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Sensitive Resources Assessment and Forest Analysis for the SSP-2A Parcel and Proposed Oak Ridge Enhanced Technology and Training Center (ORETTC), Oak Ridge, Tennessee

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OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

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Natural Resources Management Program

SENSITIVE RESOURCES ASSESSMENT AND FOREST ANALYSIS FOR THE SSP-2A PARCEL AND PROPOSED OAK RIDGE ENHANCED TECHNOLOGY AND TRAINING CENTER (ORETTC), OAK RIDGE, TENNESSEE

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ACRONYMS

ACOE	United States Army Corps of Engineers
BCC	U.S. Fish and Wildlife Service Bird of Conservation Concern
BMC	U.S. Fish and Wildlife Service Bird of Management Concern
CFR	Code of Federal Regulations
DOE	US Department of Energy
EAB	emerald ash borer
ECBI	Eastern Band of Cherokee Indians
EO	Executive Order
ERTF	Emergency Response Training Facility
ESA	Endangered Species Act
ETTP	East Tennessee Technology Park
ETW	Exceptional Tennessee Waters
FIS	Fire Intensity Scale
GA	General Agreement
HD	Hydrologic Determination
NERP	National Environmental Research Park
MBTA	Migratory Bird Treaty Act
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NNSA	National Nuclear Security Administration
NRMP	Natural Resources Management Program
ORETTC	Oak Ridge Enhanced Technology and Training Center
ORNERP	Oak Ridge National Environmental Research Park
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
ORWMA	Oak Ridge Wildlife Management Area
PIF	Partners in Flight
SNRAF	Simulated Nuclear and Radiological Activities Facility
SNS	Spallation Neutron Source
SWRA	Southern Wildfire Risk Assessment
TCA	Tennessee Code Annotated
TDEC	Tennessee Department of Environment and Conservation
TRAM	Tennessee Rapid Assessment Method
TVA	Tennessee Valley Authority
VES	visual encounter survey
TWRA	Tennessee Wildlife Resources Agency
USC	United States Code
USFWS	US Fish and Wildlife Service
WWC	Wet Weather Conveyance
Y-12	Y-12 National Security Complex

1. INTRODUCTION

1.1 OVERVIEW AND GOALS

This report summarizes current knowledge of natural and cultural resources associated with potential land use changes within an 81-acre (32.8-hectare) parcel, termed SSP-2A, on the US Department of Energy's (DOE's) Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee (Figure 1). A primary goal for the work presented here was to evaluate potential impacts to sensitive resources within the SSP-2A parcel that might result from land disturbance and construction of the Oak Ridge Enhanced Technology and Training Center (ORETTC). In addition to on-the-ground surveys of the ORETTC footprint and SSP-2A parcel during summer 2020 (Figure 1), this report leverages historical (pre-1995) and contemporary (1995–present) data from additional sources such as the Tennessee Department of Environment and Conservation (TDEC). The individuals who obtained and compiled the data that are presented here are familiar with and routinely assess, manage, and research sensitive resources on the ORR. This report should facilitate more environmentally sound decisions during planning and development of the ORETTC, provide a foundation for further assessment of sensitive and cultural resources associated with the broader SSP-2A parcel (should additional actions take place), and help project managers address regulatory guidance and DOE policy on sustainable development. Those who reference this report must consider that the timing of surveys does not permit complete delineation of resources. Data deficiencies are indicated where possible. Additional surveys may be required to account for seasonal patterns of various threatened and endangered species (e.g., bats), and additional assessment will be required if activities extend beyond the ORETTC site (Figure 2).

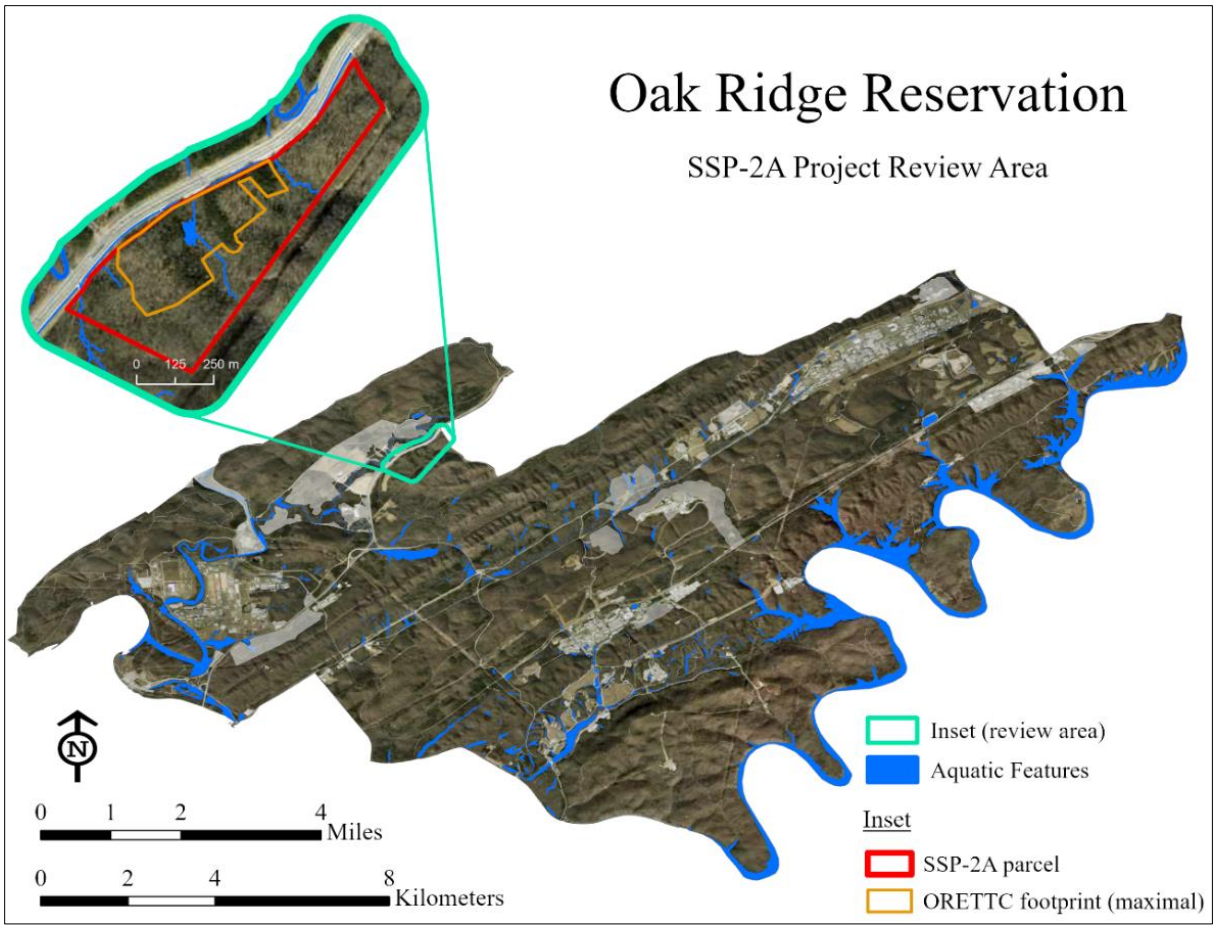

Figure 1. Review areas on the DOE Oak Ridge Reservation.

1.2 OAK RIDGE ENHANCED TECHNOLOGY AND TRAINING CENTER

The DOE National Nuclear Security Administration (NNSA) has the primary responsibility to promote the safety, security, and effectiveness of the US nuclear weapons stockpile. The administration works to reduce the global danger from weapons of mass destruction and responds to nuclear and radiological emergencies globally. NNSA oversees the National Security Enterprise, made up of six production sites and three laboratories across the country. The Y-12 National Security Complex is a critical production site, spanning 811 acres (329 ha).

NNSA has a need for highly specialized industrial training facilities and equipment with national-level emergency response experts, who will train first responders and other experts in nuclear operations, safeguards, and emergency response to support the National Security Enterprise. Currently, such training occurs at Y-12, at sites across the National Security Enterprise, and at non-NNSA facilities around the country. The absence of a centralized training facility reduces the effectiveness and efficiency of training. To reduce these limitations, NNSA proposed a new facility, the Oak Ridge Enhanced Technology and Training Center (ORETTC). The ORETTC would be a state-of-the-art training center that contains highly specialized industrial training facilities and equipment (Figure 2).

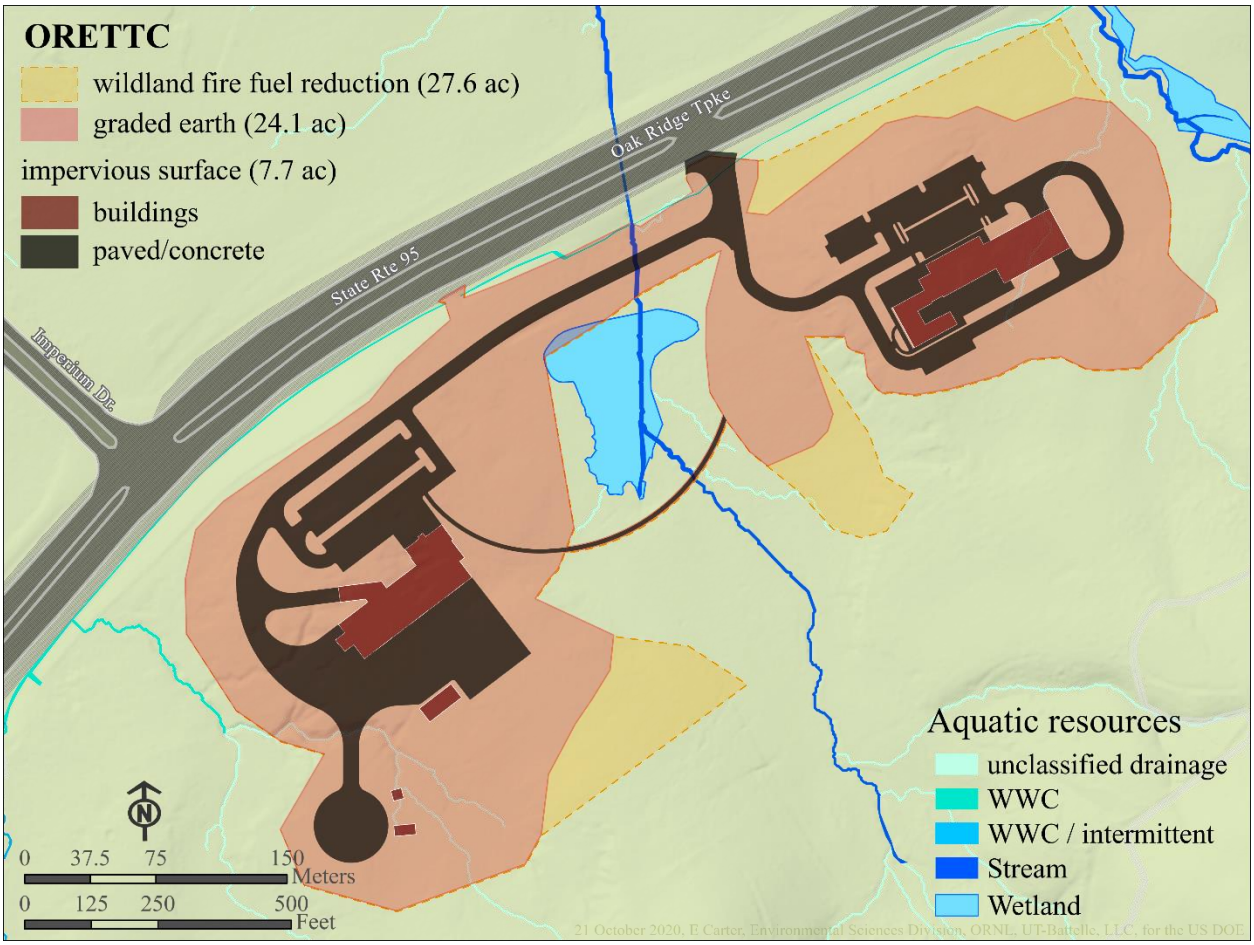

Figure 2. Oak Ridge Enhanced Technology and Training Center (ORETTC) facility conceptual design and proximate affected area(s).

The ORETTC would be located within a portion of an 81-acre (32.8-ha) parcel on the DOE ORR. The ORETTC would consist of (1) a Simulated Nuclear and Radiological Activities Facility (SNRAF) and Technical Rescue Training Area, with a Live Burn Fire Tower and Rubble Pit to be developed by NNSA; (2) an Emergency Response Training Facility (ERTF), which would be funded by the state of Tennessee and developed by the Roane County Industrial Development Board; (3) a maintenance building; and (4) utilities, roads, detention ponds, and supporting infrastructure. The primary ORETTC conceptual design includes 24.1 acres (9.8 ha) of graded earth that includes approximately 7.7 acres (3.1 ha) of impervious surfaces (Figures 2–3). Additional forest thinning—as required for wildland fire fuel reduction—will yield a maximum affected area (in terms of direct impact) equal to 27.6 acres (11.2 ha). The ORETTC would affect forested natural areas of the DOE ORR and Oak Ridge National Environmental Research Park (ORNERP) (Figures 2–3). Total manicured area and human influence into natural areas beyond the facility are not well-defined at this time; although, grading plans include 24.1 acres (9.8 ha) of disturbed earth to maintain a campus environment.

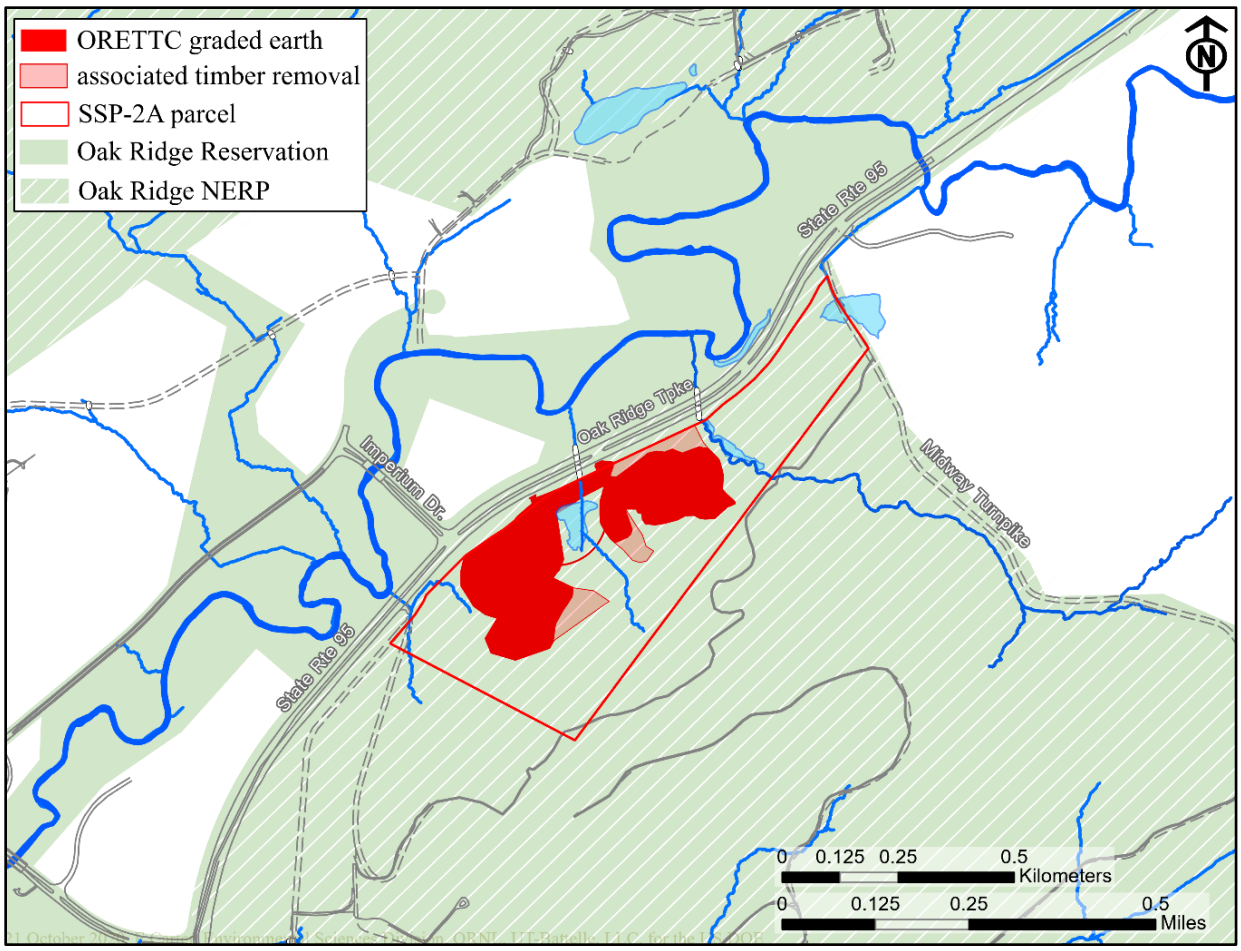

Figure 3. Location of the review areas, including ORETTC-associated timber removal, relative to major DOE boundaries. Total forest area impacted by the ORETTC project would comprise approximately 27.6 acres (11.2 ha). This would include ~3.5 acres (~1.4 ha) of additional forest thinning beyond the 24.1 acres (9.8 ha) of graded earth proposed in grading plans for the facility.

1.3 THE OAK RIDGE RESERVATION

The ORR is a 32,866-acre (13,301-ha) tract of DOE-owned land in Anderson and Roane counties in eastern Tennessee. The land on the ORR is used for multiple purposes to support DOE's mission goals and objectives. These include developed sites to support safety, security, and emergency planning; research, development, and education in energy sciences; environmental cleanup and remediation; environmental regulatory monitoring; protection of cultural and historic resources; and natural resources preservation. In addition to diverse and complex natural features that have provided a critical foundation to support DOE's environmental research mission, the ORR currently contains three facilities tied to primary DOE missions: NNSA's Y-12 National Security Complex, Oak Ridge National Laboratory (ORNL), and the East Tennessee Technology Park (ETTP).

The land that now makes up the ORR was originally acquired by the US government as a security buffer for military activities in 1941–1942. At that time, 49% of the area was composed of forest. Designation of 20,000 acres (8094 ha) of the ORR by DOE in 1980 as the ORNERP signified DOE's commitment to environmental stewardship (Figure 4). On 30 November 1984, the ORR was designated a state Wildlife Management Area [Oak Ridge WMA (ORWMA)] through a series of cooperative agreements between DOE and the Tennessee Wildlife Resources Agency (TWRA). Subsequent designation of the ORR as an

International Biosphere Reserve in 1989 marked the ORR as an important natural feature from local to international scales (Dale and Parr 1998). By 1994, ~20% of the ORR was largely transitional natural area, and ~70% was forested (Washington-Allen et al. 1995). The ~43% increase in forest cover since 1942 included many blocks of interior forest (oak-hickory, pine-hardwood, or pine) that exceeded 100 acres (40 ha) in contiguously forested area (Figure 4) (Parr and Hughes 2006).

At the western edge of the Ridge and Valley as it transitions to the Interior Plateau, the ORR contains a variety of freshwater aquatic features (palustrine wetland and riverine environments) that span seven geologic units from Ordovician to Cambrian age (Weary and Doctor 2014, Carter et al. 2020a). The highly heterogeneous landscape supports a greater number of fish and wildlife species by area than the proximate Great Smoky Mountains (Mann et al. 1996). The ORR's contiguous natural areas also offer a reprieve for migrating wildlife and game species in an otherwise challenging eastern Tennessee landscape (Carter et al. 2020a, Kwarta et al. in prep), which highlights its importance to natural and economic processes well beyond its borders. As of 2020, the value of this biodiversity center has only increased as land use changes continue to fragment eastern Tennessee (Belote et al. 2016, McKinley et al. 2019) and the ORR itself (Figure 4).

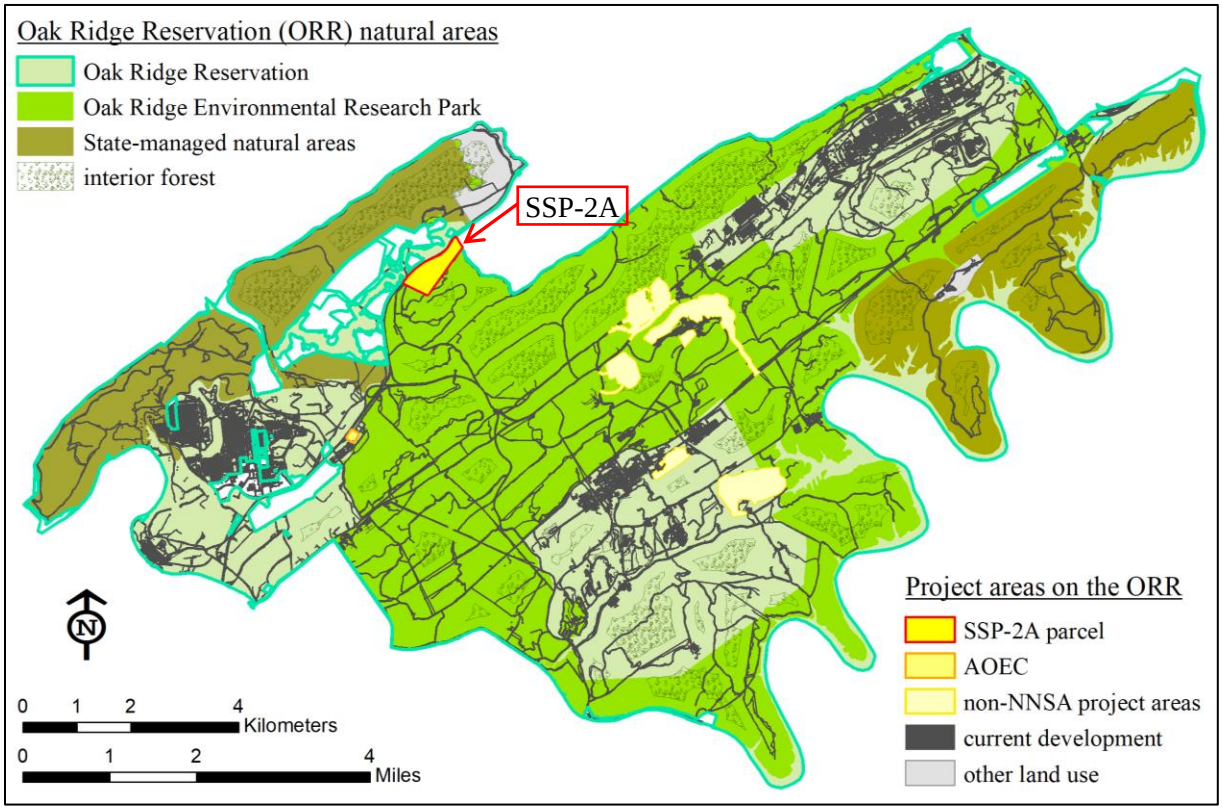

Figure 4. Boundaries and project development areas on the Oak Ridge Reservation and Oak Ridge National Environmental Research Park.

2. BASIS FOR SENSITIVE RESOURCES ASSESSMENT

While activities on the ORR are influenced by national priorities in energy, nuclear security, and scientific discovery that often call for facility improvements and expansions and new facilities, DOE works with the TWRA, TDEC, US Fish and Wildlife Service (USFWS), US Department of Agriculture, and other agencies and organizations to serve as an effective steward of the ORR's natural and cultural

resources. Project managers must ensure actions conform to environmental regulations, agreements, and policies at the federal, state, and institutional levels. These include, e.g., the US Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), Tennessee Rare Plant Protection and Conservation Act of 1985, Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974, several federal and state regulations regarding aquatic resource protection, and site-specific policy as outlined in various Oak Ridge Reservation land use and management plans developed by ORNL and TWRA for DOE (e.g., DOE 2012; Parr et al. 2012, Parr et al. 2015, Carter et al. 2020a). Minimally, wetland delineations (USACE 1987), stream evaluations (TDEC 2019), and hydrologic determinations (TDEC 2020a) are required for all wetlands, streams, and currently unclassified channels and wet weather conveyances (WWCs), respectively. Additional TDEC-prescribed assessments might be required before projects can proceed for many Exceptional Tennessee Waters (ETW) on the ORR (TDEC 2015). Likewise, forest-dwelling bats, migratory birds, and other federal- and state-listed species require detailed assessment and potential consultation with USFWS, TDEC, and/or TWRA.

The goals of various environmental and natural resource agreements between DOE and TWRA, TDEC, USFWS, EPA, and on-site contractors are to promote healthy and diverse ecosystems and game populations through the application of science and adaptive natural resources management (for details on natural resource-related agreements, see Carter et al. 2020a). Consistent with the government's programmatic use of lands, the ORR Natural Resources Management Program (NRMP) coordinates and implements these management activities on the ORR, ORNERP, and ORWMA, alongside appointed TWRA law enforcement and wildlife managers. Forest-dwelling bats and aquatic resources (biotic and abiotic) represent major focal areas for research, management, and science education activities that are carried out by UT-Battelle, LLC and TWRA on behalf of DOE. Several additional resources, notably ORNL's Focal Species for Research and Management, receive considerable funding from DOE, and several multi-institutional programs rely on the long-term health and security of focal species populations and their habitats. These and other natural resources on the ORR are thus subject to various special consideration under federal, state, and institutional regulation and policy (e.g., TDEC-classified ETW, long-term research and monitoring programs, compliance sampling, science education, and site-specific policy on biodiversity and sustainable development; for details, see Carter et al. 2020a), many of which influence directly such requirements as compensatory mitigation (Table 1).

