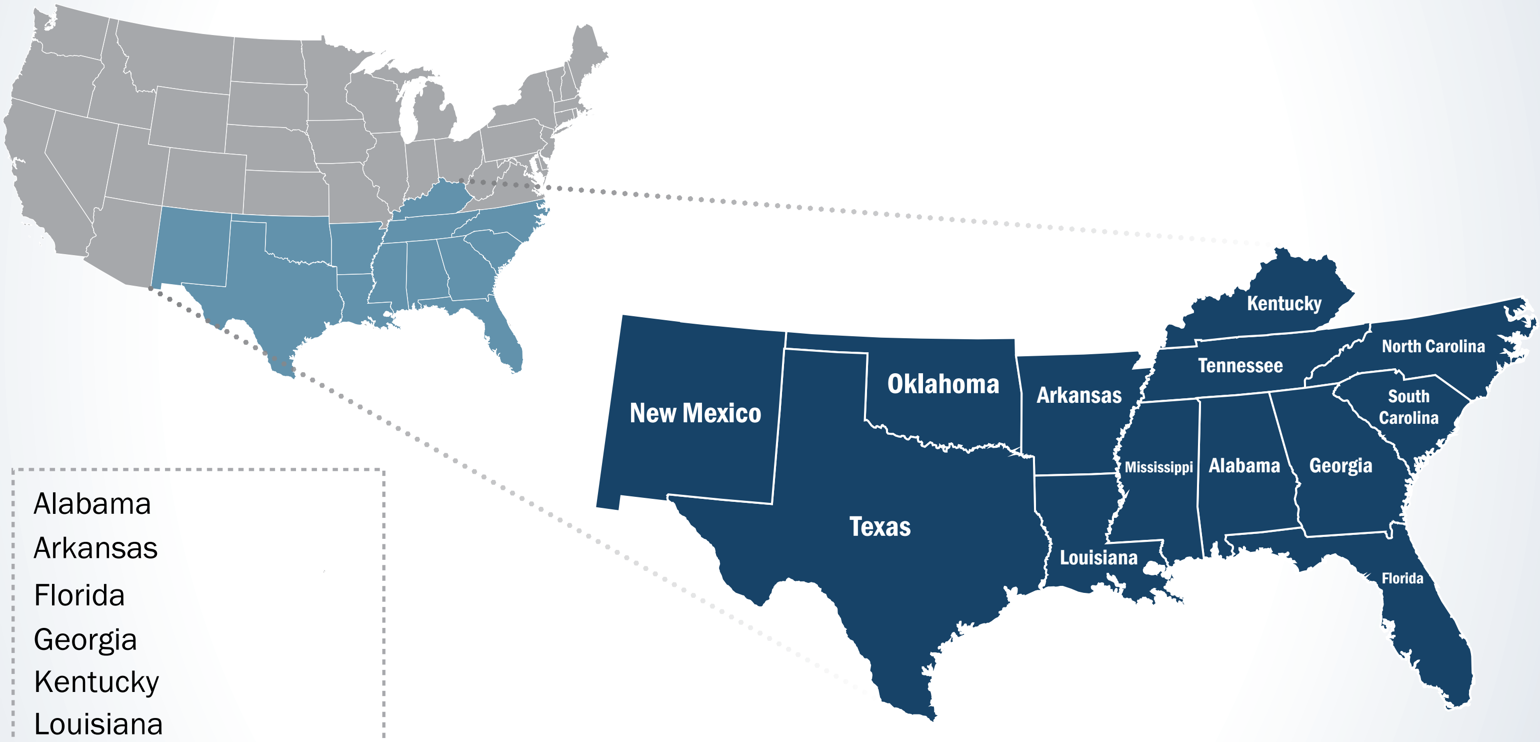
FirstNet®

Nationwide Public Safety Broadband Network

Final Programmatic Environmental Impact Statement for the Southern United States

VOLUME 12 - CHAPTER 14



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AUGUST 2017

First Responder Network Authority

FirstNet®

Nationwide Public Safety Broadband Network

Final Programmatic Environmental Impact Statement for the Southern United States

VOLUME 12 - CHAPTER 14

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Cooperating Agencies
Federal Communications Commission
General Services Administration
U.S. Department of Agriculture—Rural Utilities Service
U.S. Department of Agriculture—U.S. Forest Service
U.S. Department of Agriculture—Natural Resource Conservation Service
U.S. Department of Commerce—National Telecommunications and Information Administration
U.S. Department of Defense—Department of the Air Force
U.S. Department of Energy
U.S. Department of Homeland Security

August 2017

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14. TENNESSEE

American Indian tribes with a rich cultural history lived in what is now Tennessee for centuries before the 1600s. Both the French and the British claimed Tennessee until the French and Indian War in 1763, when the area officially became British territory (Tennessee Department of State, 2014a). By the 1770s, people from North Carolina and Virginia had begun to settle in the area. In 1976, Tennessee had become the 16th state to enter the Union (Tennessee Department of State, 2008). Kentucky and Virginia border Tennessee to the north, Missouri and Arkansas to the west, Mississippi, Alabama, and Georgia to the south, and North Carolina to the east. This chapter provides details about the existing environment of Tennessee as it relates to the Proposed Action.

General facts about Tennessee are provided below:

- **State Nickname:** The Volunteer State
- **Land Area:** 41,235 square miles; **U.S. Rank:** 34 (U.S. Census Bureau, 2015a)
- **Capital:** Nashville
- **Counties:** 95 (U.S. Census Bureau, 2015b)
- **2015 Estimated Population:** Over 6.6 million people; **U.S. Rank:** 17 (U.S. Census Bureau, 2015a)
- **Most Populated Cites:** Memphis and Nashville (U.S. Census Bureau, 2015b)
- **Main Rivers:** Mississippi River, Cumberland River, Tennessee River, Clinch River, Duck River (TN State Government, 2016)
- **Bordering Waterbodies:** Mississippi River
- **Mountain Ranges:** Smoky Mountains, and a portion of the Appalachian Mountains
- **Highest Point:** Clingmans Dome (6,643 feet) (NPS, 2016a)

14.1. AFFECTED ENVIRONMENT

14.1.1. Infrastructure

14.1.1.1. Introduction

This section provides information on key Tennessee infrastructure resources that could potentially be affected by FirstNet projects. Infrastructure consists of the systems and physical structures that enable a population in a specified area to function. Infrastructure is entirely manmade with a high correlation between the type and extent of infrastructure and the degree to which an area is characterized as "developed." Infrastructure includes a broad array of facilities such as utility systems, streets and highways, railroads, airports, buildings and structures, ports, harbors and other manmade facilities. Individuals, businesses, government entities, and virtually all relationships between these groups depend on infrastructure for their most basic needs, as well as for critical and advanced needs (e.g., emergency response, health care, and telecommunications).

Section 14.1.1.3 provides an overview of Tennessee's traffic and transportation infrastructure, including road networks, rail networks, and airport facilities. Tennessee's public safety infrastructure could include any infrastructure utilized by a public safety entity[1] as defined in Title VI of the Middle Class Tax Relief and Job Creation Act of 2012 (Public Law [Pub. L.] No. 112-96, Title VI Stat. 156 (codified at 47 United States Code [U.S.C.] 1401 et seq.) (the Act), including infrastructure associated with police, fire, and emergency medical services (EMS). However, other organizations can qualify as public safety services as defined by the Act. Public safety services in Tennessee are presented in more detail in Section 14.1.1.4. Section 14.1.1.5 describes Tennessee's public safety communications infrastructure and commercial telecommunications infrastructure. An overview of Tennessee utilities, such as power, water, and sewer, is presented in Section 14.1.1.6.

14.1.1.2. Specific Regulatory Considerations

Multiple Tennessee laws and regulations pertain to the state's public utility and transportation infrastructure and its public safety community. Table 14.1.1-1 identifies the relevant laws and regulations, the affected agencies, and their jurisdiction as derived from the state's applicable statutes and administrative rules referenced in column one. Appendix C, Environmental Laws and Regulations, identifies applicable federal laws and regulations.

Table 14.1.1-1: Relevant Tennessee Infrastructure Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Tennessee Code Unannotated: Title 1340 Safety and Homeland Security	Tennessee Emergency Management Agency (TEMA)	Works to reduce the vulnerability of the people and property of the state to natural disasters and emergencies; provides for the coordination of activities relating to emergency preparedness, response, recovery, and mitigation; cooperates with federal agencies with regard to emergency management.

[1] The term "public safety entity" means an entity that provides public safety services. (7 U.S.C. § 1401(26))

State Law/Regulation	Regulatory Agency	Applicability
Tennessee Code Unannotated: Title 65 Public Utilities and Carriers	Tennessee Regulatory Authority (TRA); Tennessee Department of Transportation (TDOT)	Regulates railroads and railroad companies; exercises general supervisory and regulatory power, jurisdiction, and control over all public utilities; fosters the development of an efficient, technologically advanced, statewide system of telecommunications services; requires a cellular or other wireless telecommunications service provider or other person who proceeds to construct a new tower to submit certain property and location information to the comptroller of the treasury.
Tennessee Code Unannotated: Title 54 Highways, Bridges, and Ferries	TDOT	Provides for the protection and promotion of safety aeronautics; adopts and enforces airport zoning regulations that specify the land uses permitted and prohibited and regulate and restrict the height to which structures and trees may be erected or allowed to grow; retains highway rights-of-way for scenic or environmental purposes.

Source: (Tennessee Department of Safety and Homeland Security, 2016) (Justia, 2016a) (Justia, 2016b)

14.1.1.3. Transportation

This section describes the transportation infrastructure in Tennessee, including specific information related to the road networks, airport facilities, and rail networks, ports, and harbors (this PEIS defines "harbor" as a body of water deep enough to allow anchorage of a ship or boat). The movement of vehicles is commonly referred to as traffic, as well as the circulation along roads. Roadways in the state can range from multilane road networks with asphalt surfaces, to unpaved gravel or private roads. The information regarding existing transportation systems in Tennessee are based on a review of maps, aerial photography, and federal and state data sources.

The Tennessee Department of Transportation (TDOT) has jurisdiction over freeways and major roads, airports, railroads, mass transit, and ports in the state; local counties have jurisdiction for smaller streets and roads. The mission of the TDOT is to "provide a safe and reliable transportation system for people, goods, and services that supports economic prosperity in Tennessee" (TDOT, 2015a).

Tennessee has an extensive and complex transportation system across the entire state. The state's transportation network consists of:

- 95,536 miles of public roads (FHWA, 2014) and 19,740 bridges (TDOT, 2015b);
- 3,019 miles of rail network that includes passenger rail and freight (TDOT, 2015b);
- 327 aviation facilities, including airstrips and heliports (FAA, 2015a) (USDOT, 2015); and
- Two major river ports (Memphis and Nashville).

Road Networks

As identified in Figure 14.1.1-1, the major urban centers of the state from north to south are Martin-Union City, Nashville-Davidson-Murfreesboro, Knoxville-Morristown-Sevierville, Johnson City-Kingsport-Bristol, Memphis-Forrest City, and Chattanooga-Cleveland-Dalton (U.S. Census Bureau, 2013). Tennessee has seven major interstates connecting its major metropolitan areas to one another, as well as to other states. Travel outside the major metropolitan areas is conducted on interstates, and state and county roads. Table 14.1.1-2 lists the interstates and their start/end points in Tennessee. Per the national standard, even numbered interstates run from west to east with the lowest numbers beginning in the south; odd numbered interstates run from north to south with the lowest numbers beginning in the west (FHWA, 2015a).

Table 14.1.1-2: Tennessee Interstates

Interstate	Southern or western terminus in TN	Northern or eastern terminus in TN
I-24	KY line in Clarksville	I-75 in East Ridge
I-26	NC line in Flag Pond	VA line in Kingsport
I-40	AR line in Memphis	NC line in Hartford
I-55	MS line in Memphis	AR line in Memphis
I-65	TN line in Ardmore	KY line in Mitchellville
I-75	GA line in East Ridge	KY line in Jellico
I-81	I-40 near Dandridge	VA line in Bristol

Source: (FHWA, 2015a)

In addition to the Interstate System, Tennessee has both National Scenic Byways and State Scenic Byways. National and State Scenic Byways are roads that are recognized for one or more archaeological, cultural, historic, natural, recreational, and scenic qualities (FHWA, 2013). Figure 14.1.1-1 illustrates the major transportation networks, including roadways, in Tennessee. Section 14.1.8, Visual Resources, describes the National and State Scenic Byways found in Tennessee from an aesthetic perspective.

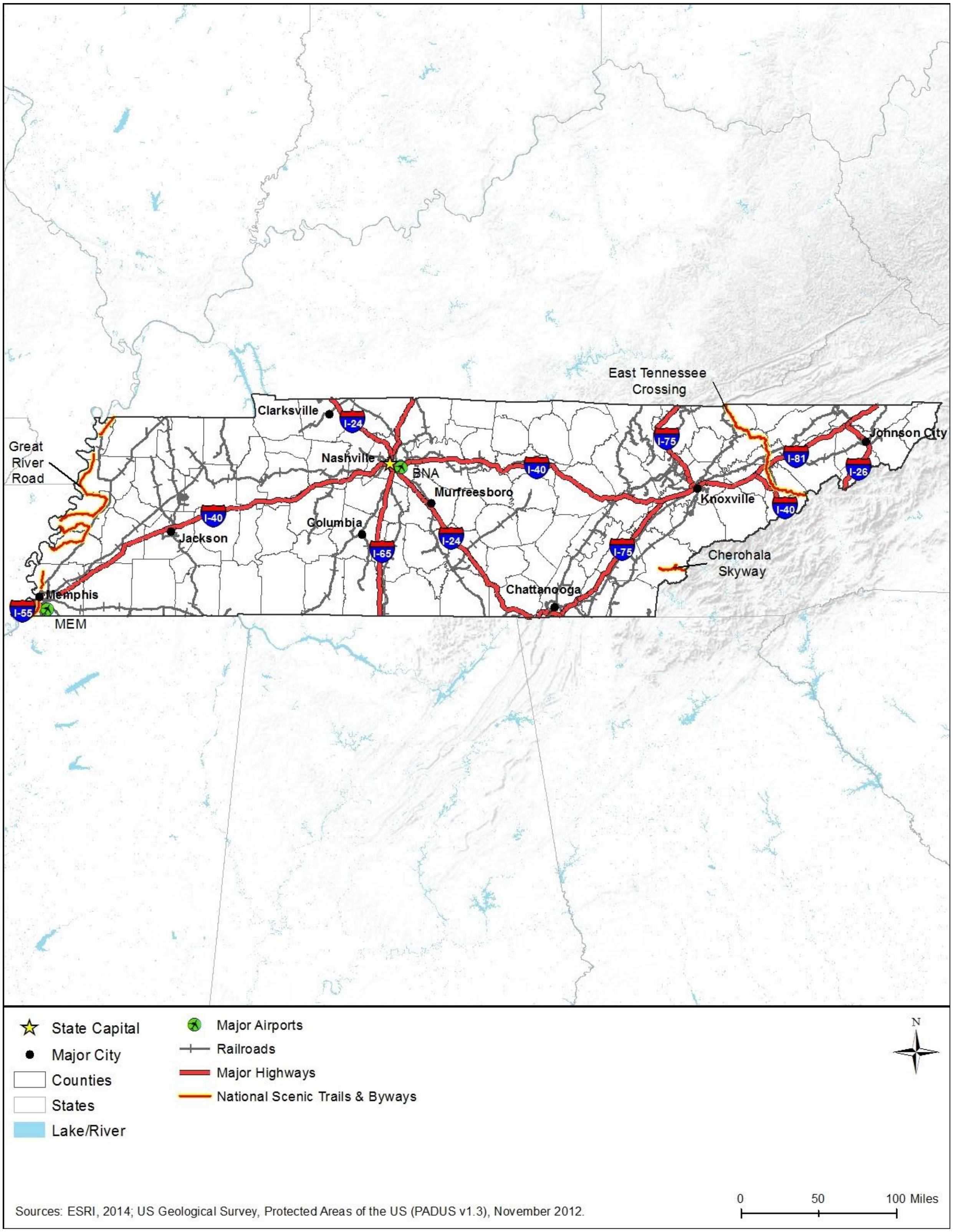


Figure 14.1.1-1: Tennessee Transportation Networks

National Scenic Byways are roads with nationwide interest; U.S. Department of Transportation's (USDOT) Federal Highway Administration (FHWA) designates and manages the byways. Tennessee has five National Scenic Byways (FHWA, 2015b):

- Cherohala Skyway: 43 miles in North Carolina and Tennessee;
- East Tennessee Crossing: 83 miles in northeastern Tennessee;
- Great River Road: 2,069 miles through Arkansas, Illinois, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Tennessee, and Wisconsin;
- Natchez Trace Parkway: 444 miles in Alabama, Mississippi, and Tennessee; and
- Woodlands Trace: 43 miles in Kentucky and Tennessee.

State Scenic Byways are roads with statewide interest; TDOT designates and manages State Scenic Byways. Some State Scenic Byways may be designated on portions of National Scenic Byways. Tennessee has 15 State Scenic Byways that crisscross the entire state (TN Trails and Byways, 2015):[2]

- Cotton Junction Trail
- Nashville's Trace Trail
- Old Tennessee
- Pie In the Sky Trail
- Promised Land
- Ring of Fire Trail
- Rocky Top Trail
- Screaming Eagle
- Sunny Side Trail
- Tanasi Trail
- Tennessee River Trail
- The Jack Trail
- Top Secret Trail
- Walking Tall Trail
- White Lightning Trail

Airports

Nashville International Airport (BNA) and Memphis International Airport (MEM) primarily provide air service to the state.

- BNA is located eight miles southeast of downtown Nashville. In fiscal year 2015, BNA served 11,199,618 passengers, facilitated 178,723 aircraft operations, and handled 40,494 pounds of cargo (BNA, 2015).
- MEM is located seven miles southeast of downtown Memphis. In 2014, MEM served 3,597,601 passengers, facilitated 219,014 aircraft operations, and handled 320,240,648 pounds of cargo (MEM, 2014). Of that cargo, Federal Express (FedEx) moved 318,510,072 pounds of cargo through MEM in 2014; FedEx's headquarters is in Memphis, with its global operations hub operating out of MEM (MEM, 2014). As a result, MEM is the busiest airport in the nation, in terms of cargo moved, and the second busiest in the world (MEM, 2015). "FedEx employs more than 11,000 employees at its Memphis hub and has more than 34 million square feet of space under lease on airport property. FedEx has 474 flights per day, and handles more than 180,000 package and 245,000 documents per hour at its Memphis hub" (MEM, 2015).

[2] The total number of State Scenic Byway may not include those segments of National Scenic Byways that are also designated as State Scenic.

McGhee Tyson Airport (TYS) and Chattanooga Metropolitan Airport (CHA) are smaller airports that also provide service in the state. Figure 14.1.1-1 illustrates the major transportation networks, including major airports, in the state. Section 14.1.7, Airspace, provides greater detail on airports and airspace in Tennessee.

Rail Networks

Tennessee is connected to a network of passenger rail (Amtrak) and freight rail. Figure 14.1.1-1 illustrates the major transportation networks, including rail lines, in Tennessee. Amtrak runs one line through Tennessee: the City of New Orleans. This line provides daily service between Chicago and New Orleans and serves two stations in Tennessee. Table 14.1.1-3 provides a complete list of Amtrak lines that run through Tennessee.

Table 14.1.1-3: Amtrak Train Routes Serving Tennessee

Route	Starting Point	Ending Point	Length of Trip	Cities Served in Tennessee
City of New Orleans	Chicago, IL	New Orleans, LA	19 hours	Newbern-Dyersburg, Memphis

Sources: (Amtrak, 2015) (Amtrak, 2016)

The Music City Star is a commuter rail line that links downtown Nashville with its eastern suburbs. The Music City Star makes six stops: Riverfront (Nashville), Donelson, Hermitage, Mt. Juliet, Martha, and Lebanon (RTA, 2015a). The service runs three trains each weekday morning and three trains every evening to accommodate commuters (RTA, 2015b). The line operates on 32 miles of track owned by the Nashville and Eastern Railroad Authority (RTA, 2015b).

Six Class I freight railroad companies and 22 short line railroads operate on Tennessee’s 3,019 miles of track (TDOT, 2005a). The Class I companies in the state are Burlington Northern Santa Fe (BNSF) Railway, Canadian National, CSX Transportation, Kansas City Southern Railway, Norfolk Southern Corporation, and Union Pacific Railroad Company (TDOT, 2005a).

Harbors and Ports

Tennessee is landlocked and has no major harbors. However, Tennessee does have several major river ports, including the river ports of Memphis and Nashville. Tennessee also has several very small river ports, including the river ports of Chattanooga and Knoxville. (NOAA, 2000)

14.1.1.4. Public Safety Services

Tennessee public safety services generally consist of public safety infrastructure and first responder personnel aligned with the demographics of the state. Table 14.1.1-4 presents Tennessee’s key demographics including population; land area; population density; and number of counties, cities/towns, and municipal governments. More information about these demographics is presented in Section 14.1.9, Socioeconomics; however, these demographics are key to understanding the breadth of public safety services throughout the state.

Table 14.1.1-4: Key Tennessee Indicators

Tennessee Indicators	
Estimated Population (2014)	6,549,352
Land Area (square miles) (2010)	41,235
Population Density (persons per sq. mile) (2010)	153.9
Municipal Governments (2013)	347

Sources: (U.S. Census Bureau, 2015c) (National League of Cities, 2007)

Table 14.1.1-5 presents Tennessee's public safety infrastructure, including fire and police stations. Table 14.1.1-6 identifies first responder personnel including dispatch, fire and rescue, law enforcement, and emergency medical personnel in the state.

Table 14.1.1-5: Public Safety Infrastructure in Tennessee by Type

Infrastructure Type	Number
Fire and Rescue Stations [a]	1,408
Law Enforcement Agencies [b]	720
Fire Departments [c]	638

Sources: (U.S. Fire Administration, 2015) (U.S. Bureau of Justice Statistics, 2011)

[a] Data collected by the U.S. Fire Administration in 2015.
[b] Number of agencies from state and local law enforcement include: local police departments, sheriffs' offices, primary state law enforcement agencies, special jurisdictional agencies, and other miscellaneous agencies, collected by the U.S. Bureau of Justice Statistics in 2008.
[c] Data collected by the U.S. Fire Administration in 2015.

