

Sensitive Resources Assessment and Forest Analysis for the Proposed Versatile Test Reactor, Oak Ridge, Tennessee



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September 2020

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Environmental Sciences Division

**SENSITIVE RESOURCES ASSESSMENT AND FOREST ANALYSIS FOR THE
PROPOSED VERSATILE TEST REACTOR, OAK RIDGE, TENNESSEE**

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September 2020

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831-6283
managed by
UT-BATTELLE, LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

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ACRONYMS

ARA	aquatic reference area
BCC	USFWS bird of conservation concern
bf	board feet (international ¼ in. rule)
BMC	USFWS bird of management concern
CBSD	common bird in steep decline
DOE	US Department of Energy
dbh	diameter at breast height (4.5 ft)
ESA	US Endangered Species Act
ETW	Exceptional Tennessee Water
FS	ORNL Focal Species
HPRR	Health Physics Research Reactor
LiDAR	light detection and ranging
MA	in need of management action
MBTA	Migratory Bird Treaty Act
NERP	National Environmental Research Park
NM	In Need of Management by rule of TWRA
OSWDF	On-Site Waste Disposal Facility
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
RC	regional concern
TDEC	Tennessee Department of Environment and Conservation
TRAM	Tennessee Rapid Assessment Method
TWRA	Tennessee Wildlife Resources Agency
USFWS	US Fish and Wildlife Service
VES	visual encounter survey
VTR	Versatile Test Reactor
WWC	wet weather conveyance
YWL	Yellow Watch List

1. INTRODUCTION

The US Department of Energy's (DOE's) Oak Ridge National Laboratory (ORNL) is a leading institution in advanced materials, supercomputing, neutrons, and nuclear science. As a research laboratory managed by UT-Battelle, LLC for DOE, ORNL has national priorities in energy, security, and scientific discovery that necessitate facility improvements and expansions. DOE is also committed to environmental stewardship. The laboratory is located on the ~32,000-acre (~13,000-ha) Oak Ridge Reservation (ORR), much of which is categorized as a National Environmental Research Park (NERP) and a state Wildlife Management Area. DOE works with the Tennessee Wildlife Resources Agency (TWRA), Tennessee Department of Environment and Conservation (TDEC), US Fish and Wildlife Service (USFWS), US Department of Agriculture, and other agencies to serve as an effective steward of the ORR. Accordingly, project managers must conform to environmental regulations, agreements, and policies at the federal, state, and institutional levels. Per 40 CFR (Code of Federal Regulations) 1508.14, potential effects on research and science education also represent potential effects of federal actions on the NERP, and impacts on, e.g., deer harvest, must be considered on the Oak Ridge Wildlife Management Area when other aspects of the human environment are affected.

The United States currently has no fast neutron testing capability to support advanced nuclear research and development. The proposed Versatile Test Reactor (VTR) will take advantage of current investments by the US government and private industry in nuclear reactors to expedite the design and construction process, using proven technology to create a world-class scientific infrastructure. The VTR will take advantage of fast neutrons provided by this proven technology, along with a capability to rapidly insert, conduct, and remove state-of-the-art experiments. An advantage of the VTR is that it can support future innovations in experimental capabilities without modifying the facility. The VTR will support progress in a variety of science and technology areas, including testing and qualification of advanced reactor fuels; testing and qualification of innovative structural materials; testing of innovative components and instruments; validation of advanced modeling and simulation tools; and versatility for future technical missions. Through proven technology, the VTR can take advantage of existing reactor designs and operating experience to reduce the risk, cost, and time for design and construction. The top available resources of DOE laboratories, industry, and universities will be used to expedite reactor design and construction toward developing the scientific infrastructure that affords a strong testing capability that can be sustained over many years.

This report summarizes current knowledge of natural and cultural resources primarily within the VTR construction area. At the time of this report, the proposed VTR site design includes a construction area of ~150.4 acres (~69.9 ha), which contains an ~51.3-acre (~20.8-ha) operations area, located within forested natural areas of the ORR (Figure 1). The primary goal of the work presented here was to evaluate potential effects on sensitive resources that might result from development and construction activities associated with VTR. In addition to on-the-ground surveys during spring and summer 2020 by the ORNL Natural Resources Management Program and Aquatic Ecology Group staff, this report makes use of historical (pre-1995) and contemporary (1995 to present) data from additional confirmed sources (e.g., TDEC). Likewise, forest conditions were compiled from a 2011 forest inventory and supplemented with limited ground observations in 2020. The individuals who obtained and compiled the data presented here are familiar with and routinely assess sensitive resources on the ORR.

Anyone who references this report must consider that the timing of surveys did not permit a complete delineation of the resources that will be affected. If the VTR project proceeds, additional surveys will be required to account for the seasonal patterns of various threatened and endangered species. Data deficiencies and potential resources that likely went undetected are indicated where possible. Accordingly, this report should facilitate more environmentally sound decisions during planning and

development of the VTR site, provide a foundation for further assessment of sensitive and cultural resources, and help project managers better address regulatory guidance and DOE policies on sustainable development in compliance with, for example, 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 policies as outlined in various ORR management plans developed by ORNL and TWRA for DOE (e.g., Carter et al. 2020).

2. METHODS

Overview—In addition to on-the-ground surveys by ORNL Natural Resources Management Program and Aquatic Ecology Group staff, who routinely assess and are familiar with sensitive resources on the ORR, this report makes use of historical (pre-1995) and contemporary (1995 to present) data, as obtained from (1) previous reports and observations by ORNL Natural Resources, (2) reports made available to the ORNL Natural Resources Management Program by researchers and contractors on the ORR, and (3) 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 failed to detect those resources, and/or—in the case of sensitive flora and fauna—other resources that are critical to their persistence were no longer present or adequate to support viable populations with the VTR project area or connectivity between populations of sensitive taxa elsewhere on the ORR.

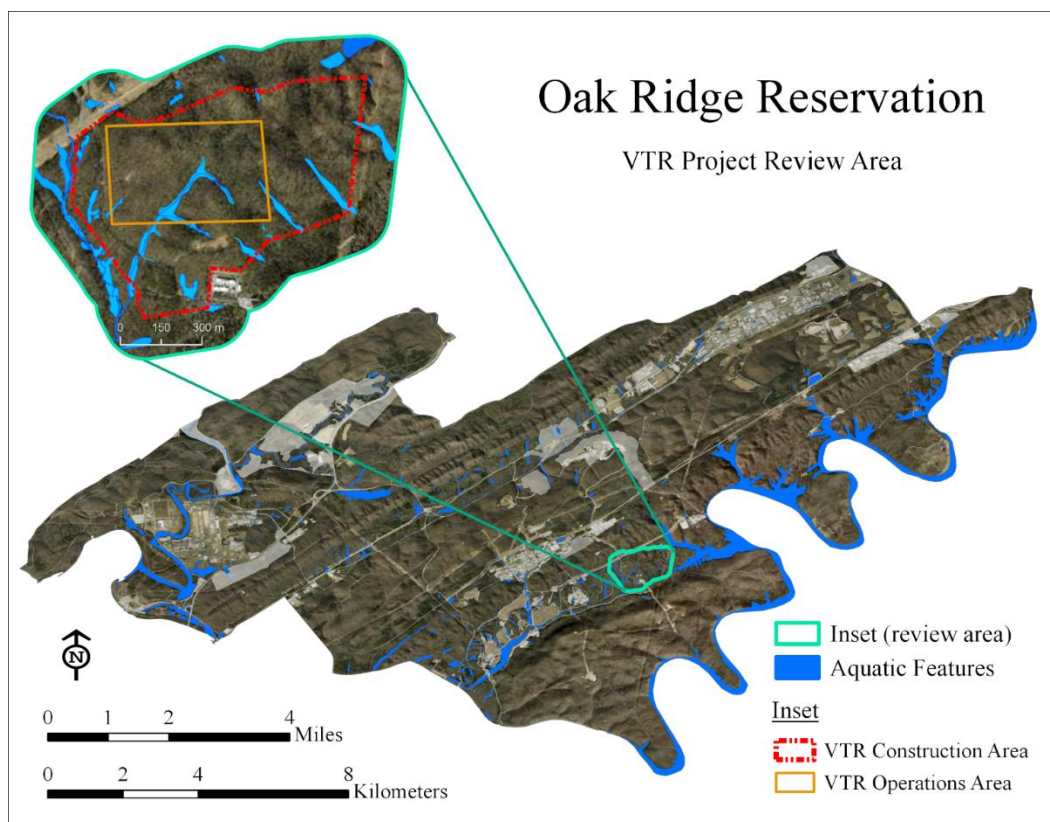


Figure 1. Review area for the proposed VTR project on DOE’s ORR, Oak Ridge, Tennessee, USA.

2.1 SENSITIVE RESOURCES SURVEYS

2.1.1 Database review and initial screening

Species-specific habitat inventory—We compiled a list of endangered, threatened, rare, or otherwise sensitive focal taxa with potential to occur within the VTR construction area. We first reviewed the ORNL natural resources database for spatial records of sensitive resources confirmed within the vicinity of the review area. These taxa were considered contemporary records if they were documented after 1995. All others were considered unconfirmed historical records unless later survey confirmed their presence within the VTR construction area. We then compiled a list of additional sensitive resources with reasonable potential to occur within the VTR construction area 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 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 USFWS’s Information for Planning and Consultation tool (<https://ecos.fws.gov/ipac/>), using the VTR construction area footprint as the input area. Habitat parameters for each of the potential sensitive resources were compiled through the same sources (Appendix I). These parameters were later used to help guide field-based survey and data collection.

2.1.2 Aquatic resources

Environmental management and protection of aquatic features on the ORR is a priority for DOE and thus a major focus of several divisions within ORNL. Accordingly, substantial efforts have been made on inventory and understanding the connectivity of surface and subterranean aquatic features (Figure 2). Thus, we first reviewed previous aquatic resource delineation efforts and reports to determine locations of known streams, wetlands, and seeps within the VTR construction area (e.g., Rosensteel, 1996; Baranski 2011, 2018). We then used these data alongside new quantitative hydrology models to focus current field-based mapping. Field-mapped seeps/springs, stream, and wetland boundaries presented here represent aquatic features within and adjacent to the VTR construction area that were mapped by an experienced hydrologic technician via a Trimble Geo 7x. However, this preliminary assessment did not include complete wetland delineations or stream determinations, which will be required by TDEC if the VTR project proceeds as currently planned. Additional detailed procedures for the preliminary aquatic feature assessment are outlined in the following paragraphs.

Modeling hydrology within the VTR construction area—The many capabilities at ORNL in advanced geographic information system mapping and modeling that have occurred since the original mapping efforts allowed us to focus on potential new wetlands, shallow ephemeral pools, streams, and wet weather conveyances (WWCs). Specifically, LiDAR (light detection and ranging) data at <1-m resolution were obtained from a winter 2015/2016 flyover (USGS 2015, 2016) of the ORR. These data—in conjunction with an inventory of 3,442 seeps, active springs, sinks, and caves within the ORR by the ORNL Natural Resources Program—were used to develop several hydrologic models. These models 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 version 4.0.2 (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 used to focus the field-based surveys herein via stream, wetland, and soil saturation predictions for the VTR construction area.

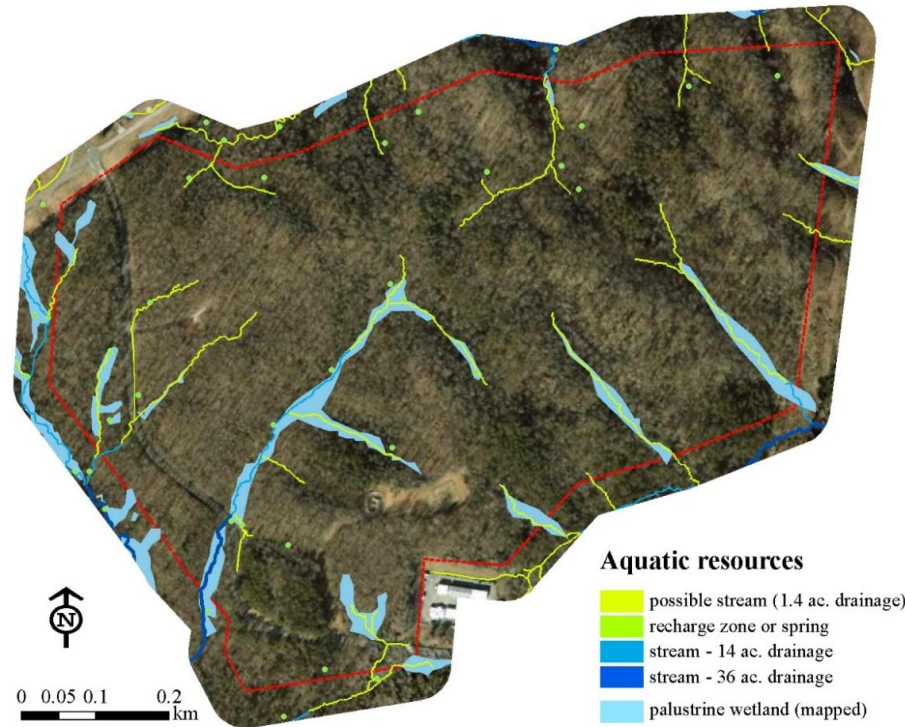


Figure 2. Previously assessed aquatic resources from the ORNL Natural Resources and Environmental Sciences Division databases. Wetlands are based on a 1999 inventory of wetlands on the ORR, springs are based on ongoing field inventory, and streams and drainages are based on remote-sensing efforts by the ORNL Environmental Sciences Division at <1-m resolution (LiDAR, aerial imagery, and satellite imagery), followed by ground delineations. Results of contemporary mapping efforts are included in Section 3.3.1.

Field-based aquatic feature inventory within the VTR construction area—Aquatic surveys were conducted between February and July 2020. Wetland surveys that required plant identification were predominantly conducted in May or June 2020. When possible, surveys for sensitive aquatic or semiaquatic species were conducted at the best time to locate those species. Additional details pertaining to wildlife and plant surveys can be found in Sections 2.1.3 and 2.1.4.

Integrating field and model based delineations—Newly acquired data were used to retrain models as new data were collected. We used updated maps to document the extensive aquatic resources within the proposed VTR site, gain a clear picture of the 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 do not represent complete wetland delineations and stream determinations. Instead, they represent aquatic features within and adjacent to the VTR construction area that were mapped by an experienced hydrologic technician via a Trimble Geo 7x. New data on plants and other unique natural features were also collected during aquatic feature surveys.

2.1.3 Plant Surveys

Plant surveys were conducted between May and July 2020 when vegetation could most easily be identified. Any potential rare species that could not be positively identified given the time frame of this study were documented and will be monitored through the remaining growing season. These species mainly include taxa that require blooms to identify beyond genus or species that are inconspicuous when

not flowering. Rare plant surveys were conducted primarily to confirm the presence or absence of suitable habitat for taxa with state or federal listing status. Existing maps and reports revealed no previously documented rare plants within the review area. Therefore, surveys prioritized habitats identified through the initial screening of sensitive resources with potential to occur within the VTR project area (see Section 2.1.1). During this initial screening, we determined that the review area has suitable habitat for multiple plant species that are threatened, endangered, or of otherwise special interest. In particular, surveys focused on federally listed Virginia spiraea (*Spiraea virginiana*) and white fringeless orchid (*Platanthera integrilabia*), and the state-listed tubercled rein orchid (*Platanthera flava* var. *herbiola*). All three species have known occurrences either on the ORR or the surrounding area. Additional rare plant species with potentially suitable habitat can be found in Appendix I. Dominant vegetation was also recorded while surveying wetlands, streams, and ridgetop locations.

2.1.4 Wildlife Surveys

Bat acoustic surveys—Bats are a primary focus of the ORNL Natural Resources Program because the ORR's forests, wetlands, and caves have the potential to support several state- and federal-listed bats. Of the bats on the ORR (McCracken et al. 2015), the Indiana bat (*Myotis sodalis*) and gray bat (*Myotis grisescens*) are listed by USFWS as federally Endangered, and the northern long-eared bat (*Myotis septentrionalis*) is listed as federally Threatened under ESA. Additionally, the little brown bat (*Myotis lucifugus*) and tricolored bat (*Perimyotis subflavus*) are currently under federal review for listing under ESA. All federally listed bats and several additional bats of the ORR carry various special protection statuses specific to the state of Tennessee (see Appendix I for details).

Six bat acoustic monitors (Wildlife Acoustics Song Meter SM4Bat FS Ultrasonic Recorders equipped with SMM-U2) were positioned in likely flyways and foraging zones throughout or immediately adjacent to the survey area from 15–21 May, 2020. Sites for acoustic recording were selected based on likelihood of use by bats as flyways to foraging grounds and/or for foraging. Microphones were mounted on 3-m poles and directed along the likely flyway. Recording began 30 min before sunset and ended 30 min after sunrise each night. All SM4Bat monitors were deployed for seven consecutive nights, beginning May 15, 2020. Additionally, four cave entrances were surveyed using bat acoustic monitors as described. Caves that may serve as hibernacula for federal- or state-listed bat species and are within 2 miles of the survey area were selected. Cave surveys were conducted from 26 March–2 April, 2020. Monitors were placed close to cave entrances to record calls of bats as they exited for nightly foraging. Data were collected and analyzed using Kaleidoscope Pro Analysis Software, version 5 with both zero-crossing and full-spectrum analysis methods, as approved by USFWS.

Bird point counts—Migratory birds also represent a major management focus for ORNL and DOE. For example, Carter (2020) 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 and potential importance of the site by migratory birds, we combined historical species occurrence primarily via ongoing Partners in Flight surveys across the ORR. To provide a more detailed assessment specific to VTR, we also implemented avian point counts at 12 equally spaced locations within the VTR construction area. All bird species seen or heard within a period of 10 min at each point were recorded. The first six points were surveyed on 7 May 2020, and the last six points were surveyed on 6 July 2020. We also recorded birds seen or heard opportunistically during visual encounter surveys (VESs).

