorb any new housing demand projected by the project. Of the 116,264 housing units available in the region during 2017, the Renter Vacancy Rate was 8.2 percent, and the Homeowner Vacancy Rate was 1.9 percent. Rental units made up 31 percent of the occupied housing units in the ROI. A total of 11,706 vacant units were in the ROI. Housing characteristics for the ROI in 2017 are shown in **Table 3–16**.

Table 3–16. Region of Influence Housing Characteristics (2017)

County	*2017 Housing Units*	*Occupied Housing Units*	*Vacant Housing Units*	*Owner-Occupied Units*	*Renter-Occupied Units*	*Vacant Homeowner Housing Units (percent)*	*Vacant Rental Units (percent)*
Bannock	33,870	30,790	3,080	21,200	9,590	711 (2.1)	2,337 (6.9)
Bingham	16,513	14,903	1,610	11,147	3,756	396 (2.4)	991 (6.0)
Bonneville	41,593	38,400	3,193	27,120	11,280	582 (1.4)	3,286 (7.9)
Butte	1,338	1,049	289	870	179	25 (1.9)	356 (26.6)
Clark	553	313	240	173	140	49 (8.9)	0 (0.0)
Jefferson	9,105	8,470	635	6,861	1,609	155 (1.7)	346 (3.8)
Madison	13,292	10,633	2,659	4,930	5,703	66 (0.5)	3,376 (25.4)

County	2017 Housing Units	Occupied Housing Units	Vacant Housing Units	Owner-Occupied Units	Renter-Occupied Units	Vacant Homeowner Housing Units (percent)	Vacant Rental Units (percent)
ROI	**116,264**	**104,558**	**11,706**	**72,301**	**32,257**	**1,984 (1.7)**	**10,692 (9.2)**
Idaho	701,196	609,124	92,072	421,439	187,685	12,620 (1.8)	37,163 (5.3)

ROI = region of influence.
Notes:
Homeowner and rental vacancy units do not add to total vacant housing units because the vacancy rates only include vacant housing units (i.e., proportion of total inventory) that are on the market for rent or for sale only.
Due to rounding, sums and products may not equal those calculated from table entries.
Source: Census 2017c.

3.1.13.2 Employment and Income

From 2010 to 2018, the ROI experienced an average annual growth rate in the labor force of just over 1 percent (from 145,027 to 157,232 jobs), while the State of Idaho's labor force grew at an average annual rate of 2.5 percent. The unemployment rate has dropped significantly since 2010. In 2018, the ROI experienced the lowest unemployment rate (2.4 percent) in decades, where the unemployment rate ranged from 1.7 percent in Madison County, to 3.2 percent in Butte County. **Table 3–17** presents employment statistics in the ROI and Idaho for 2010 and 2018. In 2018, there were 153,766 people employed in the INL ROI.

Table 3–17. Employment Statistics in the INL ROI and Idaho in 2010 and 2018

Area	Civilian Labor Force		Employment		Unemployment		Unemployment Rate	
	2010	2018	2010	2018	2010	2018	2010	2018
Bannock	41,095	41,733	37,813	40,564	3282	1169	8.0	2.8
Bingham	22,848	23,303	21,201	22,657	1647	646	7.2	2.8
Bonneville	49,099	55,200	45,683	53,842	3416	1358	7.0	2.5
Butte	1,352	1,363	1,254	1,318	98	45	7.2	3.3
Clark	537	381	487	370	50	11	9.3	2.9
Jefferson	12,611	13,611	11,721	13,297	890	314	7.1	2.3
Madison	17,485	21,641	16,546	21,262	939	379	5.4	1.8
ROI	**145,027**	**157,232**	**134,705**	**153,310**	**10,322**	**3,922**	**7.7**	**2.5**
Idaho	761,120	856,795	692,918	832,500	71,000	24,000	9.0	2.8

ROI = region of influence.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: BLS 2020a, 2020b, 2020c.

INL Employment

The prime contractors at the INL Site include BEA, the management and operations contractor for the INL Site, and Fluor Idaho, which manages ongoing cleanup operations under the ICP Core and operates the Advanced Mixed Waste Treatment Project. The most recent employment data at the INL Site, as of Spring 2020, is 6,836 workers, including 4,998 at BEA and 1,838 at Fluor (DOE 2020c); these include full-time, part-time, and temporary employees. **Figure 3–10** shows the distribution of INL employees' residences in 2010 (DOE 2016b); the current distribution is expected to be essentially the same. The largest percentage (60.4 percent) resides within Bonneville County. Another 1.5 percent live outside of the ROI.

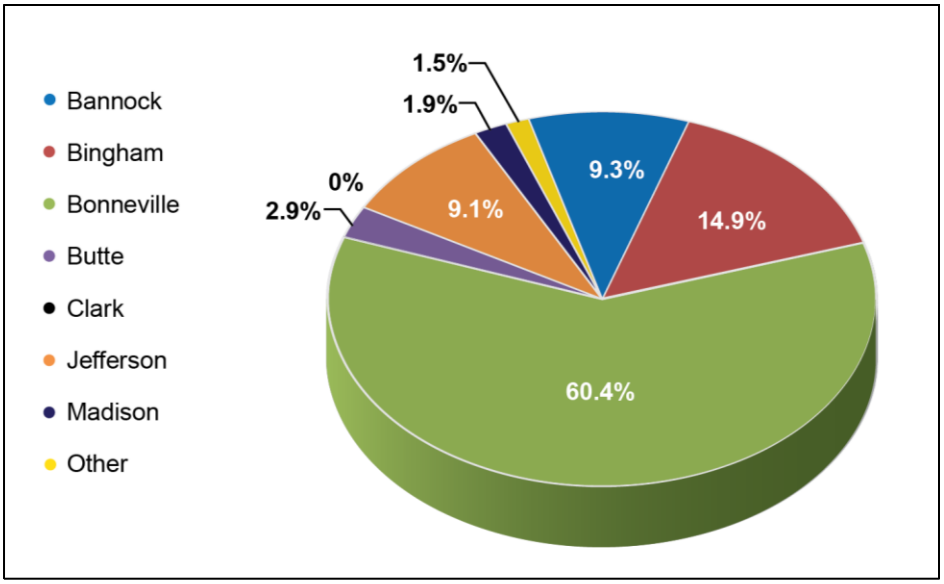


Figure 3–10. Distribution where Idaho National Laboratory Employees Live in the Region of Influence

In fiscal year (FY) 2018, the INL Site accounted for nearly 12,000 jobs (11,789), including direct, indirect, and induced employment (INL 2019d), where direct jobs include those employed directly at the INL Site , indirect jobs include jobs relating to suppliers (provide materials and supplies), and induced jobs include jobs in goods and services where workers spend their money. This total direct and indirect employment constituted about 1.4 percent of the total workforce in the State and nearly 8 percent of employment in the ROI. The INL Site is among the top 10 employers in the State – the sixth largest private employer and the ninth largest employer compared to all public and private businesses in the State; it is the largest in southeast Idaho (INL 2019d).

MFC Employment

MFC hosts the core of U.S. nuclear research and development with a wide array of facilities designed for remote work on highly irradiated fuels and materials. Areas of expertise include nuclear fuels, radiation-tolerant materials, fuel recycling, focused basic research, nuclear nonproliferation and nuclear forensics, and space nuclear power and isotope technologies. Approximately 1,094 employees currently work at MFC including government employees, subcontractors, contractors, and service employees, part-time seasonal, temporary, and occasional workers.

Local Income

The INL Site is a major economic contributor to the southeastern Idaho economy. In FY 2018, total labor income (wages and salaries, employee benefits, and payroll taxes) for INL (direct) employees totaled about $685.3 million with 98.5 percent of that distributed within the 7-county ROI, assuming a similar distribution of employee residences. The annual average wage of an INL Site employee was $97,893 in 2018 (INL 2019d).

In comparison, the per capita personal income for the ROI in 2018 was $37,494, a 27.2 percent increase from the 2010 level of $29,482, as shown in **Table 3–18**. Per capita income in 2018 in the ROI ranged from a low of $26,407 in Madison County to a high of $48,207 in Bonneville County. The per capita income in Idaho was $43,901 in 2018 (BEA 2019a).

Table 3–18. Per Capita Annual Personal Income

County	Per Capita Income ($)	
	2010	2018
Bannock	28,589	38,160
Bingham	26,299	36,335
Bonneville	34,667	48,287
Butte	32,199	38,961
Clark	39,726	39,408
Jefferson	26,241	34,900
Madison	18,651	26,407
ROI (Average)	**29,482**	**37,494**
Idaho	31,897	43,901

BEA 2019a, 2019b.
Note: Due to rounding, sums and products may not equal those calculated from table entries.

3.1.13.3 Community Services

Key community services in the ROI include education, law enforcement, fire protection, and medical services. Public school districts (29) and private schools (12) served 65,268 schoolchildren in the region in the 2018 to 2019 school year (NCES 2020). Idaho State University (Pocatello), University of Idaho Center for Higher Education (Idaho Falls), Brigham Young University-Idaho (Rexburg), and the Eastern Idaho Technical College (Idaho Falls) are institutions of higher education within the ROI.

The number of full-time law enforcement employees and firefighters by county are shown in **Table 3–19**. Data for 2016 showed the 7-county ROI having 307 law enforcement officers, including 200 sworn police officers and 107 civilians associated with the county sheriff's departments (FBI 2020a). Data are also available for law enforcement employees by city, representing the municipal police departments. Law enforcement staffing levels for the 2 largest cities in the ROI are as follows: Idaho Falls has 132 employees (including 87 sworn officers) and Pocatello has 127 employees (including 88 sworn officers) (FBI 2020b). There was a total of 318 full-time firefighters within 23 fire departments in the ROI in the period 2014 to 2015; many of the fire stations are volunteer (e.g., Clark County, all volunteer) or are staffed mostly by part-time firefighters (Jefferson and Madison Counties (80 and 50 part-time firefighters, respectively) (Fire Department 2020). In addition to these staffing levels, the INL Fire Department provides 24-hour coverage for the site. Its staff includes 68 firefighters, 11 lead firefighters, and 7 division chiefs, with no less than 16 on each shift (INL 2020f).

Table 3–19. Police and Firefighter Full-Time Employees within the Region of Influence

County	Law Enforcement	Sworn Officers	Civilians	Fire Departments	Firefighters
Bannock	66	52	14	7	76 (71 in Pocatello)
Bingham	53	34	19	5	39
Bonneville	102	67	35	5	98 (94 in Idaho Falls)
Butte	11	4	7	3	87 (all INL)
Clark	7	3	4	1	0 (all volunteer)
Jefferson	33	19	14	1	2
Madison	35	21	14	1	16
ROI	307	200	107	23	318

Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: FBI 2020a, 2020b; Fire Department 2020.

There are 58 hospital-based practices in the ROI. Approximately 84 percent of these are in Bannock and Bonneville Counties. Hospitals in the region include Eastern Idaho Regional Hospital in Idaho Falls (246 beds), Portneuf Medical Center in Pocatello (165 beds), Bingham Memorial Hospital in Blackfoot (85 beds), and Madison Memorial Hospital in Rexburg (67 beds). There are additional healthcare facilities (e.g., urgent medical care, surgical centers, community care) in Idaho Fall and Pocatello (Idaho Medical Association 2019; AHD 2020).

3.1.13.4 Public Finance

As one of the largest employers in the State, the INL Site provides a significant economic impact on Idaho's economy. In 2010, Boise State University conducted an analysis of the impacts of the INL Site on the economy of Idaho (Boise State University 2010). The analysis showed that the annual impacts of the INL Site's operations on employment, output, and income in Idaho are large by any measure, and especially significant in Idaho's largely rural economy and crucial to the economy of eastern Idaho (Boise State University 2010). INL employees spend their income on goods and services provided by residents and businesses in the area surrounding the INL Site. Total taxes and fees attributed to the INL Site and its employees amounted to more than $135 million of Idaho's total tax receipts in 2009. This represented 5.2 percent of Idaho's FY 2009 general fund revenues. These taxes and fees help fund public schools, libraries, emergency services (ambulance, police, and fire protection), road and bridge repairs, recreational opportunities, and waste disposal.

The INL Site's continued importance to the State economy is confirmed in more recent economic summaries prepared for the INL Site in 2017 and 2018 (INL 2018d, 2019d). The INL Site's total economic impact on Idaho in FY 2018 was over $2.058 billion, an increase of $123 million, or a 6.4 percent increase, from FY 2017 (INL 2019d). Updated and relevant statistics from the 2017 INL Economic Summary Report includes the following:

- The INL Site accounted for nearly 2.9 percent of statewide economic output. The INL Site's total output impact increased by $27.6 million between FY 2016 and FY 2017. This is a 1.4 percent increase.
- The INL Site generated nearly $935 million of economic output through INL Site suppliers and employee household spending.
- The INL Site increased personal income in the State by $862 million. The INL Site's economic impacts accounted for 1.3 percent of all personal income in the State.
- The INL Site impacts resulted in an estimated $69 million in State and local tax revenues.

Taxes generated by the INL Site operations account for 1.7 percent of total State and local tax revenue (based on FY 2016 State tax revenues).

3.1.14 Environmental Justice

The ROI for environmental justice is the area within a 50-mile radius of the proposed location of the VTR facilities at the MFC. The 50-mile radius was selected because it is consistent with the ROI for radiological emissions. The potentially affected area includes parts of 14 counties throughout Idaho.

Executive Order 12898 directs Federal agencies to make the achievement of environmental justice part of their mission. This goal is accomplished by identifying and addressing disproportionately high and adverse human health or environmental effects of Federal programs, policies, and activities on minority and low-income populations. The following discussion is consistent with the guidelines and procedures for compliance with the Executive order promulgated by the Council on Environmental Quality (CEQ 1997).

The definitions of minority, low-income, and minority and low-income populations are presented below.

- **Minority** – Individual(s) who are members of one or more of the following population groups as designated in the U.S. Census Bureau data: Black or African-American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, as well as Hispanic or Latino of any race.
- **Low income** – The U.S. Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty (i.e., classified as "low income"). If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. The official poverty thresholds do not vary geographically but are updated for inflation using the U.S. Consumer Price Index. The official poverty definition uses money income before taxes and does not include capital gains or noncash benefits (such as public housing, Medicaid, and food stamps) (Census 2016).
- **Minority or low-income population** – Populations where either: (a) the total number of minority or low-income individuals of the affected area exceeds 50 percent of the overall population in the same area, or (b) the total number of minority or low-income individuals within the affected area is meaningfully greater (e.g., 120 percent greater) than the minority or low-income population percentage in an appropriate comparison unit of geographic analysis. A minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above stated thresholds.

  In identifying minority or low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a geographically dispersed/transient set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.

  The selection of the appropriate unit of geographic analysis may be a governing body's jurisdiction, a neighborhood, census tract, or other similar unit that is to be chosen so as to not artificially dilute or inflate the affected minority population.
- **Meaningfully Greater** – A meaningfully greater minority or low-income population within a geographic unit affected by a Federal action is determined by comparing the minority or low-income composition of the geographic unit to the minority or low-income composition of the general population. Similar to selecting the appropriate unit of geographic analysis, a comparison population should be selected so as to not artificially dilute or inflate the affected minority populations. For this analysis, the comparison population is the total population of the 14 counties that fall within the 50-mile radius of the proposed location of the VTR facilities at the MFC.

Minority and Low-Income Populations

The analysis of minority and low-income populations focuses on census data for geographic units (i.e., block groups) that represent, as closely as possible, the potentially affected areas. A census block group is the smallest geographic area for which the U.S. Census Bureau provides consistent sample data, and generally contains a population between 600 and 3,000 individuals. In order to evaluate the potential impacts on populations in closer proximity to the MFC, radial distances of 5, 10, and 20 miles are analyzed. **Table 3–20** shows the minority and low-income composition of the potentially affected area surrounding the proposed MFC facilities at each of these distances.

Table 3–20. Minority and Low-Income Populations within the 50-Mile Radius of the Materials and Fuels Complex

Population Group	Within 5 Miles		Within 10 Miles		Within 20 Miles		Within 50 Miles	
	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total
Total Population	36	100.0	364	100.0	2,721	100.0	265,779	100.0
Nonminority	33	91.7	302	83.0	2,100	77.2	219,887	82.7
Total Minority	3	8.3	62	17.0	621	22.8	45,892	17.3
White - Hispanic/ Latino	3	8.3	27	7.4	255	9.4	16,355	6.2
Black/African American [a]	0	0.0	0	0.0	14	0.5	1,172	0.4
American Indian or Alaska Native [b]	0	0.0	0	0.0	4	0.1	5,313	2.0
Other Minority [a, b]	0	0.0	35	9.6	348	12.8	23,052	8.7
Low Income	0	0.0	33	9.1	239	8.8	39,055	14.7

[a] Includes persons who also indicated Hispanic or Latino origin.

[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.

Source: Census 2017a, 2017b.

Minority populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within 50 miles of the MFC. If a block group's percentage of minority individuals met the 50 percent criterion or was more than 120 percent of the percentage of the total minority population within the 14-county comparison population, then the block group was identified as having a minority population. The total population residing in the 14-county comparison population is 390,550, of which 18 percent would be considered members of a minority population; therefore, the meaningfully greater criterion for minority populations is 21.5 percent. Of the 188 block groups within the ROI, 10 block groups have individual racial group minority populations or aggregate minority populations that meet the 50 percent criterion, and 55 block groups meet the meaningfully greater criterion for one or more racial groups.

The overall composition of the projected populations within every radial distance is predominantly nonminority. Minority populations in the ROI are predominantly White Hispanic and Other Minority. The concentration of minority populations is greatest within the 20-mile radius. American Indian or Alaska Native populations comprise 2 percent of the population within the 50-mile radius, because the Fort Hall Reservation of the Shoshone-Bannock Tribes lies largely within the ROI. **Figure 3–11** displays the block groups identified as meeting the criteria for environmental justice minority populations surrounding the MFC, as well as population density of minority populations within each block group.

As with minority populations, low-income populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within 50 miles of the MFC. If a block group's percentage of low-income individuals met the 50 percent criterion or was more than 120 percent of the percentage of the total low-income population within the 14-county comparison population, then the area was identified as having a low-income population. Of the total population living in the 14-county MFC comparison population, about 15.5 percent are identified as living below the poverty line. Therefore, the meaningfully greater criterion for low-income populations is 18.5 percent. Of the 188 block groups within the ROI, 5 block groups have a low-income population that exceeds the 50 percent criterion, and a total of 62 block groups meet the 120 percent criterion for low-income populations. **Figure 3–12** displays the block groups identified as meeting the criteria for environmental justice low-income populations surrounding the MFC, as well as population density of low-income populations within each block group.

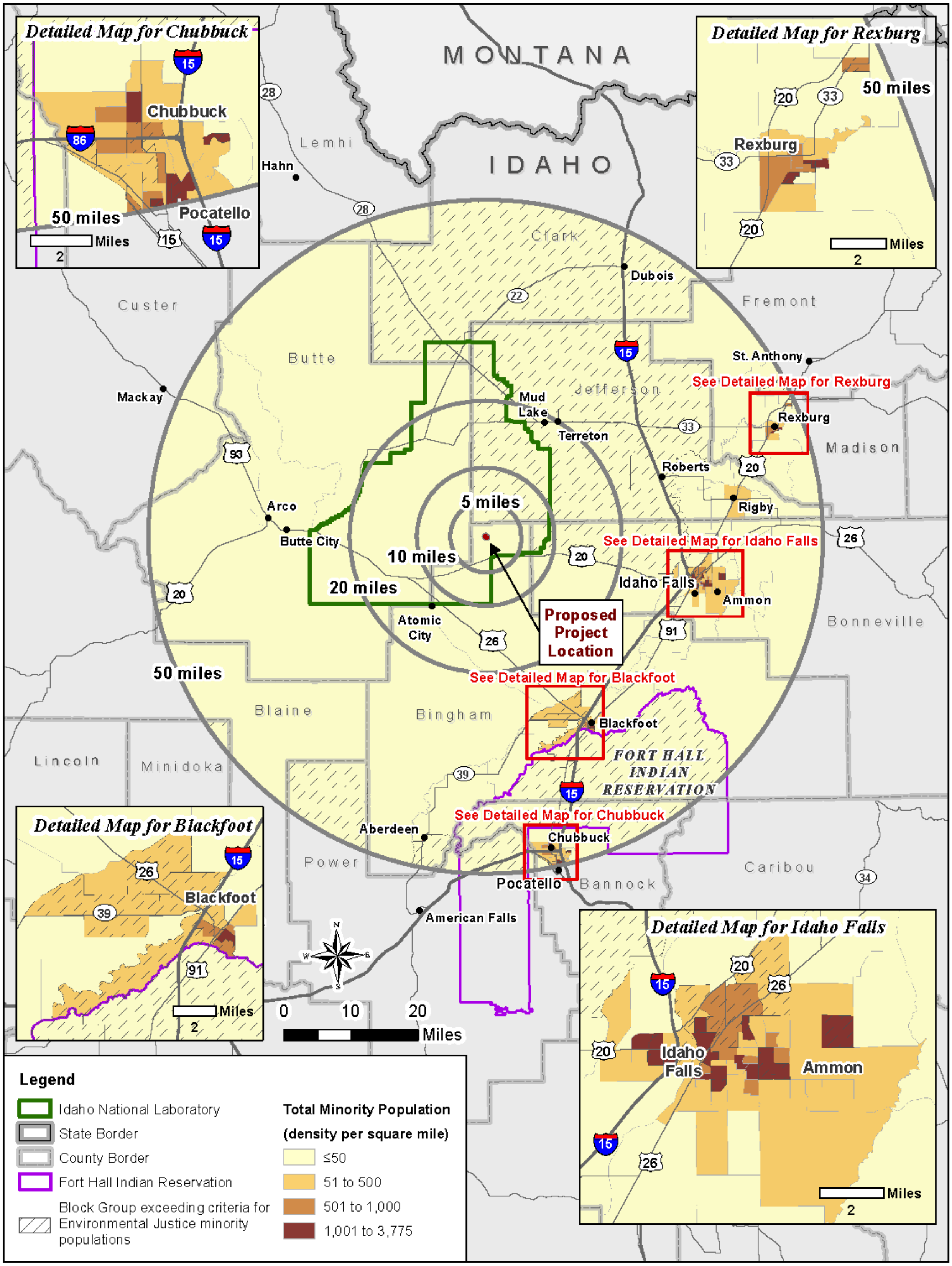


Figure 3–11. Locations of Block Groups Meeting the Criteria for Environmental Justice Minority Populations

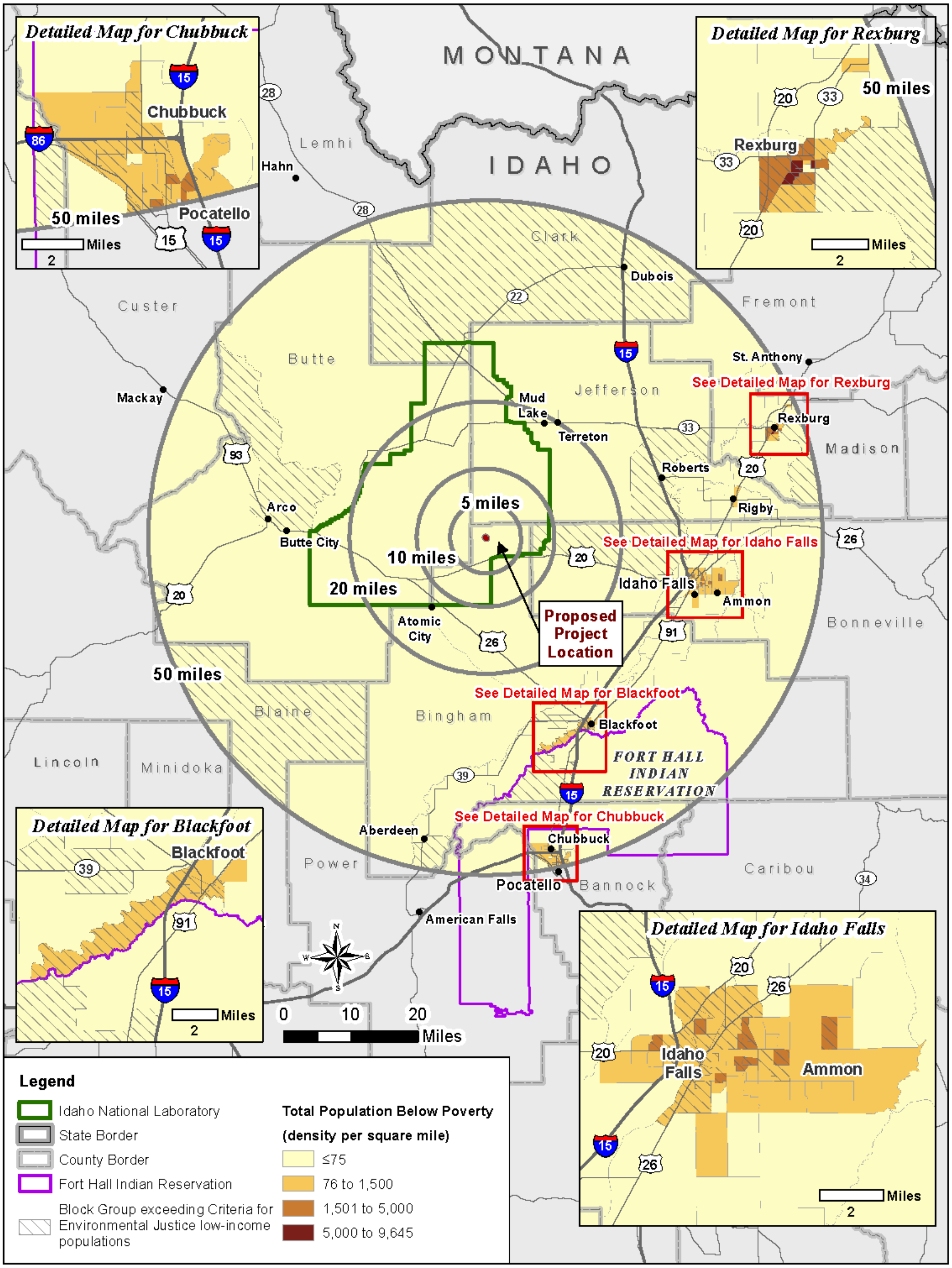


Figure 3–12. Locations of Block Groups Tracts Meeting the Criteria for Environmental Justice Low-Income Populations

3.2 Oak Ridge National Laboratory

3.2.1 Land Use and Aesthetics

This section describes the land use and aesthetics of the Oak Ridge Reservation (ORR) and the proposed project area. The ROI for land use is composed of ORNL, which resides within the ORR. Specific areas within ORNL include the proposed Melton Valley site and lands immediately adjacent. Other regional land uses are described because they can be included in the ROI for other aspects of this affected environment. The ROI for aesthetics would include any areas within line of sight of the proposed project area (near the Melton Valley site[3]) and nearby developed or industrialized areas.

Land use generally refers to human modification of land, often for residential or economic purposes. It also refers to the use of land for preservation or protection of natural resources, such as wildlife habitat, vegetation, or unique geographic features. Attributes of land use include general land use and ownership, land management plans, and special use areas.

3.2.1.1 Land Use at Oak Ridge Reservation

Situated in the Great Appalachian Valley of East Tennessee between the Cumberland Plateau and Great Smoky Mountains, the ORR encompasses about 32,867 acres of mostly contiguous land in Anderson and Roane Counties, owned by the Federal government and under the management of DOE (ORO 2019:1-3). The area is characterized by a succession of east−west-trending narrow ridges and flat-bottomed valleys. Trending northeast to southwest, the major valleys of ORR include the East Fork Valley, Bear Creek Valley, Bethel Valley, and Melton Valley. Major ridges of ORR include Black Oak Ridge, East Fork Ridge, Pine Ridge, Chestnut Ridge, Haw Ridge, and Copper Ridge. With the exception of the East Fork Ridge, these ridges and their intervening valleys extend beyond the limits of ORR. Topographic relief between valley floors and ridge crests on ORR is generally 300 to 350 feet (CROET 2007:2-1).

DOE classifies land use on ORR into five categories: institutional/research, industrial, mixed industrial, institutional/environmental laboratory, and mixed research/future initiatives. Development on ORR accounts for about 35 percent of the total acreage, leaving about 65 percent of ORR undeveloped. Industrial and mixed industrial areas of the ORR include ORNL (historically called X-10), Y-12 National Security Complex (Y-12), and East Tennessee Technology Park (ETTP). The institutional/research category applies to land occupied by central research facilities at ORNL and the Natural and Accelerated Bioremediation Field Research Center in Bear Creek Valley near Y-12. The institutional/environmental laboratory category includes the Oak Ridge Institute for Science and Education. Land within the mixed research/future initiative category includes land that is used or available for use in field research and land reserved for future DOE initiatives. Undeveloped forested lands on ORR are managed for multiple uses, habitat management, watershed protection, wildfire risk reduction, and forest health maintenance (DOE 2011c:4-2, 4-4).

The largest of the mixed industrial uses is biological and ecological research in the 20,000-acre Oak Ridge NERP. The NERP, established in 1980, is used by the nation's scientific community as an outdoor laboratory for research and education, especially in the environmental sciences (ORNL 2020a). The Oak Ridge NERP was designated an international biosphere reserve in 1989, making it one of the five units of the Southern Appalachian Biosphere Reserve. It is also part of a Tennessee Wildlife Management Area

[3] The Melton Valley site is an area at the ORNL between the High Flux Isotope Reactor and the Clinch River to the east that previously was studied for siting under the Global Nuclear Energy Partnership (CROET 2007). The proposed location of the VTR complex at ORNL is within the Melton Valley site.

(Oak Ridge Wildlife Management Area) and part of the Southern Appalachian Man and the Biosphere Cooperative (ORNL 2020a).

In 1999, the Three Bend Scenic and Wildlife Management Refuge was created in an agreement between DOE and Tennessee Wildlife Resources Agency (TWRA). The Three Bend Scenic and Wildlife Management Refuge Area consists of 2,920 acres located in the ORR buffer zone on Freels, Gallaher, and Solway bends on the north shore of Melton Hill Lake in Anderson County. The cooperative agreement establishes general guidelines for managing the area to preserve and enhance its natural attributes (ORNL 2002:2-43).

In 2005, DOE and the State of Tennessee completed arrangements to place about 3,000 acres of land on ORR into a conservation easement (the Black Oak Ridge Conservation Easement) that is managed by the State of Tennessee in accordance with State laws regarding natural areas and wildlife management areas. The agreement preserves both East and West Black Oak Ridge and McKinney Ridge for conservation and public recreation (DOE 2011c: 4-4). **Figure 3–13** shows the current land use at ORR.

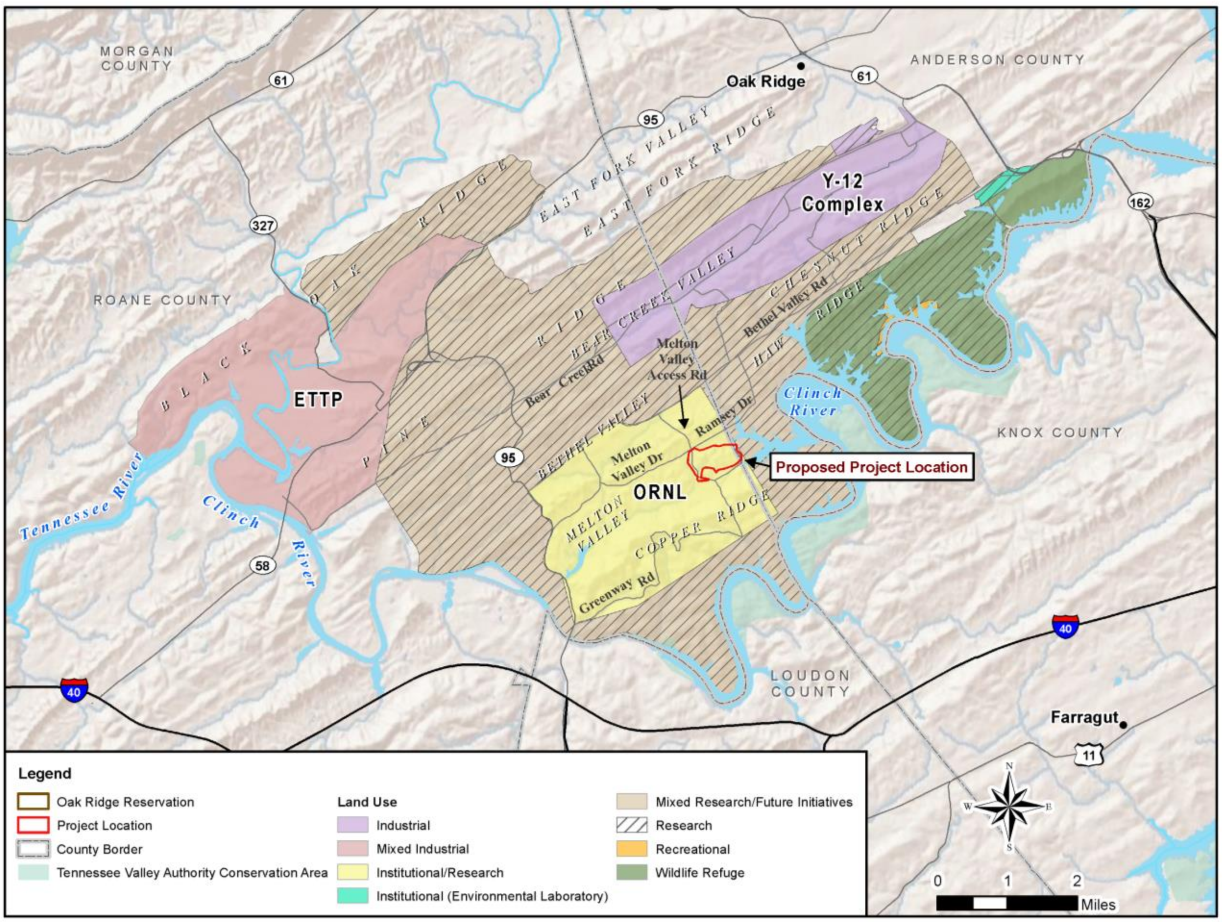


Figure 3–13. Current Land Use at Oak Ridge Reservation

The main ORNL site encompasses facilities in two valleys (Bethel and Melton Valleys) on 1,100 acres of land within the ORR. Within the main area of ORNL, the DOE land use designation is "institutional and research." ORNL supports research and development mission activities in science and technology, energy resources, environmental quality, and national security (DOE 2008a:3-1). The main campus is generally divided into three research campuses, each of which contains a mix of facilities by research type. The west campus primarily contains facilities dedicated to biological and environmental sciences. The heavily industrialized central campus contains a mix of facilities used for administration and support, energy and engineering sciences, physical sciences, and management and integration. The east campus also contains a mix of research facilities (DOE 2008a:3-2).

Land Use at Melton Valley Site

Melton Valley is a prominent northeast-southwest trending valley, typical of landforms in the Valley and Ridge Physiographic Province. The Melton Valley site is located within a relatively undeveloped area of ORNL. As described above, the zoning classification for the majority of the ORR, including the Melton Valley site, is Federal Industry and Research. The DOE designation for the Melton Valley site is institutional/research and mixed research/future initiatives. The area designated as institutional/research is primarily associated with ORNL activities. This includes DOE mission initiatives, research and education, cleanup and remediation, compliance monitoring, utilities, security, and wildlife management (CROET 2007:2-4, 2-5).

Melton Valley is also part of the TWRA Oak Ridge Wildlife Management Area through an agreement between DOE and TWRA, which provides for protection of wildlife habitat and species and restoration of other wildlife habitat and species. Land use in this area is primarily associated with research and education although utilities and some cleanup and remediation activities are present. Portions of Melton Valley are also within the Oak Ridge NERP (DOE 2008a:3-2). The Melton Valley Watershed, situated on about 1,000 acres just south of ORNL contains multiple closed remediation sites as implemented through decisions documented in the Melton Valley Watershed ROD after having been reviewed by the public and approved by DOE, EPA, and the State of Tennessee. The site under consideration for the VTR is not located in the immediate area that was addressed in the Melton Valley Watershed ROD (DOE 2000a) and as such, the Melton Valley site is not subject to the land use controls or remediation activities indicated in the Melton Valley Watershed ROD (CROET 2007:2-4).

Most of the 150-acre Melton Valley site is forested land. Several specific areas within the Melton Valley site currently are designated for other uses (CROET 2007:2-5). These include:

- Park City Road
- Potable water pipeline
- Lichen Research Site
- Explosive and Shock-Sensitive Waste Detonation Area

Regional Land Use

The City of Oak Ridge, Tennessee, forms the northern boundary of ORR and has a typical urban mix of residential, public, commercial, and industrial land uses. There are four residential areas along the northern boundary of ORR, several of which have houses located within 98 feet of the site boundary (DOE 2011c:4-2).

Except for the City of Oak Ridge, the land within 5 miles of ORR is semirural and used primarily for residences, small farms, forest land, and cattle pasture. Fishing, hunting, boating, water skiing, and swimming are popular recreational activities in the area. Other municipalities within about 20 miles of the reservation include Oliver Springs, Clinton, Rocky Top, Lenoir City, Farragut, Kingston, and Harriman. Knoxville, the major metropolitan area nearest Oak Ridge, is about 25 miles to the east (ORO 2019:1-3).