Table 14.1.1-6: First Responder Personnel in Tennessee by Type

First Responder Personnel	Number
Police, Fire and Ambulance Dispatchers [a]	2,290
Fire and Rescue Personnel [b]	21,141
Law Enforcement Personnel [c]	47,379
Emergency Medical Technicians and Paramedics [d e]	6,690

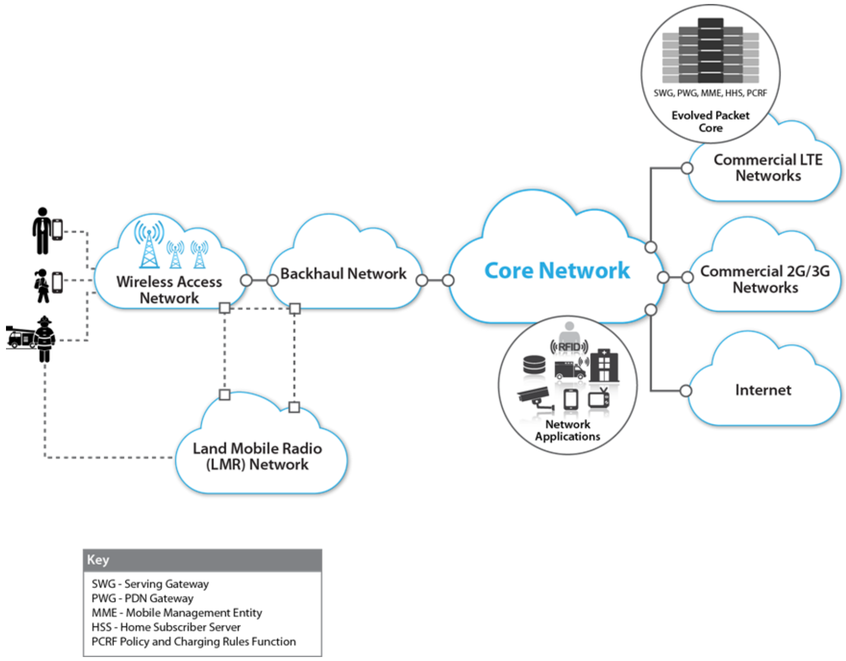
Sources: (U.S. Fire Administration, 2015) (BLS, 2015a) (U.S. Bureau of Justice Statistics, 2011)

[a] BLS Occupation Code: 43-5031.
[b] BLS Occupation Codes: 33-2011 (Firefighters), 33-2021 (Fire Inspectors and Investigators), 33-1021 (First-Line Supervisors of Fire Fighting and Prevention Workers), and 53-3011 (Ambulance Drivers and Attendants, Except Emergency Medical Technicians). Volunteer firefighters reported by the U.S. Fire Administration.
[c] Full-time employees from state and local law enforcement agencies which include: local police departments, sheriffs' offices, primary state law enforcement agencies, special jurisdictional agencies, and other miscellaneous agencies, collected by the U.S. Bureau of Justice Statistics in 2008.
[d] BLS Occupation Code: 29-2041.
[e] All BLS data collected in 2015.

14.1.1.5. Telecommunications Resources

There is no central repository of information for public safety communications infrastructure and commercial telecommunications infrastructure in Tennessee; therefore, the following information and data are combined from a variety of sources, as referenced.

Communications throughout the state are based on a variety of publicly and commercially owned technologies. Figure 14.1.1-2 presents a typical wireless configuration including both a narrowband public safety land mobile radio network (traditional radio network) and a commercial broadband access network (wireless technology); backhaul (long-distance wired or wireless connections), core, and commercial networks including a long term evolution (LTE) evolved packet core (modern broadband cellular networks); and network applications (software) delivering voice, data, and video communications (FCC, 2016a).



Prepared by: Booz Allen Hamilton

Figure 14.1.1-2: Wireless Network Configuration

Public Safety Communications

In order to protect and best serve the public interest, first responder and law enforcement communities must be able to communicate effectively. The evolution of the communications networks used by public safety stakeholders toward a broadband wireless technology, such as LTE (see Section 2.1.1), has the potential to provide users with better coverage, while offering additional capacity and enabling the use of new applications that would likely make their work safer and more efficient. Designing such a network presents several challenges due to the uniqueness of the deployment, the requirements, and the nationwide scale (Rouil, Izquierdo, Gentile, Griffith, & Golmie, 2015) (NIST, 2015). Historically, there have been many challenges and impediments to timely and effective sharing of information. Chief among these factors impacting information sharing are: network coverage gaps, land mobile radio system infrastructure diversity, insufficient budgets, and diverse radio frequencies.

Communication interoperability has also been a persistent challenge, along with issues concerning spectrum availability, embedded infrastructure, and differing standards among stakeholders (NTFI, 2005). This has caused a fragmented approach to communications implementation across the U.S. and specifically in Tennessee. There are five key reasons why public safety agencies often cannot connect through existing communications (NTFI, 2005):

- Incompatible and aging communications equipment;
- Limited and fragmented funding;
- Limited and fragmented planning;
- A lack of coordination and cooperation; and
- Limited and fragmented radio spectrum.

To help enable the public safety community to incorporate disparate Land Mobile Radio networks with a nationwide public safety LTE broadband network, the U.S. Department of Commerce Public Safety Communications Research Program (PSCR), prepared a locations-based services (LBS) research and development roadmap to examine the current state of location-based technologies, forecast the evolution of LBS capabilities and gaps, and identify potential research and development opportunities that would improve the public safety community's use of LBS within operational settings. This is the first of several technology roadmaps that PSCR plans to develop over the next few years to better inform investment decisions (PSCR, 2015).

Like most states, Tennessee's public safety Land Mobile Radio (LMR) network environment is facing transition and reflects the challenges of the need for greater system capabilities. These increasing capabilities require investment in the new 700 MHz/800 MHz Tennessee Advanced Communications Network (TACN), 800 MHz site maintenance and upgrades, incremental LMR site resiliency and reliability improvements, the expansion of the of the TACN, and planning for the adoption of broadband and new data services (RadioReference.com, 2015a).

The statewide TACN, a digital Project 25 (P25) network, was created through the combination of the Tennessee Valley Regional Communications System (TVRCS) and of the Tennessee Department of Corrections (TDOC) Radio System.

Tennessee's General Services Department has project oversight for the TACN, and although the original anchor tenant and major user of TACN was the Tennessee Highway Patrol, the TACN has been opened up to other state agencies and now supports a wide range of state and public safety agencies (Tennessee State Highway Patrol Communications Division, 2015).

Statewide/Multi-County Public Safety Networks

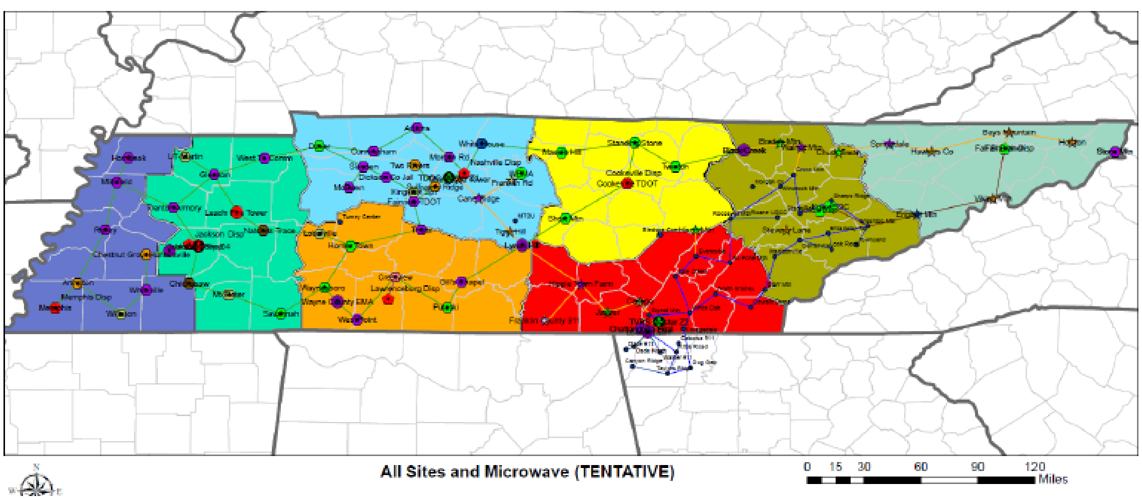
TACN provides statewide LMR coverage in Tennessee, in addition to three counties in Georgia. It is a digital P25 system operating at 700 MHz and 800 MHz, which provides public safety communications service for state, county, and local public safety agencies users; as well as for state agencies, including TDOC, the Wildlife Resources agency, and the Department of Health (RadioReference.com, 2015a).

TACN supports statewide talk group communications for the multiple Tennessee Highway Patrol (THP) troops, state correctional facility talk groups, and university and college talk groups.

In addition to the communications interoperability provided via TACN across the state, common/shared channels are available for Tennessee law enforcement on Very High Frequency (VHF)[3]. Public safety agencies employ VHF and Ultra High Frequency (UHF)[4] over multidisciplinary (cross-agency) frequencies in support of emergency communications, mutual aid needs, and incident response (RadioReference.com, 2015b).

The TACN system delivers 97 percent mobile service reliability over Tennessee and Northwest Georgia according to the THP. The system is a zoned one (i.e., divided into discrete geographic regions) with ownership for the zones and overall system design summarized by the THP as follows: "The Tennessee Advanced Communications Network is an Association of Public-Safety Communications Officials (APCO) P25 network and consists of three master server sites dividing the system into three zones. Zone 1 is owned by the TDOC and is located in Nashville controlling all correctional facilities and other radio sites throughout middle Tennessee. Zone 2 is owned by TVRCS and in located in Chattanooga and is controlling sites in northwest Georgia and East Tennessee. The third zone is owned by the Tennessee Highway Patrol and is located in Jackson and controls radio sites in West Tennessee. All three zones are connected by a microwave backbone so that all communications can have access to any site in the system provided they have sufficient permissions in the network controllers. Regional Network Operational Centers are located in Chattanooga, Nashville, and Jackson" (Tennessee State Highway Patrol Communications Division, 2015).

Figure 14.1.1-3 depicts the TACN site locations within the eight Tennessee coverage regions (color-coded on the map) (Ehlert, 2015).



Source: (Ehlert, 2015)

Figure 14.1.1-3: TACN Tower Location and Region Map

Figure 14.1.1-4 provides a picture of the summary Tennessee highway patrol coverage across the state for 700 MHz (coded blue) and the VHF coverage (coded green) (Ehlert, 2015).

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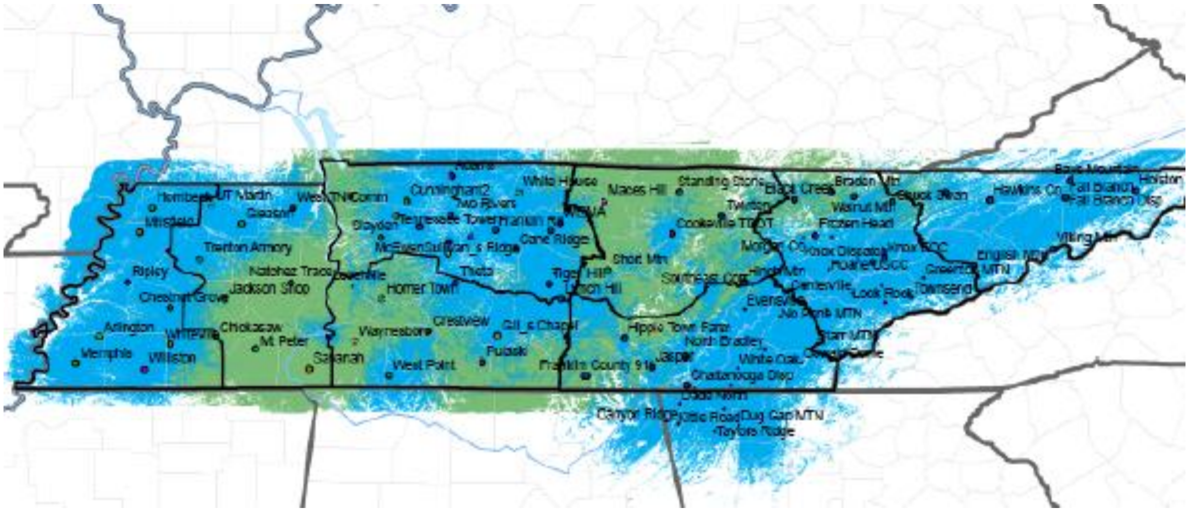
[3] VHF band covers frequencies ranging from 30 MHz to 300 MHz (NTIA, 2005).
[4] UHF band covers frequencies ranging from 300 MHz to 3000 MHz (NTIA, 2005).



Source: (Ehlert, 2015)

Figure 14.1.1-4: THP 700 MHz and VHF Coverage Map

County/City Public Safety Networks

In Tennessee, county and local public safety communications have been supported by a diverse set of systems and frequencies including VHF and UHF, with an increasing trend toward adoption of digital P25 systems. Table 14.1.1-7 below lists the P25 Networks serving Tennessee and provides the individual operational frequencies being used.

There are thirteen public safety digital P25 systems operational in Tennessee using a number of frequencies, with the majority of the systems operating on 800 MHz. Table 14.1.1-7 below lists these public safety systems which includes the Tennessee Valley Authority (TVA) (Project 25 Technology Interest Group, 2015a) (Project 25 Technology Interest Group, 2015b).

Table 14.1.1-7: Tennessee Public Safety P25 Networks

Tennessee Public Safety P25 Systems	Frequency Band
Bartlett Public Safety	800 MHz
Cumberland County Public Safety	800 MHz
Dyersburg Public Safety (P25) System	800 MHz
Franklin Public Safety	800 MHz
Johnson City & Washington County Public Safety (P25)	800 MHz
Memphis/Shelby County Public Safety	800 MHz
Metro Government Nashville & Davidson County	800 MHz
Nashville International Airport Authority	800 MHz
Pigeon Forge Public Safety	700 MHz
Tennessee Valley Authority	UHF Lo
Collierville Public Safety	800 MHz
Tennessee Advanced Communications Network (TACN)	700 MHz/800MHz

Source: (Project 25 Technology Interest Group, 2015a) (Project 25 Technology Interest Group, 2015b)

Public Safety Answering Points

According to the Federal Communications Commission's (FCC) Master Public Safety Answering Point (PSAP) registry there are 175 PSAPs in Tennessee serving Tennessee's 95 counties (FCC, 2015a).

Commercial Telecommunications Infrastructure

Tennessee's commercial telecommunications industry and infrastructure is robust with multiple service providers, offering products and services via the full spectrum of telecommunications technologies (FCC, 2014a) (FCC, 2014b). The following sub-sections present information on Tennessee's commercial telecommunications infrastructure, including information on the number of carriers and technologies deployed; geographic coverage; voice, Internet access, and wireless subscribers; and the quantity and location of telecommunications towers, fiber optic plant, and data centers.

Carriers, Coverage, and Subscribers

Tennessee's commercial telecommunications industry provides the full spectrum of telecommunications technologies and networks, including coaxial cable (traditional copper cable), fiber optics, hybrid fiber optics/coaxial cable, microwave, wireless, and satellite systems. Table 14.1.1-8 presents the number of providers of switched access[5] lines, Internet access,[6] and mobile wireless services including coverage.

[5] "A service connection between an end user and the local telephone company's switch; the basis of plain old telephone services (POTS)" (FCC, 2014a).
[6] Internet access includes Digital Subscriber Line (DSL), cable modem, fiber, satellite, and fixed wireless providers.

Table 14.1.1-8: Telecommunications Access Providers and Coverage in Tennessee as of December 31, 2013

Commercial Telecommunications Access Providers	Number of Service Providers	Coverage of Households
Switched access lines [a]	193	97% of households [b]
Internet access [c]	75	50% of households
Mobile Wireless [d]	9	100% of population

Sources: (FCC, 2014a) (FCC, 2014b) (NTIA, 2014) (FCC, 2013)

[a] Switched access lines are a service connection between an end user and the local telephone company's switch (the basis of older telephone services); this number of service providers was reported by the FCC as of December 31, 2013 in Table 17 in "Local Telephone Competition: Status as of December 31, 2013" as the total of ILEC and non-ILEC providers (FCC, 2014b).
[b] Household coverage data provided by the FCC in "Universal Service Monitoring Report" as a Voice Penetration percentage (percentage of household with a telephone in the unit) and is current as of 2013.
[c] Internet access providers are presented in Table 21 in "Internet Access Services: Status as of December 31, 2013" by technology provided; number of service providers is calculated by subtracting the reported Mobile Wireless number from the total reported number of providers. Household coverage is provided in Table 13 (FCC, 2014a).
[d] Mobile wireless provider data was retrieved from the FCC National Broadband Map website (www.broadbandmap.gov/data-download). The process of the data collection is explained in the broadband footnote.

Table 14.1.1-9 shows the wireless providers in Tennessee along with their geographic coverage. The following four maps: Figure 14.1.1-5, Figure 14.1.1-6, Figure 14.1.1-7, and Figure 14.1.1-8 show the combined coverage for the top two providers, Sprint and U.S. Cellular's coverage, T-Mobile, Cricket Wireless, and Wisper Limited Liability Company's (LLC) coverage, and the coverage of all other providers with less than 5 percent coverage area, respectively.

Table 14.1.1-9: Wireless Telecommunications Coverage by Providers

Wireless Telecommunications Providers	Coverage
AT&T Mobility LLC	92.68%
Verizon Wireless	92.02%
Sprint	57.58%
U.S. Cellular	16.96%
T-Mobile	15.85%
Cricket Wireless	12.74%
Wisper, LLC	9.85%
Other [a]	23.99%

Source: (NTIA, 2014)

[a] Other: Provider with less than 5% coverage area. Providers include: C Spire Wireless; Monster Broadband, Inc.; Ken-Tenn Wireless, LLC; Crossroads Wifi; Crossroads Tech; TNets Internet; Hotshot Wireless; Electronic Communication Systems; Planet Connect; Tennessee Wireless, LLC; Beasley Wireless; JTM Broadband, LLC; Lakeway Publishers Inc.; LogOn Computer Services Inc.; BreezeAir.net; Info-Ed, Inc.; CRU Enterprises; High Country Online, LLC; QuickRelay Networks; NetEase TNWEB, LLC; Tele-Page, Inc.; OnWav; Softek, Inc.