VESs—We implemented VESs along all streams, wetlands, and ridgetops within the review area three times between February and July 2020. We focused on the topographic/habitat extremes because the preliminary review indicated that potential sensitive flora and fauna within the review area were associated either with aquatic or ridgetop features or were more easily detected via alternative methods (Figure 3). VES transects were generated in ArcMap 10.7 (ESRI, 2018) based on previous habitat and aquatic resource mapping efforts (Rosensteel 1996; Baranski 2009, 2011, 2018). Transects and search methods were prioritized according to their level of connectivity (e.g., hydrologic or contiguous natural area) to areas with known records of rare and sensitive wildlife outside of the VTR construction area (Wade and Carter 2020; Wade, DeRolph, and Carter, in preparation). However, search areas were adjusted in the field according to current conditions and to prioritize those habitats identified through the initial screening of sensitive resources (Section 2.1.1). All wildlife encountered were recorded and photographed where possible, and surveyors maintained an active inventory of rare and sensitive species' habitat suitability by referencing the previously compiled list of potential rare and sensitive taxa (see Section 2.1.1 and Appendix I).

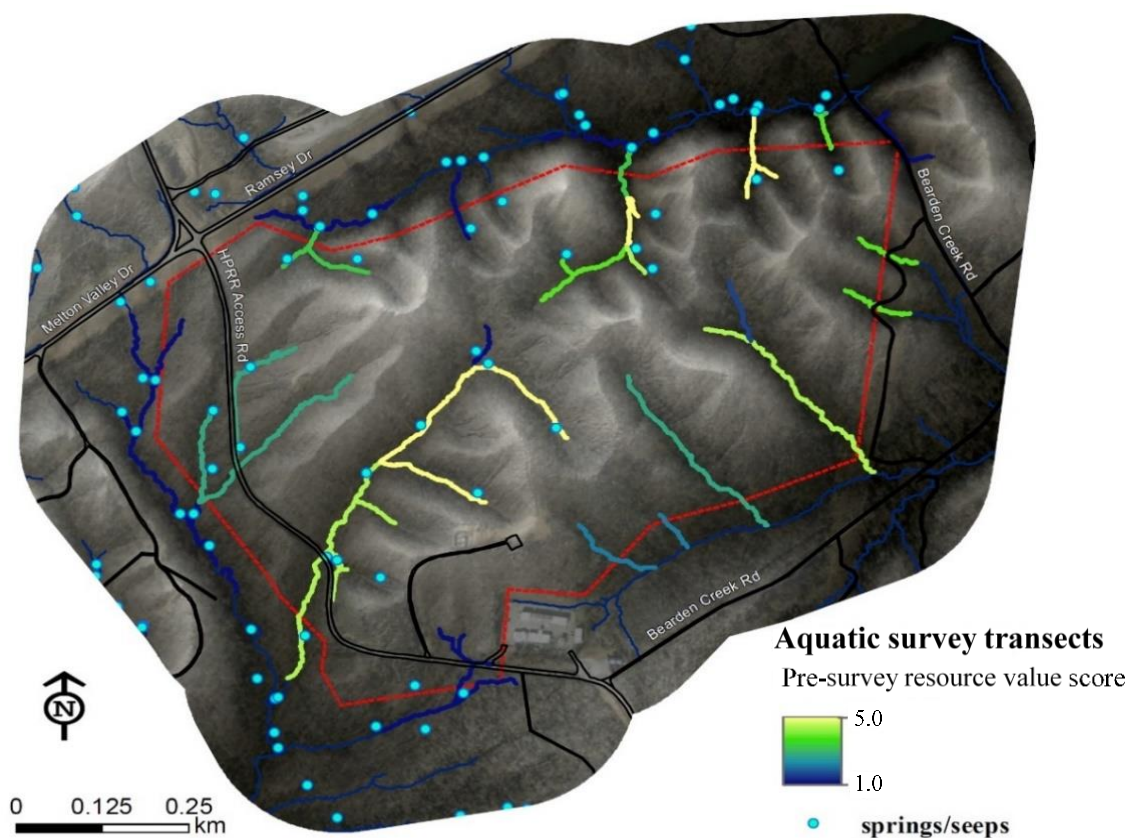


Figure 3. Aquatic resource review priority transects, color shaded according to connectivity to known sites of high natural area scores (updated with new data from Baranski 2009, 2011, 2018). Background: the lightest and darkest background areas (composite grayscale wetness/terrain exposure overlay) received the highest search efforts during VESs. The darkest areas are more likely to contain wetlands and streams, and the lightest areas represent ridgetops.

2.1.5 Forest Inventory and Analysis

Forest conditions were assessed based on previous forest inventory and contemporary ground observations. A forest inventory for Forest Management Compartment 21, which contains the VTR

review area, was concluded in September 2011 (Johnston, unpublished report to the ORNL Natural Resources Management Program).

3. RESULTS AND DISCUSSION

3.1 SENSITIVE RESOURCES SURVEYS

3.1.1 Aquatic Resources

Seeps, springs, and WWCs—The VTR construction area contains ≥ 30 seeps/active springs and extensive WWCs (Figures 4 and 5). Because springs are inherently difficult to assess, they were mapped as point features near their source. Additional surveys will be required if the VTR project proceeds.

Streams—Approximately 1,490 ft (454 m) of mapped streams are within the VTR construction area. This does not include currently unclassified channels and WWCs that will require hydrological determinations (Figure 4). The VTR construction area is drained by Melton Branch and Bearden Creek. The first- and second-order reaches of Melton Branch in the construction area eventually become a major tributary of the main stem of White Oak Creek, an aquatic system contained within the ORR that drains into the Clinch River. Sections of Melton Branch and White Oak Creek are part of the Biological Monitoring and Abatement Program that was established in the 1980s (Baranski 2009, 2011), and portions of Melton Branch and its riparian buffer zone and wetlands comprise the Melton Branch Aquatic Reference Area (ARA). ARAs were established on the ORR to protect special habitats and serve as reference or control areas for various ecological monitoring, research, and remediation activities. Impacts to Melton Branch or its associated catchment, tributaries, or wetlands might represent a significant impact to sensitive resources and decades of biological monitoring and research at ORNL.

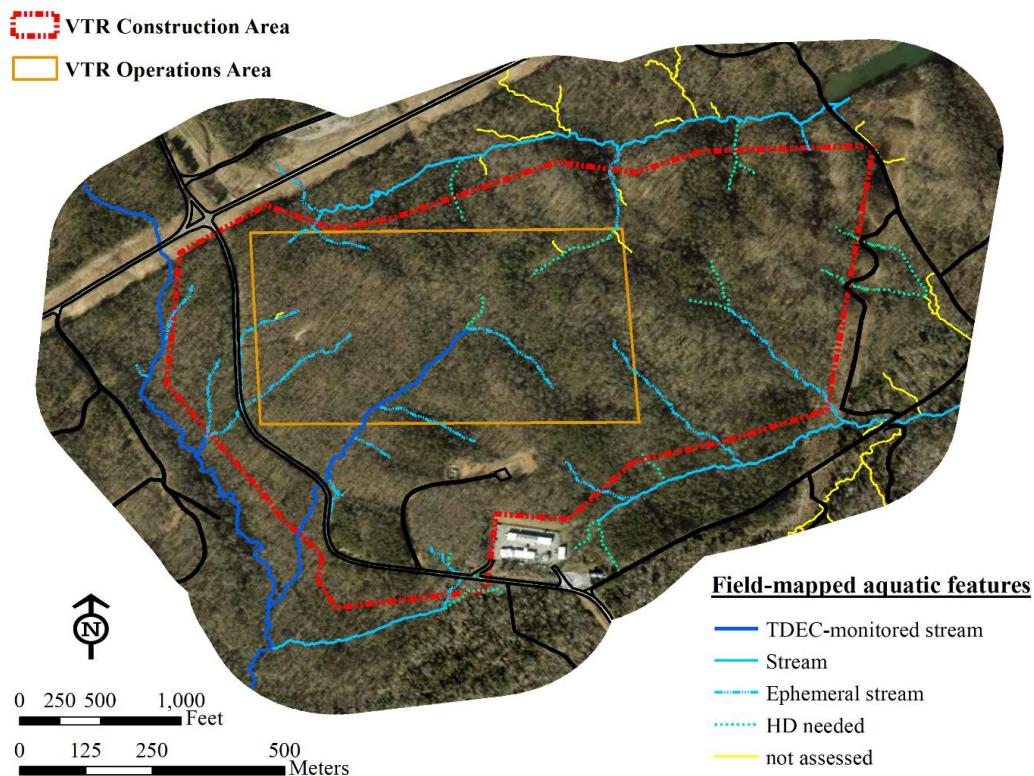


Figure 4. 2020 field-based stream mapping. Wetlands included in the Melton Branch ARA are indicated by dark blue (TDEC-monitored stream). This ARA (wetlands and tributaries included) serve as a decades-long research and reference sampling area for multiple DOE/ORNL programs.

Wetlands—Approximately 7.3 acres (2.95 ha) of previously mapped wetland occur within the VTR construction area. Field surveys documented an additional 0.8 acres (0.32 ha) of previously unmapped wetland for a total of >8.1 acres (3.3 ha). Wetlands were associated with tributaries, drainages, and topographic depressions (Figures 5 and 6). All wetlands in the footprint are classified as palustrine forested broad-leaved deciduous wetlands (PFO1) (Cowardin et al. 1979). Wetlands within the Melton Branch system were associated primarily with the stream and accompanying drainages at the bottom of steep sloped ravines, although some were located in lower elevation areas near the road. These wetlands are a mosaic of unvegetated alluvial flats, herbaceous vegetation, shrubs, and trees. Woody vegetation was located primarily along the wetland edges and along streams. Bearden Creek wetlands were associated with ravines but had a more complex network of drainages and WWCs (Figure 6). Two newly documented wetlands contained large populations of brown widelip orchid and over 50 Jack-in-the-pulpit plants. Another wetland in this system contained a similar sized population of Jack-in-the-pulpit, but these were predominantly female plants that were substantially taller, reaching heights between 2 and 3 ft. The latter plant characteristics are usually indicative of an area with nutrient rich soils that can support the additional energy it takes the female plant to bear fruit. Although neither brown widelip orchid nor Jack-in-the-pulpit are considered rare, these abbreviated surveys suggest that wetlands within the VTR construction area are characteristic of systems that support less common species or communities.

Wetlands within the VTR construction are likely to be deemed Exceptional Tennessee Waters (ETWs) owing to (1) their history and utility in ORNL/DOE research and compliance sampling programs, (2) the presence of the only known state-listed four-toed salamanders (*Hemidactylium scutatum*) south of the ORNL campus (on the ORR), (3) the presence of the only known mud salamanders, an ORNL Focal Species (FS) for research and management, in Roane or Anderson County Tennessee (Carter et al. 2020;

Carter and Wade 2020), and (4) probable occurrence of state- and/or federally listed orchids (i.e., *Platanthera flava* var. *herbiola* and/or *Platanthera integrilabia*).

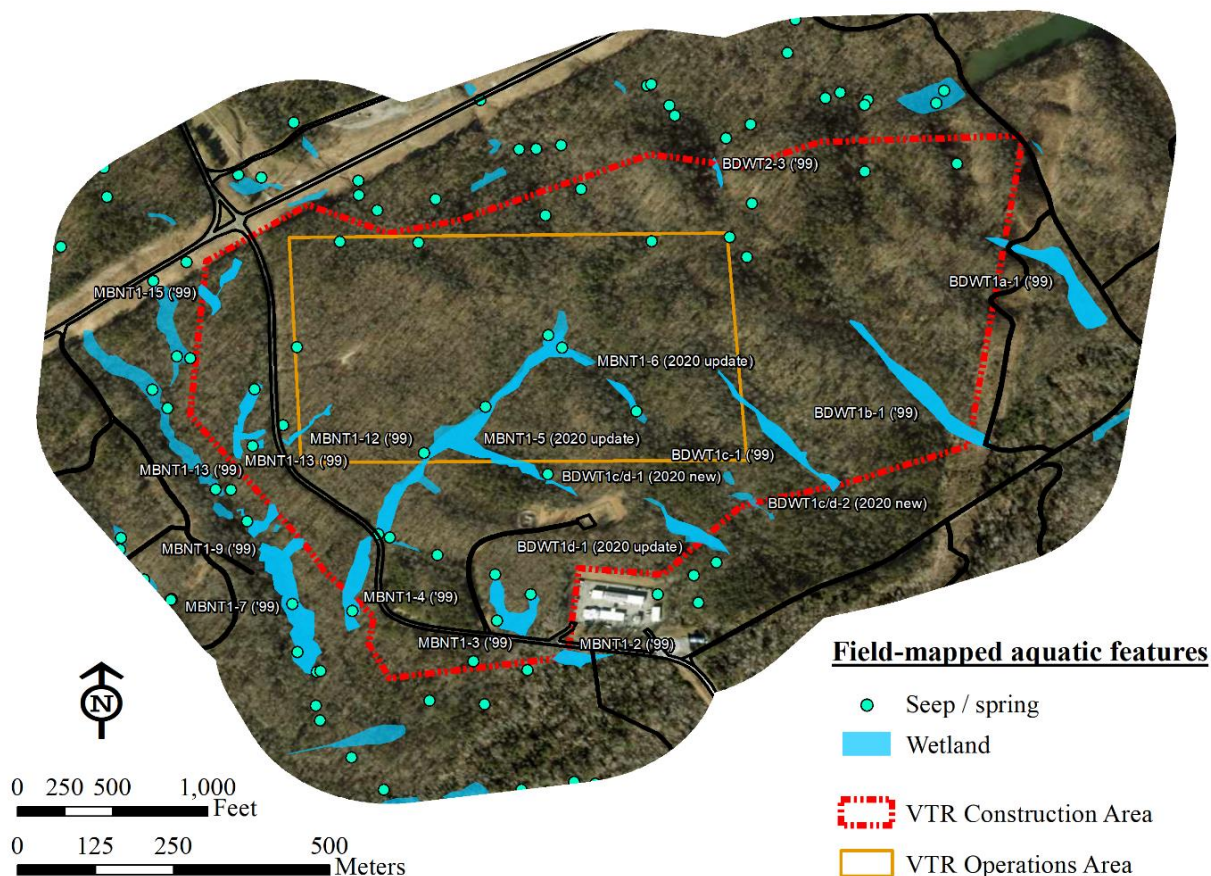


Figure 5. 2020 field-based wetland mapping. Wetlands included in the Melton Branch ARA contain the prefix MBTN. This ARA serves as a decades-long reference sampling area for multiple DOE/ORNL programs.

Additional regulatory considerations—ETWs are aquatic resources with features that merit special attention or consideration and are significant at the national, state, or regional level. An ETW designation is expected for aquatic features within the VTR construction and operations areas (Figures 4–6). The ETW designation is determined via the Tennessee Rapid Assessment Method (TRAM), a tool designed by TDEC for mitigation planning (TDEC 2015). The requirements for a wetland to be considered ETW are outlined in Rule 0400-40-03-.06(4)a of the TDEC General Water Quality Criteria (TDEC Chapter 0400-40-03, 2015). If this project proceeds, additional assessment will be required. Minimally, this would include wetland delineations (USACE 1987), stream evaluations (TDEC 2019), and hydrologic determinations of currently unclassified channels and WWCs (TDEC 2020). Any potential ETW will require the additional assessment using TRAM (TDEC 2015).

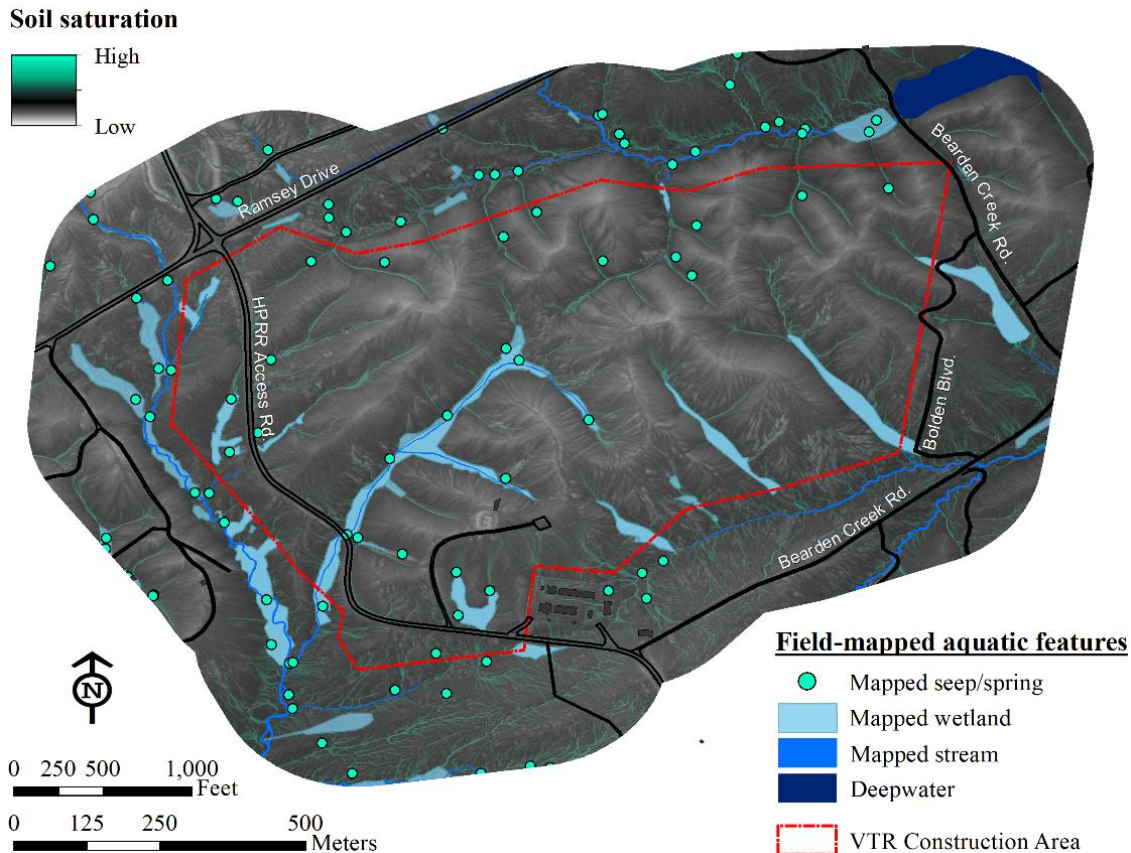


Figure 6. Field-mapped aquatic features overlaid on final model-based predictions of aquatic features. Delineated streams represent perennial streams only. Ephemeral and intermittent streams are shown in Figure 4 but strongly agree with soil saturation predictions here. Those streams will also require hydrologic determination and potential mitigation under TDEC regulation if they are affected by VTR construction.