3.2.1.2 Aesthetics at Oak Ridge Reservation

The landscape at ORR is characterized by a series of ridges and valleys that trend in a northeast to-southwest direction. Areas on ORR that are not developed consist primarily of rural land. The City of Oak Ridge is the only adjoining urban area. Viewpoints affected by facilities at ORR are primarily associated with the public access roadways, the Clinch River/Melton Hill Lake, and the bluffs on the opposite side of the Clinch River. However, viewsheds from outside the ORR are often limited by hilly terrain, heavy vegetation, and generally hazy atmospheric conditions (DOE 2011c:4-7).

The level of development of ORNL, ETTP, and Y-12 is consistent with Bureau of Land Management's VRM Class IV, which is used to describe a highly developed area. Most of the ORR land surrounding ORNL, ETTP, and Y-12 would be consistent with the VRM Classes II and III (i.e., left to its natural state with little to moderate changes).

Facilities at ORNL are brightly lit at night, making them especially visible. Structures are mostly low profile, reaching heights of three stories or less. The tallest structures are exhaust stacks on buildings, water towers, and communication and meteorological towers.

Aesthetics at Melton Valley Site

The Melton Valley site would have a VRM Class II rating. Nearby developed areas, such as the High Flux Isotope Reactor (HFIR)/Radiochemical Engineering Development Center (REDC) complex at ORNL, would have a VRM Class IV rating.

There is no public access to the Melton Valley site. The closest viewpoints for the public are located on Melton Hill Lake. Boaters outside the DOE site boundary could get within about 1 mile of the Melton Valley site boundary. The closest viewpoint from an offsite residence is located about 1.5 miles from the site boundary. Hilly terrain, heavy vegetation, and generally hazy atmospheric conditions restrict the view from most publicly accessible areas.

There are currently no lighted facilities on the 150-acre Melton Valley site. Facilities at the nearby HFIR and REDC are brightly lit at night. The tallest structure at the HFIR/REDC complex is a 250-foot exhaust stack.

3.2.2 Geology and Soils

The ROI for geology and soils includes the 150-acre proposed project area at ORNL within the ORR. ORR is located within the Valley and Ridge Physiographic Province, part of the Appalachian fold and thrust belt. The area is characterized by a succession of northeast-southwest-trending narrow ridges and flat-bottomed valleys, which formed as a result of differential erosion of the southeast dipping rocks. Topographic relief between valley floors and ridge crests on ORR is generally 300 to 350 feet (CROET 2007:2-1).

Melton Valley, the location of the 150-acre proposed project area, is a prominent northeast-southwest-trending valley typical of landforms in this type of physiographic province. Haw Ridge borders Melton Valley to the northwest with crest elevations of about 1,000 feet. Copper Ridge lies southeast of Melton Valley with a high crest of 1,356 feet. The valley is about 1.2 miles wide from ridgetop to ridgetop. A line of low knobs with crest elevations of about 940 feet occurs near the center of Melton Valley. The lowest topography in Melton Valley is at the mouth of White Oak Creek at its confluence with the Clinch River. Elevations in the proposed project area range from about 820 to 940 feet (CROET 2007:2-1, 2-2, 2-4).

3.2.2.1 Geology

Bedrock underlying Melton Valley is composed of the calcareous shales and interbedded shaley to silty limestones of the Cambrian Period Conasauga Group. Several individual geologic formations that make up this group are represented, including from north to south (ascending order): the Pumpkin Valley Shale, Rutledge Limestone (also known as the Friendship Formation), Rogersville Shale, Maryville Limestone (also known as the Dismal Gap Formation), and the Nolichucky Shale (see **Figure 3–14**) (CROET 2007:3-2). The geologic units are described in detail in ORNL 1992 and ORNL 2005.

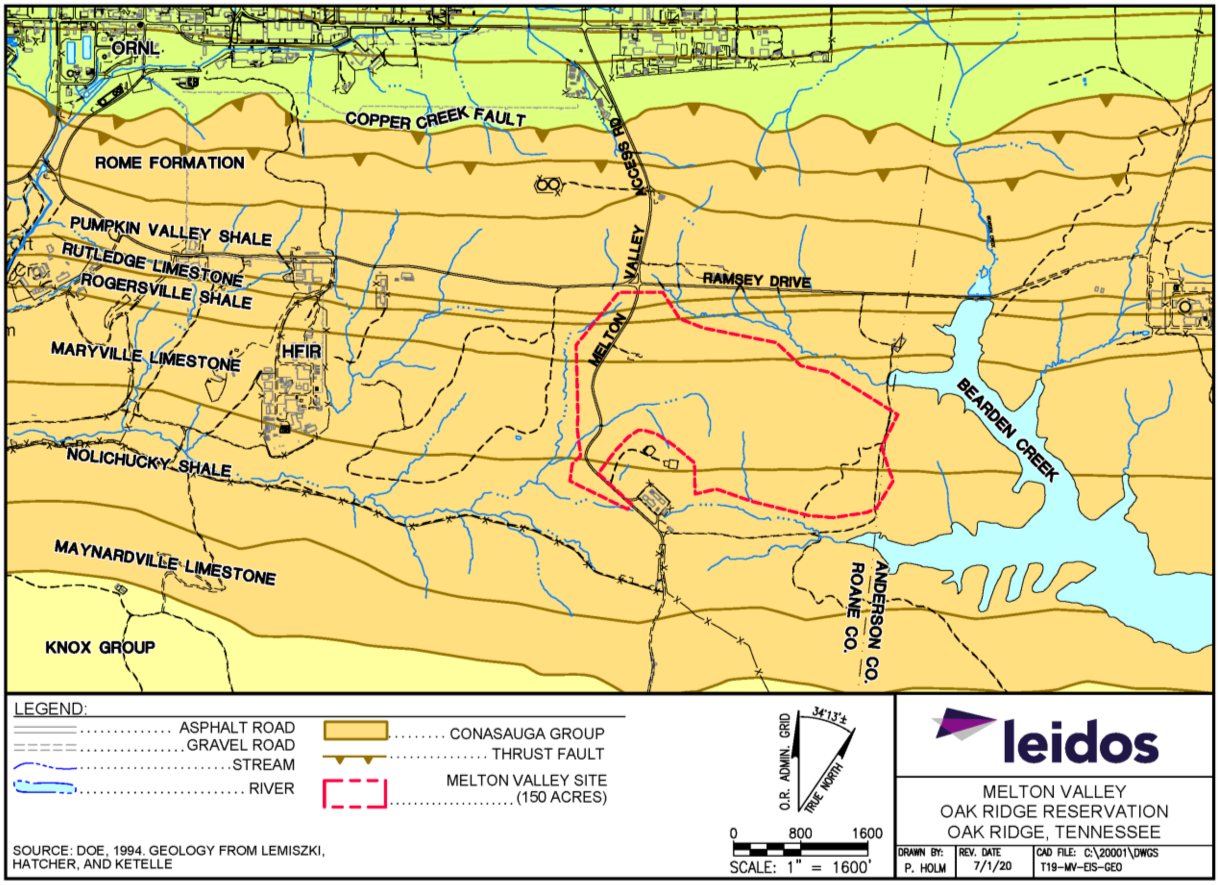


Figure 3–14. Geology of the Proposed Project Area in Melton Valley

A relatively thick zone of bedrock residuum (saprolite) immediately overlies the rocks of the Conasauga Group in Melton Valley. Rock units of the Conasauga Group generally have a low permeability and the residuum zone is highly adsorptive to radionuclides. Because the Conasauga Group has historically been the primary geologic unit for radioactive waste disposal activities, it is the most thoroughly studied rock unit on the ORR (CROET 2007:3-2).

The structural geology of ORR is dominated by two regional thrust faults: White Oak Mountain and Copper Creek faults. There is no geologic evidence indicating that these thrust faults are active or capable. As defined in 10 CFR Part 100, Appendix A, a capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years. The final episode of movement along these fault systems occurred during the Pennsylvanian or Permian Period, at least 230 million years ago (CROET 2007:3-2, 3-4). These faults are no longer active, but stress stored up at depth in these rocks is periodically released as minor earthquakes (DOE 2016d:3-29).

Haw Ridge, Melton Valley, and Copper Ridge are underlain by the Copper Creek Fault, with Melton Valley located south of the surface trace of this fault along Haw Ridge (see Figure 3–14). The Copper Creek Fault underlies Melton Valley at a depth of about 800 feet. Folds, offsets, and dislocations, prevalent in the rocks above the Copper Creek Fault, are believed to be localized in extent and related to the regional thrust faulting. Displacements on these features are generally measured in inches (CROET 2007:3-2, 3-4).

3.2.2.2 Soils

Soils across Melton Valley are generally thin and developed from residual, alluvial (stream-laid), and colluvial (material transported downslope) materials derived from parent bedrock. These soils are underlain by a thick zone of saprolite. Saprolite represents a transition zone between soil and bedrock materials. Saprolite is a soft, clay-rich material derived from decomposed rock that has been leached of cementing materials but which may retain some of the physical characteristics of the parent rock from which it formed. Based on studies performed for the characterization of the former Advanced Neutron Source (ANS) site, bedrock in Melton Valley generally weathers to a clayey residual soil that varies from a true clay at the top to a thick "saprolitic zone" commonly termed "rotten rock." While the saprolite zone is likely to vary spatially across Melton Valley, it was observed during excavation for the adjacent HFIR/REDC complex that the residuum over bedrock averaged about 20 feet in thickness and was overlain by only a thin (less than 1 foot) layer of topsoil (CROET 2007:3-6).

Surficial (geomorphic) material and derived soil types have been mapped across the ORR and Melton Valley. General surficial material types in Melton Valley include residuum, Conasauga Alluvium, Conasauga Colluvium, Pleistocene-Tertiary Alluvium, and Rome Alluvium. Detailed mapping of soil units was previously conducted as part of the ANS site characterization and provides the basis for the following discussion (CROET 2007:3-6).

Residuum. The vast majority of Melton Valley is mapped as residuum. Soils that developed as residuum (saprolite) reflect the variability and degree of weathering of the underlying bedrock formations (see Figure 3–14). Pumpkin Valley residual soils are extensive clayey or fine-loamy soils greater than 20 inches in depth to the horizon underlain by soft bedrock. Rutledge Residuum soils are described as "clayey argillic and loamy-skeletal" residual soils that formed in shale-siltstone-derived, low-glauconitic saprolite weathered from calcareous rocks. Where the saprolite was derived from shale, the material has low permeability, allowing water to perch. Rogersville Residuum soils generally are clayey, clayey argillic, and loamy-skeletal soils on summits and sideslopes. Maryville Residuum soils arose under varying degrees of weathering. Most of these soils are clayey and loamy-skeletal-type soils that formed in saprolite from less weathered but highly interbedded siltstone and claystone, with thin strata of limestone and sandstone. The depth to the horizons underlain by soft bedrock is highly variable ranging from less than 4 inches to more than 40 inches over short distances. Nolichucky Residuum consists of clayey argillic and loamy-skeletal-type soils. Due to the relatively impermeable nature of the saprolite, the upper soil becomes readily saturated (CROET 2007:3-6).

Conasauga Alluvium. This unit comprises coarse to fine, silty soils that formed in modern alluvium along surface water drainages and contributes high silt-content sediment to their drainages. Modern or recent alluvium is less than 300 years old and is the product of accelerated erosion from human settlement and related land uses, such as agriculture. Because of its age, the alluvium lacks any diagnostic soil horizons in the subsurface. Most of the soils are well to moderately well drained, but some soils grade to somewhat poorly to poorly drained, particularly along the larger drainages to Melton Branch in the central portion of Melton Valley. Most of these mapped areas contain a buried soil at depths ranging from 20 to 40 inches (CROET 2007:3-6, 3-8).

Conasauga Colluvium. These colluvial materials include fine, loamy soils that developed from parent materials from the Pumpkin Valley, Rogersville, and Maryville Limestone formations. Derived soils include rock fragment assemblages reflecting their source, including shale and siltstone fragments. Associated soils occur on toeslopes and fan terraces near first-order drainage ways (CROET 2007:3-8).

Pleistocene-Tertiary Alluvium. These alluvial materials are limited in extent and reflect older terraces of stream-deposited alluvium (CROET 2007:3-8).

No current soil surveys prepared by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) are available for Roane County. Nevertheless, maps of areas to the east of the site in Anderson County indicate that soils of the Armuchee and Montevallo Series would be representative of some soil units on the proposed project area. Armuchee soils are moderately deep and well-drained soils that occur on rolling to very steep uplands. Montevallo-Series soils consist of shallow, well-drained, moderately permeable soils on gently sloping to steep, narrow ridgetops and side slopes. Armuchee- and Montevallo-Series soils are classified as having specific limitations affecting excavation work that may be difficult to overcome without adequate engineering design and planning. Specific limitations identified for these soils include shallow depth to soft bedrock, presence of clayey strata, slope, and the tendency for cut slopes to cave (CROET 2007:3-8). More finely textured soils of the Armuchee-Montevallo-Hamblen association have been designated as prime farmland when drained (DOE 2011c:4-19).

No widespread areas of soil contamination have been identified within the proposed project area (CROET 2007:3-8).

3.2.2.3 Geologic and Soil Resources

The known geologic and soil resources exposed on the ORR are limited to quarry rock (limestone and dolomite) and clay (soils). Quarry rock was mined at several locations on ORR, but no quarries are currently in operation (DOE 1995:3.4-20–21). A number of active borrow pits at ORR have been identified for use in providing a supply of borrow materials for ongoing and future activities. The Copper Ridge Borrow Area, the nearest borrow source, is about 0.5 mile southeast of the proposed project area. No other economically viable geologic resources have been identified at ORR (DOE 1996c:3-200).

3.2.2.4 Geologic Hazards

Seismic Hazards

There is no evidence of capable faults in the immediate area of ORR, as defined by 10 CFR Part 100 (surface movement within the past 35,000 years or movement of a recurring nature within the past 500,000 years). The nearest capable faults are about 300 miles west of ORR in the New Madrid Fault zone (DOE 2011c:4-17). Historical earthquakes occurring in the Valley and Ridge Province of Tennessee are not attributable to faults in underlying sedimentary rocks but instead occur at depth in basement rock (DOE 2011d:3-156).

Seismic-hazard assessments in the Central and Eastern United States generally rely on historical seismicity to quantify seismic hazard, rather than geologic evidence of active faulting at or near the surface. ORNL is located within the Southern Appalachian Seismic Zone, which extends from western Virginia to central Alabama, subparallel to the Valley-and-Ridge and Blue Ridge physiographic provinces. While minor earthquakes are relatively common in the Southern Appalachian Region within about 60 miles of ORNL, no earthquakes above magnitude 6.0 have been documented in the region (CROET 2007:3-4).

The USGS reported 179 earthquakes greater than magnitude 2.5 occurred within 100 miles of the proposed project area between January 1973 and September 2019. Only one of the 179 earthquakes had a magnitude greater than 4.5. A magnitude 4.7 event occurred on November 30, 1973 (USGS 2019b).

The November 30, 1973, earthquake occurred in Blount County, Tennessee (in the Maryville/Alcoa area), about 21 miles from ORNL. Although this earthquake caused minor damage in eastern Tennessee, there were no earthquake-related damage reports for DOE facilities at ORR (CROET 2007:3-5).

On August 9, 2020, a magnitude 5.1 earthquake occurred near Sparta, North Carolina, over 175 miles from ORR. The earthquake was generally weakly to lightly felt in the Oak Ridge, Tennessee area, with no damage reported (USGS 2020).

Within the larger southern portion of the Appalachian Basin Tectonic Province in which the ORR is located, the strongest documented earthquake occurred in Giles County, Virginia, on May 31, 1897. Located about 220 miles from ORNL, it had an estimated magnitude of 5.8 and produced slight damage in eastern Tennessee. The strongest earthquakes to affect the ORR region were the New Madrid, Missouri, earthquakes (with estimated magnitudes ranging from 7.0 to 7.9) that occurred in 1811 and 1812 at distances of 310 to 370 miles from ORNL. It is believed that this series of earthquakes led to low-level shaking at ORR for several minutes. Second to the New Madrid earthquakes in intensity, the Charleston, South Carolina, earthquake of 1886, located about 320 miles from ORNL, produced minor damage in East Tennessee (CROET 2007:3-5).

Earthquake-produced ground motion is expressed in units of "g." (acceleration relative to that of the Earth's gravity.) PGA data from the USGS are used to indicate seismic hazard. At the proposed project area, the calculated PGA based on an earthquake with a 2 percent probability of exceedance in 50 years (or an annual occurrence probability of 1 in 2,500) is about 0.35 g (USGS 2014a, 2014b).

Current standards, including DOE Orders and prescribed standards applicable to the ORR, require the use of probabilistic seismic analysis to establish the seismic hazard curve of postulated earthquake ground motions for the site. Probabilistic seismic analysis considers all possible tectonic events that could impact the site and attempts to account for both the likelihood of occurrence, and the uncertainty in such input parameters as seismic source, seismicity, or attenuation factors. For HFIR, adjacent to the proposed VTR site, the current established peak horizontal ground acceleration for the design-basis earthquake is 0.15 g (CROET 2007:3-5).

Volcanic Hazards

The area near ORR has not experienced volcanic activity within the last 230 million years and future volcanic activity is not anticipated (DOE 1996c:3-200).

Slope Stability, Subsidence, and Liquefaction

Topographic relief and slope classifications across Melton Valley are shown in **Figure 3–15**. Slopes less than 5 percent (Class 2) cover most of Melton Valley. The steepest slopes (Class 5) generally occur along the major surface drainages like those of Bearden Creek (CROET 2007:2-2).

Karst terrain is characterized by dissolution of carbonate bedrock and development of diagnostic karst features such as sinking streams, karst springs, caves, and sinkholes. Strata of the Conasauga Group, especially the shaley members, do not pose a significant hazard for karst development, and no sinkholes or other karst features have been identified in the proposed project area. On the ORR, carbonate bedrock formations of the Knox Group have the greatest potential for karst development. The proposed project area is situated north of subcrops of the Knox Group (CROET 2007:3-2) (see Figure 3–14). Therefore, subsidence is not likely to be an issue in the proposed project area.

There is no potential for liquefaction beneath facilities constructed on firm rock. Overall, DOE's experience on the ORR has been that depths to bedrock are sufficiently shallow that any location can be expected to provide a competent bedrock foundation for major structures. The highest liquefaction potential exists for shallow foundation materials that are saturated, uniformly graded, cohesionless, fine-grained sands at low-relative density. Drilling data from the geotechnical investigation of the HFIR site in Melton Valley have shown that the soil materials above continuous rock are residual clays of relatively high density (CROET 2007:3-4, 3-5).

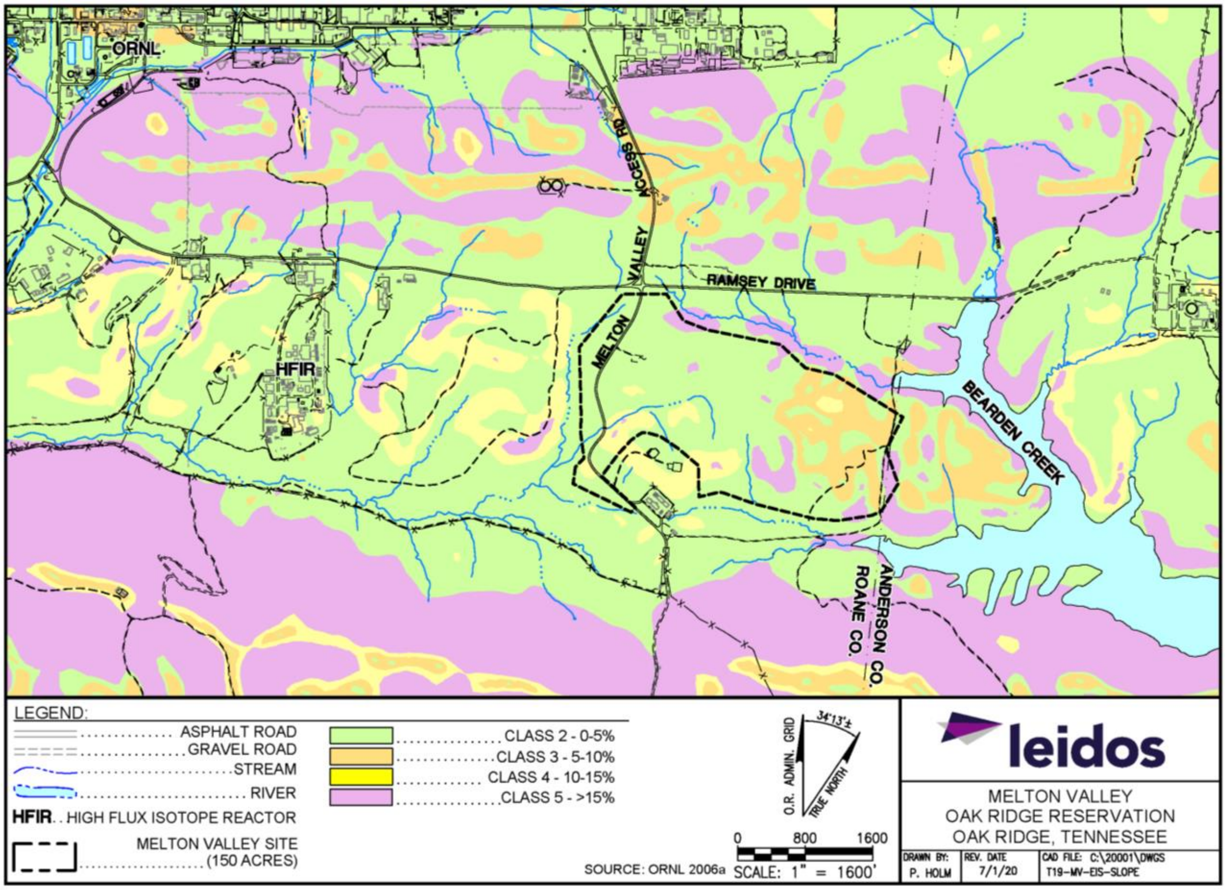


Figure 3–15. Surface Topography (Slopes) of the Proposed Project Area in Melton Valley

3.2.3 Water Resources

The ROI for water resources includes surface waters, wetlands, and groundwater present within and downstream of ORR in general and the 150-acre proposed project site within the ORNL in particular. This section describes surface and groundwater resources that drain the site and serve as sources of onsite drinking water and provides specific information regarding water availability and quality. Wastewater, stormwater, wetlands, and flooding potential are also discussed.

Chapter 0400-45-01 (Public Water Systems) of the Tennessee Department of Environment and Conservation (TDEC) outlines rules and regulations issued under the Tennessee Safe Drinking Water Act of 1983. These rules include State drinking water standards and primary and secondary constituent standards for groundwater.

3.2.3.1 Surface Water

ORR surface water drainage eventually reaches the Tennessee River via the Clinch River, which forms the southern and eastern boundaries of the ORR. There are four major subdrainage basins on ORR that flow into the Clinch River and are affected by site operations: Poplar Creek, East Fork Poplar Creek, Bear Creek, and White Oak Creek. Several smaller drainage basins — including Ish Creek, Grassy Creek, Bearden Creek, McCoy Branch, Kerr Hollow Branch, and Raccoon Creek — drain directly into the Clinch River. Each drainage basin takes the name of the major stream flowing through the area. The southwest corner of the project site drains to Melton Branch, while the remainder drains toward Bearden Creek. All surface water drainage from the project site eventually reaches the Clinch River.

The Clinch River water levels in the vicinity of ORR are regulated by a system of dams operated by the Tennessee Valley Authority. Watts Bar Dam on the Tennessee River near the lower end of the Clinch River controls the flow of the Clinch River along the southwest side of ORR. Melton Hill Dam controls the flow of the Clinch River along the northeast and southeast boundaries of ORR, including those sections of the river nearest the project site. The Melton Hill Dam on the Clinch River creates Melton Hill Reservoir, which extends about 57 miles upstream to Norris Dam (TVA 2020e).

None of the rivers or streams on or near ORR have been classified as wild and scenic per the Wild and Scenic Rivers Act, 16 U.S.C. Section 1274.

National Wetland Inventory maps prepared by the USFWS indicate wetland areas are associated with the Melton Hill Reservoir (on the Clinch River) and other drainages toward White Oak Creek, including Melton Branch. These wetlands are classified as open water, riverine, or freshwater forested/shrub wetlands.

Figure 3–16 presents water resources in the vicinity of the Melton Valley site, including surface water and wetlands.

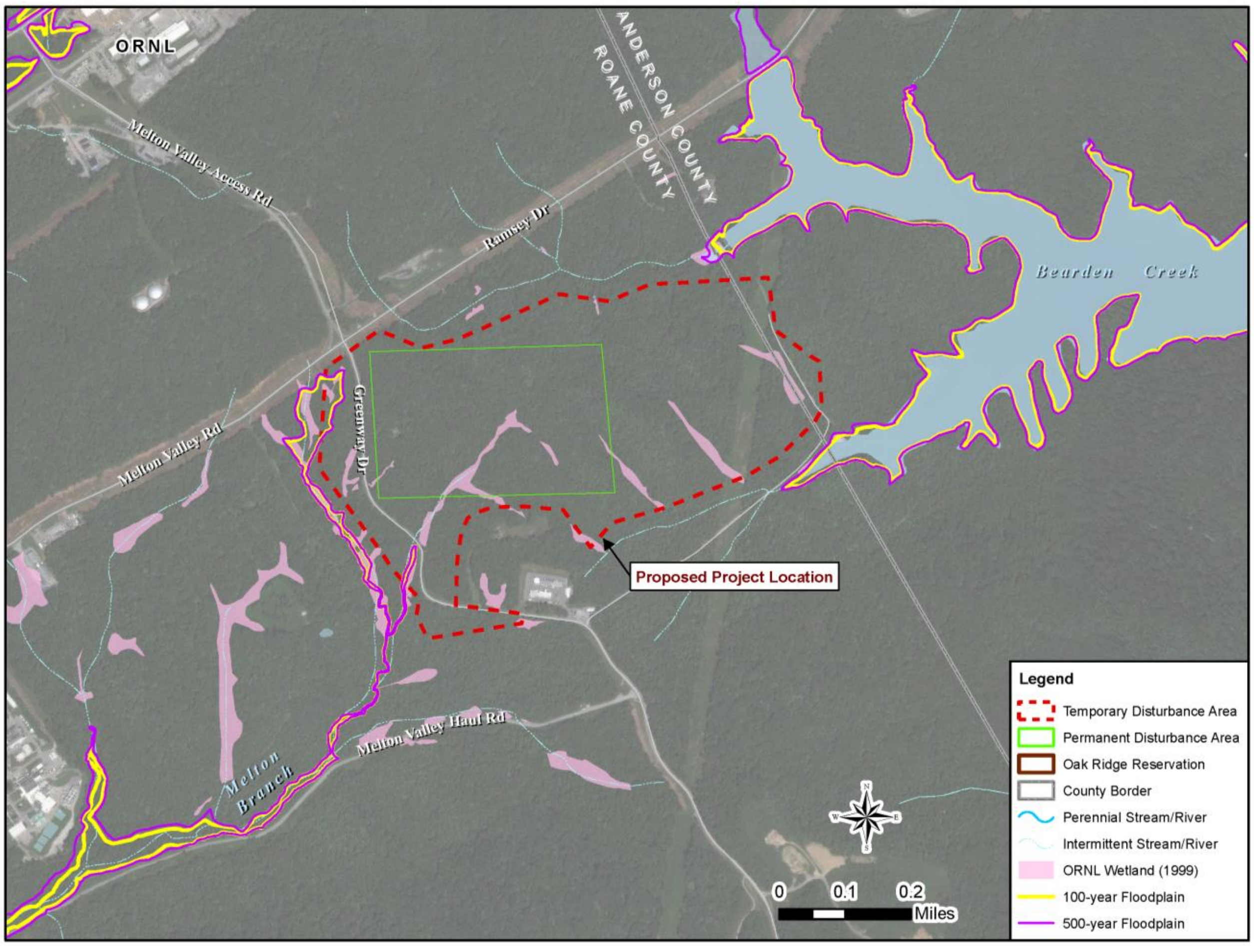


Figure 3–16. Water Resources in the Vicinity of the Melton Valley Site

3.2.3.1.1 Surface Water Quality

The surface streams of Tennessee are classified by the TDEC based on water quality, beneficial uses, and resident aquatic biota. Unless otherwise specified in Chapter 0400-40-04 of TDEC's rules, all streams in Tennessee are classified for use for fish and aquatic life, irrigation, and for livestock watering and wildlife. White Oak Creek and Melton Branch are the only streams not classified for irrigation. The Clinch River is classified for domestic water supply and for industrial water supply use. Melton Hill Reservoir (on the Clinch River) has been designated as impaired due to polychlorinated biphenyls (PCBs) and chlordane arising from contaminated sediment (TDEC 2019b).

Wastewater treatment facilities are located throughout ORR, including six treatment facilities at Y-12 that discharge to East Fork Poplar Creek and three treatment facilities at ORNL that discharge into White Oak Creek Basin. These discharge points are included in existing NPDES permit provisions. There are about 400 NPDES-permitted outfalls at ORR; many of these are stormwater outfalls. About 150 of these NPDES outfalls are located within ORNL (ORNL 2008). In 2018, the NPDES permit limit compliance rate for all discharge points was 100 percent (ORO 2019).

3.2.3.2 Groundwater

3.2.3.2.1 Local Hydrology

Groundwater in the vicinity of ORNL, including near the project site, occurs both in the unsaturated zone as transient, shallow subsurface stormwater 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 (50 to 175 feet deep). In low-lying areas where the water table occurs near the surface, the stormflow zone and saturated zone are indistinguishable. It is estimated that in undisturbed, naturally vegetated areas at ORR, about 90 percent of the infiltrating precipitation does not reach the water table but travels through the 3- to 7-foot-stormwater zone, which about corresponds to the root zone. This condition exists because of the permeability contrast between the shallow stormflow zone and the underlying unsaturated zone (ORO 2004).

Two broad hydrologic groupings have been characterized at ORR, each having fundamentally different characteristics. The Knox Group and the Maynardville Limestone of the Conasauga Group constitute the Knox Aquifer, in which the groundwater flow is dominated by a combination of solution conduits and weathered permeable fractures. The less permeable ORR aquitard units constitute the second regime, in which the groundwater flow is dominated by fractures. The combination of fractures and solution conduits in the dolostones and limestones of the Knox Aquifer control flow over substantial areas, and rather large quantities of water may move relatively long distances. Active groundwater flow can occur at substantial depths in the Knox Aquifer (300 to 400 feet deep). The Knox Aquifer is the primary source of groundwater to many streams, and most large springs on ORR receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits are reported to exceed 1,000 gallons per minute (ORO 2018).

Units constituting the ORR aquitards include the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group. The units consist mainly of siltstone, shale, sandstone, and thinly bedded limestone of low to very low permeability. The typical yield of a well in the aquitards is less than 1 gallon per minute, and the base flow of streams draining areas underlain by the aquitards are poorly sustained because of such low flow rates (DOE 2000b). Most water in the saturated zone in the ORR aquitards is transmitted through a 3- to 20-foot layer of closely spaced, well-connected fractures near the water table. Modeling by the USGS indicates that 95 percent of all groundwater flow occurs in the upper 50 to 100 feet of the saturated zone in the ORR aquitards. As a result, flow paths in the active flow zones of the aquitards are relatively short, and nearly all groundwater discharges to local surface water drainages on the ORR (DOE 2000b; ORO 2004).

3.2.3.2.2 Subsurface Water Quality

Background groundwater quality at ORR is generally good in the near-surface saturated zone and the Knox Aquifer. It is poor in the deep saturated zone (particularly in the aquitards) at depths greater than 1,000 feet due to high total dissolved solids (ORO 2004).

Groundwater near ORNL has been locally contaminated by hazardous chemicals and radionuclides from past process activities. The contaminated sites include past waste disposal sites, waste storage tanks, spill sites, and contaminated inactive facilities (DOE 2000b). In general, contaminant plumes in groundwater at ORNL are relatively small in areal extent, as contaminant sources are discretely located and flow paths to surface water outlets are short (ORO 2004).

3.2.3.3 Drinking Water

Water for ORNL is obtained from the Clinch River south of the eastern end of Y-12 and pumped to the water treatment plant located on the ridge northeast of Y-12. The treatment plant is owned and operated by the City of Oak Ridge. The water treatment plant can deliver water to two water storage reservoirs at a potential rate of 24 million gallons per day. Water from the two reservoirs is distributed to Y-12, ORNL, and the City of Oak Ridge. Water use at ORNL is discussed in Section 3.2.7, Infrastructure.

3.2.3.4 Water Use and Rights

State laws and statutes relating to water rights have continuously developed over the past century and a half. Groundwater rights in the State of Tennessee have evolved to be aligned with the Reasonable Use doctrine. Under this doctrine, landowners can withdraw groundwater as long as they exercise their rights reasonably in relation to the rights of others (DOE 2000b).

3.2.4 Air Quality

This section describes the existing air quality and climatic conditions of ORNL. Roane and Anderson Counties encompass ORNL and, therefore, comprise the immediate ROI for the project air quality analysis. However, the counties of Knox and Loudon are adjacent to portions of the southern boundary of ORR and also are part of a regional ROI for the project.

3.2.4.1 Meteorology and Climatology

Due to its latitude and location on the eastern side of North America, ORNL experiences a humid subtropical climate. This climate of the ORNL region is characterized by hot and humid summers, relatively mild winters, abundant precipitation, and minor differences in precipitation between seasons.

Moisture from the Gulf of Mexico is the main source of precipitation in the region. During the warmer months of the year, this moisture produces rain showers and thunderstorms. The occasional passage of weak polar storm systems through the region during this time of year can enhance precipitation. The remnants of tropical storms also can move into the region from the Gulf of Mexico and can augment rainfall in the late summer and early fall. During the colder months of the year, the occurrence of polar storms increases and produces occasional snow and ice.

Climate and meteorological data collected within ORNL are used to describe the climatic conditions of ORNL (ORO 2019:1.4, Appendix B). The average high and low temperatures at ORNL in July are about 89 and 68 degrees Fahrenheit, respectively. January's average high and low temperatures are about 47 and 28 degrees Fahrenheit, respectively. Annual precipitation averages about 53 inches per year. July and October are the wettest and driest months of the year, respectively. An average of 6 inches of snow falls annually at ORNL.

Thunderstorms at ORNL occur an average of 48 days per year and are most common during the months of April through October. Hailstorms can occur with these storms, although the potential for large hail (greater than 0.75 inch in diameter) is low. As an example, hail was reported only 6 times within 25 miles of ORNL from 1961 to 1990. However, in 2011, large hail was observed about 9 miles southeast of ORNL. Tornadoes are rare in the region; only six have been observed in Roane County since 1950 (National Weather Service 2019b). In February 1993, a moderately strong tornado struck the Bear Creek Valley near the Y-12 Complex. This event is the only known occurrence of a tornado on ORR.

Figure 3–17 shows a graphic of wind speed and wind direction frequencies (wind rose) for data recorded at ORNL for period 2014 through 2018 at Tower A (MT4), which is located near the HFIR and about 1 mile west of the project site (ORNL 2020c). These data show that winds at ORNL prevail from the west-southwest and east-northeast directions. This wind direction pattern is largely due to the orientation of the Clinch River valley and its paralleling mountain ridges, which forces winds up and down their axes.

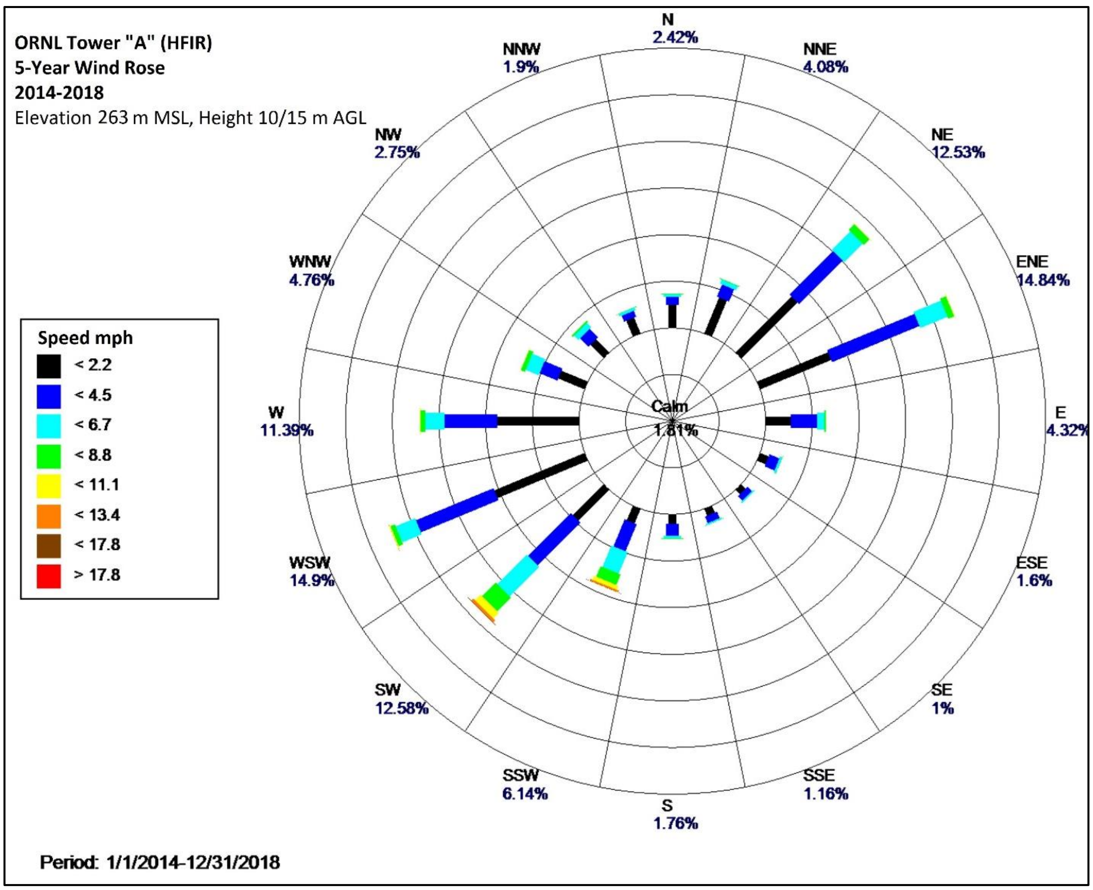


Figure 3–17. Wind Rose for Oak Ridge National Laboratory – Years 2014–2018

3.2.4.2 Air Quality Standards and Regulations

The CAA and its subsequent amendments establish air quality regulations and the NAAQS and delegate the enforcement of these standards to the States. In Tennessee, TDEC has the authority to regulate air quality. The CAA establishes air quality planning processes and requires States to develop a State Implementation Plan that details how they will maintain the NAAQS or attain a standard in nonattainment within mandated timeframes. The requirements and compliance dates for attainment are based on the severity of the nonattainment classification of the area. The following summarizes the air quality rules and regulations that apply to the proposed action at ORNL.