Although the ORR does not carry the same protection status as a national park, its status as a National Environmental Research Park and International Biosphere Reserve increases the scope of environmental and cultural impacts that must be considered (Dale and Parr 1998). For instance, per 40 CFR 1508.14, potential impacts to research and science education on the ORNERP and ORR, and impacts to hunting opportunities on the ORWMA, must be considered when other aspects of the human environment are affected (as defined at 40 CFR 1508.18). Impacts to resources on the ORR that result from federal actions are defined in terms of direct effects (direct loss or alteration) owing to project-specific actions, any indirect effects on biotic, abiotic, and cultural components that might be associated with those actions, and any cumulative effects on those resources, now or in the foreseeable future, regardless of who carries out additional actions (40 CFR 1508.7–8). Thus, sensitive resources assessments that are carried out by those who conduct natural resources management on the ORR and who contribute directly to the development of the ORR's site-specific policy on natural resources and land-use planning help to ensure full and proper consideration of impacts during such process as a National Environmental Policy Act (NEPA) review.

Table 1. Key state and federal regulations related to natural resources. For details on additional state and federal policy, DOE Orders, and ORR-specific policy and Best Management Practices, see Carter et al. 2020a.

Resource/Action	Regulations	Citation
	Aquatic resources	
Actions that involve potential impacts to, or take place within, wetlands: 10 CFR 1022	Incorporate wetland protection considerations into its planning, regulatory, and decision-making processes, and, to the extent practicable, minimize the destruction, loss, or degradation of wetlands; and preserve and enhance the natural and beneficial values of wetlands.	10 *CFR* 1022.3(a)(7) and (8)
	Undertake a careful evaluation of the potential effects of any proposed wetland action. Avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction of and occupancy and modification of wetlands. Avoid direct and indirect development in a wetland wherever there is a practicable alternative. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse wetland impacts.	10 *CFR* 1022.3(b), (c), (d)
	Alternatives. Consider alternatives to the proposed action that avoid adverse impacts and incompatible development in a wetland area, including alternate sites, alternate actions, and no action. DOE shall evaluate measures that mitigate the adverse effects of actions in a wetland including, but not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically sensitive areas.	10 *CFR* 1022.13(a)(3)
	If no practicable alternative to locating or conducting the action in the wetland is available, then before taking action, design or modify the action in order to minimize potential harm to or within the wetland, consistent with the policies set forth in Executive Order 11990.	10 *CFR* 1022.14(a)
Activity that would cause loss of a wetland, or that reduces wetland value: TDEC 0400-40-07-.03	If an applicant proposes an activity that would result in appreciable permanent loss of resource value of wetlands, the applicant must provide mitigation, which results in no overall net loss of resource value. Compensatory measures must be at a ratio of 2:1 for restoration, 4:1 for creation and enhancement, and 10:1 for preservation, or at a best professional judgment ratio agreed to by the state. For any mitigation involving the enhancement or preservation of existing wetlands, to the extent practicable, the applicant shall complete the mitigation before any impact occurs to the existing state waters. For any mitigation involving restoration or creation of a wetland, to the extent practicable, the mitigation shall occur either before or simultaneously with impacts to the existing state waters. Mitigation actions for impacts to wetlands are prioritized as listed in TDEC 0400-40-07-.04 (7)(b)(1)(i)–(viii).	TDEC 0400-40-07-.04 (7)(b)
Activity that would result in an appreciable permanent loss of resource value of a state water, other than wetlands: TDEC 0400-40-07-.03	Must provide mitigation that results in no overall net loss of resource values for any activity that would result in appreciable permanent loss of resource value of a state water. Mitigation measures include, but are not limited to, restoration of degraded stream reaches and/or riparian zones; new (relocated) stream channels; removal of pollutants from and hydrologic buffering of stormwater runoff; and other measures, which have a reasonable likelihood of increasing the resource value of a state water. Mitigation measures or actions should be prioritized in the following order: restoration, enhancement, re-creation, and protection.	TDEC 0400-40-07-.04(7)(a)

Table 1. (continued).

Resource/Action	Regulations	Citation
	Plant and Animal resources	
Action that is likely to jeopardize fish, wildlife, or plant species or adversely modify Critical Habitat: 50 *CFR* 17.11–17.12	Actions that jeopardize the existence of a listed species or result in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken.	16 *USC* 1531 et seq., Sect. 7(a)(2)
Action that impacts rare plant species, which include but are not limited to federally listed species: TDEC 0400-06-02-.04	May not knowingly uproot, dig, take, remove, damage, destroy, possess, or otherwise disturb for any purposes any endangered species.	*TCA* 70-8-309(a) 16 *USC* 1531 et seq. TDEC 0400-06-02-.04
Action that impacts Tennessee nongame species, including wildlife species which are "in need of management": *TCA* 70-8-101, *TCA* 70-8-103, TWRA Proclamations 00-14 and 00-15	May not take (i.e., harass, hunt, capture, kill or attempt to kill), possess, transport, export, or process wildlife species. May not knowingly destroy the habitat of such species. Certain exceptions may be allowed for reasons such as education, science, etc., or where necessary to alleviate property damage or protect human health or safety. Upon good cause shown and where necessary to protect human health or safety, endangered or threatened species or "in need of management" species may be removed, captured, or destroyed.	*TCA* 70-8-104(b) and (c) *TCA* 70-8-106(e)
Action that is likely to impact migratory birds: 50 *CFR* 10.13, EO 13186	Unlawful killing, possession, and sale of migratory bird species, as defined in 50 *CFR* 10.13, native to the United States or its territories is prohibited. Executive Order (EO) 13186 requires DOE to avoid or minimize the adverse impact of their actions on migratory birds and ensure that environmental analyses under the NEPA evaluate the effects of proposed federal actions on such species.	16 *USC* 703-711 EO 13186 January 10, 2001 (66 FR 3853)

3. METHODS

3.1 OVERVIEW

In addition to on-the-ground surveys by ORNL NRMP and Aquatic Ecology Group staff who routinely assess and are familiar with sensitive resources on the ORR, this report makes use of both historical (pre-1995) and contemporary (1995–present) data, as obtained from (1) previous reports and observations by NRMP, (2) reports made available to the ORR NRMP by researchers and contractors on the ORR, and (3) the TDEC's Natural Heritage Inventory Program. Historical observations (pre-1995) are especially relevant to quantify rare species, which are inherently difficult to detect. Thus, historical observations were presumed valid unless subsequent targeted surveys (1) failed to detect those resources, (2) other resources that are critical to the persistence of those resources were no longer present or adequate to support viable populations within the SSP-2A parcel or ORETTC project area, and (3) there was reasonable evidence that connectivity was impeded between the SSP-2A parcel or ORETTC project area and populations of sensitive taxa elsewhere on the ORR.

3.2 FOREST INVENTORY AND ANALYSIS

Forest conditions were assessed based on a previous forest inventory and supplemented with ground observation during summer 2020. A forest inventory for the Forest Management Compartments that contain the SSP-2A and ORETTC review areas was concluded in September 2011 (B. Johnston 2019, unpublished report to the ORNL NRMP).

A timber assessment was conducted according to ORR Wildland Fire and Forestry to aid in characterizing the forest and evaluate timber locations, timber quality, and ease of equipment access. Assessment of wildfire risk and the extent of residual vegetative debris was also prepared.

All projects involving the removal of timber on the ORR must follow ORR guidance, which includes use of a designated DOE timber salvage contractor at no cost to projects. After deduction of any access improvement costs, the contractor would remit to DOE funds that represent the stumpage (agreed merchantable value of timber) sold from the project site. The timber harvest operation should be planned in advance, subsequent to a timber assessment and based on project needs. Anticipated logging traffic should be planned and coordinated with other organizations that use or will use existing roads in the area.

3.3 SENSITIVE RESOURCES SURVEYS

3.3.1 Database review and initial screening

ORNL's NRMP compiled a list of endangered, threatened, rare, or otherwise sensitive focal taxa with potential to occur within the SSP-2A parcel. NRMP first reviewed the ORNL Natural Resources database for verified spatial records of sensitive resources within the vicinity of the review area. These taxa were considered contemporary records if they were documented after 1995. All others were considered historical records unless a later survey confirmed their presence within the SSP-2A parcel. NRMP then compiled a list of additional sensitive animal taxa with reasonable potential to occur within the SSP-2A parcel based on occurrence elsewhere on the ORR, rare and sensitive resources known to occur within the Tennessee counties of Anderson and Roane as identified through the TDEC's online Rare Species database (http://environment-online.state.tn.us:8080/pls/enf_reports/f?p=9014:3:0), and resources identified by an unofficial query of the USFWS's Information for Planning and Consultation tool (IPaC – https://ecos.fws.gov/ipac/, using the SSP-2A parcel as the input area) (USFWS 2020). Habitat parameters for each of the potential sensitive resources were compiled through the same sources. These parameters were later used to guide field-based survey.

3.3.2 Aquatic resources assessment

Environmental management and protection of aquatic features on the ORR is a priority for DOE and thus a major focus of several DOE and NERP programs. Accordingly, substantial prior effort was placed on inventory and understanding the connectivity of surface and subterranean aquatic features. Thus, we first reviewed previous aquatic resource delineation efforts and reports to determine locations of known streams, wetlands, and seeps within the SSP-2A parcel (e.g., Rosensteel 1996; Baranski 2009, 2011, 2018). We then used these data alongside new quantitative hydrology models to focus current field-based mapping.

Modeling hydrology within the SSP-2A Construction Area—LiDAR data at < 1-m resolution were obtained from a winter 2015/2016 flyover (USGS 2015, Kuxhausen 2016) of the ORR. These data, in conjunction with an inventory of 3,442 seeps, active springs, sinks, and caves on the ORR by the ORNL NRMP, were used to develop several hydrologic models (for additional details, see Wade and Carter 2020). These included surface water flow to identify streams and WWCs by catchment area via the

hydrology toolset in ArcMap 10.7 (ESRI 2018) and surface porosity (owing to karst features) via a diffusion model with elevation as a cumulative barrier in R (R Core Team 2020). The extensive inventory of macropores and other karst windows were used to either add or subtract from surface water according to their depth relative to the water table at originally mapped resolutions. These models were in turn used to focus field-based surveys herein via stream, wetland, and soil saturation predictions.

Field-based aquatic feature inventory within the SSP-2A parcel—Aquatic surveys were conducted between June and September 2020. When possible, surveys for sensitive aquatic or semi-aquatic species were conducted at the best time to locate those species (for additional details, see Section 3.3.3).

Integrating field and model based delineations—Newly acquired data were used to retrain models as new data were collected. Updated maps were used to better document the extensive aquatic resources within the SSP-2A parcel, gain a clearer understanding of aquatic connectivity in this area, and understand their relation to other sensitive resources such as stream or wetland obligate flora and fauna.

Field-mapped seeps/springs and stream and wetland boundaries presented here represent aquatic features within and adjacent to the SSP-2A parcel that were mapped via a Trimble Geo 7x by an experienced hydrologic technician trained in US Army Corps of Engineers (ACOE)/TDEC wetland delineation methods (ACOE 1987; TDEC 2015, 2020). All streams and channels with stream-like features that occur within the SSP-2A parcel were assessed via TDEC Hydrologic Determinations (TDEC 2020a). Potential ETW will require additional TDEC-prescribed assessment (TDEC 2015).

3.3.3 Wildlife surveys

Visual encounter surveys (VES)/cover boards—An initial survey of the entire SSP-2A parcel took place along a transect grid, with 53 equally spaced points generated in ArcMap 10.7 (ESRI 2018). Habitat was assessed within a minimum 30-m radius of each point and within visible distance along intervening transects. Surveyors maintained an active inventory of rare and sensitive species' habitat suitability by referencing and updating the previously compiled list of potential rare and sensitive taxa (Section 3.3.1). Further surveys concentrated effort in distinct sections of sensitive habitat features. To further aid in the detection of reptiles, amphibians, and small mammals, 32 coverboards were placed strategically throughout the site and checked during each VES survey. All wildlife encountered were recorded and photographed where possible.

Bat acoustic surveys—Bats are a primary focus of the ORNL NRMP because the ORR's forests, wetlands, and caves have potential to support several state- and federal-listed bats. Of the bats on the ORR (McCracken et al. 2015), the USFWS lists the Indiana bat (*Myotis sodalis*) and gray bat (*Myotis grisescens*) as Federally Endangered and the northern long-eared bat (*Myotis septentrionalis)* as Federally Threatened under the US Endangered Species Act (USFWS 2020). Additionally, the little brown bat (*Myotis lucifugus*) and tricolored bat (*Perimyotis subflavus*) are currently Under Review for listing under the ESA (USFWS 2020). All federal-listed bats and several additional bats of the ORR carry various special protection statuses specific to the state of Tennessee.

Eleven bat acoustic monitors (Wildlife Acoustics Song Meter SM4Bat FS Ultrasonic Recorders equipped with SMM-U2 microphones) were deployed in the SSP-2A parcel during summer forest roosting and maternity season (15 May–15 August) (Table 2). Sites were selected based on likelihood of use by bats as flyways to foraging grounds, foraging for prey, and for roosting/rearing young. Two detectors were placed along the stream riparian within the ORETTC footprint. Canopy cover at these sites varied from 60–85%. Microphones were mounted on 3-m poles and directed along the likely flyway. Recording began 30 minutes before sunset and ended 30 minutes after sunrise each night. Recordings were analyzed via

Kaleidoscope Pro Analysis Software V5, with both zero-crossing and full-spectrum analysis methods, as approved by the USFWS (2017).

Table 2. Bat acoustic monitor sites.

Site ID	Monitor ID	Date deployed	Nights deployed	Site description
SSP-1	SM4-1	6-26-2020	12	Gravel road through forest
SSP-2	SM4-4	6-26-2020	12	Mature forest, 65% canopy cover, 2 dead snags, fairly open midstory, suitable roost trees
SSP-3	SM4-3	6-26-2020	12	Mature forest, 70% canopy cover, open midstory, suitable roost trees
SSP-5	SM4-7	6-27-2020	11	Mature forest, 80% canopy cover, several dead snags, suitable roost trees, open midstory
SSP-6	SM4-8	6-27-2020	11	Mature forest, 85% canopy cover, suitable roost trees, fairly open midstory
SSP-7	SM4-7	7-14-2020	6	Mature forest, 80% canopy cover, open midstory, suitable roost trees
SSP-8	SM4-8	7-14-2020	6	Mature forest, 85–90% canopy cover, snags and suitable roost trees, open midstory
SSP-9	SM4-1	7-14-2020	6	Creek through mature forest, 70% canopy cover, few roost trees, fairly open midstory
SSP-10	SM4-2	7-14-2020	6	Small creek, cluttered forest
SSP-11	SM4-3	7-15-2020	6	Creek through mature forest, 90% canopy cover, suitable roost trees, open midstory
SSP-12	SM4-7	8/10/2020	4	Mature forest, 85% canopy cover, open midstory, suitable roost trees

Avian point counts—Migratory birds represent a major management focus for both ORNL and DOE; e.g., Carter et al. (2020a) provides details related to DOE's responsibilities specific to the ORR, and the 2013 memorandum of understanding between USFWS and DOE can be found at https://www.energy.gov/sites/prod/files/2013/10/f3/Final%20DOE-FWS%20Migratory%20Bird%20MOU.pdf).

To assess occupancy by and potential importance of the site for migratory birds, we combined historical species occurrence data primarily via ongoing Partners in Flight surveys across the ORR (Partners in Flight 2020). To provide a more detailed assessment specific to SSP-2A and ORETTC, we implemented avian point counts at eight equally spaced locations within the SSP-2A parcel. All bird species seen or heard within a period of 10 minutes at each point were recorded. Each avian point count site was visited twice throughout the survey period. Additionally, we recorded all birds seen and/or heard during visual encounter surveys and at each small mammal trap location (see below), which were visited eight times between 27 July 2020 and 7 August 2020.

Small mammal trapping—To quantify small mammal abundance and diversity, 61 Sherman live traps were positioned within the primary impact area and checked daily between 27 July 2020 and 7 August 2020.

Drift fence surveys (small vertebrates and invertebrates)—We installed a drift fence array to provide a more detailed assessment of small vertebrates within the northeastern portion of the survey area close to a

perennial stream. The drift fence array consisted of ~125 ft of silt fence installed in an "x" pattern with a four-way funnel trap at its center. The trap was checked daily, and bird seed, shelter, and a water source were provided between 15 July 2020 and 15 August 2020.

Camera-trap surveys—The area that encompasses the ORETTC footprint is known to be a wildlife corridor in eastern Tennessee (Carter et al. 2020a; Kwarta et al. in prep). To assess large mammal abundance and diversity within the area, seven trail cameras were deployed within the area for ~2 weeks per camera starting 29 June 2020 and continuing until 20 August 2020.

Nocturnal Species Survey—We implemented one 2-hour-long nighttime survey to observe nocturnal fauna in the survey area on 30 July 2020.

3.3.4 Plant surveys

A field survey for vascular plants was conducted primarily from 11–13 August 2020 within the ORETTC footprint. Notable or unusual species were also recorded and photographed during all wildlife and aquatic surveys for subsequent identification. Within the ORETTC footprint, linear search transects were positioned at 25-m intervals. Notable habitats (seeps, outcrops, and special habitats identified during the initial screening) were searched thoroughly by one to two surveyors with a combined 40 years of experience in the inventory of the ORR's flora.

4. RESULTS AND DISCUSSION

4.1 FOREST ANALYSIS (Note: this analysis was based on a previous conceptual design)

4.1.1 Forest inventory

Current condition of the SSP-2A area forest—The current condition of the SSP-2A forest can most easily be determined from a relatively recent forest inventory. The area was included in a forest inventory conducted in 2015 covering Forest Management Compartment 10, which lies in the north central portion of the ORR. Fieldwork for the inventory data used in this assessment was conducted from May 28, 2015, through August 7, 2015. Data compiled from a subset of 39 of the original 440 forest inventory points that were within the SSP-2A study area were extracted to prepare the following analysis (Figure 5).

Land use—Land use categories in the proposed SSP-2A, corresponding to habitat types, include forest and right-of-way; there are no instances of developed areas, edge, and water. Forest comprises approximately 94.2% (76.46 acres) of the area of the proposed SSP-2A (81.14 acres), and right-of-way comprises 5.8% (4.67 acres). Spatial distribution of land use types is shown in Figure 6.

Basal area—Total basal area of the SSP-2A forest in 2015 was 10,352 sq. ft. Standing dead trees accounted for approximately 4.61% of the total basal area. The average live basal area of forest was 122 sq. ft per acre.

A list of species and live tree basal area statistics are provided in Table 3. Forty-one species were identified; Fraxinus (ash) was identified to genus. Trees with a diameter at breast height (dbh, 4.5 ft) greater or equal to 10.0 in. accounted for 47.5% of the total basal area. Among trees greater than or equal to 10.0 in. dbh, five species contributed greater than 5% of forest basal area, including tulip poplar (33%), eastern redcedar (15%), loblolly pine (6%), Virginia pine (5%), and ash (5%). Among sapling-size trees (dbh greater than or equal to 2.0 in. and less than 10.0 in.), species ranking based on basal area representing > 5% included four species: loblolly pine (31%), tulip poplar (15%), American beech (9%), and ash (6%). Note that in the intervening 5 years since the inventory was conducted, most of the ash

trees on the ORR have succumbed to Emerald Ash Borer (EAB) infestations; live basal area for ash will by now have been considerably reduced.

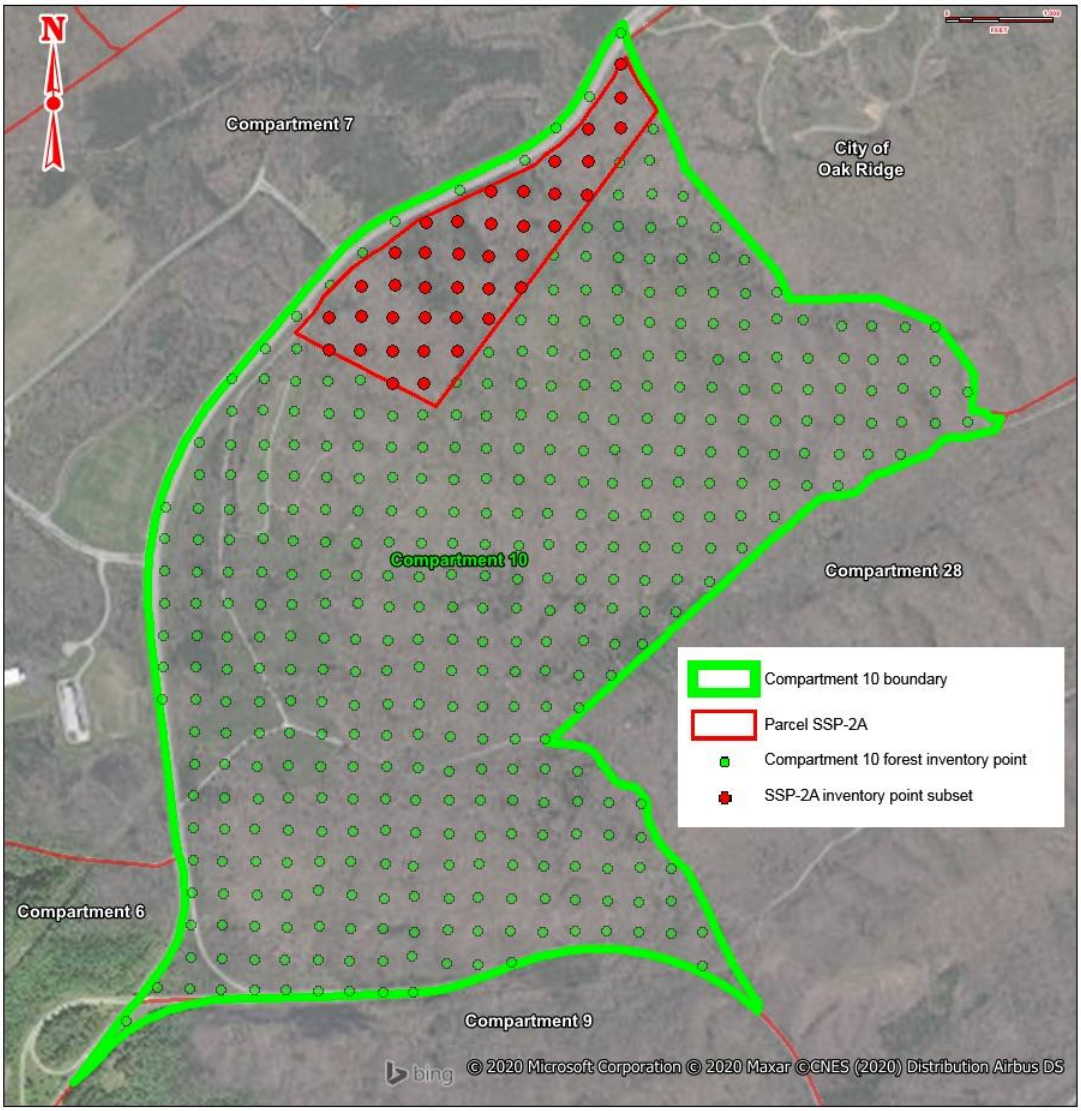

Figure 5. Forest inventory points for Compartment 10 (green) and the SSP-2A parcel (red).