Mitigation—Evaluation of aquatic resources at proposed mitigation sites might be required to assess adequate mitigation actions (TDEC, 2019; TDEC, 2015). Mitigation ratios are broadly defined as 2:1 for restoration, 4:1 for creation/enhancement, and 10:1 for preservation. For ETW, TDEC often prefers that equivalent quality habitat within the same watershed be placed into permanent conservatorship (preservation) and at rates higher than non-ETW. A preliminary look at the Melton Branch watershed suggests that the headwaters and upper reaches of Melton Branch represent the only areas within the Melton Branch or White Oak Creek watershed considered to be Reservation Clean Areas, and, even so, similar headwater seep and mucky riparian wetlands do not exist elsewhere in the Melton Branch watershed. Importantly, sensitive aquatic features occur throughout and adjacent to the VTR construction area, but the most substantial wetlands and stream environments occur within the planned VTR operations area (Figures 4–6). Moreover, the nearest known similar combination of wetland features on the ORR (in terms of quantity, structure, and species composition) is subject either to future development or to alternative land use plans. Thus, additional efforts would be required to assess the full scale of effects and to determine appropriate mitigation strategies given the number, complexity, and quality of aquatic resources (i.e., wetlands, streams, and conveyances) within the review area. The ORNL Natural Resources Program is equipped for such assessment should the project proceed.

3.1.2 Plant Surveys

Individual orchids were identified within the VTR construction area during spring and early summer 2020 as possible *Platanthera flava* var. *herbiola* (state-listed Threatened) and/or *Platanthera integrilabia* (listed Threatened under ESA). However, individuals could not be positively identified given seasonal growth patterns and the abbreviated period that was provided to conduct surveys. Additional longer-term surveying of these populations is necessary to determine impacts.

Although no rare plants were positively identified as of the timing of 1 August 2020, suitable habitat for Virginia spiraea, white fringeless orchid, and tubercled rein orchid were recorded for future reference. Additional rare and sensitive plant species that have potential habitat within the VTR project area are listed in Appendix I. Plant communities of management or research importance to the ORNL Natural Resources Program or Environmental Sciences Division were also documented during plant field surveys. A dense population of brown widelip orchids (*Liparis liliifolia*) were located in a wetland associated with Bearden Creek. Although not a federal- or state-listed species, the population consisted of >30 individuals. Wide-lip orchid populations of this size are otherwise unknown on the ORR or surrounding area. The species is known to occur with only occasional frequency in East Tennessee (Chester, et al. 2015) and is listed as threatened or endangered in multiple eastern US states (USDA NRCS, 2016). At least five other orchid species occur within the VTR construction area, which highlights the extent and variability of moist soil habitat within the construction area.

The VTR construction area primarily comprises forested wetlands with intervening steep slopes and dry-mesic ridgetops. The majority of plant community data was collected within aquatic areas and lower-elevation areas during wetland surveys. Specific tree species data and basal area can be found in Section 3.1.4. Upland herbaceous vegetation included common woodland species such as rattlesnake plantain, bedstraws, Virginia creeper, Christmas fern, Japanese honeysuckle, false Solomon's seal, and white avens. Dominant understory vegetation in the forested wetlands included saplings of red maple, sweetgum, sycamore, green ash, ironwood; understory trees and shrubs, including ironwood, spicebush, and strawberry bush; and herbaceous species, including bulbous cardamine, false nettle, marsh violet, sensitive fern, polygonum, poison ivy, rice cutgrass, *Microstegium*, hog peanut, jewelweed, agrimony, and multiple hydrophytic sedge and grass species. Additional species included pawpaw, Jack-in-the-pulpit, foam flower, and brown widelip orchid. Several representative plants found within the VTR construction area are shown in Figure 7.



Figure 7. Examples of flora encountered during 2020 field surveys.

3.1.3 Wildlife Surveys

Bat acoustic surveys (70 survey nights)—Results from bat acoustic detectors (Figure 8) are included in Tables 1 and 2. In total, 15 native bat species were detected at cave entrances. Of these, detection frequencies provide strong evidence of the occurrence of 10 species, reasonable evidence of 4 species, and 1 species was considered unlikely at cave entrances near the VTR survey area. Of the 12 native bat species detected at the VTR survey area, detection frequencies provide strong evidence of 6 species,

reasonable evidence of 3 species, and 3 species were considered unlikely within the survey area. Both state- and federally listed species—including federally Endangered gray bats (*Myotis grisescens*), state Threatened little brown bats (*Myotis lucifugus*), and state Threatened tricolored bats (*Perimyotis subflavus*) (also under federal review)—were detected at a relatively high frequency within the survey area and at cave entrances. Three additional species with state and/or federal listing status were considered probable residents given either moderate detection frequency or incidental observation that occurred outside of the 2020 survey (Tables 1 and 2).

Table 1. Results from acoustic bat detectors at the VTR survey area. Recordings are from 15–21 May 2020. The number of call detections is included for each detector. A low number of detections is considered poor evidence of presence. (SR: considered rare or regionally important by the state of Tennessee; SD: state-listed In Need of Management; ST: state-listed Threatened; SE: state-listed Endangered; FT: federally Threatened; FE: federally Endangered; UR: federal listing status currently Under Review).

Species	Ref. site	VTR forest/wetlands						Suspected impact	Status
		VTR-1	VTR-2	VTR-3	VTR-4	VTR-5	VTR-6		
<i>Myotis grisescens</i>	1050	6	1	84	0	0	10	Yes	FE, SE
<i>Myotis lucifugus</i>	2	24	97	16	0	4	182	Yes	UR, ST
<i>Myotis septentrionalis</i>	0	0	0	0	0	0	1	Uncertain	FT, ST
<i>Myotis sodalis</i>	1	0	1	0	0	1	0	Uncertain	FE, SE
<i>Perimyotis subflavus</i>	0	11	0	64	0	1	2	Yes	UR, ST
<i>Eptesicus fuscus</i>	202	2	3	6	0	2	1		
<i>Lasiurus borealis</i>	143	21	9	392	0	2	42		
<i>Lasiurus cinereus</i>	79	11	9	1	0	7	16		
<i>Lasiurus seminolus</i>	286	0	0	0	0	0	0		
<i>Lasionycteris noctivagans</i>	380	13	11	4	0	11	6		
<i>Myotis leibii</i>	0	0	0	0	0	1	1	Uncertain	SD
<i>Nycticeius humeralis</i>	61	12	3	5	0	3	0		
<i>Tadarida brisiliensis</i>	699	4	4	0	0	6	0		

Table 2. Bat acoustic results from caves near the VTR project area from 26 March – 2 April 2020. Only bat species that may hibernate in caves and are state- or federal-listed are included in this table.

Species	Cave 1	Cave 2	Cave 3	Cave 4	Suspected impact	Status
<i>Myotis grisescens</i>	32	5	461	119	Additional survey required	FE, SE
<i>Myotis lucifugus</i>	54	1	22	23	Additional survey required	UR, ST
<i>Myotis septentrionalis</i>	89	2	92	66	Additional survey required	FT, ST
<i>Myotis sodalis</i>	22	0	48	23	Additional survey required	FE, SE
<i>Perimyotis subflavus</i>	23	8	24	63	Additional survey required	UR, ST

Note: See Table 1 for explanation of status codes.

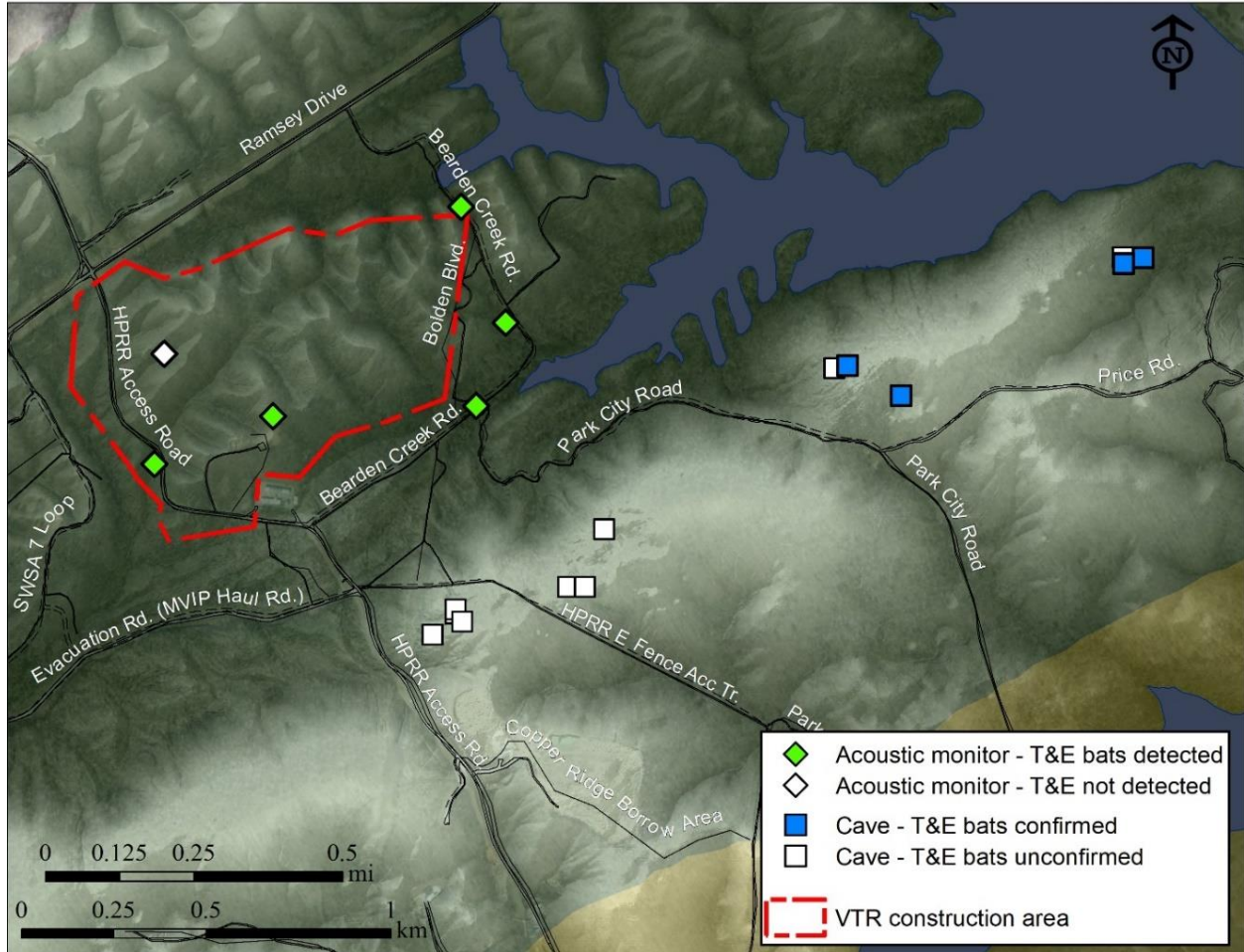


Figure 8. All known locations within the vicinity of the VTR review area with records for state- or federal-listed bat species (see Table 2). Green diamonds depict bat detector locations with positive detections of threatened and endangered bats ($n = 5$), and the single white diamond represents a detector with zero calls detected (possibly due to a malfunctioning unit). Blue squares represent caves with both acoustic and visual confirmation of threatened or endangered bat activity (e.g., visual surveys, fresh guano), and white squares represent caves with potential for bat activity but that were not confirmed through visual or acoustic survey.

Bird point counts (13 person-hours)—In total, 46 bird species were identified from March to July 2020 from approximately 13 survey hours of survey efforts. These species included 46 taxa protected under MBTA, with 1 species listed by the TWRA as In Need of Management (NM; TCA §§ 70-1-206, 70-8-104, 70-8-106, and 70-8-107, TWRA 2018), 3 species considered by USFWS to be birds of conservation concern (BCCs), 5 species considered by USFWS to be birds of management concern (BMCs), and one ORNL focal species for research and management. Additionally, nine species were considered by Partners in Flight to be species of regional concern (RC) and in need of management action (MA), there was one common bird in steep decline (CBSD), and one species was on the Yellow Watch List (YWL) (Table 3). No other state- or federally listed bird species were detected. Additional migratory birds and BCC and BMC taxa known from the VTR review area are included in Appendices I and II.

Table 3. Migratory birds recorded within the VTR construction area during 2020 field survey. Additional migratory birds are known from the site. All vertebrate fauna known from the VTR construction area are included in Appendix II.

Common name	Scientific name	Federal status	State status	Partners in Flight status	Notes
Acadian flycatcher	<i>Empidonax vireescens</i>			RC, MA	Migrant, summer
American crow	<i>Corvus brachyrhynchos</i>				Year-round
American goldfinch	<i>Spinus tristis</i>				Year-round
American robin	<i>Turdus migratorius</i>				Year-round
Barred owl	<i>Strix varia</i>				Year-round
Blue jay	<i>Cyanocitta cristata</i>				Year-round
Blue-gray gnat-catcher	<i>Poliophtila caerulea</i>				Migrant, summer
Blue-winged warbler	<i>Vermivora cyanoptera</i>	BCC, BMC			Migrant, summer
Brown thrasher	<i>Toxostoma rufum</i>				Migrant, summer
Brown-headed cowbird	<i>Molothrus ater</i>				Migrant, summer
Canada goose	<i>Branta canadensis</i>	BMC			Migrant, summer
Carolina chickadee	<i>Poecile carolinensis</i>				Year-round
Carolina wren	<i>Thryothorus ludovicianus</i>				Year-round
Downy woodpecker	<i>Dryobates pubescens</i>				Year-round
Eastern phoebe	<i>Sayornis phoebe</i>				Migrant, summer
Eastern towhee	<i>Pipilo erythrophthalmus</i>			RC, MA	Migrant, summer
Eastern wood-pewee	<i>Contopus virens</i>			RC, MA	Migrant, summer
Field sparrow	<i>Spizella pusilla</i>			CBSD, RC, MA	Migrant, summer
Hooded warbler	<i>Setophaga citrina</i>				Migrant, summer
Indigo bunting	<i>Passerina cyanea</i>				Migrant, summer
Kentucky warbler	<i>Geothlypis formosa</i>	BCC, BMC			Migrant, summer
Mourning dove	<i>Zenaida macroura</i>	BMC			Year-round
Northern cardinal	<i>Cardinalis cardinalis</i>				Year-round
Northern flicker	<i>Colaptes auratus</i>			RC, MA	Migrant, summer
Northern parula	<i>Setophaga americana</i>				Migrant, summer
Osprey	<i>Pandion haliaetus</i>				Migrant, summer
Ovenbird	<i>Seiurus aurocapilla</i>				Migrant, summer
Pileated woodpecker	<i>Dryocopus pileatus</i>				Year-round
Pine warbler	<i>Setophaga pinus</i>				Migrant, summer
Red-bellied woodpecker	<i>Melanerpes carolinus</i>				Year-round
Red-eyed vireo	<i>Vireo olivaceus</i>				Migrant, summer
Red-shouldered hawk	<i>Buteo lineatus</i>				Year-round
Red-tailed hawk	<i>Buteo jamaicensis</i>				Year-round
Rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>			RC, MA	Migrant, summer
Ruby-throated hummingbird	<i>Archilochus colubris</i>				Migrant, summer
Scarlet tanager	<i>Piranga olivacea</i>				Migrant, summer
Summer tanager	<i>Piranga rubra</i>			RC, MA	Migrant, summer
Swainson's thrush	<i>Catharus ustulatus</i>				Migrant, summer
Tufted titmouse	<i>Baeolophus bicolor</i>				Year-round
White-breasted nuthatch	<i>Sitta carolinensis</i>				Year-round
White-eyed vireo	<i>Vireo griseus</i>				Migrant, summer

Table 3. Migratory birds recorded within the VTR construction area during 2020 field survey (continued).
Additional migratory birds are known from the site. All vertebrate fauna known from the VTR construction area are included in Appendix II.

Common name	Scientific name	Federal status	State status	Partners in Flight status	Notes
Wild turkey	<i>Meleagris gallopavo</i>				Year-round
Wood thrush	<i>Hylocichla mustelina</i>	USFWS Focal Species, BCC, BMC, FS	NM*	YWL, RC, MA	Migrant, summer
Yellow warbler	<i>Setophaga petechia</i>				Migrant, summer
Yellow-breasted chat	<i>Icteria virens</i>			RC, MA	Migrant, summer
Yellow-throated warbler	<i>Setophaga dominica</i>				Migrant, summer

Federal status codes: MBTA: protected under the Migratory Bird Treaty Act; BCC: USFWS Bird of Conservation Concern; MC: USFWS Bird of Management Concern

State status codes: NM: In Need of Management by rule of TWRA (TWRA 2018)

Partners in Flight status codes: CBSD: Common Bird in Steep Decline; YWL: Yellow Watch List; RC: Regionally Important; MA: Management Attention needed

VESs (75 person-hours)—Based on VESs within the VTR construction from February to July 2020, we observed 9 reptile species (8 squamates and 1 turtle), 16 amphibian species (8 anurans and 8 caudates), and 12 mammals species. We also recorded several eyeless isopods (*Caecodotea* sp) from a spring at the southeast corner of the review area. Based on lack of pigment and absence of eyes, specimens were identified as likely *Caecodotea incurva/recurvata*, considered Rare by TDEC (Table 4). Additional vertebrate taxa known from the VTR construction area based on preliminary database review (see Section 2.1.1) are included in Appendix II.