3.2.4.3 Nonradiological Air Emission Standards

Air quality at a given location can be described by the concentrations of various air pollutants in the atmosphere. Air pollutants are defined as two general types: (1) criteria pollutants and (2) HAPs. EPA establishes the NAAQS to regulate the following criteria pollutants: O_3, CO, NO_2, SO2, PM_{10}, $PM_{2.5}$, and lead. These standards represent atmospheric concentrations to protect public health and welfare and include a reasonable margin of safety to protect the more sensitive individuals in the population. TDEC implements the NAAQS and State ambient standards for total suspended particulates (TSP), hydrogen chloride, and fluoride for purposes of regulating air quality in Tennessee. The Tennessee standards and NAAQS are shown in **Table 3–21**.

EPA designates all areas of the United States as having air quality better than (attainment) or worse than (nonattainment) the NAAQS. Former nonattainment areas that have attained the NAAQS are designated as maintenance areas. Presently, EPA categorizes Roane County that encompasses ORNL as in attainment of all NAAQS. The nearest nonattainment area to ORNL is an SO_2 nonattainment area in Sullivan County, about 120 miles to the east-northeast. The nearest maintenance area to ORNL is a lead maintenance area in Bristol, Sullivan County, about 140 miles to the east-northeast.

Table 3–21. Tennessee and National Ambient Air Quality Standards

Pollutant	Averaging Time	Tennessee Standards [a]		National Standards	
		Primary [b]	Secondary [c]	Primary [b]	Secondary [c]
Ozone (O_3)	8-hour	--	--	0.070 ppm	Same as primary
	1-hour	0.12 ppm	0.12 ppm	–	–
Carbon monoxide (CO)	8-hour	9 ppm	9 ppm	9 ppm	–
	1-hour	35 ppm	35 ppm	35 ppm	–
Nitrogen dioxide (NO_2)	Annual	0.05 ppm	0.05 ppm	0.053 ppm	Same as primary
	1-hour	--	--	0.10 ppm	–
Sulfur dioxide (SO_2)	Annual	0.03 ppm	--	--	--
	24-hour	0.14 ppm	--	–	–
	3-hour	--	0.5 ppm	–	0.5 ppm
	1-hour	--	--	75 ppb	–
Total Suspended Particulates (TSP)	24-hour	--	150 μg/m³	--	--
Respirable particulate matter (PM_{10})	Annual	50 μg/m³	50 μg/m³	–	–
	24-hour	150 μg/m³	150 μg/m³	150 μg/m³	Same as primary
Fine particulate matter ($PM_{2.5}$)	Annual	--	--	12 μg/m³	15 μg/m³
	24-hour	--	--	35 μg/m³	Same as primary
Lead	Rolling 3-month average	--	--	0.15 μg/m³	Same as primary
	Quarterly Average	1.5 μg/m³	1.5 μg/m³	–	–

$PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; ppm = parts per million; ppb = parts per billion; μg/m³ = micrograms per cubic meter.

[a] Tennessee Standards: The table only presents the TSP standard, as sources evaluated in the project air quality analysis would not emit hydrogen chloride or fluoride.

[b] Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect public health.

[c] Secondary Standards: The levels of air quality necessary to protect the public from any known or anticipated adverse effects of a pollutant.

Source: EPA 2016; TDEC 2006.

EPA also regulates HAPs that are known or are suspected to cause serious health effects or adverse environmental effects. The CAA identifies 187 substances as HAPs (e.g., benzene, formaldehyde, mercury, and toluene). HAPs are emitted from a range of industrial facilities and vehicles. EPA sets Federal regulations to reduce HAP emissions from stationary sources in the NESHAP. A "major" source of HAPs is defined as any stationary facility or source that directly emits or has the potential to emit 10 tons per year or more of any HAP or 25 tons per year or more of combined HAPs. In Tennessee, TDEC regulates HAPs and seven pollutants designated as hazardous air contaminants (HACs). Both programs set ambient levels of concern for HAPs and HACs.

As stated in Section 3.1.4.2.1 of this EIS, the PSD Regulation and CAA provide special protection for air quality and air quality-related values (including visibility and pollutant deposition) in select National Parks, National Wilderness Areas, and National Monuments in the United States. The Joyce Kilmer-Slickrock Wilderness Area is the closest PSD Class I area to ORNL; its nearest border is about 38 miles south-southeast of ORNL. Due to the proximity of this pristine area to ORNL, this EIS provides qualitative analyses of the potential for emissions generated by the project alternatives to affect visibility within this area.

The TDEC Division of Air Pollution Control (APC) is responsible for enforcing air pollution regulations in Tennessee. The APC enforces the NAAQS by monitoring air quality, developing rules to regulate and to permit stationary sources of air emissions (nonradiological and radiological), and managing the air quality attainment planning processes in Tennessee. TDEC air quality regulations, "Tennessee Air Pollution Control Regulations," are found in the Rules and Regulations of the State of Tennessee Regulation 1200, Division 3 (Tennessee Secretary of State 2019). Some sources at ORNL that emit criteria pollutants and HAPs are regulated under permits to construct and operate, as required by Chapter 1200-03-09 of the Tennessee APC Regulations (ORO 2019:5-17). For example, ORNL is not a major source of HAPs in accordance with the requirements found in Title V Permit No. 571359.

3.2.4.3.1 Greenhouse Gases and Climate Change

Section 3.1.4.2.2 of this EIS defines GHGs and the concept of CO_2e and discusses the link between the worldwide proliferation of GHG emissions by humankind and global warming. Climate change associated with global warming is predicted to produce negative environmental, economic, and social consequences across the globe.

In Tennessee, the U.S. Global Change Research Program predicts that annual average temperatures will increase between 3 and 7 degrees Fahrenheit by 2100, based on both low and high global GHG emission scenarios (USGCRP 2018:42). In addition, average precipitation for each season will increase over the long-term, with the highest increase of 10 to 20 percent occurring in winter (USGCRP 2017:217). Predictions of the impacts of these changes to Tennessee include: (1) an increase in extreme rainfall events, which will increase flood risks in low-lying regions; (2) an increase in heat, flooding, and vector-borne disease in urban areas; and (3) more frequent extreme heat episodes and changing seasonal climates will increase exposure-linked health impacts and economic vulnerabilities in the agricultural, timber, and manufacturing sectors (USGCRP 2018:744-808).

As stated in Section 3.1.4.2.2 of this EIS, Federal agencies address emissions of GHGs by reporting and meeting reductions mandated in Federal laws, Executive Orders, and agency policies. Annual emissions of GHGs from ORNL do not exceed 25,000 metric tons of CO_2e and therefore their operations are not subject to the EPA mandatory reporting requirements. However, annual emissions of GHGs from Y-12 have exceeded 25,000 metric tons of CO_2e due to the operation of natural gas-fired boilers at the onsite steam plant and, therefore, the Y-12 facility does report its annual GHG emissions to EPA (ORO 2019:4-42).

The potential effects of GHG emissions from the project alternatives are by nature global and cumulative. Given the global nature of climate change and the current state of the science, it is not useful at this time to attempt to link the emissions quantified for local actions to any specific climatological change or resulting environmental impact. Nonetheless, GHG emissions from the project alternatives are quantified in this EIS for use as indicators of their potential cumulative contributions to climate change effects and for making reasoned choices among alternatives.

3.2.4.3.2 Radiological Air Emission Standards

Facilities at ORNL emit radioactive materials and therefore are subject to NESHAP, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." Tennessee APC Regulation 1200-3-11-.08, NESHAP; Standards for Emissions of Radionuclides other than Radon from DOE Facilities, also incorporates the requirements of Subpart H. This regulation limits the radionuclide dose to a member of the public from all sources on ORR to 10 millirem per year. Subpart H also establishes requirements for monitoring emissions from facility operations and analyzing and reporting radiological doses. Airborne radiological effluents at ORNL are continuously sampled or monitored from major and minor source locations (some minor sources are sampled periodically) or are estimated based on building inventories to demonstrate compliance in accordance with the requirements of Subpart H and DOE Order 458.1, "Radiation Protection of the Public and the Environment."

3.2.4.4 Nonradiological Air Emissions

Sources of nonradiological air emissions at ORNL include natural gas and/or No. 2 fuel oil-fired boilers (steam plant), emergency diesel generators, small gasoline, diesel, and propane combustion sources such as comfort heaters, an on-road vehicle fueling station, chemical and solvent usages, and on-road and non-road vehicle sources. Facilities use emergency diesel generators for emergency electrical power and operate these sources during periodic testing activities.

3.2.4.5 Radiological Air Emissions

Sources of radionuclide emissions from ORNL mainly occur from the ventilation of (1) isotope production/handling areas, (2) reactor research, (3) accelerator operations and associated research, (4) analytical facilities, (5) out-of-service and decommissioned facilities, and (6) the storage of legacy materials (ORO 2017a:6). Minor amounts of radionuclide emissions also occur from fugitive and diffuse sources. These radionuclide emissions typically take the form of particulates, adsorbable gases, nonadsorbable gases (i.e., noble gases), and tritium. Major sources of radionuclide emissions are equipped with CEM systems and are controlled with HEPA filters, per the requirements of Subpart H. Many minor sources of radionuclide emissions also are controlled with HEPA filters.

During 2018, an estimated 147,000 curies of radioactivity were released to the atmosphere from all ORNL sources (ORO 2019:5-49). For calendar year 2018, the effective dose equivalent from all airborne radionuclide emissions on ORR to the MEI member of the public was 0.2 millirem per year, which is 2 percent of the 10 millirem per year Subpart H standard (ORO 2019:5-32). Radionuclide emissions from ORNL contributed to 19 percent of this impact. Subpart H defines the MEI as any member of the public at any offsite location where there is a residence, school, business, or office.

3.2.5 Ecological Resources

Ecological resources include the plant and animal species, habitats, and ecological relationships of the land and water areas within the ROI, which is defined as the area directly or indirectly affected by the proposed action. Particular consideration is given to sensitive species, which are those species protected under Federal or State law, including threatened and endangered species, migratory birds, and bald and golden eagles.

For the purposes of this EIS, sensitive and protected ecological resources include plant and animal species that are federally (USFWS) or State-listed (TDEC) for protection.

Ecological resources at ORNL are managed through various agencies, including DOE Reservation Management, USDA, USFWS, and TWRA. Accordingly, project managers must conform to environmental regulations, agreements, and policy at the Federal, State, and institutional level. Per 40 CFR 1508.14, potential effects on research and science education also represent probable impacts of Federal actions on the NERP. In addition, impacts to ecological resources on the Oak Ridge Wildlife Management Area must be considered when other aspects of the human environment are affected (ORNL 2020d). Further information about ecological resources is available on the ORNL website (ORNL 2020b).

3.2.5.1 Vegetation

ORR covers 32,867 acres with vegetation that consists of mostly contiguous stretches of native eastern deciduous trees and shrubs in large blocks of mature forest and interior forests (at least 656 feet from outer edge of a forest). Riparian vegetation and managed native grasslands together provide considerable habitat diversity (ORNL 2020e). Forests are mostly mixed pine-hardwoods and oak-hickory (*Quercus-Carya*), with small areas of northern hardwoods and natural stands of hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), and floodplain forests (ORNL 2017). Open water and wetland vegetation are also present in various areas throughout the ORR. Rare plant communities include northern white cedar woodland, ridge and valley calcareous mixed mesophytic forest, cedar barrens, and river bluffs (ORNL 2015, 2020c). As of 2002, over 1,100 vascular plant species were recorded on ORR (ORNL 2018a).

The majority of the 150-acre proposed project area is undeveloped and consists of about 96 percent of eastern deciduous hardwood-forest, 27 percent of which is interior forest areas, and 4 percent developed or disturbed areas (**Table 3–22**) (**Figure 3–18**). The area is comprised primarily of forested wetlands with intervening steep slopes and dry-mesic ridgetops (ORNL 2020d). Tree composition generally includes northern red oak (*Quercus rubra*), southern red oak (*Q. falcate*), black oak (*Q. velutina*), white oak (*Q. alba*), scarlet oak (*Q. coccinea*), mockernut hickory (*Carya tomentosa*), tulip poplar (*Liriodendron tulipifera*), eastern red cedar (*Juniperus virginiana*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), sweetgum (*Liquidambar styraciflua*), Virginia pine (*Pinus virginiana*), sourwood (*Oxydendrum arboreum*), and a few small natural stands of hemlock or white pine. During 1993 to 1994 and 1999 to 2000, the southern pine beetle (*Dendroctonus frontalis*), an invasive insect, diminished most of the mature pine stands within the proposed project area. These areas are now regenerating or have been replanted. The hardwood-forested areas are mostly new growth, with the exception of a few older stands within the eastern portion of the proposed project area. A small portion of the proposed project area includes previously disturbed areas that have been cleared for development of facilities, access roads and corridors, and other supporting infrastructure (ORNL 2020d).

Table 3–22. Communities within the Oak Ridge National Laboratory Proposed Project Area

Vegetation Community	***Acres within the Proposed Project Area***
Forested Areas (Interior Forest)	143.8 acres (40.4 acres)
Previously Disturbed/Facilities	6.5 acres
	Total: ~150 acres

Source: ORNL 2020d.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

3.2.5.2 Invasive Plant Species

Invasive plants are those species whose introduction does or is likely to cause economic or environmental harm or harm to human health. The Federal Noxious Weed Act of 1974 (7 U.S.C. 28142) requires each Federal land-managing agency to establish integrated management systems to control or contain undesirable plant species targeted under cooperative agreements with State agencies. Invasive species at ORNL are managed through the *Invasive Plant Management Plan for the Oak Ridge Reservation* (ORNL 2017). About 168 plant species known to occur on ORNL are non-native, and 54 have been identified as aggressively invasive (ORNL 2018a). Additionally, outbreaks of invasive insect pests, such as the hemlock woolly adelgid, southern pine beetle, and emerald ash borer, are causing the death of hemlock, pine, and ash trees.

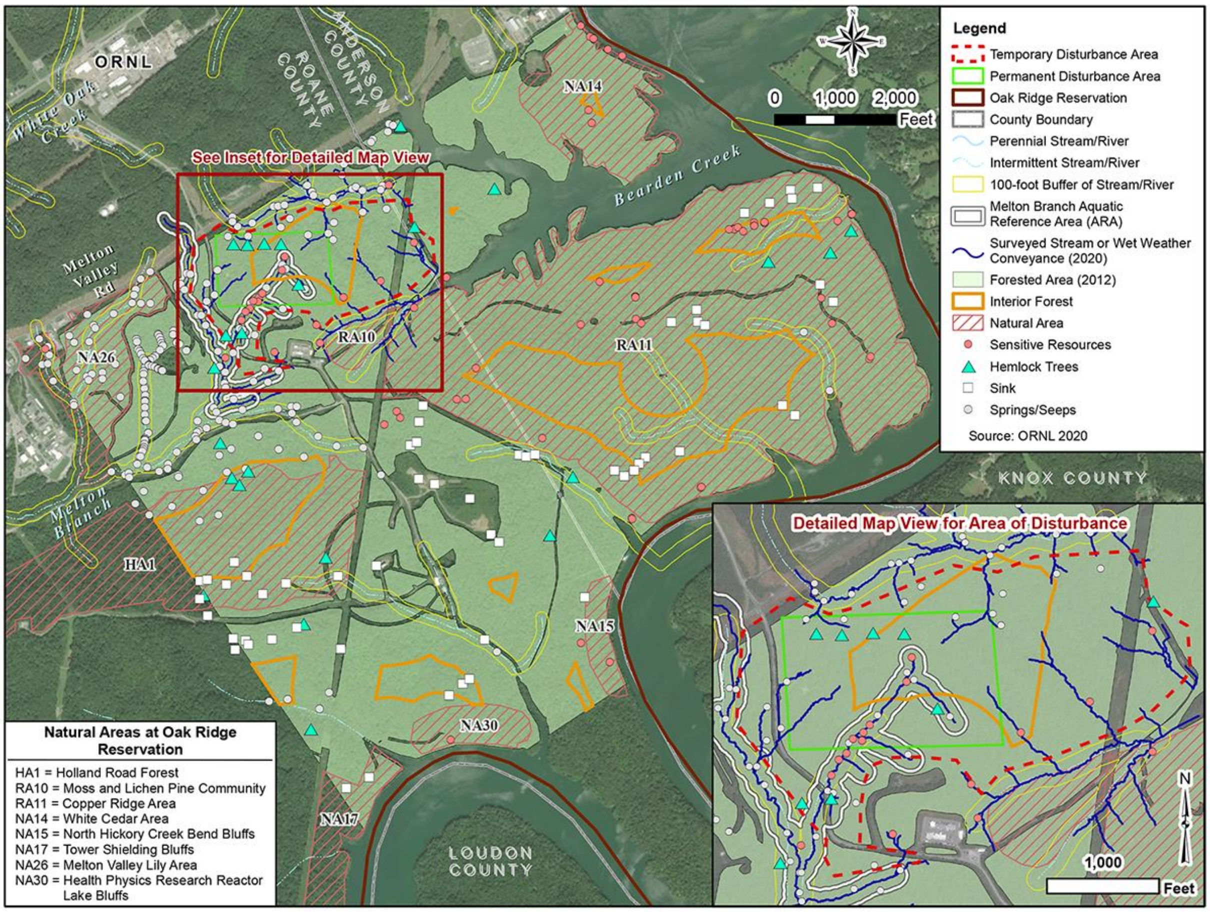


Figure 3–18. Oak Ridge National Laboratory Ecological Resources

3.2.5.3 Wildlife

The large tracts of eastern deciduous hardwood forest provide habitat for a high diversity of wildlife. The area hosts more than 63 species of fish; about 69 species of reptiles and amphibians; up to 213 species of migratory, transient, and resident birds; and 49 species of mammals, as well as numerous invertebrate species (ORNL 2020e). Game species, such as white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), and Canada geese (*Branta canadensis*) on ORNL, are controlled through managed hunts at several times throughout the year (ORNL 2020e).

Species monitoring and management for the area is implemented through the *Wildlife Management Plan for the Oak Ridge Reservation* (ORNL 2020e). This plan includes management and protection strategies for game species, non-game species, sensitive species inventories, and nuisance species. Management includes wildlife population control through hunting, trapping, removal, and habitat manipulation; wildlife damage control; restoration of wildlife species; preservation, management, and enhancement of wildlife habitats; coordination of wildlife studies and characterization of areas; and law enforcement (ORNL 2020e).

A recent survey of the proposed project area identified 151 vertebrate species and at least one notable invertebrate species, the cave isopod (*Caecidotea incurve*/*recurvata*) (ORNL 2020d).

3.2.5.4 Special Status Species

Special status species include federally threatened, endangered (per USFWS), and State-designated sensitive (per TDEC) species and their habitats. Applicable laws include the ESA, the MBTA, the Bald and Golden Eagle Protection Act (BGEPA), Tennessee Rare Plant Protection and Conservation Act of 1985, and Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974.

The USFWS's IPaC online system was accessed to identify current USFWS trust resources with potential to occur in the ROI. On January 23, 2020, the Tennessee Ecological Services Field Office provided an automated *Official Species List* via Section 7 letter that identified 20 threatened and endangered species as known to occur or have potential to occur within or near the proposed project area. These species are presented in **Table 3–23**. No designated critical habitat was identified at ORNL (USFWS 2020b).

Table 3–23. Federally Listed Species with Potential to Occur Near the Oak Ridge National Laboratory Proposed Project Area

Common Name	*Scientific Name*	*Protection Status*	*Historically Observed at ORNL?*	*Suitable Habitat Present Within the Proposed Project Area?*
Amphibians				
Berry Cave Salamander	*Gyrinophilus gulolineatus*	FC	no	Unknown. Underlying karst and aquatic subterranean habitat exists, but a lack of human-accessible caves might prevent detection.
Mammals				
Gray Bat	*Myotis grisescens*	FE	yes	Yes. Species detected in NA14, NA15, NA26, and RA11. Suitable foraging habitat and suitable hibernacula are present within the proposed project area. Additionally, known maternity habitat occurs within 0.5 miles of the proposed project area.
Indiana Bat	*Myotis sodalis*	FE	yes	Yes. Detected at an extremely low frequency within the proposed project area. Species detected in NA15 and RA11. Foraging, suitable hibernacula, and maternity habitat within regulatory distance of the proposed project area.
Northern Long-eared Bat	*Myotis septentrionalis*	FT	yes	Yes. Detected at an extremely low frequency within the proposed project area. Species detected in NA26 and RA11. Suitable foraging habitat and suitable hibernacula are present within the proposed project area. Additionally, known maternity habitat occurs within 0.5 miles of the proposed project area.
Tricolored Bat	*Perimyotis subflavus*	UR	yes	Yes, foraging habitat occurs within the proposed project area.
Little Brown Bat	*Myotis lucifugus*	UR	yes	Yes, foraging habitat occurs within the proposed project area.
Clams				
Alabama Lampmussel	*Lampsilis virescens*	FE	no	no
Cracking Pearlymussel	*Hemistena lata*	FE	no	no

Common Name	***Scientific Name***	***Protection Status***	***Historically Observed at ORNL?***	***Suitable Habitat Present Within the Proposed Project Area?***
Dromedary Pearlymussel	*Dromus dromas*	FE	yes	no
Fanshell	*Cyprogenia stegaria*	FE	yes	no
Finerayed Pigtoe	*Fusconaia cuneolus*	FE	yes	no
Orangefoot Pimpleback (pearlymussel)	*Plethobasus cooperianus*	FE	yes	no
Pink Mucket (pearlymussel)	*Lampsilis abrupta*	FE	yes	no
Ring Pink (mussel)	*Obovaria retusa*	FE	no	no
Rough Pigtoe	*Pleurobema plenum*	FE	no	no
Rough Rabbitsfoot	*Quadrula cylindrica strigillata*	FE	yes	no
Sheepnose Mussel	*Plethobasus cyphyus*	FE	yes	no
Shiny Pigtoe	*Fusconaia cor*	FE	yes	no
Spectaclecase (mussel)	*Cumberlandia monodonta*	FE	yes	no
White Wartyback (pearlymussel)	*Plethobasus cicatricosus*	FE	no	no
Snails				
Anthony's Riversnail	*Athearnia anthonyi*	FE	no	no
Spiny Riversnail	*Io fluvialis*	UR	yes	no
Flowering Plants				
Virginia Spiraea	*Spiraea virginiana*	FT	no	Yes, potential suitable habitat occurs within the proposed project area.
White Fringeless Orchid	*Platanthera integrilabia*	FT	no	Yes, potential suitable habitat occurs within the proposed project area.

FC = federally listed candidate species; FE = federally listed endangered species; FT= federally listed threatened species; UR = status under federal review.
NA = Natural Area; RA = Reference Area; HA = Habitat Area
Note: Species occurrence is within an ORR designated NA, RA, or HA (refer to Section 3.2.5.5 for additional details).
Source: ORNL 2020c, 2020d; USFWS 2020b.

Recent biological surveys were completed at ORNL during the spring of 2020 to support the planning and development of the VTR project. Further details of the sensitive resources identified during the survey efforts will be provided once available (ORNL 2020d).

Of the 21 federally listed species presented in Table 3–23, only three have been documented on the ORNL site. These species are the gray bat (*Myotis grisescens*), Indiana bat (*M. sodalis*), and northern long-eared bat (*M. septentrionalis*). The proposed project area includes suitable bat foraging and roosting habitat. Acoustic surveys conducted in proposed project area in the spring of 2020 confirmed the presence of 15 native bat species and 5 special status bat species (ORNL 2020d): three federally listed bat species - gray, Indiana, and northern long-eared bats; and two species under Federal review for ESA listing - little brown (*Myotis lucifugus*) and tricolored bat (*Perimyotis subflavus*) (ORNL 2020d). All five of these bat species are also State-listed in Tennessee. Furthermore, suitable hibernacula and maternity habitat for gray, Indiana, and northern-long eared bats occurs within 0.5 mile of the proposed project area (ORNL 2020c). No federally listed flowering plants have been positively identified but potential habitat occurs for the white-fringeless orchid (*Platanthera integrilabia*) and Virginia spiraea (*Spiraea virginiana*) (ORNL 2020d). Ridge and Valley Calcareous mixed mesophytic forest, a rare plant community and designated as ORR historical as well as other plant communities of management or research importance are also present within the project area (ORNL 2020d).

Additionally, 37 special status species (Tennessee State-listed species and species of special concern) were identified as known to occur, or having the potential to occur in the proposed project area following spring 2020 surveys (ORNL 2020c, 2020d). These species are presented below in **Table 3–24** (ORNL 2020c; ORNL 2020d).

Table 3–24. State-listed and Species of Special Concern Known to Occur Near the Oak Ridge National Laboratory Proposed Project Area

Common Name	***Scientific Name***	***Status in Tennessee***	***Other Protection Status***	***Historically Observed at ORNL?***	***Suitable Habitat Present Within the Proposed Project Area?***
Amphibians					
Green Salamander	*Aneides aeneus*	Rare	S3, S4	yes	Unlikely. Minimal availability of suitable habitat. Suitable habitat includes damp crevices in shaded rock outcrops and ledges; beneath loose bark and cracks of trees and sometimes in/or under logs.
Hellbender	*Cryptobranchus alleganiensis*	Endangered	S3	yes	no
Berry Cave Salamander	*Gyrinophilus gulolineatus*	Threatened	S1	no	Unlikely, but aquatic subterranean habitat present.
Four-toed Salamander	*Hemidactylium scutatum*	In Need of Management	S3 populations on ORR are the subject of ongoing research	yes	Yes, adults and nests with eggs observed throughout the proposed action area. Moist forest and sphagnum in and along all wetlands and slow-moving waterways within project area.
Mud Salamander	*Pseudotriton montanus*	Rare	populations on ORR are the subject of ongoing research	yes	Yes, detected within the proposed project area. Suitable habitat includes headwater streams, seepages, and mucky wetlands throughout project area.
Arachnids					
A cave spider	*Nesticus paynei/ tennesseensis*	Rare	S2, S3, S4	yes	Unlikely, terrestrial cave obligate.
Insects					
Cave beetle (multiple species, including one yet to be described)	*Pseudanophthalmus* spp.	Rare	S1–S3	yes	Yes. Troglobitic, typically along subterranean streams.
Mammals					
Allegheny Woodrat	*Neotoma magister*	In Need of Management	S3	yes	Yes, suitable habitat present including outcrops, cliffs, talus slopes, crevices, sinkholes, caves & karst. Observations exist in caves just outside proposed project area.
Little Brown Bat	*Myotis lucifugus*	Threatened	S3, Federal status currently under review	yes	Yes, detected at relatively high frequency within the proposed project area. Suitable habitat present within caves, hollow trees often associated with forested areas.

Common Name	Scientific Name	Status in Tennessee	Other Protection Status	Historically Observed at ORNL?	Suitable Habitat Present Within the Proposed Project Area?
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*	In Need of Management	S3, S4	yes	Yes, detected near the proposed project area.
Small-footed Bat	*Myotis leibii*	In Need of Management	S2	yes	Yes, detected at a relatively low frequency near the proposed project area.
Southern Bog Lemming	*Synaptomys cooperi*	In Need of Management	S4	yes	Yes, detected near the proposed project area along Bearden Creek Road.
Tri-colored Bat	*Perimyotis subflavus*	Threatened	S2, S4, Federal status currently under review	Species is associated with the VTR Study area (historical – pre-1995)	Yes, detected at relatively high frequency within the proposed project area. Suitable habitat present within marshy meadows, wet balds, and rich upland forests.
Birds					
Bald Eagle	*Haliaeetus leucocephalus*	In Need of Management	BCC, BGEPA, FS, BMC, MBTA	Yes, breeding habitat present at ORNL.	Yes, breeding pairs have been noted in recent years within the proposed project area.
Wood Thrush	*Hylocichla mustelina*	In Need of Management	BCC, PIF, BMC, FS, MBTA	Species associated with the VTR Study area.	Yes, breeding pairs have been noted within the proposed project area.
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Rare	BCC, BMC, MBTA	Species associated with the VTR Study area.	Yes. Species observed in RA11.
Worm-eating Warbler	*Helmitheros vermivorum*	SNR	BCC, BMC, PIF, MBTA	Species associated with the VTR Study area.	yes
Eastern Whip-poor-will	*Caprimulgus vociferus*	SNR	BCC, PIF, MTBA	Species associated with the VTR Study area.	yes
Red-headed Woodpecker	*Melanerpes erythrocephalus*	SNR	BCC, PIF	Species associated with the VTR Study area.	yes
Chuck-Will's Widow	*Antrostomus carolinensis*	SNR	PIF, MBTA	Species associated with the VTR Study area.	yes
Yellow-billed Cuckoo	*Coccyzus americanus*	SNR	PIF, MBTA	Species associated with the VTR Study area.	yes
Kentucky Warbler	*Geothlypis formosa*	SNR	BCC, PIF, MBTA	Species associated with the VTR Study area.	yes
Plants					
Spreading False-foxglove	*Aureolaria patula*	Special Concern	S3	yes	Yes, species observed in NA14, NA17, NA30. Suitable habitat present including oak woods and edges.
Pink Lady's-slipper	*Cypripedium acaule*	Special Concern-Commercially Exploited	S4	yes	Yes, species observed in NA14.
Appalachian Bugbane	*Cimicifuga rubifolia*	Rare	S3	yes	Yes, suitable habitat present including rich woods (especially northeastern portion of project area and west of HPRR Access Rd).
Canada Lily	*Lilium canadense*	Rare	S3; monitored as rare for the ORR	yes	Yes, species observed in NA26. Suitable habitat present including rich woods and seeps.

Common Name	Scientific Name	Status in Tennessee	Other Protection Status	Historically Observed at ORNL?	Suitable Habitat Present Within the Proposed Project Area?
		(recently delisted from Threatened status)			
Goldenseal	*Hydrastis canadensis*	Special Concern-Commercially Exploited	S4	yes	Yes, species observed in RA11. Suitable habitat present including moist woods with rich soils (especially in shaded valleys in the southern and eastern portions of project area, and west of HPRR Access Rd).
Ginseng	*Panax quinquefolius*	State listed Special Concern – Commercially Exploited, Special Concern-Commercially Exploited	S3, S4	Species associated with the VTR Study area.	Yes, suitable habitat present - especially in northeastern portion of project area and west of HPRR Access Rd.
Tubercled Rein Orchid	*Platanthera flava* var. *herbiola*	Threatened	S2	Yes, possible sprout observed within project area in March 2020.	Yes, suitable habitat present including mucky seeps, swamps, and floodplain throughout project area.
October Ladies'-Tresses	*Spiranthes ovalis*	Sensitive	SNR	yes	Yes, suitable habitat present including wet to mesic forests.
Northern Bush-honeysuckle	*Diervilla lonicera*	Threatened	S2	yes	Yes, species observed in NA14. Suitable habitat present including rocky woodlands and bluffs.
Northern White Cedar	*Thuja occidentalis*	Special Concern, Rare	S3	yes	Yes, species observed in NA14. Suitable habitat present including calcareous rocky seeps, cliffs (eastern portion of project area).
Butternut	*Juglans cinerea*	Threatened	S3	yes	Yes, suitable habitat present including rich woods and hollows.
Reptiles					
Northern Pine Snake	*Pituophis melanoleucus*	Threatened	S3	yes	Yes, suitable habitat present including well-drained sandy soils in pine/pine-oak woods.
Eastern Slender Glass Lizard	*Ophisaurus attentuatus longicaudus*	In Need of Management	S3	yes	Yes, suitable habitat present including dry upland areas including brushy, cut-over woodlands and grassy fields; fossorial (eastern and central portion of the proposed project area).
Snails					
Cave Thorn Snail	*Carychium stygium*	Rare	S2	no	Possible suitable habitat available within stygobitic areas such as Highland Rim and Cumberland Plateau; no known human accessible caves in the proposed project area.
A Cave Obligate Snail	*Helicodiscus notius specus*	Rare	S1	no	Possible suitable habitat available within troglobitic areas like Ridge & Valley and Eastern Highland Rim; no known human accessible caves in the proposed project area.

Common Name	*Scientific Name*	*Status in Tennessee*	*Other Protection Status*	*Historically Observed at ORNL?*	*Suitable Habitat Present Within the Proposed Project Area?*

BCC = designated bird of conservation concern in the region; BGEPA = Bald and Golden Eagle Protection Act; MBTA = Migratory Bird Treaty Act; PIF = Partners In Flight; NatureServe National and Subnational Conservation Status: S2 = imperiled; S3 = vulnerable; S4 = apparently secure; SNR = unranked.
NA = Natural Area; RA = Reference Area; HA = Habitat Area
Note: Species occurrence is within an ORR designated NA, RA, or HA [refer to Section 3.2.5.5 for additional details).
The State of Tennessee adopts all federally listed (USFWS) species. Therefore, species listed in Table 3–23 (Federally Listed Species with Potential to Occur Near the ORNL Proposed Project Area) are also considered for evaluation by the State.
Source: NatureServe 2020; ORNL 2020c, 2020d; TWRA 2016.

The ORNL Natural Resources Program employs breeding bird surveys through the international Partners In Flight (PIF) program. PIF surveys are conducted yearly on the ORR by ORNL and TWRA personnel and volunteers. A total of 11 PIF routes are present on the ORR and cover a mixture of forest, edge, old field, and grassland habitats. About six to eight surveys are conducted in May and June during the breeding season for most bird species (ORNL 2020e). Several species identified as BCC under the MBTA are known to occur (observed nesting or soaring) at the ORNL site. The proposed project area is located within BCR 28 (Appalachian Mountains) and there are 25 BCC species listed (USFWS 2008). Forty-six bird species protected under the MBTA were detected during recent surveys conducted in the spring of 2020 (March – July) (ORNL 2020d). This included one species listed by the TWRA as In Need of Management (TCA §§ 70-1-206, 70-8-104, 70-8-106, and 70-8-107, TWRA 2016), three species considered by USFWS to be BCCs, five species considered by USFWS to be Birds of Management Concern, and one ORNL Focal Species. Additionally, nine species are considered by PIF to be species of Regional Concern and in Need of Management Action, one Common Bird in Steep Decline, and one species on the Yellow WatchList (ORNL 2020d).

Bald eagles (*Haliaeetus leucocephalus*), protected under the BGEPA, have been observed in the winter throughout the ORNL site. TWRA conducts yearly midwinter bald eagle counts along the Clinch River, which borders the ORR, in accordance with the continuing statewide monitoring program. It is part of a count conducted statewide by the agency to monitor population trends for this species, which is increasing in numbers in eastern Tennessee. The ORR supports one or two nests per year, and these are continually monitored (ORNL 2020e). There is one active bald eagle nest located about 2 miles northeast of the proposed project area.

3.2.5.5 Natural Areas

The ORNL is located within the ORR, much of which is categorized as a NERP and a state Wildlife Management Area. The ORR is comprised of various special and sensitive natural resource areas recognized in the Research Park. These areas are characterized as Natural Areas (NA), Aquatic Natural Areas (ANA), Reference Areas (RA), Aquatic Reference Areas (ARA), Cooperative Management Areas (CMA), Habitat Areas (HA), and Potential Habitat Areas (PHA). The *Natural Areas Analysis and Evaluation* report (ORNL 2009) serves as a systematic analysis of each area; developed in partnership between DOE Reservation Management, USDA, TDEC, and TWRA.

There are eight natural areas within the proposed project area; characterized as NAs, RAs, and one HA (Figure 3–18) (ORNL 2020c). Definitions for these natural area designations and general descriptions are as follows:

Natural Area (NA) – These are areas that contain and protect sensitive species and that have been traditionally defined as containing State-listed and Federally listed species, species under consideration for such listing, or species considered globally imperiled or rare by NatureServe, an international network of natural heritage programs. NAs are primarily terrestrial but may include aquatic aspects.