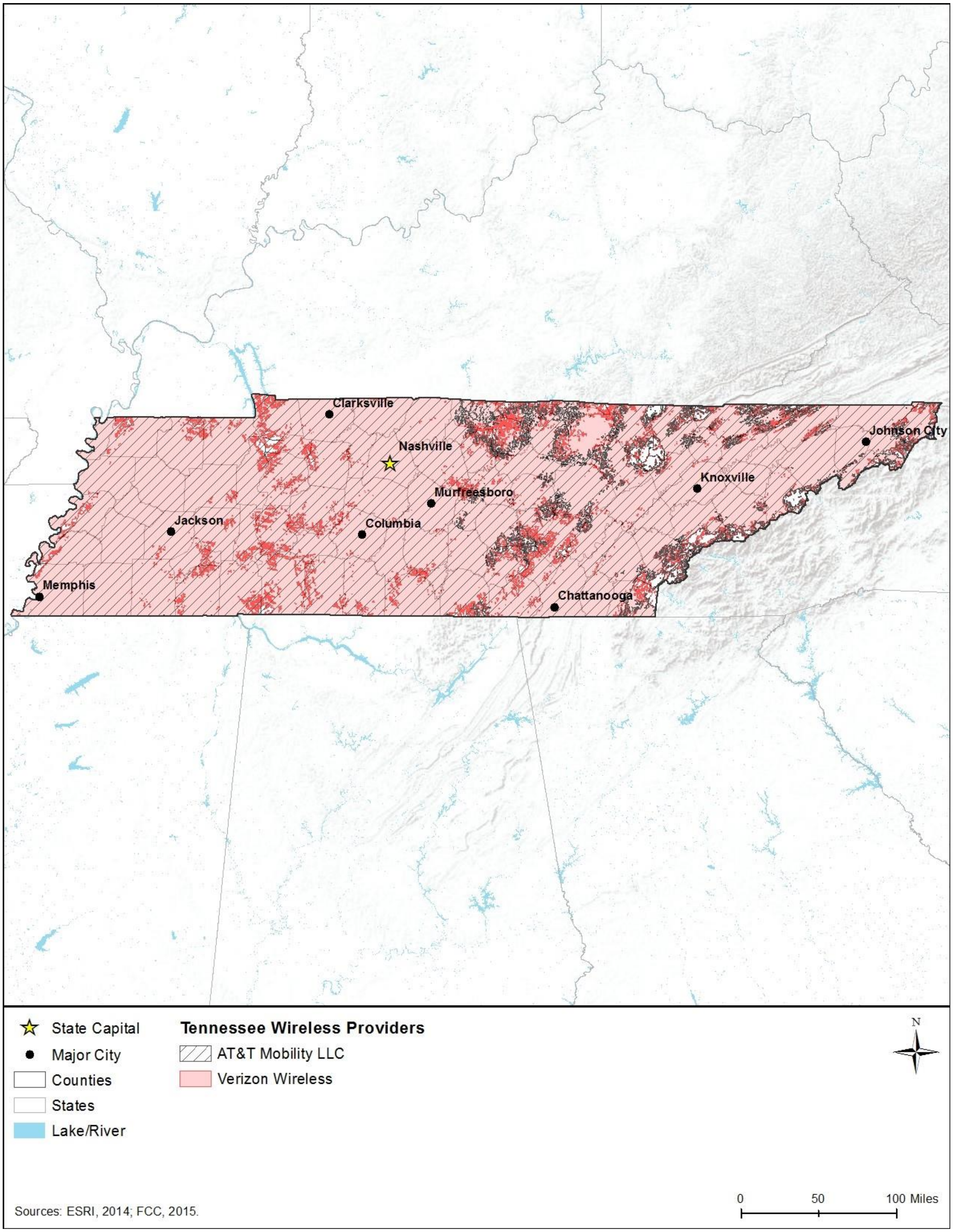


Figure 14.1.1-5: Top Wireless Providers Availability in Tennessee

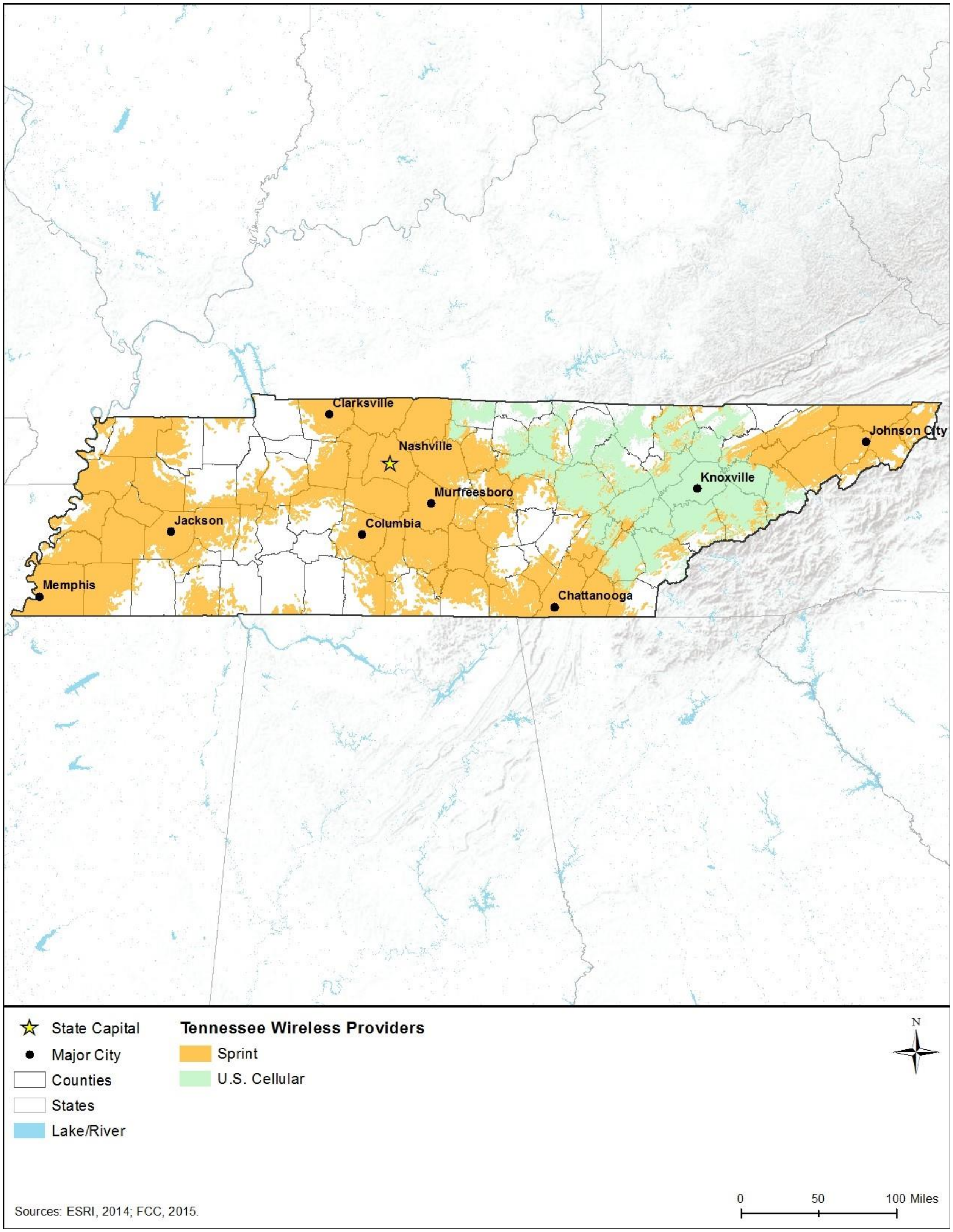


Figure 14.1.1-6: Sprint and U.S. Cellular Wireless Availability in Tennessee

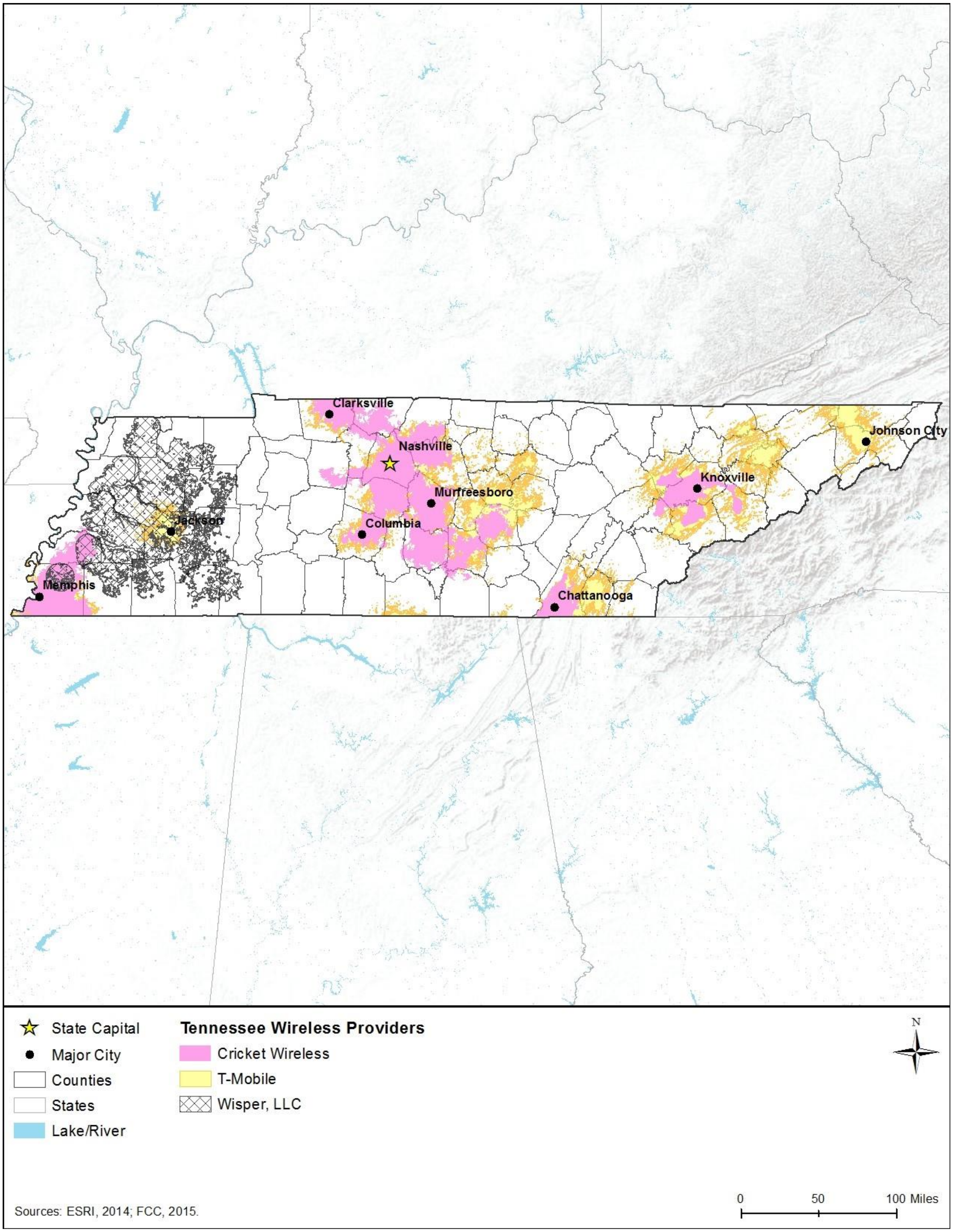


Figure 14.1.1-7: T-Mobile, Cricket Wireless, and Wisper LLC Wireless Availability in Tennessee

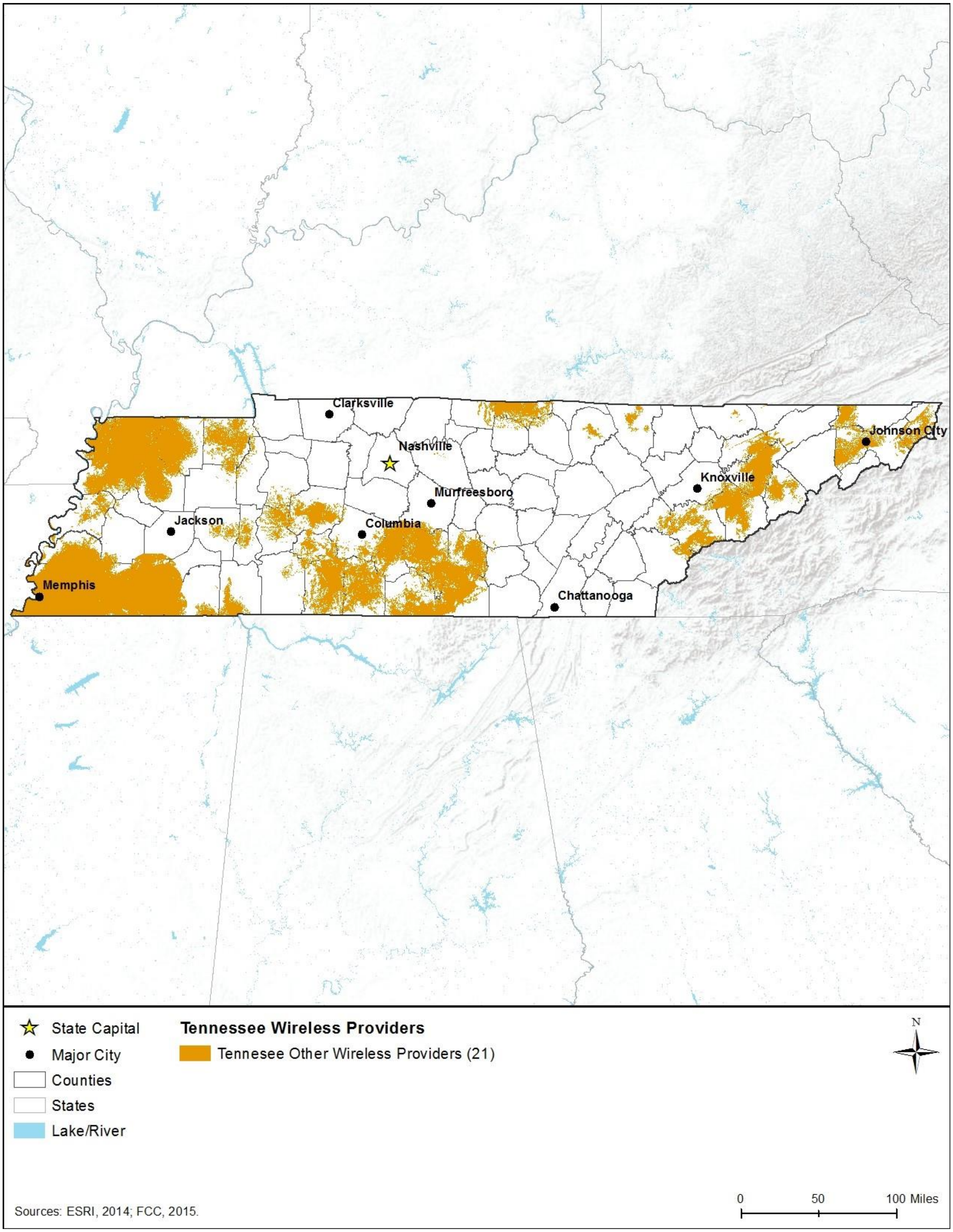


Figure 14.1.1-8: Other Providers Wireless Availability in Tennessee

Towers

There are many types of domestic towers employed today by the telecommunications industry, government agencies, and other owners. Towers are designed and used for a variety of purposes, and the height, location, and supporting structures and equipment are all designed, constructed, and operated according to the technical specifications of the spectrum used, the type of equipment mounted on the tower, geographic terrain, need for line-of-sight transmissions to other towers, radio frequency needs, and other technical specifications. There are three general categories of stand-alone towers: monopole, lattice, and guyed. Typically, monopole towers are the smallest, followed by lattice towers at a moderate height, and guyed towers at taller heights (with the guyed wires providing tension support for the taller heights) (CSC, 2007). In general, taller towers can provide communications coverage over larger geographic areas, but require more land for the actual tower site, whereas shorter towers provide less geographic coverage and require less land for the tower site (USFS, 2009a). Figure 14.1.1-9 presents representative examples of each of these categories or types of towers.

Monopole
100 – 200 feet
Source: http://laps.noaa.gov/birk/laps_intranet/site_photos/Monarch/tower.jpg

Lattice
200 – 400 feet
Source: Personal Picture

Guyed
200 – 2,000 feet
Source: http://www.esrl.noaa.gov/gmd/ccgg/insitu/

Figure 14.1.1-9: Types of Towers

Telecommunications tower infrastructure proliferates throughout Tennessee, although tower infrastructure is concentrated in the higher and more densely populated areas of Tennessee: Clarksville, Johnson City, Knoxville, Nashville, Murfreesboro, Columbia, Chattanooga, Jackson, and Memphis. Owners of towers and some types of antennas are required to register those infrastructure assets with the FCC (FCC, 2016b).[7] Table 14.1.1-10 presents the number of towers (including broadcast towers) registered with the FCC in Tennessee, by tower type, and Figure 14.1.1-10 presents the location of those 2,727 structures, as of June 2015.

[7] An antenna structure must be registered with the FCC if the antenna structure is taller than 200 feet above ground level or may interfere with the flight path of a nearby airport (FCC, 2016b).

Table 14.1.1-10: Number of Commercial Towers in Tennessee by Type

Constructed[a] Towers[b]		**Constructed Monopole Towers**	
100ft. and over	329	100ft. and over	0
75ft. – 100ft.	1,003	75ft. – 100ft.	1
50ft. – 75ft.	592	50ft .– 75ft.	54
25ft. – 50ft.	284	25ft. – 50ft.	57
25ft.and below	60	25ft.and below	26
Subtotal	**2,268**	**Subtotal**	**138**
Constructed Guyed Towers		**Buildings with Constructed Towers**	
100ft.and over	30	100ft. and over	0
75ft .– 100ft.	38	75ft. – 100ft.	0
50ft. – 75ft.	11	50ft. – 75ft.	8
25ft. – 50ft.	5	25ft. – 50ft.	2
25ft. and below	0	25ft. and below	1
Subtotal	**84**	**Subtotal**	**11**
Constructed Lattice Towers		**Multiple Constructed Structures[c]**	
100ft. and over	21	100ft. and over	1
75ft. – 100ft.	128	75ft .– 100ft.	1
50ft. – 75ft.	47	50ft .– 75ft.	0
25ft. – 50ft.	18	25ft. – 50ft.	0
25ft. and below	1	25ft. and below	0
Subtotal	**215**	**Subtotal**	**2**
Constructed Tanks[d]			
Tanks	9		
Subtotal	**9**		
Total All Tower Structures		**2,727**	

Source: (FCC, 2015b)

[a] Planned construction or modification has been completed. Results will return only those antenna structures that the FCC has been notified are physically built or planned modifications/alterations to a structure have been completed (FCC, 2015b).
[b] Self standing or guyed (anchored) structure used for communication purposes (FCC, 2012).
[c] Multiple constructed structures per antenna registration (FCC, 2016c).
[d] Any type of tank – water, gas, etc. with a constructed antenna (FCC, 2016c).

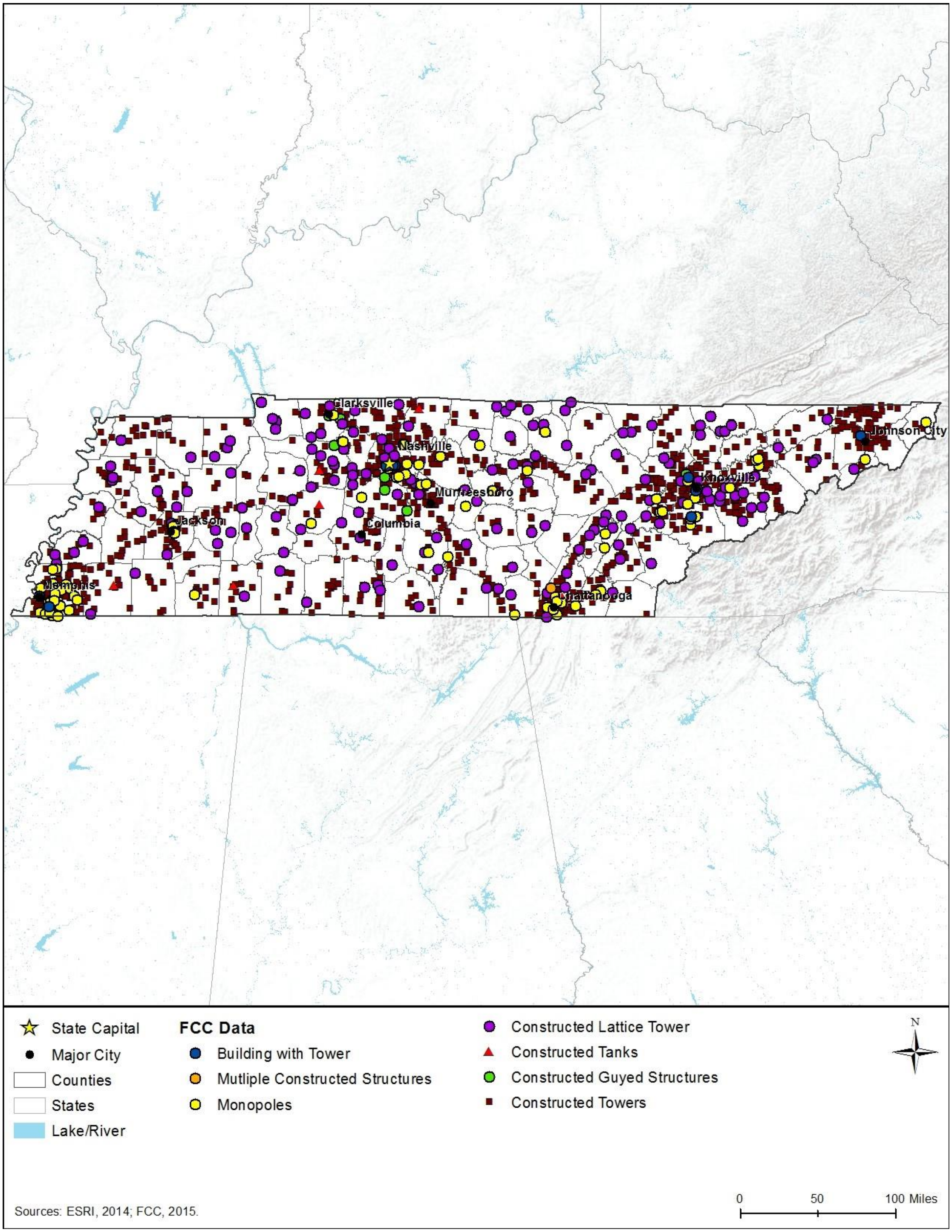
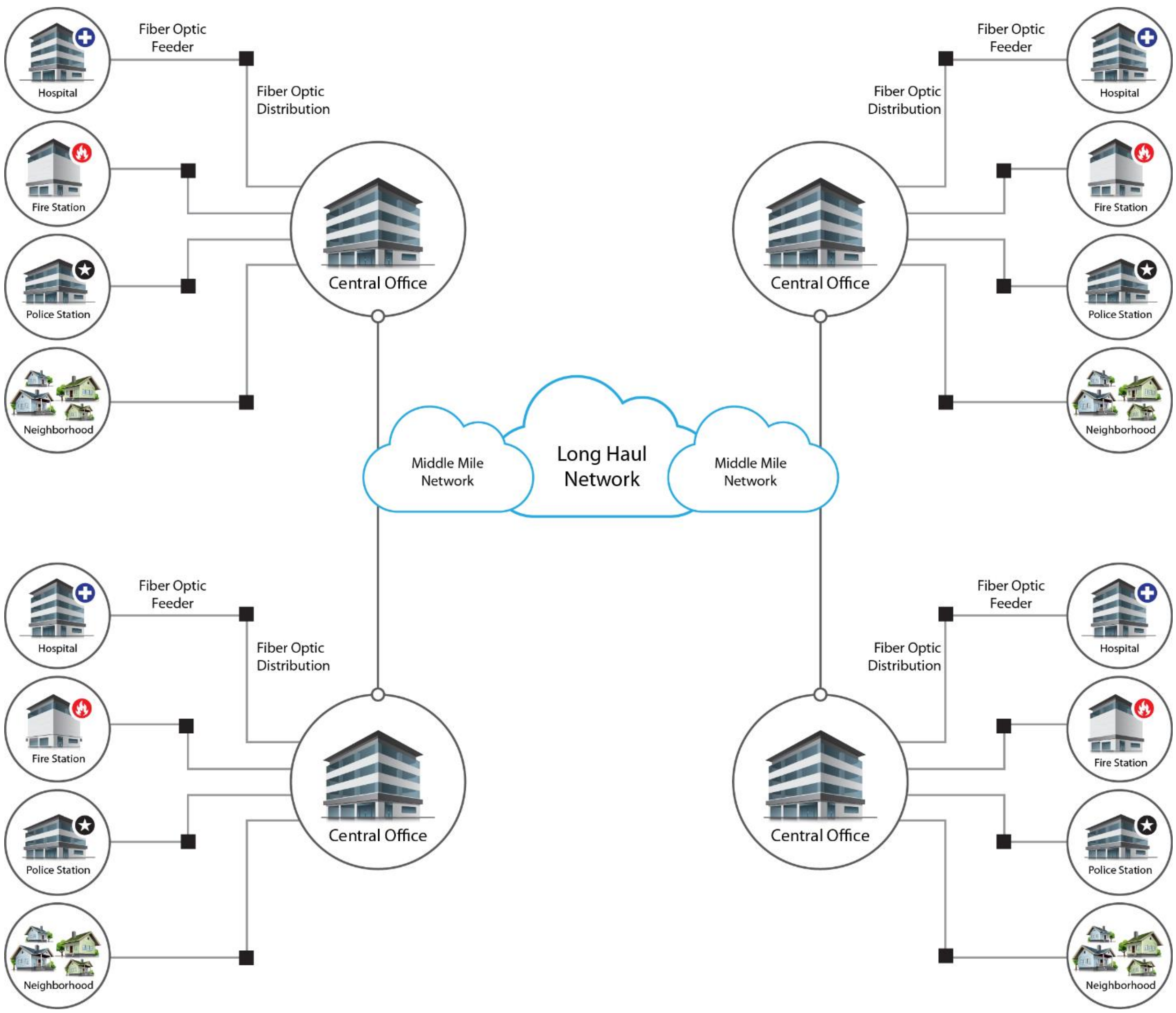


Figure 14.1.1-10: FCC Tower Structure Locations in Tennessee

Fiber Optic Plant (Cables)

Fiber optic plant, or cables, can be buried directly in the ground; pulled, blown, or floated into ducts, conduits, or innerduct (flexible plastic protective sleeves or tubes); placed under water; or installed aerially between poles, typically on utility rights-of-way (ROWs). A fiber optic network includes an access network consisting of a central office, distribution and feeder plant (cables of various sizes directly leaving a central office and splitting to connect users to the network), and a user location, as shown in Figure 14.1.1-11. The network also may include a middle mile component (shorter distance cables linking the core network between central offices or network nodes across a region) and a long haul network component (longer distance cables linking central offices across regions) (FCC, 2000).