Most notably among vertebrate fauna, breeding populations and active nests of four-toed salamanders (*Hemidactylium scutatum*) were found in wetlands and mucky streams within the VTR construction area and operations area footprints (Figure 9). This species is listed as In Need of Management by the state of Tennessee and represents an ORNL FS owing to its highly specialized breeding biology—a requirement for unique bog or muck wetlands with abundant mats of moss that are used for oviposition and egg development. The species is highly sensitive to even minor changes in hydroperiod because eggs develop in moss immediately over water until hatching as aquatic larvae (Pasachnik and Niemiller 2011). The VTR construction area serves as a considerable source (~33%) of all known four-toed salamanders on the ORR based on around two seasons of extensive sampling and population connectivity modeling efforts (Figure 10, Wade and Carter 2020).

An additional FS for research and management, the mud salamander (*Pseudotriton montanus*), occurs at low detection frequency within the isolated seeps and springs in the VTR construction area and operations area, particularly along headwater streams with mucky substrates (Figure 11). Two juvenile mud salamanders—one observed near the center of wetland MBNT1-5 on 13 March 2020, and one observed near the extreme southwest edge of MBNT1-5 on 30 March 2020 (see Figure 5 for wetland IDs)—represent the first and only mud salamanders recorded and verified on the ORR or in Roane County Tennessee (Figures 11 and 12). The individuals were officially verified by A. Floyd Scott of The Center for Field Biology, Austin Peay State University, and catalogued as APSU20008 (photo vouchers in the [Atlas of Amphibians in Tennessee](#)). Although mud salamanders were not previously known from Anderson County or Roane County, the ORNL Natural Resources Program expected that they occur within select uncontaminated mucky wetlands and seeps on the ORR, and considerable efforts were made to locate populations within the White Oak Creek and Melton Branch watersheds from February to July 2020 and the Bear Creek watershed from March 2019 to July 2020. Thus far, red salamanders are known

from several headwater streams and seeps throughout the White Oak, Melton Branch, and Bear Creek watersheds, whereas mud salamanders have been identified only within wetland MBTN1-5 (Figure 12).





Figure 9. Examples of four-toed salamander (*Hemidactylium scutatum*) habitat within the VTR construction area and operations area footprints. Top group: Wetlands associated with Bearden Creek; top left inset: adult four-toed salamander. Bottom group: wetlands associated with Melton Branch; Bottom right inset: four-toed salamander nest with eggs.

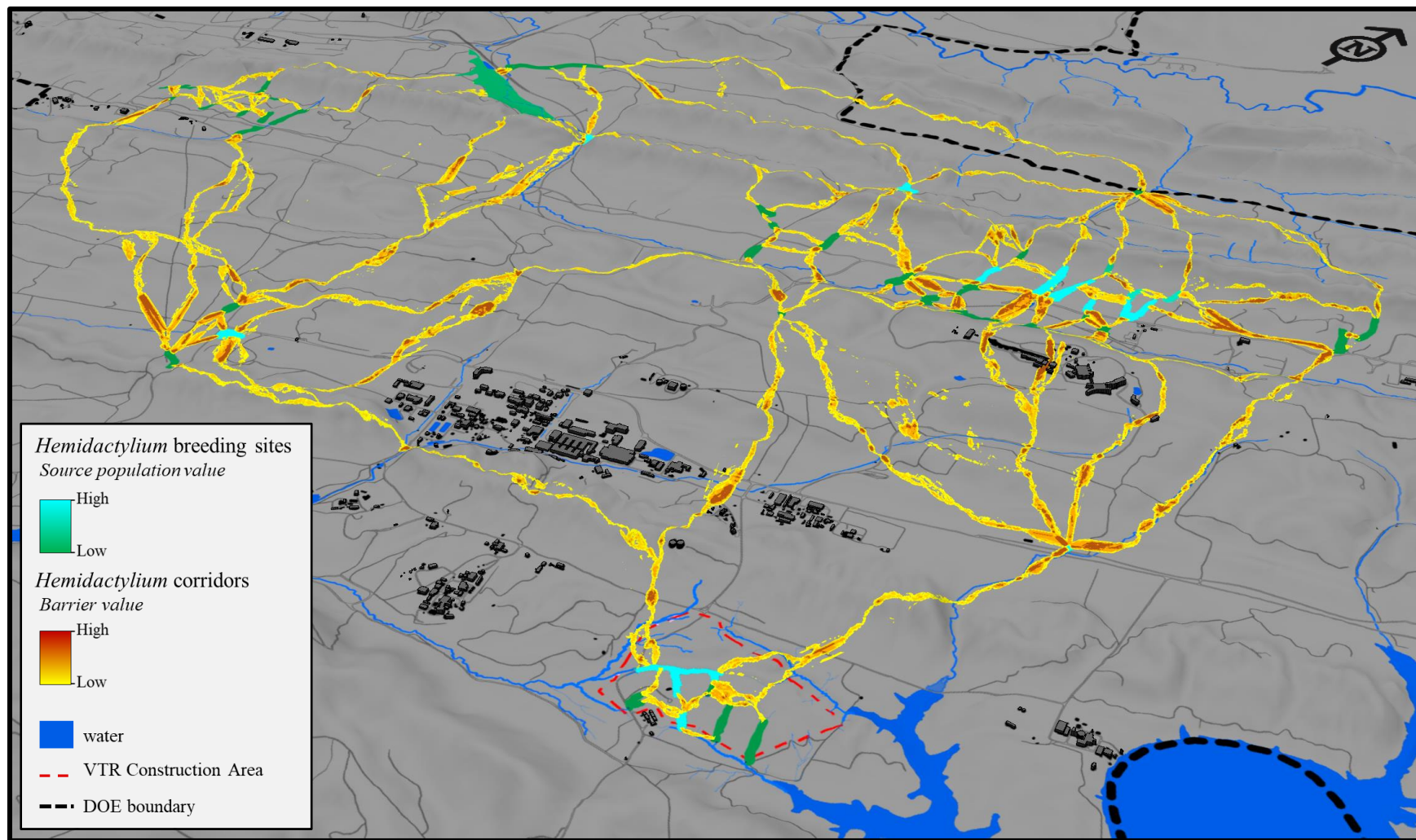


Figure 10. Four-toed salamander (*Hemidactylium scutatum*) core populations (brighter cores indicate larger population size) and dispersal corridors (darker reds indicate presence of barriers) on the ORR as modeled with the Circuitscape toolkit (McRae et al. 2013) with a composite cost surface (vegetation height, soil saturation, infrastructure, and landscape “ruggedness”) at <1-m raster cell resolution (adapted from Wade and Carter, 2020).



Figure 11. Left: Recently metamorphosed mud salamander (*Pseudotriton montanus*) observed on 13 March 2020 in a seep associated with Melton Brach and wetland MBNT1-5 in the VTR operations area. Right: Second metamorph mud salamander observed on 30 March 2020 in a seep at the lower end of MBNT1-5 near where Melton Branch passes under the HPPR (Health Physics Research Reactor) Access Road. Mud salamanders have not been recorded outside of the VTR construction area, despite decades of aquatic sampling by the ORNL Environmental Sciences Division within other portions of the Melton Branch watershed. The two individuals pictured here represent the first and only mud salamanders verified within Roane County, Tennessee. Their associated wetlands fall within the comparatively less disturbed portion of Melton Branch watershed (see Figure 12).

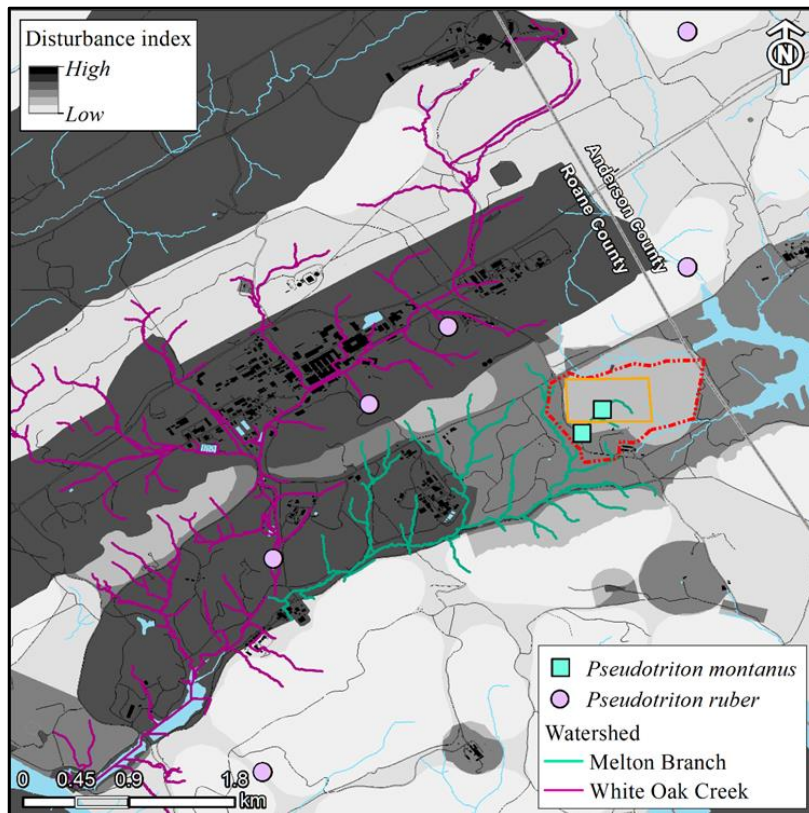


Figure 12. Distribution of *Pseudotriton* spp in the White Oak Creek and Melton Branch watershed based on targeted survey from 2019 to 2020. The mud salamander (*Pseudotriton montanus*) has been observed only in the smaller and comparatively less disturbed Melton Branch watershed, within the VTR construction area (red) and operations area (orange). Lighter areas indicate lower frequency and extent of human disturbance. Disturbance index was defined as the scaled sum effect of development, contaminant presence, and frequency of forest thinning through time.

Table 4. Wildlife observed during 2020 visual encounter and nighttime call surveys (anurans). Appendix II includes all contemporary and historical vertebrate fauna known from the VTR review area.

Common name	Scientific name	Status
Amphibians		
<i>Anurans (including calls)</i>		
American toad	<i>Anaxyrus americanus</i>	
Cope's gray treefrog	<i>Hyla chrysoscelis</i>	
Bullfrog	<i>Lithobates catesbeianus</i>	
Green frog	<i>Lithobates clamitans</i>	
Pickerel frog	<i>Lithobates palustris</i>	
Southern leopard frog	<i>Lithobates sphenoccephalus</i>	
Spring peeper	<i>Pseudacris crucifer</i>	
Upland chorus frog	<i>Pseudacris feriarum</i>	
<i>Caudates</i>		
Spotted salamander	<i>Ambystoma maculatum</i>	
Dusky salamander	<i>Desmognathus fuscus</i> complex	
Two-lined salamander	<i>Eurycea bislineata</i> complex	
Four-toed salamander	<i>Hemidactylium scutatum</i>	SD, FS
Eastern newt	<i>Notophthalmus viridescens</i>	
Slimy salamander	<i>Plethodon glutinosus</i>	
Zigzag salamander	<i>Plethodon ventralis</i>	
Mud salamander	<i>Pseudotriton montanus</i>	FS
Mammals		
<i>Small mammals</i>		
Short-tailed shrew	<i>Blarina brevicauda</i>	
Long-tailed weasel	<i>Mustela frenata</i>	
White-footed mouse	<i>Peromyscus leucopus</i>	
Peromyscus	<i>Peromyscus</i> spp	
Eastern gray squirrel	<i>Sciurus carolinensis</i>	
Cotton rat	<i>Sigmodon hispidus</i>	
Eastern cottontail	<i>Sylvilagus floridanus</i>	
Eastern chipmunk	<i>Tamias striatus</i>	
<i>Other (including sign)</i>		
Coyote	<i>Canis latrans</i>	
Bobcat	<i>Lynx rufus</i>	
Raccoon	<i>Procyon lotor</i>	
Deer	<i>Odocoileus virginianus</i>	
Reptiles		
<i>Squamates</i>		
Wormsnake	<i>Carphophis amoenus</i>	
Racer	<i>Coluber constrictor</i>	
Watersnake	<i>Nerodia sipedon</i>	
Ratsnake	<i>Pantherophis spiloides</i>	
Five-lined skink	<i>Plestiodon fasciatus</i>	

Table 4. Wildlife observed during 2020 visual encounter and nighttime call surveys (anurans) (continued).

Appendix II includes all contemporary and historical vertebrate fauna known from the VTR review area.

Common name	Scientific name	Status
Gartersnake	<i>Thamnophis sirtalis</i>	
Little brown skink	<i>Scincella lateralis</i>	
Redbellied snake	<i>Storeria occipitomaculata</i>	
	<i>Testudines</i>	
Box turtle	<i>Terrapene carolina</i>	
	<i>Notable invertebrates</i>	
Cave isopods	<i>Caecodotea incurva/recurvata</i>	

SD – State-listed In Need of Management

3.1.4 Forest Inventory

Current condition of the VTR footprint forest—The VTR construction area footprint occupies 150.4 acres (60.86 ha) in the Ramsey Drive and HPRR (Health Physics Research Reactor) Access Road area southeast of the main ORNL campus. The current condition of the VTR footprint forest can most easily be determined from a previous forest inventory undertaken in 2011 covering portions of Wildland Management Unit (Compartment) #21, which lies near the southcentral portion of the ORR. Fieldwork for the inventory was conducted from 9–15 September 2011. Sampling points were established on a 300 by 300 ft grid. A subset of 66 sampling points that fell within the review area was extracted from the original inventory data set to prepare the following analysis (Figure 13).

The following analysis describes the forest on a 135.1-acre (54.67-ha) portion of the footprint east of HPRR Access Road. Although no recent inventory can be used to describe the remaining 15.3 acres (6.19 ha) of the footprint west of HPRR Access Road, general observations and records maintained the ORNL Forester indicate that the area is slightly more mature forest than east of HPRR Access Road. Unlike the area east of HPRR Access Road, much of this forest was not subject to pine salvage during the 1965 to 1966 southern pine beetle outbreak. The area also was used as an ORNL Ecology Field Area during the 1960s and 1970s.

Land use—Spatial distribution of land use categories in the proposed VTR review area corresponding to habitat types are shown in Figure 14. The uses include forest, right-of-way, and developed areas. Forest comprises approximately 94.6% (127.9 acres) of the area, right-of-way comprises 3.0% (4.0 acres), developed areas occupy 1.9% (2.5 acres), and early successional vegetation occurs on 0.5% (0.6 acres). Sections 3.1.1–3.1.4 provide details of finer-scale forest plant community and water resources.

Basal area—The total basal area of the VTR forest in 2011 was 17,686 ft² with standing dead trees accounting for approximately 5.6%. However, because of the loss ash trees caused by a subsequent Emerald Ash Borer infestation, this figure may approach 10.6% by now. Basal area per acre for live trees averaged 123 ft² per acre.

A list of species and live tree basal area statistics for the study area are provided in Table A3.1 (Appendix III). Thirty-five species were identified. Trees with a diameter at breast height (dbh, 4.5 ft) ≥10.0 in. accounted for 61.0% of the total basal area. Among trees ≥10.0 in. dbh, 6 species contributed >5% of forest basal area, including white oak (21%), tulip poplar (13%), Virginia pine (13%), sweetgum (9%), northern red oak (8%), and red maple (7%). Among sapling-size trees (dbh ≥2 in. and <10 in.), species ranking based on basal area representing >5% included 8 species: red maple (14%), sweetgum (14%),

white oak (9%), ash (7%), mockernut hickory (6%), sourwood (6%), Virginia pine (6%), and eastern redcedar (5%).

At the genus level, oaks in the review area accounted for 38% of the live basal area of trees ≥ 10 in. dbh (Table A3.2) but provided only 11% of the sapling-size class basal area (a typical symptom of mature oak forests in the absence of fire and canopy disturbances, and also increased herbivory. Under these conditions, oak faces an eventual diminishment within the stand). White oaks (including white, post, and chinkapin oaks) provided 21% of the live basal area of trees ≥ 10 in. dbh but only represented 9% of the sapling-size class basal area. Red oaks (including northern red, southern red, scarlet, and black oaks) provided 17% of the live basal area of trees ≥ 10 in. dbh but only represented 2% of the sapling-size class basal area. Pines accounted for 17% of the live basal area of trees ≥ 10 in. dbh and 9% of the total basal area for trees < 10 in. dbh. Maples accounted for 8% of the live basal area of trees ≥ 10 in. dbh and 19% of the live basal area of trees < 10 in. dbh. Hickories accounted for 5% of trees ≥ 10 in. dbh and 6% of the saplings.

Tree number and density—The number of live trees and saplings in the VTR review area forest in 2011 totaled 64,178, averaging 475 stems per acre of trees > 2 in. dbh (Table A3.3). There were 68.2 trees > 10 in. dbh per acre on average across all forested sample points in the area, totaling 9,214 trees. There was an average of 406.8 sapling trees (< 10 in. dbh) per acre in this forest, totaling 54,964 saplings. For trees ≥ 10 in. dbh, white oak (12.5) provided the greatest average number of stems per acre, followed by Virginia pine (10.8), sweetgum (7.7), yellow poplar (7.2), and red maple (5.8). Among sapling-size trees, species ranking for the average number of stems per acre included sweetgum (78.8), red maple (46.9), dogwood (39.8), black gum (27.6), and sourwood (27.3).