- NA14 White Cedar Area: Ridges dissected by deep ravines, with steep slopes and shaley cliffs dropping into Melton Hill Lake. Old second-growth mixed mesic hardwood forest in spots, especially in deep ravines and steep slopes; uplands are generally younger second-growth hardwood; dry to mesic oak–hickory forest with some mature beech forest, particularly in ravines. Northern white cedar and northern bush-honeysuckle are typically found at more northern latitudes. Spreading false-foxglove is present at the base of the cliff. Area includes a significant amount of forested lakeshore, some small quality wetlands, and some remnant bottomland forest.
- NA15 North Hickory Creek Bend Bluffs/Hickory Creek Bend Bluffs: Steep, forested southeast-facing slope overlooking Melton Hill Lake. The overstory is mixed hardwood and pine.
- NA 17 Tower Shielding Bluffs: Steep east-facing slope overlooking Melton Hill Lake. The overstory consists primarily of oaks and hickories with some mesic species such as sugar maple.
- NA26 Melton Valley Lily Area: The NA includes a substantial stream system with forested headwater stream bottomlands of Melton Branch, steep ridges, and older forest, including large bottomland oaks and huge white pines (*Pinus strobus*). Some regionally uncommon tree species are also present. At certain times of the year, ephemeral shallow water-filled depressions in one headwater stream bottom form that may serve as important amphibian breeding sites. Two small nonflowering Canada lily plants occur in a forested wetland.
- NA30 Health Physics Research Reactor Lake Bluffs: This area of steep rocky limestone bluffs runs along the shoreline of Melton Hill Lake south of the Health Physics Research Reactor. Spreading false-foxglove occurs here.

Reference Area (RA) – These are areas that recognize special habitats (e.g., cedar barrens, wetlands) or features (e.g., caves); these areas may also serve as references or controls for biological monitoring, environmental remediation and characterization, and other ecological research activities.

- RA10 Moss and Lichen Pine Community: This area provides a good illustration of plant community succession following serious soil erosion damage. Mosses and lichens are abundant under pines, which is typical of early successional stages in this region. The dominant ground cover is the lichen reindeer moss (*Cladonia subtenuis*).
- RA11 Copper Ridge Area: This large and relatively undisturbed area includes communities in various stages of succession. Some of the major community types include oak–hickory, pine, and cedar forests. The ridge section is extremely rocky, and there are numerous limestone rocky sinks and several caves.

Habitat Area (HA) – These are areas known to harbor commercially exploited State-listed species. The plants involved, though not rare, are listed by the State for special management because of their commercial exploitation.

- HA1 West Copper Ridge/ Holland Road Forest: Largely consists of interior forest.

3.2.5.6 Aquatic Resources

Aquatic resources at the ORNL site range from small, free-flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction (DOE 2011c). These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small seasonal and intermittent perennial streams (DOE 2011c).

Wetlands – Wetlands are recognized as a special aquatic site under CWA Section 404(b)(1) guidelines, and a “no net loss” policy continues to guide Federal regulatory actions affecting wetlands. Jurisdictional wetlands are a subset of jurisdictional waters of the United States, which include streams, rivers, ponds, and lakes. The proposed project area is located within the Bearden Creek Watershed and includes the Melton Branch stream system and its tributaries, which feed into White Oak Creek, White Oak Lake, and ultimately the Clinch River (ORNL 2006).

Numerous wetland areas occur across the ORR at low-elevation positions, primarily in the riparian zones of headwater streams and their receiving streams, as well as in Clinch River embayments (ORNL 2006). Wetland types include open water, riverine, and freshwater forested/shrub wetlands (USFWS 2019c). These wetlands are ephemeral, depressional ponds in forested, headwater streams, and stream bottom areas. Most of the wetlands on the ORR are classified as palustrine forested, scrub-shrub, and emergent (Cowardin et al. 1979).

About 9.7 acres of previously mapped wetland occur within the proposed project area. Recent field surveys documented an additional 0.8 acre of previously unmapped wetland for a total of more than 10.5 acres within the proposed project area (ORNL 2020d). Wetlands were associated with tributaries, drainages, and topographic depressions (Figure 3–18). All wetlands in the footprint are classified as palustrine forested broad-leaved deciduous wetlands (Cowardin et al. 1979).

Exceptional Tennessee Waters are aquatic resources with features that merit special attention or consideration and are significant at the national, state, or regional level. An Exceptional Tennessee Water designation is expected for aquatic features within the proposed project area. The Exceptional Tennessee Water designation is determined via the Tennessee Rapid Assessment Method, a tool designed by TDEC for mitigation planning (TDEC 2015). The requirements for a wetland to be considered Exceptional Tennessee Waters are outlined in Rule 0400-40-03-.06(4)a of the TDEC General Water Quality Criteria (TDEC Chapter 0400-40-03, 2015).

Streams – About 7,428 feet of mapped stream occur within the proposed project area. This does not include 8,209 feet of currently unclassified channels and wet weather conveyances that will require hydrological jurisdictional determinations approved by the U.S. Army Corps of Engineers. The proposed project area is drained by Melton Branch and Bearden Creek. The first- and second-order reaches of Melton Branch in the proposed project area eventually become a major tributary of the main stem of White Oak Creek, an aquatic system contained within the ORR that drains into the Clinch River. Sections of Melton Branch and White Oak Creek are part of the Biological Monitoring and Abatement program that was established 35 years ago, and portions of Melton Branch and its riparian buffer zone and wetlands comprise the Melton Branch ARA (Figure 3–18). ARAs were established on the ORR to protect special habitats and serve as reference or control areas for various ecological monitoring, research, and remediation activities (ORNL 2020d).

Seeps, Springs, and Wet Weather Conveyances – There are an estimated 3,442 seeps, active springs, sinks, and caves within ORNL (ORNL 2020d). The proposed project area contains more than 30 seeps/active springs and extensive wet weather conveyances (ORNL 2020d).

3.2.6 Cultural and Paleontological Resources

3.2.6.1 Area of Potential Effect

The project area and APE for direct physical effects is located in a currently undeveloped area about 1 mile east of ORNL's main campus (see Figure 2–8). It comprises 150 acres, including laydown areas, defensible security buffers, and egress during construction. Due to the local vegetation and terrain, the APE associated with the historic viewshed is defined as a 0.25-mile radial buffer surrounding the 150-acre APE proposed for development.

3.2.6.2 Ethnographic Resources

Resources that may be sensitive to American Indian groups include remains of prehistoric and historic villages, ceremonial lodges, cemeteries, burials, and traditional plant gathering areas. Apart from prehistoric archaeological sites, to date no American Indian resources have been identified at ORR. No American Indian sacred sites or cultural items have been found within or immediately adjacent to the 150-acre proposed VTR project area.

3.2.6.3 Cultural Resources

Archaeological Resources

Prehistoric resources are physical properties that remain from human activities that predate written record. More than 20 cultural resources surveys have been conducted at ORR. About 90 percent of ORR has received at least some preliminary walkover or archival-level study, but less than 5 percent has been intensively surveyed. Most cultural resource studies have occurred along the Clinch River and adjacent tributaries. Prehistoric sites recorded at ORR include villages, potential burial mounds, camps, quarries, a chipping station, limited activity locations, and shell scatters. Forty-four archeological sites have been recorded at ORR to date. At least 13 prehistoric sites are considered potentially eligible for the NRHP, but most of these sites have not yet been evaluated. Additional prehistoric sites may be anticipated in the unsurveyed portions of ORR. In 1994, a Programmatic Agreement concerning the management of historic and cultural properties at ORR was executed among the DOE Oak Ridge Operations Office, the Tennessee State Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation. This agreement was executed to satisfy DOE's responsibilities regarding Sections 106 and 110 of the National Historic Preservation Act (NHPA) and resulted in DOE preparing a Cultural Resources Management Plan for ORR (DOE-OR 2001). No prehistoric properties are known to exist within or immediately adjacent to 150-acre APE.

Historic Resources

Several historic resources surveys have been conducted at ORR. Historic resources identified at ORR consist of both archaeological remains and standing structures. Documented log, wood frame, or fieldstone structures include cabins, barns, churches, grave houses, springhouses, storage sheds, smokehouses, log cribs, privies, henhouses, and garages. Archaeological remains consist primarily of historic building foundations, roads, and trash scatters. A total of 32 cemeteries are located within the present boundaries of ORR. More than 250 historic resources have been recorded at ORR, and 41 of those sites are considered potentially eligible for listing on the NRHP. The NRHP-eligible structures that pre-date the establishment of the Manhattan Project include the Freel's Bend Cabin and two church structures: George Jones Memorial Baptist Church (also known as the "Wheat Church") and the New Bethel Baptist Church. Sites associated with the Manhattan Project include the X-10 Graphite Reactor at ORNL, listed on the NRHP as a National Historic Landmark, and three traffic checkpoints: Bear Creek Road, Bethel Valley Road, and Oak Ridge Turnpike Checking Stations. Many other buildings and facilities at ORR are associated with the Manhattan Project and are eligible for the NRHP (DOE-OR 2001).

Historic building surveys were conducted in 1993, 2003, and 2017 to identify properties at ORNL that are included or are eligible for inclusion in the NRHP (ORNL 2020c). Eligible properties include the ORNL Historic District in ORNL's East Support Area, the Molten-Salt Reactor Experiment Facility, (previously known as the Aircraft Reactor Experiment Building), the Tower Shielding Facility, and White Oak Lake and Dam.

There are no known historic architectural resources within the 150-acre proposed VTR project area. Of all the known NRHP-eligible and -listed buildings, the NRHP-listed New Bethel Baptist Church is the closest to the 150-acre proposed VTR project area. It is located about 0.5 mile to the northwest. In addition, there are seven historic archaeological sites and one cemetery within 0.25 mile of the proposed VTR project area. The cemetery is identified as the Friendship Baptist Church Cemetery. The historic archaeological sites consist of the remains of a church, dwellings, barns, and various outbuildings related to homesteads. None of these sites have any standing structures, and none have been recommended eligible for listing on the NRHP (ORNL 2020c).

3.2.6.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. Paleontological remains consist of fossils and their associated geological information. The majority of geological units with surface exposures at ORR contain paleontological materials. Paleontological materials consist primarily of invertebrate remains, and these have relatively low research potential. Paleontological resources at ORNL would not be expected to differ from those found elsewhere on ORR.

3.2.7 Infrastructure

Site infrastructure includes those basic resources and services required to support planned construction and operations activities and the continued operations of existing facilities. For the purposes of this EIS, infrastructure is defined as electricity, fuel, water, and sewage. The ROI for infrastructure includes those items at ORNL. Waste management and transportation infrastructure are addressed separately in Sections 3.2.9 and 3.2.12, respectively. Capacities and usage of ORNL's utility infrastructure are summarized in **Table 3–25**.

Table 3–25. Oak Ridge National Laboratory Infrastructure Characteristics

Resource	*Site Usage*	*Site Capacity*
Electricity		
Energy Consumption (megawatt-hours per year)	583,000 [a]	1,227,000 [b, c]
Peak Load (megawatts)	68.5 [b]	140 [b]
Fuel		
Natural Gas (million cubic feet per year)	600 [b]	3,214
Fuel Oil - for heating (gallons per year)	122,000 [a]	Not limited [d]
Diesel fuel	NA	Not limited [d]
Gasoline	NA	Not limited [d]
Propane	NA	Not limited [d]
Water (million gallons per year)	730 [b]	1,460 [b]
Sanitary Wastewater Treatment (gallons per day)	186,100 [b]	300,000 [e]

NA = not available.
[a] ORNL 2018b:10.
[b] ORNL 2020c.
[c] Capacity available if peak power were maintained 24 hours a day for every day in the year; since this assumes continual demand of peak power, annual site usage is typically well below site capacity.
[d] Capacity is limited only by the ability to ship fuel to the ORNL.
[e] DOE 1999b:4-65, 4-66.

3.2.7.1 Electricity

ORNL purchases its electricity from the Tennessee Valley Authority. Power is supplied to ORNL via three 161-kV transmission lines (DOE 2008b:3-12). At a substation, power is stepped down to 13.8 kV before distribution to ORNL via overhead and underground lines (DOE 1999b:4-64, 4-65).

Electrical energy available to ORNL is about 1,227,000 MWh per year, with 2018 electrical energy consumption of about 583,000 MWh per year. The recorded peak load for ORNL was about 140 MW (ORNL 2020c).

There are two 13.8 kV feeders that parallel Melton Valley Drive and Ramsey Drive north of the Melton Valley site (CROET 2007:11-4; ORNL 2020c). The maximum capacity of each feeder is about 12 MW. The peak load on feeder 294 is about 4 MW and the peak load on feeder 216 is about 7 MW (ORNL 2020c).

3.2.7.2 Fuel

Fuel consumed at ORNL includes natural gas, fuel oil (for heating), diesel fuel, gasoline, and propane. Natural gas is supplied to ORR via a 22-inch main that enters ORR from Morgan County to the west and Knox County to the east, crosses the Clinch River, and proceeds to a valve station located along Bethel Valley Road. Smaller pipelines (up to 6 inches) supply gas to various facilities around ORNL. Mainline pressures range from 450 to 600 pounds per square inch, but are reduced to 100 pound per square inch for distribution to ORNL. The annual natural gas demand for ORNL is about 600 million cubic feet per year; annual natural gas capacity for ORNL is about 3,214 million cubic feet per year (ORNL 2020c).

Currently, there are no natural gas lines on the Melton Valley site. There is a 6-inch, 100-pound-per-square-inch natural gas pipeline that supplies natural gas to the Main Campus Steam Plant and facilities on the main campus. A 4-inch branch line of the 6-inch line supplies natural gas to the Melton Valley Steam Plant. Currently, the line goes to the Melton Valley Steam Plant at the intersection of Melton Valley Drive and the HFIR Access Road (ORNL 2020c).

ORNL used about 122,000 gallons of fuel oil in 2018 (ORNL 2018b:10). Fuel oil, diesel fuel, gasoline, and propane are delivered to facilities at ORNL as needed. Therefore, capacities are not limited, and these fuel types are not discussed further.

3.2.7.3 Water

Water is withdrawn from the Clinch River at a point south of the eastern end of Y-12. The water is filtered and treated at the City of Oak Ridge water treatment plant, located north of Y-12, and distributed to the City of Oak Ridge, Y-12, and ORNL. This treatment facility provides potable water through two storage reservoirs with a combined capacity of 7 million gallons (DOE 1999b:4-65, 4-66). Water to ORNL is provided via a single, 24-inch gravity line from the water plant. The water line feeds the ORNL reservoir system, which consists of one 3-million-gallon concrete reservoir, a 1.5-million-gallon steel reservoir on Chestnut Ridge, and two 1.5-million-gallon steel reservoirs on Haw Ridge. From these reservoirs, water flows by gravity through the plant’s water distribution system (DOE 2008b:3-13).

Total ORNL water use ranges from about 2.5 million gallons per day (912.5 million gallons annually) during the winter to about 4 million gallons per day (1.46 billion gallons annually) during the summer, but usage can approach 5 million gallons per day (1.83 billion gallons annually) (ORNL 2002). ORNL water system’s capacity is about 7 million gallons per day, with an average yearly usage of about 730 million gallons (ORNL 2020c).

An existing 16-inch, potable water pipeline supplies water to HFIR/REDC. This line is backed up by a 12-inch water line that follows Melton Valley Drive (DOE 2008b:3-13). In addition, existing pipelines supply potable water to the Hazardous Waste Treatment and Storage Facility on the southern boundary of the proposed project area (ORNL 2020c).

3.2.7.4 Sanitary Wastewater Treatment

ORNL operates and maintains an individual sanitary wastewater treatment plant (SWTP). The SWTP is located at the western end of ORNL. The SWTP’s current capacity is 300,000 gallons per day, while the average daily flow to the SWTP is less than 186,100 gallons per day (DOE 1999b:4-66; ORNL 2020c). There are existing sanitary sewer pipelines that connect HFIR and REDC to the SWTP (CROET 2007:11-4).

3.2.8 Noise

The ROI for noise extends 0.5 mile from the edge of the construction area, which is the area that could be susceptible to noise impacts.

This EIS considers the following data sources for characterizing the noise environment and vibration:

- Aerial photography is used to identify potential noise-sensitive receptors near the project area, including the Google Earth™ mapping service imagery for counties within the project area.
- The 2018 DOT Federal Transit Administration published the *Transit Noise and Vibration Impact Assessment Manual* with methodology to estimate ambient, construction, and operational noise levels, and to evaluate general noise and vibration concepts (DOT 2018).
- EPA methodology characterizes noise concepts and sets limits (EPA 1978).

Section 3.1.8.1, Noise and Vibration Overview, discusses background information relevant to understanding the evaluation of this resource area. Refer to that section for information about the characterization and measurement of sound, sound levels of different activities, the definition of noise, and sound attenuation.

3.2.8.1 Noise Regulations

The Noise Control Act of 1972 (42 U.S.C. 4901) directs Federal agencies to comply with applicable Federal, State, interstate roadways, and local noise control regulations. The primary responsibility of addressing noise pollution has shifted to State and local governments. In 1974, EPA Office of Noise Abatement and Control published its document entitled *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin on Safety*, which evaluated the effects of environmental noise with respect to health and safety (EPA 1974). The document provides information for State and local agencies to use in developing their ambient noise standards. As set forth in the publication, EPA provided information suggesting that an equivalent sound level of 70 dBA is the level above which environmental noise could cause hearing loss if heard consistently over several years. A day-night average sound level of 55 dBA outdoors and 45 dBA indoors is the threshold above which noise could cause interference or annoyance (EPA 1974:9).

The State of Tennessee has not established noise regulations that specify noise limits. ORNL is located in Anderson and Roane Counties and adjacent to Knox County. Anderson and Knox counties have established residential noise level standards of 65 dBA during the daytime. Anderson County has quantitative noise limit regulations per zoning district under Section 045-107 of the Zoning Resolution (refer to **Table 3–26**). Similarly, Knox County established noise limits for three specific land use types under Section 1203 of the Code of Ordinances (refer to Table 3–26). Both Anderson and Knox counties have exemptions for noise limits due to construction activities, but Section 1205 of Knox County Code of Ordinances specifies exemptions to include construction activities from 7 a.m. to 6 p.m. Roane County has not established noise regulations. For areas without standardized criteria, the Federal Transit Administration recommends the following standards for construction noise in residential areas: construction noise levels at the sensitive receptor should not exceed an 8-hour equivalent sound level of 80 dBA during daytime (7 a.m. to 10 p.m.), an 8-hour equivalent sound level of 70 dBA during nighttime (10 p.m. to 7 a.m.), and a 30-day average day-night average sound level of 75 dBA (DOT 2018:193).

Table 3–26. Allowable Noise Levels by Zoning District in Anderson and Knox Counties, Tennessee

Zoning District	***Allowable Noise Levels (day-night average sound level)***	
	7 a.m. to 10 p.m.	***10 p.m. to 7 a.m.***
Anderson County, Tennessee		
Suburban-residential	60	55
Rural-residential	65	60
Agricultural-forest	65	60
General Commercial	70	65
Light Industrial	70	70
Heavy Industrial	80	80
Floodway	80	80
Knox County, Tennessee		
Residential	65	60
Commercial	80	75
Industrial	80	80

dBA = A-weighted sound level in decibels.
Source: Anderson County 2015; Knox County 2019.

3.2.8.2 Existing Noise Environment

The major noise sources within ORNL include industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, intercom paging systems, construction and materials-handling equipment, and vehicles). These noise sources primarily occur within developed or active areas at ORNL. Noise emissions outside of these active areas consist primarily of vehicles. Most industrial facilities are a sufficient distance from the site boundary that noise levels from these sources at the boundary are not measurable or are barely distinguishable from background noise levels (DOE 2005b).

There are no existing noise-generating equipment and facilities at the proposed project area and other potential sources of noise are located over 2,000 feet away (ORNL 2020c). The only existing noise sources in the vicinity of the proposed project area would be vehicular traffic along Melton Valley Drive. The land surrounding the proposed project area includes existing ORNL-owned property in all directions. The closest offsite receptors include residential homes located to the east across the Clinch River in Knox County and more than 1.25 miles away. Because the site does not have major noise sources, the ambient noise levels were estimated based on the population density of the affected county using the methodology described in DOT's *Transit Noise and Vibration Impact Assessment* (DOT 2018).

The proposed project area is located on property within both Anderson and Roane Counties Tennessee. According to the U.S. Census Bureau, the population density of the Anderson County and Roane County is about 222.8 and 150.2 people per square mile, respectively (Census 2010b, 2010c:1). As a result, the existing day-night average sound level in the vicinity of the project area is estimated to be 40 dBA, and the existing ambient equivalent continuous sound levels (in equivalent sound level) during daytime and nighttime are estimated to be about 40 and 30 dBA, respectively (DOT 2018:66). Ambient (background) noise levels could occur from roadway traffic, farm machinery, pets, and various other household noises.

The closest Federal and State parks to the proposed project area are the Manhattan Project National Historical Park (buildings are on ORR), Frozen Head State Park (17 miles northwest), Obed National Wild and Scenic River National Park (20 miles northwest), Norris Dam State Park (22 miles north), Fort Loudoun State Historic Park (22 miles south), and Great Smoky Mountains National Park (26 miles southeast).

3.2.9 Waste and Spent Nuclear Fuel Management

This section describes the current average annual "baseline" generation rates and management practices for the waste categories that will be generated if the VTR alternative is implemented at ORNL

(ORNL 2020c). The ROI for waste management activities includes everything within the ORR boundaries. Offsite locations, including other DOE and commercial facilities, are not included in the waste management ROI. The potential impacts at these non-ORR disposition facilities were considered as part of the licensing/permitting/approval process for these sites and are not detailed in this document. There would be no additional impacts, including exposure to the offsite public or onsite workers. All waste disposition actions would comply with the licenses, permits, and/or approvals applicable to the facilities described in this document. Those waste categories are LLW, MLLW, and TRU waste; RCRA hazardous and TSCA wastes; and nonhazardous solid waste and recyclable materials. HLW is also managed at ORNL; however, no HLW will be generated under the VTR alternative. Therefore, HLW will not be discussed further in the section. Additionally, while not a waste, spent nuclear fuel will also be generated and is discussed in this section. **Table 3–27** presents the latest available 5-year annual generation by waste category.

Table 3–27. 5-Year Annual "Baseline" Generation by Waste Category in Cubic Meters

Waste Type	***2015***		***2016***		***2017***		***2018***		***2019***		***Average***	
	ORR	***ORNL***	***ORR***	***ORNL***	***ORR***	***ORNL***	***ORR***	***ORNL***	***ORR***	***ORNL***	***ORR***	***ORNL***
LLW	100,000	400	78,000	360	62,000	1,000	61,000	390	104,000	480	81,000	530
MLLW	500	36	520	65	590	61	870	50	1,000	73	700	57
TRU Waste	13	13	20	20	43	17	380	6.0	260	7.8	140	13
Hazardous and TSCA	170	130	190	150	210	100	1,200	130	1,300	110	610	120
C&D	43,000	51	33,000	110	46,000	250	34,000	80	74,000	86	46,000	120

C&D = Construction and demolition and industrial waste; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; ORR = Oak Ridge Reservation; ORNL = Oak Ridge National Laboratory; TRU = transuranic waste.
Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries. ORR quantities include ORNL quantities.
Source: ORNL 2020c.

3.2.9.1 Low-Level Waste, Mixed Low-Level Waste, and Transuranic Waste

LLW and MLLW are processed, treated, packaged/repackaged, characterized at the Transuranic Waste Processing Center and transported off site for disposal at NNSS or treatment, disposal, or both at other approved offsite Federal and commercial facilities. TRU waste is also processed, treated, packaged/repackaged, characterized at the Transuranic Waste Processing Center and transported off site for disposal at the WIPP facility.

3.2.9.2 Resource Conservation and Recovery Act and Hazardous and Toxic Substance Control Act Wastes

Resource Conservation and Recovery Act Wastes

The Hazardous Waste Program under RCRA establishes a system for regulating hazardous wastes from the initial point of generation through final disposal. In Tennessee, TDEC has been delegated authority by EPA to implement the Hazardous Waste Program; EPA retains an oversight role. DOE and its contractors at ORNL are jointly regulated as a "large-quantity generator of hazardous waste" under EPA ID TN1890090003 because, collectively, they generate more than 1,000 kilograms of hazardous/mixed wastes in at least one calendar month of a year. Hazardous wastes are accumulated in satellite accumulation areas or in less-than-90-day accumulation areas and are stored and/or treated in RCRA-permitted units. In addition, hazardous wastes are shipped off site for treatment and disposal. Reporting is required for hazardous waste activities on 20 active waste streams at ORNL. In April 2018, TDEC Division of Solid Waste Management conducted a Hazardous Waste Compliance Evaluation inspection of ORNL generator areas; universal waste collection areas; RCRA-permitted treatment, storage, and disposal facilities; hazardous waste training records; site-specific contingency plans; and RCRA records. TDEC also reviewed the Hazardous Waste Transporter Permit; DOT inspection records for tractors, trailers, and tankers; driver qualification files; hazardous waste manifests; and DOT training records. All records and areas were found to be in compliance with RCRA regulations and the RCRA permits.

Toxic Substance Control Act Wastes

PCB uses and waste at ORNL are regulated under TSCA. There are nine PCB waste storage areas at ORNL. When longer-term storage is necessary, PCB/radioactive wastes are stored in RCRA-permitted storage buildings at ORNL. The continued use of authorized PCBs in electrical systems or equipment (e.g., transformers, capacitors, rectifiers) is regulated at ORNL. Most of the equipment at ORNL that required regulation under TSCA has been dispositioned.

Because of the age of many of the ORNL facilities and the continued presence of PCBs in gaskets, grease, building construction, and equipment, DOE self-disclosed unauthorized use of PCBs to EPA in the late 1980s. DOE continues to notify EPA when additional unauthorized uses of PCBs, such as PCBs in paint, adhesives, electrical wiring, or floor tile, are identified at ORNL.

3.2.9.3 Nonhazardous Solid Waste and Recyclable Materials

ORNL/ORR operates several landfills that are permitted by the Tennessee Solid Waste Division. Each landfill has established criteria for determining the waste acceptable for disposal. There are three landfills that are permitted to receive construction/demolition debris, two that are permitted to receive sanitary industrial waste, and one that is permitted to receive classified waste. **Table 3–28** summarizes the permitted waste and remaining capacity of those landfills.

Table 3–28. Landfill Criteria and Capacities

Waste Disposal Facility	*Permitted Waste*	*Approximate Remaining Capacity (cubic meters)*
Construction/Demolition Landfill VII	Construction/demolition debris	990,000
Industrial Landfill IV	Classified, sanitary industrial waste (including office waste, equipment, construction/demolition debris)	42,000
Industrial Landfill V	Sanitary industrial waste (including office waste, equipment, construction/demolition debris)	940,000

Source: ORNL 2020c.

3.2.9.4 Spent Nuclear Fuel

ORNL has a long history of managing spent nuclear fuel. This spent fuel history includes post irradiation examination and onsite storage. Spent nuclear fuel from the Bulk Shielding, Health Physics Research, and Tower Shielding No. II reactors have been historically been generated, examined and analyzed, and stored at ORNL. Spent fuel from ongoing operations at HFIR are only stored onsite for a short period of time before they are transported to the DOE Savannah River Site in South Carolina where they are processed.

3.2.10 Human Health – Normal Operation

The impact on human health during normal facility operations addresses the potential impacts from exposure to ionizing radiation and chemicals. Potential human health impacts from exposure to radiation from normal operational conditions is considered for both an individual and the population as a whole for both the public and site workers; this constitutes the ROI. For the existing environment, the public population is considered to be all people living within 50 miles of ORR. The maximally exposed individual is considered to be a hypothetical person who could receive the maximum possible dose from ORR site releases. In addition, for workers the potential human health impacts associated with exposure to workplace chemicals are considered.

3.2.10.1 Radiation Exposure and Risk

DOE monitors radiation in the environment and exposure of workers and calculates the radiation exposures of members of the offsite general public[4] and onsite workers from operation of ORR. **Table 3–29** presents data on radiation doses to the public for the years 2013 to 2018. The maximum radiation dose to an offsite member of the public during this period as a result of onsite facility operations was estimated to be 3.5 millirem per year (ORO 2018:Table 7.8). The risk of developing an LCF from this dose is extremely small, about 1 in 500,000). The calculation of this total dose considers the maximum dose to an individual from air emissions, from the use of water (drinking water), and from the consumption of wildlife harvested in the vicinity of ORR. Although the annual site environmental reports include a dose contribution from irrigation, they also state that there are no known sources of irrigation using water from sources near ORR. Therefore, this contribution to the individual and population dose was not included. Direct radiation measurements have confirmed that direct radiation does not contribute to a dose to any member of the public (ORO 2015). The average annual dose to an individual from ORR operations is less than one percent of the average dose of 300 millirem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for someone living in the United States (ORO 2019:7-5).

There are two dose limits relevant to the exposure of an individual member of the public near a DOE site. As shown in Table 3–29, all of the doses to the maximally exposed individual from the operation of ORR are well below the DOE dose limit for a member the general public, which is 100 millirem per year from all pathways, as prescribed in DOE Order 458.1 (DOE 2011b). The table also shows that the dose from the air pathway is well below the NESHAPs dose limit for emissions from DOE facilities of 10 millirem per year (40 CFR Part 61, Subpart H).

Table 3–29. Annual Radiation Doses to the Public from Oak Ridge Reservation Operations 2014–2018

Source of Dose	*Maximally Exposed Individual*					*Population*		
	Dose (millirem per year)				*LCF Risk*			
	Airborne radionuclides [a]	*Water Use* [b]	*Consumption of Wildlife* [c]	*Total*	*Total* [d]	*Estimated Population Dose (person-rem)*	*LCFs* [d]	*Estimated Dose from Background (person-rem)*
2018	0.2	0.04	2.2	2.4	(e)	12	0.007	363,000
2017	0.3	0.02	3.2	3.5	(e)	13	0.008	363,000
2016	0.2	0.10	2.3	2.6	(e)	13	0.008	363,000
2015	0.4	0.03	1.9	2.3	(e)	13	0.008	363,000
2014	0.6	0.03	2.1	2.8	(e)	53	0.03	363,000
Average	**0.3**	**0.04**	**2.3**	**2.7**	**(e)**	**21**	**0.01**	**363,000**

LCF = latent cancer fatality.

[a] DOE (DOE 2011b) and the EPA (40 CFR Part 61 subpart H) limit the dose to a member of the public from airborne radionuclides to 10 millirem per year.

[b] Water use includes drinking water and recreational activities.

[c] Wildlife consumption includes fish, deer, geese, and turkey.

[d] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem.

[e] The probability of this individual contracting a fatal cancer range from about 1 in 500,000 to 1 in 700,000.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: ORO 2015:Table 7.7, 2016:Table 7.7, 2017b:Table 7.7, 2018:Table 7.8, 2019:Table 7.7.

[4] Public impacts at ORR derive from operations at Y-12, ORNL, and the ETTP. Estimates of the dose from air emissions for these individual facilities can be found in the Annual Site Environmental Reports (ORO 2015, 2016, 2017b, 2018, 2019). Only the totals for all three sites are presented here.

The population dose is the sum of average individual doses to the entire population within 50 miles of ORR. Table 3–29 shows that over the years 2014 through 2018, the population dose from operations at ORR ranged from 12 to 53 person-rem. No LCFs would be expected from these doses. The higher population dose in 2014 is coincidental with increased demolition activities at ORR (ORO 2015). Population doses from background sources of radiation are also presented in Table 3–29. The doses from ORR operations are a small fraction of the background doses to the affected population of 1,172,530 living within 50 miles of any ORR facility (ORO 2019).

Worker doses at ORNL primarily result from:

- Work related to the Spallation Neutron Source and HFIR,
- Nuclear reactor research and radioisotope production, and
- Facility maintenance.

Of the workers at ORR (about 4,800 workers in 2017 [Crocker 2017]) nearly 13 percent received a measurable dose (a detectable dose) during the period of 2014 through 2018. The average collective worker dose during this time was 73.0 person-rem per year with no LCFs expected (calculated value of 0.04). Considering only the workers who received a measurable dose (on average 622 workers per year and ranging from 598 to 661), the average annual dose to a worker was 117 millirem. No single worker received a dose greater than 2,000 millirem (DOE 2015g, 2016j, 2017g, 2018b, 2019g). To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year (DOE 2017f), and maintained as low as reasonably achievable. **Table 3–30** presents ORNL worker dose information for the years 2014 to 2018.

Table 3–30. Annual Radiation Doses to Oak Ridge National Laboratory Workers from Operations 2014–2018

Year	*Collective Dose (person-rem)*	*Workers With a Measurable Dose*	*Average Dose Among Workers With a Dose (rem)*	*Exposed Worker Population LCF Risk* [a]
2018	76.8	615	0.125	0 (0.05)
2017	87.6	661	0.133	0 (0.05)
2016	69.4	617	0.112	0 (0.04)
2015	60.0	598	0.100	0 (0.04)
2014	71.3	618	0.115	0 (0.04)
Average	**73.0**	**622**	**0.117**	**0 (0.04)**

[a] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem. A value of less than 0.5 is considered to result in no LCFs. Values in parentheses are calculated values.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: DOE 2017g:Exhibit B-1, 2018b:Exhibits B-1–B-3, 2019g:Exhibit B-3.

3.2.10.2 Nonradiological Health and Safety

Nonradiological exposures at ORNL are controlled through programs intended to protect workers from normal industrial hazards. These programs are controlled by the safety and health regulations for DOE contractor workers governed by 10 CFR Part 851, which establishes requirements for worker safety and health programs to ensure that workers have a safe work environment. Included are provisions to protect against occupational injuries and illnesses, accidents, and hazardous chemicals.

DOE monitors worker safety through CAIRS. CAIRS is a computerized database used to collect and analyze DOE reports of injuries, illnesses, and accidents that occur during facility operations. Two metrics generated for the tracking of injury, illness, and accident rates are the DART rate and the TRC rate. The

DART rate is an indication of the instances of injuries, illnesses, and accidents that result in, at worst, lost work days or days lost due to transfer or worker job restrictions. The TRC rate is an indication of the total number of work-related injuries or illnesses that resulted in death, days away from work, job transfer or restriction, or recordable case as identified in the Occupational Safety and Health Administration's Form 300. For the years 2015 through 2019 the ORNL DART and TRC rates (incidents per 200,000 work hours or the equivalent of 100 full-time workers) average 0.19 and 0.65, respectively. For the years 2015 through 2019, the DART and TRC rates for all DOE facilities combined average 0.39 and 0.86, respectively (DOE 2019a).

3.2.10.3 Regional Cancer Rates

The National Cancer Institute publishes national, State, and county incidence rates of various types of cancer (NCI 2018). However, the published information does not provide an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–31** presents incidence rates for the United States, Tennessee, Anderson County, Roane County, and the 18 counties within about 50 miles of ORR. (ORNL is located in Anderson and Roane Counties.) Additional information about cancer profiles in the vicinity of ORNL is available in State Cancer Profiles and in Incidence Rates Tables (NCI 2018). Not all types of cancer are presented in this table; totals for individual cancers will not sum to the All Cancer values.

Table 3–31. Cancer Incidence Rates for the United States, Tennessee, and Counties Adjacent to Oak Ridge National Laboratory, 2012–2016

Region	*Cancer Incidence Rates* [a]						
	All Cancers	*Thyroid*	*Breast (female)*	*Lung and Bronchus*	*Leukemia*	*Prostate*	*Colon and Rectum*
United States	448.0	14.5	125.2	59.2	14.1	104.1	38.7
Tennessee	462.6	12.9	122.6	75.1	13.7	110.4	40.5
Anderson County [(b)]	469	15	135.7	71	10.7	112.1	39.8
Bledsoe County	412.5	(c)	84.3	84.1	(c)	68.5	32.7
Blount County	483	13.6	122.7	78.6	19	99	37.5
Campbell County	510.8	16.2	113.8	115	15.8	96.6	47.4
Claiborne County	530.6	15.4	133.6	116.1	14.1	99.7	46.2
Cumberland County	448.5	14.6	116	73.5	10.1	108.5	40
Fentress County	491.8	(c)	116.3	99.2	(c)	95.6	48.7
Grainger County	501.2	17.6	103.6	91.7	13.5	105	43.7
Jefferson County	468.7	16.9	125.3	73.3	17.6	85.8	39.6
Knox County	465.4	15.1	129.3	68.7	12.9	115.7	36.2
Loudon County	494.9	19.2	136	72.3	12.5	102.2	28.8
McMinn County	441.5	10.6	106.5	78	13.9	75.3	42.1
Meigs County	505.8	(c)	95.6	90.9	(c)	89.8	48
Monroe County	462	7.6	96	95.8	13.3	87.1	33.5
Morgan County	471.5	(c)	143.5	99.1	(c)	107.2	36.8
Rhea County	498	11.7	123	102	13.4	88.1	45.1
Roane County [(b)]	459.2	16.3	135.2	79.3	15.8	89.5	37.6
Scott County	511.3	19.3	125.7	104	(c)	118	41.9
Sevier County	490	15.2	133	79.5	13.8	106.3	40.7
Union County	502	23.4	99	114.8	12	94.8	35

[a] Age-adjusted incidence rates; cases per 100,000 persons per year.
[b] ORNL is located in Anderson and Roane Counties.
[c] Data have been suppressed by the National Cancer Institute to ensure the confidentiality and stability of rate estimates when the annual average count is three or fewer cases.
Source: NCI 2018.