Prepared by: Booz Allen Hamilton

Source: (ITU-T, 2012)

Figure 14.1.1-11: Typical Fiber Optic Network in Tennessee

Last Mile Fiber Assets

In Tennessee, fiber access networks are concentrated in the highest population centers as shown in the figures below. In Tennessee, 49 fiber providers offer service in the state, as listed in Table 14.1.1-11.

Figure 14.1.1-12 shows coverage for AT&T Tennessee, Figure 14.1.1-13 shows coverage for Charter Communications Inc. and Comcast, and Figure 14.1.1-14 shows coverage for other providers with less than 5 percent coverage area, respectively.[8]

Table 14.1.1-11: Fiber Provider Coverage

Fiber Provider	Coverage
AT&T Tennessee	23.48%
Charter Communications Inc.	14.96%
Comcast	13.43%
Other[a]	35.51%

Source: (NTIA, 2014)

[a] Other: Provider with less than 5% coverage area. Providers include: MegaPath Corporation; CenturyLink; TDS Telecom; Frontier Communications; Ben Lomand; Volunteer First Services, LLC; Twin Lakes Telephone Cooperative Corporation; Level 3 Communications, LLC; Highland Telephone Cooperative, Inc.; DTC Communications; TEC; EPB; North Central Telephone Cooperative; United Communications; Bledsoe Telephone Cooperative; WK&T; Spirit Broadband; Loretto Communication Services, Inc.; BigRiver.net; TW Telecom of Tennessee LLC; Time Warner Cable; Bristol Tennessee Essential Services; Mediacom; Ardmore Telephone Company Inc.; XIPLINE Broadband Internet; Cable ONE; Jackson Energy Authority; Celina Cable; Vyve Broadband; CDE Lightband; InfoStructure Cable; WOW!; Fayetteville Public Utilities; Aurora Cable TV; Benton County Cable; ETC; Morristown Utility FiberNET; Spring City Cable; Trenton TV Cable Company; Pulaski Electric System; Zito Media; CPWS; CPWS Broadband; Tullahoma Utilities Board; Skybest; Access Cable Television, Inc.; Pickwick Cablevision, Inc.; Trinity Communications LLC; Cogent Communications, Inc.

[8] The broadband map utilized data collected as part of the broadband American Recovery and Reinvestment Act initiative. The data was retrieved from the FCC National Broadband Map website (www.broadbandmap.gov/data-download). Each state's broadband data was downloaded accordingly. The data pertaining to broadband data/coverage for census blocks, streets, addresses, and wireless were used. Census blocks, roads, and addresses were merged into one file and dissolved by similar business and provider names. Square miles were calculated for each provider. The maps show all providers over 5% on separate maps; providers with areas under 5% were merged and mapped as "Tennessee Other Fiber Providers". All Wireless providers were mapped as well; those with areas under 5% were merged and mapped as "Tennessee Other Wireless Providers". Providers under 5% were denoted in their respective tables.

Data Centers

Data centers (also known as network access points, collocation facilities, hosting centers, carrier hotels, and Internet exchanges) are large telecommunications facilities that house routers, switches, servers, storage, and other telecommunications equipment. These data centers facilitate efficient network connectivity among and between telecommunications carriers and between carriers and their largest customers. These facilities also provide racks and cages for equipment, power and cooling, cabling, physical security, and 24x7 monitoring (CIO Council, 2015; GAO, 2013). Ownership of data centers may be public or private; comprehensive information regarding data centers may not be publicly available as some are related to secure facilities.

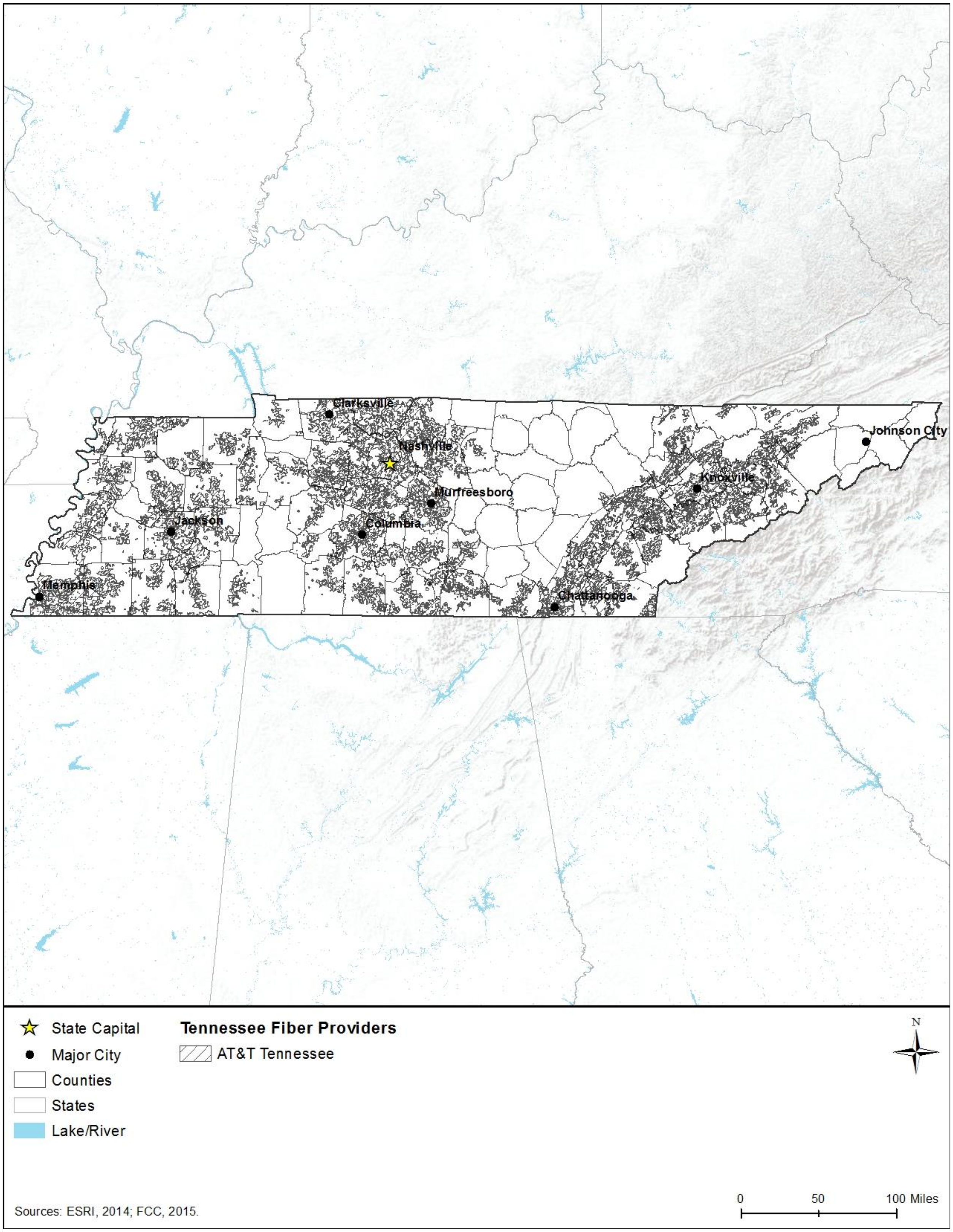


Figure 14.1.1-12: Fiber Availability in Tennessee for AT&T Tennessee

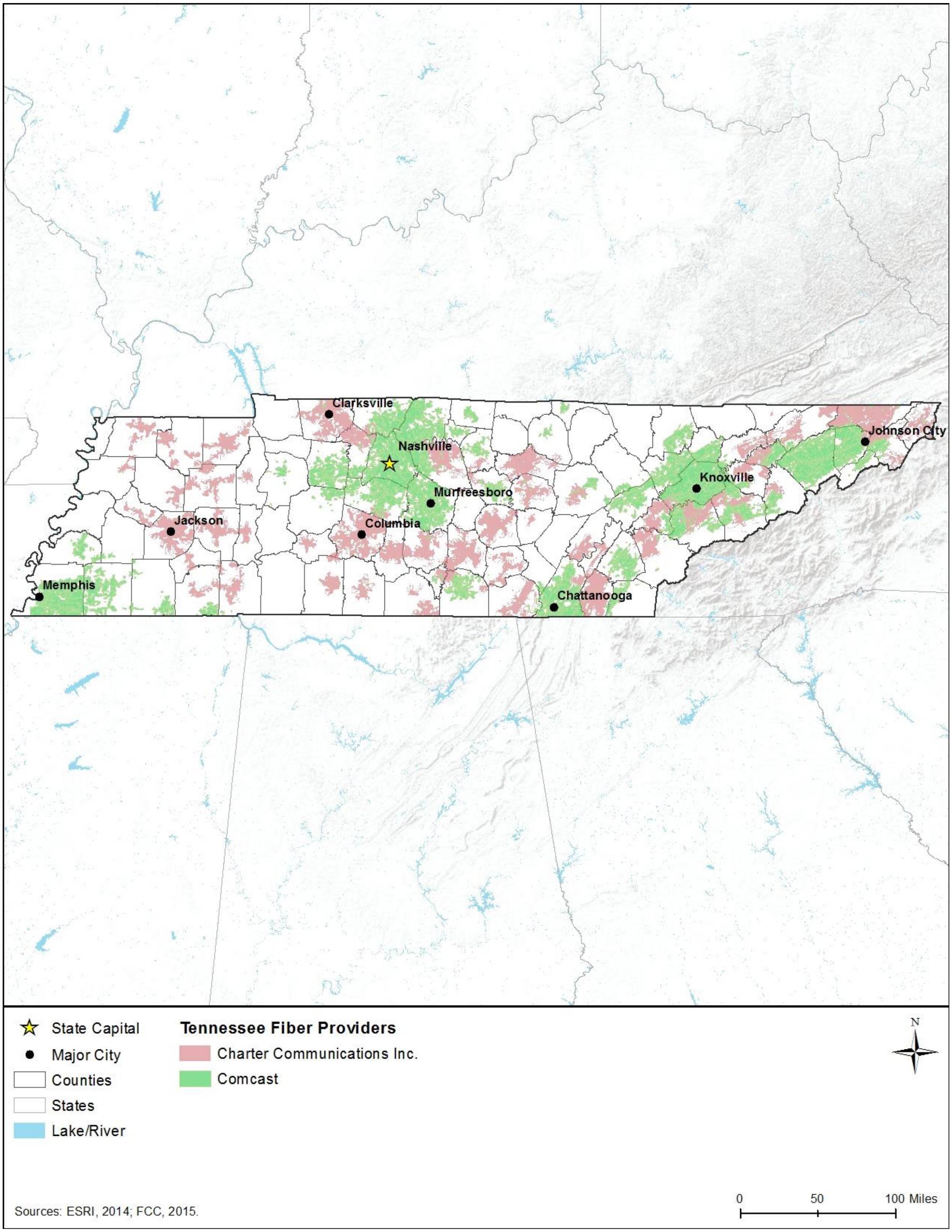


Figure 14.1.1-13: Charter Communications Inc. and Comcast's Fiber Availability in Tennessee

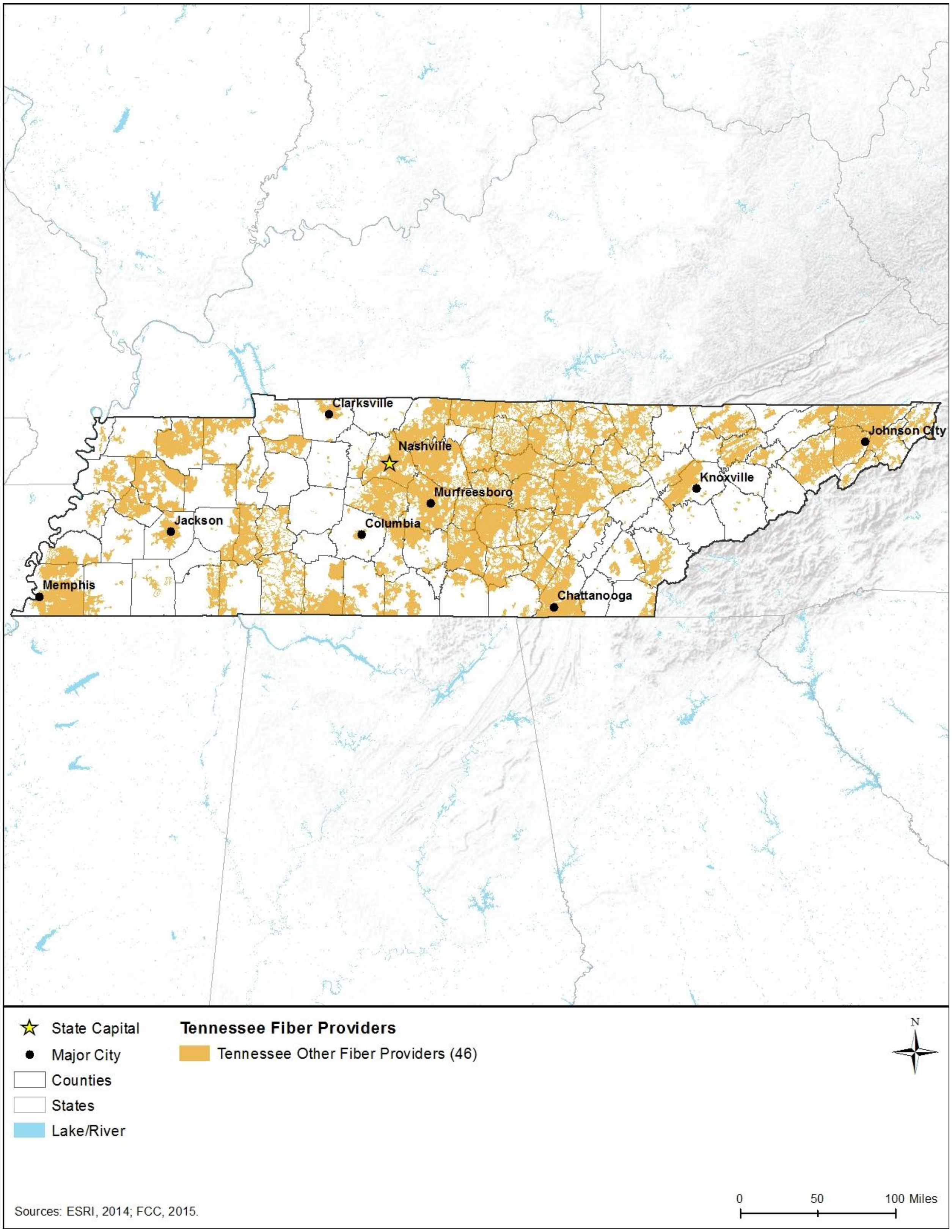


Figure 14.1.1-14: Other Provider's Fiber Availability in Tennessee

14.1.1.6. Utilities

Utilities are the essential systems that support daily operations in a community and cover a broad array of public services, such as electricity, water, wastewater, and solid waste. Section 14.1.4, Water Resources, describes the potable water sources in the state.

Electricity

Electric utilities in Tennessee have some parts of their operations regulated by the Tennessee Regulatory Authority (TRA). The Utilities Division of the TRA investigates the rates of utilities, as well as the terms and conditions of services provided to customers (TRA, 2015a). Through its Consumer Service Division, the TRA also investigates consumer complaints against electric utilities under its jurisdiction (TRA, 2015b). As the TRA only regulates privately owned companies, there are five electric utilities that report to them: Appalachian Power Company, Entergy Arkansas Inc., Kentucky Utilities Company, Kingsport Power Company and Plains, and Eastern Clean Line LLC (TRA, 2015c) (TRA, 2015d). Nearly all of the state's electricity comes from one of four sources: coal, nuclear power, hydroelectric facilities, or natural gas (EIA 2015a). In 2016, coal contributed 31,168 thousand megawatthours[9] of electricity, or 38.9 percent of the total 80,035 thousand megawatthours generated in the state that year (EIA, 2017a). Nuclear power facilities contributed 29,578 thousand megawatthours (37.0 percent), while natural gas and hydroelectric facilities created 11,296 thousand megawatthours (14.1 percent), and 7,418 thousand megawatthours (9.3 percent), respectively (EIA, 2017a). Petroleum liquids provided a negligible amount of electricity, as did renewables such as wind power, solar power, and biomass (EIA 2015a). in 2015, "Tennessee's net electricity generation from hydroelectric power was the third-highest among states east of the Mississippi River, and sixth-highest in the nation as a whole. In 2014, the transportation and industrial sectors within Tenessee used the larger portions of the state's electricity. The transportation sector uses 27.8 percent, while the industrial sector used 26.9 percent. The residential and commercial sectors used 25.6 percent and 19.8 percent, respectively (EIA, 2015b).

Water

The TRA oversees service rates, terms, and conditions of privately owned water utilities (TRA, 2015a). There are six such privately owned utilities in the state: Aqua Utilities Company, Inc., Condo Villas of Gatlinburg Association, Inc., Newport Resort Water System, Shiloh Falls Utilities, Inc., Tennessee Water Service, Inc., and the Tennessee-American Water Company (TRA, 2015d). The Tennessee Department of Environment and Conservation's (TDEC) Division of Water Resources supervises construction and operation of water facilities, enforces the requirements of the Safe Drinking Water Act, certifies testing laboratories, and giving technical assistance to public water systems when needed (TDEC, 2015a). Public water systems are defined as those that provide "water for human consumption and has 15 or more service connections or when your water system provides water regularly for 25 or more persons at least 60 days out of the year" (TDEC, 2003). These are further broken into three groups: community

[9] One megawatthour is defined as "one thousand kilowatthours or 1 million watthours." One watthour is "the electrical energy unit of measure equal to one watt of power supplied to, or taken from, an electric circuit steadily for one hour." (EIA, 2016).

systems, transient non-community systems, and non-transient non-community systems. Community systems serve year-round residents, while transient non-community systems serve occasional users-25 or more people at least 60 days a year. Non-transient non-community systems regularly serve “at least 25 of the same people over 6 months of the year,” examples include factories or schools (TDEC, 2003). Utilities that provide water are also required to provide a Consumer Confidence Report to their customers. A Consumer Confidence Report outlines information about the drinking water provided, such as the source of the water and a list of any contaminants found during laboratory testing (TDEC, 2014a).

Wastewater

The management of Tennessee’s wastewater is handled by the TDEC. Among their other regulatory responsibilities, they issues National Pollutant Discharge Elimination System (NPDES) permits to wastewater facilities to authorize their ability to discharge pollutants into state surface waters. “Industries sending wastewater to public sewers, called publicly owned treatment works (POTW), are considered indirect dischargers, and they do not need an NPDES discharge permit,” these facilities must be permitted through their POTW (TNDEC, 2016). In order to receive a permit, the TDEC needs general information on the facility, as well as information on the discharges to be authorized. General permits, have similar requirements such as amounts and types of pollutants to be discharged, cover most facilities. Individual permits are also available for specific dischargers or situations where a general permit may not be appropriate (TDEC, 2015b).

The TDEC also certifies wastewater facility operators, to ensure they are properly educated and trained, a means of protecting public health by controlling the management of wastewater facilities (TDEC, 2015c). Both wastewater treatment plants and operator certifications are graded based on the size of the population served, the type of facility, and the level of complexity required to treat the wastewater (TDEC, 2014b). Different certification grades require different levels of experience and education, both to obtain a certification and to keep one. This helps to ensure that facility operators stay up-to-date on changing information and standards in the field (TDEC, 2015d).

Solid Waste Management

The management of Tennessee’s solid waste also falls to the TDEC. In order to ensure “safe and sanitary processing and disposal of solid waste,” the TDEC “regulates material recovery facilities, transfer stations, and landfills for sanitary or municipal solid waste, industrial waste, farming wastes, and construction and demolition waste” (TDEC, 2015e). As a means of regulation, the TDEC also offers three types of solid waste facility permits for facilities to operate; landfill permits, permit-by-rule, and special waste disposal permits (TDEC, 2015f). While landfill permits and special waste (medical or hazardous waste) are self-explanatory, permit-by-rule authorizations are used for facilities that change “the chemical or physical characteristics of a solid waste,” as well as coal fill areas and tire storage facilities (TDEC, 2015g). Tennessee is home to 48 landfills dedicated to municipal waste, though only 34 are actively operating. The remaining 14 landfills are either closed or have yet to open. The 2015

Solid Waste and Materials Management Plan indicated that these 34 landfills accept an annual average of 6,784,415 tons of material (TDEC, 2015h). Most will be open until at least 2034, though eight are scheduled to close between 2016 and 2021. In addition to these, Tennessee boasts 84 transfer stations, though there is only one permitted compost facility in the state. There are 55 publicly owned material recovery facilities in the state, as well as 21 that are privately owned. While they are not required to report their tonnage data, there is some general information available. In 2012, 3,609,241 tons of municipal waste was reported as recycled (TDEC, 2015h). This amount was a combination of commercially and privately created waste products, but the information was insufficient to tell what was generated by commercial sources and what came from residences. The 2015 Solid Waste and Materials Management Plan outline goals that the state wishes to accomplish by 2025, including increasing access to and participation in recycling efforts, as well as supporting new technology to help reduce waste (TDEC, 2015h).