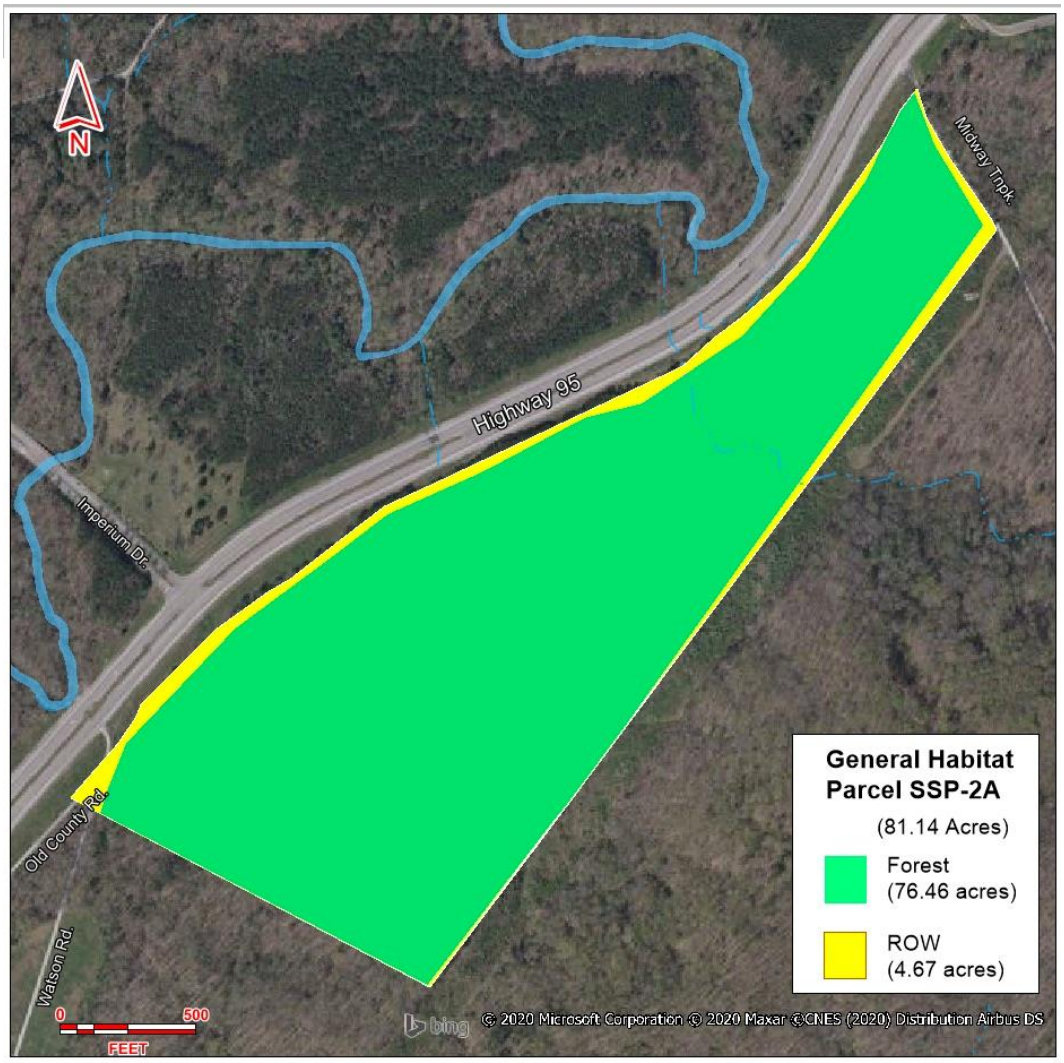

Figure 6. Land cover type within the SSP-2A parcel.

Table 3. Parcel SSP-2A species list and live tree basal area statistics.

		Basal Area (ft^2)				Basal Area (%)			
Scientific Name	Common Name	Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable	Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable
Acer rubrum	red maple	196	216	412	59	4%	4%	4%	2%
Acer saccharum	sugar maple	98	59	157	39	2%	1%	2%	1%
Aesculus flava	yellow buckeye	39	20	59		1%	0%	1%	0%
Carpinus caroliniana	iron wood	0	39	39		0%	1%	0%	0%
Carya cordiformis	bitternut hickory	20	20	39	20	0%	0%	0%	1%
Carya glabra	pignut hickory	78	0	78	39	2%	0%	1%	1%
Carya ovalis	sweet pignut hickory	0	39	39		0%	1%	0%	0%
Carya pallida	pale hickory	20	0	20	20	0%	0%	0%	1%
Carya tomentosa	mockernut hickory	0	20	20		0%	0%	0%	0%
Celtis sp.	hackberry	98	20	118	59	2%	0%	1%	2%
Cercis canadense	redbud	20	118	137		0%	2%	1%	0%
Cornus florida	flowering dogwood	0	176	176		0%	3%	2%	0%
Diospyros virginiana	persimmon	0	39	39		0%	1%	0%	0%
Fagus grandifolia	American beech	157	451	608	20	3%	9%	6%	1%
Fraxinus sp.	ash	235	294	529	20	5%	6%	5%	1%
Juglans nigra	black walnut	39	39	78	20	1%	1%	1%	1%
Juniperis virginiana	eastern red cedar	686	196	882	549	15%	4%	9%	17%
Liquidambar styraciflua	sweetgum	118	118	235	78	2%	2%	2%	2%
Liriodendron tulipifera	tulip poplar	1,568	784	2,353	1,314	33%	15%	24%	41%
Magnolia acuminata	cucumber magnolia	0	78	78		0%	2%	1%	0%
Morus rubra	red mulberry	20	0	20		0%	0%	0%	0%
Nyssa sylvatica	black gum	0	20	20		0%	0%	0%	0%
Ostrya virginiana	hophornbeam	0	20	20		0%	0%	0%	0%
Oxydendrum arboreum	sourwood	0	59	59		0%	1%	1%	0%
Pinus echinata	short-leaf pine	39	0	39	39	1%	0%	0%	1%
Pinus strobus	white pine	59	0	59	39	1%	0%	1%	1%
Pinus taeda	loblolly pine	294	1,608	1,902	294	6%	31%	19%	9%
Pinus virginiana	Virginia pine	255	59	314	176	5%	1%	3%	6%
Platanus occidentalis	sycamore	39	0	39		1%	0%	0%	0%
Prunus serotina	black cherry	78	216	294	39	2%	4%	3%	1%
Quercus alba	white oak	137	78	216	137	3%	2%	2%	4%
Quercus coccinea	scarlet oak	20	0	20	20	0%	0%	0%	1%
Quercus falcata	southern red oak	20	39	59	20	0%	1%	1%	1%
Quercus montana	chestnut oak	98	0	98	39	2%	0%	1%	1%
Quercus muehlenbergii	chinquapin oak	20	175	195		0%	3%	2%	0%
Quercus rubra	northern red oak	59	39	98	59	1%	1%	1%	2%
Quercus shumardii	Shumard oak	20	0	20	20	0%	0%	0%	1%
Sassafras albidum	sassafras	0	20	20		0%	0%	0%	0%
Tilia americana	basswood	39	20	59	20	1%	0%	1%	1%
Ulmus alata	winged elm	98	59	157	39	2%	1%	2%	1%
Ulmus americana	American elm	39	59	98		1%	1%	1%	0%
		4,705	5,194	9,900	3,176	100%	100%	100%	100%

At the genus level, poplar accounted for 33% of the live basal area of trees ≥ 10.0 in. dbh (Table 4) and provided only 15% of the sapling size class basal area. Pines accounted for 14% of the live basal area of trees ≥ 10.0 in. dbh but 32% of live basal area of trees < 10 in. dbh, indicating an increasing presence is possible over time. Eastern redcedar comprised 15% of the live basal area of trees ≥ 10.0 in. dbh but 4% of live basal area of trees < 10 inches dbh, indicating a decreasing presence is likely over time. Oaks accounted for only 8% of the live basal area of trees ≥ 10.0 in. dbh and 6% of live basal area of trees < 10 in. dbh. White oaks (includes white, chinquapin, and chestnut oaks) provided 5% of the live basal area of trees ≥ 10.0 in. dbh and 5% of the sapling size class basal area. Red oaks (includes northern red, southern red, scarlet, and Shumard oaks) provided 3% of the live basal area of trees ≥ 10.0 in. dbh and 2% of the sapling size class basal area. Beech (6%), maple (6%), and ash (5%) were the only others representing greater than 5% of total basal area.

Tree number and density—Number of live trees and saplings in the SSP-2A forest in 2015 totaled 44,627, averaging 550 stems per acre of trees > 2.0 in. dbh (Table 5). There were 51.8 trees > 9.9 in. dbh

per acre on average across all forested sample points in the area, totaling 3,959 trees. There was an average of 498.2 sapling trees (< 10.0 in. dbh) per acre in this forest, totaling 38,091 saplings. For trees ≥ 10.0 in. dbh, tulip poplar (14.6) provided the greatest average number of stems per acre, followed by eastern redcedar (8.0), loblolly pine (4.9), Virginia pine (3.6), and ash (2.8). Among sapling-size trees, species ranking for average number of stems per acre included loblolly pine (97.9), beech (82.3), tulip poplar (45.0), dogwood (35.4), ash (28.9), sweetgum (27.8), and chinquapin oak (24.9).

Table 4. Parcel SSP-2A live tree basal area statistics by genus.

		Basal Area (ft^2)				Basal Area (%)			
Scientific Name	Common Name	Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable	Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable
Liriodendron	tulip poplar	1,568	784	2,353	1,314	33%	15%	24%	41%
Pinus	pine	647	1,666	2,313	549	14%	32%	23%	17%
Juniperis	eastern red cedar	686	196	882	549	15%	4%	9%	17%
Quecus	oak	373	332	705	294	8%	6%	7%	9%
	white oak group	255	254	509	176	5%	5%	5%	6%
	red oak group	118	78	196	118	3%	2%	2%	4%
Fagus	beech	157	451	608	20	3%	9%	6%	1%
Acer	maple	294	274	569	98	6%	5%	6%	3%
Fraxinus	ash	235	294	529	20	5%	6%	5%	1%
Prunus	black cherry	78	216	294	39	2%	4%	3%	1%
Ulmus	elm	137	118	255	39	3%	2%	3%	1%
Liquidambar	sweetgum	118	118	235	78	2%	2%	2%	2%
Carya	hickory	118	78	196	78	3%	2%	2%	2%
Cornus	flowering dogwood	0	176	176		0%	3%	2%	0%
Cercis	redbud	20	118	137		0%	2%	1%	0%
Celtis	hackberry	98	20	118	59	2%	0%	1%	2%
Juglans	walnut	39	39	78	20	1%	1%	1%	1%
Magnolia	magnolia	0	78	78		0%	2%	1%	0%
Aesculus	buckeye	39	20	59		1%	0%	1%	0%
Oxydendrum	sourwood	0	59	59		0%	1%	1%	0%
Tilia	basswood	39	20	59	20	1%	0%	1%	1%
Carpinus	iron wood	0	39	39		0%	1%	0%	0%
Diospyros	persimmon	0	39	39		0%	1%	0%	0%
Platanus	sycamore	39	0	39		1%	0%	0%	0%
Morus	mulberry	20	0	20		0%	0%	0%	0%
Nyssa	black gum	0	20	20		0%	0%	0%	0%
Ostrya	hophornbeam	0	20	20		0%	0%	0%	0%
Sassafras	sassafras	0	20	20		0%	0%	0%	0%
		4,705	5,194	9,900	3,176	100%	100%	100%	100%

Volume of merchantable timber—Volume of merchantable timber in the SSP-2A in 2015 totaled 353,501 board feet (bf, International ¼ in. rule), averaging 4,623.3 bf per acre (Table 6). Tulip poplar (171,934 bf), eastern redcedar (45,712 bf), loblolly pine (26,309 bf), Virginia pine (17,957 bf), and white oak (16,078 bf) collectively contributed 78.5% of the merchantable timber in this area. Species rank for the number of merchantable stems (Table 5) included tulip poplar (901), eastern redcedar (480), loblolly pine (371), Virginia pine (182), and hackberry (74). Table 7 provides the merchantable volume ranking at the genus level. Tulip poplar, pine, redcedar, and oaks accounted for 87% of the marketable timber in the area. To estimate the current volume of timber, the volumes determined from the 2015 inventory may be adjusted by compounding over the five intervening growing seasons. A modest annual volume growth rate of 3% was assumed and applied to reflect an estimate of present stand volume. For example, total volume at the time of this report would approach 409,805 bf, or 5,360 bf per acre.

Table 5. Parcel SSP-2A tree density per acre.

		Total Trees				Average Trees per Acre			
Scientific Name	Common Name	Trees dbh > 10.0 inches	Saplings 2 > dbh < 10.0 inches	All tally trees (dbh > 2.0 in)	Merchantible Trees	Trees dbh > 10.0 inches	Saplings 2 > dbh < 10.0 inches	All tally trees (dbh > 2.0 inches)	Merchantible Trees
Pinus taeda	loblolly pine	371	7,489	7,860	371	4.9	97.9	102.8	4.9
Fagus grandifolia	American beech	126	6,292	6,418	15	1.6	82.3	83.9	0.2
Liriodendron tulipifera	tulip poplar	1,117	3,439	4,556	901	14.6	45.0	59.6	11.8
Cornus florida	flowering dogwood	0	2,705	2,705	0	0.0	35.4	35.4	0.0
Fraxinus sp.	ash	218	2,206	2,424	18	2.9	28.9	31.7	0.2
Liquidambar styraciflua	sweetgum	91	2,125	2,216	53	1.2	27.8	29.0	0.7
Quercus muehlenbergii	chinquapin oak	5	1,904	1,909	0	0.1	24.9	25.0	0.0
Acer rubrum	red maple	164	1,883	2,047	38	2.1	24.6	26.8	0.5
Prunus serotina	black cherry	96	1,551	1,647	38	1.3	20.3	21.5	0.5
Oxydendrum arboreum	sourwood	0	1,163	1,163	0	0.0	15.2	15.2	0.0
Ulmus americana	American elm	45	913	958	0	0.6	11.9	12.5	0.0
Cercis canadense	redbud	35	849	884	0	0.5	11.1	11.6	0.0
Carya ovalis	sweet pignut hickory	0	681	681	0	0.0	8.9	8.9	0.0
Quercus alba	white oak	58	660	718	58	0.8	8.6	9.4	0.8
Juniperis virginiana	eastern red cedar	608	605	1,213	480	8.0	7.9	15.9	6.3
Magnolia acuminata	cucumber magnolia	0	567	567	0	0.0	7.4	7.4	0.0
Ostrya virginiana	hophornbeam	0	532	532	0	0.0	7.0	7.0	0.0
Carpinus caroliniana	iron wood	0	499	499	0	0.0	6.5	6.5	0.0
Quercus falcata	southern red oak	9	332	341	9	0.1	4.3	4.5	0.1
Ulmus alata	winged elm	99	258	357	36	1.3	3.4	4.7	0.5
Acer saccharum	sugar maple	51	258	309	0	0.7	3.4	4.0	0.0
Pinus virginiana	Virginia pine	272	189	461	182	3.6	2.5	6.0	2.4
Quercus rubra	northern red oak	37	172	209	37	0.5	2.2	2.7	0.5
Diospyros virginiana	persimmon	0	170	170	0	0.0	2.2	2.2	0.0
Tilia americana	basswood	53	123	176	21	0.7	1.6	2.3	0.3
Aesculus flava	yellow buckeye	29	103	132	15	0.4	1.3	1.7	0.2
Sassafras albidum	sassafras	0	103	103	0	0.0	1.3	1.3	0.0
Juglans nigra	black walnut	29	86	115	14	0.4	1.1	1.5	0.2
Carya cordiformis	bitternut hickory	13	69	82	13	0.2	0.9	1.1	0.2
Carya tomentosa	mockernut hickory	0	64	64	0	0.0	0.8	0.8	0.0
Celtis sp.	hackberry	121	56	177	74	1.6	0.7	2.3	1.0
Nyssa sylvatica	black gum	0	45	45	0	0.0	0.6	0.6	0.0
Carya glabra	pignut hickory	79	0	79	43	1.0	0.0	1.0	0.6
Pinus strobus	white pine	44	0	44	28	0.6	0.0	0.6	0.4
Platanus occidentalis	sycamore	44	0	44	0	0.6	0.0	0.6	0.0
Quercus montana	chestnut oak	42	0	42	11	0.5	0.0	0.5	0.1
Morus rubra	red mulberry	31	0	31	0	0.4	0.0	0.4	0.0
Pinus echinata	short-leaf pine	29	0	29	29	0.4	0.0	0.4	0.4
Carya pallida	pale hickory	27	0	27	27	0.4	0.0	0.4	0.4
Quercus coccinea	scarlet oak	8	0	8	8	0.1	0.0	0.1	0.1
Quercus shumardii	Shumard oak	8	0	8	8	0.1	0.0	0.1	0.1
		3,959	38,091	42,050	2,527	51.8	498.2	550.0	33.0

Table 6. Parcel SSP-2A timber volume per acre, by species.

		Volume (bf)		Present Volume (bf)	
Scientific Name	Common Name	Compartment Total	Average per Acre	Tract Total	Average per Acre
Liriodendron tulipifera	tulip poplar	171,934	2,249	199,319	2,607
Juniperis virginiana	eastern red cedar	45,712	598	52,993	693
Pinus taeda	loblolly pine	26,309	344	30,499	399
Pinus virginiana	Virginia pine	17,957	235	20,817	272
Quercus alba	white oak	16,078	210	18,639	244
Liquidambar styraciflua	sweetgum	9,127	119	10,581	138
Quercus rubra	northern red oak	8,381	110	9,716	127
Quercus montana	chestnut oak	6,552	86	7,596	99
Acer rubrum	red maple	5,107	67	5,920	77
Pinus strobus	white pine	4,589	60	5,320	70
Pinus echinata	short-leaf pine	4,470	58	5,182	68
Prunus serotina	black cherry	4,378	57	5,075	66
Aesculus flava	yellow buckeye	4,311	56	4,998	65
Celtis sp.	hackberry	4,213	55	4,884	64
Ulmus alata	winged elm	4,013	52	4,652	61
Carya glabra	pignut hickory	3,334	44	3,865	51
Juglans nigra	black walnut	2,914	38	3,378	44
Quercus coccinea	scarlet oak	2,645	35	3,066	40
Quercus falcata	southern red oak	2,619	34	3,036	40
Fagus grandifolia	American beech	2,006	26	2,326	30
Fraxinus sp.	ash	1,954	26	2,265	30
Quercus shumardii	Shumard oak	1,578	21	1,829	24
Carya cordiformis	bitternut hickory	1,519	20	1,761	23
Tilia americana	basswood	1,440	19	1,669	22
Carya pallida	pale hickory	361	5	418	5
	Total	353,501	4,623	409,805	5,360

Table 7. Parcel SSP-2A timber volume per acre, by genus.

		Volume (bf)		Present Volume (bf)	
Scientific Name	Common Name	Compartment Total	Average per Acre	Tract Total	Average per Acre
Liriodendron	tulip poplar	171,934	2,249	199,319	2,607
Pinus	pine	53,325	697	61,818	809
Juniperis	eastern red cedar	45,712	598	52,993	693
Quecus	oak	37,853	495	43,882	574
	white oak group	22,630	296	26,234	343
	red oak group	15,223	199	17,648	231
Liquidambar	sweetgum	9,127	119	10,581	138
Carya	hickory	5,214	68	6,044	79
Acer	maple	5,107	67	5,920	77
Prunus	black cherry	4,378	57	5,075	66
Aesculus	buckeye	4,311	56	4,998	65
Celtis	hackberry	4,213	55	4,884	64
Ulmus	elm	4,013	52	4,652	61
Juglans	walnut	2,914	38	3,378	44
Fagus	beech	2,006	26	2,326	30
Fraxinus	ash	1,954	26	2,265	30
Tilia	basswood	1,440	19	1,669	22
	Total	353,501	4,623	409,805	5,360

Large diameter trees—Table 8 provides a list of the largest diameter trees of selected species and a count of all tally trees greater than 30 in. dbh, measured at sample points in the area. The tally tree with

greatest dbh in the area was a 42.7-in. yellow buckeye. There were six tally trees with dbh ≥ 30 in., of which three were tulip poplar and one was an ash, likely now dead due to EAB. The locations of trees greater than 30 in. dbh in and around the parcel are shown in Figure 7.

Table 8. Parcel SSP-2A largest diameter of selected species and number of trees over 30 in. in diameter.

Scientific name	Common Name	dbh of largest tally tree (inches)	Number of tally trees with dbh >= 30.0 inches
Acer rubrum	red maple	24.4	
Acer saccharum	sugar maple	24.8	
Aesculus flava	yellow buckeye	42.7	1
Carpinus caroliniana	iron wood	3.7	
Carya cordiformis	bitternut hickory	16.7	
Carya glabra	pignut hickory	14.4	
Carya ovalis	sweet pignut hickory	3.3	
Carya pallida	pale hickory	11.6	
Carya tomentosa	mockernut hickory	7.5	
Celtis sp.	hackberry	14.1	
Cercis canadense	redbud	10.1	
Cornus florida	flowering dogwood	6.8	
Diospyros virginiana	persimmon	9.2	
Fagus grandifolia	American beech	27.8	
Fraxinus sp.	ash	32.1	1
Juglans nigra	black walnut	15.9	
Juniperis virginiana	eastern red cedar	24.9	
Liquidambar styraciflua	sweetgum	21.8	
Liriodendron tulipifera	tulip poplar	37.7	3
Magnolia acuminata	cucumber magnolia	9.2	
Morus rubra	red mulberry	10.8	
Nyssa sylvatica	black gum	8.9	
Ostrya virginiana	hophornbeam	2.6	
Oxydendrum arboreum	sourwood	8.9	
Pinus echinata	short-leaf pine	17.7	
Pinus strobus	white pine	21.5	
Pinus taeda	loblolly pine	17.8	
Pinus virginiana	Virginia pine	18.9	
Platanus occidentalis	sycamore	21.4	
Prunus serotina	black cherry	16.8	
Quercus alba	white oak	30.9	1
Quercus coccinea	scarlet oak	20.6	
Quercus falcata	southern red oak	19.7	
Quercus montana	chestnut oak	26.9	
Quercus muehlenbergii	chinquapin oak	28.1	
Quercus rubra	northern red oak	27.9	
Quercus shumardii	Shumard oak	21.1	
Sassafras albidum	sassafras	5.9	
Tilia americana	basswood	13.2	
Ulmus alata	winged elm	20.1	
Ulmus americana	American elm	13.4	
		Total >= 30.0	6

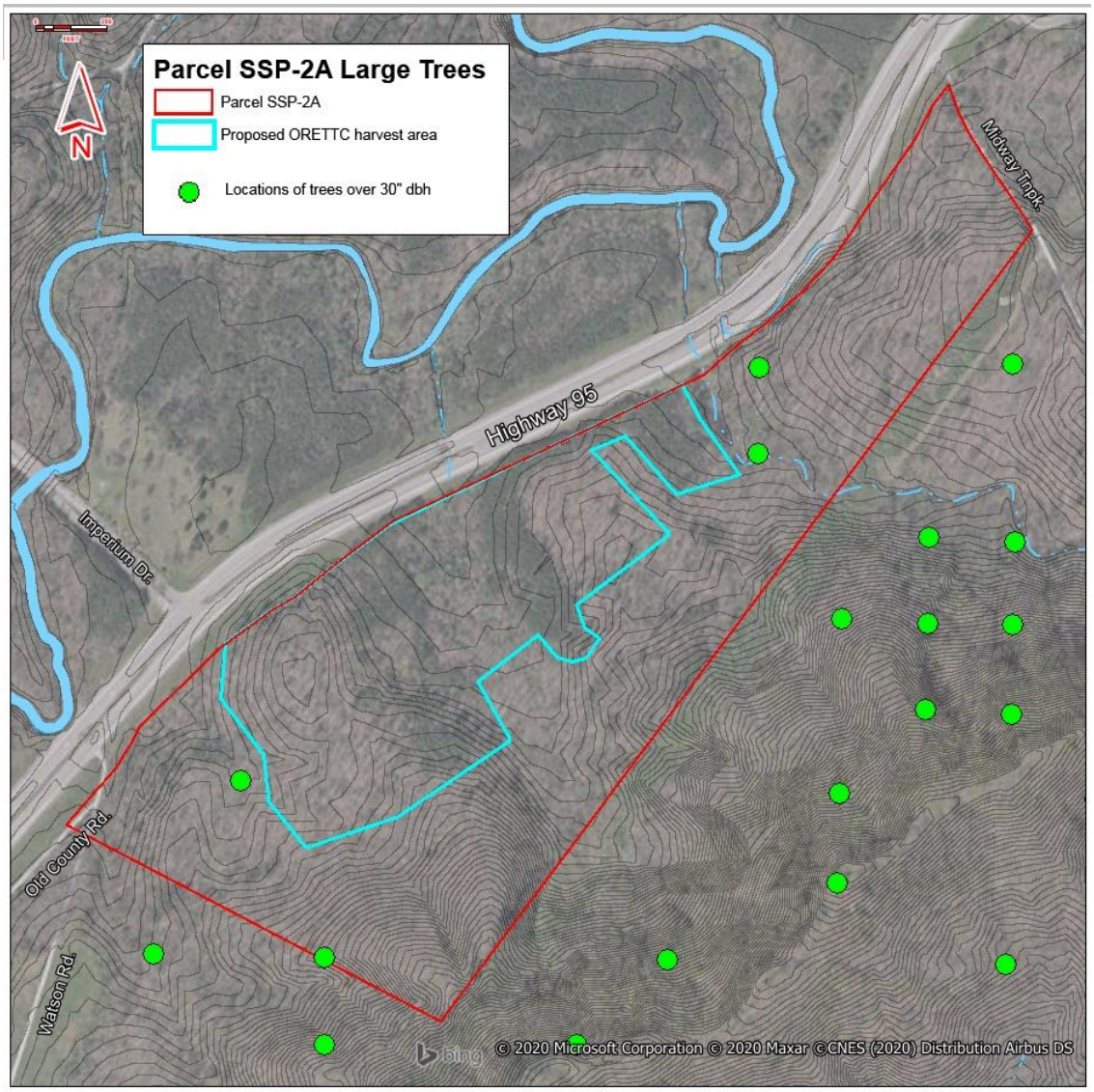

Figure 7. Large diameter trees within the SSP-2A parcel. (Note: ORETTC boundaries shown are based off a previous conceptual design. See Figures 2, 3 and 19 for latest project design and boundaries of disturbance.)