Volume of merchantable timber—The volume of merchantable timber in the VTR footprint in 2011 totaled 750,319 board ft (bf, international $\frac{1}{4}$ in. rule), averaging 5,554 bf per acre (Table A3.4). White oak (174,201 bf), yellow poplar (152,698 bf), Virginia pine (97,584 bf), and sweetgum (80,285 bf) collectively contributed 67% of the merchantable timber in this area. Species rank for number of merchantable stems (Table A3.3) included white oak (1260), Virginia pine (1063), yellow poplar (906), sweetgum (875), and shortleaf pine (334). At the genus level, oaks collectively with yellow poplar accounted for 60% of the marketable timber in the area (Table A3.5). To estimate the current volume of marketable timber, the volumes determined from the 2011 inventory may be adjusted by compounding over the 8 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, the total volume at the time of this report would approach 930,304 bf, or 6,886 bf per acre. Ash volumes were excluded from the compounding due to near complete tree mortality following emerald ash borer infestations following the original inventory.

Large-diameter trees—Table A3.6 provides a list of the largest-diameter trees of selected species and a count of all tally trees > 30 in. dbh, measured at sample points in the area. Only 2 trees were tallied with a dbh > 30 in. in the study area; both were oaks, and each measured at 30.5 in. One, a southern red oak, is located near the center of the proposed VTR operations area.

Additional observations—Because of the effect of the introduction of an invasive exotic insect (the emerald ash borer), ash (*Fraxinus* spp) on the site, originally representing approximately 5% of live basal area and 2.1% of the merchantable volume, may now be considered absent from the live component of the current VTR forest.

No chestnut oak was recorded in the inventory, but there was an abundance of white oak and sweetgum; this would be expected given the low elevations (< 950 ft).

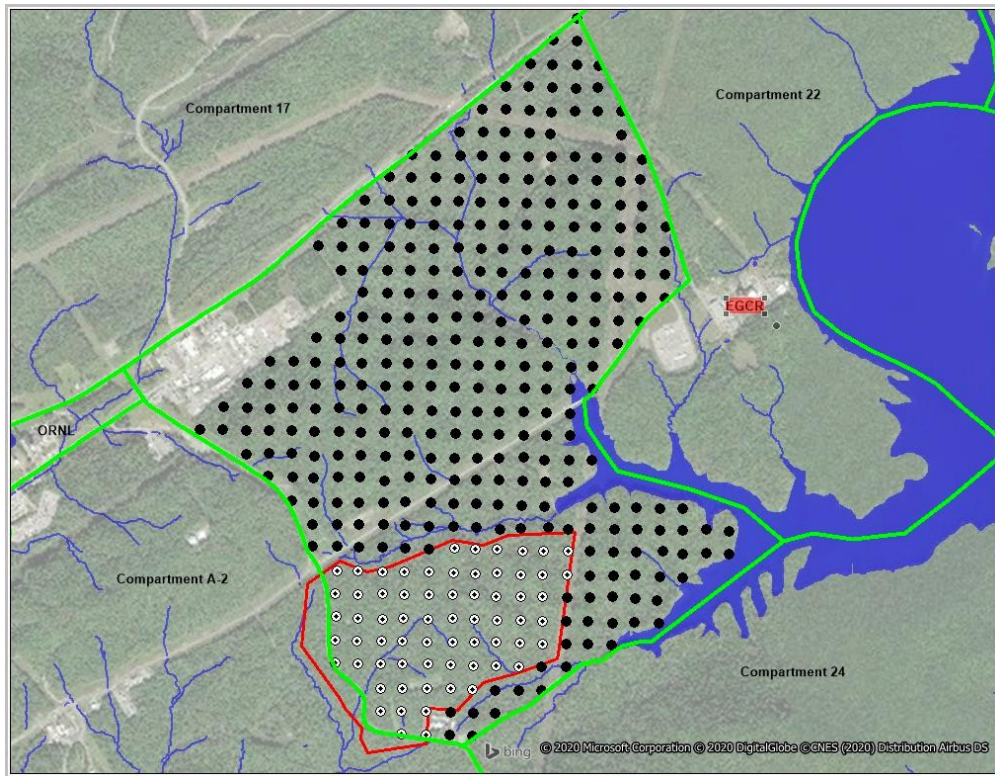


Figure 13. 2011 forest inventory map for the proposed VTR site and vicinity.



Figure 14. Spatial distribution of land use types for the proposed VTR site.

4. TIMBER CLEARING AND DISPOSAL

Timber clearing—Timber is a 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 designated reservation forester facilitates this operation on behalf of DOE to ensure agreement terms and state logging regulations are followed. There would be no cost to the project for these actions. Furthermore, a project may experience a significant cost abatement as the volume of the site vegetation to be disposed is greatly reduced.

The contractor should be allowed to examine the site as soon as possible prior to VTR construction area footprint clearing to verify timber quality, volume estimates, and access requirements and should be made aware of project startup dates and deadlines to arrange 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 by administrative delays caused by competing site security or utility operations. Ideally, for a project of this size, a planning allowance of at least 12 months in advance of construction startup should be adequate for the logging period and potential delays.

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

Logging access/egress—The VTR site is easily accessible from the HPRR Access Road from two existing points that avoid wetland crossings. Wood taken from the site would likely be sent in two directions depending on markets used; the following describes routes least impactful for ORNL operations.

For wood taken to Oak Ridge and other points to the northeast, the recommended routing would be northward along the HPRR Access Road, then northeastward along Ramsey Drive to the EGCR (Experimental Gas Cooled Reactor) Access Road, then northward to Bethel Valley Road, northeastward through the ORNL East Portal to Scarboro Road; transporting vehicles exit the ORR either by turning northward onto Scarboro Road to SR 62 or by continuing northeastward as Bethel Valley Road becomes SR 170 (under various names) to US 25W or I-75.

For wood taken toward Kingston and pointed west, the recommended routing would be northward along the HPRR Access Road, then southwest along Melton Valley Drive to First Street, northward to Bethel Valley Road, and then southwestward to SR 95. Traveling northward on SR 95 and then westward at SR 58 allows wood to be taken to a chipping facility at the East Tennessee Technology Park on the ORR or onward to I-40.

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, although depths may be recommended to promote biotic recovery and discourage leachates entering nearby waterways. Nearby reservation sites should be identified beforehand that could accommodate staging of any surplus mulch. To limit the effect of complete vegetation removal, this can be performed

piecemeal, depending on the pace of the site grade work, although care must be taken to avoid leaving inaccessible pockets of debris that would increase 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 size of the proposed clearing, the amount of residual debris would likely overwhelm the capacity of the nearby Hawk’s Nest Woody Debris Disposal Facility and so this option is not recommended.

Because of wildfire risk, under no circumstances should woody debris be left on site.

Wildland fire planning—Construction of the VTR at the proposed location will create an additional wildland interface of site operations with the ORR’s wildfire fuels, requiring the application of current, applicable National Fire Protection Association Standards (1141, 1143, and 1144). The proposed VTR site lies within portions of two fire management units, #20 Melton Valley and #21 Ramsey, and construction would require modification to the corresponding existing wildland fire pre-plans. The site is also currently within the ORNL emergency response zone; response times to and through the area following project completion should remain unchanged. Fuel beds may need to be modified (clearing and maintaining setbacks, reducing residual fuel loads presented by dead and dense vegetation or logging slash) to ensure safe conditions remain post-construction.

5. CONCLUSIONS AND CULTURAL CONSIDERATIONS

This report includes a compilation of new and existing data regarding aquatic resources, sensitive flora and fauna, forest condition, and cultural and historical resources that might be impacted if the proposed VTR project proceeds at the Oak Ridge site. Table 5 outlines effects that have the potential to be deemed significant impacts, alongside social and cultural considerations. This assessment is limited to resources that are known contemporary components of the VTR review area. Appendix I provides additional resources that were identified during pre-survey screening, and Appendix II identifies all vertebrate wildlife known from the VTR review area.

In total, 151 vertebrate wildlife and at least 1 notable invertebrate are known from the review area (Appendix II). We observed few rare plant species during spring and summer 2020, but additional survey is required to confirm presence of state- and/or federally listed orchids (*Platanthera integrilabia* and *P. flava* var. *herbiola*). Of all the species known from the VTR construction area, at least 10 are afforded special legal protection under state or federal law, 5 species are considered to be both BCCs and BMCs, 3 species are BCC-only, and 2 species are BMC-only (in addition to ≥ 98 bird species afforded protection under MBTA 16 U.S.C. §§703-711). Additionally, at least 1 species is considered rare by TDEC, and 10 species represent ORNL FS for management and/or research (Appendix II).

Impacts to FS and the Melton Branch ARA would represent impacts to long-term research and monitoring programs that involve ORNL, TDEC, DOE, and many of their government and university partners (Baranski 2009, 2011, Carter et al. 2020). Moreover, considerable effort is placed into development of management plans for FS (e.g., Giffen et al. 2012; Roy et al. 2014; McCracken et al. 2015; Par et al. 2015; McCracken et al. 2017; Carter et al. 2020), and loss of diversity or natural area on the ORR, and Oak Ridge National Environmental Research Park represents additional potential impacts to research and science education.

Considering other longer-term surveys elsewhere on the ORR (e.g., DeRolph et al. 2019a; Carter et al. 2019), the VTR construction area contains above average quantity and quality of natural and culturally important resources (Baranski 2009, 2011). The highest richness and diversity within the site appear to be associated with wetland MBTN1-5, the seeps that feed it, and stream riparian along Melton Branch (Melton Branch ARA). Unidentified (potentially state- and/or federally listed) *Platanthera* spp, state-listed in-need-of-management four-toed salamanders (*Hemidactylium scutatum*, a FS for both research and management on the ORR), and a second FS, the mud salamander (*Pseudotriton montanus*), were each observed within wetland MBTN1-5. Nevertheless, sensitive and focal resources are present in all wetlands in the VTR construction area, and higher apparent diversity in MBTN1-5 might reflect the relatively greater amount of search effort that it received. For instance, four-toed salamanders were not detected in MBTN1-5 until the third survey, in which 5 nests were located within 10 m of young *Platanthera* spp. In contrast, additional wetlands within the Bearden Creek watershed portion of the VTR construction area (Figure 5) were surveyed for the first time in June 2020, yet several individuals were located along wetland BDWT1d-1 during a single survey. Given habitat characteristics, we expect that state-listed *H. scutatum* occurs in wetlands and moist forest throughout the VTR review area. Under either scenario, presence either *Platanthera* species, wetlands within the review area comprise a significant number of all known demes for this sensitive FS on the ORR (Figure 10).

The combination of *Platanthera* spp, *H. scutatum*, and *Pseudotriton* on the ORR is indicative of acidic seep wetlands connected by complex ephemeral drainages, often with losing reaches along first-order streams (Chester et al. 2015; Baranski 2009, 2011; Carter et al. 2020). The only other wetland-stream complex on the ORR in which *Platanthera flava* var. *herbiola*, *H. scutatum*, and *Pseudotriton* (albeit a separate species, *P. ruber*) each occur is in a portion of Bear Creek Valley that is also under strong consideration for development. Indeed, many of the associated wetlands in Bear Creek Valley were already lost or hydrologically compromised during development of the Environmental Management Waste Management Facility and the extension of the UPF Haul Road (Peterson et al. 2005). Additional adjacent wetlands were compromised by construction of access roads during site characterization for the planned On-Site Waste Disposal Facility (OSWDF). These and nearly all other wetlands with the described species composition—or characteristics to support them—are found within the footprint of the proposed OSWDF (DeRolph et al. 2019a, 2019b). Overall, the area proposed for the OSWDF represents a higher-value natural area by nearly all definitions (Peterson et al. 2018, DeRolph et al. 2019b), but additive effects from these current land use plans deem the VTR review area to be of exceptional natural and cultural value.

Table 5. Overview of potential impacts on known resources to result from development of the VTR and associated infrastructure. Impacts stated here represent the opinion of the ORNL Natural Resources Program only. In providing this opinion, the ORNL Natural Resources Program considered federal and state listing status, current state of the given resource(s) elsewhere on the ORR, concurrent or imminent loss of habitat from additional projects, and additive, cumulative, and long-term effects of the VTR project. Additional sensitive resources identified during pre-survey analysis but concluded to be absent or unlikely within the VTR review area are outlined in Appendix I.

Resource	Summary	Natural resource value	Additional considerations: social/cultural value and anticipated level of impact
<ul style="list-style-type: none"> Gray bat (<i>Myotis grisescens</i>) 	<ul style="list-style-type: none"> Gray bats were detected within or adjacent to the VTR construction area at relatively high frequency Caves within 1 mile of VTR construction area contain gray bats 	<ul style="list-style-type: none"> Federal- and state-listed Endangered species 	<ul style="list-style-type: none"> Impact to federal- and state-listed species or habitat Impacts to gray bats would result primarily from loss of foraging habitat Additional surveys within the VTR operations area are needed Winter and early- to mid-summer surveys of caves adjacent to VTR are needed Impact likely less than significant Additive effects might be significant
<ul style="list-style-type: none"> Northern long-eared bat (<i>Myotis septentrionalis</i>) 	<ul style="list-style-type: none"> Northern long-eared bats were detected at extremely low frequency within the VTR construction area Caves within 1 mile of VTR construction area contain northern long-eared bats 	<ul style="list-style-type: none"> Federal- and state-listed Threatened species 	<ul style="list-style-type: none"> Impact to federal and state-listed species or habitat Impacts to northern long-eared bats would result from loss of foraging and maternity roost habitat Despite low detection frequency within the VTR construction area, preliminary surveys did not occur within much of the forest interior Additional surveys are needed within the VTR operations area to detect potential summer roosts Winter hibernaculum surveys of caves adjacent to VTR are needed per USFWS Impact likely less than significant Additive effects might be significant
<ul style="list-style-type: none"> Indiana bat (<i>Myotis sodalis</i>) 	<ul style="list-style-type: none"> Indiana bats were detected at extremely low frequency within the VTR construction area Caves within 1 mile of VTR construction area contain Indiana bats 	<ul style="list-style-type: none"> Federal- and state-listed Endangered species 	<ul style="list-style-type: none"> Impact to federal and state-listed species or habitat Impacts to Indiana bats would result from loss of foraging and maternity roost habitat Despite low detection frequency within the VTR construction area, preliminary surveys did not occur within much of the forest interior Additional surveys are needed within the VTR operations area to detect potential summer roosts Winter hibernaculum surveys of caves adjacent to VTR are needed per USFWS Impact likely less than significant Additive effects might be significant

Table 5. Overview of potential impacts on known resources to result from development of the VTR and associated infrastructure (continued). Impacts stated here represent the opinion of the ORNL Natural Resources Program only. In providing this opinion, the ORNL Natural Resources Program considered federal and state listing status, current state of the given resource(s) elsewhere on the ORR, concurrent or imminent loss of habitat from additional projects, and additive, cumulative, and long-term effects of the VTR project. Additional sensitive resources identified during pre-survey analysis but concluded to be absent or unlikely within the VTR review area are outlined in Appendix I.

Resource	Summary	Natural resource value	Additional considerations: social/cultural value and anticipated level of impact
<ul style="list-style-type: none"> Little brown bat (<i>Myotis lucifugus</i>) 	<ul style="list-style-type: none"> Little brown bats were detected at relatively high frequency within the VTR construction area 	<ul style="list-style-type: none"> State-listed Threatened 	<ul style="list-style-type: none"> Impact to state-listed species or habitat Currently under review for ESA listing Impact likely less than significant Additive effects might be significant
<ul style="list-style-type: none"> Tricolored bat (<i>Perimyotis subflavus</i>) 	<ul style="list-style-type: none"> Tricolored bats were detected at relatively high frequency within the VTR construction area 	<ul style="list-style-type: none"> State-listed Threatened 	<ul style="list-style-type: none"> Impact to state-listed species or habitat Currently under review for ESA listing Impact likely less than significant Additive effects might be significant
<ul style="list-style-type: none"> Small-footed bat (<i>Myotis leibii</i>) 	<ul style="list-style-type: none"> Small-footed bats were detected at relatively low frequency in the VTR construction area 	<ul style="list-style-type: none"> State-listed In Need of Management 	<ul style="list-style-type: none"> Impact to state-listed species or habitat Habitat within the VTR construction area is less than ideal for small-footed bats Impact likely not significant Additive effects might be significant
<ul style="list-style-type: none"> Migratory birds BCCs BMCs 	<ul style="list-style-type: none"> 98 species of migratory birds have been recorded within the VTR construction area, including birds detected during adjacent Partners in Flight surveys 2020 field surveys confirmed current occupancy of the VTR construction area by 48 migratory bird species 6 bird species that are considered as both BCCs and BMCs occur within the VTR construction area 2 additional species are BCC-only 2 additional species are BMC-only 	<ul style="list-style-type: none"> MBTA USFWS focal species <ul style="list-style-type: none"> - 2 BCC taxa - 2 BMC taxa - 6 BCC + BMC taxa FS 	<ul style="list-style-type: none"> By definition of “migratory bird,” timing of survey insufficient to provide the full extent of occupancy of the VTR construction area by migratory species Observable impacts to overall ORR populations require additional surveys and analyses Impacts to migratory birds from VTR alone are likely less than significant If one considers additional impending development on the ORR, additive effects highly likely to be significant
<ul style="list-style-type: none"> Bald eagle (<i>Haliaeetus leucocephalus</i>) 	<ul style="list-style-type: none"> Bald eagle breeding pairs have been noted in recent years within the VTR construction area 	<ul style="list-style-type: none"> Bald and Golden Eagle Protection Act 	<ul style="list-style-type: none"> Impact to federal and state-listed species or habitat Habitat within VTR less than ideal for bald eagles

Table 5. Overview of potential impacts on known resources to result from development of the VTR and associated infrastructure (continued). Impacts stated here represent the opinion of the ORNL Natural Resources Program only. In providing this opinion, the ORNL Natural Resources Program considered federal and state listing status, current state of the given resource(s) elsewhere on the ORR, concurrent or imminent loss of habitat from additional projects, and additive, cumulative, and long-term effects of the VTR project. Additional sensitive resources identified during pre-survey analysis but concluded to be absent or unlikely within the VTR review area are outlined in Appendix I.