3.2.11 Emergency Preparedness

Every site in the DOE complex has an established emergency management program that is activated in the event of an accident. These programs have been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. Emergency management programs address emergency planning, training, preparedness, and response for both onsite and offsite personnel.

DOE Order 151.1D, *Comprehensive Emergency Management System* (DOE 2016i), describes detailed requirements for emergency management that all DOE sites must implement. Each DOE site, facility, and activity, including ORNL, establishes and maintains a documented emergency management program that implements the requirements of applicable Federal, State, and local laws, regulations, and ordinances for fundamental worker safety programs (e.g., fire, safety, and security). This is the Emergency Management Core Program. In addition, each DOE site, facility, and activity containing hazardous materials (i.e., radioactive materials or certain chemicals that do not fall under the purview of fundamental worker safety programs) establishes and maintains an Emergency Management Hazardous Materials Program. Finally, each site that receives or initiates shipments managed by the Office of Secure Transportation must be prepared to manage an emergency involving such a shipment, should that emergency occur on site.

These programs involve providing specialized training and equipment for local fire departments and hospitals, State public safety organizations, and other government entities that may participate in response actions, as well as specialized assistance teams. These programs also provide for notification of local governments whose constituencies could be threatened in the event of an accident. Broad ranges of drills and exercises are run to ensure the systems are working properly, from facility-specific exercises to regional responses. In addition, there are internal and external audits. Lessons learned from exercises and audits are used to continuously strengthen ORNL's emergency management program.

In summary, the emergency management system at ORNL includes emergency response facilities and equipment, trained staff, and effective interface and integration with offsite emergency response authorities and organizations. ORNL personnel maintain the necessary apparatus, equipment, and a state-of-the-art Emergency Operations Center.

3.2.12 Traffic

3.2.12.1 Transportation Infrastructure

The ROI for the transportation infrastructure includes two U.S. Interstate Highways, three U.S. Highways, four Tennessee State Highways, and the ORNL onsite road systems. Major transportation routes to ORNL are via two Interstate Highways (I) I-40 and I-75, as well as U.S. Highways (US), US 11, US 25W, and US 70. DOE has transferred some roads at ETTP to the City of Oak Ridge to provide access to property that has already been transferred.

3.2.12.2 Regional

The primary regional roadway network consists of the following main roads:

- Interstate I-40, an east-west route located south of ORR;
- State Route (SR) 95 (Oak Ridge Turnpike) from the City of Oak Ridge to the SR 95/58 interchange on ORR;
- SR 95 (White Wing Road) from Interstate I-40 to the SR 95/58 interchange;
- SR 327 (Blair Road) from SR 61 to the north to SR 58;
- SR 58 from Gallaher Road to the west to the SR 95/58 interchange;

- SR 62 (S. Illinois Avenue) and Scarboro Road from Oak Ridge southeast to roads leading onto ORR; and
- SR 162 (Pellissippi Parkway) from Interstate I-40/Interstate I-75 to SR-62.

3.2.12.3 Oak Ridge Reservation Onsite Road Systems

Within the ORR there are about 197 miles of roadways (Census 2019b). Employees leaving ORNL can choose from several routes that pass through the ORR. Within ORR, several routes are used to transfer traffic from the State routes to the main plant areas, including ORNL (ORNL 2002). Bear Creek Road, north of Y-12, runs in an east-west direction and connects Scarboro Road on the east end with SR 95 and SR 58. Bear Creek Road has restricted access around Y-12 and is not a public thoroughfare. The main ORNL access road, Bethel Valley Road, is closed to the public, but open to ORNL staff and authorized visitors. This east-west road extends from the east end of ORR at Scarboro Road to the west end at SR 95 and provides access to the site and leads to all the parking lots.

Blair Road (SR 327) is a collector roadway with a section of the roadway located on DOE property. Under a bilateral agreement with the State, a permanent easement for this section is maintained by the Tennessee DOT. The roadway provides a connection from SR 61 to SR 58. The intersection of Blair Road and SR 58 is signalized.

Once on site, access to the VTR complex will be directly provided by Melton Valley Access Road from a north-south direction and Melton Valley Drive/Ramsey Drive from an east-west direction.

Heavy equipment accessing ORNL is processed in accordance with access protocols that include all vehicles being subject to search. Preplanning and notification are necessary for oversized or unusual shipments. Loads must be configured so security personnel can do a visual inspection of both the vehicle and load. Searches are conducted randomly. Bills of lading and government forms of identification are verified prior to allowing the vehicle onto the site.

Two main branches provide rail service for ORR. The CSX Transportation line at Elza Gate (just east of Oak Ridge) serves the Y-12 Complex and the Office of Science and Technological Information in east Oak Ridge. The Norfolk Southern main line from Blair Road provides easy access to ETTP (DOE 2005b). No rail spurs run to the ORNL site.

3.2.12.4 Existing Traffic Conditions

In 2018, the annual average daily traffic for regional roadways near the study site ranged from 2,485 (SR 327) to 12,641 (SR 58) vehicles a day, which is considered light compared to other roadways in the City of Oak Ridge (TDOT 2019). There are two primary entrances/exits to ORNL: Bethel Valley Road eastbound towards SR-62 and Bethel Valley Road westbound towards SR-95. SR 95 from the intersection with SR 62 (S. Illinois Avenue) to the SR 95/58 interchange has been recently widened to a four-lane divided highway. SR-162 is the main thoroughfare for commuters to ORNL coming west on I-40 from Knoxville to ORNL's east gate at Bethel Valley Road.

Table 3–32 provides average daily traffic data for selected segments of routes in the vicinity of ORNL. The daily average of each route is the annual average daily traffic on the route.

ORNL employs about 5,000 employees (ORNL 2019). The majority of ORNL's commuting traffic comes from Oak Ridge via Bethel Valley Road, while smaller amounts come from Blair Road and south SR 95 (DOE 1997c). During 2019, an average of about 4,750 vehicles came onto the site each day. Peak travel times are considered 6:30 a.m. to 9:30 a.m. for the morning commute and 3:30 p.m. to 5:30 p.m. for the evening commute, with most congestion occurring at the east and west portals during morning and evening commute times. Traffic studies have been conducted for select intersections on site. A study for the entire site has not been completed.

Table 3–32. Average Daily Traffic Volume

Route	*Average Daily Traffic Volume (2018)*
SR 95 from the SR 95/58 Exchange to Wisconsin Avenue	11,486
SR 95 from the SR 95/58 Exchange to Bear Creek Road	5,830
SR 327 from SR 61 to SR 58	2,485
SR 58 from Gallaher Road to the SR 95/58 interchange	12,641
SR 162 from I-40/I-75 to the SR 162/62 interchange	64,715

Source: TDOT 2019.

3.2.13 Socioeconomics

This section describes current socioeconomic conditions and local community services within the four-county ROI (or region) associated with ORNL: Anderson, Knox, Loudon, and Roane Counties in eastern Tennessee. ORNL is located in Roane and Anderson Counties, about 25 miles northwest of the City of Knoxville. About 87.6 percent of people employed at ORR, including about 4,400 employees at ORNL, reside in these four counties (DOE 2005b; OREM 2019). Therefore, these four counties are identified as the ROI in this socioeconomics analysis. Figure 2–7 shows the four counties in the ROI as well as towns and major transportation routes.

3.2.13.1 Population and Housing

Knox County is the largest county in the ROI. It had a 2018 population of 465,289, including the population of Knoxville, the largest city in the ROI with a population of 187,500 in 2018 (Census 2020c). Loudon County is the smallest county in the ROI with a total population of 53,054 in 2018. The City of Oak Ridge and ORNL are located in both Roane and Anderson Counties which had 2018 populations of 53,140 and 76,482, respectively (Census 2020c); Oak Ridge, the closest city to ORNL, had a population of 29,109 in 2018 (Census 2020c).

In 2018, the population in the ROI was estimated to be 546,358. From 2010 to 2018, the total population in the ROI increased at an average annual rate of about 0.8 percent, which was slightly lower than the growth rate in Tennessee. Over the same time period, the total population of Tennessee increased at an average annual rate of about 0.84 percent, to 6,770,010 people. The populations of the ROI and Tennessee are shown in **Table 3–33**.

Table 3–33. Population of the Oak Ridge National Laboratory Region of Influence 2000–2018

County	*Year*				*Population Projection 2050*
	2000	*2010*	*2018*	*Population Change 2010-2018 (percent)*	
Anderson	71,330	75,129	76,482	1.8	82,280
Knox	382,032	432,226	465,289	7.6	587,800
Loudon	39,086	48,556	53,054	9.3	69,712
Roane	51,910	54,181	53,140	-1.9	50,723
ROI	**544,358**	**610,092**	**647,965**	**6.2**	**790,515**
Tennessee	5,689,283	6,346,105	6,770,010	6.7	8,306,294

ROI = region of influence.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: Census 2020a, 2020b, 2020c; Tennessee State Data Center 2020.

Housing

As of 2017, the ROI had 283,708 housing units of which 89.7 percent were occupied and 10.3 percent were vacant. In Tennessee, an estimated 12.3 percent of the stock is vacant. Vacant rental stock makes up 7 percent of the stock in Tennessee. The distribution of housing units in the ORNL ROI and Tennessee is presented in **Table 3–34**.

Table 3–34. Region of Influence Housing Characteristics (2017)

County	2017 Housing Units	Occupied Housing Units	Vacant Housing Units	Owner-Occupied Units	Renter-Occupied Units	Vacant Homeowner -Housing Units (percent)	Vacant Rental Housing Units (percent)
Anderson	34,864	30,518	4,346	20,584	9,934	872 (2.5)	2,162 (6.2)
Knox	200,608	182,315	18,293	116,893	65,422	3,810 (1.9)	11,033 (5.5)
Loudon	22,571	20,090	2,481	15,282	4,808	315 (1.4)	1,015 (4.5)
Roane	25,665	21,619	4,046	16,274	5,345	667 (2.6	2,617 (10.2)
ROI	**283,708**	**254,542**	**29,166**	**169,033**	**85,509**	**5,664 (2.0)**	**16,827 (5.9)**
Tennessee	2,903,199	2,547,194	356,005	1,688,565	858,629	52,257 (1.8)	203,224 (7.0)

ROI = region of influence.
Notes:
Homeowner and rental vacancy units do not add to total vacant housing units because the vacancy rates only include vacant housing units (i.e., proportion of total inventory) that are on the market for rent or for sale only.
Due to rounding, sums and products may not equal those calculated from table entries.
Source: Census 2017c.

3.2.13.2 Employment and Income

From 2010 to 2018, the ROI experienced an average annual growth rate in the civilian labor force of just under 0.4 percent (from 311,401 to 320,327), while the State of Tennessee's labor force grew at an average annual rate of about 0.6 percent. Employment in the ROI grew at an average annual rate of 1.0 percent, compared to the State of Tennessee's rate of about 1.5 percent. At the same time, the number of unemployed people decreased by 5.2 percent – reflecting the economic recovery from the recession of 2008 – 2010. The ROI experienced a slightly lower unemployment rate (3.2 percent) in 2018 than the State of Tennessee (3.5 percent). Within the ROI, the unemployment rate ranged from 2.9 percent in Knox County to 4.1 percent in Roane County. **Table 3–35** presents employment statistics in the ROI and Tennessee for 2010 and 2018. In 2018, there were 310,260 people employed in the ORNL ROI.

Table 3–35. Employment Statistics in the Oak Ridge National Laboratory Region of Influence and Tennessee in 2010 and 2018

Area	Civilian Labor Force		Employment		Unemployment		Unemployment Rate	
	2010	2018	2010	2018	2010	2018	2010	2018
Anderson	34,926	34,283	31,675	32,995	3,251	1,288	9.3	3.8
Knox	229,800	240,034	212,757	232,986	17,043	7,048	7.4	2.9
Loudon	22,352	22,857	20,280	22,078	2,072	779	9.3	3.4
Roane	24,323	23,153	22,089	22,201	2,234	952	9.2	4.1
ROI	**311,401**	**320,327**	**286,801**	**310,260**	**24,600**	**10,067**	**7.9**	**3.1**
Tennessee	3,090,795	3,244,921	2,792,063	3,131,660	298,732	**113,261**	9.7	3.5

ROI = region of influence.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: BLS 2020a, 2020b, 2020c.

ORNL/ORR Employment

ORNL is managed by UT-Battelle, LLC. ORR also includes Y-12 and the ETTP (formerly K-25 Site or Oak Ridge Gaseous Diffusion Plant), managed by UCOR. UCOR is the prime contractor for most environmental management activities at ORR, including on the ORNL campus. The Oak Ridge Institute for Science and Education is a DOE entity that is operated by Oak Ridge Associated Universities.

Table 3–36 provides residence information for the four-county ROI. As shown in this table, about 87.6 percent of ORR, employees, including those working at ORNL, reside in this ROI. Total onsite employees in 2019 was 14,300, including 1,900 at ETTP (including 200 private workers), 8,000 at Y-12, and 4,400 at ORNL (OREM 2019).

Table 3–36. Distribution of Employees by Place of Residence in the Oak Ridge National Laboratory Region of Influence

County	*Number of Employees*	*Percent of Total Site Employment*
Anderson	3,930	27.5
Knox	5,380	37.6
Loudon	760	5.3
Roane	2,460	17.2
ROI [a]	**12,530**	**87.6**

ROI = Region of Influence.

[a] Total employees and county of residence based on 2003 data (DOE 2005b).

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Source: DOE 2005b; OREM 2019.

A comparison of 2018 data for direct onsite employment levels and ROI employment levels show that direct ORNL onsite residence employment accounted for about 3.6 percent of employment in the ROI.

Local Income

ORR is a major economic contributor to the Tennessee economy. In FY 2017, nearly $2.2 billion in total personal income was generated DOE-related activities in Tennessee, including a direct income benefit of over $1.1 billion, the majority of which was generated in Knox, Anderson, and Roane counties (DOE 2018g). The annual average salary for a DOE-related employee is $81,000. This is significantly higher than the average per capita income in the ROI of $45,265 in 2018 (BEA 2019a). Per capita income in 2018 in the ROI ranged from a low of $40,980 in Roane County to a high of $49,738 in Knox County. The per capita income in Tennessee was $46,900 in 2018 (BEA 2019a). Per capita annual income statistics for 2010 to 2018 are shown in **Table 3–37**.

Table 3–37. Per Capita Annual Personal Income

County	*Per Capita Income ($)*	
	2010	*2018*
Anderson	34,585	41,853
Knox	37,542	49,738
Loudon	36,759	48,491
Roane	32,984	40,980
ROI (Average)	**35,468**	**45,265**
Tennessee	35,835	46,900

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Source: BEA 2019a, 2019b.

3.2.13.3 Community Services

Key community services in the ROI include education, law enforcement, fire protection, and medical services. Seven school districts with 149 schools provide public education services and facilities in the ORNL ROI. Educational services are provided for about 86,715 students by an estimated 5,428 teachers for the 2018-2019 school year (NCES 2020). The student-to-teacher ratio in these school districts ranges from a high of 16.4:1 in the Knox County School District to a low of 13.9:1 in the Oak Ridge School District. The average student-to-teacher ratio in the ROI was 16:1 (NCES 2020).

The counties within the ROI include 83 fire departments and fire stations that employ about 1,112 firefighters (601 full-time, 180 part-time, and 331 volunteer). This includes 4 fire stations in the City of Oak Ridge that employ 70 full-time firefighters and 4 part-time firefighters; and 1 fire station at ORNL that employs 40 full-time firefighters (Fire Department 2020).

The counties within the ROI include 1,070 law enforcement officers: 583 employed by the counties' sheriff departments; 487 employed by the city police departments of Knoxville (in Knox County), Clinton, and Oak Ridge; and 55 employed in Anderson County and Lenoir City in Loudon County (FBI 2020a, 2020b).

There are 15 hospitals that serve residents of the ROI with the majority located in Knox County (12). These hospitals have a total bed capacity of 2,195 persons (Tennessee Hospital Association 2020).

3.2.13.4 Public Finance

A 2018 study examined DOE's economic impact on the State of Tennessee based on data and analysis from FY 2017 (DOE 2018g). It looked at the direct effects of DOE investment, including payroll disbursements, pensions, taxes paid, charitable giving, and the indirect ripple effects of this spending within East Tennessee and the ORNL ROI. The study indicates that ORR is critical to the State's economic success.

For each job created and dollar paid by DOE, multiple jobs and additional tax revenue are generated in the State. In total, DOE's economic impact in Tennessee is $5.6 billion and supports more than 34,000 jobs, with a workforce spanning 50 of Tennessee's 95 counties. Key economic impact findings at the State level include:

- DOE and its major contractors directly created 12,618 full-time jobs, with annual wages and salaries totaling more than $1 million. For every one job created by DOE and its contractors, an additional 1.7 jobs were created across the State (12,618 direct employment; 21,878 created by multiplier effect of DOE investment).
- Tennessee's gross domestic product increased by over $3.3 billion as a result of direct and indirect effects of DOE expenditures as follows: $1.5 billion in payroll spending (46 percent), including just over $1 billion in direct payroll spending; over $200 million in pension disbursement (6 percent), including just over $137 million in direct pension disbursement; and $1.6 billion in non-payroll spending (49 percent), all indirect spending.
- DOE spending supports private-sector businesses. Of the more than $1.1 billion in non-payroll (direct procurement) spending from DOE and its contractors, more than $943 million went to Tennessee businesses for the procurement of raw materials, services, and supplies. The majority of DOE spending occurred in three counties within the ROI: Anderson (51 percent), Knox (29 percent), and Roane (7 percent).
- DOE-related spending generated over $32 million in State and local tax revenue. A portion of these tax dollars enable the City of Oak Ridge to provide critical infrastructure to support DOE missions and fund schools and education programs.
- DOE's spending in Oak Ridge creates high quality jobs throughout East Tennessee. The annual salary for a DOE employee of $81,000 is significantly above the Statewide average ($51,344 in 2016).

Local Fiscal Characteristics (City of Oak Ridge)

The City of Oak Ridge's general fund revenues and expenditures for FY 2017 and anticipated revenues and expenditures for FY 2019 are presented in **Table 3–38**. The general fund supports the ongoing operations of local governments as well as community services, such as police protection and parks and recreation. The largest revenue sources have traditionally been local taxes (which include taxes on property, real estate, hotel/motel receipts, and sales) and intergovernmental transfers from the Federal or State government. Roughly 92 percent of the 2017 general fund revenue came from these combined sources (City of Oak Ridge 2019). For FY 2019, the property tax rate is $2.54 per $100 of assessed value. The assessment rate is 40 percent for industrial and commercial property and 25 percent for residential property (City of Oak Ridge 2019). The city receives a payment-in-lieu-of-tax for ORR acreage that falls within the city limits. The payment is based on its value as farmland and assessed at the farmland rate of 25 percent. In 2019, the city expects DOE PILOT funds and grants of about $2,022,543 (City of Oak Ridge 2019). The Roane County tax rate was $2.35 per $100 of assessed value in 2017 (City of Oak Ridge 2019).

Table 3–38. City of Oak Ridge Revenues and Expenditures (in 2017 and 2019)

	2017 Actual (in dollars)	*2019 Budgeted (in dollars)*
Revenues		
Taxes	$33,987,182	$34,934,413
Licenses and Permits	306,359	307,500
Intergovernmental Revenues	4,027,393	3,943,490
Charges for Services	1,232,188	1,175,532
Fines and Forfeitures	364,740	344,500
Other	$625,133	654,762
Grants	953,970	1,918,065
Total Revenues	41,497,965	43,278,262
Expenditures and Other Financing		
Expenditures	21,658,072	24,177,407
Other Financing Uses [a]	19,259,617	19,466,238
Total Expenditures and Other Financing	**$40,917,689**	**$43,643,645**

[a] Includes items such as capital projects fund, solid waste fund, economic diversification fund, debt service, and schools.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: City of Oak Ridge 2019.

3.2.14 Environmental Justice

The ROI for environmental justice is the area within a 50-mile radius of the proposed project area. The 50-mile radius was selected because it is consistent with the ROI for evaluating human health impacts from radiological emissions. The potentially affected area includes parts of 31 counties throughout Tennessee, Kentucky, and North Carolina within the 50-mile radius of the site.

Discussion of the regulatory environment; definitions of minority, low-income, and minority and low-income populations; and a description of meaningfully greater populations for environmental justice concerns is provided in Section 3.1.14 for INL. In accordance with those earlier definitions, minority and low-income populations for ORNL are present when either (a) the total number of minority or low-income individuals of the affected area exceeds 50 percent of the overall population in the same area, or (b) the total number of minority or low-income individuals within the affected area is meaningfully greater (e.g., 120 percent greater) than the minority or low-income population percentage in an appropriate comparison unit of geographic analysis.

Minority and Low-Income Populations

Selection of units of analysis focus on geographic units (i.e., block groups) that represent, as closely as possible, the potentially affected areas. Refer to Section 3.1.14 for further discussion.

In order to evaluate the potential impacts on populations in closer proximity to the proposed project area at ORNL, radial distances of 5, 10, and 20 miles are analyzed. **Table 3–39** shows the composition of the ROI surrounding the proposed project area at each of these distances.

Table 3–39. Total Minority and Low-Income Population within 50 miles of Oak Ridge National Laboratory

Population Group	Within 5 Miles		Within 10 Miles		Within 20 Miles		Within 50 Miles	
	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total
Total Population	9,648	100.0	129,979	100.0	480,103	100.0	1,229,361	100.0
Nonminority	8,602	89.2	113,139	87.0	415,389	86.5	1,089,401	88.6
Total Minority	1,046	10.8	16,840	13.0	64,714	13.5	139,960	11.4
White - Hispanic/Latino	174	1.8	4,986	3.8	15,038	3.1	33,085	2.7
Black/African American [a]	335	3.5	4,069	3.1	23,214	4.8	54,847	4.5
American Indian or Alaska Native [b]	1	0.0	203	0.2	1,260	0.3	4,692	0.4
Other Minority [a, b]	536	5.6	7,582	5.8	25,202	5.2	47,336	3.9
Low Income	1,008	10.4	13,688	10.5	64,165	13.4	195,925	15.9

[a] Includes persons who also indicated Hispanic or Latino origin.

[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races. None of these other groups individually exceed 3 percent of the total population at any distance.

Source: Census 2017a, 2017b.

Minority populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within 50 miles of ORNL. If a block group's percentage of minority individuals met the 50 percent criterion or was more than 120 percent of the total minority population of the percentage within the 31-county comparison population, then the area was identified as having a minority population. The total population residing in the 31-county comparison population is about 1,611,861, of which 11.1 percent would be considered members of a minority population; therefore, the meaningfully greater criterion for minority populations is 13.4 percent. Of the 766 block groups within the ROI, 22 block groups have individual racial group minority populations or aggregate minority populations that meet the 50 percent criterion, and 204 block groups meet the meaningfully greater criterion for one or more racial groups.

The overall composition of the projected populations within every radial distance is predominantly nonminority. The concentration of minority populations is greatest within the 20-mile radius. The Black or African American and Hispanic or Latino populations are the largest minority group within every radial distance, constituting 4.3 and 3.6 percent of the total population within 50 miles, respectively. **Figure 3–19** displays the block groups identified as meeting the criteria for environmental justice minority populations surrounding ORNL, as well as population density of minority populations within each block group.

As with minority populations, low-income populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within 50 miles of ORNL. If a block group's percentage of low-income individuals met the 50 percent criterion or was more than 120 percent of the percentage of the total low-income population within the 31-county comparison population, then the area was identified as having a low-income population. Of the total population residing in the 31-county ORNL comparison population, about 18 percent are identified as living below the poverty line; therefore, the meaningfully greater criterion for low-income populations is 21.6 percent. Of the 766 block groups within the ROI, 26 block groups have a low-income population that exceeds the 50 percent criterion, and a total of 224 block groups meet the 120 percent criterion for low-income populations. **Figure 3–20** displays the block groups identified as meeting the criteria for environmental justice low-income populations surrounding ORNL, as well as population density of low-income populations within each block group.

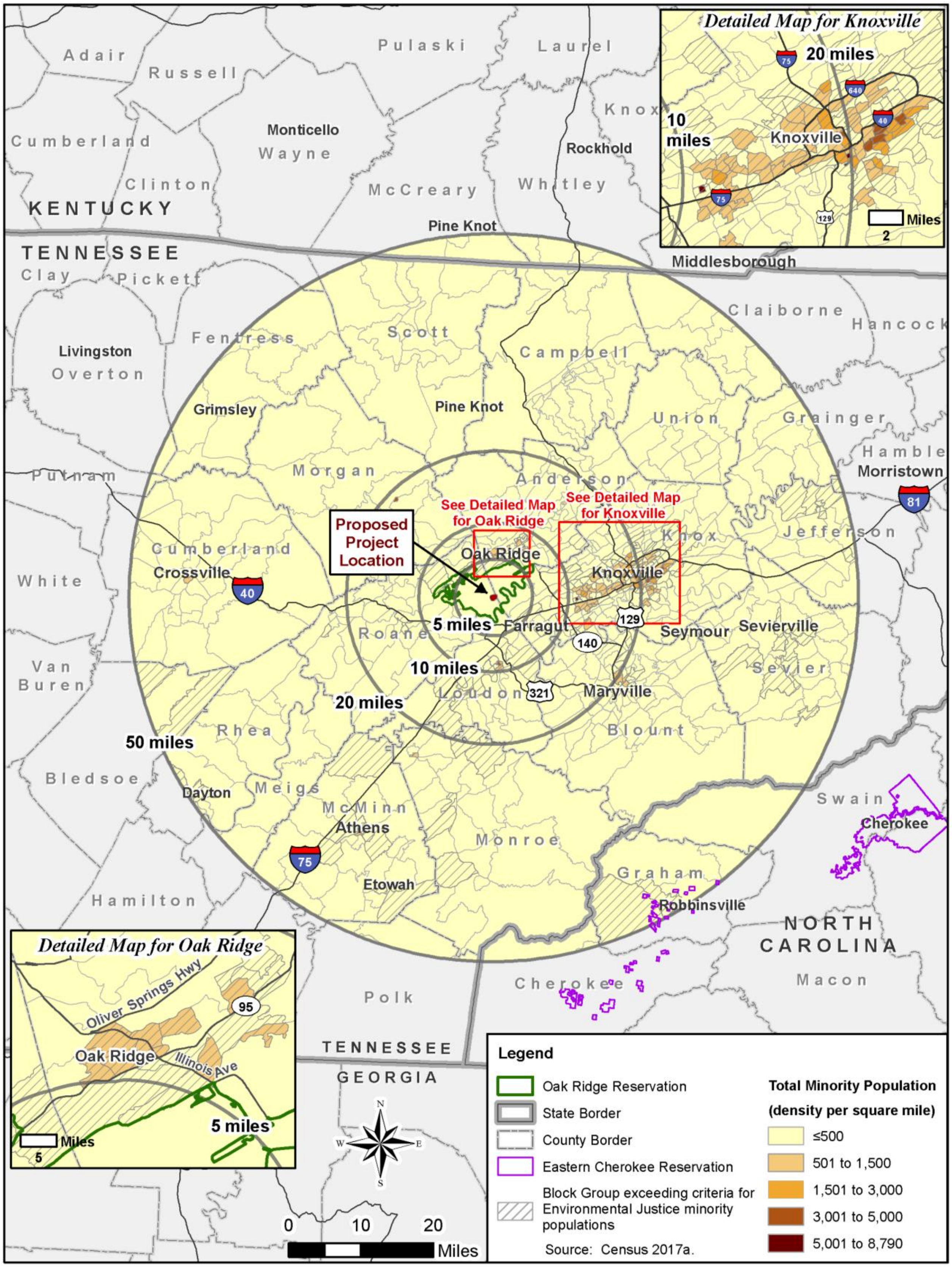


Figure 3–19. Locations of Block Groups Meeting the Criteria for Environmental Justice Minority Populations

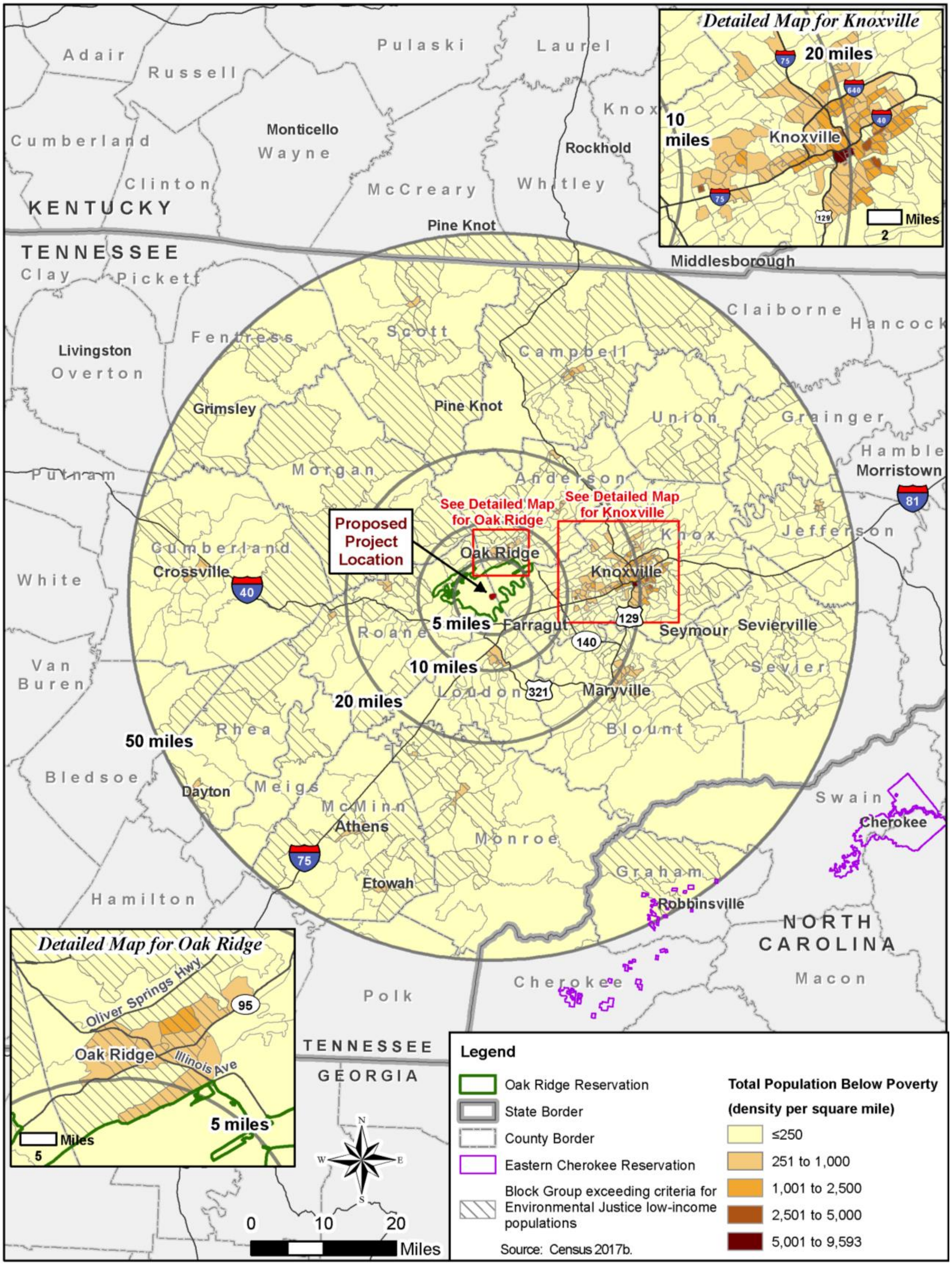


Figure 3–20. Locations of Block Groups Tracts Meeting the Criteria for Environmental Justice Low-Income Populations

3.3 Savannah River Site

3.3.1 Land Use and Aesthetics

The ROI for land use consists of SRS and land immediately adjacent, including portions of the three-county region where the site is located. Other regional land uses are described because they can be included in the ROI for other aspects of this affected environment.

3.3.1.1 Land Use at Savannah River Site

SRS is located on a 310-square mile (198,344-acre) parcel of land in southwestern South Carolina in a generally rural area about 25 miles southeast of Augusta, Georgia, and 12 miles south of Aiken, South Carolina, the nearest population centers. SRS is bordered by the Savannah River to the southwest and includes portions of three South Carolina counties: Aiken, Allendale, and Barnwell. SRS is a controlled area, with public access limited to through traffic on State Highway 125 (SRS Road A), U.S. Highway 278 (SRS Road 1), and a CSX railway line (DOE 1999b:3-163; SRNS 2019a:1-5).

DOE either owns or controls all SRS land. Specific uses of SRS land are determined by the missions established for DOE and other missions or uses established by Congress. DOE requires that any land no longer required for SRS missions be made available for public use (SRNS 2014:5). About 86 percent of the total land on SRS is a buffer zone or natural and managed forest land, and the remaining 14 percent is either industrial area (7 percent) or areas reserved for the DOE Research Set-Aside Program (7 percent). SRS consists of four major forest types: 1) mixed pine-hardwood, 2) sandhills pine savanna, 3) bottomland hardwood, and 4) swamp floodplain forest. These forests are accessible to the public when visiting the Crackerneck Wildlife Management Area and Ecological Reserve near Jackson, South Carolina (SRNS 2019a:1-7).

The USFS conducts a comprehensive natural resource management program for SRS under an interagency agreement. Under this agreement, the USFS manages timber production on about 149,000 acres on SRS. Other management activities covered under this agreement include wildland fire suppression, threatened and endangered species restoration, invasive species control, habitat management, watershed management, boundary maintenance, management of secondary roads, and related research (SRNS 2014:10).

Public hunts for white-tailed deer (*Odocoileus virginianus*), feral hogs (*Sus scrofa*), wild turkeys (*Meleagris gallopavo*), and coyote (*Canis latrans*) are allowed on site. In 2018, public hunts harvested 275 deer, 66 hogs, 14 coyotes, and 27 turkeys (SRNS 2019a:5-30).

Soil map units that meet the requirements for prime farmland soils exist on SRS. However, the USDA NRCS does not identify these as prime farmlands because the land is not available for agricultural production (DOE 1999b:3-163–165).

Decisions on future land uses at SRS are made by DOE through site development, land use, and future planning processes. SRS has established a Land Use Technical Committee that is composed of representatives from DOE, the management and operating contractor, and other SRS organizations (DOE 1999b:3-165). DOE has prepared a number of documents addressing the future of SRS, including the *Savannah River Site End State Vision* (SRS 2005), *Savannah River Site Comprehensive Plan/Ten Year Site Plan, Fiscal Year 2011-2020* (SRNS 2010), *Savannah River Site Ten Year Site Plan, Fiscal Year 2016 – 2025* (SRNS 2015a), and *SRS Environmental Management Program Management Plan* (DOE 2016c). As noted in these documents, the Environmental Management Cleanup Project and mission will be complete by 2065 and ongoing National Nuclear Security Administration (NNSA) nuclear industrial missions will continue. SRS is a site with an enduring mission and is not a closure site; thus, SRS land will be federally owned, controlled, and maintained in perpetuity (SRNS 2015a:1-4; SRS 2005:4).

As depicted in **Table 3–40** and **Figure 3–21**, SRS is divided into six land use management areas, based on existing biological and physical conditions, operational capability, and suitability for mission objectives. The 38,300-acre Industrial Core Management Area contains the major SRS facilities. The primary objective of this area is to support facilities and site missions. Other important objectives are to promote conservation and restoration, provide research and educational opportunities, and generate revenue from the sale of forest products. Protection of the red-cockaded woodpecker (*Picoides borealis*) dominates natural resource decisions in the 87,200-acre Red-cockaded Woodpecker Management Area and the 47,100-acre Supplemental Red-cockaded Woodpecker Management Area (DOE 2019f:3-6). The Crackerneck Wildlife Management Area and Ecological Reserve is 11,000 acres and is managed by the South Carolina Department of Natural Resources (SCDNR) (SCDNR 2016). The primary objective of this management area is to enhance wildlife habitat through forestry and wildlife management practices. The management objective of the 9,900-acre Savannah River Swamp and 4,300-acre Lower Three Runs Corridor Management Area is to improve the physical and biological quality of the wetland environment (DOE 2019f:7).

Table 3–40. Savannah River Site Management Area Descriptions

Management Area	*Name*	*Size (acres)*	*Primary Functions*	*Facility Areas*
1	Industrial Core Management Area	38,300	SRS facility operations	B, C, D, E, F, H, N, S, T
2	Red-Cockaded Woodpecker Management Area	87,200	Protection of the red-cockaded woodpecker	None
3	Supplemental Red-Cockaded Woodpecker Management Area	47,100	Protection of the red-cockaded woodpecker; reintroduction of native savanna species	A, L, K, P, R, RR, Z
4	Crackerneck Wildlife Management Area and Ecological Reserve	11,000	Enhance wildlife habitat	None
5	Savannah River Swamp Management Area	9,900	Wetland improvement; limited natural resource management	None
6	Lower Three Runs Corridor Management Area	4,300	Wetland improvement; limited natural resource management	None

Source: DOE 2019f.