Additional observations—Due to the impact of the introduction of an invasive exotic insect, the Emerald Ash Borer (EAB), ash species (*Fraxinus*) on the site, originally representing approximately 0.8% of the live basal area but none of the merchantable volume may now be considered absent from the live component of the current SSP-2A forest.

In 2015, eight invasive plant species were recorded within the forest at 37 of the 39 inventory points. Species noted include Japanese honeysuckle (*Lonicera japonica*, at 36 points), Japanese stiltgrass (*Microstegium vimineum*, at 20 points), privet (*Ligustrum* spp. at 18 points), autumn-olive (*Elaeagnus umbellata*, at 14 points), and Amur honeysuckle (*Lonicera maackii*, at 6 points). Winged burning bush (*Euonymus alatus*), multiflora rose (*Rosa multiflora*), and fire thorn (*Pyrocantha* spp.) were observed at one point each. The extensive prevalence of invasives would appear to be a consequence of forest

fragmentation resulting from the presence of right-of-way clearing for both the TVA power line and Highway 95 and extensive pine clearing during efforts to control southern pine beetles in 1994.

4.1.2 Forest conditions within the ORETTC site

Forest condition within the ORETTC construction area—The forest within the ORETTC footprint (per the design of 7/24/2020) can be characterized by further extraction of the 2015 forest inventory data. A subset of 14 of the original inventory points that fell within the proposed ORETTC construction site was used to prepare the following analysis (Figure 8). The total area considered for this examination was 27.6 acres, composed of the 24.1-acre footprint, plus an additional 3.5 acres to remove hazard trees and dense pine that would present high-intensity wildfire fuels adjacent to the proposed facility.

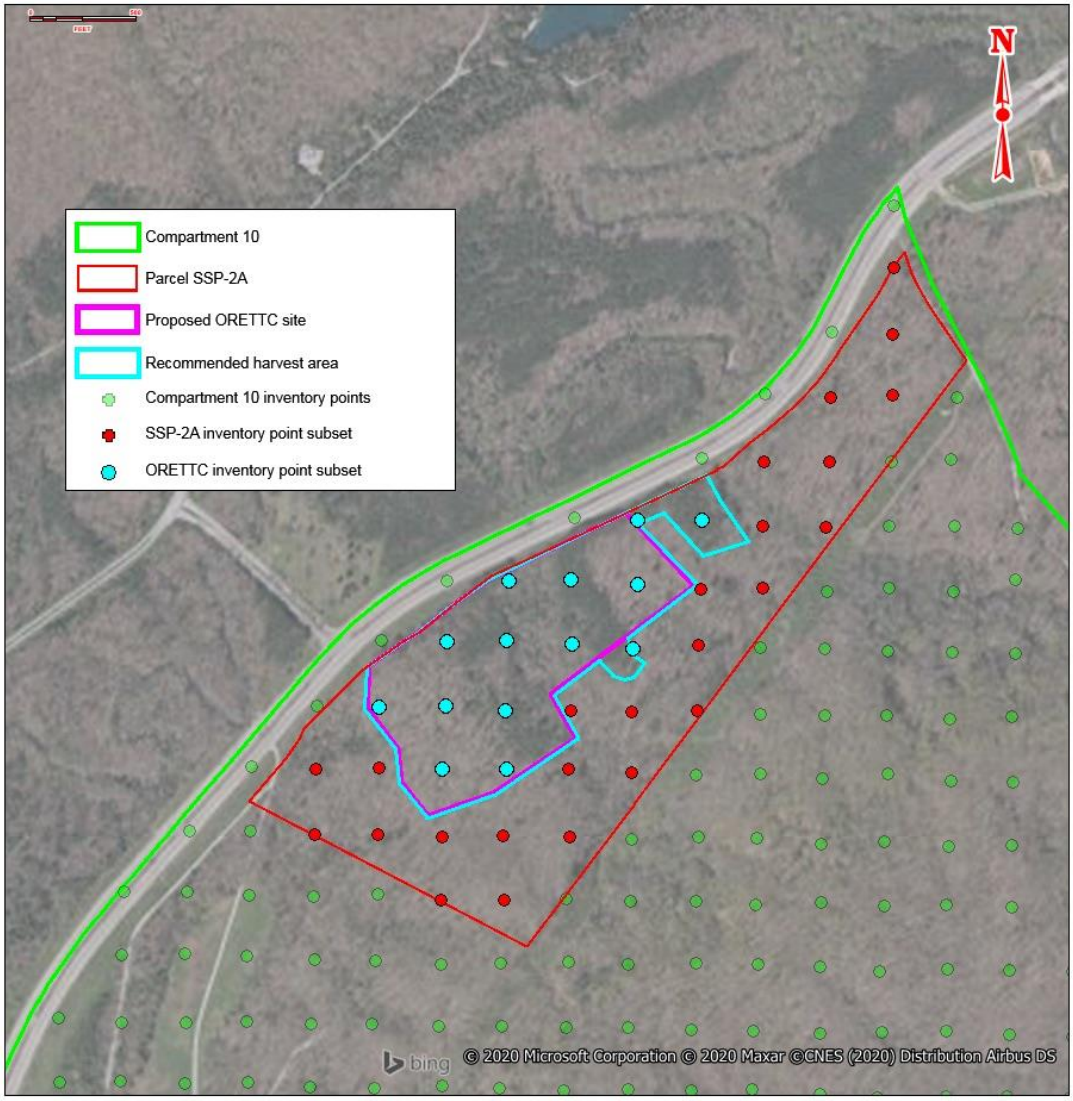

Figure 8. Subset of forest inventory points for the SSP-2A parcel, ORETTC footprint, and ORETTC timber harvest/fuel reduction area. (Note: ORETTC boundaries shown are based off a previous conceptual design. See Figures 2, 3 and 19 for latest project design and boundaries of disturbance.)

Basal area—Total basal area of the forest within the ORETTC site was 4,205 sq. ft. Standing dead trees accounted for approximately 11.8% of the total basal area (and by now would constitute a significant amount of dead and down wildfire fuels). The average live basal area of forest was 142 sq. ft per acre, a bit denser than the overall SSP-2A parcel.

A list of 22 species, with respective live tree basal area statistics, is provided in Table 9. Trees with a dbh greater or equal to 10.0 in. accounted for only 31.7% of the total basal area. Among trees greater than or equal to 10.0 in. dbh, four species contributed greater than 5% of the forest basal area, including eastern redcedar (32%), tulip poplar (21%), loblolly pine (17%), and ash (6%). Among sapling-size trees (dbh greater than or equal to 2.0 in. and less than 10.0 in.), species ranking based on basal area representing > 5% included four species: loblolly pine (59%), tulip poplar, (7%), American beech (6%), and ash (6%). Note that in the intervening 5 years since the inventory was conducted, most of the ash trees on the ORR have succumbed to EAB infestations; live basal area for ash by now will have been considerably reduced and contribute to an even higher percentage of standing dead basal area, or increased dead and down material.

Tree number and density—The number of live trees and saplings in the proposed construction area forest in 2015 totaled 21,787, averaging a considerably dense 781stems per acre (Table 10). There were 47.0 trees >9.9 in. dbh per acre on average across the area, totaling 1,311trees. There was an average of 733.9 sapling trees (< 10.0 in. dbh) per acre in this forest, totaling 20,476 saplings. For trees ≥10.0 in. dbh, eastern redcedar (11.8) provided the greatest average number of stems per acre, followed by loblolly pine (10.9) and tulip poplar (9.3). Among sapling-size trees, species ranking for average number of stems per acre included loblolly pine (268.8), beech (129.4), ash (48.1), sweetgum (45.3), sourwood (40.7), American elm (30.4), black cherry (30.1), and tulip poplar (28.3).

Volume of merchantable timber—The volume of merchantable timber in the ORETTC site in 2015 totaled 80,444 bf, averaging 2,883.3 bf per acre (Table 11). Eastern redcedar (27,815 bf), tulip poplar (24,012 bf), and loblolly pine (15,957 bf) collectively contributed 84.2% of the merchantable timber in this area. To estimate the current volume of timber, the volumes determined from the 2015 inventory may be adjusted by compounding over the five intervening growing seasons. Given the younger age of the timber, a somewhat more aggressive annual volume growth rate of 5% was assumed and applied to reflect an estimate of present stand volume. For example, the total volume at the time of this report, excluding ash mortality, would approach 100,134 bf, or 3,589 bf per acre.

Large diameter trees—No trees in excess of 30 in. dbh were tallied on the proposed ORETTC construction site during the 2015 forest inventory. The tally tree with greatest dbh in the ORETTC area was a 27.9-in. northern red oak.

Table 9. ORETTC site species list and live tree per acre statistics.

		Basal Area (ft^2)				Basal Area (%)			
Scientific Name	Common Name	Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable	Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable
Acer rubrum	red maple	40	60	100		3%	2%	3%	0%
Carpinus caroliniana	iron wood	0	20	20		0%	1%	1%	0%
Celtis sp.	hackberry	20	0	20		2%	0%	1%	0%
Cercis canadense	redbud	20	40	60		2%	1%	2%	0%
Cornus florida	flowering dogwood	0	20	20		0%	1%	1%	0%
Fagus grandifolia	American beech	20	159	179		2%	6%	5%	0%
Fraxinus sp.	ash	80	159	239	20	6%	6%	6%	2%
Juniperis virginiana	eastern red cedar	399	60	458	339	32%	2%	12%	39%
Liquidambar styraciflua	sweetgum	20	80	100	20	2%	3%	3%	2%
Liriodendron tulipifera	tulip poplar	259	199	458	219	21%	7%	12%	25%
Magnolia acuminata	cucumber magnolia	0	20	20		0%	1%	1%	0%
Nyssa sylvatica	black gum	0	20	20		0%	1%	1%	0%
Oxydendrum arboreum	sourwood	0	40	40		0%	1%	1%	0%
Pinus taeda	loblolly pine	219	1,594	1,814	219	17%	59%	46%	25%
Platanus occidentalis	sycamore	20	0	20		2%	0%	1%	0%
Prunus serotina	black cherry	60	60	120	20	5%	2%	3%	2%
Quercus alba	white oak	0	20	20		0%	1%	1%	0%
Quercus falcata	southern red oak	20	20	40	20	2%	1%	1%	2%
Quercus muehlenbergii	chinquapin oak	0	80	80		0%	3%	2%	0%
Quercus rubra	northern red oak	20	0	20	20	2%	0%	1%	2%
Ulmus alata	winged elm	40	20	60		3%	1%	2%	0%
Ulmus americana	American elm	20	40	60		2%	1%	2%	0%
		1,256	2,710	3,966	877	100%	100%	100%	100%
	Totals	31.7%	68.3%	100%					

Table 10. ORETTC site tree density per acre.

		Total Trees				Average Trees per Acre			
Scientific Name	Common Name	Trees dbh > 10.0 inches	Saplings 2 > dbh < 10.0 inches	All tally trees (dbh > 2.0 in)	Merchantible Trees	Trees dbh ≥ 10.0 inches	Saplings 2 > dbh < 10.0 inches	All tally trees (dbh > 2.0 inches)	Merchantible Trees
Acer rubrum	red maple	36	632	668	18	1.3	22.6	23.9	0.6
Carpinus caroliniana	iron wood	0	240	240		0.0	8.6	8.6	0.0
Celtis sp.	hackberry	26	0	26		0.9	0.0	0.9	0.0
Cercis canadense	redbud	36	335	371		1.3	12.0	13.3	0.0
Cornus florida	flowering dogwood	0	253	253		0.0	9.1	9.1	0.0
Fagus grandifolia	American beech	22	3,610	3,631		0.8	129.4	130.1	0.0
Fraxinus sp.	ash	83	1,343	1,426		3.0	48.1	51.1	0.0
Juniperis virginiana	eastern red cedar	330	142	471	287	11.8	5.1	16.9	10.3
Liquidambar styraciflua	sweetgum	8	1,262	1,270	8	0.3	45.3	45.5	0.3
Liriodendron tulipifera	tulip poplar	258	788	1,047	210	9.3	28.3	37.5	7.5
Magnolia acuminata	cucumber magnolia	0	140	140		0.0	5.0	5.0	0.0
Nyssa sylvatica	black gum	0	46	46		0.0	1.7	1.7	0.0
Oxydendrum arboreum	sourwood	0	1,136	1,136		0.0	40.7	40.7	0.0
Pinus taeda	loblolly pine	304	7,500	7,803	304	10.9	268.8	279.7	10.9
Platanus occidentalis	sycamore	37	0	37		1.3	0.0	1.3	0.0
Prunus serotina	black cherry	85	841	926	25	3.0	30.1	33.2	0.9
Quercus alba	white oak	0	282	282		0.0	10.1	10.1	0.0
Quercus falcata	southern red oak	9	282	291	9	0.3	10.1	10.4	0.3
Quercus muehlenbergii	chinquapin oak	0	694	694		0.0	24.9	24.9	0.0
Quercus rubra	northern red oak	5	0	5	5	0.2	0.0	0.2	0.2
Ulmus alata	winged elm	53	101	154		1.9	3.6	5.5	0.0
Ulmus americana	American elm	20	849	870		0.7	30.4	31.2	0.0
		1,311	20,476	21,787	866	47.0	733.9	780.9	31.0

Table 11. ORETTC site timber volume by species.

Scientific Name	Common Name	Volume (bf)		Present Volume (bf)	
		Compartment Total	Average per Acre	Tract Total*	Average per Acre
Juniperis virginiana	eastern red cedar	27,815	997	35,500	1,272
Liriodendron tulipifera	tulip poplar	24,012	861	30,646	1,098
Pinus taeda	loblolly pine	15,957	572	20,365	730
Quercus rubra	northern red oak	3,400	122	4,339	156
Liquidambar styraciflua	sweetgum	2,722	98	3,474	125
Quercus falcata	southern red oak	2,662	95	3,398	122
Fraxinus sp.	ash	1,986	71	0	0
Prunus serotina	black cherry	1,890	68	2,413	86
	Total	80,444	2,883	100,134	3,589

* Ash volumes not considered to be present following recent Emerald Ash Borer infestation.

4.1.3 Timber clearing and disposal

Timber clearing—Timber (the marketable portion of the forest) is considered a DOE Realty asset and must therefore be properly disposed. DOE currently has a timber sale agreement in place with a local wood-using business, Oak Ridge Hardwoods, LLC (RE-Timber-03-0001). This contractor has the option to harvest or otherwise recover merchantable wood from project sites and in return agrees to remit to DOE an established stumpage (price per unit of wood removed). The Reservation Forester coordinates the execution of the agreement on behalf of the Real Estate Officer, and any supported project's interface with logging personnel would be via the Forester. Among other terms, the agreements will specify "The Guide to Forestry Best Management Practices in Tennessee" as appropriate erosion control guidance and other requirements such as OSHA Title 29 CFR, Part 1910.266, "Logging Operations." During field surveys to determine the forest conditions, a general plan was developed for harvesting equipment to reach the timber, staging areas (log landings) to handle and load logs, and safe egress of loaded log trucks to reach public roads and marketing venues. There would be no cost to the project for these actions. Further, a project may experience a significant cost abatement as the volume of the site vegetation to be disposed is greatly reduced.

It is recommended that the contractor be provided project timelines and allowed to examine the site as soon as possible prior to SSP-2A Construction Area footprint clearing to verify timber quality, volume estimates, and access requirements and to arrange for a qualified logging crew to perform the harvest. The duration of logging operations varies with site size, terrain and access limitations, and seasonal weather and may be further constrained by timing considerations to protect endangered species or administrative delays caused by competing site security or utility operations. Ideally, a planning allowance of at least 12 months in advance of construction startup should be adequate for the logging period and potential delays.

It is important to understand that residual vegetation woody debris would remain following the harvest and that the land use would technically still be considered "forestland." The construction project would be responsible for taking the defining steps of converting the harvested forestland to a "developed" land use classification by initiating activities that are more purely "clearing" (removal of all vegetation, leaf litter, stumps, soil grading, etc.). The DOE timber sale agreement does not include any requirement for the performance of land clearing; state forestry best management practices would apply to the site until development is initiated.

Logging access/egress—The SSP-2A site is directly accessible from State Route 95 (Oak Ridge Turnpike) from two existing points that avoid wetland crossings. There is a designed woodlands access point from SR 95 585 ft northeast of the Imperium Drive intersection. Midway Turnpike is also an established logging access point to SR 95 and preferable for activities on the eastern portion of the tract.

Timber taken from the site would likely be sent in either of two different directions, depending on the markets used. For wood taken to Oak Ridge and other points to the northeast, typical routing would be northeastward along SR 95 into the business district of Oak Ridge, then westward on SR 62 to SR 61, and then eastward to the Oak Ridge Hardwoods Mill in Marlowe. For wood taken toward Kingston and points west, typical routing would be southwestwardly along SR 95 to Oak Ridge Forest Products' chipping facility at ETTP on the ORR or onward to I-40 and points southward. Figure 9 illustrates how a logging plan for the ORETTC facility might appear (large arrows indicate previously used logging access to Highway 95).

Disposal of residual vegetation—The preferred method for disposing of remaining vegetation is grinding/mulching. The mulched material may be repurposed as erosion control cover and berms, though depths may be recommended in order to promote biotic recovery and discourage leachates entering

nearby waterways. It is recommended nearby ORR sites be identified beforehand that could accommodate staging of any surplus mulch. To limit the impact of complete vegetation removal, this can be performed piecemeal, depending on the pace of the site grade work, though care must be taken to avoid leaving inaccessible pockets of debris that would become increased residual wildfire fuel loads.

Alternatively, woody debris may be burned in place with trench, pile, or windrow burning. Per the DOE ORR Wildland Fire Management Plan, all open burning on the ORR requires review and authorization by the Federal Reservation Manager, the appropriate site office, and the Reservation Forester; prerequisite burn plan development, review, and authorization can typically require 6–8 weeks to complete.

Given the unknown size of the proposed clearing, the amount of residual debris would be difficult to estimate but could overwhelm the capacity of ORR's Hawk's Nest Woody Debris Disposal Facility at ORNL. The burnyard is nearly 9 miles away, so hauling would not be economically feasible nor recommended.

Due to wildfire risk, under no circumstances should woody debris be left onsite untreated.

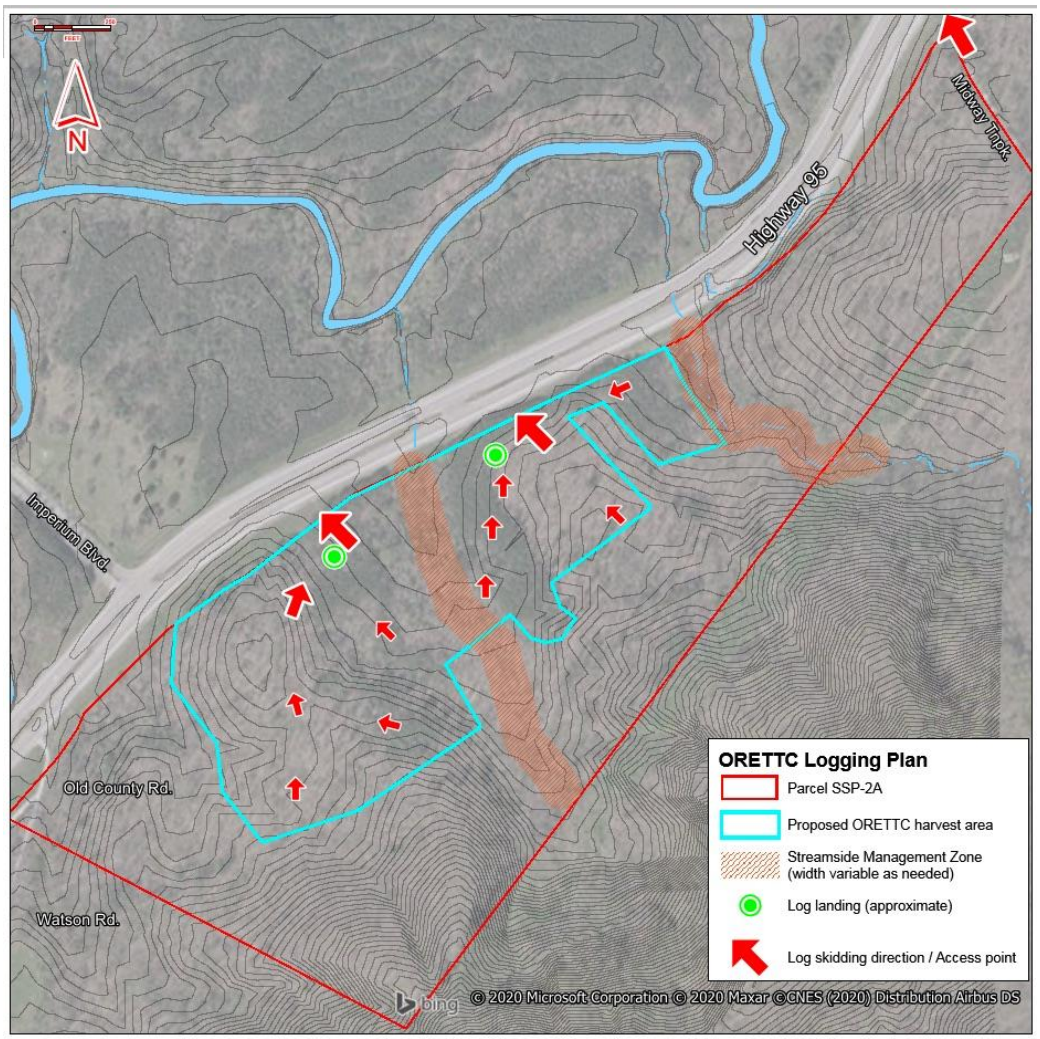

Figure 9. Logging plan to accompany ORETTC site construction activities. (Note: ORETTC boundaries shown are based off a previous conceptual design. See Figures 2, 3 and 19 for latest project design and boundaries of disturbance.)

4.1.4 Wildland fire planning

Wildland fire planning—Construction at the SSP-2A location will create an additional wildland interface of site operations with the reservation's wildfire fuels, requiring the application of current, applicable National Fire Protection Association (NFPA) Standards 1141, 1143, and 1144. The proposed SSP-2A site lies within portions of fire management units, #9 Old County, and construction would require modification to its corresponding wildland fire pre-plan.

Wildfire fuels and hazards—The parcel is generally composed of problematic wildfire fuels consisting of heavy down wood and dense vegetation growing in the wake of southern pine beetle outbreaks (Figure 10). Fire suppression in these fuels generally requires mechanized support as direct attack by personnel is unsafe.

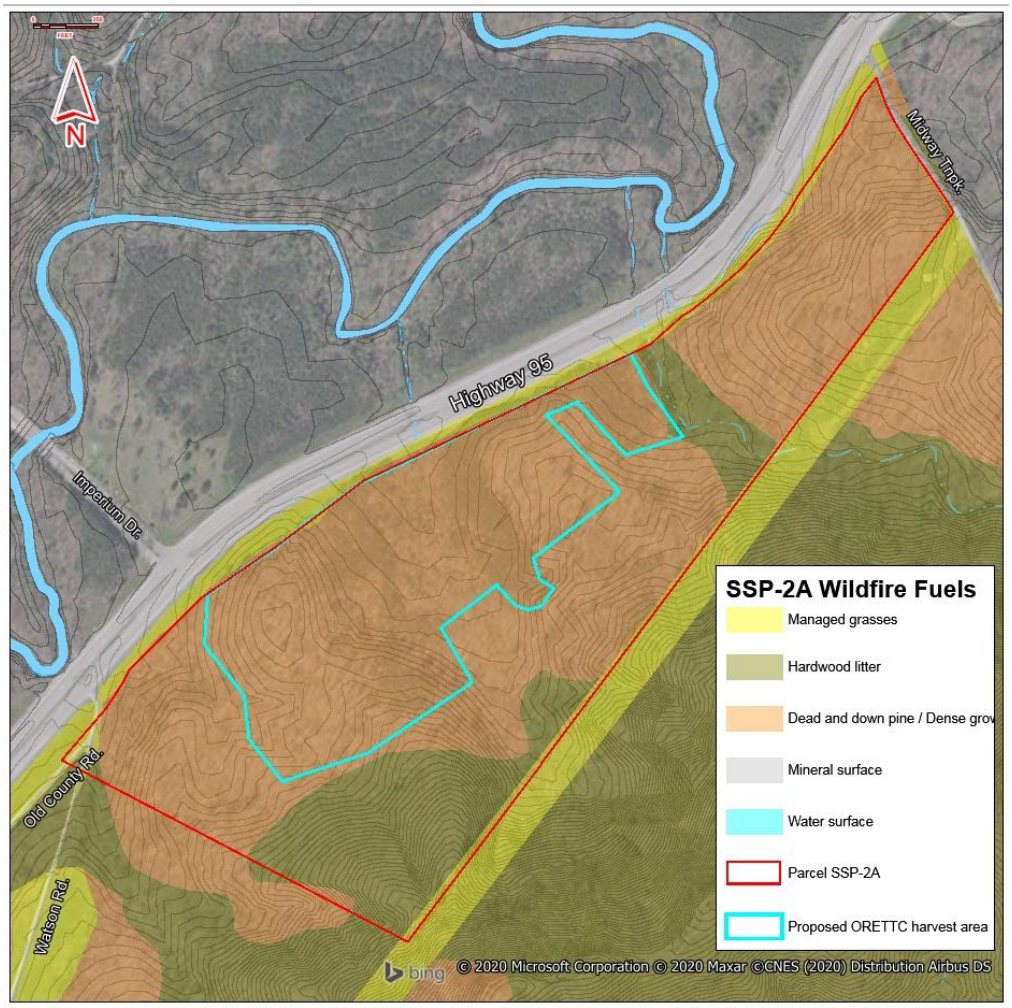

Figure 10. Wildfire fuels within the SSP-2A and ORETTC project area. (Note: ORETTC boundaries shown are based off a previous conceptual design. See Figures 2, 3 and 19 for latest project design and boundaries of disturbance.)