Resource	Summary	Natural resource value	Additional considerations: social/cultural value and anticipated level of impact
		<ul style="list-style-type: none"> • State-listed In Need of Management • BCC • BMC • FS 	<ul style="list-style-type: none"> • Impacts likely less than significant on local bald eagle populations • Additive effects likely less than significant
• Wood thrush (<i>Hylocichla mustelina</i>)	• Wood thrush breeding pairs were observed within the VTR construction area	<ul style="list-style-type: none"> • State-listed In Need of Management • USFWS focal species • BCC • BMC • FS 	<ul style="list-style-type: none"> • Impact to state-listed species or habitat • Impact to NERP diversity / research opportunities • Impact to ongoing management effort • Impact not quantifiable without additional surveys • Additive effects might be significant
• <i>Platanthera</i> spp	<ul style="list-style-type: none"> • <i>Platanthera</i> spp sprouts were observed in wetland MBNT1-5, inside the VTR construction area, but could not be positively identified at this time because of seasonal growth patterns • Likely to be state-listed Threatened <i>P. flava</i> var. <i>herbiola</i>, but unable to rule out presence of federally listed, Threatened, <i>P. integrilabia</i> without additional monitoring 	<ul style="list-style-type: none"> • Federal- and/or state-listed species • Rare (<i>P. flava</i> var. <i>herbiola</i>) and/or otherwise unknown (<i>P. integrilabia</i>) on the ORR • Wetland indicator • FS 	<ul style="list-style-type: none"> • Impact to federal- and/or state-listed species or habitat • Impact to NERP diversity/research opportunities • NERP and ORR historically recognized for its <i>P. flava</i> var. <i>herbiola</i> populations • Largest <i>P. flava</i> var. <i>herbiola</i> populations elsewhere on the ORR are under imminent threat of development • Impact highly likely to be significant • Additive effects significant
• Ginseng	• <i>Panax quinquefolius</i>	<ul style="list-style-type: none"> • State-listed Of Special Concern—Commercially Exploited 	<ul style="list-style-type: none"> • Impact to state-listed species or habitat • Impacts likely less than significant • Additive effects might be significant
• Four-toed salamander (<i>Hemidactylium scutatum</i>)	• Several four-toed salamander adults and nests with eggs were observed throughout the VTR construction and operations area	<ul style="list-style-type: none"> • State-listed In Need of Management • FS • VTR populations represent ~33% of 	<ul style="list-style-type: none"> • Impact to state-listed species or habitat • Largest populations elsewhere on the ORR are under imminent threat of development • Impact to NERP diversity/research opportunities and ongoing management effort

Table 5. Overview of potential impacts on known resources to result from development of the VTR and associated infrastructure (continued). Impacts stated here represent the opinion of the ORNL Natural Resources Program only. In providing this opinion, the ORNL Natural Resources Program considered federal and state listing status, current state of the given resource(s) elsewhere on the ORR, concurrent or imminent loss of habitat from additional projects, and additive, cumulative, and long-term effects of the VTR project. Additional sensitive resources identified during pre-survey analysis but concluded to be absent or unlikely within the VTR review area are outlined in Appendix I.

Resource	Summary	Natural resource value	Additional considerations: social/cultural value and anticipated level of impact
<ul style="list-style-type: none"> • Mud salamander (<i>Pseudotriton montanus</i>) 	<ul style="list-style-type: none"> • Two recently metamorphosed mud salamanders were observed in wet MBTN1-5, inside the VTR operations area 	<p><i>Hemidactylium</i> source populations on the ORR</p> <ul style="list-style-type: none"> • Wetland indicator • Contaminants indicator • Wetland/stream indicator • Contaminants indicator • Exceedingly rare on ORR • FS 	<ul style="list-style-type: none"> • Populations are subject to ongoing research in the ORNL Environmental Sciences Division • Impact would be significant • Additive effects would be significant • Loss would represent 100% loss of known mud salamanders in Anderson and Roane Counties, Tennessee • Impact to NERP diversity/research opportunities and ongoing management effort • Populations are subject to ongoing research in the ORNL Environmental Sciences Division • Impact would be significant • Additive effects would be significant
<ul style="list-style-type: none"> • Wetlands 	<ul style="list-style-type: none"> • No less than 8.1 acres (3.3 ha) of wetland occur within the VTR construction area • Additional wetland would require delineation if the project proceeds 	<ul style="list-style-type: none"> • Aquatic resource • Subject to all applicable state and federal regulation • Provide habitat for FS, state-listed species, and possible federal-listed species 	<ul style="list-style-type: none"> • Impact to an aquatic resource • Wetlands are likely to be classified as ETWs • In-kind mitigation likely not possible on ORR • Impact to NERP diversity/research opportunities • ORNL/TDEC ARA (Melton Branch ARA) • ORNL Biological Monitoring and Abatement Program focal watershed • Habitat for only <i>Pseudotriton montanus</i> in Anderson County or Roane County, Tennessee • Impact would be significant • Additive effects would be significant
<ul style="list-style-type: none"> • Streams 	<ul style="list-style-type: none"> • 1,490 ft of mapped stream and extensive WWCs within the VTR construction area will require additional hydrological determination 	<ul style="list-style-type: none"> • Aquatic resource • Subject to all applicable state and federal regulation • Provide habitat for FS, state-listed species, and possible federal-listed species 	<ul style="list-style-type: none"> • Impact to an aquatic resource • Impact to NERP diversity/research opportunities • ORNL/TDEC ARA (Melton Branch ARA) • ORNL Biological Monitoring and Abatement Program focal watershed • Habitat for only <i>Pseudotriton montanus</i> in Anderson County or Roane County, Tennessee • Impact would be significant

Table 5. Overview of potential impacts on known resources to result from development of the VTR and associated infrastructure (continued). Impacts stated here represent the opinion of the ORNL Natural Resources Program only. In providing this opinion, the ORNL Natural Resources Program considered federal and state listing status, current state of the given resource(s) elsewhere on the ORR, concurrent or imminent loss of habitat from additional projects, and additive, cumulative, and long-term effects of the VTR project. Additional sensitive resources identified during pre-survey analysis but concluded to be absent or unlikely within the VTR review area are outlined in Appendix I.

Resource	Summary	Natural resource value	Additional considerations: social/cultural value and anticipated level of impact
<ul style="list-style-type: none"> Seeps/springs 	<ul style="list-style-type: none"> ≥30 seeps and active springs occur within the VTR construction area 	<ul style="list-style-type: none"> Aquatic resource Subject to all applicable state and federal regulation Provide habitat for FS, state-listed species, and possible federal-listed species 	<ul style="list-style-type: none"> Additive effects would be significant Impact to an aquatic resource Impact to NERP diversity/research opportunities Habitat for only <i>Pseudotriton montanus</i> in Anderson County or Roane County, Tennessee Impact would be significant Additive effects would be significant
<ul style="list-style-type: none"> Hemlock treatment area 	<ul style="list-style-type: none"> 37 treated hemlocks occur within the VTR operations area 	<ul style="list-style-type: none"> FS Vulnerable in Southeastern United States owing to hemlock woolly adelgid 	<ul style="list-style-type: none"> Hemlocks within the VTR operations area are among the largest-diameter hemlocks on the ORR Impact to NERP diversity, research opportunities, and ongoing management effort Additive effects might be significant

Mitigation—Mitigation is anticipated if the VTR project proceeds as proposed at the Oak Ridge site. We cannot provide recommendations for mitigation options without additional assessment. However, our current results and ongoing assessment of the ORR’s resources suggest that in-kind mitigation (i.e., protection or enhancement of ecologically similar resources) could entail greater acreage than might be available elsewhere on the ORR. Acceptable mitigation measures for many resources—notably, aquatic features (under Tennessee regulations) and federally listed bats—depend on the quality and type of habitat (e.g., foraging, roosting, hibernacula). Thus, additional surveys may be required by USFWS and TDEC to adequately assess the extent and nature of occupancy by status species. Minimally, these should include targeted surveys for federally listed bats from early summer to late winter, additional monitoring of unidentified *Platanthera* spp through late summer, and additional assessment of ETWs via TRAM. Thus, avoidance of sensitive resources during construction and operations activities is the preferred first approach. If avoidance is not possible, at least informal consultation between DOE, USFWS, and TDEC should be initiated immediately. Owing to agreements between DOE, TDEC, and TWRA (Giffen et al. 2012; Carter et al. 2020), TDEC and TWRA must also be notified and/or engaged in consultation concerning known or suspected impacts to state-listed fauna.

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APPENDIX I. PRE-SURVEY SCREENING OF FEDERALLY LISTED TAXA, HABITAT SUITABILITY, AND HISTORICAL AND CONTEMPORARY PRESENCE WITHIN THE VTR CONSTRUCTION AREA

Table I.1. Federally listed species with the potential to occur within the VTR construction area.
Table A1.2 includes BCC or BMC.

Common name	Scientific name	Status	ECOS doc	ORR historical	Habitat within VTR project area	VTR confirmed contemporary	Notes/suspected Impacts
Amphibians							
Berry Cave salamander	<i>Gyrinophilus gulolineatus</i>	CS	Link Link Link	no	Underlying karst and aquatic subterranean habitat exists, but a lack of human-accessible caves might prevent detection under the provided timeline	No*	Disturbance of deeper karst and groundwater would be detrimental to this and other subterranean taxa
Mammals							
Gray bat	<i>Myotis grisescens</i>	FE	Link	Yes	Foraging habitat	Yes	Known hibernaculum and maternity habitat within 0.5 miles of project area
Indiana bat	<i>Myotis sodalis</i>	FE	Link	Yes	Foraging and maternity habitat	Probable [†]	Probable hibernacula within regulatory limits of project area—numerous caves with previous observations
Northern long-eared bat	<i>Myotis septentrionalis</i>	FT	Link	Yes	Foraging and maternity habitat	Probable [†]	Suitable hibernaculum within 0.5 miles of project area
Tricolored bat	<i>Perimyotis subflavus</i>	UR	Link	Yes	Foraging habitat	Yes	
Little brown bat	<i>Myotis lucifugus</i>	UR	Link	Yes	Forging habitat	Yes	
Clams							
Alabama lampmussel	<i>Lampsilis virescens</i>	FE	Link	No	No	No	No impact

Table I.1. Federally listed species with the potential to occur within the VTR construction area (continued).
Table A1.2 includes BCC or BMC.

Common name	Scientific name	Status	ECOS doc	ORR historical	Habitat within VTR project area	VTR confirmed contemporary	Notes/suspected Impacts
Cracking pearlymussel	<i>Hemistena lata</i>	FE	Link	No	No	No	No impact
Dromedary pearlymussel	<i>Dromus dromas</i>	FE	Link	Yes	No	No	Low to no impact
Fanshell	<i>Cyprogenia stegaria</i>	FE	Link	Yes	No	No	Low to no impact
Finerayed pigtoe	<i>Fusconaia cuneolus</i>	FE	Link	Yes	No	No	Low to no impact
Orangefoot pimpleback	<i>Plethobasus cooperianus</i>	FE	Link	Yes	No	No	Low to no impact
Pink mucket	<i>Lampsilis abrupta</i>	FE	Link	Yes	No	No	Low to no impact
Ring pink	<i>Obovaria retusa</i>	FE	Link	No	No	No	No impact
Rough pigtoe	<i>Pleurobema plenum</i>	FE	Link	No	No	No	No impact
Rough rabbitsfoot	<i>Quadrula cylindrica strigillata</i>	FE	Link	Yes	No	No	Low to no impact
Sheepnose Mussel	<i>Plethobasus cyphus</i>	FE	Link	Yes	No	No	Low to no impact
shiny pigtoe	<i>Fusconaia cor</i>	FE	Link	Yes	No	No	Low to no impact
Spectaclecase	<i>Cumberlandia monodonta</i>	FE	Link	Yes	No	No	Low to no impact
White wartyback	<i>Plethobasus cicatricosus</i>	FE	Link	No	No	No	No impact
Snails							
Anthony's riversnail	<i>Athearnia anthonyi</i>	FE	Link	No	No	No	No impact
Spiny riversnail	<i>Io fluvialis</i>	UR	Link	Yes	No	No	Low to no impact
Flowering plants							
Virginia spiraea	<i>Spiraea virginiana</i>	FT	Link	No	Several streams with high degree of scouring from periodic flood, many areas resulting in low potential for competition from woody vegetation	No	No impact

Table I.1. Federally listed species with the potential to occur within the VTR construction area (continued).
Table A1.2 includes BCC or BMC.

Common name	Scientific name	Status	ECOS doc	ORR historical	Habitat within VTR project area	VTR confirmed contemporary	Notes/suspected Impacts
White fringeless orchid	<i>Platanthera integrilabia</i>	FT	Link	No	Several seepy, boggy wetlands within the VTR construction area provide ideal habitat for this species	Possible [‡]	Possible <i>Platanthera</i> spp sprouts observed in March 2020 in wetlands within project area. Could not yet be identified to species level

* Could not confirm because of no known human accessible caves within project area. Does not preclude occurrence.

† Record based on few acoustic monitor detections, but presence is assumed given habitat and nearby records.

‡ Timing of surveys did not permit positive identification because diagnostic characters are largely absent during spring/early summer.

ECOS: Environmental Conservation Online System. Federal listing status codes: FE: federally listed Endangered species; FT: federally listed Threatened species; UR: currently under review for federal listing; CS: species is not listed or under review currently but continues to be a candidate species for federal listing owing to insufficient data.

Table I.2. State-listed taxa, sensitive communities, and focal species on the ORR. The state of Tennessee adopts by default all federally listed species statuses (see Table A1.1 for federally listed taxa).

Common name	Scientific name	Status	Other protection status	ORR historical	Habitat within VTR project area	VTR confirmed contemporary
<i>Amphibians</i>						
Green salamander	<i>Aneides aeneus</i>	R	S3S4	Yes	Unlikely; minimal availability of damp crevices in shaded rock outcrops and ledges; beneath loose bark and cracks of trees; and sometimes in/or under logs	No
Hellbender	<i>Cryptobranchus alleganiensis</i>	E	S3	Yes	No	No
Berry Cave salamander	<i>Gyrinophilus gulolineatus</i>	T	S1	No	Possible;* but aquatic subterranean habitat present	No*
Four-toed salamander	<i>Hemidactylium scutatum</i>	SD	S3; populations on ORR are the subject of ongoing research	Yes	Yes; moist forest and sphagnum in and along all wetlands and slow-moving waterways within project area	Yes
Mud salamander	<i>Pseudotriton montanus</i>	R	Populations on ORR are the subject of ongoing research	unknown	Yes; headwater streams, seepages, and mucky wetlands throughout project area	Yes
<i>Arachnids</i>						
A cave spider	<i>Nesticus paynei/tennesseensis</i>	R	S3, S2S4	Yes	Unlikely; terrestrial cave obligate	No*
Southeastern cave pseudoscorpion	<i>Hersperochernes mirabilis</i>	R	S3	No	Unlikely; terrestrial cave obligate	No*
<i>Crustaceans</i>						
cave isopods	<i>Caecodotea incurva/recurvata</i>	R	S1, S2	Unknown	Yes; aquatic subterranean	Yes
<i>Insects</i>						
Cave beetle (multiple species, including one yet to be described)	<i>Pseudanophthalmus</i> spp	R	S1–S3	Yes	Yes; troglobitic, typically along subterranean streams	No*

Table I.2. State-listed taxa, sensitive communities, and focal species on the ORR (continued). The state of Tennessee adopts by default all federally listed species statuses (see Table A1.1 for federally listed taxa).

Common name	Scientific name	Status	Other protection status	ORR historical	Habitat within VTR project area	VTR confirmed contemporary
Mammals						
Allegheny woodrat	<i>Neotoma magister</i>	SD	S3	Yes	Yes; outcrops, cliffs, talus slopes, crevices, sinkholes, caves, and karst Observations exist in caves just outside project area	Probable
Rafinesque's big-eared bat	<i>Corynorhinus rafinesquii</i>	SD	S3S4	Yes	Yes; caves, hollow trees, abandoned buildings; often associated with forested areas Calls recorded near site	Yes
Gray bat	<i>Myotis grisescens</i>	E	See Table A1.1	Yes	Yes	Yes
Eastern small-footed bat	<i>Myotis leibii</i>	SD		Yes	Yes	Yes
Little brown bat	<i>Myotis lucifugus</i>	T	See Table A1.1	Yes	Yes	Yes
Little brown bat	<i>Myotis lucifugus</i>	T	See Table A1.1	Yes	Yes	Yes
Northern long-eared bat	<i>Myotis septentrionalis</i>	T	See Table A1.1	Yes	Yes	Probable [†]
Indiana bat	<i>Myotis sodalis</i>	E	See Table A1.1	Yes	Yes	Probable [†]
Tri-colored bat	<i>Perimyotis subflavus</i>	T	See Table A1.1	Yes	Yes	Yes
Southern bog lemming	<i>Synaptomys cooperi</i>	SD	S4	Yes (pre-1995)	Yes; marshy meadows, wet balds, and rich upland forests (especially in northern and eastern portion of project area)	No
Birds						
Bald eagle	<i>Haliaeetus leucocephalus</i>	SD	BCC, BGEP, FS, BMC, MBTA	Breeding habitat	Yes; breeding pairs have been noted in recent years	Yes

Table I.2. State-listed taxa, sensitive communities, and focal species on the ORR (continued). The state of Tennessee adopts by default all federally listed species statuses (see Table A1.1 for federally listed taxa).