14.1.2. Soils

14.1.2.1. Introduction

The Soil Science Society of America defines soil as:

(i) "The unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants." (NRCS, 2015a)

(ii) "The unconsolidated mineral or organic matter on the surface of the Earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro- and microorganisms, conditioned by relief, acting on parent material over a period of time. A product-soil differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics." (NRCS, 2015a)

Five primary factors account for soil development patterns. A combination of the following variables contributes to the soil type in a particular area (University of Minnesota, 2001):

- *Parent Material*: The original geologic source material from the soil formed affects soil aspects, including color, texture, and ability to hold water.
- *Climate*: Chemical changes in parent material occur slowly in low temperatures. However, hot temperatures evaporate moisture, which also facilitates chemical reactions within soils. The highest degree of reaction within soils occurs in temperate, moist climates.
- *Topography*: Steeper slopes produce increased runoff, and, therefore, downslope movement of soils. Slope orientation also dictates the microclimate to which soils are exposed, because different slope faces receive more sunlight than others.
- *Biology*: The presence/absence of vegetation in soils affects the quantity of organic content of the soil.
- *Time*: Soil properties are dependent on the period over which other processes act on them.

14.1.2.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of NEPA and other applicable laws and regulations. Applicable federal laws and regulations that apply for Soils, such as the Farmland Protection Policy Act of 1981, are in Appendix C, Environmental Laws and Regulations. A list of applicable state laws and regulations is included in Table 14.1.2-1 below.

Table 14.1.2-1: Relevant Tennessee Soil Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Tennessee Water Control Act of 1977 (Tennessee Code Annotated [T.C.A.] 69-3-101)	TDEC	Sediment and erosion controls are required as part of the NPDES Permit for construction activities that disturb one acre or more.

Source: (Justia, 2016c)

14.1.2.3. Environmental Setting

Tennessee is composed of three Land Resource Regions,[10] as defined by the National Resources Conservation Service (NRCS) (NRCS, 2006):

- East and Central Farming and Forest Region;
- Mississippi Delta Cotton and Feed Grains Region; and
- South Atlantic and Gulf Slope Cash Crops, Forest, and Livestock Region.

Within and among Tennessee's three Land Resource Regions are 9 Major Land Resource Areas (MLRA),[11] which are characterized by patterns of soils, climate, water resources, land uses, and type of farming (NRCS, 2006). The locations and characteristics of Tennessee's MLRAs are presented in Figure 14.1.2-1 and Table 14.1.2-2.

Soil characteristics are an important consideration for FirstNet insomuch as soil properties could influence the suitability of sites for network deployment. Soil characteristics can differ over relatively short distances, reflecting differences in parent material, elevation, and position on the landscape, biota such as bacteria, fungi, biological crusts, vegetation, animals, and climatic variables such as precipitation and temperature. For example, expansive soils with wet and dry seasons alternately swell and shrink, which presents integrity risks to structural foundations (Rogers, Olshansky, & Rogers, 2004). Soils can also be affected by a variety of surface uses that loosen topsoil and damage or remove vegetation or other groundcover, which may result in accelerated erosion, compaction, and rutting (discussed further in the subsections below).

[10] Land Resource Region: "A geographical area made up of an aggregation of Major Land Resource Areas (MLRA) with similar characteristics" (NRCS, 2006).
[11] Major Land Resource Area: "A geographic area, usually several thousand acres in extent, that is characterized by a particular pattern of soils, climate, water resources, land uses, and type of farming" (NRCS, 2006).

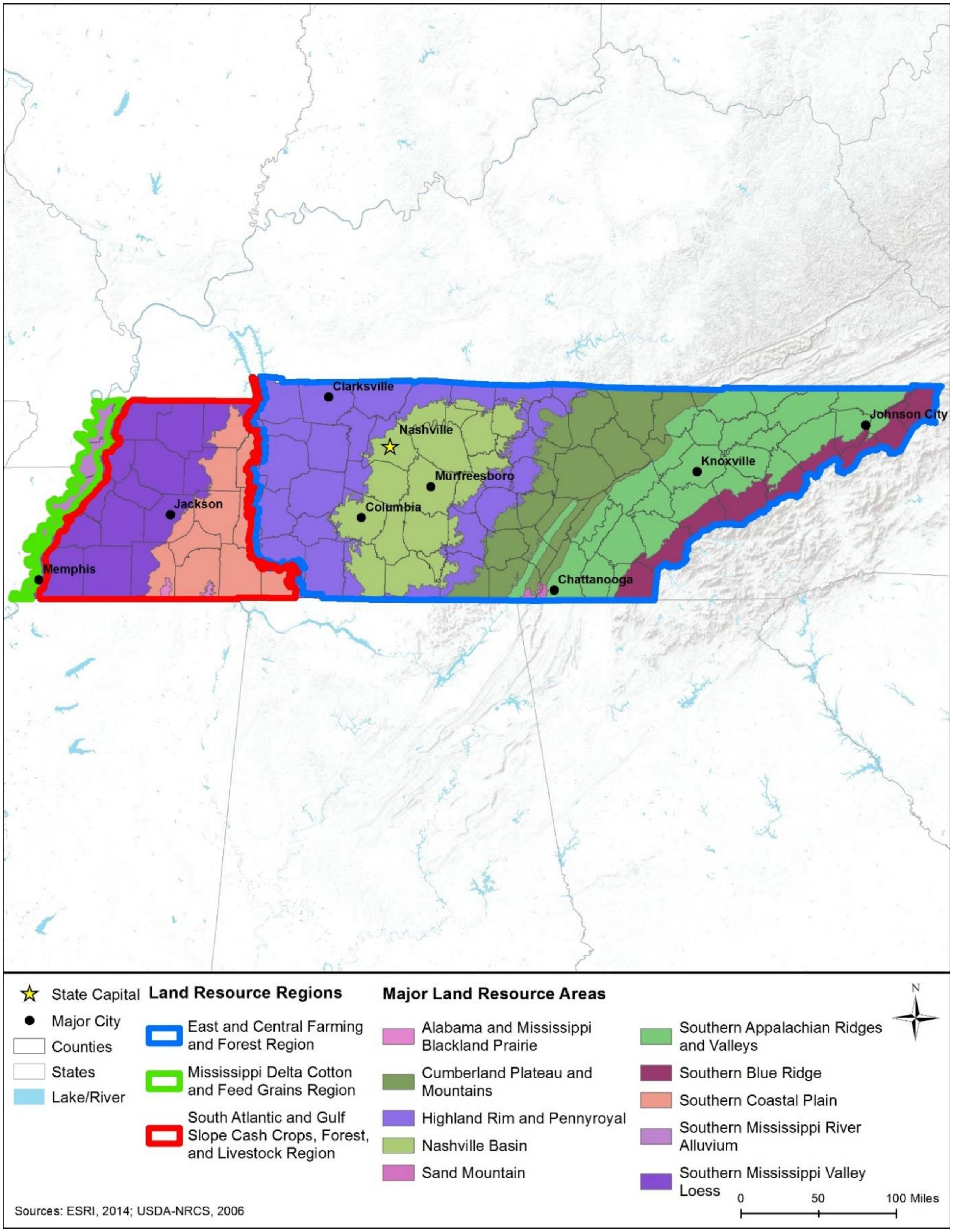


Figure 14.1.2-1: Locations of Major Land Resource Areas in Tennessee

Table 14.1.2-2: Characteristics of Major Land Resource Areas in Tennessee

MLRA Name	Region of State	Soil Characteristics
Cumberland Plateau and Mountains	Eastern Tennessee	Most of the soils are Hapludults These soils range from shallow to very deep, and from moderately well drained to somewhat excessively drained. They are clayey or loamy[a].
Highland Rim and Pennyroyal	Central Tennessee	Alfisols[b], Inceptisols[c], and Ultisols [d] are the dominant soil orders. These clayey or loamy soils are typically moderately well drained or well drained, and are moderately deep to very deep.
Nashville Basin	Central Tennessee	These soils are typically Udalfs. They are clayey, well drained, and range from moderately deep to very deep.
Sand Mountain	Southeastern Tennessee	Inceptisols and Ultisols are the dominant soil orders. These well drained and loamy soils range from shallow to very deep.
Southern Appalachian Ridges and Valleys	Eastern Tennessee	These soils are typically Udults and Udepts (less so). They are generally well drained, range from shallow to very deep, and are shaly or stony.
Southern Blue Ridge	Eastern Tennessee	Inceptisols and Ultisols are the dominant soil orders. These clayey or loamy soils range from shallow to very deep.
Southern Coastal Plain	Western Tennessee	Entisols[f], Inceptisols, and Ultisols are the dominant soil orders. These loamy soils range from poorly drained to somewhat excessively drained, and are typically very deep.
Southern Mississippi River Alluvium	Western Tennessee	Alfisols, Entisols, Inceptisols, and Vertisols[f] are the dominant soil orders. These generally clayey or loamy soils range from poorly drained to somewhat poorly drained, and are very deep.
Southern Mississippi Valley Loess	Western Tennessee	Alfisols, Entisols, Inceptisols, and Ultisols are the dominant soil orders. These deep or very deep soils range from well drained to poorly drained and are loamy or silty.

Source: (NRCS, 2006)

[a] Loamy Soil: "[A soil] that combines [sand, silt, and clay] in relatively equal amounts." (Purdue University Consumer Horticulture, 2006)

[b] Alfisols: "Soils found in semiarid to moist areas that are formed from weathering processes that leach clay minerals and other constituents out of the surface layer and into the subsoil. They are productive for most crop, are primarily formed under forest or mixed vegetative cover, and make up nearly 10% of the world's ice-free land surface." (NRCS, 2015b)

[c] Inceptisols: "Soils found in semiarid to humid environments that exhibit only moderate degrees of soil weathering and development. They have a wide range of characteristics, can occur in a wide variety of climates, and make up nearly 17% of the world's ice-free land surface." (NRCS, 2015b)

[d] Ultisols: "Soils found in humid environments that are formed from fairly intense weathering and leaching processes. This results in a clay-enriched subsoil dominated by minerals. They have nutrients concentrated in the upper few inches and make up 8% of the world's ice-free land surface." (NRCS, 2015b)

[e] Entisols: "Soils that show little to no pedogenic horizon development. They occur in areas of recently deposited parent materials or in dunes, steep slopes, or flood plains where erosion or deposition rates are faster than rate of soil development. They make up nearly 16% of the world's ice-free land surface." (NRCS, 2015b)

[f] Vertisols: "Vertisols have a high content of expanding clay minerals. They undergo pronounced changes in volume with changes in moisture, and have cracks that open and close periodically, and that show evidence of soil movement. Vertisols transmit water very slowly, have undergone little leaching, and tend to be high in natural fertility. They make up about 2% of the world's ice-free land surface." (NRCS, 2015b)

14.1.2.4. Soil Suborders

Soil suborders are part of the soil taxonomy (a system of classification used to make and interpret soil surveys). Soil orders are the highest level in the taxonomy; there are twelve soil orders in the world and they are characterized by both observed and inferred properties, such as texture, color, temperature, and moisture regime. Soil suborders are the next level down, and are differentiated within an order by soil moisture and temperature regimes, as well as dominant physical and chemical properties (NRCS, 2015c). FirstNet used the STATSGO2 database to obtain soils information at the programmatic level to ensure consistency across all the states and territories. This regional information provides a sufficient level of detail for a programmatic analysis. The best available soils data and information, including the use of the more detailed SSURGO database, will be used, as appropriate, during subsequent site-specific assessments. The State Soil Geographic (STATSGO2)[12] soil database identifies 13 different soil suborders in Tennessee (NRCS, 2015d). Figure 14.1.2-2 depicts the distribution of the soil suborders, and Table 14.1.2-3 provides a summary of the major physical-chemical characteristics of the various soil suborders found.

[12] STATSGO2 is the Digital General Soil Map of the United States that shows general soil association units across the landscape of the nation. Developed by the National Cooperative Soil Survey, STATSGO2 supersedes the State Soil Geographic (STATSGO) dataset.

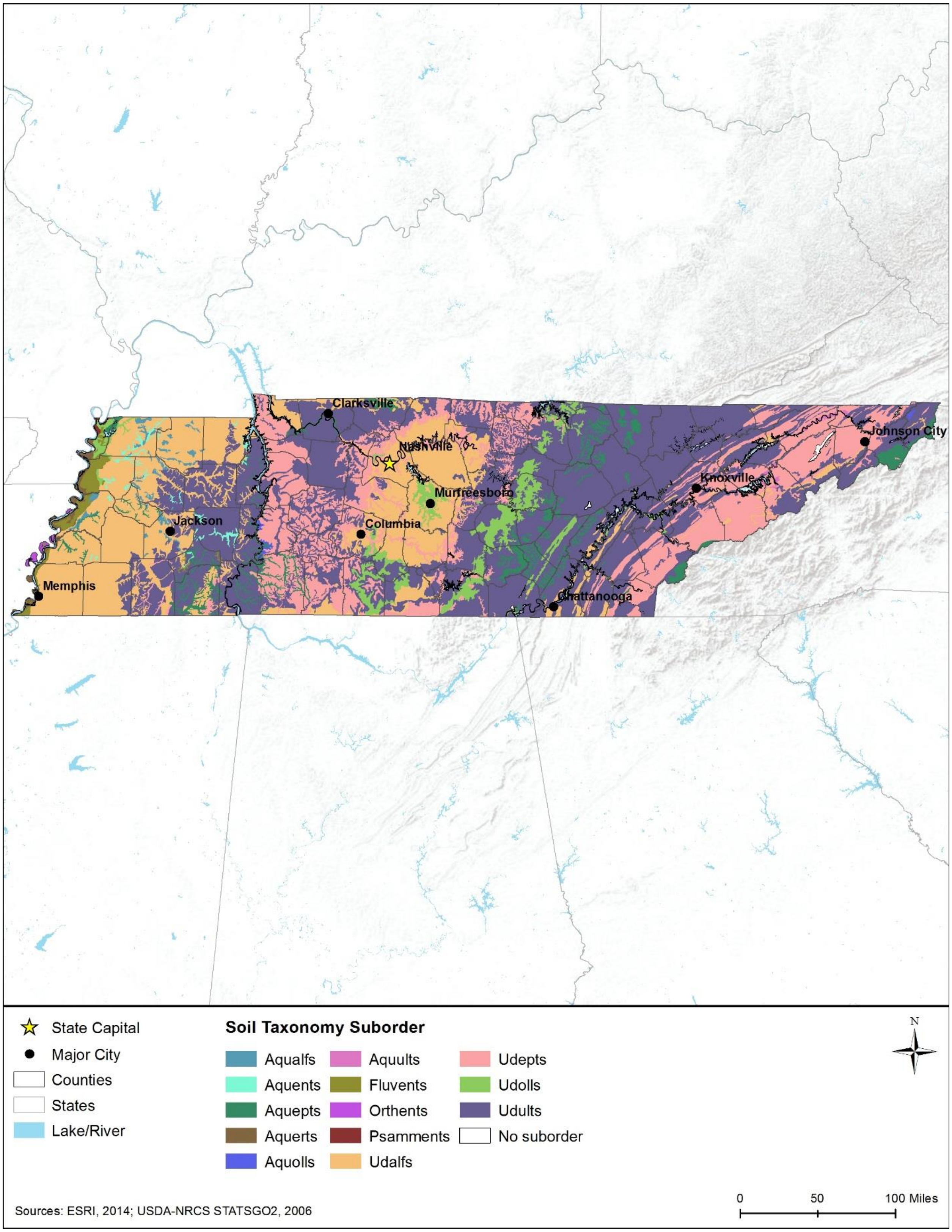


Figure 14.1.2-2: Tennessee Soil Taxonomy Suborders

Table 14.1.2-3: Major Characteristics of Soil Suborders[a] Found in Tennessee, as depicted in Figure 14.1.2-2

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Drainage Class	Hydric Soil[b]	Hydrologic Group	Runoff Potential	Permeability[c]	Erosion Potential	Compaction and Rutting Potential
Alfisols	Aqualfs	Generally have warm and aquic (saturated with water long enough to cause oxygen depletion) conditions. Aqualfs are used as cropland for growing corn, soybeans, and rice, and most have some artificial drainage or other water control. Nearly all Aqualfs have likely supported forest vegetation in the past.	Silt loam	0-3	Poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Entisols	Aquents	Widely distributed, with some forming in sandy deposits, and most forming in recent sediments. Aquents support vegetation that tolerates either permanent or periodic wetness, and are mostly used for pasture, cropland, forest, or wildlife habitat.	Sandy loam, Silt loam	0-2	Poorly drained to somewhat poorly drained	No, Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Inceptisols	Aquepts	Aquepts have poor or very poor natural drainage. If these soils have not been artificially drained, groundwater is at or near the soil surface at some time during normal years (although not usually in all seasons). They are used primarily for pasture, cropland, forest, or wildlife habitat. Many Aquepts have formed under forest vegetation, but they can have almost any kind of vegetation.	Fine sandy loam, Loam, Silt loam, Variable	0-3	Very poorly drained to somewhat poorly drained	No, Yes	B, C, D	Medium, High	Moderate, Low, Very Low	Medium to High, depending on slope	High, due to hydric soil and poor drainage conditions
Vertisols	Aquerts	Aquerts are wet soils, with prolonged moisture at or near the soil surface. Their natural vegetation includes savanna, grass, and forest. They are used as forest, rangeland, and cropland, although drainage for cropland can be difficult due to poor drainage.	Clay	0-5	Poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Mollisols	Aquolls	Aquolls support grass, sedge, and for[b] vegetation, as well as some forest vegetation. However, most have been artificially drained and utilized as cropland.	Silt loam, Silty clay	0-3	Very poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Ultisols	Aquults	Aquults are found in wet areas where groundwater is very close to the surface during part of each year, usually in winter and spring. Their slopes are gentle, with many soils formerly and currently supporting forest vegetation.	Clay loam, Silty clay loam	0-2	Poorly drained	Yes	D	High	Very Low	High	High, due to hydric soil and poor drainage conditions
Entisols	Fluvents	Fluvents are mostly freely drained soils that form in recently deposited sediments on flood plains, fans, and deltas located along rivers and small streams. Unless protected by dams or levees, these soils frequently flood. Fluvents are normally utilized as rangeland, forest, pasture, or wildlife habitat, with some also used for cropland.	Fine sandy loam	0-5	Well drained	No	B	Medium	Moderate	Medium	Low
Entisols	Orthents	Orthents are commonly found on recent erosional surfaces and are used primarily as rangeland, pasture, or wildlife habitat.	Variable	0-15	NA[d]	No	NA	-	-	-	-

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Drainage Class	Hydric Soil[b]	Hydrologic Group	Runoff Potential	Permeability[c]	Erosion Potential	Compaction and Rutting Potential
Entisols	Psamments	Psamments are sandy in all layers. In some arid and semi-arid climates, they are among the most productive rangeland soils, and are primarily used as rangeland, pasture, or wildlife habitat. Those Psamments that are nearly bare are subject to wind erosion and drifting, and do provide good support for wheeled vehicles.	Loamy fine sand	0-5	Excessively drained	No	A	Low	High	Low	Low
Alfisols	Udalfs	Udalfs have an udic (humid or subhumid climate) moisture regime, and are believed to have supported forest vegetation at some time during development.	Channery silty clay loam, Clay, Gravelly clay, Gravelly silt loam, Gravelly silty clay loam, Loam, Loamy sand, Silt loam, Silty clay, Silty clay loam, Unweathered bedrock	0-50	Moderately well drained to well drained	No	B, C, D	Medium, High	Moderate, Low, Very Low	Medium to High, depending on slope	Low
Inceptisols	Udepts	Udepts have an udic or perudic (saturated with water long enough to cause oxygen depletion) moisture regime, and are mainly freely drained. Most of these soils currently support or formerly supported forest vegetation, with mostly coniferous forest in the Northwest and mixed or hardwood forest in the East. Some also support shrub or grass vegetation, and in addition to being used as forest, some have been cleared and are used as cropland or pasture.	Channery silt loam, Channery silty clay loam, Clay loam, Cobbly sandy loam, Extremely channery loam, Fine sandy loam, Flaggy silty clay loam, Gravelly loam, Gravelly silt loam, Loam, Silt loam, Silty clay loam, Stratified sandy loam to silty clay loam, Unweathered bedrock, Very channery silt loam, Weathered bedrock	0-80	Somewhat poorly drained to excessively drained	No, Yes	B, C, D	Medium, High	Moderate, Low, Very Low	Medium to High, depending on slope	High, due to hydric soil and poor drainage conditions
Mollisols	Udolls	Udolls are found in humid climates. They are more or less freely drained, and have historically supported tall grass prairie. They are used as pasture or rangeland, and as cropland in areas with little slope.	Silt loam, Silty clay, Silty clay loam, Stratified fine sand to silty clay loam	0-12	Somewhat poorly drained to well drained	No	B, C, D	Medium, High	Moderate, Low, Very Low	Medium to High, depending on slope	Low

Soil Order	Soil Suborder	Ecological Site Description	Soil Texture	Slope (%)	Drainage Class	Hydric Soil[b]	Hydrologic Group	Runoff Potential	Permeability[c]	Erosion Potential	Compaction and Rutting Potential
Ultisols	Udults	Udults are more or less freely drained, relatively humus poor, and have an udic moisture regime. Most of these soils currently support or formerly supported mixed forest vegetation, and many have been cleared and used as cropland (mostly with the use of soil amendments).	Channery loam, Channery silt loam, Clay, Clay loam, Extremely channery silt loam, Fine sandy loam, Gravelly clay, Gravelly clay loam, Gravelly fine sandy loam, Gravelly loam, Gravelly silt loam, Gravelly silty clay loam, Loam, Sandy clay, Sandy clay loam, Sandy loam, Silt loam, Silty clay, Silty clay loam, Stony clay loam, Stratified weathered bedrock to fine sandy loam, Unweathered bedrock, Variable, Very channery silty clay, Very gravelly fine sandy loam, Very gravelly sandy clay loam	0-70	Somewhat poorly drained to somewhat excessively drained	No	A, B, C, D	Low, Medium, High	High, Moderate, Low, Very Low	Low to High, depending on slope	Low

Sources: (NRCS, 2015d) (NRCS, 1999)

[a] Soil suborders constitute a broad range of soil types. Within each suborder, the range of soil types may have a range of properties across the state, which result in multiple values being displayed in the table for that suborder.
[b] Hydric Soil: "A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part." (NRCS, 2015e) Soil suborders constitute a broad range of soil types. Within each soil suborder, some specific soil types are hydric while others are not.
[c] Based on Runoff Potential, described in Section 14.1.2.5.
[d] The dataset from NRCS is missing the attributes to populate this information.