Figure 11 shows the Characteristic Fire Intensity Scale (FIS) at the SSP-2A area is generally moderate to high. Characteristic FIS specifically identifies areas where significant fuel hazards and associated dangerous fire behavior potential exist based on a weighted average of four percentile weather categories. Similar to the Richter scale for earthquakes, FIS provides a standard scale to measure potential wildfire intensity. The FIS consist of five classes in which the order of magnitude between classes is tenfold. The minimum class, Class 1, represents very low wildfire intensities, and the maximum class, Class 5, represents very high wildfire intensities. Refer to descriptions below.

1. Class 1, Very Low:
   Very small, discontinuous flames, usually less than 1 ft in length; very low rate of spread; no spotting. Fires are typically easy to suppress by firefighters with basic training and non-specialized equipment.

2. Class 2, Low:
   Small flames, usually less than 2 ft long; small amount of very short-range spotting possible. Fires are easy to suppress by trained firefighters with protective equipment and specialized tools.

3. Class 3, Moderate:
   Flames up to 8 ft in length; short-range spotting is possible. Trained firefighters will find these fires difficult to suppress without support from aircraft or engines, but dozer and plows are generally effective. Increasing potential for harm or damage to life and property.

4. Class 4, High:
   Large flames, up to 30 ft in length; short-range spotting common; medium-range spotting possible. Direct attack by trained firefighters, engines, and dozers is generally ineffective; indirect attack may be effective. Significant potential for harm or damage to life and property.

5. Class 5, Very High:
   Very large flames up to 150 ft in length; profuse short-range spotting, frequent long-range spotting; strong fire-induced winds. Indirect attack marginally effective at the head of the fire. Great potential for harm or damage to life and property.

[This dataset was derived from updated fuels and canopy data as part of the 2010 Southern Wildfire Risk Assessment (SWRA) Update Project completed in May 2014 and made available by the Southern Group of State Foresters via SWRA web Portal (SouthWRAP).]

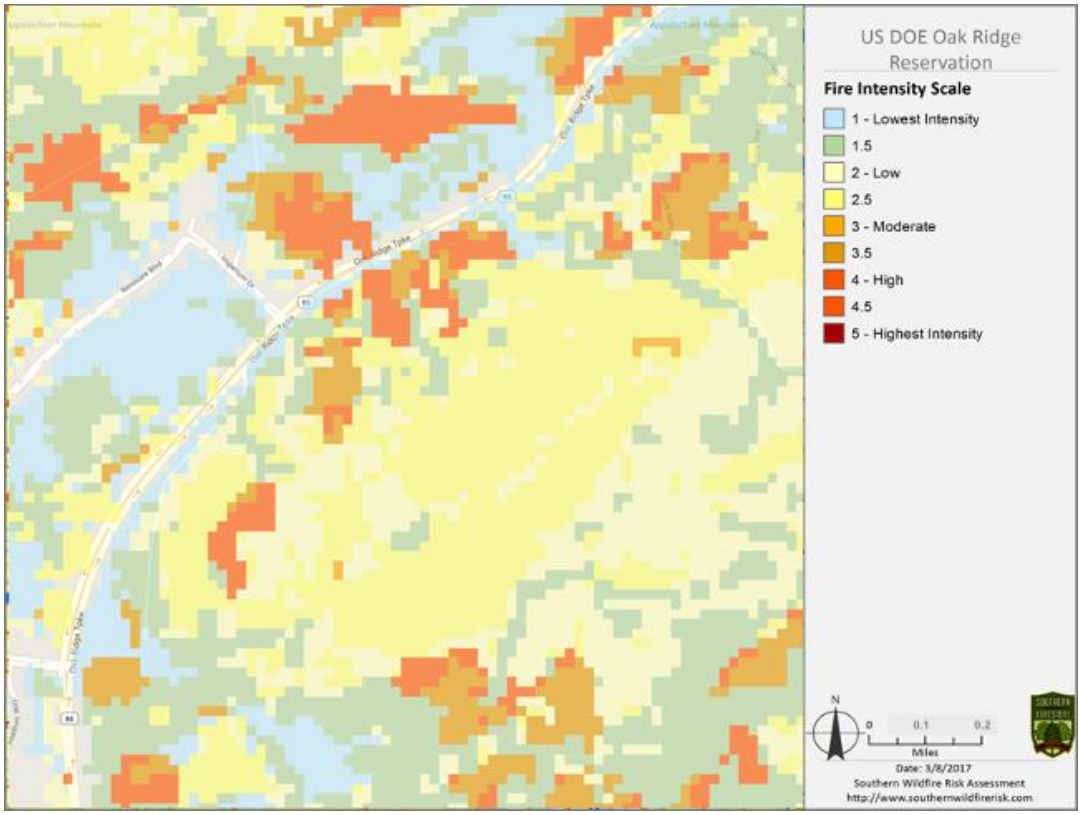

Figure 11. Fire Intensity Scale for the SSP-2A area.

As outlined in Section 4.1.2, these hazards can be most easily mitigated by the modification of surrounding pockets of pine during timber harvesting prior to construction. Residual fuels may need to be modified during construction clearing and setbacks maintained to ensure safe conditions remain post-construction. Additionally, increased fire ignition risks accompanying new developments could require mitigations to protect the White Wing Scrapyard contamination area (another moderate-to-high fire intensity area at the bottom center of Figure 11) and the Old Growth Forest Natural Area upslope of SSP-2A. (Note that the extent of any actual fuelbed modifications may require adjustments in favor of any coexistent ecological concerns determined during this review, or prior to initiation of the task.)

Emergency response and access—The site is currently within the City of Oak Ridge emergency response zone for the ORR. No impact to typical response times to and through the area is anticipated as a result of project completion.

Given the surrounding fuel types and terrain, access to the site must be maintained at strategic points to allow for wildfire defense. A fence is not currently planned for the facility, but should one be installed, gates should be wide enough to permit dozers/plows to pass and open inward to facilitate responder escapes from wildfires (gates opening outward often fail due to blockage by unmanaged vegetation). Site design should be reviewed to ensure a hydrant is accessible at all times by non-ORETTC personnel.

4.2 PREVIOUS LAND USE AND CULTURAL ACTIVITIES

Prior landownership and use—Parcel SSP-2A is derived from two older parcels acquired by the federal government for the Manhattan Project in 1942 (Figure 12). The bulk of the parcel was derived from Acquisition Parcel J-975 (J.E. Williams and wife), with the eastern portion originating from Acquisition Parcel J-939 (Lucy Montcastle). No improvements associated with these parcels were located on the

SSP-2A parcel, although a small tenant house with J-975 was located just outside on a site since disturbed by widening of State Route 95.

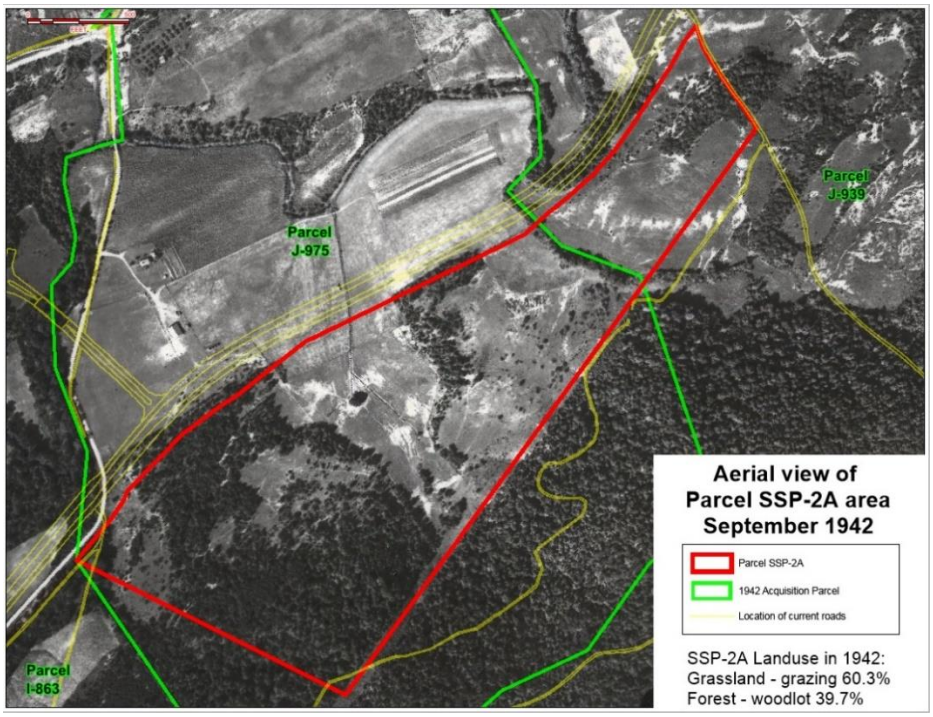

Figure 12. 1942 Aerial view of the SSP-2A parcel.

The land use was rural/agrarian, with only about 32 acres (39.7%) under forest, which included open woodland at that time, with the remaining 49 acres (60.3%) in pasture and grazing land (row crops occurred on more suitable soils north of the site, and what little development existed was northwest of the site). Obvious in the 1942 image are lighter patches indicative of soil erosion due to overgrazing on thin soils. The watershed in the center of SSP-2A was also clearly channelized before this time. Also visible at the southern line of Parcel SSP-2A is the TVA Norris–Wilson power transmission line, the oldest of several now crossing the reservation. It had been constructed about 6 years earlier.

Subsequent land use—After the conclusion of the Manhattan Project, reforestation initiatives were undertaken to quickly increase forest cover on abandoned farmland in valleys and lower slopes. The eroded soils in Parcel SSP-2A were planted in loblolly pine in 1950. Commercial thinning of this pine occurred in 1969 and 1978. In 1994, the remaining loblolly pine was harvested during an outbreak of southern pine beetles. The current dense pine is the result of the abundant seed that had accumulated in the forest litter prior to the previous harvest. There was also one hardwood sawtimber harvest conducted in 1975 that included the upland area of the southwest corner of the site. Figure 13 illustrates the area of both selective harvest and the loblolly pine planting and harvests.

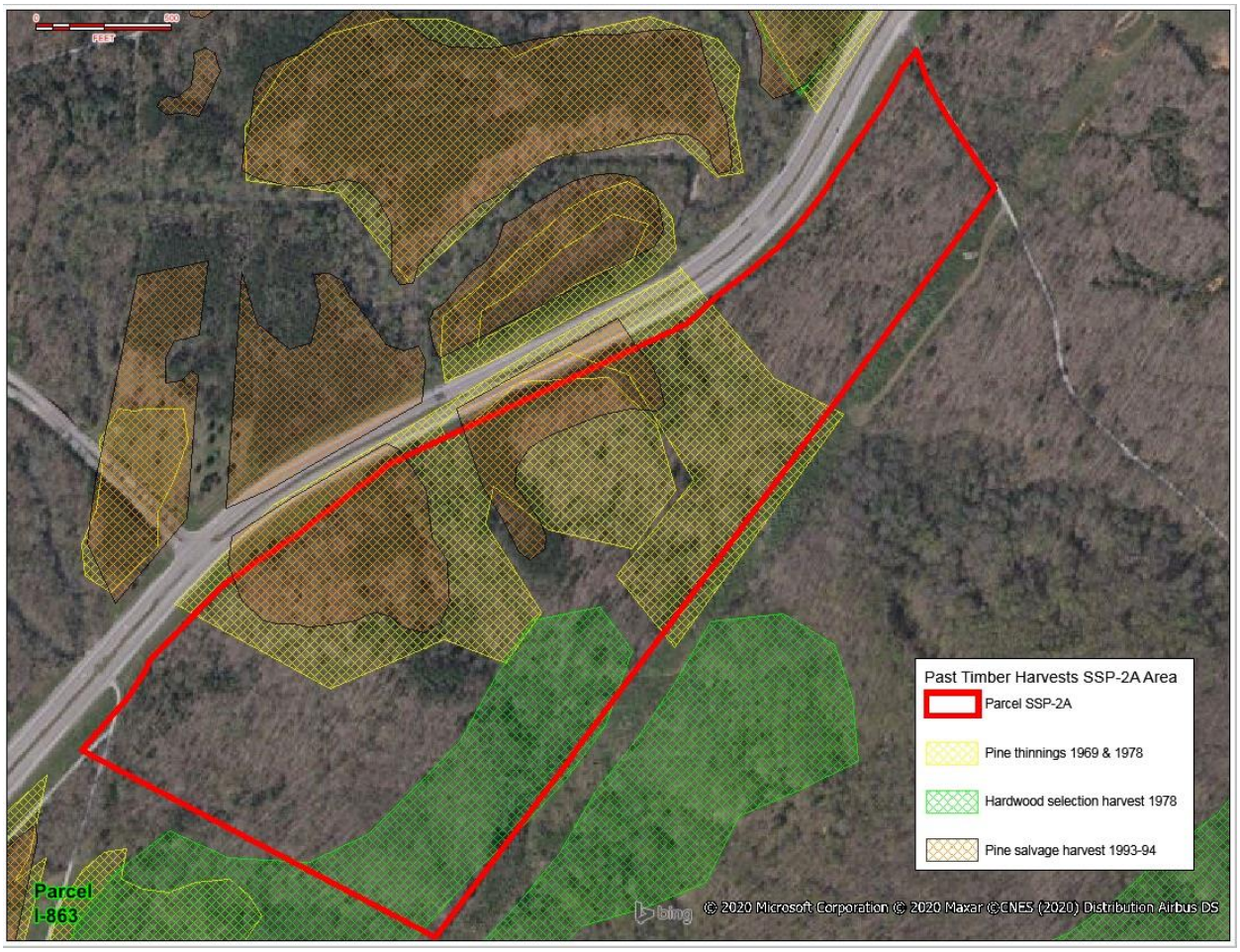

Figure 13. Prior timber harvest within and adjacent to the SSP-2A parcel.

4.3 WILDLIFE SURVEYS

All vertebrate wildlife known from the SSP-2A parcel are included in Appendix A. In total, >106 animals are known from the review area. This included 88 vertebrates: 9 amphibians, 39 birds, 25 mammals, 11 reptiles, and 4 fish (14 insects, 2 crustaceans, and 2 molluscs were also identified). Of all species known from the SSP-2A review area, at least 46 are afforded special legal protection under state or federal law. Among migratory birds, 3 species are considered by USFWS to be both Birds of Conservation Concern (BCC) and Birds of Management Concern (BMC), 2 species are considered BCC, and 3 species are considered BMC [all 39 bird species are afforded protection under the Migratory Bird Treaty Act (16 U.S.C. §§703-711)]. One migratory bird species, wood thrush (*Hylocichla mustelina*), is also a USFWS Focal Species. Five wildlife species are considered In Need of Management by the state of Tennessee (4 confirmed and 1 historical record), 3 species (including one unconfirmed bat) are state-listed Threatened, and 2 species (including 1 unconfirmed bat) are state-listed Endangered. Of these, 2 bat species (1 confirmed and 1 unconfirmed) are federal listed as Endangered, 1 unconfirmed bat is federal listed as Threatened, and two confirmed bat species are currently under review for federal listing (Appendix A, see also subsections below). At least one species is considered rare by TDEC (mountain disc, *Anguispira jessica*), and 6 confirmed species (plus 2 suspected species that cannot be confirmed at this time) are Focal Species for Management and Research for the ORR and ORNERP (Appendix A).

Exact locations for most animal resources were omitted here intentionally owing to their sensitivity. Locations have been provided to ORETTC project personnel.

4.3.1 Visual encounter surveys/cover boards (200 person-hours)

NRMP staff implemented VES 45 times between 22 June 2020 and 10 Sept 2020 along transects (60 person-hours) and all streams, wetlands, forest edges, and roadsides within the review area (60). A later survey effort (80 person-hours) was concentrated along stream, seep, and karst features that were identified through habitat surveys (Section 3.3.4) and the continually updated screening tool (Section 3.3.1).

NRMP staff detected 75 wildlife species during the approximately 200 hours of VES effort. This included the apparent first record of the state-listed black mountain salamander (*Desmognathus welteri*) on the ORR and for Roane County, Tennessee. VES efforts also confirmed the presence of state-listed Tennessee dace (*Chrosomus tennesseensis*) in both major drainages within the SSP-2A parcel, which includes the central stream that passes through the ORETTC. Additional species of note included the mountain disc snail, an ORR Focal Species and considered "Rare" by TDEC (TDEC 2020b; Withers 2016), several of which were located within two separate karst outcrops within the primary ORETTC footprint. Suitable breeding habitat was detected for four-toed salamanders (*Hemidactylium scutatum*) in several wetland and seep areas in the SSP-2A parcel and ORETTC footprint (Figure 14). The four-toed salamander is state-listed as "In Need of Management" and represents a Focal Species for Research and Management for the ORR and ORNERP.

Figure 14. Examples of four-toed salamander breeding habitat within the SSP-2A and ORETTC footprint.

4.3.2 Bat acoustic surveys (91 survey nights)

Initial habitat surveys of the SSP-2A parcel revealed the presence of suitable roost trees for forest dwelling bats, notably Indiana bat and northern long-eared bat. This was particularly true of the higher elevations where forest midstory was open. Areas within the ORETTC stream buffer and east of the central stream contained dense understory to midstory, with limited trees suitable for roosting (lighter green areas in Figure 15).

We obtained useable acoustic data from 11 acoustic bat detectors within the SSP-2A parcel between 26 June and 14 August 2020, covering 91 detector nights (Figure 15). In total, 10 native bat species were detected. Of these, detection frequencies provide strong evidence for 8 species and reasonable evidence for two species (Table 12). Both state- and federal-listed species were detected within or immediately adjacent to the SSP-2A parcel. Federal-Endangered Gray Bats (*Myotis grisescens*) were detected at frequencies that indicate use of the SSP-2A survey area for foraging (Gray Bats roost only in caves). Federal-Endangered Indiana Bat (*Myotis sodalis*) and Federal-Threatened Northern Long-eared Bat (*Myotis septentrionalis*) were detected at extremely low frequencies. State-Threatened Little Brown Bat (*Myotis lucifugus*) and State-Threatened Tricolored Bat (*Perimyotis subflavus*)—both species also Under Review for listing under the Endangered Species Act—were detected at high frequency within the SSP-2A survey area.

Relatively few bats were detected within the denser vegetation within the stream riparian that bisects the proposed ORETTC. Although the majority of the ORETTC footprint lacks suitable foraging or roosting habitat due to cluttered midstory and understory, this area contains several potential roost trees, either with peeling bark or as dead snags. Moreover, such dense vegetation limits the detectability of smaller habitat patches that might still be important, and it reduces the effective range of acoustic monitors. Finally, we note a deficiency in acoustic data coverage for the sparser and more mature upland forest areas on the NNSA side of the ORETTC facility footprint (Figure 15).

Additional surveys are necessary for the upcoming fall swarming and winter hibernation seasons. Although not shown in the maps herein, the ORR contains numerous caves within 5 miles of the review area. Limited cave surveys and acoustic data from cave entrances indicate that the ORR's caves support hibernating Indiana bats and northern long-eared bats and gray bat maternity colonies (data available upon request).

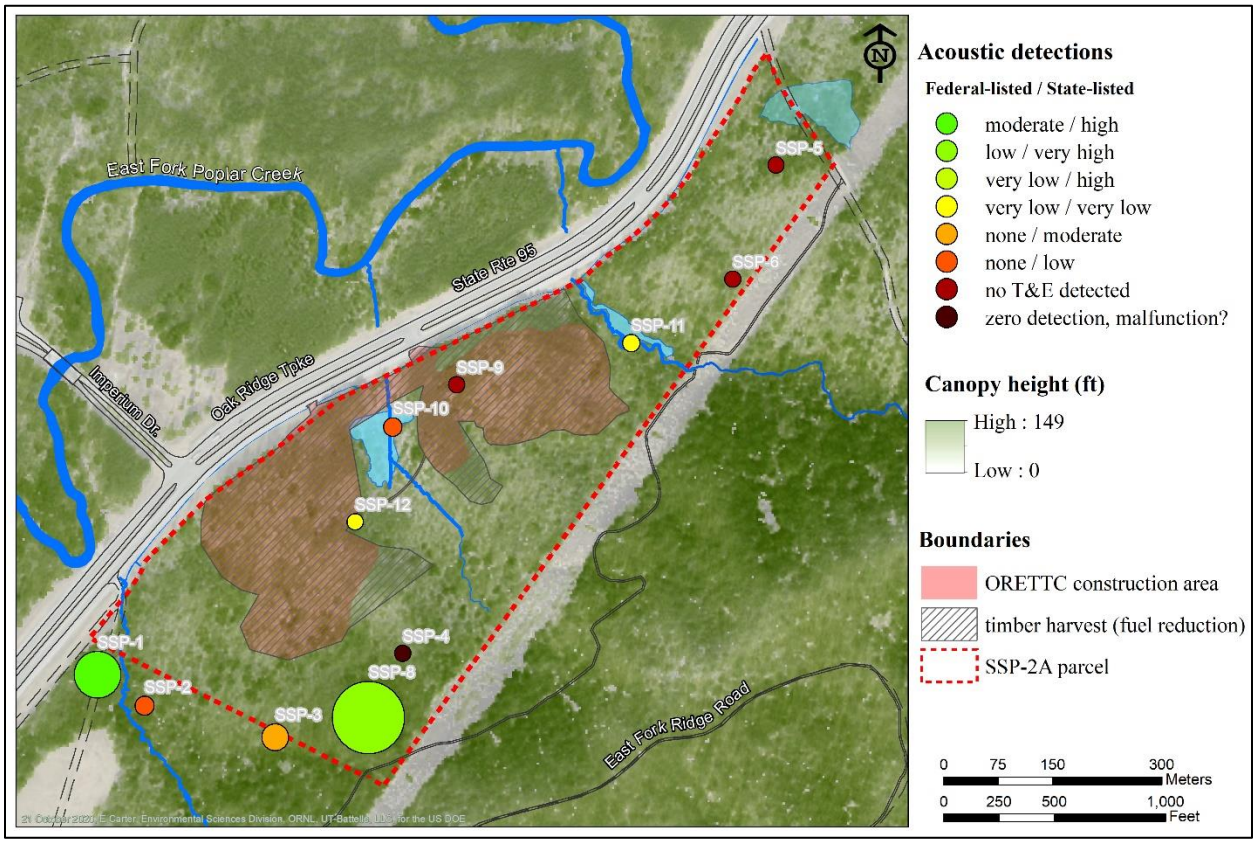

Figure 15. Locations of acoustic bat detectors and aquatic resources within the SSP-2A parcel. Bat detector locations are colored according to the frequency of detection of federal-listed species and are sized relative to the total number of calls detected for both state- and federal-listed species. Map background is aerial imagery combined with a LiDAR-derived canopy height overlay (partial transparency). Darker green regions indicate higher and denser canopy, lighter green regions indicate dense understory and a lack of overstory, and tan-to-grey regions indicate lack of vegetation.

Table 12. Detections from bat acoustic monitors. Monitors 1–4 were deployed for 12 nights, and monitors 5 and 6 were deployed for 11 nights, beginning 26 June 2020. Monitors 7–11 were deployed for 6 nights beginning 14 July 2020.