In 1972, SRS was designated as a National Environmental Research Park. The purpose of the National Environmental Research Park is to provide research and education activities that assess and document environmental effects associated with energy and weapons material production. Park staff explores methods for eliminating or minimizing adverse effects of energy development and nuclear materials on the environment and train others in ecological and environmental sciences (Rhodes 2018). DOE has also established a set-aside program to provide reference areas for understanding human impacts on the environment. The SRS set-aside program currently contains 30 research reserves totaling 14,006 acres and represents 7 percent of total SRS land. These reserves were chosen as representatives of the eight major vegetation communities on the site (SREL 2019).

No areas on SRS are subject to American Indian treaty rights. However, six American Indian groups, the Yuchi Tribal Organization, the National Council of Muskogee Creek, the Indian Peoples Muskogee Tribal Town Confederacy, the Pee Dee Indian Association, the Ma Chis Lower Alabama Creek Indian Tribe, and the United Keetoowah Band of Cherokee Indians have expressed concern over sites and items of religious significance on SRS. DOE routinely notifies these organizations about major planned actions at SRS and asks them to comment on SRS documents prepared in accordance with NEPA (DOE 1999b:5-15).

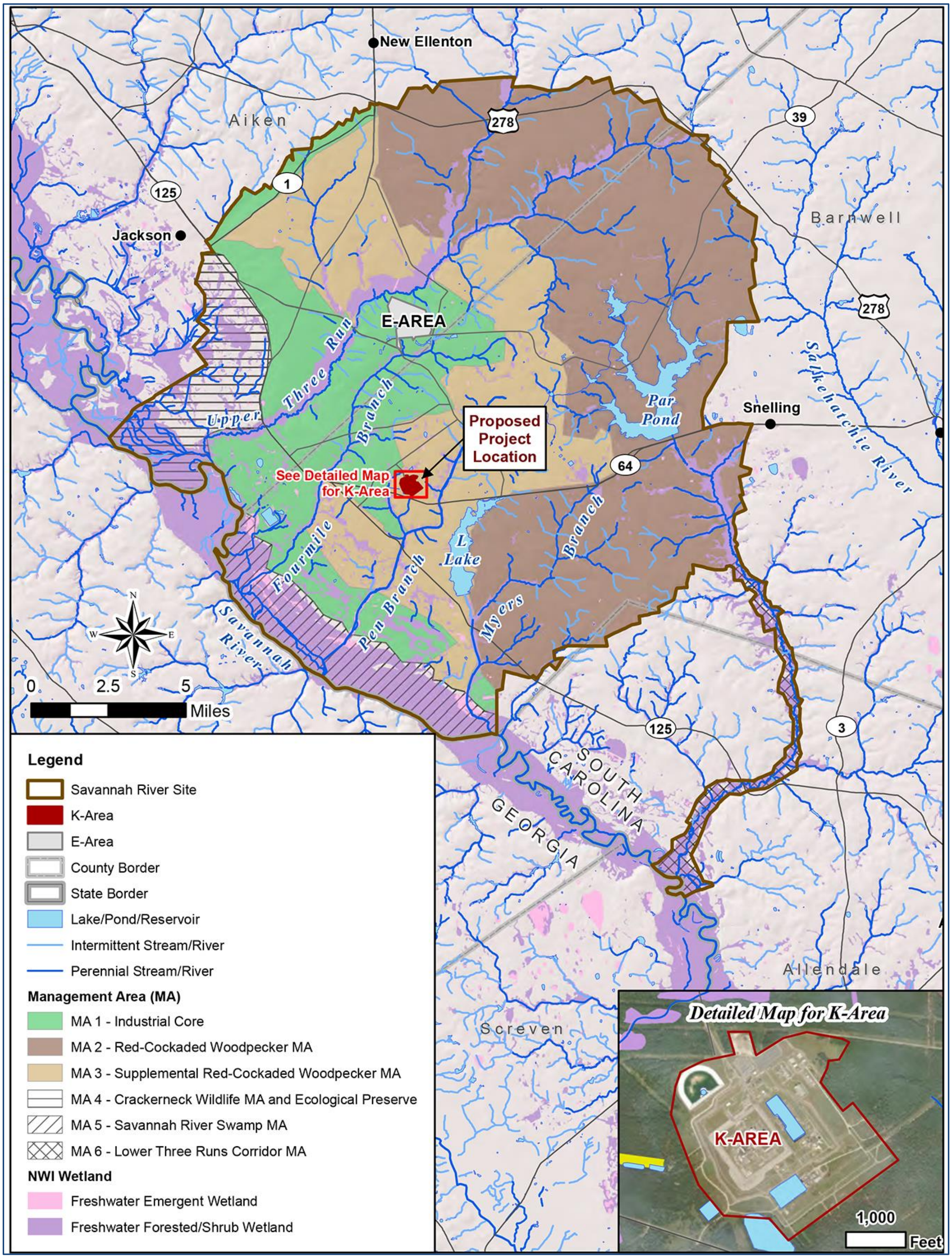


Figure 3–21. Savannah River Site Management Areas

Land Use at Proposed Facility Location (K Area)

The location of the facility at SRS that would support the VTR project is known as K Area. K Area is a 3,558-acre area situated near the center of SRS and located just outside of the Industrial Core Management Area within the Supplemental Red-Cockaded Woodpecker Management Area. The area is 5.5 miles from the site boundary. K Area was one of five SRS reactor areas with the original mission of producing material for the U.S. nuclear weapons program for four decades during the Cold War. However, the K Area production reactor is shutdown with no restart capability. The K Area Material Storage Area is located in the K Area Complex, which is used by the NNSA to safely store non-pit plutonium awaiting disposition. NNSA also uses the K Area Complex to perform inspections to confirm the safe storage of plutonium and to dilute plutonium in order to prepare it for disposal as transuranic waste at the WIPP facility near Carlsbad, New Mexico (SRNS 2010:3-85; SRNS 2019a).

Regional Land Use

Predominant regional land uses in the vicinity of SRS include urban, residential, industrial, agricultural, and recreational. SRS is bordered largely by forest and agricultural land, with limited urban and residential development. The nearest residential areas are located to the west, north, and northeast, some within 200 feet of the SRS boundary (NRC 2005a:3-36). Farming and livestock production is diversified throughout Aiken, Allendale, and Barnwell Counties and includes such crops as corn, hay, peanuts, cotton, and winter wheat. Agricultural production in these three counties represents 7 percent of South Carolina's total production (USDA 2019b). Industrial areas are also present within 25 miles of the site; industrial facilities include textile mills, polystyrene foam and paper plants, chemical processing plants, the Barnwell LLW facility, and the Vogtle Electric Generating Plant (a commercial nuclear power plant). Open water and nonforested wetlands occur along the Savannah River Valley. Recreational areas within 50 miles of SRS include Sumter National Forest, Santee National Wildlife Refuge, and J. Strom Thurmond Reservoir (also known as Clarks Hill Lake). State, county, and local parks include Redcliffe Plantation State Historic Site, Battle of Rivers Bridge State Historic Site, Barnwell State Park, and Aiken State Park in South Carolina, and Mistletoe State Park in Georgia. The Crackerneck Wildlife Management Area and Ecological Reserve occupies a portion of SRS along the Savannah River and is open for hunting and fishing only during designated dates and times when public access is tightly controlled (SCDNR 2016).

The State of South Carolina Councils of Governments were formed in 1967, when the State was divided into 10 planning districts, with the goal of coordinating cooperative development among local governments. Six counties are included in the Lower Savannah River Planning District, including Aiken, Allendale, and Barnwell Counties, the three counties within which SRS is located (SCARC 2019). Private lands bordering SRS are subject to the planning regulations of these three counties (DOE 1999b:3-163).

3.3.1.2 Aesthetics at Savannah River Site

Aesthetics consider natural and manmade features that provide a particular landscape its character and visual quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape and, they exert varying degrees of influence. Landscapes are aesthetically pleasing when they offer a harmonious balance of multiple inviting elements in a natural composition (DOE 1999b:3-166). The ROI for aesthetics would include SRS and areas that are located within the view of industrial areas at SRS. Assessment of the aesthetics in this EIS follows the BLM Visual Resource Management guidelines (BLM 1986). The guidelines are discussed in Section 3.1.1, Land Use and Aesthetics for the INL Site.

General Site Description

The dominant viewshed at and in the vicinity of SRS consists mainly of agricultural land and forest, with some limited residential and industrial areas. The SRS landscape is characterized by wetlands and upland hills. Vegetation includes bottomland hardwood forests, scrub oak and pine forests, and forested wetlands. Facilities are scattered throughout SRS and are brightly lit at night. These facilities are generally not visible off site, as views are limited by rolling terrain, normally hazy atmospheric conditions, and heavy vegetation. The only areas visually impacted by the DOE facilities are those within the view corridors of State Highway 125 and U.S. Highway 278 (DOE 1999b:3-166).

Developed areas and utility corridors (e.g., transmission lines and aboveground pipelines) of SRS are consistent with a VRM Class IV designation. The remainder of SRS is consistent with a VRM Class II or Class III designation. Management activities within Class II and Class III areas may be seen but do not dominate the view; management activities in Class IV areas dominate the view and are the focus of viewer attention (BLM 1986:6, 7).

Aesthetics at K Area

Industrial facilities within K Area consists of large concrete structures, smaller administrative and support buildings, trailers, and parking lots. The structures range in height from 10 to 100 feet, with a few stacks and towers that reach up to 200 feet. The facilities in these areas are brightly lit at night and visible when approached via SRS access roads (DOE 1999b:3-164). Visual resource conditions in the proposed facility location is consistent with a VRM Class IV designation. K Area is about 1.2 miles from State Highway 125 and 10 miles from U.S. Highway 278. Heavily wooded areas and the nature of the terrain bordering segments of State Highway 125 and U.S. Highway 278 restrict public views of facilities within K Area. Moreover, facilities are not visible from the Savannah River, which is about 5.5 miles from any of industrialized area at SRS (DOE 1999b:3-166).

3.3.2 Geology and Soils

The ROI for geology and soils includes SRS and K Area. SRS is located in the Atlantic Coastal Plain physiographic province (DOE 2015a:3-7). Elevations at SRS range from 420 feet above mean sea level in the northwest part of the site to about 80 feet above mean sea level along the Savannah River to the south (DOE 2016a:10-11).

3.3.2.1 Geology

The Atlantic Coastal Plain sediments at SRS are about 600 to 1,400 feet thick (DOE 2002b:3-1). The sedimentary sequence consist of sand, silt, clay, limestone, and conglomerate ranging in age from Late Cretaceous to Holocene (DOE 2016a:10-12). The youngest deposits on SRS are fine to coarse sands associated with Savannah River stream terraces and tributary stream alluvium. The loosely consolidated Atlantic Coastal Plain sediments are located above bedrock that consists of Paleozoic-age metamorphic and igneous rock (e.g., schist and granite), and Triassic-age sedimentary rock (e.g., siltstone and sandstone) of the Dunbarton Basin (DOE 2015a:3-7). The geology of the region and SRS are described in more detail in Section 3.1.2.1 of the *Surplus Plutonium Disposition Supplemental EIS* (DOE 2015a) and by Denham (1999).

Geologic conditions in K Area are consistent with those found throughout SRS, including the occurrence of "soft zones" (i.e., areas of sand containing calcium carbonate subject to dissolution by water, encountered in boreholes throughout SRS). Soft zones at SRS are limited in areal extent, less than about 15 feet thick, and are poorly interconnected. The most well-developed soft zone in K Area is about 50 feet wide by 200 feet long (DOE 2015a:3-9).

3.3.2.2 Soils

The Natural Resources Conservation Service identified 28 soil series occurring on SRS, grouped into seven broad soil associations. Generally, sandy soils that are well drained occupy the uplands and ridges, and loamy-clayey soils that are poorly to moderately well drained occupy the stream terraces and floodplains

(Rogers 1990:62-82, 127). The soils at SRS are considered acceptable for standard construction techniques (DOE 1999b:3-151).

Most soils within the fence lines of K Area have been disturbed to accommodate buildings, parking lots, and roadways. Disturbed soils within these areas are considered to be urban land where covered by structures or udorthents (NRCS 2018). Udorthents are well-drained, heterogeneous soil materials that are the spoil or refuse from excavations and major construction activities, and they are often heavily compacted (Rogers 1990:79). Undisturbed soils near K Area are classified as the Fuquay–Blanton–Dothan Association. These soils are nearly level to sloping and are well drained. Soils along the Pen Branch floodplain are classified as the Vaucluse-Ailey Association. These soils are sloping and strongly sloping soils of low permeability (DOE 2015a:3-10). Four soil map units near K Area could be classified as prime farmland (NRCS 2018; Rogers 1990:43-44, 62-82, 127). However, USDA's NRCS does not identify these lands as prime farmland because they are not available for agricultural use (NRC 2005a:3-5).

3.3.2.3 Geologic and Soil Resources

The mixed sands, gravels, and clays commonly found beneath SRS are widespread and, therefore, are of limited commercial value. A possible exception might be well-sorted quartz sand, which is valuable as a filtration medium, an abrasive, or an engineering backfill. No sizable, economically valuable deposits of quartz sand are evident at the surface or in the shallow subsurface in K Area (DOE 2015a:3-9, 3-10).

3.3.2.4 Geologic Hazards

Seismic Hazards

Geophysical studies have identified seven subsurface faults beneath SRS. The actual faults do not reach the surface, stopping at least several hundred feet below grade (DOE 2015a:3-8). None of the fault systems at SRS is considered "capable" (as defined in 10 CFR Part 100) because there has been no movement along these faults that can be traced to the ground surface in the past 35,000 years (DOE 2016a:10-15). The only known faults within a 200-mile radius of SRS capable of producing a significant earthquake are within the Charleston, South Carolina, seismic zone (located about 70 miles southeast of SRS) (NRC 2005a:3-4).

The Charleston earthquake of 1886 (estimated Richter scale magnitude of 6.8) is the most damaging earthquake known to have occurred in the southeastern United States and one of the largest historic shocks in eastern North America. At SRS, this earthquake had an estimated Richter scale magnitude ranging from 6.5 to 7.5. The SRS area experienced an estimated peak ground acceleration (PGA) of 0.10 g (one-tenth the acceleration of gravity) during this event (DOE 2015a:3-8). Paleoliquefaction features indicate that the Charleston-type earthquake has reoccurred at least 7 times in the last 6,000 years. The paleoliquefaction features were produced by earthquakes with magnitudes between 5.3 and 7.8 (NRC 2005b:1-16).

The U.S. Geological Survey reported 88 earthquakes greater than magnitude 2.5 occurred within 100 miles of the SRS K Area between January 1973 and October 2019. Only 1 of the 88 earthquakes had a magnitude greater than 4.5. A magnitude 4.7 event occurred 90 miles east-southeast of K Area on November 22, 1974 (USGS 2019a). Earthquakes capable of producing structural damage are not likely to originate in the vicinity of SRS (DOE 1999b:3-149).

Earthquake-produced ground motion is expressed in units of percent g (acceleration relative to that of the Earth's gravity). PGA data from the U.S. Geological Survey are used to indicate seismic hazard. At K Area, the calculated PGA is based on an earthquake with a 2 percent probability of exceedance in 50 years (an annual occurrence probability of 1 in 2,500) and is about 0.16 g (USGS 2014a, 2014b).

Volcanic Hazards

There are no volcanic hazards at SRS. The area has not experienced volcanic activity within the last 230 million years. Future volcanism is not expected because SRS is located along the passive continental margin of North America (DOE 1999b:3-151).

Slope Stability, Subsidence, and Liquefaction

Soils at SRS are subject to erosion, although slope instability has not been a significant regional issue (NRC 2005a:3-5). Because the land at K Area is relatively flat, slope instability is not expected.

Dissolution of the carbonate materials in the soft zones is so slow (if it is occurring at all) that it is not expected to affect any present or future SRS facility. Because of the depth of the soft zones, there are no static stability issues, but a conservative analysis was performed, assuming that the arches supporting the soft zones would lose strength during a seismic event and result in surface subsidence. Estimates of the total potential ground surface settlements from design-basis earthquake loading of the soft zones were between 1.4 and 1.75 inches at K Area (DOE 2015a:3-8, 3-9).

No evidence of seismically induced liquefaction has been discovered at SRS (NRC 2005b:1-24, 1-25). Previous studies at other SRS sites (e.g., F-Area) found the liquefaction susceptibility of soils to be low because of their low clay content and liquid limit and because earthquakes at SRS historically do not have the shear wave velocities required to cause liquefaction of soils (DOE 2016a:10-17).

3.3.3 Water Resources

The ROI for water resources at SRS includes the Savannah River and the groundwater present beneath and downstream of the site. This section describes SRS surface and groundwater resources in general and provides specific information regarding water availability and quality. Wastewater, stormwater, and flooding potential are discussed.

South Carolina's State Safe Drinking Water Act (Title 44 Chapter 55 of South Carolina Code of Laws) and South Carolina Department of Health and Environmental Control (SCDHEC) Regulation 61-58 outline state drinking water standards and constituent standards for groundwater.

3.3.3.1 Surface Water

3.3.3.1.1 Natural Water Features

The Savannah River is the principal surface water feature in the region, forming the southwestern border of SRS for about 35 miles (WSRC 2006a). The Savannah River reach along the SRS boundary has a wide channel, numerous tributaries, and extensive floodplain swamps (WSRC 2006b). Five major watershed tributaries of the Savannah River Basin within SRS discharge into the Savannah River: Upper Three Runs, Beaver Dam Creek, Fourmile Branch, Steel Creek, and Lower Three Runs. Pen Branch is also a major stream at SRS, but it does not flow directly into the Savannah River (DOE 2002d). No streams or tributaries at SRS are federally designated Wild and Scenic Rivers or State-designated Scenic Rivers (NPS 2019).

Additionally, there are about 300 natural Carolina bays at SRS. Carolina bays, a type of wetland unique to the southeastern United States, are natural shallow depressions that occur in interstream areas where they collect surface and groundwater. No direct effluent discharges from SRS are released into the Carolina bays. However, they do receive stormwater runoff (NRC 2005a).

Surface water samples are collected monthly and quarterly from 11 onsite streams and 5 locations along the Savannah River. About 85 percent of the samples collected in 2018 met South Carolina Freshwater Quality Standards (SRNS 2019a).

3.3.3.1.2 Fabricated Water Features

There are two fabricated lakes at SRS: L-Lake (which discharges to Steel Creek) and Par Pond (which discharges to Lower Three Runs). Additionally, there are about 50 other small, fabricated ponds at SRS.

3.3.3.1.3 Surface Water Quality

The Savannah River, except for sections of the river near the coast, and all streams located within SRS are classified as "freshwater" (Class FW) that are suitable for primary- and secondary-contact recreation, drinking water supply (after appropriate treatment), fishing, industrial purposes, and agricultural uses (SRNS 2019a). The nearest downstream water intake is the Beaufort-Jasper Water and Sewer Authority's (BJWSA) Purrysburg Water Treatment Plant, which is about 90 river miles and 78.5 hours of river travel time from the easternmost extent of the SRS boundary. The BJWSA is permitted to withdraw 100 million gallons of water per day. The treatment plant produces about 15 million gallons of water per day for Beaufort and Jasper Counties, South Carolina (City of Hardeeville 2009). This production rate is well within the plant's capacity of up to 39 million gallons of water per day (BJWSA 2019).

3.3.3.1.4 Wastewater and Storm Water

In accordance with NPDES permits, industrial wastewater and stormwater samples are collected from outfalls located across SRS for nonradiological monitoring. A total of 28 industrial wastewater outfalls and 39 industrial stormwater outfalls were monitored in 2018. All samples collected from industrial wastewater outfalls met NPDES permit requirements, and only one outfall, located in N-Area, exceeded benchmark limits for industrial stormwater (SRNS 2019a). A summary of K Area outfalls is presented in **Table 3–41**.

Table 3–41. Summary of K Area Outfalls Sampled in 2018

Outfall	*Receiving Stream*	*Drainage (acres)*	*Type*
K-02	Pen Branch	2.55	Industrial stormwater
K-06	Indian Grave Branch	0.02	Industrial wastewater
K-12		None	
K-18		5.1	

Source: DOE 2007; SCDHEC 2003; SRNS 2012b, 2019a.

The SCDHEC is the regulatory authority for the physical properties and concentrations of chemicals and metals in SRS effluents under the NPDES program. In 2018, SRS held 11 Clean Water Act permits (see Section 7.2.3). SRS stormwater runoff permits require the implementation and maintenance of approved best management practices to assure that SRS stormwater discharges do not impair the water quality of receiving water resources (DOE 2007).

Industrial wastewater monitoring results are reported to SCDHEC through monthly discharge monitoring reports. SRS industrial wastewater outfalls were 100 percent compliant with NPDES permit requirements in 2018 (SRNS 2019a).

3.3.3.1.5 Floodplains and Wetlands

SRS wetlands, most of which are associated with floodplains, streams, and impoundments, include bottomland hardwood, cypress-tupelo, scrub-shrub, emergent vegetation, Carolina bays, and open water. Bottomland hardwood forest is the most extensive wetlands vegetation type along the Savannah River (DOE 1999b).

DOE Order 420.1B outlines the requirements for natural phenomena hazard (including flood events) mitigation for new and existing DOE facilities. In 2000, SRS was required to determine flood elevations as a function of return period for up to 100,000 years and to determine the flood recurrence intervals for

SRS facilities. The facility-specific probabilistic flood hazard curve defines the annual probability of occurrence (or the return period in years) as a function of water elevation. The calculated results in 2000 of the probabilistic flood hazard curve illustrated that the probabilities of flooding in K Area are significantly less than 0.00001 per year (WSRC 2000).

The majority of land within the K Area has been developed for industrial use. As a result, no wetlands currently exist within this location, although fabricated impoundments occur throughout the developed portions of this area, including a large impoundment adjacent to the main processing building at the K Area Complex.

3.3.3.2 Groundwater

3.3.3.2.1 Local Hydrology

Topography and lithology are major factors controlling the direction and relative rate of groundwater flow. Groundwater can flow in aquifers both horizontally and vertically to points of discharge such as streams, swamps, underlying aquifers, and sometimes to overlying aquifers. SRS is underlain by sediment of the Atlantic Coastal Plain, which consists of a southeast-dipping wedge of unconsolidated sediment that extends from its contact with the Piedmont Province at the fall line to the edge of the continental shelf. The sediment, existing as layers of sand, muddy sand, and clay with subordinate calcareous sediments, rests on crystalline and sedimentary basement rock. Water flows easily through the sand layers, but is slowed by less-permeable clay beds, creating a complex system of aquifers (WSRC 2007).

Groundwater recharge is a result of infiltration of precipitation at the land surface. The precipitation moves downward through the unsaturated zone to the water table. The depth to the water table varies throughout SRS. Upon entering the saturated zone at the water table, water moves predominantly in a horizontal direction toward local discharge zones along the headwaters and midsections of streams, while some water moves into successively deeper aquifers. Groundwater velocities at SRS range from several inches to several feet per year in aquitards and from tens to hundreds of feet per year in aquifers (WSRC 2007).

Although many different systems have been used to describe groundwater systems at SRS, for this EIS, the uppermost aquifer is referred to as the "water table aquifer." It is supported by the leaky "Green Clay" Aquitard, which confines (overlies) the Congaree Aquifer. Below the Congaree Aquifer is the leaky Ellenton Aquitard, which confines the Cretaceous Aquifer, also known as the Tuscaloosa Aquifer. In general, groundwater in the water table aquifer flows downward to the Congaree Aquifer or discharges to nearby streams. Flow in the Congaree Aquifer is downward to the Cretaceous Aquifer or horizontal to stream discharge or the Savannah River, depending on the location within SRS (DOE 1999b).

3.3.3.2.2 Subsurface Water Quality

To meet State and Federal laws and regulations, extensive groundwater monitoring is conducted around SRS waste sites and operating facilities, using about 3,000 monitoring wells. Major contaminants include volatile organic compounds, metals, and radionuclides. Groundwater quality varies across the site, but groundwater contamination has not been detected beyond SRS boundaries (DOE 1999b). All drinking water samples collected and analyzed by SRS and SCDHEC in 2018 meet the SCDHEC and EPA bacteriological and chemical drinking water quality standards (SRNS 2019a).

The water table at K Area is encountered at about 70 feet and flows in the southwest direction toward Indian Grave Branch at about 75 feet per year (WSRC 2008). Due to the historical treatment, storage, and disposal of chemical and radioactive waste byproducts of SRS nuclear material production, about 5 to 10 percent of SRS groundwater resources have been contaminated with radionuclides, industrial solvents, metals, and other chemicals. Groundwater contamination sites are primarily located in proximity to the reactor facilities (including K Area), the General Separations Area, and the waste management areas. For the reactor facilities, tritium and trichloroethylene are the primary contaminants identified in groundwater plumes; however, concentrations of other radionuclides, organics, and metals are also present. Groundwater from the K Area Seepage Basin, closed in 2002, migrates toward Pen Branch (SRNS 2019a). A 2007 evaluation by the U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry (ATSDR) determined that, based on existing conditions and operations, SRS posed no apparent public health hazard to surrounding communities from groundwater or surface water exposure (ATSDR 2007).

3.3.3.3 Drinking Water

SRS hydrology is complex due to heterogeneities in the vadose zone (i.e., the unsaturated area between the ground surface and the water table) and in the multilayer aquifer system (SRNS 2009). SRS's groundwater flow system is characterized by four major aquifers separated by confining units. All aquifers are defined as potential sources of drinking water by the South Carolina Pollution Control Act (WSRC 2008). None of these aquifers, however, is designated as a sole-source aquifer. A sole-source aquifer is defined as an aquifer that supplies at least 50 percent of the drinking water to the area above the aquifer (EPA 2011).

Groundwater withdrawn in and around SRS is used extensively for domestic, industrial, and municipal purposes. Groundwater is regularly withdrawn from the Cretaceous and water table aquifers (DOE 1999b).

Domestic and process water for SRS is supplied by water supply systems that use groundwater sources. SRS's domestic and process water systems are supplied from a network of about 40 production wells in widely scattered locations across the site, eight of which supply the primary drinking water system. No domestic water systems are located in K Area, but this area does contain process water systems.

3.3.3.4 Water Use and Rights

The South Carolina Groundwater Use and Reporting Act of 2000 and Surface Water Withdrawal, Permitting Use, and Report Act of 2010 mandate that any person withdrawing groundwater or surface water for any purpose in excess of 3 million gallons during any 1 month from a single or multiple wells or intakes under common ownership and within 1 mile of an existing or proposed well or intake must register with, annually report to, and be permitted by SCDHEC (SCDHEC 2005). SRS consumed about 2.49 million gallons of water per day in 2018 (SRNS 2019a). As such, SRS reports water use to SCDHEC, which compiles data from all registered and permitted users into an annual report. According to the 2018 annual report, 1,088 water withdrawers used more than 2.2 x 10^{13} gallons of surface and groundwater; the vast majority (over 91 percent) of these withdrawals were for hydroelectric purposes (SCDHEC 2019).

While SRS continues to consume large volumes of water, onsite water withdrawals have declined in recent years. Groundwater withdrawals were reduced by more than two-thirds, from 10.8 million gallons per day from 1983 to 1986 to 3.4 million gallons per day in 2010. Total annual water use was reduced by about 22 percent between 2008 and 2010 (from 2.3 billion gallons to 1.8 billion gallons) (SRNS 2011). Potable water consumption was reduced by about 17 percent through FY 2018 as compared to the base year of 2007 (SRNS 2019a). Facility shutdowns, site population reductions, and water supply system upgrades and consolidation have contributed to this observed reduction in water use demand.

SRS occupies portions of Aiken, Allendale, and Barnwell Counties within the Savannah River Basin. Primary tri-county water use categories for 2010 included irrigation, golf course, industrial, water supply, mining, and thermoelectric (SCDHEC 2011). For the tri-county area, surface water uses accounted for about 89 percent of total water withdrawals. Industrial (fabrication, processing, washing, in-plant conveyance and cooling) and thermoelectric (electricity generation from fossil fuel, biomass, solid waste, geothermal, or nuclear energy) sources accounted for about 23 and 73 percent of total surface water withdrawal, respectively. Water supply accounted for about 53 percent of total groundwater withdrawals. SRS primary water use categories related to the 2010 tri-county data would include industrial and water supply. For comparison, SRS total water withdrawals accounted for about 2 percent of the total reported water withdrawals for the tri-county area.

3.3.4 Air Quality

This section describes the existing air quality and climatic conditions of SRS. Aiken and Barnwell Counties encompass the portions of SRS affected by the proposed fuel fabrication action and, therefore, comprise the ROI for the project air quality analysis.

3.3.4.1 Meteorology and Climatology

Due to its southern latitude and location on the eastern side of North America, SRS experiences a humid subtropical climate. This climate is characterized by humid and hot summers, mild winters, and abundant precipitation during all months of the year.

During the warmer months of the year, SRS experiences frequent intense rain showers and thunderstorms. The remnants of tropical storms can produce substantial amounts of precipitation during late summer and early fall. During the colder months of the year, polar storms produce precipitation events that are of longer duration compared to summertime thunderstorms.

Climate and meteorological data collected at Barnwell (NCEI 2019a) and the Aiken area (National Weather Service 2019a), about 16 miles east and 20 miles north of the SRS K Area, respectively, are used to describe the climatic conditions of SRS. The average high and low temperatures at SRS in July are about 93 and 68 degrees Fahrenheit, respectively. The average high and low temperatures for January are about 58 and 32 degrees Fahrenheit, respectively. Annual precipitation averages about 47 inches per year. July and November are the wettest and driest months of the year, respectively. An average of 1 inch of snow falls annually at SRS.

Thunderstorms cause several occurrences of high winds each year in the region. Hailstorms can occur with these storms and large hail (greater than 0.75 inch in diameter) has been observed annually since 1993 in the Aiken/Barnwell Counties region (NCEI 2019b). Tornadoes do occur in the region, as 57 were observed in Aiken and Barnwell Counties from 1950 through 2018 (National Weather Service 2019b). From 1950 to 2017, 10 hurricanes hit South Carolina (National Hurricane Center 2019). On one occasion, during Hurricane Gracie in 1959, hurricane-force winds of 75 miles per hour (mph) were observed at SRS (DOE 2015a:3-20).

3.3.4.2 Air Quality Standards and Regulations

The CAA and its subsequent amendments establish the NAAQS and air quality regulations and delegate their enforcement to the States. In South Carolina, SCDHEC has the authority to regulate air quality. The CAA establishes air quality planning processes and requires States to develop an SIP that details how they will maintain the NAAQS or attain a standard in nonattainment within mandated timeframes. The requirements and compliance dates for attainment are based on the severity of the nonattainment classification of the area. The following section summarizes the air quality rules and regulations that apply to the proposed action at SRS.

3.3.4.2.1 Nonradiological Air Emission Standards

Section 3.1.4.2.1 of this EIS defines air quality concepts related to (1) criteria pollutants, (2) HAPs, and (3) ozone formation. The SCDHEC implements the NAAQS and State ambient standards for benzene and gaseous fluoride for purposes of regulating air quality in South Carolina. The NAAQS are shown in

Table 3–2, Section 3.1.4.2.1 of this EIS. The SCDHEC also regulates HAPs and 257 TAPs. Both programs set ambient levels of concern for HAPs and TAPs.

If the air quality in an area of the United States meets or is cleaner than the national standard, EPA designates it as an attainment area; if worse than the national standard, it is a nonattainment area. Former nonattainment areas that have attained the NAAQS are designated as maintenance areas. Presently, EPA categorizes Aiken and Barnwell Counties that encompass SRS as in attainment of all NAAQS.

The SCDHEC is responsible for enforcing air pollution regulations in South Carolina. The SCDHEC enforces the NAAQS by monitoring air quality, developing rules to regulate and permit stationary sources of air emissions (nonradiological and radiological), and managing the air quality attainment planning processes in South Carolina. The SCDHEC air quality regulations, "Air Pollution Control Regulations and Standards," are found in the South Carolina Code of State Regulations Chapter 61-62 (South Carolina Legislature 2019). Some sources at SRS that emit criteria pollutants and HAPs are regulated under construction and operational permits, as required in Chapter 61-62.1, Section II of the Air Pollution Control Regulations and Standards (SRNS 2018a:3-11). The following permits regulate air emissions activities at SRS:

- Part 70 Air Quality Permit (TV-0080-0041)
- 784-7A Biomass Boiler Construction Permit (TV-0080-0041a-CG-R1)
- 784-7A Oil Boiler Construction Permit (TV-0080-0041a-CF-R1)
- Mixed Oxide Fuel Fabrication Facility (TV-0080-0139-CA-R1)
- Building 235-F D&D Construction Permit (TV-0080-0041-C1)
- Ameresco Federal Solutions, Inc., Biomass Facilities Permit (TV-0080-0144)

3.3.4.2.2 Greenhouse Gases and Climate Change

Section 3.1.4.2.2 of this EIS defines GHGs and the concept of CO_2e and discusses the link between the worldwide proliferation of GHG emissions by humankind and global warming. Global climate change has already had observable negative effects on the environment. The potential future effects of global climate change include more worldwide environmental, economic, and social consequences.

In South Carolina, the U.S. Global Change Research Program predicts that annual average temperatures will increase between 3 and 6 degrees Fahrenheit by 2100, based on both low and high global GHG emission scenarios (USGCRP 2018:42). In addition, average precipitation for each season will increase over the long-term, with the highest increase of 10 to 20 percent occurring in winter (USGCRP 2017:217). Predictions of climate change impacts to South Carolina include: (1) an increase in extreme rainfall events, which will increase flood risks in low-lying regions; (2) an increase in urban heat and vector-borne disease; and (3) more frequent extreme heat episodes and changing seasonal climates, which will increase exposure-linked health impacts and economic vulnerabilities in the agricultural, timber, and manufacturing sectors (USGCRP 2018:744-808).

As stated in Section 3.1.4.2.2 of this EIS, Federal agencies address emissions of GHGs by reporting and meeting reductions mandated in Federal laws, Executive orders, and agency policies. SRS uses its Site Sustainability Plan to implement its environmental and sustainability goals of conserving energy and water and reducing solid waste generation. The Savannah River Site Biomass Cogeneration Facility became operational in 2012, and SRS no longer uses coal to generate energy. Operation of the Biomass Cogeneration Facility and three biomass facilities play a significant role in supporting the renewable and alternative energy goals of SRS. As a result, annual emissions of GHGs from SRS operations no longer exceed 25,000 metric tons of CO_2e and, therefore, their operations are not subject to the EPA mandatory GHG reporting requirements (EPA 2019d).

The potential effects of GHG emissions from the project alternatives are by nature global and cumulative. Given the global nature of climate change and the current state of the science, it is not useful at this time to attempt to link the emissions quantified for local actions to any specific climatological change or resulting environmental impact. Nonetheless, GHG emissions from the project alternatives are quantified in this EIS for use as indicators of their potential cumulative contributions to climate change effects and for making reasoned choices among alternatives.

3.3.4.2.3 Radiological Air Emission Standards

Facilities at SRS emit radioactive materials and, therefore, are subject to NESHAP, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." South Carolina's Air Pollution Control Regulations and Standards Subchapter 61-62.61 incorporates Subpart H by reference. This regulation limits the radiological dose to a member of the public from all sources on SRS to 10 millirem per year. Subpart H also establishes requirements for monitoring emissions from facility operations and analyzing and reporting of radiological doses. Airborne radiological effluents are monitored at individual SRS facilities to demonstrate compliance with the requirements of Subpart H and DOE Order 458.1, "Radiation Protection of the Public and the Environment."

3.3.4.3 Nonradiological Air Emissions

Sources of nonradiological air emissions at SRS include a biomass (wood) cogeneration facility that produces steam and electricity, wood- and fuel oil-fired boilers, diesel engines, emergency diesel generators, small gasoline and propane combustion sources, chemical and solvent usages, and on-road and non-road vehicle sources. K Area facilities use emergency diesel generators for emergency electrical power; emissions from these sources occur from periodic testing. **Table 3–42** presents a summary of the nonradiological air emissions that occurred in 2017 from stationary sources at SRS (SRNS 2018b).

Table 3–42. Savannah River Site Facility-Wide Emissions – Calendar Year 2017

Source	Air Pollutant (tons per year)							
	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	Single HAP/TAP	Total HAPs/TAPs
SRS Facility-Wide	35.6	45.9	62.1	4.2	6.8	5.0	1.26	32.2

CO = carbon monoxide; HAP = hazardous air pollutant; NOx = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_x = particulate matter less than x microns in diameter; Single HAP/TAP = nitric acid; SO_2 = sulfur dioxide; TAP = toxic air pollutant; VOC = volatile organic compounds.
Source: SRNS 2018b.

3.3.4.4 Radiological Air Emissions

Sources of radionuclide emissions from SRS mainly occur from the ventilation of: (1) lab hoods, (2) evaporators, (3) waste tanks, (4) tritium separation areas, and (5) non-operating reactors and spent nuclear fuel facilities (SRNS 2019b:5-6). Minor amounts of radionuclide emissions also occur from fugitive and diffuse sources. These radionuclide emissions mainly take the form of tritium and krypton-85. Major sources of radionuclide emissions are equipped with CEM systems and are controlled with HEPA filters, per the requirements of Subpart H. Many minor sources of radionuclide emissions within SRS also are controlled with HEPA filters.