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14.1.2.5. Runoff Potential

The NRCS uses four Hydrologic Soil Groups (A, B, C, and D) that are based on a soil's runoff potential.[13] Group A generally has the smaller runoff potential, whereas Group D generally has the greatest (Purdue University, 2015). Table 14.1.2-3 provides a summary of the runoff potential for each soil suborder in Tennessee.

Group A. **Sand, loamy sand or sandy loam soils.** This group of soils has "low runoff potential and high infiltration rates[14] even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission" (Purdue University, 2015). Psamments and Udults fall into this category in Tennessee.

Group B. **Silt loam or loam soils.** This group of soils has a "moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures" (Purdue University, 2015). This group has medium runoff potential. Aquepts, Fluvents, Udalfs, Udepts, Udolls, and Udults fall into this category in Tennessee.

Group C. **Sandy clay loam soils.** This group of soils has "low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure" (Purdue University, 2015). This group has medium runoff potential. Aquepts, Udalfs, Udepts, Udolls, and Udults fall into this category in Tennessee.

Group D. **Clay loam, silty clay loam, sandy clay, silty clay, or clay soils.** This group of soils "has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material" (Purdue University, 2015). Aqualfs, Aquents, Aquepts, Aquerts, Aquolls, Aquults, Udalfs, Udepts, Udolls, and Udults fall into this category in Tennessee.

14.1.2.6. Soil Erosion

"Soil erosion involves the breakdown, detachment, transport, and redistribution of soil particles by forces of water, wind, or gravity" (NRCS, 2015f). Water-induced erosion can transport soil into streams, rivers, and lakes, degrading water quality and aquatic habitat. When topsoil is eroded, organic material is depleted, creating loss of nutrients available for plant growth. Soil particles displaced by wind can cause human health problems and reduced visibility, creating a public safety hazard (NRCS, 1996a). Table 14.1.2-3 provides a summary of the erosion potential

[13] Classifying soils is highly generalized and it is challenging to differentiate orders as soil properties can change with distance or physical properties. The soil suborders are at a high level, therefore soil groups may be found in multiple hydrologic groups within a state, as composition, topography, etc. varies in different areas.
[14] Infiltration Rate: "The rate at which a soil under specified conditions absorbs falling rain, melting snow, or surface water expressed in depth of water per unit time" (FEMA, 2010).

for each soil suborder in Tennessee. Soils with medium to high erosion potential in Tennessee include those in the Aqualfs, Aquents, Aquepts, Aquerts, Aquolls, Aquults, Fluvents, Udalfs, Udepts, Udolls, and Udults suborders, which are found throughout most of the state (Figure 14.1.2-2).

14.1.2.7. Soil Compaction and Rutting

Soil compaction and rutting occurs when soil layers are compressed by machinery or animals, which decreases both open spaces in the soil, as well as water infiltration rates (NRCS, 1996b). Moist soils with high soil water content are most susceptible to compaction and rutting, as they lack the strength to resist deformation caused by pressure. When rutting occurs, channels form and result in downslope erosion (USFS, 2009b). Other characteristics that factor into compaction and rutting risk include soil composition (i.e., low organic soil is at increased risk of compaction), amount of pressure exerted on the soil, and repeatability (i.e., the number of times the pressure is exerted on the soil). Machinery and vehicles that have axle loads greater than ten tons can cause soil compaction of greater than 12 inches (NRCS, 1996b) (NRCS, 2003).

Loam, sandy loam, and sandy clay loam soils are most susceptible to compaction and rutting; silt, silty clay, silt loam, silty clay loam, and clay soils are more resistant to compaction and rutting (NRCS, 1996b). Table 14.1.2-3 provides a summary of the compaction and rutting potential for each soil suborder in Tennessee. Soils with the highest potential for compaction and rutting in Tennessee include those in the Aqualfs, Aquents, Aquepts, Aquerts, Aquolls, Aquults, and Udepts suborders, which are found throughout the state (Figure 14.1.2-2).

14.1.3. Geology

14.1.3.1. Introduction

The U.S. Geological Survey (USGS) is the primary government organization responsible for the nation's geological resources. USGS defines geology as an interdisciplinary science with a focus on the following aspects of earth sciences: geologic hazards and disasters, climate variability and change, energy and mineral resources, ecosystem and human health, and groundwater availability. Several of these elements are discussed in other sections of this Programmatic Environmental Impact Statement (PEIS), including groundwater (Section 14.1.4), human health (Section 14.1.15), and climate change (Section 14.1.14).

This section covers the six aspects of geology most relevant to the Proposed Action and Alternatives:

- Section 14.1.3.3, Environmental Setting: Physiographic Regions and Provinces; [15,16]
- Section 14.1.3.4, Surface Geology;
- Section 14.1.3.5, Bedrock Geology;[17]

[15] Physiographic regions: Areas of the United States that share commonalities based on topography, geography, and geology (Fenneman, 1916).
[16] Physiographic provinces: Subsets within physiographic regions (Fenneman, 1916).
[17] Bedrock: Solid rock beneath the soil and superficial rock (USGS, 2015a).

- Section 14.1.3.6, Paleontological Resources;[18]
- Section 14.1.3.7, Fossil Fuel and Mineral Resources; and
- Section 14.1.3.8, Geologic Hazards.[19]

14.1.3.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of NEPA and other applicable laws and regulations. A list of applicable state laws and regulations is included in Table 14.1.3-1.

Table 14.1.3-1: Relevant State Geology Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Tennessee Building Codes	Local Agencies	Check county, city, and other local agencies for seismic guidelines in building codes.
Rules of the TDEC Chapter 0400-2-9 Management of Tennessee Archaeological Areas	TDEC	Any location on Tennessee State Park lands with paleontological remains must not be excavated without a permit from the State Archaeologist.

Sources: (ICC, 2016) (Tennessee Department of Environment & Conservation, 2016a)

14.1.3.3. Environmental Setting: Physiographic Regions and Provinces

Geologist Nevin Fenneman, as a way to describe areas of the United States based on common landforms (i.e., not climate or vegetation), created the concept of physiographic regions in 1916. Physiographic regions are areas of distinctive topography, geography, and geology. Important physiographic differences between adjacent areas are generally due to differences in the nature or structure of the underlying rocks. There are eight distinct physiographic regions in the continental United States: 1) Atlantic Plain, 2) Appalachian Highlands, 3) Interior Plains, 4) Interior Highlands, 5) Laurentian Upland, 6) Rocky Mountain System, 7) Intermontane Plateaus, and 8) Pacific Mountain System. Regions are further sub-divided into physiographic provinces based on differences observed on a more local scale (Fenneman, 1916).

Tennessee has three major physiographic regions: Appalachian Highlands (Blue Ridge, Valley and Ridge, and Appalachian Plateaus Provinces), Interior Plains (Interior Low Plateaus Province), and Atlantic Plain (Coastal Plain Province) (USGS, 2003a) (NRCS, 2006). The locations of these regions and their respective provinces are shown in Figure 14.1.3-1, and their general characteristics summarized in the following subsections.

[18] Paleontology: "Study of life in past geologic time based on fossil plants and animals" (USGS, 2015b).
[19] Geologic Hazards: Any geological or hydrological process that poses a threat to people and/or their property, which includes but is not limited to volcanic eruptions, earthquakes, landslides, sinkholes, mudflows, flooding, and shoreline movements (NPS, 2013).

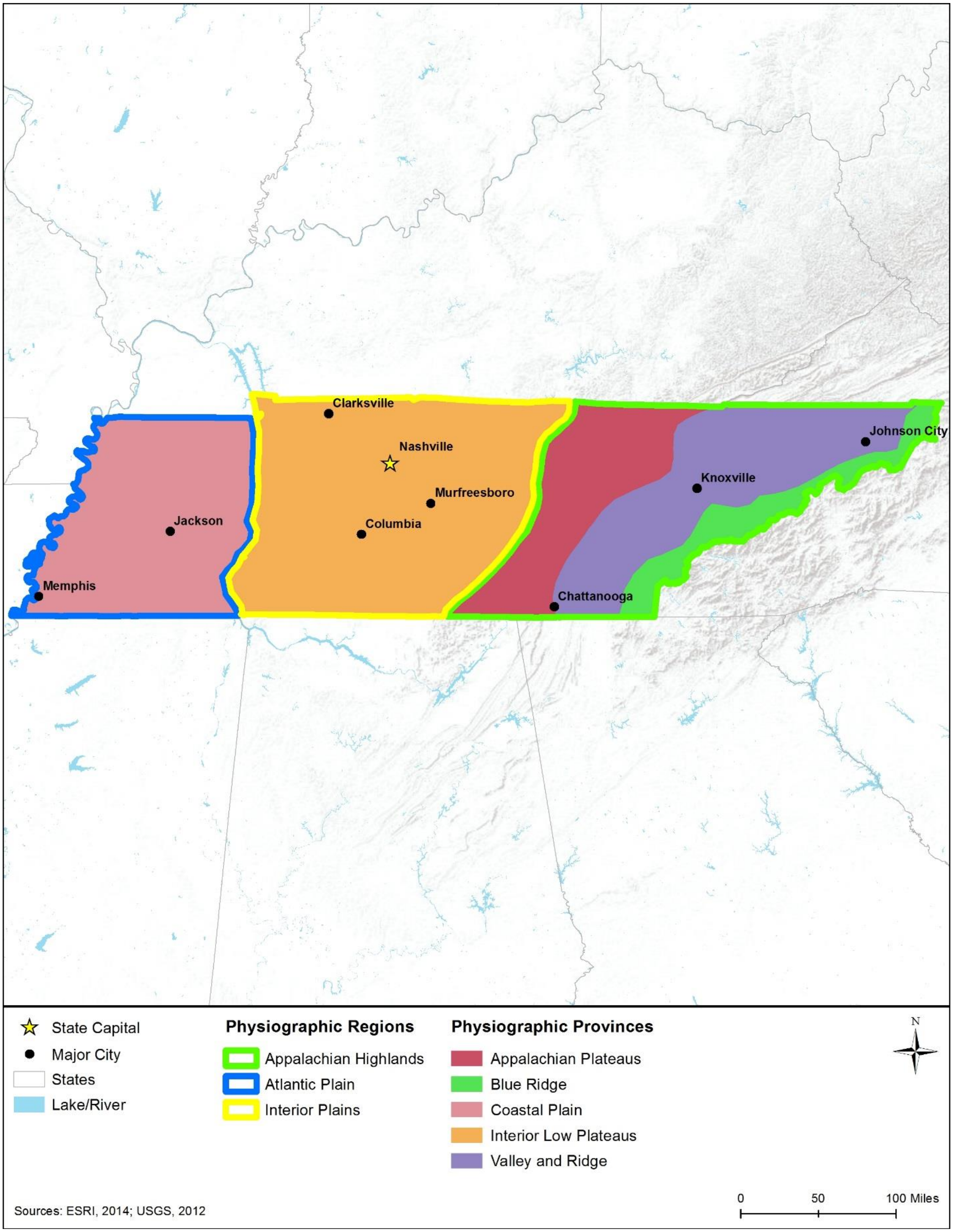

Figure 14.1.3-1: Physiographic Regions and Provinces of Tennessee

Appalachian Highlands Region

The Appalachian Highlands Region extends from Canada to Alabama. This region is composed of layers of folded sedimentary rock[20] created when the North American plate collided with Eurasian and African plates approximately500 million years ago (MYA) (USGS, 2016a).[21] Since that time, the Appalachian Highlands have eroded considerably, and most peaks are now under 5,000 feet above sea level (ASL). The current Appalachian Highlands Region is characterized by prime and unique farmlands and is rich in mineral resources. (USGS, 2003a)

As reported above, the Appalachian Highlands Region within Tennessee is composed of three physiographic provinces, including the Blue Ridge, Valley and Ridge, and Appalachian Plateaus Provinces (USGS, 2003a).

Blue Ridge Province – Tennessee's Blue Ridge Province (locally referred to as the Unaka Mountains) is composed of the eastern edge of the state along the length of the state's border with North Carolina. Topography ranges from 1,500 feet above sea level (ASL) in the western portion of the province, to more than 5,000 feet ASL along the border with North Carolina. Local relief is typically 2,000 feet between mountain peaks and valleys (King & Ferguson, 1960).

Valley and Ridge Province – To the west of Tennessee's Blue Ridge Province is the Valley and Ridge Province. In most locations, the Valley and Ridge Province measures about 45 miles across from east to west. "The topography of the Valley and Ridge consists of long linear ridges and parallel lowland valleys that trend in a northeast to southwest direction" (TDEC, Air Pollution Control Division et al, 2010). Ridge elevations generally range between 1,100 and 1,500 feet ASL, while valleys range between 700 and 1,000 feet ASL. Elevations generally decrease from north to south throughout the province (TDEC, Air Pollution Control Division et al, 2010).

Appalachian Plateaus Province – The Appalachian Plateaus Province (locally referred to as the Cumberland Plateau) lies to the west of the Blue Ridge Province. "As a landform, this great plateau reaches from north-central Alabama through Tennessee and Kentucky and Pennsylvania to the western New York border" (NPS, 2015a). Within Tennessee, the Province's width varies from 75 miles near the state's northern border with Kentucky to 35 miles along the state's southern border with Georgia and Alabama (TDEC, Air Pollution Control Division et al, 2010). The average elevation throughout Tennessee's Appalachian Plateaus Province is 1,800 feet ASL with topographic relief varying between 100 and 400 feet (TDEC, Air Pollution Control Division et al, 2010).

[20] Sedimentary Rock: "Rocks that formed from pre-existing rocks or pieces of once-living organisms. They form from deposits that accumulate on the Earth's surface. Sedimentary rocks often have distinctive layering or bedding." (USGS, 2014a)
[21] For consistency, this PEIS uses the University of California Berkeley Geologic Time Scale for all of the FirstNet PEIS state documents. Time scales differ among universities and researchers; FirstNet utilized a consistent time scale throughout, which may differ slightly from other sources. (University of California Museum of Paleontology, 2011)

Interior Plains Region

The Interior Plains Region extends across much of the interior of the United States, roughly between the western edge of the Appalachian Highlands (near states including Ohio, Tennessee, and Alabama), and the eastern edge of the Rocky Mountain System (including states such as Montana, Wyoming, and Colorado) (Fenneman, 1916). Metamorphic and igneous rocks dating to the Precambrian Era (older than 542 MYA) underlie the entire region. There is minimal topographic relief throughout the region, except for the Black Hills of South Dakota. During the Mesozoic Era (251 to 66 MYA), much of the Interior Plains were covered by the oceans, resulting in the formation of sedimentary rocks, which lie on top of the Precambrian basement rocks. Erosion from the Rocky Mountains to the west and the Ozark/Ouachita Mountains to the east, also contributed to the formation of sandstone, mudstone,[22] and clay (USGS, 2014b).

Interior Low Plateaus Province – Tennessee's Interior Low Plateaus Province includes much of the central portion of the state between the Appalachian Plateaus Province to the east and the Coastal Plain Province to the west. The eastern and western edges of the Province are locally referred to as the Highland Rim, which is characterized as a relatively flat plain with occasional small hills. "Elevations on the Western Highland Rim's tableland range from 800 to 1000 feet, while relief varies from 100 to 200 feet. The Eastern Highland Rim averages 25 miles in width and has an elevation of 900 to 1100 feet" (TDEC, Air Pollution Control Division et al, 2010). The central part of the province, near the City of Nashville, is referred to as the Central Basin, and, in most locations, is surrounded by the Highland Rim. "This topography is extremely level and has an average elevation of 650 feet. Relief in most areas is less than 50 feet" (TDEC, Air Pollution Control Division et al, 2010).

Atlantic Plain Region

The Atlantic Plain Region includes the Continental Shelf and the Gulf and Atlantic Coast plains stretching from New York south to Florida and west to Texas. The Atlantic Plain Region formed through the repetitive rise and fall of the oceans over the last 150 million years. Sedimentary strata become thinner moving westward through the region, and thicken to several thousand feet thick along the coastline. Erosion from the Appalachian Mountains, which began to form 480 to 440 MYA, dislodged sediments, which were subsequently deposited by rivers to form the Atlantic Plain. Gentle topography and a transition zone between the land and sea often having marshes, lagoons, swamps, sand bars, and reefs characterize the area. Deposits of coastal marine life over millions of years form the basis for rich fossil fuel reserves in the region. (NPS, 2015b)

As reported above, the Atlantic Plain Region within Tennessee is composed of one physiographic province: the Coastal Plain Province (USGS, 2003a).

Coastal Plain Province – Within Tennessee, the Coastal Plain Province includes the western portion of the state. "The average elevation of this floodplain region is 235 feet, although it may be as high as 290 feet in Lake County and as low as 185 feet in Shelby County" (TDEC, Air Pollution Control Division et al, 2010). Topography in the eastern portion of the Coastal Plain is characterized as "a relatively flat terrain that slopes gently westward to the Mississippi River

[22] Mudstone: "A very fine-grained sedimentary rock formed from mud" (NPS, 2000).

floodplain. Elevations of 450 feet are found [in the eastern portion of the Province] and around 280 feet [in] the west. Relief in most areas is less than 200 feet" (TDEC, Air Pollution Control Division et al, 2010).

14.1.3.4. Surface Geology

Surficial geology is characterized by materials such as till,[23] sand and gravel, or clays that overlie bedrock. The surface terrain, which can include bedrock outcrops, provides information on the rock compositions and structural characteristics of the underlying geology. Because surface materials are exposed, they are subject to physical and chemical changes due to weathering from precipitation (rain and snow), wind and other weather events, and human-caused interference. Depending on the structural characteristics and chemical compositions of the surface materials, heavy precipitation can cause slope failures,[24] subsidence,[25] and erosion (Thompson, 2015).

Most of the surficial materials in Tennessee are modern day river deposits. In western Tennessee, Quaternary (2.6 MYA to present) floodplain deposits from the Mississippi River are composed of sand, silt, clay, gravel, and loess (TDEC, 1966). "Sand is very fine-grained to coarse-grained quartz with chert" (USGS, 2004a). Deposits reach depths of more than 100 feet adjacent to the Mississippi River, and thin moving to the east within the Coastal Plain Province (USGS, 2004a). Tertiary (66 to 2.6 MYA) deposits extend throughout much of the Coastal Plain Province, with the exception of the Mississippi River Floodplain (TDEC, 1966). Glacial deposits from the Pleistocene Ice Age (2.6 MYA to 11,700 years ago) did not reach Tennessee (USGS, 1995). Figure 14.1.3-2 depicts the main surficial composition of Tennessee.

[23] Till: "An unsorted and unstratified accumulation of glacial sediment, deposited directly by glacier ice. Till is a heterogeneous mixture of different sized material deposited by moving ice (lodgement till) or by the melting in-place of stagnant ice (ablation till). After deposition, some tills are reworked by water." (USGS, 2013a)
[24] Slope failure, also referred to as mass wasting, is the downslope movement of rock debris and soil in response to gravitational stresses (Idaho State University 2000).
[25] Subsidence: "Gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials" (USGS, 2000).

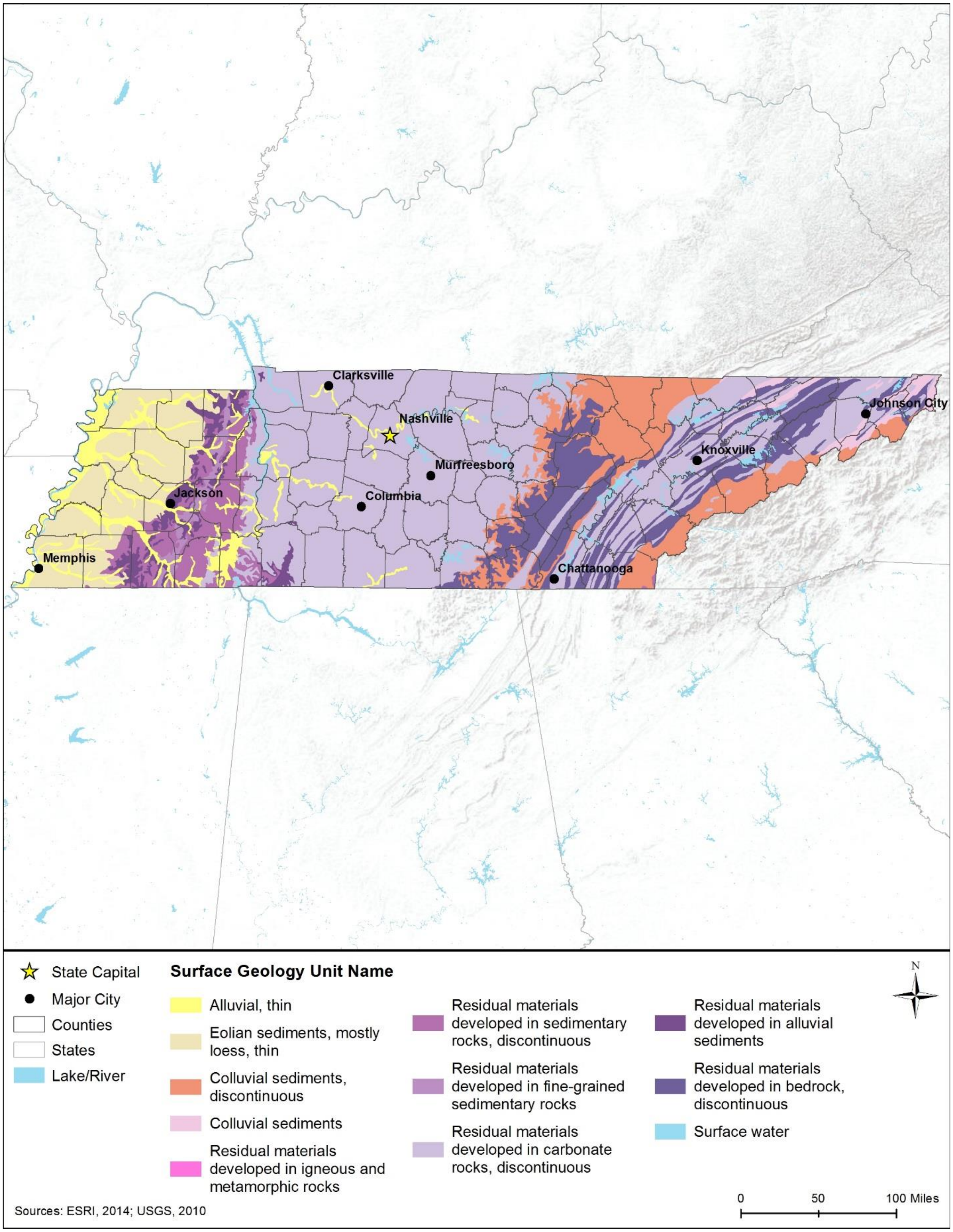

Figure 14.1.3-2: Generalized Surface Geology for Tennessee

14.1.3.5. Bedrock Geology

Bedrock geology analysis, and "the study of distribution, position, shape, and internal structure of rocks" (USGS, 2015c) reveals important information about a region's surface and subsurface characteristics (i.e., three-dimensional geometry), including dip (slope of the formation),[26] rock composition, and regional tectonism.[27] These structural aspects of bedrock geology are often indicative of regional stability, as it relates to geologic hazards such as landslides, subsidence, earthquakes, and erosion (New Hampshire Department of Environmental Services, 2014).