Species	Common name	Status			Monitor ID [SSP-#]											
		State	Federal	Other	1	2	3	4*	5	6	7	8	9	10	11	12
Eptesicus fuscus	Big Brown Bat				1410	10	62	0	0	1	12	344	0	3	0	0
Lasiurus borealis	Eastern Red Bat				426	7	5	0	0	0	1	45	0	0	0	0
Lasiurus cinereus	Hoary Bat				10	8	9	0	4	6	0	3	1	0	0	0
Lasionycteris noctivagans	Silver-Haired Bat				4	1	0	0	0	0	0	1	0	1	0	0
Lasiurus seminolus	Seminole Bat				6	1	0	0	0	0	0	3	0	0	0	0
Myotis grisescens	Gray Bat	E	E	G4	20	0	0	0	0	0	5	5	0	0	1	0
Myotis lucifugus	Little Brown Bat	T	UR	G3	139	7	40	0	0	0	3	138	0	1	1	1
Myotis septentrionalis	Northern Long-eared Bat	T	T	G1G2	0	0	0	0	0	0	0	2	0	0	0	0
Myotis sodalis	Indiana Bat	E	E	G2	0	0	0	0	0	0	0	2	0	0	0	0
Nycticeius humeralis	Evening Bat				17	2	0	0	0	0	0	7	0	0	1	0
Perimyotis subflavus	Tricolored Bat	T	UR	G2G3	16	3	1	0	0	0	90	79	0	3	0	0
Tadarida brasiliensis	Brazilian Free-Tailed Bat				2	6	2	0	8	3	4	29	0	2	0	0

Federal listing status codes:
E – Federally listed Endangered
T – Federally listed Threatened
UR – Currently Under Review for federal listing

State-listing status codes:
E – Endangered
T – Threatened
NM – In Need of Management
SC – Of Special Concern

***** Detector SSP4 malfunctioned, hence no bat calls were recorded.

4.3.3 Avian point counts (20 person-hours)

In total, 37 bird species were recorded within the survey area from approximately 20 survey hours from 22 June 2020 to 13 August 2020. This includes 37 species protected under the Migratory Bird Treaty Act. Four species are considered by USFWS to be Birds of Management Concern, and two species are considered by USFWS to be Birds of Conservation Concern. Several additional species carry Partners in Flight conservation designations. These include two species considered to be Species in Steep Decline, six species considered to be Of Regional Concern, two species listed on the Yellow Watch List, and six species deemed Management Action Needed (Table 13). Additional Migratory Birds known from the SSP-2A parcel are included in Table 14 and Appendix A.

Table 13. Migratory Birds (under the MBTA) documented within the SSP-2A parcel during 2020 surveys.

Species	Common name	State	Federal	Other	PIF
Archilochus colubris	Ruby-throated Hummingbird				
Baeolophus bicolor	Tufted Titmouse				
Buteo platypterus	Broad-winged Hawk				
Megascops asio	Eastern Screech owl				
Meleagris gallopavo	Wild Turkey		BMC		
Cardinalis cardinalis	Northern Cardinal				
Contopus virens	Eastern-wood Pewee				RC, MA
Dryobates pileatus	Pileated Woodpecker				
Melanerpes carolinus	Red-bellied Woodpecker				
Coccyzus americanus	Yellow-billed Cuckoo				CBSD
Dryocopus villosus	Hairy Woodpecker				
Dryobates pubescens	Downy Woodpecker				
Colaptes auratus	Northern Flicker				CBSD
Empidonax virescens	Acadian Flycatcher				RC, MA
Geothlypis formosa	Kentucky Warbler		BCC+BMC		YWL, RC, MA
Hylocichla mustelina	Wood Thrush	NM*	BCC+BMC	Focal	YWL, RC, MA
Icteria virens	Yellow-breasted Chat				RC, MA
Melospiza melodia	Song Sparrow				
Molothrus ater	Brown-headed Cowbird				
Cyanocitta cristata	Blue Jay				
Corvus brachyrhynchos	American Crow				
Passerina cyanea	Indigo Bunting				
Pipilo erythrophthalmus	Eastern Towhee				RC, MA
Piranga olivacea	Scarlet Tanager				
Poecile carolinensis	Carolina Chickadee				
Polioptila caerulea	Blue-gray Gnatcatcher				
Seiurus aurocapilla	Ovenbird				
Setophaga americana	Northern Parula				
Setophaga citrina	Hooded Warbler				
Setophaga pensylvanica	Chestnut-sided Warbler				
Setophaga petechia	Yellow Warbler				

Table 13. (continued).

Species	Common name	State	Federal	Other	PIF
Sitta carolinensis	White-Breasted Nuthatch				
Spinus tristis	American Goldfinch				
Thryothorus ludovicianus	Carolina Wren				
Vireo griseus	White-eyed Vireo				
Vireo olivaceus	Red-eyed Vireo				
Zenaida macroura	Mourning Dove		BMC		

Federal status codes:
BCC – Birds of Conservation Concern
BMC – Birds of Management Concern
Focal –investment of resources to address conservation or management issues.

State status codes:
E – Endangered
T – Threatened
NM – In Need of Management (TWRA 2018)
SC – Of Special Concern

PIF status codes – Bird Conservation Region 28:
RC = Regional Concern
MA = Management Attention needed
YWL = Yellow Watch List
CBSD = Common Bird in Steep Decline

4.3.4 Additional wildlife survey results

Small mammal trapping (493 trap-nights)—No status small mammal species were detected during the survey. Common species included deer mice (*Peromyscus* spp) and chipmunk (*Tamias striatus*). Twenty-eight of 61 traps were pulled one trap-night early owing to damage caused by a black bear, which frequented the survey area. Contemporary records of state-listed long-tailed shrew (*Sorex dispar*) exist for SSP-2A (Table 14).

Drift fence surveys (small vertebrates and invertebrates) (30 trap days and nights)—The most common species captured during drift fence array surveys were harvestmen (*Leiobunum spp.).* Others included the upland chorus frog (*Pseudacris feriarum*), cotton rat (*Sigmodon hispidus*), white-footed mouse (*Peromyscus leucopus*), and various carabid beetles.

Camera-trap surveys (98 traps days and nights)—Ten species of wildlife were observed via camera trap surveys. The most common animals observed included raccoons (*Procyon lotor*) and white-tailed deer (Od*ocoileus virginianus*). Others included black bear (*Ursus americanus*), bobcat (*Lynx rufus*), wild turkey (*Meteagris gallopava silvestris*), cottontail rabbit (*Sylvilagus floridanus*), American crow (*Corvus brachyrhynchos*), squirrel (*Sciurus carolinensis)*, and eastern chipmunk (*Tamias striatus*) (Figure 16). Notably, black bear are known to use the ORR but remain a rare observation during field surveys. Indeed longer-term surveys that use similar methods at four densely forested sites on the ORR have not detected black bear directly (Carter et al. 2020b; Carter et al. 2020c; DeRolph et al. 2019a; Peterson et al. 2018). These results confirm previous and ongoing work that detail the importance of this area to wildlife movement through the ORR and broader eastern Tennessee (Carter et al. 2020a; Kwarta et al. in prep).

Sensitive species habitat screening tool—All species identified through the pre-screening tool are included in Table 14. The final sensitive fauna screening tool indicated habitat was present within the SSP-2A and ORETTC footprint for 19 species with federal listing statuses (i.e., Endangered, Threatened, Under Review, BCC, BMC, and USFWS focal species), 16 state-listed species (i.e., Need of Management, Threatened, and Endangered), and 8 Focal Species for Research and Management for the ORR and ORNERP (Table 14). All taxa known from the SSP-2A parcel are included in Appendix A.

Figure 16. Examples of wildlife observed via camera traps. The area is a wildlife corridor in eastern Tennessee and ranks among the highest areas on the ORR for reports of wildlife activity (Darling et al. unpublished data).

Table 14. Animals with various levels of protection status with potential to be affected by ORETTC construction activities. Tables include status at the federal and state level; Partners in Flight (PIF) conservation status (also ORNL focal species); historical occurrence, expected occurrence when one considers frequency of observation and current state of the ORR, and contemporary records for the Oak Ridge Reservation; and historical (pre-1995), expected, and contemporary occurrence (since 1995) for the SSP-2A and the maximal ORETTC affected area (Figure 3). Tables also include whether habitat for each species was detected within the SSP-2A parcel during summer 2020 field-based assessment (Section 3.3.1 and 3.3.4). Color ramp shading in the name columns indicates likelihood of negative effects to that species owing to ORETTC construction activities (unlikely ⟶ highly likely).

Scientific name	Common name	Status			Oak Ridge Reservation			SSP-2A+ORETTC			
		Federal	State	PIF	Historical	Expected	Contemporary	Historical	Expected	Contemporary	Habitat
				FISH							
Erimonax monachus	Spotfin chub	T	T		**yes, CH**	**unk**	no	no	no	**unk**	yes
Erimystax cahni	Slender chub	T	T		**no**	**no**	no	no	no	no	no
Hemitremia flammea	Flame chub		NM		yes	**unk**	no	yes	**unk**	**unk**	yes
Noturus flavipinnis	Yellowfin Madtom	T	T		no	no	no	no	no	no	no
*Chrosomus tennesseensis**	Tennessee dace*		NM		yes	yes	yes	yes	yes	yes	yes
				AMPHIBIANS							
*Desmognathus welteri**	Black Mountain salamander*		NM		no	yes	yes	no	yes	yes	yes
*Hemidactylium scutatum**	Four-toed salamander*		NM		yes	yes	yes	no	yes	**unk**	yes
				REPTILES							
*Pituophis melanoleucus**	Northern pinesnake*		T		yes	**unk**	no	no	**unk**	no	**unk**
*Ophisaurus attenuatus**	Slender glass lizard*		NM		yes	**unk**	no	no	**unk**	no	**unk**
				BIRDS							
Aegolius acadicus	Northern saw-whet owl	BMC			yes	yes	yes	no	**unk**	no	yes
Ammodramus henslowii	Henslow's sparrow	BCC,BMC,Focal	T	IM,RC,YWL	yes	yes	yes	no	no	no	no
Ammodramus savannarum	Grasshopper sparrow	BMC,Focal		CBSD,RC,IM	yes	yes	yes	no	no	no	no
Anhinga anhinga	Anhinga		NM		yes	yes	yes	no	no	no	no
Caprimulgus vociferus	Whip-poor-will	BCC			yes	yes	yes	no	yes	yes	yes
Coccyzus americanus	Yellow-billed Cuckoo			CBSD,RC,IM	yes	yes	yes	no	yes	yes	yes
Contopus cooperi	Olive-sided flycatcher	BCC,BMC		YWL	yes	yes	yes	no	no	no	no
Contopus virens	Eastern-wood Pewee			RC,MA	yes	yes	yes	no	yes	yes	yes
Dendroica discolor	Prairie Warbler	BCC		YWL,RC,MA	yes	yes	yes	no	yes	yes	yes
Dolichonyx oryzivorus	Bobolink	BMC		YWL,RC,MA	yes	yes	yes	no	no	no	no
Egretta caerulea	Little blue heron		NM		yes	yes	yes	no	no	no	no
Empidonax trailii	Willow flycatcher	BMC			yes	yes	yes	no	no	no	no
Empidonax virescens	Acadian Flycatcher			RC,MA	yes	yes	yes	no	yes	yes	yes
Falco peregrinus	Peregrine falcon	BCC,BMC		RC,MA	yes	yes	yes	no	no	no	no
Falco sparverius	American kestrel	BCC,BMC			yes	yes	yes	no	yes	no	no
Geothlypis formosus	Kentucky warbler	BCC,BMC		YWL,RC,MA	yes	yes	yes	no	yes	yes	yes
Haliaeetus leucocephalus	Bald eagle	BCC,BMC,Focal	NM		yes	yes	yes	no	no	no	no
Helmitheros vermivorus	Worm-eating warbler	BCC,BMC			yes	yes	yes	no	**unk**	**unk**	yes
*Hylocichla mustelina**	Wood thrush*	BCC,BMC,Focal	NM†	YWL,RC,MA	yes	yes	yes	no	yes	yes	yes
Icteria virens	Yellow-breasted Chat			RC,MA	yes	yes	yes	no	yes	yes	yes
Ixobrychus exilis	Least bittern	BCC	NM		yes	yes	yes	no	no	no	no
Lanius ludovicianus	Loggerhead shrike	BCC,BMC	NM	CBSD,FS	yes	yes	yes	no	no	no	no

Table 14. (continued).

Scientific name	Common name	Status			Oak Ridge Reservation			SSP-2A+ORETTC			
		Federal	State	PIF	Historical	Expected	Contemporary	Historical	Expected	Contemporary	Habitat
Limnothlypis swainsonii	Swainson's warbler	BCC,BMC	NM	RC,MA	yes	yes	yes	no	no	no	no
Melanerpes erythrocephalus	Red-headed woodpecker	BCC,BMC		YWL	yes	yes	yes	no	**unk**	**unk**	yes
Meteagris gallopava silvestris	Wild turkey	BMC			yes	yes	yes	yes	yes	yes	yes
Nycticorax nycticorax	Black-crowned Night-heron		NM		yes	yes	yes	no	**unk**	**unk**	**unk**
Parkesia motacilla	Louisiana waterthrush	BMC			yes	yes	yes	no	no	no	no
Pipilo erythrophthalmus	Eastern Towhee			RC,MA	yes	yes	yes	no	yes	yes	yes
Porzana carolina	Sora	BMC			yes	yes	yes	no	no	no	no
Protonotaria citrea	Prothonotary warbler	BCC,BMC		YWL,RC,MA	yes	yes	yes	no	no	no	no
Scolopax minor	American woodcock	BMC,Focal		YWL,RC	yes	yes	yes	no	**unk**	no	no
Setophaga cerulea	Cerulean warbler	BCC,BMC,Focal	NM	YWL,RC,IM	yes	yes	yes	no	no	no	**unk**
Sitta pusilla	Brown-headed nuthatch	BCC,BMC			yes	yes	yes	no	no	**unk**	yes
Sphyrapicus varius	Yellow-bellied sapsucker	BMC			yes	yes	yes	no	yes	yes	yes
Vermivora chrysoptera	Golden-winged warbler	BCC,BMC,Focal	T	CBSD,RWL	yes	yes	yes	no	no	no	no
Vermivora pinus	Blue-winged warbler	BCC,BMC			yes	yes	yes	no	yes	yes	yes
Zenaida macroura	Mourning Dove	BMC			yes	yes	yes	no	yes	yes	yes
				MAMMALS							
Sorex dispar	Long-tailed Shrew		NM		yes	yes	yes	no	yes	yes	yes
Synaptomys cooperi	Southern bog lemming		NM		yes	**unk**	no	no	**unlikely**	no	yes
Corynorhinus rafinesquii	Rafenisque's big-eared bat		NM		yes	yes	yes	no	yes	no	yes
*Myotis grisescens**	Gray bat*	E	E		yes	yes	yes	no	yes	yes	yes
Myotis leibii	Eastern small-footed bat		NM		yes	yes	yes	no	yes	no	yes
Myotis lucifugus	Little brown bat	UR	T		yes	yes	yes	no	yes	yes	yes
*Myotis septentrionalis**	Northern long-eared bat*	T	T		yes	yes	yes	no	yes	**likely**	yes
*Myotis sodalis**	Indiana bat*	E	E		yes	yes	yes	no	yes	**likely**	yes
*Perimyotis subflavus**	Tri-colored bat*	UR	T		yes	yes	yes	no	yes	yes	yes
				CLAMS							
Lampsilis virescens	Alabama Lampmussel	E	E		no	no	no	no	no	no	no
Hemistena lata	Cracking Pearlymussel	E	E		no	no	no	no	no	no	no
Dromus dromas	Dromedary Pearlymussel	E	E		yes	no	no	no	no	no	no
Cyprogenia stegaria	Fanshell	E	E		yes	no	no	no	no	no	no
Fusconaia cuneolus	Finerayed Pigtoe	E	E		yes	no	no	no	no	no	no
Plethobasus cooperianus	Orangefoot Pimpleback	E	E		yes	no	no	no	no	no	no
Lampsilis abrupta	Pink Mucket	E	E		yes	no	no	no	no	no	no
Obovaria retusa	Ring Pink	E	E		no	no	no	no	no	no	no
Pleurobema plenum	Rough Pigtoe	E	E		no	no	no	no	no	no	no
Quadrula cylindrica strigillata	Rough Rabbitsfoot	E	E		yes	no	no	no	no	no	no
Plethobasus cyphyus	Sheepnose Mussel	E	E		yes	no	no	no	no	no	no
Fusconaia cor	Shiny Pigtoe	E	E		yes	no	no	no	no	no	no
Cumberlandia monodonta	Spectaclecase	E	E		yes	no	no	no	no	no	no
Plethobasus cicatricosus	White Wartyback	E	E		no	no	no	no	no	no	no
				SNAILS							
Athearnia anthonyi	Anthony's riversnail	E	E		no	no	no	no	no	no	no
*Anguispira jessica**	Mountain disc*		Rare		yes	yes	yes	no	yes	yes	yes

Table 14. (continued).

Scientific name	Common name	Status			Oak Ridge Reservation			SSP-2A+ORETTC			
		Federal	State	PIF	Historical	Expected	Contemporary	Historical	Expected	Contemporary	Habitat
*Cambarus deweesae**	Valley flame crayfish*		E		yes	yes	yes	no	unk	unk	yes
Io fluvialis	Spiny riversnail	UR			yes	no	**unk**	no	**unlikely**	no	**unlikely**

Federal listing status codes:
- E – Federally listed Endangered
- T – Federally listed Threatened
- UR – Currently Under Review for federal listing
- CH – Critical Habitat present
- BCC – Birds of Conservation Concern
- BMC – Birds of Management Concern
- Focal – USFWS Focal

State-listing status codes:
- E – Endangered
- T – Threatened
- NM – In Need of Management
- SC – Of Special Concern
- Rare – Rare, not listed

Partners in Flight status codes – Region 28:
- RC = Regional Concern
- MA = Management Attention needed
- IM = Immediate Management Att Needed
- YWL = Yellow Watch List
- RWL = Red Watch List
- CBSD = Common Bird in Steep Decline

***** Focal Species for Research and Management on the ORR and ORNERP

† In Need of Management by rule of TWRA (TWRA 2018)

4.4 PLANT SURVEYS

Botanical surveys of the SSP-2A parcel received ~40 person-hours of search effort, and the proposed ORETTC footprint received an additional 30 person-hours of effort. One listed plant species and one species of cultural significance to the Eastern Band of Cherokee Indians (EBCI) was detected within the ORETTC and SSP-2A parcel. At least five additional species of management concern were detected through both areas. The broader SSP-2A parcel will require additional sensitive plant surveys should impacts occur beyond the primary ORETTC facility footprint (Figure 2). Maps herein do not include plant species given their sensitive nature. Locations have been provided to project managers for use in avoidance measures. Sensitive plant species identified through the initial screening tool are included in Table 15 alongside likelihood of occurrence based on updated habitat surveys.

4.4.1 Federal-listed plant species

No federal-listed plants were found within the proposed ORETTC footprint. Federal-listed plant species are considered unlikely within the SSP-2A parcel. Several seeps and springs are suitable for *Platanthera integrilabia* (white fringeless orchid), which is known from wetlands and stream margins adjacent to the ORR. However, no specimens are known from the ORR at this time. Detection of some taxa (e.g., state-listed *P. integrilabia* and *P. flava* var. *herbiola*, which have seasonally limited diagnostic characters) might have been limited by the abbreviated late summer survey period.

4.4.2 State-listed plant species

American ginseng (*Panax quinquefolius*), state-listed Of Special Concern–Commercially Exploited, occurs throughout the SSP-2A parcel and was confirmed within the NNSA side of the ORETTC footprint. No other state-listed species have been confirmed, although some such as *Platanthera* spp and mountain witch-alder (*Fothergilla major*) may be expected. This is especially true within the springs and smaller seep wetlands within the broader SSP-2A parcel and central stream buffer for the ORETTC.

4.4.3 Plant species of management concern

Additional plant species that occur infrequently on the ORR and are of management concern for the ORR and ORNERP included (1) Netted Chain Fern (*Woodwardia areolata*), found near a spring within the central stream buffer that bisects the ORETTC footprint, (2) Crested Coralroot (*Hexalectris spicata*), and (3) Jacob's Ladder (*Polemonium reptans*). Two formerly listed species, goldenseal (*Hydrastis canadensis*) and October lady's-tresses (*Spiranthes ovalis*), also were found in the vicinity of the ORETTC footprint. Several examples of sensitive or otherwise indicator species are shown in Figure 17.

4.4.4 Plants with cultural significance

Green-headed coneflower (*Rudbeckia laciniata*) occurs within the SSP-2A parcel along the eastern stream (Figure 17, panel g). This species, also called Sochan, is a culturally significant plant species to the Eastern Band of Cherokee of Indians (ECBI). ORNL, as part of the Culturally Significant Plant Species Initiative, is working to protect and conserve culturally significant species (e.g., green-headed coneflower) on the ORR and the broader southern Appalachian region. In accordance with 36 CFR 2.6, the cultural significance of this species recently led to a General Agreement (GA) between the National Park Service and the ECBI that allows enrolled members of ECBI to harvest select parts of green-headed coneflower for traditional purposes from the Great Smoky Mountains National Park (NPS/EBCI Plant Gathering GA Final March 2019). DOE has not entered into such an agreement that would allow harvest on the ORR. However, in line with the goals of the Culturally Significant Plant Species Initiative, such

non-public-accessible lands provide opportunities for long-term protection. Preservation ensures the legacy of these honored species and enables repatriation elsewhere when the need arises.

Table 15. Status plant species with potential to occur within the SSP-2A parcel and proposed ORETTC footprint. Most species are still considered possible within the SSP-2A parcel at this time. Only American ginseng and green-headed coneflower have been confirmed within the ORETTC footprint.

Scientific name	Common Name	Status		Expected in SSP-2A
		Federal	State	
Spiraea virginiana	Virginia spiraea	T		unlikely
Platanthera integrilabia	White fringeless orchid	T		possible
Aureolaria patula	Spreading false foxglove		S	unknown
Berberis canadensis	American barberry		S	unlikely
Bolboschoenus fluviatilis	River bulrush		S	unlikely
Delphinium exaltatum	Tall larkspur		E	unlikely
Diervilla lonicera	Northern bush honeysuckle		T	unlikely
Draba ramosissima	Branching Whitlow-grass		S	no
Elodea nuttallii	Nuttall's waterweed		S	no
Eupatorium godfreyanum	Godfrey's thoroughwort		S	unlikely
Fothergilla major	Mountain witch-alder		T	possible
Helianthus occidentalis	Naked-stem sunflower		S	unlikely
Juglans cinerea	Butternut		T	no
Juncus brachycephalus	Small-headed rush		S	unlikely
Liparis loeselii	Fen orchid		T	unlikely
Panax quinquefolius	**American ginseng**		**S**	**yes***
Platanthera flava var. *herbiola*	Tubercled rein-orchid		T	possible
Rudbeckia laciniata	**Green-headed coneflower**	**(culturally significant†)**		**yes***
Spiranthes lucida	Shining Ladies'-tresses		T	unlikely
Thuja occidentalis	Northern white cedar		S	no

Federal: T = Threatened; State: S = Of Special Concern, T = Threatened, E = Endangered
* Confirmed within the SSP-2A and ORETTC facility footprint
† Green-headed coneflower is of cultural significance to the Eastern Band of Cherokee Indians. ORNL, as part of the Southern Appalachian Man and the Biosphere Cooperative and Culturally Significant Plant Species Initiative is working to protect and conserve culturally significant species, including green-headed coneflower.