Common name	Scientific name	Status	Other protection status	ORR historical	Habitat within VTR project area	VTR confirmed contemporary
Worm-eating Warbler	<i>Helmitheros vermivorum</i>	SNR	BCC, BMC, PIF, MBTA	Breeding habitat	Yes	Yes
Eastern whip-poor-will	<i>Caprimulgus vociferus</i>	SNR	BCC, PIF, MTBA	Breeding habitat	Yes	Yes
Red-headed woodpecker	<i>Melanerpes erythrocephalus</i>	SNR	BCC, PIF	Breeding habitat	Yes	Yes
Chuck-will's widow	<i>Antrostomus carolinensis</i>	SNR	PIF, MBTA	Breeding habitat	Yes	Yes
Wood thrush	<i>Hylocichla mustelina</i>	NM	BCC, PIF, BMC, FS, MBTA	Breeding habitat	Yes	Yes
Yellow-bellied sapsucker	<i>Sphyrapicus varius</i>	SNR	BCC, BMC, MBTA	Breeding habitat	Yes	Yes
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	SNR	PIF, MBTA	Breeding habitat	Yes	Yes
Kentucky warbler	<i>Geothlypis formosa</i>	SNR	BCC, PIF, MBTA	Breeding habitat	Yes	Yes
Plants						
Spreading False-foxglove	<i>Aureolaria patula</i>	SC	S3	Yes	Yes; oak woods and edges	
Pink lady's-slipper	<i>Cypripedium acaule</i>	SC-CE	S4	Yes	Possible; piney woods, central portion of project area	
Appalachian bugbane	<i>Cimicifuga rubifolia</i>	R	S3	Yes	Yes; rich woods (especially northeastern portion of project area and west of HPRR Access Road)	
Canada lily	<i>Lilium canadense</i>	R(T)	S3; monitored as rare for the ORR	Yes	Yes; rich woods and seeps	
Goldenseal	<i>Hydrastis canadensis</i>	SC-CE	S4	Yes	Yes; moist woods with rich soils (especially in shaded valleys in the southern and eastern portions of project area, and west of HPRR Access Road)	

Table I.2. State-listed taxa, sensitive communities, and focal species on the ORR (continued). The state of Tennessee adopts by default all federally listed species statuses (see Table A1.1 for federally listed taxa).

Common name	Scientific name	Status	Other protection status	ORR historical	Habitat within VTR project area	VTR confirmed contemporary
Ginseng	<i>Panax quinquefolius</i>	SC-CE	S3S4	Yes	Yes; especially in northeastern portion of project area and west of HPRR Access Road	Yes
Tuberclad rein orchid	<i>Platanthera flava</i> var. <i>herbiola</i>	T	S2	Yes	Yes; mucky seeps, swamps, and floodplain throughout project area	Highly likely [‡] ; <i>Platanthera</i> spp sprouts observed in project area
White fringeless orchid	<i>Platanthera integrilabia</i>	E	S2S3	No	Yes; several seepy, boggy wetlands within the VTR construction area provide ideal habitat for this species	Possible [‡] ; <i>Platanthera</i> spp sprouts observed in project area
October ladies'-tresses	<i>Spiranthes ovalis</i>	S	SNR	Yes	Yes; wet to mesic forests	
Northern bush-honeysuckle	<i>Diervilla lonicera</i>	T	S2	Yes	Possible; rocky woodlands and bluffs	
Northern white cedar	<i>Thuja occidentalis</i>	SC, R	S3	Yes	Yes; calcareous rocky seeps, cliffs (eastern portion of project area)	
Butternut	<i>Juglans cinerea</i>	T	S3	Yes	Yes; rich woods and hollows	
Rare plant communities						
Northern white cedar woodland	<i>Thuja occidentalis</i> ; various species	R	G2G3, S1	Yes	No	No
Ridge and valley calcareous mixed mesophytic forest	various species	R	G3, S3	Yes	Yes; but subjected to disturbance	Yes; integrity compromised
Other plant communities						
Eastern hemlock treatment area	<i>Tsuga canadensis</i>	SNR	FS; vulnerable in Southeastern United States	Yes	Yes; site contains 37 treated hemlocks, among the largest diameter hemlocks on the ORR	Yes

Table I.2. State-listed taxa, sensitive communities, and focal species on the ORR (continued). The state of Tennessee adopts by default all federally listed species statuses (see Table A1.1 for federally listed taxa).

Common name	Scientific name	Status	Other protection status	ORR historical	Habitat within VTR project area	VTR confirmed contemporary
Reptiles						
Northern pine snake	<i>Pituophis melanoleucus</i>	T	S3	Yes	Yes; well-drained sandy soils in pine/pine-oak woods	No
Eastern slender glass lizard	<i>Ophisaurus attenuatus longicaudus</i>	SD	S3	Yes	Yes; dry upland areas including brushy, cut-over woodlands and grassy fields; fossorial (eastern and central portion of project area)	No
Snails						
Cave thorn snail	<i>Carychium stygium</i>	R	S2	No	Yes; stygobitic, Highland Rim and Cumberland Plateau	No*
A cave obligate snail	<i>Helicodiscus notius specus</i>	R	S1	No	Yes; troglobitic, ridge, valley, and Eastern Highland Rim	No*

* Could not confirm due to no known human accessible caves within project area. Does not preclude occurrence.

† Record based on few acoustic monitor detections, but presence is assumed given habitat and nearby records.

‡ Timing of surveys did not permit positive identification, because diagnostic characters are largely absent during spring/early summer.

State-listing status codes: SNR: state not ranked; S: sensitive; R: rare; SD: In Need of Management; SC: Of Special Concern; SC-CE: Of Special Concern-Commercially Exploited; T: Threatened; E: Endangered

Other status codes: BGEPA: Bald and Golden Eagle Protection Act; PIF: has listing status under Partners in Flight

APPENDIX II. COMPLETE LIST OF VERTEBRATE WILDLIFE DOCUMENTED WITHIN THE VTR CONSTRUCTION AREA

Table II.1. Vertebrate fauna observed within the VTR construction area since 1995.

Type	Scientific name	Common name	State status	State rank	Federal status	Other/global
Amphibian	<i>Ambystoma maculatum</i>	Spotted salamander				
Amphibian	<i>Anaxyrus americanus</i>	American toad				
Amphibian	<i>Desmognathus fuscus</i> complex	Dusky salamander				
Amphibian	<i>Eurycea bislineata/wilderiae</i>	Two-lined salamander				
Amphibian	<i>Hemidactylium scutatum</i>	Four-toed salamander	D	S3		G5
Amphibian	<i>Hyla chrysoscelis</i>	Cope's gray treefrog				
Amphibian	<i>Lithobates clamitans</i>	Green frog				
Amphibian	<i>Lithobates catesbeianus</i>	American bullfrog				
Amphibian	<i>Lithobates palustris</i>	Pickerel frog				
Amphibian	<i>Lithobates sphenoccephalus</i>	Southern leopard frog				
Amphibian	<i>Notophthalmus viridescens</i>	Eastern newt				
Amphibian	<i>Plethodon glutinosus</i>	Slimy salamander				
Amphibian	<i>Plethodon ventralis</i>	Zigzag salamander				
Amphibian	<i>Pseudacris crucifer</i>	Spring peeper				
Amphibian	<i>Pseudacris feriarum</i>	Upland chorus frog				
Amphibian	<i>Pseudotriton montanus</i>	Mud salamander				
Amphibian	<i>Pseudotriton ruber</i>	Red salamander				
Bat	<i>Corynorhinus rafinesquii</i>	Rafinesque's big-eared bat	D	S3		G3G4
Bat	<i>Eptesicus fuscus</i>	Big brown bat				
Bat	<i>Lasionycteris noctivagans</i>	Silver-haired bat				
Bat	<i>Lasiurus borealis</i>	Eastern red bat				
Bat	<i>Lasiurus cinereus</i>	Hoary bat				
Bat	<i>Lasiurus seminolus</i>	Seminole bat				
Bat	<i>Myotis grisescens</i>	Gray bat	E	S2	FE	G4
Bat	<i>Myotis leibii</i>	Eastern small-footed bat	D	S2S3		G4

Table II.1. Vertebrate fauna observed within the VTR construction area since 1995.

Type	Scientific name	Common name	State status	State rank	Federal status	Other/global
Bat	<i>Myotis lucifugus</i>	Little brown bat	T	S3	UR	G3
Bat	<i>Myotis septentrionalis</i>	Northern long-eared bat	T	S1S2	FT	G1G2
Bat	<i>Myotis sodalis</i>	Indiana bat	E	S1	FE	G2
Bat	<i>Nycticeius humeralis</i>	Evening bat				
Bat	<i>Perimyotis subflavus</i>	Tricolored bat	T	S2S3	UR	G2G3
Bat	<i>Tadarida brasiliensis</i>	Brazilian free-tailed bat				
Bird	<i>Ardea herodias</i>	Great-blue heron				
Bird	<i>Branta canadensis</i>	Canada goose				BMC
Bird	<i>Aix sponsa</i>	Wood duck				
Bird	<i>Coragyps atratus</i>	Black vulture				
Bird	<i>Cathartes aura</i>	Turkey vulture				
Bird	<i>Accipiter striatus</i>	Sharp-shinned hawk				
Bird	<i>Accipiter cooperii</i>	Cooper's hawk				
Bird	<i>Haliaeetus leucocephalus</i>	Bald eagle	D	S3		BCC, BMC/G5
Bird	<i>Buteo lineatus</i>	Red-shouldered hawk				
Bird	<i>Vireo olivaceus</i>	Broad-winged hawk				
Bird	<i>Strix varia</i>	Barred owl				
Bird	<i>Pandion haliaetus</i>	Osprey				
Bird	<i>Megascops asio</i>	Eastern screech owl				
Bird	<i>Bubo virginianus</i>	Great horned owl				
Bird	<i>Antrostomus carolinensis</i>	Chuck-will's Widow				
Bird	<i>Antrostomus vociferus</i>	Whip-poor-will				BCC
Bird	<i>Chordeiles minor</i>	Common nighthawk				
Bird	<i>Archilochus colubris</i>	Ruby-throated hummingbird				
Bird	<i>Sphyrapicus varius</i>	Yellow-bellied sapsucker				BCC, BMC
Bird	<i>Melanerpes erythrocephalus</i>	Red-headed woodpecker				BCC
Bird	<i>Dryocopus pileatus</i>	Pileated woodpecker				
Bird	<i>Melanerpes carolinus</i>	Red-bellied woodpecker				
Bird	<i>Picoides pubescens</i>	Downy woodpecker				
Bird	<i>Dryobates pubescens</i>	Hairy woodpecker				

Table II.1. Vertebrate fauna observed within the VTR construction area since 1995.

Type	Scientific name	Common name	State status	State rank	Federal status	Other/global
Bird	<i>Coccyzus americanus</i>	Yellow-billed cuckoo				
Bird	<i>Colaptes auratus</i>	Northern flicker				
Bird	<i>Sitta carolinensis</i>	White-breasted nuthatch				
Bird	<i>Falco sparverius</i>	American kestrel				
Bird	<i>Contopus virens</i>	Eastern wood-pewee				
Bird	<i>Empidonax virescens</i>	Acadian flycatcher				
Bird	<i>Myiarchus crinitus</i>	Great crested flycatcher				
Bird	<i>Sayornis phoebe</i>	Eastern phoebe				
Bird	<i>Tyrannus tyrannus</i>	Eastern kingbird				
Bird	<i>Vireo griseus</i>	White-eyed vireo				
Bird	<i>Vireo flavifrons</i>	Yellow-throated vireo				
Bird	<i>Vireo olivaceus</i>	Red-eyed vireo				
Bird	<i>Vireo solitarius</i>	Blue-headed vireo				
Bird	<i>Cyanocitta cristata</i>	Blue jay				
Bird	<i>Corvus brachyrhynchos</i>	American crow				
Bird	<i>Poecile carolinensis</i>	Carolina chickadee				
Bird	<i>Baeolophus bicolor</i>	Tufted titmouse				
Bird	<i>Hirundo rustica</i>	Barn swallow				
Bird	<i>Tachycineta bicolor</i>	Tree swallow				
Bird	<i>Regulus satrapa</i>	Golden-crowned kinglet				
Bird	<i>Regulus calendula</i>	Ruby-crowned kinglet				
Bird	<i>Certhia americana</i>	Brown creeper				
Bird	<i>Poliophtila caerulea</i>	Blue-gray gnatcatcher				
Bird	<i>Troglodytes aedon</i>	House wren				
Bird	<i>Troglodytes aedon</i>	Winter wren				
Bird	<i>Thryothorus ludovicianus</i>	Carolina wren				
Bird	<i>Sturnus vulgaris</i>	European starling				
Bird	<i>Dumetella carolinensis</i>	Gray catbird				
Bird	<i>Toxostoma rufum</i>	Brown thrasher				
Bird	<i>Mimus polyglottos</i>	Northern mockingbird				

Table II.1. Vertebrate fauna observed within the VTR construction area since 1995.

Type	Scientific name	Common name	State status	State rank	Federal status	Other/global
Bird	<i>Sialia sialis</i>	Eastern bluebird				
Bird	<i>Catharus ustulatus</i>	Swainson's thrush				
Bird	<i>Hylocichla mustelina</i>	Wood thrush	NM			BCC, BMC
Bird	<i>Catharus guttatus</i>	Hermit thrush				
Bird	<i>Catharus fuscescens</i>	Veery				
Bird	<i>Turdus migratorius</i>	American robin				
Bird	<i>Bombycilla cedrorum</i>	Cedar waxwing				
Bird	<i>Haemorhous mexicanus</i>	House finch				
Bird	<i>Haemorhous purpureus</i>	Purple finch				
Bird	<i>Spinus tristis</i>	American goldfinch				
Bird	<i>Passerculus sandwichensis</i>	Savannah sparrow	Rare	S1B,S4N		G5
Bird	<i>Melospiza melodia</i>	Song sparrow				
Bird	<i>Zonotrichia albicollis</i>	White-throated sparrow				
Bird	<i>Spizella pusilla</i>	Field sparrow				
Bird	<i>Junco hyemalis</i>	Dark-eyed junco				
Bird	<i>Pipilo erythrophthalmus</i>	Eastern towhee				
Bird	<i>Icteria virens</i>	Yellow-breasted chat				
Bird	<i>Icterus spurius</i>	Orchard oriole				
Bird	<i>Agelaius phoeniceus</i>	Red-winged blackbird				
Bird	<i>Molothrus ater</i>	Brown-headed cowbird				
Bird	<i>Quiscalus quiscula</i>	Common grackle				
Bird	<i>Helmitheros vermivorum</i>	Worm-eating warbler				BCC, BMC
Bird	<i>Setophaga citrina</i>	Hooded warbler				
Bird	<i>Setophaga pensylvanica</i>	Chestnut-sided warbler				
Bird	<i>Setophaga pinus</i>	Pine warbler				
Bird	<i>Vermivora cyanoptera</i>	Blue-winged warbler				BCC, BMC
Bird	<i>Seiurus aurocapilla</i>	Ovenbird				
Bird	<i>Parkesia motacilla</i>	Louisiana waterthrush				
Bird	<i>Geothlypis formosa</i>	Kentucky warbler				BCC
Bird	<i>Geothlypis trichas</i>	Common yellowthroat				

Table II.1. Vertebrate fauna observed within the VTR construction area since 1995.

Type	Scientific name	Common name	State status	State rank	Federal status	Other/global
Bird	<i>Setophaga citrina</i>	Hooded warbler				
Bird	<i>Setophaga americana</i>	Northern parula				
Bird	<i>Setophaga petechia</i>	Yellow warbler				
Bird	<i>Cardinalis cardinalis</i>	Northern cardinal				
Bird	<i>Setophaga coronata</i>	Yellow-rumped warbler				
Bird	<i>Setophaga discolor</i>)	Prairie warbler				
Bird	<i>Setophaga virens</i>	Black-throated green warbler				
Bird	<i>Piranga olivacea</i>	Scarlet tanager				
Bird	<i>Piranga rubra</i>	Summer tanager				
Bird	<i>Cardinalis cardinalis</i>	Northern cardinal				
Bird	<i>Pheucticus ludovicianus</i>	Rose-breasted grosbeak				
Bird	<i>Passerina caerulea</i>	Blue grosbeak				
Bird	<i>Passerina cyanea</i>	Indigo bunting				
Bird	<i>Zenaidura macroura</i>	Mourning dove				BMC
Bird	<i>Meteagris gallopavo silvestris</i>	Wild turkey				
Mammal	<i>Blarina brevicauda</i>	Short-tailed shrew				
Mammal	<i>Canis latrans</i>	Coyote				
Mammal	<i>Lynx rufus</i>	Bobcat				
Mammal	<i>Mustela frenata</i>	Long-tail weasel				
Mammal	<i>Odocoileus virginianus</i>	Deer				
Mammal	<i>Peromyscus leucopus</i>	White-footed mouse				
Mammal	<i>Peromyscus</i> spp	Peromyscus				
Mammal	<i>Procyon lotor</i>	Raccoon				
Mammal	<i>Sciurus carolinensis</i>	Eastern gray squirrel				
Mammal	<i>Sigmodon hispidus</i>	Cotton rat				
Mammal	<i>Sylvilagus floridanus</i>	Eastern cottontail				
Mammal	<i>Tamias striatus</i>	Eastern chipmunk				
Reptile	<i>Carphophis amoenus</i>	Wormsnake				
Reptile	<i>Coluber constrictor</i>	Racer				
Reptile	<i>Nerodia sipedon</i>	Watersnake				

Table II.1. Vertebrate fauna observed within the VTR construction area since 1995.