During 2018, an estimated 49,593 curies of radioactivity were released to the atmosphere from all SRS sources (SRNS 2019b:A1). The effective dose equivalent from all airborne radionuclide emissions on SRS to the MEI member of the public was 0.09 millirem, which is about 1 percent of the 10 millirem per year Subpart H standard (SRNS 2019b:8). Subpart H defines the MEI as any member of the public at any offsite location where there is a residence, school, business, or office.

3.3.5 Ecological Resources

Ecological resources at SRS are managed through the Natural Resources unit of the USDA/USFS Savannah River office under an existing interagency agreement with DOE/SRS. This agreement includes managing timber; maintaining and improving habitat for special status species; maintaining secondary roads and SRS boundaries; performing prescribed burns and protecting SRS from wildland fires; and evaluating the effects of its management practices on the environment (SRNS 2018a). The USDA/USFS prepared a *Natural Resources Management Plan* for DOE to implement in 2005 and an updated plan in 2019. The plan details all-natural resource operations, including management, education, and research programs (DOE 2019f). Further information for Ecological Resources on SRS are available on the USDA Forest Service's Savannah River website (USDA 2019c).

3.3.5.1 Vegetation

SRS covers about 198,000 acres and consists almost entirely (90 percent) of forested lands managed by the USFS. The remaining area (10 percent) is developed or disturbed and includes industrial areas, roads, buildings, and landscaped vegetation (SRNS 2018a). Forest habitats include mixed pine-hardwood, sandhills pine savanna, bottomland hardwood, and swamp floodplain. Land management by the USFS has focused largely on timber management and watershed protection, thus changing the site's land predominantly to forested areas. SRS and surrounding lands are comprised of six Management Areas as presented on Figure 3–21.

Project activities would occur in the K Area Complex located in K Area. All of K Area has been previously developed or disturbed (classified as "industrial"). The remaining vegetation in K Area consists of managed grassy meadows subject to periodic mowing (DOE 2019f).

3.3.5.2 Invasive Plant Species

Invasive species at SRS are managed by the USFS and controlled locally where they present a threat to natural resource management goals and objectives (DOE 2019f).

Due to the disturbed and developed nature of K Area, invasive species are relatively sparse and limited to areas such as fence lines and roadways.

3.3.5.3 Wildlife

The forested ecosystems provide habitat for a variety of terrestrial wildlife species at SRS. According to the *Environmental Information Document* (WSRC 2006b), 44 species of amphibians, 60 species of reptiles, 255 species of birds, and 55 species of mammals are known to occur within SRS. These populations include urban wildlife, such as frogs, toads, snakes, squirrels, skunks, foxes, and cottontails. Also included are game species [white-tailed deer (*Odocoileous virginianus*) and wild pig (*Sus scrofa*)] and avifauna (raptors, waterfowl, game bird species, and various passerines). Federally listed wildlife species have potential to occur near the proposed project area.

Thirty-six wildlife species are documented as occurring in K Area, most of which live in the open, nonforested habitats (WSRC 2006b). See the *Environmental Information Document* for a full taxonomic listing of these species (WSRC 2006b).

3.3.5.4 Special Status Species

According to the USFWS IPaC report, 10 federally listed species were identified as "known to occur" or "with potential to occur" within or near the SRS proposed project area (see **Table 3–43**). There is no federally designated critical habitat at SRS (USFWS 2020b).

Table 3–43. Federally Listed Species with Potential to Occur Near K Area

Common Name	Scientific Name	Protection Status	Historically Observed at SRS?
Birds			
Red-cockaded Woodpecker	*Picoides borealis*	FE	yes
Wood Stork	*Mycteria americana*	FT	yes
Reptiles			
Gopher Tortoise	*Gopherus polyphemus*	FC	yes
Amphibians			
Frosted Flatwoods Salamander	*Ambystoma cingulatum*	FT	no
Flowering Plants			
Smooth Coneflower	*Echinacea laevigata*	FE	yes
Pondberry	*Lindera melissifolia*	FE	yes
Canby's Dropwort	*Oxypolis canbyi*	FE	no
Harperella	*Ptilimnium nodosum*	FE	no
American Chaffseed	*Schwalbea americana*	FE	no
Relict Trillium	*Trillium reliquum*	FE	no

FE = federally listed endangered species; FT= federally listed threatened species; FC = federally listed candidate species.
Source: USFWS 2020b.

Of the 10 federally listed species presented in Table 3–43, 5 species have been documented at SRS. These species include two plants (smooth coneflower and pondberry), one reptile (gopher tortoise), and two birds (red-cockaded woodpecker and wood stork). None of these species, except the red-cockaded woodpecker, occurs near the K Area (SREL 2018a, 2018b; SRNS 2018a; Tuberville et al. 2007). The K Area is located within a red-cockaded woodpecker habitat management area (DOE 2019f) (Figure 3–21); however, the nearest colony is located about 4 miles to the east.

SRS provides habitat for at least 40 plant species that are of State or regional concern (SRNS 2018a). Based on a field review conducted in 2005, no federally or State-listed species were found to be present within the then-proposed 210-acre K Area boundary expansion (DOE 2019f).

Several species identified as BCC under the MBTA are known to occur (observed nesting or soaring) at SRS. The proposed project area is located within BCR 27 (Southeastern Coastal Plain) (USFWS 2008). There are 53 species listed in BCR 27. Additionally, the USFWS IPaC system identified 22 migratory bird species with potential to occur in the proposed project area (USFWS 2020b).

Bald (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos canadensis*), protected under the BGEPA, have been observed throughout SRS. Golden eagles have been seen foraging in SRS within open habitats (DOE 2019f). According to the SCDNR bald eagle monitoring program, there are four known bald eagle nests within SRS (SCDNR 2019); however, none of these nests occur within the K Area. The closest known bald eagle nest occurs about 10 miles away. Due to development and ongoing disturbance, there is no suitable foraging habitat available within the K Area.

3.3.5.5 Aquatic Resources

The Savannah River bounds SRS on the southwest for 35 river miles and includes an extensive network of tributaries, fabricated ponds, Carolina bays, reservoirs, and floodplain swamps. SRS also encompasses various ponds and lakes. There are more than 50 fabricated impoundments throughout the site that support populations of bass and sunfish. Carolina bays can range from lakes to shallow marshes, herbaceous bogs, shrub bogs, or bottomland hardwood forests. Among the 300 Carolina bays found throughout SRS, fewer than 20 have permanent fish populations. Wetlands compose about 49,000 acres on SRS, or roughly 25 percent of the total area (SRNS 2018a). More than 400 isolated wetlands occur on SRS, many of which are Carolina bays, fed largely by rain and shallow groundwater (SREL 2018c;

SRNS 2018a). While wetlands are prevalent on SRS and surround most of K Area, there are no wetlands within K Area (DOE 2019f).

3.3.5.6 Wildfire

Fire management at SRS is enforced through the USDA Forest Service Savannah River Fire unit. Annual management activities include fire suppression and prescribed burns within the 310 square miles of DOE's SRS. Prescribed burns reduce hazardous forest fuels and restore ecological processes, including land clearing for timber to restore longleaf pine populations and to create habitat for the red-cockaded woodpecker. Fire is commonly used as a management tool under the current silvicultural practices employed on much of the SRS forested areas (WSRC 2006b).

3.3.6 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape; this section will discuss cultural resources on SRS (DOE 2015a). The section also contains SRS's paleontological resources, as defined in the Paleontological Resources Preservation Act (16 U.S.C. § 470aaa).

The proposed fuel preparation equipment would be installed in Building 105-K that is part of the K Area Complex, which is designated as site industrial. Internal modifications to Building 105-K would require minimal ground disturbances outside the existing facility. The ROI includes Building 105-K and previously disturbed area within K Area that could be used for a construction laydown area. The construction of the K Area during the 1950s likely destroyed any archaeological resources, so there is little likelihood that prehistoric resources with research potential would be found (DOE 2005c).

3.3.6.1 Cultural Resources

SRS is federally owned land managed and operated by a private contractor, and as such, is required to comply with Federal cultural resources compliance requirements in addition to those required by NHPA Section 106 (54 U.S.C. § 306101) and NEPA (42 U.S.C. § 4321 et seq.).

Archaeological resources at SRS are managed through a Programmatic Memorandum of Agreement between the DOE Savannah River Operations Office, South Carolina Historic Preservation Office (SHPO), and the Advisory Council on Historic Preservation (SRARP 2016). DOE uses this agreement to identify archaeological resources, assess their eligibility for listing on the NRHP, and consult with the South Carolina SHPO to develop mitigation plans for resources affected by SRS undertakings (SRARP 2016). Guidance on the management of archaeological resources at SRS is included in the Archeological Resource Management Plan of the Savannah River Archeological Research Program (SRARP 2016).

DOE developed a Programmatic Agreement in consultation with the South Carolina SHPO, the Advisory Council on Historic Preservation, the SRS Citizen Advisory Board, Citizens for Nuclear Technology Awareness, and the cities of Aiken, Augusta, and New Ellenton for the preservation, management, and treatment of NRHP-eligible structures constructed during SRS's operational history that are contributing to the SRS Cold War Historic District (DOE, SC SHPO, and ACHP 2020). As a result, the SRS Cultural Resources Management Plan, which was developed to preserve the site's historic contributions in the 1950 to 1989 period, outlines the decision-making process for managing NRHP-eligible Cold War historic properties (DOE, SC SHPO, and ACHP 2020).

As of 2018, 36.4 percent of surveyable land has been studied (70,458 acres of 193,276 acres) for archaeological resources and for identification of historic-era built resources that date prior to 1950. In addition, 100 percent of Cold War-era resources constructed between 1950 and 1989 were inventoried by 2004 (SRARP 2017:16).

Archaeological Resources and Historic-Era Buildings and Structures

A total of 2,043 archaeological sites have been identified at SRS; of which 1,303 are prehistoric-era sites and 740 are historic-era sites.

At SRS, seven historic buildings/structures constructed prior to 1950 have been identified, and all have been determined to be NRHP-eligible (SRNS 2020). There are 232 Cold War-era buildings and structures determined to be individually eligible for listing on the NRHP and/or as contributing elements to the NHRP-eligible Cold War Historic District (DOE, SC SHPO, and ACHP 2020). The District includes a landscape, sites, buildings, and structures constructed between 1950 and 1989.

Within K Area, 20 Cold War buildings and structures are eligible for listing on the NRHP (DOE, SC SHPO, and ACHP 2020).

3.3.6.1.1 Traditional Cultural Properties

Although no documented traditional cultural properties are identified on SRS, Native American resources in the region include remains of villages or townsites, ceremonial lodges, burials, cemeteries, and natural areas, containing traditional plants used in religious ceremonies and for medicinal purposes (DOE 1999b).

3.3.6.2 Paleontological Resources

Paleontological materials in the SRS area date largely from the Eocene Age (54 to 39 million years ago) and include fossilized plants and invertebrate fossils, including giant oysters (*Crassostrea gigantissima*), other mollusks, and bryozoa. With the exception of the giant oysters, all other fossils are fairly widespread and common; therefore, the assemblages have low research potential or scientific value (DOE 2015a:3-36). Paleontological resources are unlikely to be found within K Area due to the highly disturbed nature of these areas (DOE 2015a:3-36).

3.3.7 Infrastructure

Site infrastructure includes those basic resources and services required to support planned construction and operations activities and the continued operations of existing facilities. For the purposes of this EIS, infrastructure is defined as electricity, fuel, water, and sewage. **Table 3–44** describes the SRS infrastructure. Waste management and transportation infrastructure are addressed separately in Sections 3.3.9 and 3.3.12, respectively. Capacities and characteristics of SRS's utility infrastructure are described in Table 3–44.

3.3.7.1 Electricity

The majority of the electrical power consumed by SRS is generated by offsite, coal-fired and nuclear power plants, and is supplied by Dominion Energy (formerly South Carolina Electric and Gas Company). About 310,000 megawatt-hours per year of electricity is used at SRS, with an available capacity of 4,400,000 megawatt-hours per year (SRNS 2012a). The peak load use is estimated to be 60 megawatts, with a peak load capacity of 500 megawatts.

3.3.7.2 Fuel

Biomass is used primarily at SRS to produce steam in boiler plants. Fuel oil is used to back up biomass when needed and is also used to power emergency generators. The steam plant in A-Area, which burned coal, is no longer used and was replaced with a biomass plant with fuel oil backup. Natural gas is not used at SRS (DOE 2015a:3-42). An estimated 410,000 gallons of fuel oil per year are consumed at SRS (SRNS 2012a). Onsite fuel oil supplies can be replenished by truck or rail deliveries as needed. In addition, temporary storage tanks can be installed to supplement fuel consumption needs during construction or other activities. Due to these factors, the capacity for fuel is generally not considered to be limited for SRS.

Table 3–44. Savannah River Site-wide Infrastructure

Resource	*Estimated Site Use*	*Site Capacity*	*Available Site Capacity*
Electricity			
Power Consumption (megawatt-hours per year) [a]	310,000	4,400,000	4,100,000
Peak Load (megawatts) [a]	60	500	440
Fuel [b]			
Oil (gallons per year)	410,000	NA [c]	NA
Biomass (tons per year)	300,000	20,000,000	19,700,000
Domestic Water (gallons per year) [a]	320,000,000	2,950,000,000	2,630,000,000
Sewage (gallons per year)	250,000,000	383,000,000 [d]	133,000,000

NA = not applicable or not available.
[a] DOE 2015a.
[b] Oil use is for A-Area and K Area.
[c] Capacity is generally not limited, as delivery frequency can be increased to meet demand.
[d] Capacity includes the Central Sanitary Wastewater Treatment Facility and smaller treatment units in K- and L-Areas.
Note: Totals are rounded to two significant figures from information included in SRS Infrastructure Power Quantity Cost Distribution Report D7257000, FY 2010 (SRNS 2012a).

3.3.7.3 Water

SRS has 13 domestic water systems, including 1 large system that supplies 98 percent of the site's domestic water requirements. The large system consists of a primary plant in A-Area and a backup plant in B-Area. This water system, including elevated storage tanks and distribution mains, was constructed between 1993 and 1997. The water system currently consists of 1 large system, the A-Area and B-Area treatment plants, and 12 small systems. The large system consists of A- and B-Area plants for chemical treatment and system monitoring, 4 deep wells, 4 elevated storage tanks and about 27 miles of 10-inch pipe for the site loop. Average domestic water production at SRS is about 820,000 gallons per day (SRNS 2019c). Raw water is drawn from subsurface aquifers through 20-inch- (51-centimeter-) diameter production wells using vertical turbine pumps. Once treated, the potable water is stored in the four elevated storage tanks and distributed to the various facilities through a network of piping (DOE 2015a:3-42).

About 320 million gallons of domestic water are used at SRS annually, with a capacity to supply up to 2,950 million gallons per year (SRNS 2012). Process water for individual areas is supplied through separate deep groundwater wells or river intake systems (DOE 2015a:3-43).

Sewage

The Central Sanitary Wastewater Treatment Facility (CSWTF), installed on Burma Road in 1995, collects and treats 98 percent of sanitary wastewater generated at SRS. Also constructed in 1995, 18 miles of pressurized sewer line and 12 lift stations are used to transport sanitary waste to the CSWTF. The CSWTF has a treatment capacity of 1.05 million gallons per day. The balance of the sanitary waste is treated at two smaller, older independent facilities installed in the 1970s located in K Area and L-Area. The K Area plant has an operating capacity of 24,000 gallons per day. The original treatment facilities, lift stations, and about 45 miles of gravity pipe were installed in the 1950s. Collectively, the sanitary systems at SRS include 56 lift stations, and 18 miles of force main (pressure), and 48 miles of gravity drain piping throughout the site (SRNS 2019c:408-411). The CSWTF and the smaller treatment units in K Area and L-Area are estimated to collect and treat about 250 million gallons of sewage per year with a capacity to treat up to 383 million gallons per year of sewage (SRNS 2012a).

3.3.7.4 Proposed Facility Location (K Area)

Proposed activities analyzed in this EIS would be located in K Area. **Table 3–45** provides estimated current consumption of resources in K Area.

Table 3–45. Current Use of Resources at K Area

Resource	***K Area***
Electricity	
Power Consumption (megawatt-hours per year)	9,200
Peak Load (megawatts)	5.8
Diesel/Fuel Oil (gallons per year)	170,000
Domestic Water (gallons per year)	3,600,000

Note: Totals are rounded to two significant figures from information included in SRS Infrastructure Power Quantity Cost Distribution Report D7257000, FY 2010 (SRNS 2012a).

3.3.7.4.1 Electricity

Step-down transformers are used to reduce the electrical power from the 115-kV transmission loop to medium voltage levels, typically 4.16 or 13.8 kV, in individual areas. There are two 30-megavolt-amp transformers for K Area.

The current estimated yearly power consumption for K Area that would be affected by the proposed activities totals about 9,200 MWh, which accounts for about 2 percent of current site-wide electrical usage and represents about 0.1 percent of the site-wide available capacity. The current theoretical maximum peak load that could be experienced by K Area's given current estimated peak is 5.8 MW, compared to a site-wide peak load of 60 MW. SRS has the capacity to deliver a peak load of up to 500 MW.

3.3.7.4.2 Fuel

Package boilers in K Area have been deactivated and replaced with a single boiler unit that can run on biomass fuel or fuel oil. This biomass facility only operates in the winter. The estimated 170,000 gallons of fuel oil used annually in K Area represents about 41 percent of the current site-wide consumption of fuel oil.

3.3.7.4.3 Water

The estimated current annual consumption of domestic water for K Area is about 3.6 million gallons, which represents 3 percent of the site-wide use and about 0.1 percent of site-wide capacity.

3.3.8 Noise

Region of Influence

The ROI for noise extends 0.5 mile from the edge of the SRS construction area, which is the area that could be susceptible to noise impacts.

State of South Carolina Regulations

The State of South Carolina and Barnwell County have not established noise regulations that specify noise limits. Aiken County Zoning and Development Standards Ordinance provides limits to noise levels per frequency band (Aiken County Planning Commission 2013:145). For areas without standardized criteria, the Federal Transit Administration recommends the following standards for construction noise in residential areas: construction noise levels at the sensitive receptor should not exceed an 8-hour equivalent sound level of 80 dBA during daytime (7 a.m. to 10 p.m.); an 8-hour L_{eq} of 70 dBA during nighttime (10 p.m. to 7 a.m.); and a 30-day average day-night average sound level of 75 dBA (DOT 2018:193).

3.3.8.1 Environmental Noise and Vibration

3.3.8.1.1 Major Noise Sources

The major noise sources within SRS include industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, intercom paging systems, construction and materials-handling equipment, and vehicles). These noise sources primarily occur within developed or active areas at SRS. Noise emissions outside of these active areas consist primarily of vehicles and rail operations. Existing noise sources of importance to the public and sensitive receptors at SRS are related to transportation of people and materials to and from the site, including trucks, private vehicles, helicopters, and trains (DOE 2015a). In addition, noise emissions from traffic to and from SRS occur along access highways through the nearby towns of New Ellenton, Jackson, and Aiken, South Carolina.

3.3.8.1.2 Noise Measurements

Noise measurements recorded during 1989 and 1990 along State Route 125 in the town of Jackson at a point about 50 feet from the roadway estimated day-night average sound levels of 66 dBA for summer and 69 dBA for winter. Similarly, noise measurements along State Route 19 in the town of New Ellenton at a point about 50 feet from the roadway estimated average day-night average sound levels of 68 dBA for summer and 67 dBA for winter (DOE 1999b:324). Although SRS does not publish reports on ambient noise, typical noise levels are estimated to be about 50 to 60 dBA, with some equipment, such as heating, ventilation, and air conditioning (HVAC) systems, causing noise levels to be about 70 dBA.

The proposed K Area Complex is about 5.5 miles from the SRS boundary and the closest offsite receptors. The proposed project area and most industrial facilities at SRS are far enough from the site boundary that noise levels at the boundary from these sources would not be measurable or would be barely distinguishable from background levels.

The existing noise levels in a particular area are generally based on its proximity to nearby major roadways or railroads or on population density (DOT 2018:64). The land surrounding the K Area Complex and the closest offsite receptors are primarily rural with agricultural areas. The Alvin W. Vogtle Electric Generating Plant is located off site to the southwest of the proposed site in Burke County. State Route 125 (Augusta Highway) accounts for the majority of noise but since it is more than 1.5 miles away, it is not considered a major source of noise for the closest sensitive receptor. Therefore, ambient noise levels were estimated based on the population density of the affected county using the methodology described in USDOT's Transit Noise and Vibration Impact Assessment (DOT 2018).

According to the Census Bureau, the population densities of Aiken and Barnwell Counties are about 149.5 and 41.2 people per square mile, respectively (Census 2010b, 2010d). As a result, the existing day-night average sound level in the vicinity of the proposed project area and the closest offsite receptors is estimated to be 40 dBA, and the existing ambient equivalent continuous sound levels (in equivalent sound level) during daytime and nighttime are estimated to be about 40 dBA and 30 dBA, respectively (DOT 2018:66). Burke County, Georgia has a population density of 28.2 people per square mile (Census 2010c). As a result, the existing day-night average sound level for the offsite receptors to the south/southwest of the proposed project area is estimated to be 35 dBA (DOT 2018:66). Ambient (background) noise levels could occur from roadway traffic, farm machinery, pets, and various other household noises.

3.3.8.1.3 Public Parks

The closest Federal and State parks to the K Area Complex are the Redcliffe Plantation State Historic Site, Barnwell State Park, and Congaree National Park, which are about 18 miles northwest, 22 miles northeast, and 62 miles northeast of the proposed project location, respectively.

3.3.9 Waste Management

This section describes the current average annual "baseline" generation rates and management practices for the waste categories that will be generated if fuel preparation activities are implemented at SRS (SRNS 2020). The ROI for waste management activities includes everything within the SRS boundaries. Offsite locations including other DOE and commercial facilities are not included in the waste management ROI. The potential impacts at these non-SRS disposition facilities were considered as part of the licensing/permitting/approval process for these sites and are not detailed in this document. There would be no additional impacts, including exposure to the offsite public or onsite workers. All waste disposition actions would comply with the licenses, permits, and/or approvals applicable to the facilities described in this document. Those waste categories are LLW, MLLW, and TRU waste; RCRA hazardous and TSCA wastes; and nonhazardous solid waste and recyclable materials. HLW is also managed at SRS; however, no HLW would be generated by fuel preparation activities and, therefore, is not discussed further in the section. **Table 3–46** presents the latest available 5-year annual generation by waste category.

Table 3–46. 5-Year Annual "Baseline" Generation by Waste Category in Cubic Meters

	2015		*2016*		*2017*		*2018*		*2019*		*Average*	
Waste Type	***SRS***	***K Area***	***SRS***	***K Area***	***SRS***	***K Area***	***SRS***	***K Area***	***SRS***	***K Area***	***SRS***	***K Area***
LLW	4,400	0	6,800	48	4,800	14	5,900	10	4,400	15	5,300	17
MLLW [a]	180	0	3.7	5.7	84	1.3	3.4	0	3.7	0	55	1.4
TRU waste	10	0	7.2	0.21	8.6	0	13	0	17	0.63	11	0.17
Hazardous and TSCA [a]	77	0.095	230	0.004	100	0	150	0.001	5,700	0.033	1,300	0.027
C&D	41,000	260	25,000	170	23,000	340	43,000	510	45,000	1,200	35,000	500

C&D = construction and demolition and industrial waste; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; SRS = Savannah River Site; TRU = transuranic waste.

[a] Quantities are in 1,000s of pounds [will be converted to cubic meters when the specific waste category conversion factors are available].

Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.

Source: SRNS 2020c.

3.3.9.1 Radioactive Waste

Low-Level Waste

Liquid and solid LLW are treated and disposed of at SRS. Most aqueous LLW streams are sent to the F- and H-Area Effluent Treatment Project and treated by pH adjustment, submicron filtration, organic removal, reverse osmosis, and ion exchange to remove chemical and radioactive contaminants other than tritium. This facility is designed to process 100,000 to 250,000 gallons of low-level radioactive wastewater daily. After treatment, the effluent is discharged to Upper Three Runs through an NPDES-permitted outfall. The treatment residuals are concentrated by evaporation and stored in the H-Area tank farm for eventual treatment in the onsite Z-Area Saltstone Facility, where wastes are immobilized with grout for disposal.

Solid LLW is primarily disposed of in engineered trenches and slit trenches. About 14,000 cubic meters of disposal space remains in the engineered trenches and about 23,000 cubic meters of disposal space remains in two active slit trenches. Together, the remaining solid LLW disposal capacity at SRS is estimated to be 37,000 cubic meters. While most solid LLW is disposed of on site at SRS, some is shipped off site for disposal at Federal and commercial disposal facilities.

Mixed Low-Level Waste

MLLW is radioactive waste that contains material that is regulated as hazardous waste. Storage facilities for MLLW are located in several different SRS areas. These facilities are regulated under RCRA or as Clean

Water Act-permitted tank systems. MLLW is sent off site to NNSS or RCRA-regulated treatment, storage, and disposal facilities. A section of the TRU waste storage pads has been permitted to store MLLW and hazardous waste and has a storage capacity of 296 cubic meters.

Transuranic Waste/Mixed Transuranic Waste

Transuranic waste, including mixed transuranic waste, is transported to E-Area via closed-body trucks from the generating site and stored on covered storage pads. The TRU waste storage pads in E-Area can store up to about 13,200 cubic meters of transuranic waste. Transuranic waste is characterized, packaged, and certified to meet the criteria for transportation and disposal. The certified waste containers are subsequently loaded into Type B shipping casks and transported to the WIPP facility near Carlsbad, New Mexico, for disposal.

3.3.9.2 Resource Conservation and Recovery Act Hazardous and Toxic Substances Control Act

Hazardous waste is nonradioactive waste that is regulated by the State of South Carolina under RCRA. Hazardous waste is accumulated at the generating location as permitted by regulation or stored in DOT-approved containers. A section of the TRU waste storage pads in E-Area has been permitted to store hazardous waste and has a storage capacity of 296 cubic meters. Most of the waste is shipped off site to commercial RCRA-permitted treatment and disposal facilities using DOT-certified transporters. DOE plans to continue to recycle, reuse, or recover certain hazardous wastes, including metals, excess chemicals, solvents, and chlorofluorocarbons.

PCBs are present at SRS in various forms. The majority of the PCBs are in special purpose coatings and paints. PCBs are also known to be present in fluorescent light ballasts and old capacitors, and may be present in caulking materials and cable insulation. Wastes containing PCBs are managed in accordance with TSCA regulations (40 CFR Part 761) and applicable EPA approval documents issued to SRS. PCB wastes are not eligible for disposal at SRS and must be disposed of at an offsite TSCA-authorized facility.

3.3.9.3 Nonhazardous Solid Waste

Nonhazardous solid sanitary waste is sent to the Three Rivers Regional Landfill, which is located within the SRS boundary and serves as a regional municipal landfill for Aiken, Allendale, Bamberg, Calhoun, Edgefield, McCormick, Orangeburg, and Saluda Counties. The Three Rivers Landfill has a total permitted capacity of 30 million metric tons and can receive up to 500,000 metric tons per year. About 2.4 million metric tons of solid waste had been disposed of in the landfill. Construction and demolition debris is disposed of in a landfill near N-Area.

3.3.10 Human Health – Normal Operation

The impact on human health during normal facility operations addresses the potential impacts from exposure to ionizing radiation and chemicals. Potential human health impacts from exposure to radiation from normal operational conditions is considered for both an individual and the population as a whole for both the public and site workers; this constitutes the ROI. For the existing environment, the public population is considered to be all people living within 50 miles of SRS. The maximally exposed individual is considered to be a hypothetical person who could receive the maximum possible dose from SRS site releases. In addition, for workers the potential human health impacts associated with exposure to workplace chemicals are also considered.

3.3.10.1 Radiation Exposure and Risk

DOE monitors radiation in the environment and exposure of workers and calculates the radiation doses of members of the offsite general public and onsite workers from operation of SRS. **Table 3–47** presents data on radiation doses to the public for the years 2014 through 2018. The average radiation dose to a representative offsite member[5] of the public as a result of onsite facility operations was estimated to be 0.21 millirem per year. The risk of developing an LCF from this dose is extremely small, much less than 1 in a million. The calculation of this maximum dose considers the maximum dose to an individual from air emissions and from the use of water (drinking water).[6] The maximum dose to an offsite individual does not include a contribution from direct radiation. This dose is less than one-tenth of a percent of the average dose of 311 millirem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for someone living in the United States (SRNS 2019a).

Table 3–47. Annual Radiation Doses to the Public from Savannah River Site Operations 2014–2018

Source of Dose	Representative Individual					Population		
	Dose (millirem per year)				LCF Risk			
	Airborne Radionuclides [a]	Water Use [b]	Sportsman Dose [c]	Total	Total [d]	Estimated Population Dose (person-rem)	LCFs [d]	Estimated Dose from Background (person-rem)
2018	0.082	0.19	11.1	0.27	e	6.0	0 (0.004)	243,000
2017	0.027	0.22	12.2	0.25	e	4.4	0 (0.003)	243,000
2016	0.038	0.15	13.5	0.19	e	4.9	0 (0.003)	243,000
2015	0.032	0.15	12.9	0.18	e	3.7	0 (0.002)	243,000
2014	0.044	0.12	18.3	0.16	e	3.7	0 (0.002)	243,000
Average	**0.045**	**0.17**	**13.6**	**0.21**	**e**	**4.5**	**0 (0.002)**	**243,000**

LCF = latent cancer fatality

[a] DOE (DOE 2011b) and EPA (40 CFR Part 61 Subpart H) limit the dose to a member of the public from airborne radionuclides to 10 millirem per year.

[b] Water use includes drinking water, irrigation, and recreational activities.

[c] Sportsman dose is the dose from hunting and consuming wildlife including fish, deer, and wild hog. The value given is the largest estimate from the doses to an onsite hunter, fisherman, or an offsite hunter.

[d] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem. Values in parentheses are the calculated number of LCFs in the population. A value less than 0.5 is considered to result in no LCFs.

[e] The probability of this individual contracting a fatal cancer range from about 1 in 6,000,000 to 1 in 10,000,000.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: SRNS 2015b, 2016, 2017, 2018a, 2019a.

There are two dose limits relevant to the exposure of an individual member of the public near a DOE site. As shown in Table 3–47, all of the doses to the representative individual from the operation of SRS are well below the DOE dose limit for a member the general public, which is 100 millirem per year from all pathways, as prescribed in DOE Order 458.1 (DOE 2011b). The table also shows that the dose from the air pathway is well below the NESHAPs dose limit for emissions from DOE facilities of 10 millirem per year (40 CFR Part 61, Subpart H).

The population dose is the sum of average individual doses to the entire population within 50 miles of SRS. Table 3–47 shows that over the years 2014 through 2018, the population dose from operations at SRS ranged from 3.7 to 6.0 person-rem. No LCFs would be expected from these doses. Population doses

[5] SRS calculates individual doses to a representative member of the public for air and liquid releases. SRS also calculates an MEI dose for air releases using parameters defined by EPA, which differ from those used by SRS, to comply with NESHAP regulations. For the NESHAP calculation, SRS assumes all site releases are from the H-Area versus the multiple release points in several areas for the DOE calculation. For 2018, the NESHAP reported MEI dose was 0.088 millirem.

[6] SRS does not include the wildlife consumption dose in the estimated total representative individual dose. The largest estimated sportsman dose to an onsite hunter, 18.3 millirem in 2014, would increase the risk of an LCF by about a 1 in 90,000 and is about 6 percent of the average annual dose from natural background radiation.

from background sources of radiation are also presented in Table 3–47. The doses from SRS operations are a small fraction of the background doses.

Worker doses at SRS primarily result from:

- Liquid waste evaporator repair;
- Defense Waste Processing Facility equipment removal and replacement;
- Glovebox maintenance;
- Target residual material processing; and
- Gallery inspections in high radiation areas.

Of the estimated 5,500 workers at SRS during 2017, nearly 70 percent received a measureable (detectable) dose (DOE 2017b). The total worker dose averaged 113 person-rem for the 5-year period of 2014 through 2018 with no LCFs expected. Considering only the workers who received a measurable dose (on average 2,767 workers and ranging between 1,584 and 4,101), the average annual dose to a worker was 44 millirem. No single worker received a dose greater than 500 millirem during this period (DOE 2015g, 2016j, 2017g, 2018b, 2019g). To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year (DOE 2017f), and maintained as-low-as-reasonably-achievable. **Table 3–48** presents SRS worker dose information for the years 2014 to 2018.

Table 3–48. Annual Radiation Doses to Savannah River Site Workers from Operations 2014–2018

Year	*Collective Dose (person-rem)*	*Workers with a Measurable Dose*	*Average Dose Among Workers with a Dose (rem)*	*Exposed Worker Population LCFs* [a]
2018	126.9	4,101	0.031	0 (0.08)
2017	152.4	3,830	0.039	0 (0.09)
2016	99.0	2,437	0.041	0 (0.06)
2015	95.1	1,884	0.050	0 (0.06)
2014	93.0	1,584	0.059	0 (0.06)
Average	**113.3**	**2,767**	**0.044**	**0 (0.07)**

LCF = latent cancer fatality; rem = roentgen equivalent man.

[a] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem. Values in parentheses are the calculated number of LCFs within the worker population. A value less than 0.5 is considered to result in no LCFs.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: DOE 2017b:Exhibit B-1; DOE 2018b:Exhibits B-1, B-2, B-3; DOE 2019g:Exhibit B-3.

3.3.10.2 Nonradiological Health and Safety

Nonradiological exposures at SRS are controlled through programs intended to protect workers from normal industrial hazards. These programs are controlled by the safety and health regulations for DOE contractor workers governed by 10 CFR Part 851, which establishes requirements for worker safety and health programs to ensure that workers have a safe work environment. Included are provisions to protect against occupational injuries and illnesses, accidents, and hazardous chemicals.

DOE monitors worker safety through CAIRS. CAIRS is a computerized database used to collect and analyze DOE reports of injuries, illnesses, and accidents that occur during facility operations. Two metrics generated for the tracking of injury, illness, and accident rate are the DART rate and the TRC rate. The DART rate is an indication of the instances of injuries, illnesses, and accidents that result in, at worst, lost work days or days lost due to transfer or worker job restrictions. The TRC rate is an indication of the total number of work-related injuries or illnesses that resulted in death, days away from work, job transfer or restriction, or recordable case as identified in the Occupational Safety and Health Administration

Form 300. For the years 2015 through 2019 the SRS DART and TRC rates (incidents per 200,000 work hours or the equivalent of 100 full-time workers) averaged 0.26 and 0.48, respectively. For the years 2015 through 2019, the DART and TRC rates for all DOE facilities combined averaged 0.39 and 0.86, respectively (DOE 2019a).

3.3.10.3 Regional Cancer Rates

The National Cancer Institute publishes national, State, and county incidence rates of various types of cancer (NCI 2018). However, the published information does not provide an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–49** presents cancer incidence rates for the United States and the 12 South Carolina and Georgia counties within about 50 miles of SRS. Additional information about cancer profiles near SRS is available in State Cancer Profiles, Incidence Rates Tables (NCI 2018). Not all types of cancer are presented in this table; totals for individual cancers will not sum to the All Cancers values.

Table 3–49. Cancer Incidence Rates for the United States, South Carolina, Georgia, and Counties Adjacent to Savannah River Site, 2012–2016

Region	*Cancer Incidence Rates* [a]						
	All Cancers	*Thyroid*	*Breast (female)*	*Lung and Bronchus*	*Leukemia*	*Prostate*	*Colon and Rectum*
United States	448.0	14.5	125.2	59.2	14.1	104.1	38.7
South Carolina	457.3	11.6	129.2	65.5	13.5	115.4	38.6
Aiken County [b]	411	13.5	123.6	55.9	15	92.3	36.9
Allendale County [b]	388.2	(c)	83.7	61.4	(c)	122.6	28
Bamberg County	432.3	20	128.9	54.5	(c)	127.8	37.6
Barnwell County [b]	412.8	14.1	123.4	54.7	(c)	93.2	31.8
Edgefield County	399.5	13.3	109.4	52.4	17.1	101.9	41.5
Georgia	466.4	12.1	125.8	64.1	14.5	122.3	41.8
Burke County	473.6	(c)	130.8	77.4	14.7	102.7	57.6
Columbia County	401.1	10.6	131.7	56.5	10.2	98.3	25.3
Emanuel County	424.3	(c)	94.4	85.5	13.6	92.6	54.3
Jefferson County	447.9	(c)	97.6	56.2	(c)	135	54.1
Jenkins County	434.4	(c)	127.8	71	(c)	111.8	29.7
Richmond County	468.6	11.3	134	70.2	10.8	130.4	38.3
Screven County	478.2	(c)	139.2	79.5	19.6	117.4	45.4

[a] Age-adjusted incidence rates; cases per 100,000 persons per year.
[b] SRS is located in Aiken, Barnwell, and Allendale Counties, South Carolina.
[c] Data have been suppressed by the National Cancer Institute to ensure the confidentiality and stability of rate estimates when the annual average count is three or fewer cases.
Source: NCI 2018.

3.3.11 Emergency Preparedness

Savannah River Nuclear Solutions, LLC (SRNS) is responsible for overall site management and operations, including the site-level emergency management program. Savannah River Remediation, LLC, and Ameresco, Inc., operate hazardous material facilities at SRS and are responsible for implementing the facility-level exercise program at their respective facilities. The DOE Office of Environmental Management is responsible for overall site operation, including oversight of the site-level emergency management program, and provides Federal oversight through the Savannah River Operations Office. The NNSA Savannah River Field Office provides Federal oversight for tritium facilities and operations.