Tennessee's bedrock geology at the land surface varies significantly by physiographic province. While sedimentary rocks underlie the Coastal Plain, Interior Low Plateaus, Appalachian Plateaus, and Valley and Ridge Provinces, easternmost Tennessee, within the Blue Ridge Province, is underlain by igneous and metamorphic rocks (TDEC, 1966). An overview of the bedrock geology of each province is provided below and in Figure 14.1.3-3.

- The Blue Ridge Province is underlain by Precambrian (older than 542 MYA) and Cambrian (542 to 488 MYA) igneous,[28] metamorphic,[29] and sedimentary rocks (USGS, 1995). "In the northeastern most Tennessee the Unaka ridges are formed by quartzite,[30] [sandstone],[31] and associated sandy and silty shale[32]… Between the Unaka ridges are valleys and lowlands of varying width carved from carbonate[33] rocks (limestones,[34] dolomites,[35] and limy shales). They are extensively blanketed by residual clay and bouldery wash spread out from the adjacent ridges" (King & Ferguson, 1960).
- The Valley and Ridge Province is underlain by "Cambrian, Ordovician [(488 to 444 MYA)], and Mississippian [(359 to 318 MYA)] carbonate rocks that are interbedded with fine- and coarse-grained siliciclastic rocks and a thin bed of Devonian [(416 to 359 MYA)] and Mississippian shale. Carbonate rocks underlie the broad valleys and sandstone and shale underlie ridges" (USGS, 2012a).
- The Appalachian Plateaus is underlain by Carboniferous Period (359 to 299 MYA) "layers of limestone, shale, coal, and sandstone" (NPS, 2015a).

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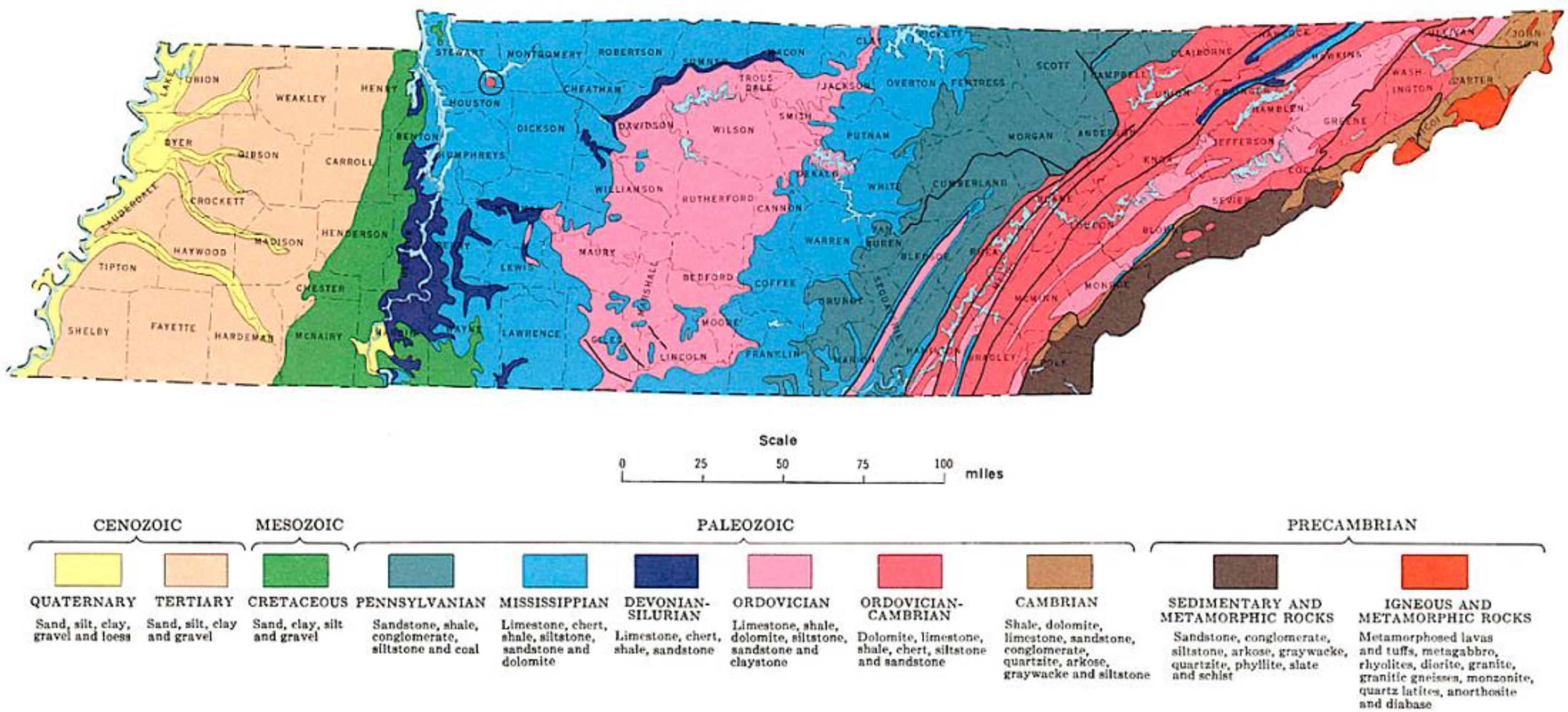
[26] Dip: "A measure of the angle between the flat horizon and the slope of a sedimentary layer, fault plane, metamorphic foliation, or other geologic structure" (NPS, 2000).
[27] Tectonism: "Structure forces affecting the deformation, uplift, and movement of the earth's crust" (USGS, 2015d).
[28] Igneous Rock: "Rock that forms when hot, molten rock (magma) crystallizes and solidifies" (USGS, 2005).
[29] Metamorphic Rock: "A rock that has undergone chemical or structural changes produced by increase in heat or pressure, or by replacement of elements by hot, chemically active fluids" (NPS, 2000).
[30] Quartzite: "Hard, somewhat glassy-looking rock made up almost entirely of quartz. Metamorphosed quartz sandstone and chert are quartzites" (NPS, 2000).
[31] Sandstone: "Sedimentary rock made mostly of sand-sized grains" (NPS, 2000).
[32] Shale: "Sedimentary rock derived from mud. Commonly finely laminated (bedded). Particles in shale are commonly clay minerals mixed with tiny grains of quartz eroded from pre-existing rocks." (NPS, 2000)
[33] Carbonate: "A sedimentary rock made mainly of calcium carbonate ($CaCO_3$). Limestone and dolomite are common carbonate sedimentary rocks." (NPS, 2000)
[34] Limestone: "A sedimentary rock made mostly of the mineral calcite (calcium carbonate). Limestone is usually formed from shells of once-living organisms or other organic processes, but may also form by inorganic precipitation." (NPS, 2000)
[35] Dolomite: "A magnesium-rich carbonate sedimentary rock. Also, a magnesium-rich carbonate mineral ($CaMgCO_3$)." (NPS, 2000)



Source: (TDEC, 1966)

Figure 14.1.3-3: Generalized Bedrock Geology for Tennessee

- Within Tennessee, the Interior Low Plateaus are underlain primarily by Ordovician (limestone, shale, dolomite, siltstone,[36] and claystone) and Mississippian (limestone, chert,[37] shale, siltstone, sandstone, and dolomite) sedimentary rocks (TDEC, 1966).
- The westernmost portion of the Coastal Plain Province includes the alluvial plain of the Mississippi River, which is underlain by Quaternary (2.6 MYA to present) sand, silt, clay, gravel, and loess.[38] Further to the east, Cretaceous (151 to 66 MYA) and Tertiary (66 to 2.6 MYA) sand, silt, clay, and gravel underlie the remainder of the Coastal Plain (TDEC, 1966).

14.1.3.6. Paleontological Resources

Fossils of crinoids,[39] brachiopods,[40] and bryozoans[41] are found in abundance in Ordovician Period (488 to 444 MYA) sedimentary rocks in central Tennessee, as Tennessee was covered by warm, shallow seas. Silurian (444 to 416 MYA) and Devonian (416 to 359 MYA) Period marine fossils in Tennessee include crinoids, corals, trilobites,[42] brachiopods, and bryozoans. Silurian Period fossils are primarily in southwestern Tennessee, and Devonian Period fossils are in southeastern, western, and central parts of the state. Tropical seas continued to cover most of the state into the Carboniferous Period (359 to 299 MYA), with fossils preserved from crinoids, brachiopods, and bryozoans found in sediments, along with terrestrial fossils such as horsetail rushes, tall scale trees, and other plants. Cretaceous Period (146 to 66 MYA) fossils include crinoids, clams, oysters, and snails.. One Cretaceous fossil of note is Tennessee's state fossil, *Pterotrigonia (Scabrotrigonia) thoracica*, a floor-dwelling bivalve from the Coon Creek Formation of the late Cretaceous age (University of Tennessee Martin, 2014). The only dinosaur fossils found in Tennessee are from the Cretaceous Period, and include the hadrosaur *Edmontosaurus*. During the Cenozoic Era (66 MYA to present), western Tennessee was flooded periodically by a warm sea, with marine fossils found in sediments from this time. Eastern Tennessee was above sea level, and fossils from early elephants, tapirs, badgers, lesser panda, and alligators have been recorded. Mastodon fossils

Source: (Paleontology Portal, 2015)

Tennessee State Fossil
Pterotrigonia (Scabrotrigonia) thoracica

[36] Siltstone: "A sedimentary rock made mostly of silt-sized grains" (NPS, 2000).
[37] Chert: "A very fine-grained sedimentary rock made of quartz. Usually made of millions of globular siliceous skeletons of tiny marine plankton called radiolarians." (NPS, 2000)
[38] Loess: "A wind-blown deposit of sediment made mostly of silt-sized grains" (NPS, 2000).
[39] Crinoid: "The common name for any echinoderm of the class Crinoidea, including sea lilies, feather stars, etc. Crinoids are common fossils in the Paleozoic and persist to the present. Many species have stalks and radiating arms and feed on particles in the water column." (Smithsonian Institution, 2016)
[40] Brachiopod: "Any member of a phylum of marine invertebrate animals called Brachiopoda. Brachiopods are sessile, bivalved organisms, but are more closely related to the colonial Bryozoa than the bivalved mollusks. Brachiopod diversity peaked in the Paleozoic, but some species survive." (Smithsonian Institution, 2016)
[41] Bryozoan: "Common name for any member of the phylum Bryozoa. Bryozoans are invertebrate aquatic organisms most commonly found in large colonies." (Smithsonian Institution, 2016)
[42] Trilobite: "Any member of Trilobita, an extinct class of marine arthropods. Trilobites are known from the Cambrian to the Permian. They had segmented, oval-shaped bodies and were the first animals to have complex eyes (similar to the compound eyes in modern insects)." (Smithsonian Institution, 2016)

from the Quaternary Period (2.6 MYA to present) have also been found in Tennessee (Paleontology Portal, 2015).

14.1.3.7. Fossil Fuel and Mineral Resources

Oil and Gas

In 2016, Tennessee produced 252,000 barrels of crude oil, which ranked 28th out of 31 oil producing states nationwide. "Only 0.01% of the nation's total crude oil output is produced in Tennessee today". (EIA, 2017b).

In 2015, Tennessee produced 4,276 million cubic feet of natural gas, which ranked 25th among natural gas producing states nationwide. This level of production accounted for less than 0.2 percent of the country's total natural gas production. Most natural gas wells are in the northeastern portion of the state (EIA, 2017b)

Minerals

As of 2015, Tennessee's nonfuel mineral production value was $1,21B, which ranked 23th nationwide (in terms of dollar value). This level of production accounted for 1.62 percent of the total production value nationwide. As of 2014, Tennessee's leading nonfuel minerals were crushed stone, zinc, portland cement, construction sand and gravel, and industrial sand and gravel (USGS, 2014c). As of 2013, Tennessee was the leading producer of ball clay nationwide (out of five states that produce ball clay). Other minerals produced in the state include zinc concentrate, dolomite, granite, cadmium metal, dimension marble, sandstone, quartzite, masonry cement, lime, natural gemstones, synthetic graphite, synthetic gypsum, salt, common clay, dimension stone,[43] germanium, , fuller's earth, , (USGS, 2015e).

As of 2015, Tennessee produced 897 thousand short tons of coal, which accounted for less than 0.1 percent of total nationwide production. Tennessee ranked 21nd among the 25 coal producing states nationwide, with production occurring in both eastern and east-central portions of the state (EIA, 2017b).

14.1.3.8. Geologic Hazards

The three major geologic hazards of concern in Tennessee are earthquakes, landslides, and subsidence. Volcanoes do not occur in Tennessee and therefore do not present a hazard to the state (USGS, 2015f). The subsections below summarize current geologic hazards in Tennessee.

Earthquakes

Areas of greatest seismicity in Tennessee are concentrated in the western portions of the state, although eastern Tennessee is also susceptible to significant earthquake events. Between 1973 and March 2012, there were more than 20 earthquakes of a magnitude 3.5 (on the Richter scale) or greater in Tennessee, although numerous earthquakes that originated in nearby states were felt

[43] Dimension stone: "Natural rock material quarried for the purpose of obtaining blocks or slabs that meet specifications as to size (width, length, and thickness) and shape" (USGS, 2016b).

in Tennessee (USGS, 2014d). Earthquakes are the result of large masses of rock moving against each other along fractures called faults. Earthquakes occur when landmasses on opposite sides of a fault suddenly slip past each other; the grinding motion of each landmass sends out shock waves. The vibrations travel through the Earth and, if they are strong enough, they can damage natural and manmade structures on the surface. Earthquakes can produce secondary flooding impacts resulting from dam failure (USGS, 2012b).

The shaking due to earthquakes can be significant many miles from its point of origin depending on the type of earthquake and the type of rock and soils beneath a given location. Crustal earthquakes, the most common, typically occur at depths of 6 to 12 miles; these earthquakes typically do not reach magnitudes higher than 6.0 on the Richter scale.[44] Subduction zone earthquakes occur where Earth's tectonic plates collide. "When tectonic plates collide, one plate slides beneath the other, where it is reabsorbed into the mantle of the earth" (Oregon Department of Geology, 2015). Subduction zones are found off the coast of Washington, Oregon, and Alaska. Convergence boundaries between two tectonic plates can result in earthquakes with magnitudes that exceed 8.0 on the Richter scale (Oregon Department of Geology, 2015).

Figure 14.1.3-4 depicts the seismic risk throughout Tennessee; the box surrounding the range of colors shows the seismic hazards in the state. The map indicates levels of horizontal shaking (measured in Peak Ground Acceleration) that have a 2 percent chance of being exceeded in a 50-year period. Units on the map are measured in terms of acceleration due to gravity (% g). Most pre-1965 buildings are likely to experience damage with exceedances of 10 % g. Post-1985 buildings (in California) have experienced only minor damage with shaking of 60 % g. (USGS, 2010)

Western Tennessee is highly susceptible to experiencing earthquakes due to its position within the New Madrid Seismic Zone (NMSZ), which is the most seismically active area of the United States east of the Rockies. The NMSZ includes parts of Illinois, Kentucky, Missouri, Arkansas, and Tennessee (USGS, 2009a). Three damaging earthquakes occurred along the NMSZ during 1811 and 1812; these earthquakes measured between 7.3 and 7.5 on the Richter scale (USGS, 2014e). "Geologic studies indicate that large earthquakes [also] occurred along the [NMSZ] in approximately 300 A.D., 900 A.D., and 1400 A.D.… [Some estimates suggest] that there is about a 10 percent chance of a magnitude 7-8 earthquake in the [NMSZ] in a 50 year time interval" (MDNR, 2015). If a magnitude 7.0 or greater earthquake were to occur within the NMSZ, "soil liquefaction[45] and related ground failures are likely to occur in downtown Memphis along the Mississippi River" (USGS, 2009a).

[44] The Richter scale is a numerical scale for expressing the magnitude of an earthquake on the basis of seismograph oscillations. The more destructive earthquakes typically have magnitudes between about 5.5 and 8.9; the scale is logarithmic and a difference of one represents an approximate thirtyfold difference in magnitude. (USGS, 2014f)

[45] Liquefaction: "A process by which water-saturated sediment temporarily loses strength and acts as a fluid…This effect can be caused by earthquake shaking." (USGS, 2009a)

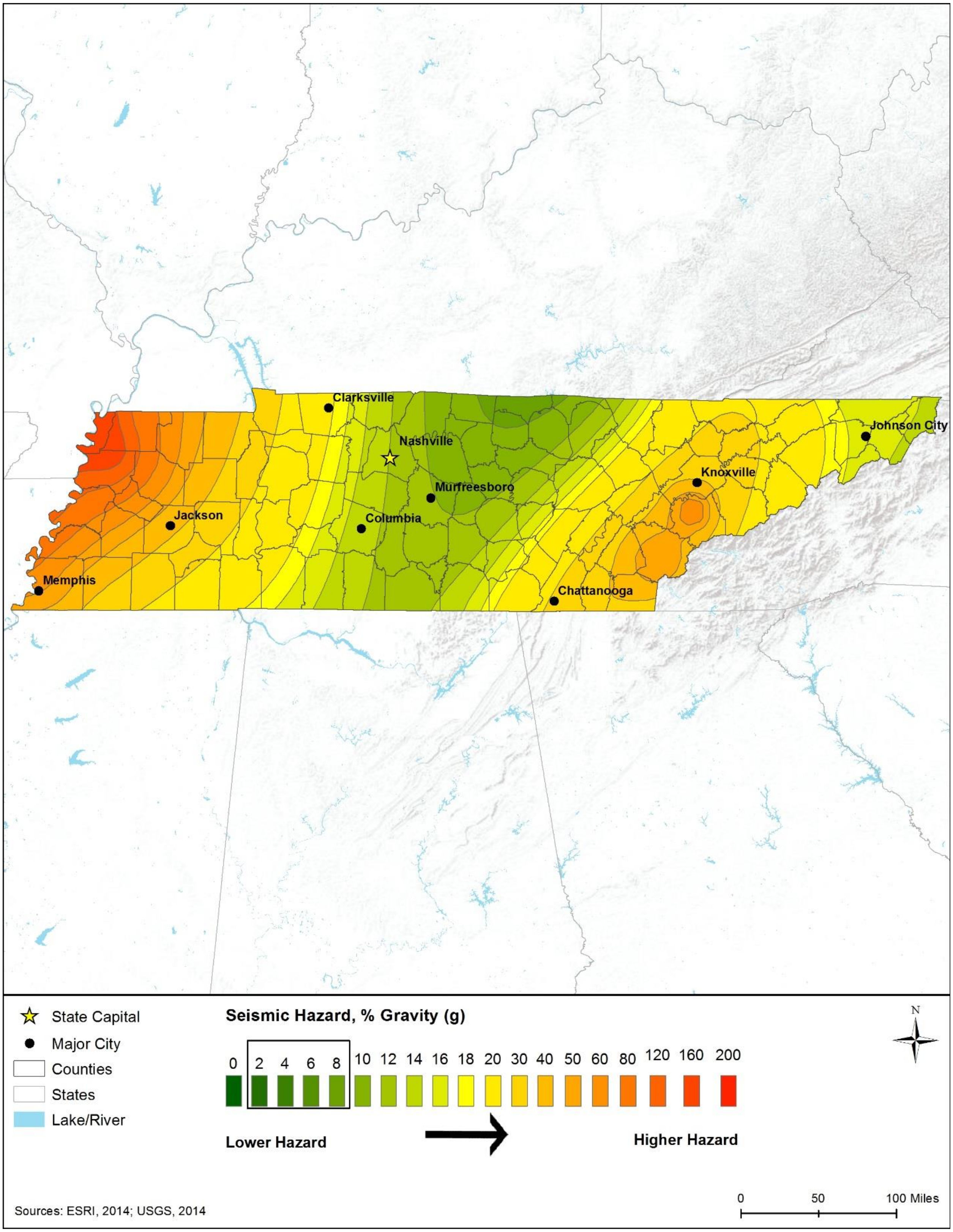


Figure 14.1.3-4: Tennessee 2014 Seismic Hazard Map

Eastern Tennessee also is highly susceptible to experiencing earthquakes due to its position within the Eastern Tennessee Seismic Zone. "The zone spans portions of eastern Tennessee, North Carolina, Virginia, Georgia and Alabama and is, after the New Madrid seismic zone, the second most active seismic region of the North America east of the Rocky Mountains…The largest recorded earthquake in this seismic zone was a magnitude 4.6 that occurred in 1973 near Knoxville… Small, non-damaging, felt earthquakes occur about once a year" (USGS, 2012c).

Landslides

The western portion of the Appalachian Highlands Region, including portions of Tennessee, are among the locations most susceptible to landslides nationwide (Radbruch-Hall, et al., 1982). "The term 'landslide' describes many types of downhill earth movements, ranging from rapidly moving catastrophic rock avalanches and debris flows in mountainous regions to more slowly moving earth slides and other ground failures" (USGS, 2003b). Geologists use the term "mass movement" to describe a great variety of processes such as rock fall, creep, slump, mudflow, earth flow, debris flow, and debris avalanche regardless of the time scale (USGS, 2003b).