Type	Scientific name	Common name	State status	State rank	Federal status	Other/global
Reptile	<i>Pantherophis spiloides</i>	Rat snake				
Reptile	<i>Plestiodon fasciatus</i>	Five-lined skink				
Reptile	<i>Scincella lateralis</i>	Little brown skink				
Reptile	<i>Storeria occipitomaculata</i>	Redbellied snake				
Reptile	<i>Terrapene carolina</i>	Eastern box turtle				
Reptile	<i>Thamnophis sirtalis</i>	Gartersnake				

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; SD: state-listed In Need of Management; ST: state Threatened; SE: state Endangered

APPENDIX III. ADDITIONAL DETAILS FROM 2013 FOREST INVENTORY

Table III.1. List of species and live tree basal area statistics for the VTR review area.

		Basal Area (ft ²)				Basal Area (%)			
		Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable Trees	Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable Trees
<u>Scientific Name</u>	<u>Common Name</u>								
<i>Acer rubrum</i>	red maple	757	942	1,699	143	7%	14%	10%	2%
<i>Acer saccharum</i>	sugar maple	82	266	348	41	1%	4%	2%	1%
<i>Aesculus flava</i>	yellow buckeye	0	123	123	0	0%	2%	1%	0%
<i>Ailanthus altissima</i>	tree-of-heaven	0	20	20	0	0%	0%	0%	0%
<i>Albizia julibrissin</i>	mimosa	0	41	41	0	0%	1%	0%	0%
<i>Carya cordiformis</i>	bitternut hickory	20	20	41	20	0%	0%	0%	0%
<i>Carya glabra</i>	pignut hickory	82	0	82	61	1%	0%	0%	1%
<i>Carya ovata</i>	shagbark hickory	20	0	20	0	0%	0%	0%	0%
<i>Carya tomentosa</i>	mockernut hickory	368	389	757	225	4%	6%	5%	3%
<i>Cercis canadensis</i>	redbud	0	82	82	0	0%	1%	0%	0%
<i>Cornus florida</i>	flowering dogwood	0	225	225	0	0%	3%	1%	0%
<i>Fagus grandifolia</i>	American beech	20	164	184	0	0%	3%	1%	0%
<i>Fraxinus americana</i>	white ash	430	450	880	164	4%	7%	5%	2%
<i>Juglans nigra</i>	black walnut	0	20	20	0	0%	0%	0%	0%
<i>Juniperus virginiana</i>	red cedar	225	328	553	102	2%	5%	3%	1%
<i>Liquidambar styraciflua</i>	sweetgum	921	880	1,801	798	9%	14%	11%	11%
<i>Liriodendron tulipifera</i>	tuliptree, yellow poplar	1,290	287	1,576	1,208	13%	4%	9%	17%
<i>Magnolia acuminata</i>	cucumbertree	20	0	20	0	0%	0%	0%	0%
<i>Nyssa sylvatica</i>	black gum	20	266	287	20	0%	4%	2%	0%
<i>Ostrya virginiana</i>	American hophornbeam	0	41	41	0	0%	1%	0%	0%
<i>Oxydendrum arboreum</i>	sourwood	20	368	389	0	0%	6%	2%	0%
<i>Pinus echinata</i>	short-leaf pine	328	205	532	266	3%	3%	3%	4%
<i>Pinus strobus</i>	white pine	82	20	102	82	1%	0%	1%	1%
<i>Pinus virginiana</i>	scrub pine, Virginia pine	1,310	368	1,679	983	13%	6%	10%	14%
<i>Platanus occidentalis</i>	sycamore	164	41	205	102	2%	1%	1%	1%
<i>Prunus serotina</i>	black cherry	82	123	205	41	1%	2%	1%	1%
<i>Quercus alba</i>	white oak	2,108	573	2,682	1,719	21%	9%	16%	24%
<i>Quercus coccinea</i>	scarlet oak	389	61	450	328	4%	1%	3%	5%
<i>Quercus falcata</i>	southern red oak	491	20	512	368	5%	0%	3%	5%
<i>Quercus muehlenbergii</i>	chinkapin oak	0	41	41	0	0%	1%	0%	0%
<i>Quercus rubra</i>	northern red oak	798	61	860	471	8%	1%	5%	7%
<i>Quercus stellata</i>	post oak	61	0	61	20	1%	0%	0%	0%
<i>Quercus velutina</i>	black oak	61	0	61	41	1%	0%	0%	1%
<i>Sassafras albidum</i>	sassafras	0	41	41	0	0%	1%	0%	0%
<i>Ulmus americana</i>	American elm	20	41	61	20	0%	1%	0%	0%
	Totals	10,173	6,509	16,683	7,225	100%	100%	100%	100%

Table III.2. Live basal area statistics by genus for the VTR review area.

<u>Scientific Name</u>	<u>Common Name</u>	Basal Area (ft ²)				Basal Area (%)			
		Trees	Saplings	All tally	Merchantable	Trees	Saplings	All tally trees	Merchantable
		(dbh > 10.0 inches)	(2 > dbh < 10.0 inches)	trees (dbh > 2.0 inches)		(dbh > 10.0 inches)	(2 > dbh < 10.0 inches)	(dbh > 2.0 inches)	
<i>Quercus</i>	white oak group	2,170	614	2,784	1,740	21%	9%	17%	24%
	red oak group	1,740	143	1,883	1,208	17%	2%	11%	17%
<i>Pinus</i>	pine	1,719	594	2,313	1,331	17%	9%	14%	18%
<i>Acer</i>	maple	839	1,208	2,047	184	8%	19%	12%	3%
<i>Liquidambar</i>	sweetgum	921	880	1,801	798	9%	14%	11%	11%
<i>Liriodendron</i>	tuliptree	1,290	287	1,576	1,208	13%	4%	9%	17%
<i>Carya</i>	hickory	491	409	901	307	5%	6%	5%	4%
<i>Fraxinus</i>	ash	430	450	880	164	4%	7%	5%	2%
<i>Juniperus</i>	red cedar	225	328	553	102	2%	5%	3%	1%
<i>Oxydendrum</i>	sourwood	20	368	389	0	0%	6%	2%	0%
<i>Nyssa</i>	black gum	20	266	287	20	0%	4%	2%	0%
<i>Cornus</i>	dogwood	0	225	225	0	0%	3%	1%	0%
<i>Platanus</i>	sycamore	164	41	205	102	2%	1%	1%	1%
<i>Prunus</i>	black cherry	82	123	205	41	1%	2%	1%	1%
<i>Fagus</i>	beech	20	164	184	0	0%	3%	1%	0%
<i>Aesculus</i>	buckeye	0	123	123	0	0%	2%	1%	0%
<i>Cercis</i>	redbud	0	82	82	0	0%	1%	0%	0%
<i>Ulmus</i>	elm	20	41	61	20	0%	1%	0%	0%
<i>Albizia</i>	mimosa	0	41	41	0	0%	1%	0%	0%
<i>Ostrya</i>	hophornbeam	0	41	41	0	0%	1%	0%	0%
<i>Sassafras</i>	sassafras	0	41	41	0	0%	1%	0%	0%
<i>Ailanthus</i>	tree-of-heaven	0	20	20	0	0%	0%	0%	0%
<i>Juglans</i>	walnut	0	20	20	0	0%	0%	0%	0%
<i>Magnolia</i>	cucumbertree	20	0	20	0	0%	0%	0%	0%
Totals		10,173	6,509	16,683	7,225	100%	100%	100%	100%

Table III.3. Total trees and trees per acre by species and size class for the VTR review area.

Scientific Name	Common Name	Total Trees				Average Trees per Acre			
		Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable Trees	Trees (dbh > 10.0 inches)	Saplings (2 > dbh < 10.0 inches)	All tally trees (dbh > 2.0 inches)	Merchantable Trees
<i>Quercus alba</i>	white oak	1,695	3,185	4,880	1,260	12.5	23.6	36.1	9.3
<i>Pinus virginiana</i>	scrub pine, Virginia pine	1,460	1,178	2,638	1,063	10.8	8.7	19.5	7.9
<i>Liquidambar styraciflua</i>	sweetgum	1,042	10,649	11,691	875	7.7	78.8	86.5	6.5
<i>Liriodendron tulipifera</i>	tuliptree, yellow poplar	975	1,843	2,818	906	7.2	13.6	20.9	6.7
<i>Acer rubrum</i>	red maple	786	6,333	7,119	109	5.8	46.9	52.7	0.8
<i>Quercus rubra</i>	northern red oak	482	287	770	292	3.6	2.1	5.7	2.2
<i>Fraxinus americana</i>	white ash	474	1,875	2,349	150	3.5	13.9	17.4	1.1
<i>Carya tomentosa</i>	mockernut hickory	415	2,816	3,231	210	3.1	20.8	23.9	1.6
<i>Pinus echinata</i>	short-leaf pine	413	717	1,131	334	3.1	5.3	8.4	2.5
<i>Quercus falcata</i>	southern red oak	324	56	379	272	2.4	0.4	2.8	2.0
<i>Quercus coccinea</i>	scarlet oak	270	194	464	234	2.0	1.4	3.4	1.7
<i>Juniperus virginiana</i>	red cedar	245	3,292	3,537	92	1.8	24.4	26.2	0.7
<i>Acer saccharum</i>	sugar maple	99	1,955	2,054	28	0.7	14.5	15.2	0.2
<i>Prunus serotina</i>	black cherry	92	670	762	44	0.7	5.0	5.6	0.3
<i>Platanus occidentalis</i>	sycamore	81	91	172	40	0.6	0.7	1.3	0.3
<i>Carya glabra</i>	pignut hickory	72	0	72	67	0.5	0.0	0.5	0.5
<i>Quercus stellata</i>	post oak	53	0	53	20	0.4	0.0	0.4	0.1
<i>Pinus strobus</i>	white pine	45	46	92	45	0.3	0.3	0.7	0.3
<i>Oxydendrum arboreum</i>	sourwood	36	3,690	3,726	0	0.3	27.3	27.6	0.0
<i>Carya ovata</i>	shagbark hickory	31	0	31	0	0.2	0.0	0.2	0.0
<i>Quercus velutina</i>	black oak	29	0	29	18	0.2	0.0	0.2	0.1
<i>Carya cordiformis</i>	bitternut hickory	23	54	78	23	0.2	0.4	0.6	0.2
<i>Ulmus americana</i>	American elm	23	391	414	23	0.2	2.9	3.1	0.2
<i>Magnolia acuminata</i>	cucumbertree	21	0	21	0	0.2	0.0	0.2	0.0
<i>Nyssa sylvatica</i>	black gum	19	3,732	3,751	19	0.1	27.6	27.8	0.1
<i>Fagus grandifolia</i>	American beech	8	1,422	1,430	0	0.1	10.5	10.6	0.0
<i>Aesculus flava</i>	yellow buckeye	0	995	995	0	0.0	7.4	7.4	0.0
<i>Ailanthus altissima</i>	tree-of-heaven	0	47	47	0	0.0	0.4	0.4	0.0
<i>Albizia julibrissin</i>	mimosa	0	155	155	0	0.0	1.1	1.1	0.0
<i>Cercis canadensis</i>	redbud	0	1,852	1,852	0	0.0	13.7	13.7	0.0
<i>Cornus florida</i>	flowering dogwood	0	5,372	5,372	0	0.0	39.8	39.8	0.0
<i>Juglans nigra</i>	black walnut	0	48	48	0	0.0	0.4	0.4	0.0
<i>Ostrya virginiana</i>	American hophornbeam	0	644	644	0	0.0	4.8	4.8	0.0
<i>Quercus muehlenbergii</i>	chinkapin oak	0	1,018	1,018	0	0.0	7.5	7.5	0.0
<i>Sassafras albidum</i>	sassafras	0	357	357	0	0.0	2.6	2.6	0.0
Totals		9,214	54,964	64,178	6,125	68.2	406.8	475.0	45.3

Table III.4. Total and per acre merchantable volume of timber by species for the VTR review area.

		<u>2011 Volume (board feet)</u>		<u>Estimated 2019 Volume (board feet)</u>		
<u>Scientific Name</u>	<u>Common Name</u>	<u>Tract Total</u>	<u>Average per Acre</u>	<u>Tract Total</u>	<u>Average per Acre</u>	<u>Percent of Total</u>
<i>Quercus alba</i>	white oak	174,201	1,289	220,673	1,633	23.2%
<i>Liriodendron tulipifera</i>	tuliptree, yellow poplar	152,698	1,130	193,433	1,432	20.4%
<i>Pinus virginiana</i>	scrub pine, Virginia pine	97,584	722	123,617	915	13.0%
<i>Liquidambar styraciflua</i>	sweetgum	80,285	594	101,703	753	10.7%
<i>Quercus rubra</i>	northern red oak	47,388	351	60,029	444	6.3%
<i>Quercus falcata</i>	southern red oak	38,024	281	48,167	357	5.1%
<i>Quercus coccinea</i>	scarlet oak	32,395	240	41,037	304	4.3%
<i>Pinus echinata</i>	short-leaf pine	27,221	201	34,483	255	3.6%
<i>Carya tomentosa</i>	mockernut hickory	19,016	141	24,090	178	2.5%
<i>Fraxinus americana</i>	white ash	15,928	118	0	0	2.1%
<i>Platanus occidentalis</i>	sycamore	13,419	99	16,999	126	1.8%
<i>Acer rubrum</i>	red maple	11,507	85	14,577	108	1.5%
<i>Pinus strobus</i>	white pine	10,349	77	13,109	97	1.4%
<i>Juniperus virginiana</i>	red cedar	7,672	57	9,719	72	1.0%
<i>Carya glabra</i>	pignut hickory	4,497	33	5,696	42	0.6%
<i>Quercus velutina</i>	black oak	4,381	32	5,550	41	0.6%
<i>Acer saccharum</i>	sugar maple	3,750	28	4,751	35	0.5%
<i>Prunus serotina</i>	black cherry	3,007	22	3,809	28	0.4%
<i>Nyssa sylvatica</i>	black gum	2,498	18	3,165	23	0.3%
<i>Quercus stellata</i>	post oak	1,518	11	1,923	14	0.2%
<i>Ulmus americana</i>	American elm	1,491	11	1,889	14	0.2%
<i>Carya cordiformis</i>	bitternut hickory	1,488	11	1,885	14	0.2%
Totals		750,319	5,554	930,304	6,886	

Table III.5. Total and per acre merchantable volume of timber by genus for the VTR review area.

<u>Scientific Name</u>	<u>Common Name</u>	<u>2011 Volume (board feet)</u>			<u>Estimated 2019 Volume (board feet)</u>	
		<u>Tract Total</u>	<u>Average per Acre</u>	Percent of total	<u>Tract Total</u>	<u>Average per Acre</u>
<i>Acer</i>	maple	15,258	113	2.0%	19,328	143
<i>Carya</i>	hickory	25,001	185	3.3%	31,670	234
<i>Fraxinus</i>	ash	15,928	118	2.1%	0	0
<i>Juniperus</i>	red cedar	7,672	57	1.0%	9,719	72
<i>Liquidambar</i>	sweetgum	80,285	594	10.7%	101,703	753
<i>Liriodendron</i>	tuliptree, yellow poplar	152,698	1,130	20.4%	193,433	1,432
<i>Nyssa</i>	gum	2,498	18	0.3%	3,165	23
<i>Pinus</i>	pine	135,154	1,000	18.0%	171,210	1,267
<i>Platanus</i>	sycamore	13,419	99	1.8%	16,999	126
<i>Prunus</i>	cherry	3,007	22	0.4%	3,809	28
<i>Quercus</i>	oak	297,907	2,205	39.7%	377,379	2,793
<i>Ulmus</i>	elm	1491	11	0.2%	1,889	14
Totals		750,319	5,554	100%	930,304	6,886

Table III.6. Largest trees of each species for the VTR review area.

<u>Common Name</u>	<u>dbh of largest tally tree (inches)</u>	<u>Number of tally trees with dbh >= 30.0 inches</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Common Name</u>	<u>dbh of largest tally tree (inches)</u>	<u>Number of tally trees with dbh >= 30.0 inches</u>	<u>Latitude</u>	<u>Longitude</u>
red maple	24.5				red maple	24.5			
sugar maple	21.2				sugar maple	21.2			
yellow buckeye	7.9				yellow buckeye	7.9			
tree-of-heaven	8.9				tree-of-heaven	8.9			
mimosa	7.7				mimosa	7.7			
bitternut hickory	12.7				bitternut hickory	12.7			
pignut hickory	27				pignut hickory	27			
shagbark hickory	11				shagbark hickory	11			
mockernut hickory	24.1				mockernut hickory	24.1			
redbud	4.4				redbud	4.4			
flowering dogwood	5.7				flowering dogwood	5.7			
American beech	21.2				American beech	21.2			
white ash	22.5				white ash	22.5			
black walnut	8.8				black walnut	8.8			
red cedar	19				red cedar	19			
sweetgum	18.6				sweetgum	18.6			
tuliptree	24.3				tuliptree	24.3			
cucumbertree	13.3				cucumbertree	13.3			
black gum	14				black gum	14			
American hophornbeam	5.4				American hophornbeam	5.4			
sourwood	10.2				sourwood	10.2			
short-leaf pine	15.2				short-leaf pine	15.2			
white pine	26.4				white pine	26.4			
scrub pine	20.8				scrub pine	20.8			
sycamore	23.8				sycamore	23.8			
black cherry	16.7				black cherry	16.7			
white oak	27.3				white oak	27.3			
scarlet oak	26				scarlet oak	26			
southern red oak	30.5	1	35.92801	-84.2868	southern red oak	30.5	1	35.92801	-84.2868
chinkapin oak	3.2				chinkapin oak	3.2			
northern red oak	30.5	1	35.92474	-84.2899	northern red oak	30.5	1	35.92474	-84.2899
post oak	15.4				post oak	15.4			
black oak	21.9				black oak	21.9			
sassafras	4.8				sassafras	4.8			
American elm	12.8				American elm	12.8			
Total over 30" dbh		2			Total over 30" dbh		2		