Much of detailed information below is abstracted from a recent audit of the SRS Emergency Plan. The audit was carried out by DOE's Office of Emergency Management Assessments within the independent Office of Enterprise Assessments (DOE 2018i).

DOE Order 151.1D, *Comprehensive Emergency Management System* (DOE 2016i),[7] describes requirements for emergency management that all DOE sites must implement. These requirements include:

- Develop a formal exercise program that includes: (1) a matrix that identifies planned exercises and the elements tested over the next 5 years; (2) rotation among scenarios identified in the Technical Planning Basis; (3) exercise scenarios involving radiological hazardous materials (HAZMAT), if applicable; (4) a method for determining the appropriate number of exercises and rotation of exercise scenarios among HAZMAT facilities over a 5-year period to ensure demonstration of responder proficiency; (5) invitations every 3 years to offsite responding agencies and national assets (e.g., Centers for Disease Control, Department of Agriculture); (6) severe event scenarios every 5 years; (7) test of design control and/or mitigation features in multiple facilities; (8) demonstration of Emergency Response Organization capability; and (9) integration with local, State, and Federal agencies.

- Develop challenging exercises based on scenarios identified in the technical planning basis that involve high-consequence scenarios, include multiple response elements, and result in offsite effects.

- In order to test and demonstrate the site/facility/activity integrated emergency response capability, conduct the annual site-level exercise as a full-scale exercise that involves site-level Emergency Response Organization elements and resources. Invite some offsite response organizations to participate in a full-scale or full-participation exercise every 3 years. This exercise must use a scenario from the spectrum of potential operational emergencies, as identified in DOE's *Emergency Planning Hazard Assessments* (EPHAs) guidance (rotated among facilities and type of incident and/or initiator) and include demonstration of protective actions. An EPHA is required be conducted for each DOE site or activity where identified hazardous materials are present in quantities exceeding the quantity that can be "easily and safely manipulated by one person" and whose potential release would cause the impacts and require response activities characteristic of an Operational Emergency (DOE Order 151.1D, Attachment 4, paragraph 15).

The SRS plan for complying with the above requirements is documented in SCD–7, *Savannah River Site Emergency Plan*, which includes drills and exercises.

A full-scale exercise scenario was carried out in May 2018 and, as noted above, was audited by the Office of Enterprise Assessments. The scenario involved an earthquake with limited damage to SRS H-Area facilities. The hypothesized damage included a partial loss of power to the H-Canyon and HB-line, loss of containment of nitric acid in the Outside Facilities H-Area, a ceiling collapse, and combustion in a Savannah River Tritium Enterprise (SRTE) building. The hypothesized scenario's damage in SRTE "resulted" in a radiological stack release of tritium in the form of tritium oxide gas (referred to as tritium in this report) and loss of power to the H-Area Tank Farm. Multiple injuries "occurred," some of which included chemical or radiological contamination. All H-Canyon, HB-line, Outside Facilities H-Area, SRTE, H-Area Tank Farm, and Effluent Treatment Facility personnel participated in the response, although by exercise design, only H-Canyon/Outside Facilities H-Area and SRTE Emergency Response Organizations were activated. In

[7] SRNS emergency management program is currently making the transition from DOE Order 151.1C (DOE O 151.1C, Comprehensive Emergency Management System, 11/2/05) to DOE Order 151.1D requirements, which is scheduled to be completed during calendar year 2020.

addition, personnel in the nearby site training center participated by taking appropriate protective actions for co-located workers. This was a complicated and challenging exercise.

After observation of the 2018 full-scale exercise and other documentation, the Office of Enterprise Assessments concluded that "overall, the site, area, and facility emergency response organizations followed procedures and adequately performed many response functions, including issuing appropriate protective actions to co-located workers and notifications to executives and workers. Nevertheless, integrated emergency response organization actions to communicate, assess, and respond to the potential exposure to fire department and facility responders from the postulated tritium release were not fully adequate." The Office of Enterprise Assessments' observations resulted in a number of recommendations that will result in improvements to the SRS Emergency Plan.

3.3.12 Traffic

This section describes the traffic and transportation conditions in the SRS environment.

The ROI for the transportation infrastructure includes two U.S. Interstate Highways (Interstates I-20 and I-520), two U.S. Highways (U.S. Highways 278 and 301), four South Carolina State Highways (State Highways 19, 64, 125, 781), and the SRS onsite road network.

3.3.12.1 Transportation Infrastructure

3.3.12.1.1 Transportation Planning Agencies

In addition to State transportation departments, three major planning agencies collect and maintain data on the efficiency of the transportation system in the region: the Augusta Planning Commission in Georgia, the North Augusta Planning Commission, and the Lower Savannah Council of Governments Planning Department in South Carolina.

Regional Infrastructure

Vehicular access to SRS is provided from South Carolina State Highways 19, 64, 125, 781, and U.S. Highway 278. State Highway 19 runs north from the site through New Ellenton toward Aiken; State Highway 64 runs in an easterly direction from the site toward Barnwell; State Highway 125 runs through the site itself in a southeasterly direction between North Augusta and Allendale, passing through Beech Island and Jackson. U.S. Highway 278 also runs through the site, in a southeasterly direction between North Augusta and Barnwell. State Highway 781 connects U.S. Highway 278 with Williston to the northeast of the site. The northern perimeter of the site is about 10 miles from downtown Aiken. Commuter traffic between SRS and Georgia crosses the Savannah River primarily on I–20 and I–520 and primary arteries, State Routes 28 and 1, and Business Route 25 to the north of SRS. Another primary artery, U.S. Highway 301, crosses the Savannah River to the south of SRS.

A major expansion of the I-20 bridge over the Savannah River and Augusta Canal between Augusta and North Augusta began in December 2019 and is expected to be completed in early 2022 (GDOT 2020). The bridges are currently parallel two-lane structures that will be expanded to a single large six-lane structure (three lanes in each direction).

Rail service in the region is provided by the Norfolk Southern Corporation and CSX Transportation; rail access to SRS is provided by the Robbins Station on the CSX Transportation line (DOE 1999b:3-144). Barge transportation is available using the Savannah River. Currently, the Savannah River is used primarily for recreation.

SRS Onsite Infrastructure

SRS is managed as a controlled area with limited public access. Within SRS, there are about 130 miles of primary and 1,230 miles of secondary roads (DOE 2005a, 2005e:3.1.4-3, 2015a). The primary SRS roadways are in good condition, and are typically wide, firm shoulder border roads that are either straight or have wide gradual turns. Intersections are well marked for both traffic and safety identification.

In addition, 32 miles of railroad tracks are present within SRS, dedicated primarily for transporting large volumes or oversized loads of materials or supplies (DOE 2005e:3.1.4-3, 2015a). The railroad tracks are well maintained, and the rails and cross lines are in good condition. The Savanah River rail classification yard is east of P-Area. This facility sorts and redirects railroad cars. The railroads support delivery of foreign and domestic research reactor spent nuclear fuel shipments, delivery of construction materials for new projects, and movement of nuclear materials and equipment on site (DOE 2005a).

Travel between facilities in K Area and facilities in E-, F-, H-, and S-Areas can be accomplished by both surface roads and railroads.

SRS has no commercial docking facilities but has a boat ramp in the former T-Area that has accepted large transport barge shipments (DOE 1999b:3-144).

DOE operates a heliport on SRS in B-Area, about 3 miles from the facility formerly known as the Mixed Oxide Fuel Fabrication Facility, where two lightweight, multipurpose helicopters are based to provide support to the security services at SRS. USFS conducts regular helicopter operations across SRS for purposes of wildfire detection/response, prescribed fire operations, and wildlife/forest health surveillance. USFS operations originate from the heliport adjacent to the USFS facility on SRS. In addition, Dominion Energy (formerly known as South Carolina Electric and Gas) conducts limited helicopter operations across SRS for purposes of right-of-way inspection and clearance. Operations originate off site, with site access only accomplished via electrical line pathways (NNSA 2020).

3.3.12.2 Existing Traffic Conditions

Refer to Section 3.1.12.1 for an overview of road performance measurements using LOS ratings. In the Lower Savannah Council of Governments planning area, the roads with the highest levels of traffic operate at LOS A (LSCOG 2006). This area includes the counties immediately surrounding SRS. In the North Augusta Planning Area, roads operate at LOS C or better (NA 2005). This area includes the northwest part of Aiken County and Edgefield County. In the Augusta-Richmond County Planning Area, several streets and highway system segments operate below LOS C. These roads include segments of Interstate 520 (I–520) (Bobby Jones Expressway) and I–20 (Carl Sanders Highway), and segments of principal arterial roads, including Deans Bridge Road, Doug Barnard Parkway, Mike Padgett Highway, Peach Orchard Road, Washington Road, and Wrightsboro Road.

Most of the congested segments are located in the urbanized part of the county (ARC 2008). Roads in Columbia County operating below LOS C also include segments of I–520, I–20, Belair Road, Lewiston Road, Horizon South Parkway, Old Evans Road, and Washington Road (TEI 2004). Most SRS employees live in the Augusta area and the city of Aiken and would use roads in these planning areas to commute to SRS (DOC 2008).

Table 3–50 lists the annual average daily traffic statistics for several routes used to access the site. Traffic levels have shifted over time, depending on the route. State routes accessing the site from the south and from the northeast have increased traffic by more than 20 percent since 2009. Although LOS determinations have not been reported for these access routes, in terms of the impacts on LOS of higher baseline traffic, the increases are not likely sufficient to cause a decline in the LOS of those routes, because sufficient capacity likely still exists (LSCOG 2017).

Table 3–50. 2009–2018 Annual Average Daily Traffic for Principal Savannah River Site Access Routes

Access Route	Annual Average Daily Traffic			2009–2018 Change
	2009	2012	2018	
SR-125: Barnwell County Line to SRS Gate	2,700	2,700	2,300	-14.8%
SR-125: Barnwell to Allendale County Line	1,800	1,900	2,200	22.2%
SR-125: Jackson, SC, to SRS Gate	10,900	12,800	11,700	7.3%
Woodland Drive: Old Whiskey Road to SR-278	1,950	1,900	2,300	17.9%
SR-278: Whiskey Road to Barnwell County Line	3,700	4,100	4,600	24.3%
SR-64: Snelling, SC to SRS Gate	1,150	1,550	1,000	-13.0%

SC = South Carolina; SR = State Route; SRS = Savannah River Site
Source: PNNL 2018; SCDOT 2019.

3.3.13 Socioeconomics

This section describes current socioeconomic conditions and local community services within the four-county ROI (or region) associated with SRS where the activities described in Chapter 2 would most likely occur. These counties include Columbia and Richmond Counties, Georgia, and Aiken and Barnwell Counties, South Carolina. Figures 2–11 and 3–21 show the counties in the ROI as well as towns and major transportation routes. SRS borders the Savannah River and encompasses about 310 square miles in the South Carolina counties of Aiken and Barnwell. SRS is about 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia (Figure 2–11). The Savannah River flows along the site's southwestern border.

3.3.13.1 Population and Housing

3.3.13.1.1 Population

In 2018, the population in the ROI was estimated to be 546,358 (Census 2018). From 2010 to 2018, the total population in the ROI increased at an average annual rate of about 1 percent, which was slightly lower than the growth rate in both Georgia and South Carolina. Over the same time period, the total population of Georgia increased at an average annual rate of about 1.1 percent, to 10,519,475 people. South Carolina experienced an increase of about 1.2 percent annually to 5,084,127 people in 2018. The populations of the ROI, Georgia, and South Carolina are shown in **Table 3–51**. Population projections are also provided out to 2050, based on an extrapolation of the state projected growth rates between 2018 and 2025.

Table 3–51. Population of the Savannah River Site Region of Influence: 2000–2018

County	Year			Population Change 2010-2018 (percent)	Population Projection 2050
	2000	2010	2018		
Aiken, South Carolina	142,552	160,099	169,401	5.8	193,188
Barnwell, South Carolina	22,478	22,621	21,112	-6.7	13,972
Columbia, Georgia	89,288	124,053	154,291	24.4	188,389
Richmond, Georgia	199,775	200,549	201,554	0.5	198,965
ROI	**454,093**	**507,322**	**546,358**	**7.7**	**594,514**
South Carolina	4,012,012	4,625,364	5,084,127	9.9	7,697,956
Georgia	9,186,453	9,687,653	10,519,475	8.6	14,186,991

ROI = region of influence.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: Census 2020a, 2020b, 2020c; Georgia Governor's Office 2020; South Carolina Revenue and Fiscal Affairs Office 2020.

3.3.13.1.2 Housing

The most recent housing stock statistics from the Census Bureau report (Census 2017c) estimated the 2017 housing occupancy by type (owned or rented). Of interest for impact analysis is the capacity of the ROI to absorb any new housing demand projected by the project. As of 2017, the ROI had 228,447 housing units of which 84.2 percent were occupied and 15.8 percent were vacant. In Georgia, an estimated 12.9 percent of the stock is vacant, while 16.1 percent of the stock in South Carolina is vacant. Vacant rental stock makes up almost 3 percent of the stock in both states. The distribution of housing units in the SRS ROI, Georgia, and South Carolina in 2017 is presented in **Table 3–52**.

Table 3–52. Region of Influence Housing Characteristics (2017 data)

County	*2017 Housing Units*	*Occupied Housing Units*	*Vacant Housing Units*	*Owner-Occupied Units*	*Renter-Occupied Units*	*Vacant Homeowner Housing Units (percent)*	*Vacant Rental Housing Units (percent)*
Aiken	75,249	65,703	9,546	47,484	18,219	1,430 (1.9)	3,537 (4.7)
Barnwell	10,525	8,426	2,099	5,826	2,600	200 (1.9)	905 (8.6)
Columbia	57,472	43,990	13,482	34,706	9,284	3,620 (6.4)	9,770 (17.0)
Richmond	88,641	71,411	17,230	37,704	33,707	2,660 (3.0)	11,965 (13.5)
ROI	**231,887**	**189,530**	**42,357**	**125,720**	**63,810**	**7,910 (3.4)**	**26,177 (11.3)**
Georgia	4,282,254	3,745,074	537,180	2,354,992	1,390,152	81,363 (1.9)	286,911 (6.7)
South Carolina	2,284,820	1,905,100	379,720	1,309,670	595,430	41,127 (1.8)	205,634 (9.0)

Notes:
Homeowner and rental vacancy units do not add to total vacant housing units because the vacancy rates only include vacant housing units (i.e., proportion of total inventory) that are on the market for rent or for sale only.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: Census 2017c.

3.3.13.2 Employment and Income

From 2010 to 2018, the ROI experienced an average annual growth rate in the civilian labor force of just over 0.7 percent (from 231,266 to 243,863), while the State of Georgia's and South Carolina's labor force grew at average annual rates of about 1.1 percent and 1 percent, respectively. Employment in the ROI grew at an average annual rate of 1.4 percent, compared to the State of Georgia and South Carolina, each of which had an average annual growth rate of 2.1 percent. The ROI experienced a higher unemployment rate (4.1 percent) in 2018, compared to the unemployment rates in Georgia (3.9 percent) and South Carolina (3.5 percent); within the ROI, the unemployment rate ranged from 3.3 percent in Aiken County (South Carolina) to 5.1 percent in Richmond County (Georgia). **Table 3–53** presents employment statistics in the ROI and the states of Georgia and South Carolina for 2010 and 2018. In 2018, there were 232,921 people employed in the SRS ROI.

Table 3–53. Employment Statistics in the Savannah River Site Region of Influence, Georgia, and South Carolina in 2010 and 2018

Area	*Civilian Labor Force*		*Employment*		*Unemployment*		*Unemployment Rate*	
	2010	*2018*	*2010*	*2018*	*2010*	*2018*	*2010*	*2018*
Aiken	72,368	73,944	65,639	71,470	6,729	2,474	9.3	3.3
Barnwell	9,489	8,343	7,913	7,944	1,576	399	16.6	4.8
Columbia	61,522	74,950	57,027	71,341	4,495	2,609	7.3	3.5
Richmond	87,887	86,626	78,209	82,166	9,678	4,460	11.0	5.1
ROI	**231,266**	**243,863**	**208,788**	**232,921**	**22,478**	**9,942**	9.7	4.1
Georgia	4,696,676	5,080,472	4,202,052	4,880,038	494,624	200,434	10.5	3.9

Area	Civilian Labor Force		Employment		Unemployment		Unemployment Rate	
	2010	2018	2010	2018	2010	2018	2010	2018
South Carolina	2,155,668	2,339,939	1,915,045	2,259,057	240,623	80,882	11.2	3.5

ROI = region of influence
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: BLS 2020a, 2020b, 2020c.

SRS Employment

The DOE Environmental Management program and the NNSA offices direct operations at SRS. They are supported in a variety of ways by the USDA, USFS, two state universities (University of Georgia and University of South Carolina), and several contractors (e.g., SRNS, Savannah River Remediation, LLC, and Parsons Government Services, Inc.) (SRNS 2019a). Nearly 11,100 people were employed at SRS as of September 30, 2019, including employees of SRNS, SRR, DOE, NNSA, Centerra-SRS, MOX, SREL, USFS, subcontractors, limited service employees, and others. Of this total, 6,305 persons were directly employed at SRS; 4,438 resided in South Carolina and 1,831 resided in Georgia (36 in other locations). Much of the services and material consumed by SRS activities are provided by local businesses. A comparison of 2018 data for direct onsite employment levels and ROI employment levels show that direct SRS onsite residence employment accounted for about 4 percent of employment in the ROI. **Table 3–54** provides residence information for the four-county ROI. As shown in this table, about 87.4 percent of SRS employees reside in this ROI.

Table 3–54. Distribution of Employees by Place of Residence in the Savannah River Site Region of Influence in 2019

County	Number of Employees	% of Total Site Employment
Aiken	3393	53.8
Barnwell	402	6.4
Columbia	977	15.5
Richmond	738	11.7
ROI	**5,510**	**87.4**

Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: SRNS 2020.

Employment in the K Area Complex

Activities in K Area include packaging, storage, and monitoring of special nuclear materials and a low level of activities to process surplus plutonium for disposal as waste. Staffing at the K Area Complex is currently about 300 people.

Local Income

SRS employs highly skilled technical personnel with an annual average salary of $85,000 in 2010 (Noah et al. 2011). This is significantly higher than the average per capita income in the ROI of $40,886 in 2018 (BEA 2019a). From 2010 to 2018, the average real per capita income of the ROI increased by about 24.9 percent, to $40,886. Georgia and South Carolina experienced a higher increase than in the ROI, with Georgia increasing about 33.6 percent to $46,482 and South Carolina increasing 34.6 percent to $43,702. **Table 3–55** presents the per capita incomes of the ROI, Georgia, and South Carolina.

Table 3–55. Per Capita Personal Income

County	Per Capita Income	
	2010	2018
Aiken	33,489	42,511
Barnwell	26,811	33,363
Columbia	40,094	49,473
Richmond	30,515	38,196
ROI (Average)	**32,727**	**40,886**
Georgia	34,524	46,482
South Carolina	32,454	43,702

ROI -= region of influence.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: BEA 2019a, 2019b.

3.3.13.3 Community Services

Key community services in the ROI include education, law enforcement, fire protection, and medical services. Seven school districts provide public education services and facilities in the SRS ROI.

Aiken County Public Schools in Aiken, South Carolina has 24,135 students in 43 public schools, including 21 elementary schools, 11 middle schools, 8 high schools, and 2 charter schools. Barnwell County, South Carolina has 3 school districts that operate a total of 10 school facilities located in Barnwell, Blackville, and Williston. These include four elementary schools, three middle schools (one is combined with an elementary school), three high schools and a career center. There are 3,640 students in the public school system and over 250 students attending 4 private schools (NCES 2020).

The Columbia County School System in Georgia includes 17 elementary schools, 8 middle schools, and 6 high schools. Total enrollment in the 2018-2019 school year was 24, 649 students, about a 15 percent increase over the past 10 years based on comparative data from the Georgia Department of Education (NCES 2020).

Richmond County Public School System operates 60 schools. Of these, 33 are elementary, 11 are middle (including 2 charter schools), 8 are high schools, 4 are magnet schools, and 3 are alternative or specialty schools. There are 14 private grade schools in Augusta, serving 3,038 students. Combined, these schools serve more than 32,000 students; it is the tenth largest school district in Georgia. With over 4,000 employees, Richmond County public schools are the third largest employer in Augusta-Richmond County (NCES 2020).

The numbers of full-time law enforcement employees and firefighters by county are shown in **Table 3–56**.

There are 20 police and sheriff departments within the ROI, employing about 654 law enforcement personnel (406 officers and 248 civilians) (FBI 2020a, 2020b). There are 74 fire stations within 31 cities/communities within the ROI, including 683 career (paid) firefighters and a total of 1,493 career and volunteer firefighters (Fire Department 2020).

There are 10 hospitals in the ROI, all of which provide short-term acute medical care and emergency services. Nine are in Richmond County, Georgia (all in the Augusta area) and one hospital is in Aiken County, South Carolina. Aiken Regional Medical Center is a 266-bed acute care facility offering a comprehensive range of specialties and services. University Hospital in Augusta, Georgia is a 574-bed private hospital and the largest hospital in the ROI (AHD 2020). There are no hospitals in Barnwell County, South Carolina (Barnwell County Hospital, a 53-bed facility closed in 2016) or Columbia County, Georgia. Residents of Columbia County rely on the closest hospitals in Augusta, Georgia.

Table 3–56. Police and Firefighter Full-Time Employees within Region of Influence

County	*Law Enforcement*	*Sworn Officers*	*Civilians*	*City/Community Fire Departments*	*Firefighters*
Aiken, SC	246 (county/sheriff's department) 114 (city of Aiken)	136 86 (city of Aiken)	110 28 (city of Aiken)	17/25 stations	145 (FTEs in Aiken and North Augusta); most of others are volunteer with some part-time too
Barnwell, SC	64	28	36	5/8 stations	0 (all staffed by volunteers)
Columbia, GA	344	242	102	5/19 stations	176
Richmond, GA	No data available specific to county or largest city of Augusta, GA. Only data indicate that the Richmond County Sheriff's Department employs more than 250 professionals (presumably full-time and part-time employees).			4/22 stations	362
ROI	**654 (excluding Richmond County)**	**406 (excluding Richmond County)**	**248 (excluding Richmond County)**	**31/74 stations**	**683**

FTE = full-time equivalent.
Source: FBI 2020a, 2020b; Richmond County Sheriff's Department 2020; Fire Department 2020.

3.3.13.4 Public Finance

SRS is a major employer and economic contributor in the ROI. The operations at SRS create jobs, generate income, and contribute to the tax revenues across both South Carolina and Georgia.

A study was conducted to determine the economic impact the SRS has on a multi-county region in South Carolina and Georgia based on FY 2010 (Noah et al. 2011). The study examined five counties surrounding SRS – the four-county ROI and Allendale County, South Carolina – but the results are applicable in that they support the significant contribution SRS makes to the local and regional economy. Report highlights are provided below:

- During FY 2010, SRS spent $1.191 billion within the region (through payroll and procurement), thus greatly and positively stimulating local economies. These expenditures generated an additional $1.195 billion in output. As a result of this spending, the local labor force market was enriched by a total of 23,262 preserved or newly created jobs. These jobs represent 12.09 percent of the local labor force, which in essence means that for every one job created by SRS an additional 2.5 jobs are created in the local economy.
- Industry diversification is commonly viewed as a goal of economic development. While SRS may seem homogenous from an outside view, from an economic perspective it is actually diverse, with its major economic impact falling in the manufacturing, waste, and construction categories.
- The average salary of local workers at SRS is about $85,031 as compared to the average salary of $35,427 in the five-county area.
- Overall, for the five-county area, the total SRS economic effect on household incomes is $853 million. In FY 2010, DOE, their contractors, and other SRS organizations spent a total of $2.4 billion on wages, fringes, and other direct expenditures. Thirty-nine percent of this total was spent on wages, 10 percent on fringes, and the reminder (51 percent) on other direct expenditures
- Locally, DOE and SRS Site contractors spent $1.2 billion (or 50.6 percent of the total expenditures of the site) in the five-county area on wages, fringes, and other direct expenditures.
- The increase in sales and income results in increases from sales tax, personal tax, property tax, tax contributions (and other types of tax revenue), and social insurance. **Table 3–57** illustrates the tax impacts of SRS operations on different State and local taxes.

Table 3–57. State and Local Tax Impacts of Savannah River Site Operations (2010)

Taxes	*Amount*	*Percentage*
Sales Tax	$42,427,076	33
Property Tax	$34,880,671	28
Personal Income Tax	$18,796,622	15
Corporate Profits and Dividends	$12,371,308	10
Indirect Business Tax	$9,062,212	7
Other Personal Tax	$8,563,168	7
Total State and Local Tax Impact	$126,101,057	–

Source: Noah et al. 2011.

SRS also contributes to the local economy by a mechanism known as "Payment in Lieu of Taxes". Payments in Lieu of Taxes is Federal compensation to local governments that help offset losses in property taxes due to non-taxable Federal lands within their boundaries. In SRS's case this is land that used to be owned by Aiken, Barnwell, and Allendale Counties but has been taken off their tax rolls because it is now owned by the Federal government. Each year the Federal government provides $6.2 million for the counties to use as they see fit (Aiken County designates 60 percent of its share to public education). In 2009, the Federal government allocated $6.2 million to three of the five area counties: Barnwell – $4,506,166, Aiken – $1,620,000, Allendale – $89,508.

3.3.14 Environmental Justice

The ROI for environmental justice is the area within a 50-mile radius of the proposed location of the VTR fuel production facilities within the K-Area at SRS. The 50-mile radius was selected because it is consistent with the ROI for evaluating human health impacts from radiological emissions. The potentially affected area includes parts of 26 counties throughout Georgia and South Carolina.

Discussion of the regulatory environment; definitions of minority, low-income, and minority and low-income populations; and a description of meaningfully greater populations for environmental justice is provided in Section 3.1.14 of this EIS. In accordance with those earlier definitions, low-income populations for SRS are present when either (a) the total number of low-income individuals of the affected area exceeds 50 percent of the overall population in the same area, or (b) the total number of low-income individuals within the affected area is meaningfully greater (e.g., 120 percent greater) than the low-income population percentage in an appropriate comparison unit of geographic analysis. The definition of minority populations is distinguished for SRS due to the high presence of minority populations in the region. The average minority population percentage of South Carolina and Georgia is about 43 percent and the average minority population percentage of the 26 counties within 50 miles of the K-Area at SRS is about 42 percent. Comparatively, a meaningfully greater minority population percentage relative to the general population of the State and the surrounding counties would exceed the 50 percent threshold defined by the Council on Environmental Quality. Therefore, the lower threshold of 50 percent is used to identify areas with meaningfully greater minority populations surrounding SRS.

Minority and Low-Income Populations

Selection of units of analysis focus on geographic units (i.e., block groups) that represent, as closely as possible, the potentially affected areas. Refer to Section 3.1.14 for further discussion.

In order to evaluate the potential impacts on populations in closer proximity to the proposed project area at SRS, radial distances of 5, 10, and 20 miles are analyzed. **Table 3–58** shows the composition of the ROI surrounding the proposed SRS facilities at each of these distances. No populations reside within the 5-mile radius of the proposed project location.

Table 3–58. Total Minority and Low-Income Population within 50 Miles of K Area

Population Group	Within 10 Miles		Within 20 Miles		Within 50 Miles	
	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total
Total Population	1,235	100.0	56,883	100.0	756,593	100.0
Nonminority	558	45.2	36,132	63.5	412,201	54.5
Total Minority	677	54.8	20,751	36.5	344,392	45.5
White - Hispanic/Latino	13	1.1	1,504	2.6	23,684	3.1
Black/African American [a]	645	52.2	17,048	30.0	280,151	37.0
American Indian or Alaska Native [b]	5	0.4	240	0.4	2,240	0.3
Other Minority [a, b]	14	1.1	1,959	3.4	38,317	5.1
Low Income	383	31.0	10,545	18.5	140,240	18.5

Source: Census 2017a, 2017b.

[a] Includes persons who also indicated Hispanic or Latino origin.

[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.

Minority populations were evaluated using the absolute 50 percent criterion for potentially affected block groups within 50 miles of the K-Area at SRS. If a block group's percentage of minority individuals met the 50 percent criterion, then the area was identified as having a minority population. Of the 550 block groups within the ROI, 230 block groups have individual racial group minority populations or aggregate minority populations that meet the environmental justice criterion.

The overall composition of the projected populations is predominantly Black or African American within the 10-mile radial distance and predominantly non-minority within the 50-mile radial distance. The concentration of minority populations is greater within the 10-mile radial distance. The Black or African American population is the largest minority group within every radial distance, constituting about 37 percent of the total population within 50 miles. **Figure 3–22** displays the block groups identified as meeting the criteria for environmental justice minority populations surrounding SRS, as well as population density of minority populations within each block group.

Low-income populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within the ROI. If a block group's percentage of low-income individuals met the 50 percent criterion or was more than 120 percent of the total low-income population within the 26 counties encompassing the 50-mile radius of the K-Area at SRS, then the area was identified as having a low-income population. Of the total population residing in the 26-county SRS comparison population, about 18.0 percent are identified as living below the poverty line; therefore, the meaningfully greater criterion for low-income populations is 21.6 percent. Of the 550 block groups within the ROI, 30 block groups have a low-income population that exceeds the 50 percent criterion, and a total of 230 block groups meet the 120 percent criterion for low-income populations. **Figure 3–23** displays the block groups identified as meeting the criteria for environmental justice low-income populations surrounding SRS, as well as population density of low-income populations within each block group.

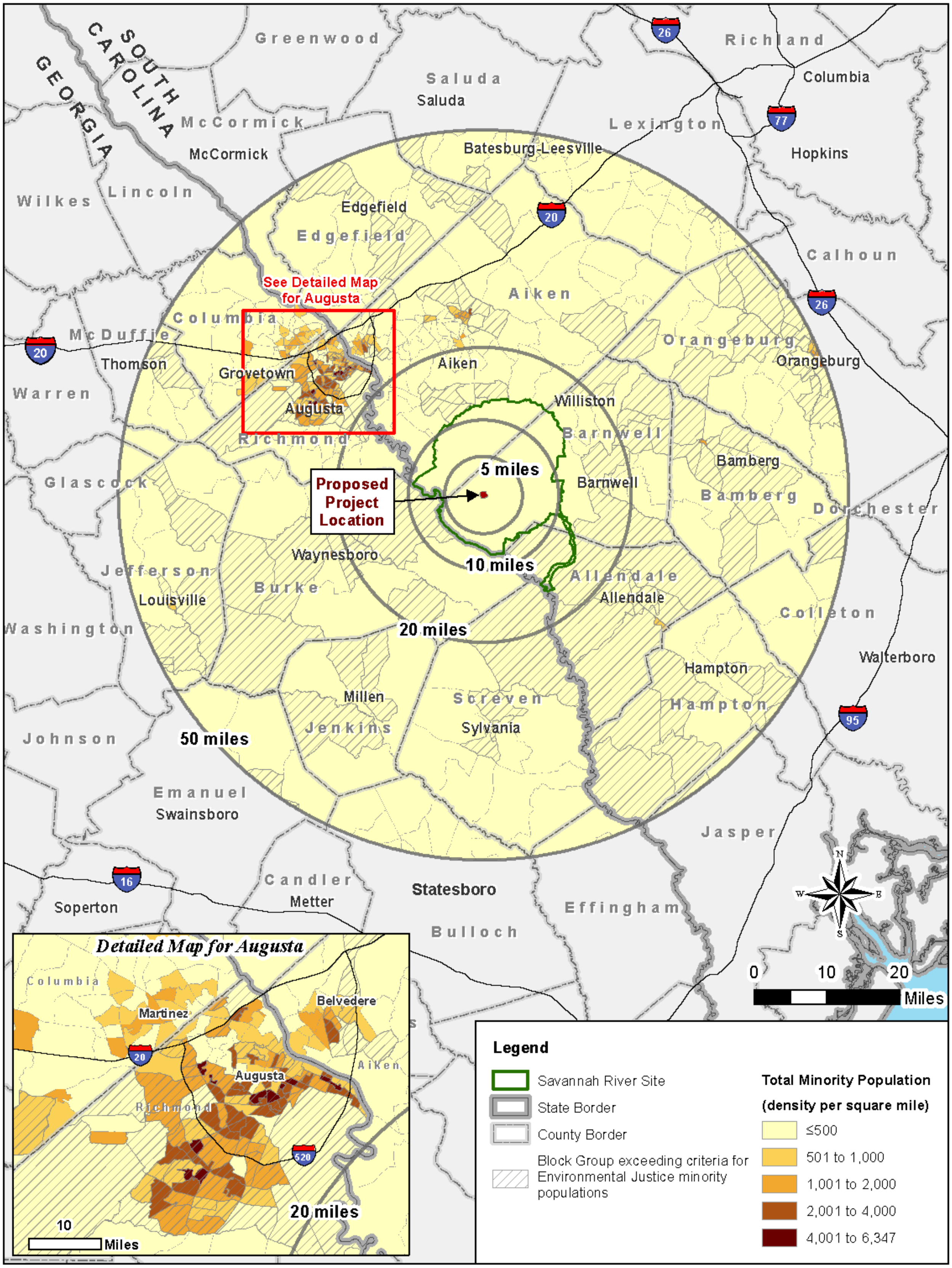


Figure 3–22. Locations of Block Groups Meeting the Criteria for Environmental Justice Minority Populations

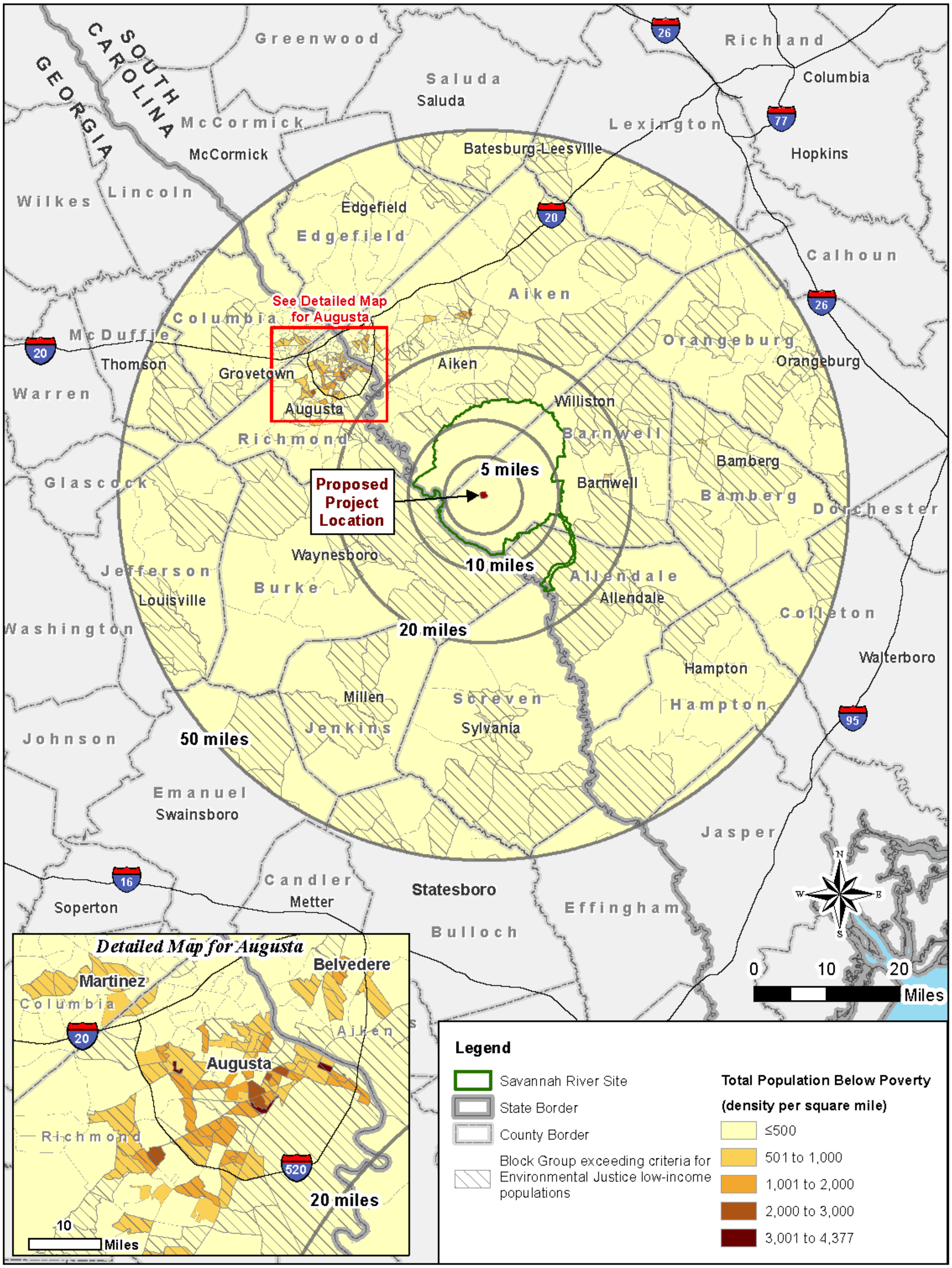


Figure 3–23. Locations of Block Groups Tracts Meeting the Criteria for Environmental Justice Low-Income Populations