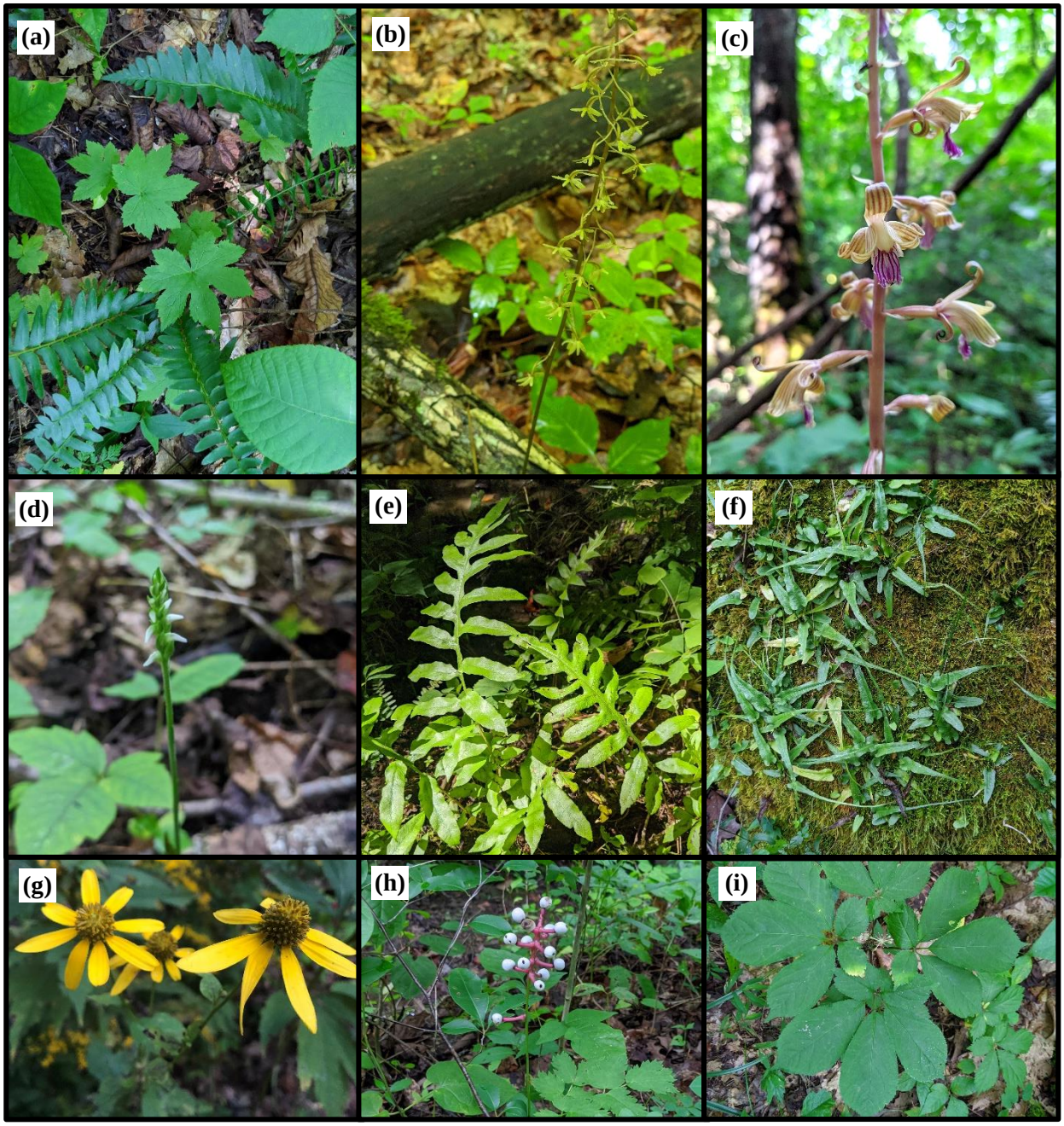

Figure 17. Examples of flora encountered during 2020 field surveys of the SSP-2A parcel and proposed ORETTC footprint. (a) goldenseal (*Hydrastis canadensis*), (b) cranefly orchid (*Tipularia discolor*), (c) coralroot (*Hexalectris spicata*), (d) October ladies'-tresses (*Spiranthes ovalis*), (e) sensitive fern (*Onoclea sensibilis*), (f) walking fern (*Asplenium rhizophyllum*), (g) green-head coneflower (*Rudbeckia laciniata*), (h) doll's-eyes (*Actaea pachypoda*), (i) American ginseng (*Panax quinquefolius*).

4.5 AQUATIC RESOURCES

Hydrologic models and field-mapped aquatic features for the SSP-2A parcel and surrounding watershed indicate a complex drainage structure (Figure 18). Subsurface flows are only approximate and based on likely points of entry into groundwater conduits. Resurgence, modeled according to the location and hydroperiod of surface aquatic features, would occur along most streams, seeps, and springs (Figures 19–20). This is supported by the presence of extensive stream bank undercutting and inward flow along the length of each stream along with some losing reaches (Figures 21–22).

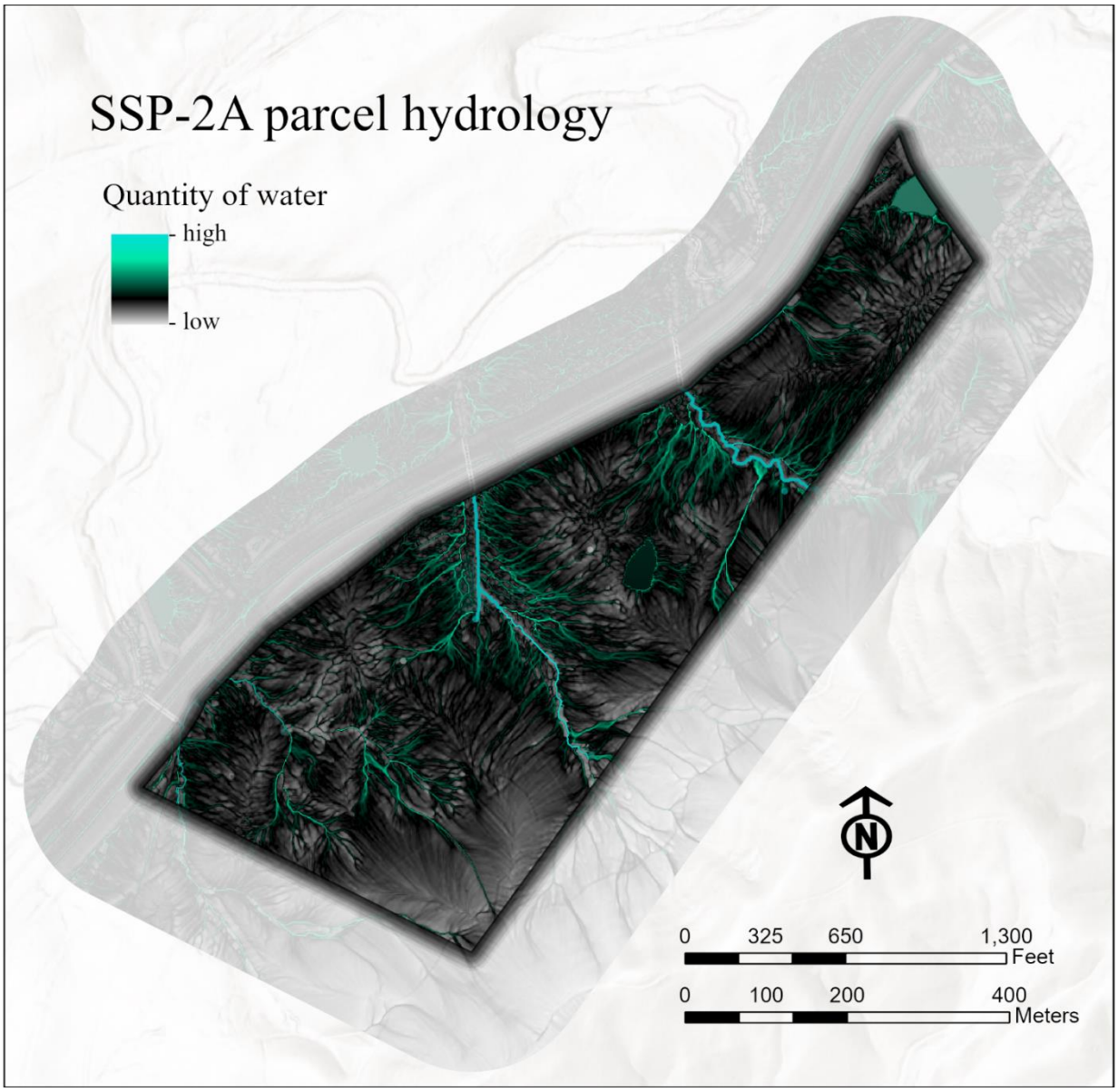

Figure 18. Final hydrologic model for the SSP-2A parcel. Shading represents the amount of water moved through the landscape via both surface and subsurface flow (composite). Movement of water was modeled as a function of elevation and known karst features (sinks, springs, macropores, and outcrops). Model was initially trained on known aquatic features (e.g., Rosensteel 1996; Baranski 2009, 2011, 2018) and continually retrained using aquatic and karst features as they were mapped. Teal regions indicate WWCs and/or expected routes of subsurface flow. Blue regions indicate field-mapped streams.

4.5.1 Wetlands

Total wetland acreage within the SSP-2A parcel was estimated at > 2.3 acres (0.93 ha) (Table 16). At least 1.1 acres (0.45 ha) of wetland occur within the ORETTC area of possible disturbance (Figures 19–20). At least 0.05 acre (0.02 ha) of this wetland overlaps directly with the ORETTC facility footprint (outside of the stream buffer zones) (Figure 19). Additional seep wetlands and springs occur throughout SSP-2A and might be affected by the planned sidewalk (Figure 2) and ~ 24.1 acres of graded earth. Sites within the stream buffer and within the broader SSP-2A parcel will require additional assessment if impacts occur beyond the ORETTC footprint (Figure 19). Smaller seep wetlands have not be mapped beyond point features but do add to the overall wetland acreage within the SSP-2A parcel and proposed ORETTC footprint. Additionally, several drainages that were classified via stream determinations as WWC—including some within the ORETTC facility footprint—contain hydric soils and thus likely represent linear wetlands under ACOE and TDEC guidance. Wetland delineations are necessary for these sites (Figure 19).

4.5.2 Streams and wet weather conveyances

Total stream length within the SSP-2A parcel was estimated at ~2634 ft (802.8 m) (Table 16). At least 927 ft (283 m) of WWC has been mapped; at least 1,591.4 ft (485.1 m) of stream occur within the ORETTC possible area of disturbance. Approximately 138.3 ft (42.2 m) of stream would be impacted directly via road and sidewalk crossings (Table 16). This does not include impacts owing to other potential crossings along site boundaries, effects of altered hydrology and water temperature, or other direct and indirect effects on aquatic and terrestrial communities (plants and animals) that are likely to result from physical changes to the landscape (e.g., ~ 24.1 acres of graded earth). These changes can result in loss of biodiversity (e.g., Grant et al. 2014) and thus an appreciable loss of aquatic resource value via TDEC guidance.

Hydrologic determinations remain necessary for several channels and probable WWCs (Figures 18–19; Table 16). Two primary drainages occur with potential to be affected by ORETTC construction and operations activities, including encroachment into the riparian of the eastern stream by wildfire fuel reduction/grading (Figure 19). Both streams contain abundant subsurface flow. Banks contain extensive undercutting and porous rock and soil that promote a shallow yet perennial hydroperiod (Figures 22–23). In a preliminary report provided by the authors to Consolidated Nuclear Security (CNS) on 16 July 2020, and additional data files provided on 14 August 2020, several streams were identified as “HD Needed” or as “Wet Weather Conveyance”. Four of these previously unclassified aquatic features were since classified as stream via TDEC Stream Determinations during August and September 2020 (Figure 19).

Table 16. Quantities of aquatic resources within the SSP-2A parcel, ORETTC’s possible area of disturbance, and the ORETTC infrastructure footprint. 0.05 acre (0.02 ha) of wetland originates from a single 1.1-acre (0.445-ha) wetland that is intersected by ORETTC infrastructure in three separate areas.

Aquatic Feature	SSP-2A	ORETTC (possible)*	ORETTC (direct)*
unclassified drainage	6393 ft (1949 m)	> 1919.6 ft (585.1 m)	~ 1709.6 ft (521.1 m)
seep/spring	7	2	2
wetland	> 2.3 acres (0.931 ha)	≥ 1.1 acres (0.445 ha)	0.05 acre (0.02 ha)
WWC	> 927 ft (283 m)	NA	NA
stream	2634 ft (802.8 m)	≥ 1591.4 ft (485.1 m)	~ 138.3 ft (42.2 m)

* See Figure 2 and associated text for explanations of ORETTC area of disturbance. Possible impacts to streams include those reaches of stream that would be impacted in the absence of proper stormwater management owing to grading and placement of impervious surface over major drainages within the catchment area (see also Figure 18).

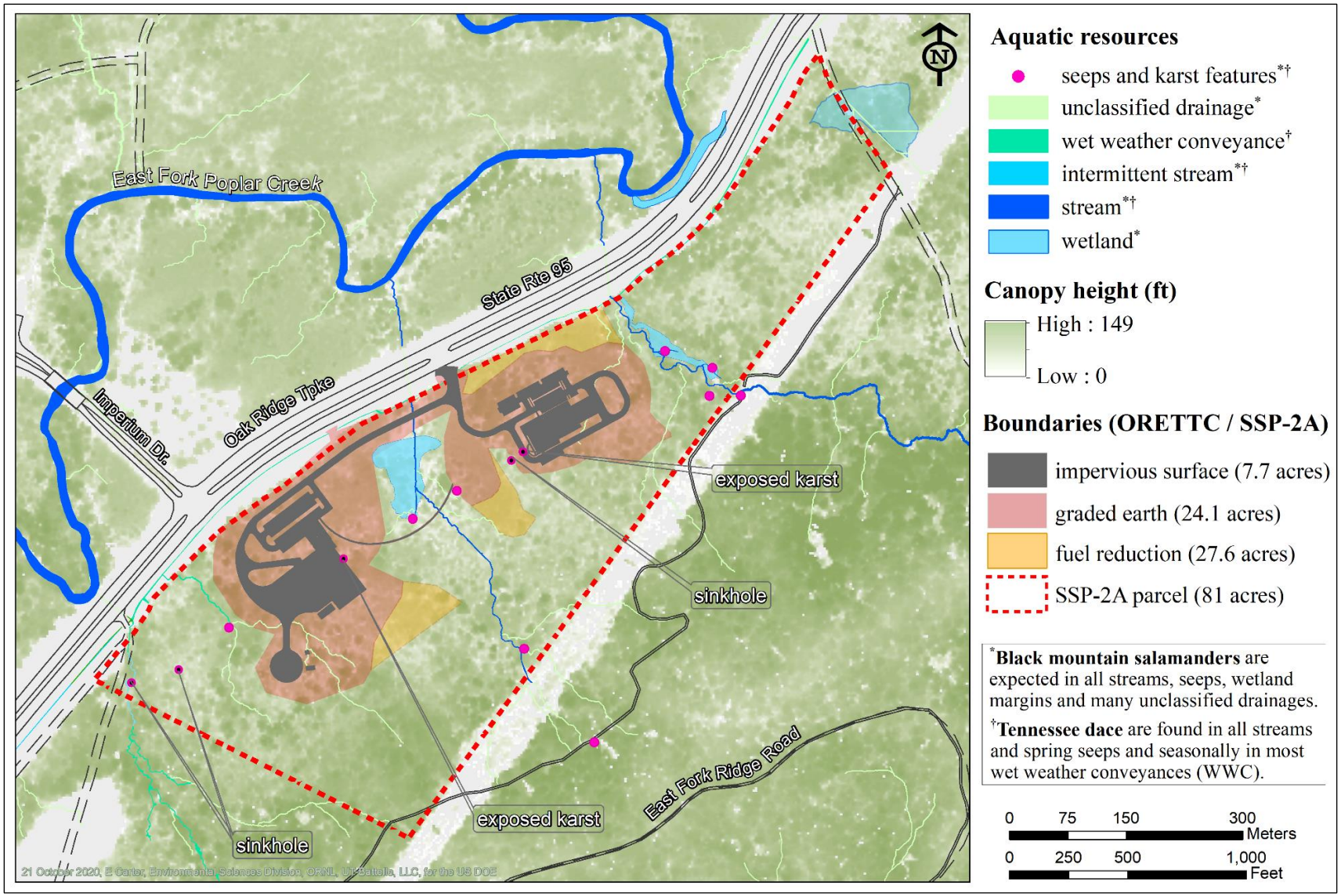

Figure 19. Field-mapped aquatic resources within the SSP-2A parcel. Known resources include classified streams (dark blue lines), perennial – ephemeral streams (light blue lines), wet weather conveyances (teal lines), unclassified drainages (faint yellow-green lines), and seeps and karst features (pink circles). (See Figure 2 for additional details on project infrastructure.)

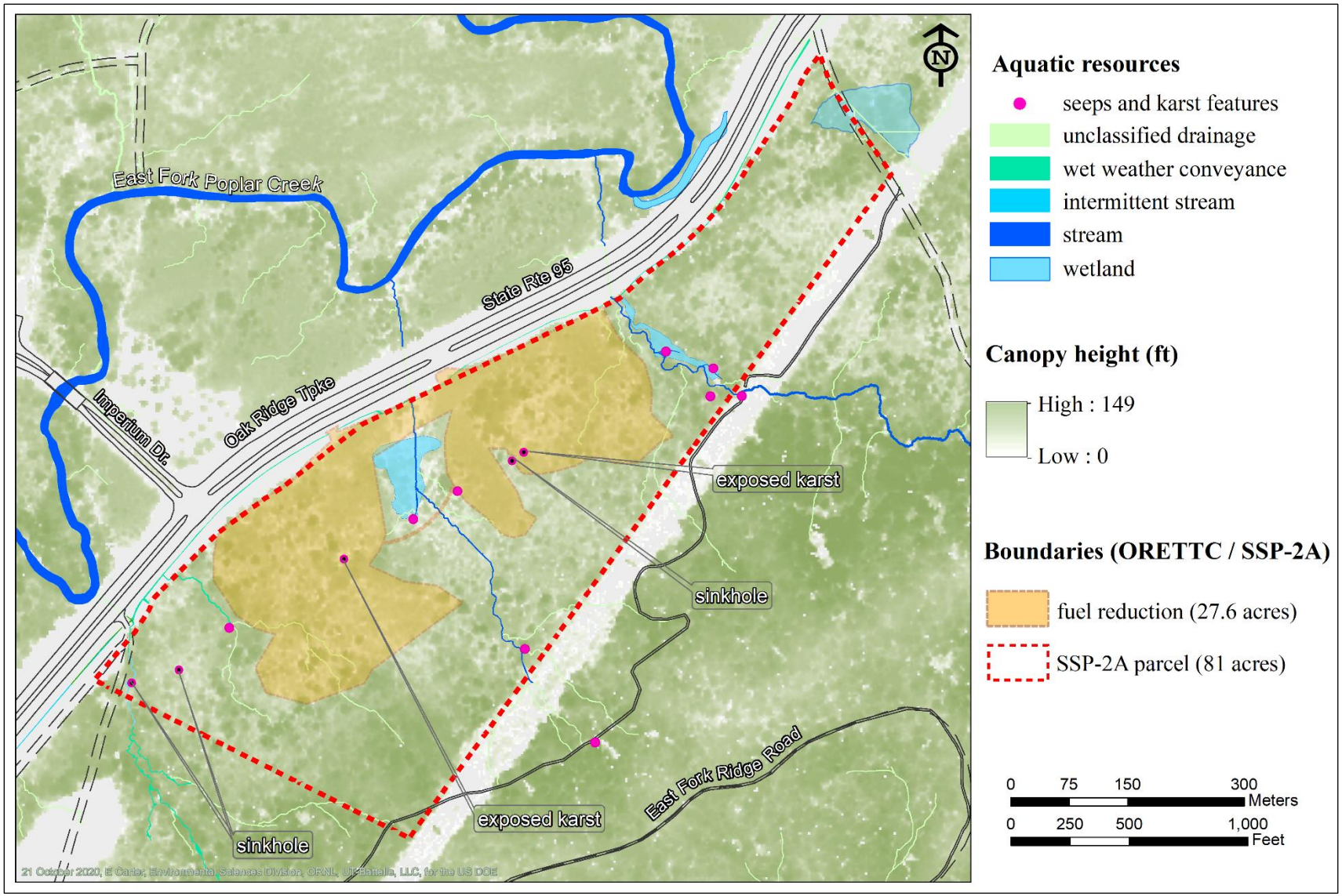

Figure 20**. Aquatic resources in relation to wildland fire fuel reduction for the ORETTC facility.**

All streams are expected to support Tennessee dace (*Chrosomus tennesseensis*) (Figures 21–22), which are listed as In Need of Management in Tennessee and represent an ORNL Focal Species for management and ongoing research. Two streams, including the stream that intersects the planned ORETTC facility, contain relatively dense populations of Tennessee dace (confirmed in July 2020 and indicated by the blue lines). Flame chub (*Hemitremia flammea* – Tennessee In Need of Management) were collected somewhere within this watershed during the 1940s and 1950s, but they have not been identified on the ORR since that time.

All streams and seeps within the SSP-2A parcel are also expected to support state-listed, In Need of Management, black mountain salamanders (*Desmognathus welteri*) (Figures 21–23). Both dace core habitat streams contain the only suspected populations of black mountain salamander on the ORR and the only observations for Roane County, Tennessee (genetic and phylogeographic analyses to determine the structure and origin of various *Desmognathus* spp on the ORR are currently under way). Watersheds adjacent to SSP-2A were inventoried in 2019, and the only site other than SSP-2A that might contain black mountain salamander populations is in the ORR's Old Growth Forest, which is connected hydrologically to SSP-2A streams. The Old Growth Forest is separated from SSP-2A by ≤ 150 ft of powerline right-of-way at the northeast end of the SSP-2A parcel.

Figure 21. Intermittent streams along the eastern boundary of the SSP-2A parcel.

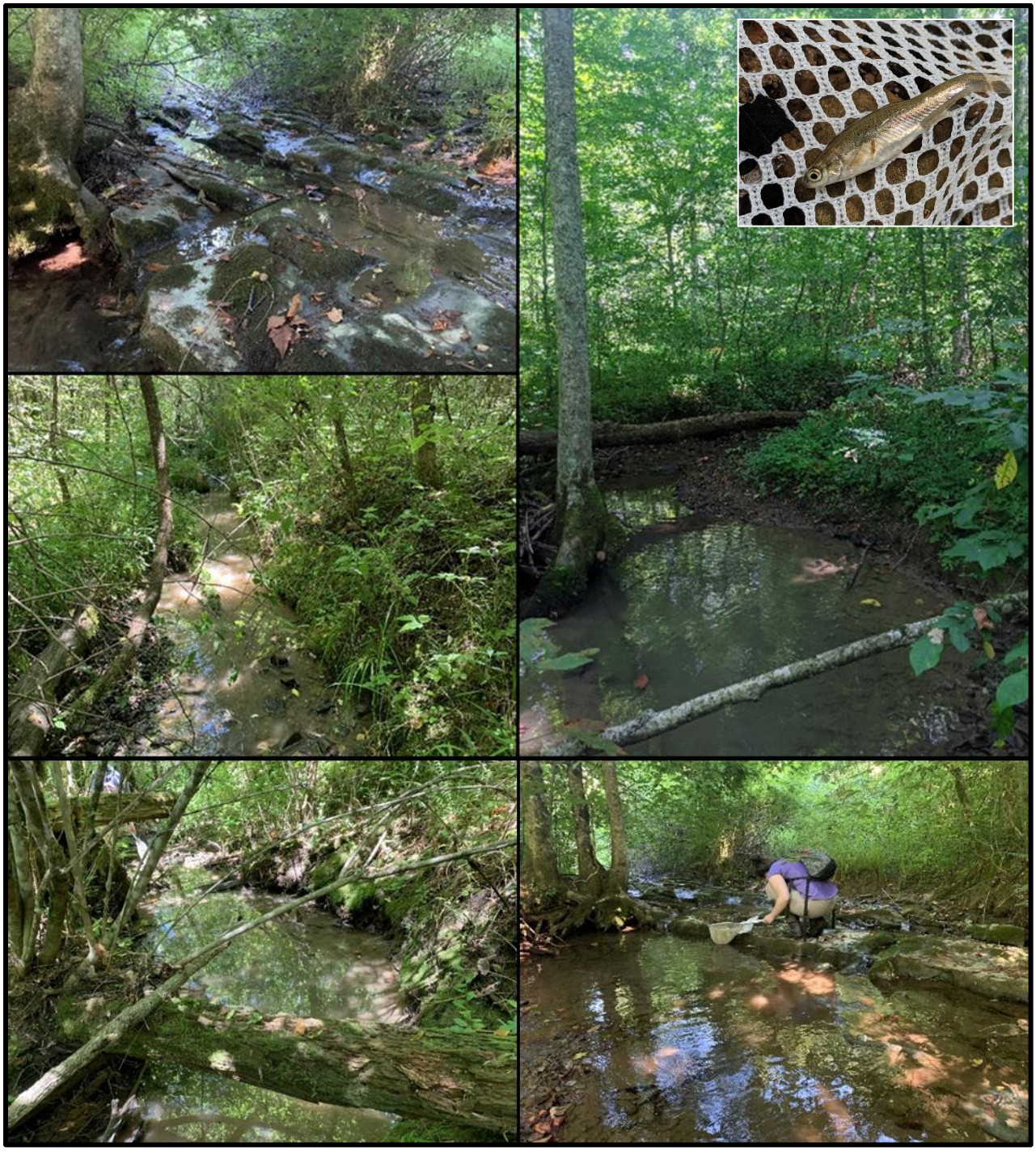

Figure 22. Diversity of structure and flow characteristics of streams within the central portion of the SSP-2A parcel. All reaches contain state-listed Tennessee dace (*Chrosomus tennesseensis*) (upper right inset, July 2020).

Figure 23. Representative springs/seeps within the SSP-2A parcel. All sites shown contain suspected populations of state-listed black mountain salamander (*Desmognathus welteri*) (top left inset), and all connected streams contain extant populations of state-listed Tennessee dace (*Chrosomus tennesseensis*). Both species are considered Focal Species for Research and Management on the Oak Ridge National Environmental Research Park and the focus of ongoing ecological and molecular study.

5. CONSIDERATION OF IMPACTS

Major natural features of concern within the SSP-2A and ORETTC footprint include aquatic and karst features, which also support an array of rare and sensitive fauna and at least some sensitive flora. Given the natural value of these resources, importance to research and science education on the ORR and ORNERP, and at least one plant of cultural significance, mitigation and avoidance measures are needed. Mitigation may also be required for impacts to aquatic resources, most notably wetlands.

Additional habitat features such as the upland exposed karst area on the SNRAF side that contains state-listed American ginseng and mountain disc snails (*Anguispira jessica*–an ORR Focal Species, considered "rare" by TDEC) correspond to the same upland forest in which bat acoustic surveys were insufficient but wherein suitable bat roosting habitat exists (Figure 15). As with the 100-ft stream buffer, avoidance and minimization of impacts in this area and specifically to the karst features would be prudent and an extra show of good faith to regulators and stakeholders of the ORR's and ORNERPS's resources. (ORNL NRMP previously supplied locations of all known sensitive features to ORETTC project personnel.)

5.1 AQUATIC RESOURCES AND KARST FEATURES

The complex structure of the SSP-2A parcel has greatly complicated wetland delineations and stream determinations for this site. The majority of the parcel occurs within the Chickamauga Group, a diverse rock unit that, here, is composed of exposed and shallow mantled karst. Streams and wetlands in the SSP-2A parcel and proposed ORETTC footprint are fed by abundant subsurface flows and resurgences. The southeast dipping of the bedrock, combined with the primarily northeastern surface drainage, generates a complex matrix of wet-woods, ephemeral pools, seeps, springs, wetlands, and wet weather conveyances and streams (Figures 18–19), many with losing reaches (Figures 21–23).

Additional wetland delineation and evaluation of WWCs is required before such requirements as Aquatic Resource Alteration Permits can be prepared. At this time, it is clear that the ORETTC facility will intersect an approximately 1-acre wetland formed along the central stream riparian. Both the SNRAF and state side of the ORETTC will intersect this complex wetland (see Figures 2 and 19). Furthermore, at least two portions of the central stream will be affected by a road and sidewalk crossing. According to current designs (Figure 2), the sidewalk will pass near a spring/seep that forms the head of the western branch of the central stream. It remains unclear if this portion of stream or the seep will be impacted directly. The sidewalk will then continue across the main branch of the central stream (Figure 19). The road to the north that will connect the SNRAF and state-side facilities will also pass over the central stream near its northernmost point before it passes beneath State Route 95 via 200 feet of existing culvert. Infrastructure along site boundaries is not expected at this time. ***TDEC and ACOE assessments and Aquatic Resource Alteration Permits are required before any WWC, stream, or wetland is affected by the ORETTC project (ACOE 2018; TDEC). Additional assessment of Exceptional Tennesssee Waters might also be required given the presence of state-listed fauna.***

Standard hydrology models that might be used during the design of ORETTC infrastructure are likely to lead to insufficient stormwater mitigation designs. Consideration of the numerous recharge zones, seeps, and general porous nature of the site's bedrock will be necessary. This is especially true of the central stream and wetland that bisects the ORETTC footprint. For more information on stormwater design considerations and relevant models, see Bonneau et al. (2017), Eger et al. (2017), Kong et al. (2017), and Li et al. (2019). As described in Section 5.2, these considerations also are relevant to the assessment of potential impacts to aquatic and semi-aquatic biota.

5.2 RARE AND SENSITIVE FAUNA

Owing to the underlying karst geology and drainage characteristics of the current natural area that comprise the ORETTC footprint, there is a high probability that the ~ 24 acres of graded earth will result in altered hydrology within the ephemeral wetland and stream at the center of the ORETTC facility (Figures 18–20). The listed species identified within the parcel (Table 14 and Appendix A) would be affected by the associated hydrologic and structural changes. The habitat requirements of these fauna are relatively specific to complex shallow subterranean habitat and are dependent on hydrologic stability, as facilitated by perennial seeps and springs that maintain consistent flow throughout the year (Culver and Pipan 2014). For instance, state-listed Tennessee dace rely on shallow headwater streams and seeps such as those within the SSP-2A parcel that typically support few or no additional fish species. The extremely shallow waters, losing reaches, and abundant seepy micropores provide a sustained aquatic refuge during relatively dry periods and abundant troglogphilic invertebrate prey (Etnier and Starnes 1991, 1993; Culver and Pipan 2014). Such streams in Tennessee are also unique in that they typically contain both sensitive fish and sensitive smaller-bodied salamanders such as state-listed black mountain salamanders (*Desmognathus welteri*) and four-toed salamanders (*Hemidactylium scutatum*) (semi-aquatic and aquatic-breeding amphibians with an aquatic larval stage that is vulnerable to fish predation) (Niemiller and Reynolds 2011). Finally, we were not able to assess subterranean fauna; however, there is high likelihood that several species that are considered rare or focal species by TDEC or that have current petitions under the ESA are present within the shallow subterranean habitat that underlies the ORETTC facility footprint [see, e.g., Neimiller et al. (2016), Neimiller et al. (2017), Engel et al. (2017)].

Impervious surfaces such as roads, sidewalks, buildings, and parking lots of the ORETTC will compromise the hydrologic stability and subterranean habitat in the area, well beyond its direct facility footprint. Such infrastructure isolates waters at the surface rather than by the typical diffuse subsurface drainage through underlying karst (Bonneau et al. 2017; Kong et al. 2017). However questionable, it also introduces contaminants via runoff, alters microclimate via reduced canopy and heat effects of paved surfaces and buildings, and increases risk of direct mortality through increased anthropogenic activity (Zaimes et al. 2007; Kingsbury et al. 2015; Eger et al. 2017; Li et al. 2019).

5.2.1 Federal-listed bats and Migratory Birds

Thirty-nine species of migratory birds are known within the ORETTC footprint and SSP-2A parcel (Appendix A). Migratory birds are protected under the Migratory Bird Treaty Act, and several species within the review area carry additional USFWS designations such as BCC, BMC, and USFW Focal species (Table 14 and Appendix A). Discussions and potential consultation with USFWS should be initiated to determine project requirements for minimizing impacts to these species in accordance with regulations and agreements between DOE and USFWS (see Section 2, Basis for Sensitive Resources Assessment).

Federal-listed bats were detected at relatively low frequency within the ORETTC footprint and SSP-2A parcel. If we assume a maximum disturbance area of 25 acres for the ORETTC facility, it is the opinion of the ORNL NRMP that the ORETTC project could proceed with no significant impact to federal- or state-listed forest bats. However, pine forest thinning for fuel reduction will be a necessary safety component of ORETTC construction and operations. This fuel reduction must occur in parallel with ORETTC construction activities and should be considered the responsibility of DOE, because wildland fire management is a requirement on the DOE ORR. Moreover, personnel and equipment access to address fire risk to additional areas of the ORR owing to fuel loads in the SSP-2A parcel will be impeded by the ORETTC. Although this ~3.5-acre additional effect on forest resources is unlikely to introduce significant impacts on forest-dwelling bats, an additional survey might be required by USFWS during the fall swarming and winter hibernation seasons. Minimally, potential roost trees should be assessed

immediately prior to tree cutting, or such manipulation should be carried out between 15 October and 31 March. For projects that affect Indiana bat swarming habitat (near hibernacula), this period should be reduced to 15 November through 31 March (USFWS 2017). Discussions and potential consultation between DOE and USFWS will ultimately determine project requirements and avoidance and minimization measures.

5.2.2 Undetected rare species

Surveys of the SSP-2A parcel and proposed ORETTC footprint occurred from late June through early September 2020. This abbreviated and seasonally restricted survey period severely limits detection of rare flora and fauna. Many plants have low detectability owing to dense surrounding vegetation or lack diagnostic features during summer. Furthermore, many rare and sensitive wildlife species exhibit seasonally restricted activity patterns. For example, some amphibians aestivate or remain dormant during warm summer months, and many migratory bird species are absent altogether.

Species accumulation curves for survey results presented here indicate a clear deficiency in the detection of wildlife (Figure 24). At their simplest, species accumulation curves represent the cumulative number of species observed according to survey effort. When all species (not individuals) have been detected within an area, the curves become saturated. This saturation is indicated by horizontal "flatness" or an asymptote in the number of species observed, as no new species are detected regardless of additional survey effort. Species that are not detected typically represent rarer species, which tend to also be those that are listed or protected under state and federal law. When considering all vertebrate wildlife and migratory birds separately, neither reached saturation during summer 2020 surveys of the SSP-2A parcel (Figure 24).

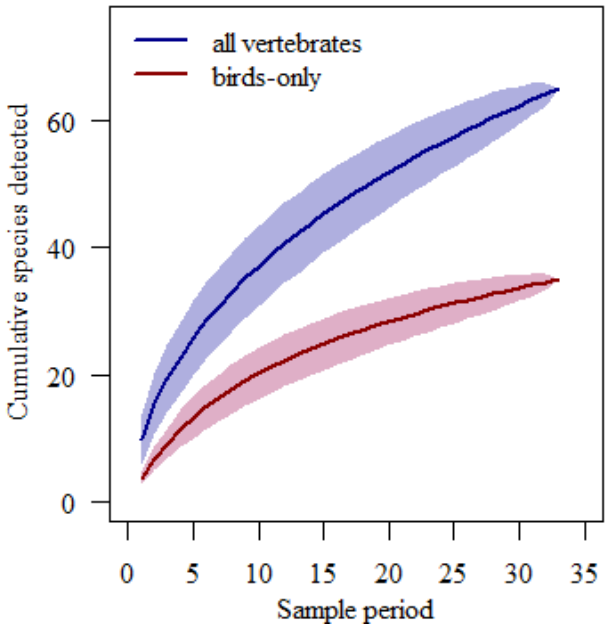

Figure 24. Species accumulations curves for wildlife surveys of the SSP-2A parcel. Lines represent the cumulative number of species detected through time. Lack of saturation (an asymptotic horizontal "flattening") in accumulation curves indicates that rarer species were not detected during 2020 field surveys of the ORETTC and SSP-2A parcel. Lines represent cumulative richness, and shaded regions represent the interquartile range of simulated values for all vertebrates (blue) and birds only (red).

5.3 ADDITIONAL CONSIDERATIONS

5.3.1 Deer reduction hunts for the ORR

TWRA and ORNL operate deer reduction harvests on the ORR that are intended to increase public safety through reduced deer-vehicle collisions, healthier ecosystems via healthier deer herds and reduced browse in natural areas, and protection of human health through reduced risk of zoonotic disease, as outlined in various management plans for the ORR. Deer hunts also provide outdoor recreation opportunities to the public and are thus a vital component of positive relations between DOE, the state of Tennessee, and the public.

Development and operations of the ORETTC will negatively impact deer reduction efforts and hunting opportunities in a high deer density/high harvest area of the ORR. A required no hunting safety buffer would extend 300 ft on all sides of the ORETTC footprint, beginning at the outermost use areas, including safety buffers around all adjacent roads. This would represent an approximately 70-acre loss of huntable land on the ORR. The specific tract of forest that comprises the ORETTC footprint consistently produces the largest deer harvest numbers on the ORR during annual hunts, in terms of both number and size of bucks taken by hunters (~8 deer per year) (Giffen et al. 2012; Carter et al. 2020a). The area also sees a high frequency of deer-vehicle collisions (Giffen et al. 2012). Eliminating hunting around the ORETTC, including a required 300 ft buffer around any facility or manicured campus areas—combined with a stated daily visitor number of up to 500—would likely increase animal-vehicle collisions along State Route 95. Necessary wildland fire fuel reduction in the current dense pine forest immediately east of the ORETTC will further increase the density of deer and exposure to traffic via an increase in forage and suitable bedding area. Additional areas on the ORR are not available to offset this effect via hunting because (1) acreage available for hunts has steadily declined owing to development projects over the past several years, (2) there will be additional known decrese of 140–253 acres in the next 2 years, (3) and no areas adjacent to the SPP-2A parcel are open to hunters. The latter applies to both badged and non-badged hunter access.

5.3.2 Wildlife corridors

The area that encompasses the ORETTC footprint is known to be a wildlife corridor in eastern Tennessee. It remains the subject of research and management by the ORNL Environmental Sciences Division and the NRMP. Attempts have and continue to be made to establish a permanent tract of protected land through the ORR (including portions of the SSP-2A parcel) that includes a least cost path of travel for wildlife through the ORR. The camera trap in the ORETTC facility footprint confirmed that black bear and other medium-to-large forest fauna rely on this area for movement (Carter et al. 2020a; Kwarta et al. in prep). The ORETTC facility will intersect this corridor. Maintenance of a 100 ft stream buffer on either side of the central stream (Figure 2) might reduce impacts to wildlife movement, but the road and sidewalk crossing would continue to deter these typically shy species and/or promote conditions for negative human-wildlife interactions.

5.3.3 Research and science education of the ORR and ORNERP

Effects on research and science education on the ORR and ORNERP require further consideration.

5.4 CUMULATIVE IMPACTS

Since 2010, approximately 300 acres of previously declared natural area (Baranski 2009, 2011, 2018) on the ORR and ORNERP has been lost to new project development, and 243 acres are currently slated for deforestation and development (Figure 4). Thus far, the cumulative effects of these projects have not been

considered alongside new development and land use changes. Although the US ESA defines cumulative impact in terms of the specific project, cumulative impacts remain an often-overlooked or misunderstood component of the NEPA, which, per 40 CFR 1508.7, defines cumulative impact as follows:

> *"Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."*

Thus, impacts to resources owing to ORETTC development *might* not be significant when considered individually, such as (1) a marginal loss of forest resources for listed bat species, (2) lost hunting and deer reduction opportunities for the ORWMA, or (3) effects on research and science education on the ORNERP. When considered alongside past, present, and future project development, additional review and consideration are clearly warranted. Stakeholders of the ORR's and ORNERP's natural and cultural resources also require further consideration.

6. MITIGATION AND AVOIDANCE

Although ~ 0.05 acre of wetland is estimated to be lost via construction activities (Figure 19), this includes loss of part of a larger 1.1-acre wetland. TDEC considers impacts to wetlands in terms of aquatic resource value (Table 1). Thus, combined with elimination of nearby upland habitat for aquatic-terrestrial fauna and the potential for altered hydrology, appreciable loss of aquatic resource value is expected. Moreover, the presence of state-listed species (Section 4.3–4.5) increases present wetland and stream value, which can affect compensatory mitigation requirements in the state of Tennessee (Section 2).

Compensatory mitigation for federal-listed bats is not expected given low-detection frequencies within the ORETTC footprint. However, hibernacula are known to occur nearby, and some suitable roost trees are present within the ORETTC area. Construction activities should occur in accordance with existing guidance on tree cutting (Section 5.2.1). Good faith effort might involve installation of artificial roost structures. These activities can be carried out with assistance of the ORNL NRMP.

Exact locations for most plant and animal resources were intentionally omitted here owing to their sensitivity. However, ORNL NRMP previously supplied locations of all known sensitive resources (biotic and abiotic) within the SSP-2A parcel to ORETTC project personnel for use in avoidance where possible.

6.1 STREAM (AND SPRING / SEEP) CROSSINGS WITHIN THE ORETTC

Stream crossings by roads and pedestrian bridges are among the most impactful activities that occur in small- to medium-sized watersheds. On the ORR, numerous road crossings of various design have negatively impacted all of the major drainages. These impacts include introduction of sediments, contaminants from road runoff, and alteration of available habitat. Many of these factors remain a major focus of ORNL's Aquatic Ecology Group (https://www.ornl.gov/group/ae).

The most significant impact to the ORR's drainages typically results from limitations imposed on movement by both terrestrial and aquatic wildlife. Highway 95 presents the most significant barrier to wildlife movement from east to west across the ORR. A close examination of important corridors in eastern Tennessee reveals that the less contiguous natural areas that exist west of Hwy 95 are too isolated to support major movements or core habitat at a regional level (Kwarta et al. in prep). Moreover, in most areas where movement appears to be important to maintain current biodiversity, connectivity would be facilitated by bridges that pass beneath Hwy 95. Smaller road systems across the ORR do not often

contain such infrastructure that allows safe movement for medium- to large-size wildlife or continuously traversable habitat for aquatic fauna and/or small-bodied terrestrial and semi-aquatic species (e.g., waterways or riparian areas with natural substrates that minimize exposure).

Dedicated wildlife road crossings have been increasingly implemented with a positive effect across the globe. Such road crossings are typically aimed at ungulates and other large mammals. At their most basic, these crossings are bridges or large open-bottom arches that contain natural substrates and are wide and tall enough to facilitate movement by wildlife. However, with careful design through consideration of the unique movement patterns and habitat requirements of the animal communities within a given area, road crossings can be implemented to optimize local and regional biodiversity, and/or they can be targeted at vulnerable focal species (e.g., smaller open-bottom culverts for amphibians and reptiles).

When one considers (1) which species on the ORR are at highest risk of habitat loss and isolation and (2) which species within broader eastern Tennessee are most affected by land use on the ORR, and (3) the cost of bridging, it becomes clear that smaller open-bottom culverts would provide the greatest biodiversity and ecosystem health benefits when implemented in smaller watersheds. Benefits of these structures can include improved aquatic and wildlife connectivity both for horizontal passage and via vertical drainage into underlying shallow subterranean habitat (excluding stormwater management channels). The realization of the full suite of benefits of open-bottom culverts has recently led DOE Reservation Management for the Oak Ridge Site to replace round culverts with open-bottom arch culverts for several roads that pass over streams and some WWCs.

Installation of open-bottom culverts comes with two caveats. First, culverts should ideally be wide enough to facilitate passage by terrestrial fauna. That is, the culvert footprint should encompass the full width of the stream, its banks, and some riparian area during normal flows. In some cases, dry platforms can be installed along the inside edges of arch culverts. Otherwise, the amount of terrestrial habitat to include within the culvert can be just inches if the goal is to facilitate passage by small vertebrates, or it may be several feet if medium- to large-sized wildlife are targeted, as could be applied along the central stream that bisects the ORETTC footprint. Second, wildlife road crossings may be targeted solely at terrestrial fauna, so they need not be associated with an aquatic resource. These terrestrial road crossings may even, as promoted by the Federal Highway Administration, cross over rather than under a road. These larger, over-the-road crossings are most apt to larger roads and likely well-beyond consideration and unsuitable for ORETTC site design. Given the importance of the stream and stream buffer within the ORETTC project area to movement by larger wildlife, larger open bottom culverts should be considered for the road. The relatively small size of the stream might, however, reduce costs and allow a bridge crossing. This is especially applicable should the sidewalk crossing be necessary.

For more on wildlife crossings from the U.S. Department of Transportation, see https://rosap.ntl.bts.gov/view/dot/41646.

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APPENDIX A. COMPLETE LIST OF VERTEBRATE FAUNA FOUND WITHIN THE SSP-2A PARCEL

Type	Scientific name	Common name	State status	Federal status	PIF/Other status
Amphibian	*Anaxyrus americanus*	American toad			
Amphibian	*Desmognathus fuscus* complex	Northern dusky salamander			
Amphibian	*Desmognathus welteri**	Black mountain salamander	NM		
Amphibian	*Eurycea bislineata/wilderae*	Two-lined salamander			
Amphibian	*Hyla chrysoscelis*	Cope's gray treefrog			
Amphibian	*Lithobates clamitans*	Green frog			
Amphibian	*Lithobates sylvaticus*	Wood frog			
Amphibian	*Pseudacris feriarum*	Upland chorus frog			
Amphibian	*Pseudotriton ruber*	Red salamander			
Bird	*Archilochus colubristurker*	Ruby-throated hummingbird			
Bird	*Baeolophus bicolor*	Tufted titmouse			
Bird	*Buteo platypterus*	Broad-winged hawk			
Bird	*Caprimulgus vociferus*	Whip-poor-will		BCC	
Bird	*Cardinalis cardinalis*	Northern cardinal			
Bird	*Coccyzus americanus*	Yellow-billed cuckoo			CBSD, RC, IM
Bird	*Colaptes auratus*	Northern Flicker			CBSD
Bird	*Contopus virensg*	Eastern wood-pewee			RC, MA
Bird	*Corvus brachyrhynchos*	American crow			
Bird	*Cyanocitta cristata*	Blue jay			
Bird	*Dendroica discolor*	Prairie Warbler			YWL, RC, MA
Bird	*Dryocopus pileatus*	Pileated woodpecker			
Bird	*Empidonax virescens*	Acadian flycatcher			RC, MA
Bird	*Geothlypis formosa*	Kentucky warbler		BCC, BMC	YWL, RC, MA
Bird	*Hylocichla mustelina*	Wood thrush	NM	BCC, BMC, Focal	YWL, RC, MA
Bird	*Icteria virens*	Yellow-breasted chat			RC, MA
Bird	*Leuconotopicus villosus*	Hairy woodpecker			
Bird	*Melanerpes carolinus*	Red-bellied woodpecker			
Bird	*Melospiza melodia*	Song sparrow			
Bird	*Meteagris gallopava silvestris*	Wild turkey		BMC	
Bird	*Molothrus ater*	Brown-headed cowbird			
Bird	*Passerina cyanea*	Indigo bunting			
Bird	*Picoides pubescens*	Downy woodpecker			

Type	Scientific name	Common name	State status	Federal status	PIF/Other status
Bird	*Pipilo erythrophthalmus*	Eastern towhee			RC, MA
Bird	*Piranga olivacea*	Scarlet tanager			
Bird	*Poecile carolinensis*	Carolina chickadee			
Bird	*Polioptila caerulea*	Blue-gray gnatcatcher			
Bird	*Seiurus aurocapilla*	Ovenbird			
Bird	*Setophaga americana*	Northern parula			
Bird	*Setophaga pensylvanica*	Chestnut-sided warbler			
Bird	*Setophaga petechia*	Yellow warbler			
Bird	*Sitta carolinensis*	White-breasted nuthatch			
Bird	*Sphyrapicus varius*	Yellow-bellied sapsucker		BMC	
Bird	*Spinus tristis*	American goldfinch			
Bird	*Thryothorus ludovicianus*	Carolina wren			
Bird	*Vermivora pinus*	Blue-winged warbler		BCC, BMC	
Bird	*Vireo griseus*	White-eyed vireo			
Bird	*Vireo olivaceus*	Red-eyed vireo			
Bird	*Zenaida macroura*	Mourning dove		BMC	
Mammal	*Blarina brevicauda*	Short-tailed shrew			
Mammal	*Canis latrans*	Coyote			
Mammal	*Eptesicus fuscus*	Big brown bat			
Mammal	*Lasionycteris noctivagans*	Silver-haired bat			
Mammal	*Lasiurus borealis*	Red bat			
Mammal	*Lasiurus cinereus*	Hoary bat			
Mammal	*Lasiurus seminolus*	Seminole bat			
Mammal	*Lynx rufus*	Bobcat			
Mammal	*Mephitis mephitis*	Striped Skunk			
Mammal	*Myotis grisescens*	Gray bat	E	E	
Mammal	*Myotis lucifugus*	Little brown bat	T	UR	
Mammal	*Myotis septentrionalis**	Northern long-eared bat	T	T	
Mammal	*Mytotis sodalis**	Indiana bat	E	E	
Mammal	*Nycticeius humeralis*	Evening bat			
Mammal	*Odocoileus virginianus*	Deer			
Mammal	*Perimyotis subflavus*	Tri-colored bat	T	UR	
Mammal	*Peromyscus leucopus*	White-footed mouse			
Mammal	*Procyon lotor*	Raccoon			
Mammal	*Sciurus carolinensis*	Eastern gray squirrel			

Type	Scientific name	Common name	State status	Federal status	PIF/Other status
Mammal	*Sigmodon hispidus*	Cotton rat			
Mammal	*Sorex dispar*	Long-tailed shrew	NM		
Mammal	*Sylvilagus floridanus*	Eastern cottontail			
Mammal	*Tadarida brasiliensis*	Brazilian free-tailed bat			
Mammal	*Tamias striatus*	Eastern chipmunk			
Mammal	*Ursus americanus*	American black bear			
Fish	*Chrosomus tennesseensis*	Tennessee dace	NM		
Fish	*Cottus carolinae*	Banded sculpin			
Fish	*Hemitremia flammea*	Flame chub	NM		
Fish	*Rhinichthys atratulus*	Eastern blacknose dace			
Reptile	*Agkistrodon contortrix*	Eastern copperhead			
Reptile	*Carphophis amoenus*	Eastern Wormsnake			
Reptile	*Coluber constrictor*	Eastern Racer			
Reptile	*Diadophis punctatus*	Ring-necked snake			
Reptile	*Nerodia sipedon*	Northern Watersnake			
Reptile	*Plestiodon fasciatus*	Common Five-lined skink			
Reptile	*Scincella lateralis*	Little brown skink			
Reptile	*Storeria dekayi*	Dekay's brown snake			
Reptile	*Storeria occipitomaculata*	Redbelly snake			
Reptile	*Terrapene carolina*	Eastern box turtle			
Reptile	*Thamnophis sirtalis*	Common gartersnake			
		Notable invertebrates			
Mollusc	*Anguispira jessica*	Mountain disc	Rare		

Federal status codes (ESA): FE: federally endangered; FT: federally threatened; UR: under federal review for listing under ESA.
State status codes: Rare: considered rare by TDEC; NM: in need of management by rule of TWRA (TWRA 2018); SD: state-listed in need of management; ST: state threatened; SE: state endangered.
Partners in Flight status codes (Bird Conservation Region 28): RC = Regional Concern; MA = Management Attention needed; IM = Immediate Management Attention Needed; YWL = Yellow Watch List; RWL = Red Watch List; CBSD = Common Bird in Steep Decline.
* Historical record.
† Considered possible based on nearby records and limited acoustic detection.