Landslides can be triggered by a single severe storm or earthquake, causing widespread damage in a short period. Most landslide events are triggered by water infiltration that decomposes and loosens rock and soil, lubricates frictional surfaces, adds weight to an incipient landslide, and imparts buoyancy to the individual particles. Intense rainfall, rapid snowmelt, freeze/thaw cycles, earthquakes, volcanic eruptions, and human alterations to the natural landscape can trigger mass land movements. Large landslides can dam rivers or streams, and cause both upstream and downstream flooding (USGS, 2003b).

Portions of Tennessee within the Appalachian Highlands are highly susceptible to experiencing landslide events. "In Tennessee and Kentucky, landslides are common in colluvial[46] soil as thick as 20 [meters] along the valley walls of the [Appalachian Plateaus]… Southeast of the Appalachian Plateau, the flanks of the Appalachian Ridges and the Blue Ridge are covered by extensive colluvium that is highly susceptible to sliding" (Radbruch-Hall, et al., 1982). For example, the Multi-Hazard Mitigation Plan for northeastern Tennessee's Sullivan County indicates that "134 square miles [(i.e., 31 percent of the county)] are identified as high susceptibility to landslides" (Sullivan County, Tennessee, 2014). In Knox County, two damaging landslides were documented between 2000 and 2009, both of which resulted from improper grading and clearing on hillslopes (KCHMP, 2011).

Western Tennessee is at significant risk to landslide events due to its proximity to the NMSZ. One study mapped 221 landslides in western Kentucky and Tennessee along the Mississippi River which likely developed in association with the earthquakes of 1811 and 1812. "The average height of the bluffs in the study area is 120 [feet], though at some localities they are as high as 225 [feet]." (Jibson & Keefer, 1988) Figure 14.1.3-5 shows landslide incidence and susceptibility throughout Tennessee.

[46] Colluvium: "A general term applied to unconsolidated material deposited by rainwash or slow continuous downslope creep, usually collecting at the base of hillsides" (NPS, 2000).

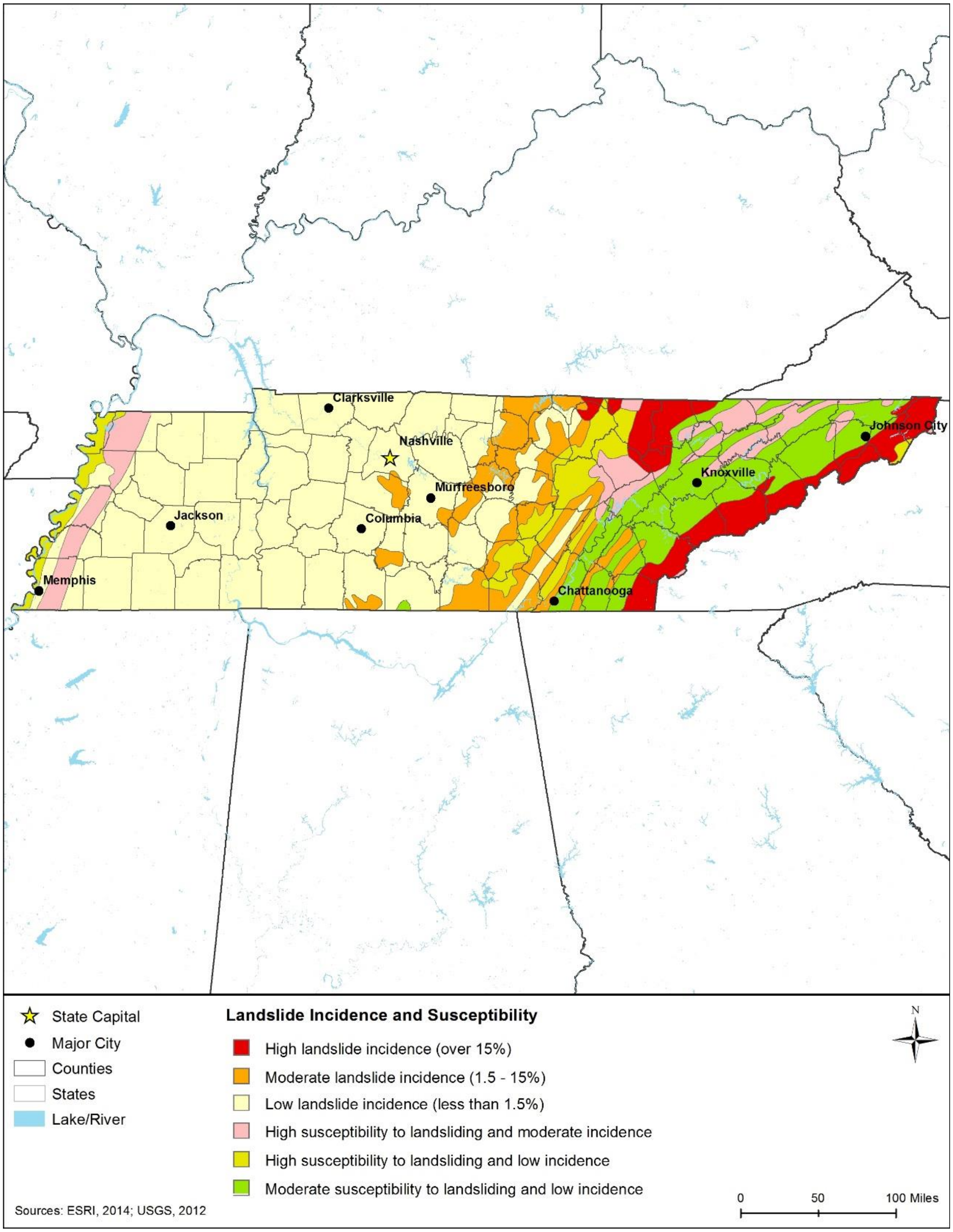


Figure 14.1.3-5: Tennessee Landslide Incidence and Susceptibility Hazard Map[47]

[47] Susceptibility hazards not indicated in Figure 14.1.3-5 where same or lower than incidence. Susceptibility to landslides is defined as the probable degree of response of areal rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying the incidence of landslides. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated. (USGS, 2014g)

Subsidence

Land subsidence is a "gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials" (USGS, 2000). Portions of Tennessee are susceptible to land subsidence due to the development of sinkholes and mine subsidence (Kohl, 2001). The primary causes of land subsidence are attributed to aquifer system compaction, drainage of organic soils, underground mining, sinkholes, and thawing permafrost (alhough permafrost is not an issue in Tennessee). More than 80 percent of subsidence in the United States is a consequence of over-withdrawal of groundwater. In many aquifers, which are subsurface soil layers through which groundwater moves, water is pumped from pore spaces between sand and gravel grains. If layers of silt or clay, which do not transport groundwater, confine an aquifer, the lowered water pressure in the sand and gravel causes slow drainage of water from the clay and silt beds. The reduced water pressure compromises support for the clay and silt beds, causing them to collapse on one another. The effects of this compression are seen in the permanent lowering of the land surface elevation (USGS, 2000).

Land subsidence can result in altered stream elevations and slopes; detrimental effects to infrastructure and buildings; and collapse of wells due to compaction of aquifer sediments. Subsided areas can become more susceptible to inundation, both during storm events and non-events. Lowered terrain is more susceptible to inundation during high tides. Additionally, land subsidence can affect vegetation and land use (USGS, 2013b).

In eastern and central Tennessee, a significant cause of land subsidence is the formation of sinkholes and dolines[48] in areas that contain karst topography.[49] In Tennessee, karst topography forms in areas that are underlain by carbonate bedrock (USGS, 2015g). "Limestone or dolomite bedrock creates the potential for both sinkhole and doline formation. The primary threat from dolines comes from flooding and ponding… [With sinkholes], damage to buildings commonly results from collapse of soil and/or rock material into void space" (TDEC, 2001). Figure 14.1.3-6 displays the areas within Tennessee that are subject to land subsidence due to karst topography.

In western Tennessee, within the greater Memphis area, observations regarding land subsidence vary. Despite the fact that Memphis relies exclusively on groundwater withdrawals for its water supply, land subsidence due to aquifer compaction historically has not been observed (USGS, 2004b). One study from the National Oceanic and Atmospheric Administration (NOAA); however, indicates that Memphis may be subsiding at rates between 1 and 2 millimeters per year (Shinkle & Dokka, 2004).

[48] Doline: "Depressions in the buried or exposed bedrock surface, whether narrow crevices or broad valleys" (Kohl, 2001).
[49] Karst: "A distinctive landscape (topography) that can develop where the underlying bedrock, often limestone or marble, is partially dissolved by surface or groundwater" (USGS, 2015d).

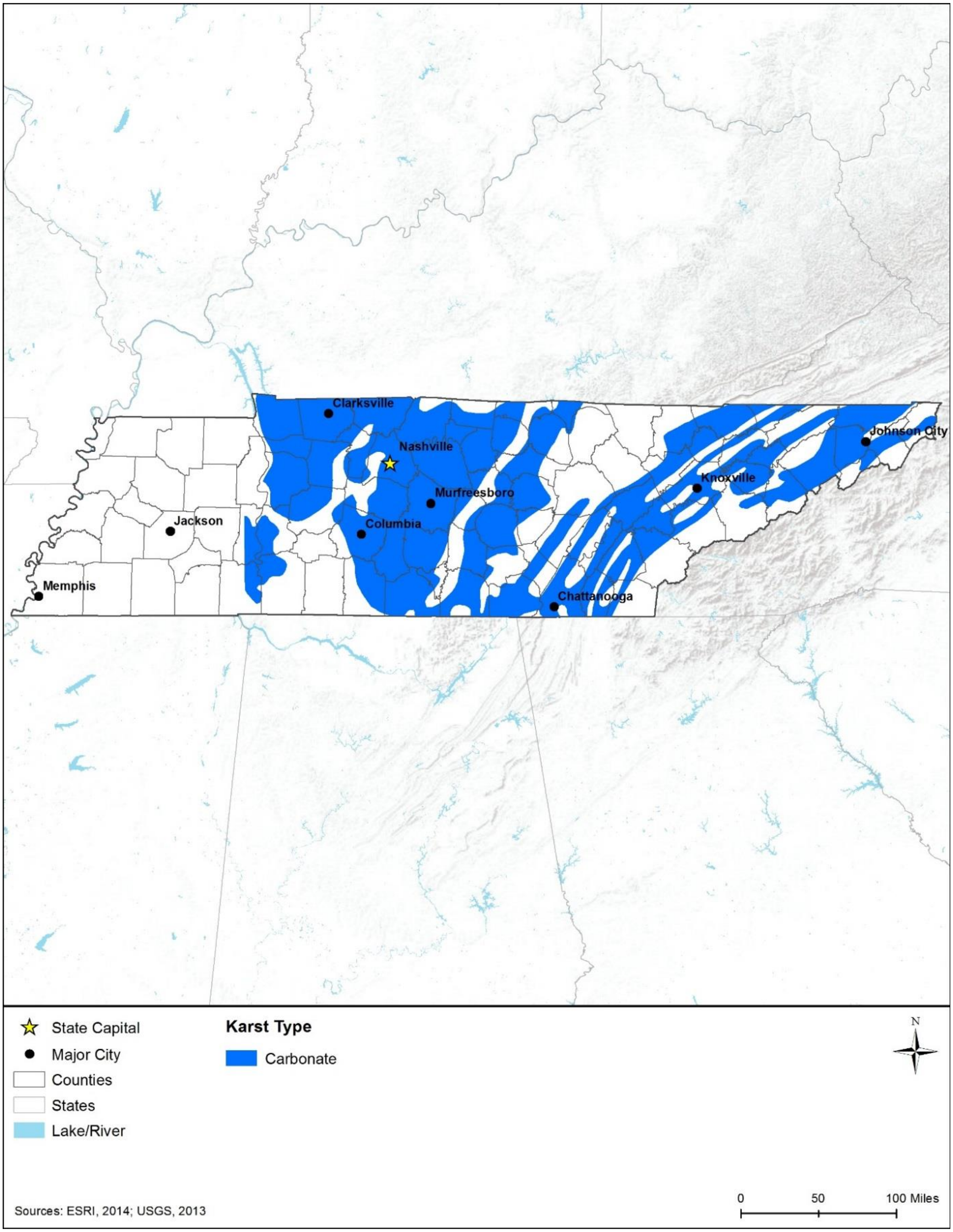


Figure 14.1.3-6: Areas Susceptible to Subsidence due to Karst Topography in Tennessee

14.1.4. Water Resources

14.1.4.1. Introduction

Water resources are defined as all surface waterbodies and groundwater systems including streams, rivers, lakes, floodplains, aquifers, and other aquatic habitats (wetlands are discussed separately in Section 14.1.5). These resources can be grouped into watersheds, which are defined as areas of land whose flowing water resources (including runoff from rainfall) drain to a common outlet such as a river or ocean. The value and use of water resources are influenced by the quantity and quality of water available for use and the demand for available water. Water resources are used for drinking, irrigation, industry, recreation, and as habitat for wildlife. Some water resources that are particularly pristine, sensitive, or of great economic value enjoy special protections under federal and state laws. An adequate supply of water is essential for human and ecological health and economic wellbeing. (USGS, 2014h)

14.1.4.2. Specific Regulatory Considerations

Federal laws relevant to protecting the quality and use of water resources are summarized in Appendix C, Environmental Laws and Regulations, and Section 1.8, Overview of Relevant Federal Laws and Executive Orders. Table 14.1.4-1 identifies the relevant laws and regulations for water resources in Tennessee.

Table 14.1.4-1: Relevant Tennessee Water Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Clean Water Act (CWA) Section 401 Water Quality Certification	TDEC	In accordance with Section 401 of the CWA, activities that may result in a discharge to waters of the U.S. require approval from TDEC indicating that the proposed activity will not violate water quality standards.
CWA Section 404 permit, Nationwide Permit (NWP), Tennessee State Regional Conditions	U.S. Army Corps of Engineers (USACE)	Work must not commence without the USACE's approval for 12: Utility Line Activities, work involving more than 0.25 acres of fill in waters of the U.S or if located in outstanding resource streams; 27: Stream and Wetland Activities.
NPDES Program	TDEC	Regulates the discharge of pollutants in stormwater discharges associated with construction activities that disturb one or more acres.
Tennessee Water Resources Information Act	TDEC	TCA Section 69-7-304 regulates the withdrawal of water from surface or groundwater sources through a registration process.
Tennessee Water Quality Control Act, Tennessee Code Annotated (TCA) § 69-3-101	Tennessee Board of Water Quality, Oil and Gas	Establish standards for pollution prevention, abatement, and control regarding quality of any Waters of the State in relation to their reasonable and necessary use.

Sources: (OpenEI, 2016) (USACE, 2016) (Tennessee Department of Environment & Conservation, 2016b) (Justia, 2016d) (Justia, 2016e)

14.1.4.3. Environmental Setting: Surface Water

Surface water resources are lakes, ponds, rivers, and streams. According to the TDEC, "Tennessee has more than 60,000 miles of rivers and streams and more than 570,000 lake and reservoir acres" (TDEC, 2014c). These surface waters supply drinking water; provide flood control and aquatic habitat; and support recreation, tourism, agriculture, fishing, power generation, and manufacturing across the state (TDEC, 2014c).

Watersheds

Watersheds, or drainage areas, consist of surface water and all underlying groundwater, and encompass an area of land that drains streams and rainfall to a common outlet (e.g., reservoir, bay). Tennessee's waters (lakes, rivers, and streams) are divided into 6 major watersheds, or drainage basins (Figure 14.1.4-1), Upper Tennessee, Cumberland, Lower Tennessee, Mississippi, Ohio River, and Mobile Bay. Visit www.tn.gov/environment/water/watersheds/ for information and additional maps about each watershed's location, size, and water quality.

The Cumberland River Watershed, in northern Tennessee, drains 18,000 square miles of land that is home to almost 2 million people. The Upper Tennessee River Watershed, along the eastern edge of the state, includes approximately 200 river miles, from the confluence of the Holston and French Broad rivers on the east side of Knoxville, to where the river crosses into northern Alabama just west of Chattanooga. The Mississippi River Basin covers more than 1.24 million square miles, includes all or parts of 31 states and 2 Canadian provinces. The entire watershed drains 41 percent of the land area of the 48 contiguous states to the Gulf of Mexico. Within Tennessee, the Mississippi River Watershed is in the southwestern part of the state, and covers approximately 590 square miles. The Lower Tennessee River Basin includes approximately 160 river miles in Tennessee, from where the river reenters Tennessee from northern Alabama at Pickwick Landing, to where it crosses into Kentucky at Land Between the Lakes. (TDEC, 2010)

Freshwater

As shown in Figure 14.1.4-1, there are five major rivers in Tennessee: Tennessee, Mississippi, Cumberland, Clinch, and Duck Rivers. The Tennessee River is almost 650 miles long, passing through three states and draining parts of four others, before eventually emptying into the Ohio River at Paducah, Kentucky. The Mississippi River is the second-longest river in the U.S., with a length of 2,320 miles. It has the third largest drainage basin in the world, exceeded in size only by the watersheds of the Amazon and Congo Rivers. The 688-mile long Cumberland River starts in eastern Kentucky, flows through southeastern Kentucky and crosses into Tennessee, and then curves back up into western Kentucky before draining into the Ohio River, a tributary to the Mississippi River. The Clinch and Powell rivers begin in southwestern Virginia and are considered the only ecologically intact (undammed) headwaters of the Tennessee River system. The Clinch River basin has been identified as the "number-one 'hotspot' in the nation for imperiled aquatic species. The Clinch River includes Kyles Ford Preserve, an 850-acre property with a shoal in a shallow section of the Clinch River containing at least 35 mussel species, more than any other place on Earth" (TDEC, 2010). The Duck River runs east to west 270 miles through the center of Tennessee, draining approximately roughly eight percent of Tennessee's total land area, and serves as the primary source of drinking water for 200,000 residents in the center of the state. As one of the longest free flowing rivers in the state, the Duck River supports diverse aquatic plants, fish, and invertebrate habitat (TDEC, 2010).

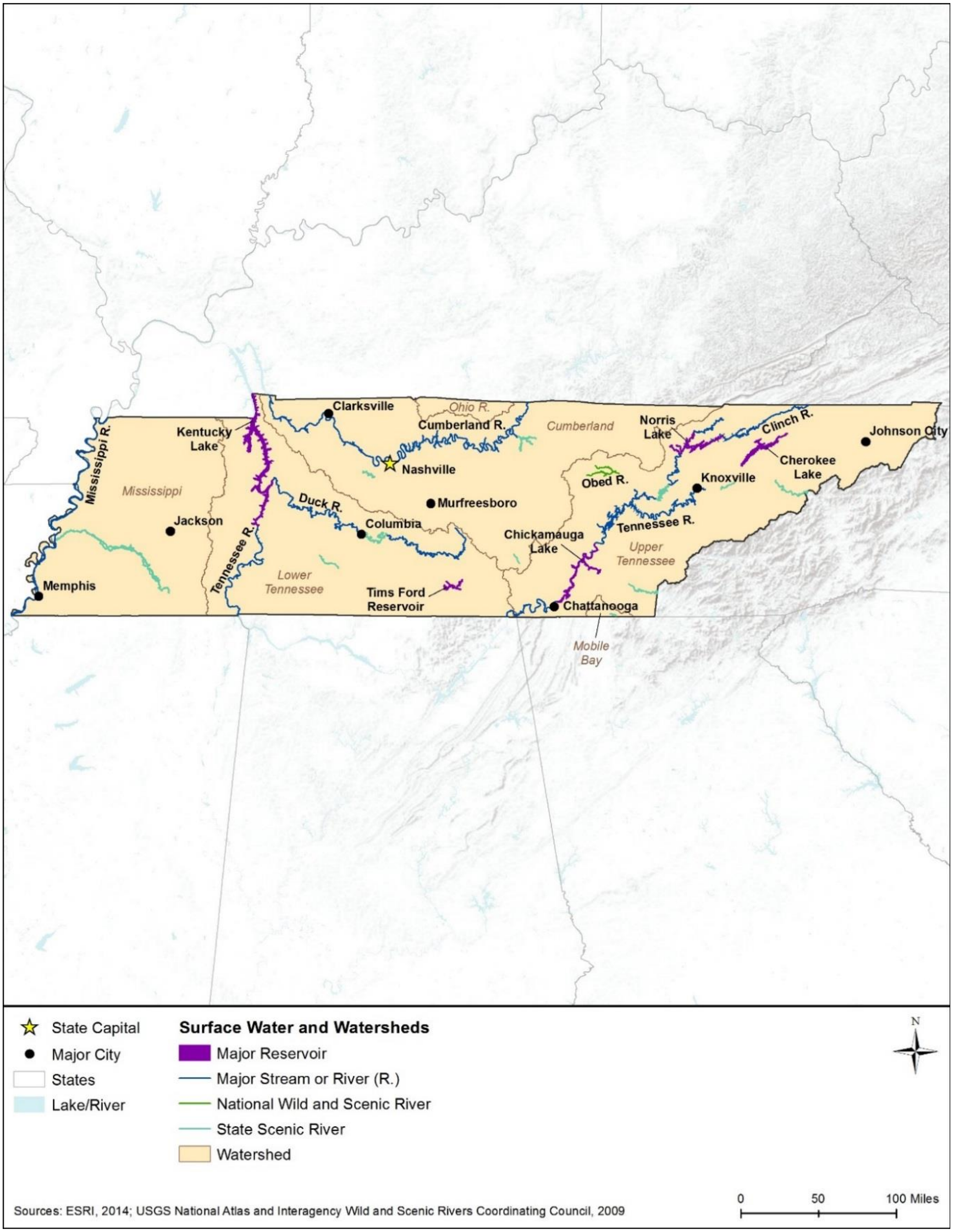


Figure 14.1.4-1: Major Tennessee Watersheds and Surface Waterbodies

Tennessee has over 90 public reservoirs or lakes with a total size over 572,000 acres (TDEC, 2014c). Some of the state's large lakes and dammed reservoirs provide flood control, hydropower[50] generation, and drinking water sources. The Kentucky Reservoir (Tennessee portion) is the largest lake at 117,500 acres, followed by Watts Bar Reservoir at 39,000 acres, Barkley Reservoir (Tennessee Portion) at 35,400 acres, and Chickamauga Reservoir at 35,400 acres. Almost all lakes in Tennessee are reservoirs that were created by the impoundment of a stream or river. The only large natural lake is the 15,000-acre Reelfoot Lake, formed by a series of earthquakes in 1811 and 1812 (TDEC, 2014c).

14.1.4.4. Sensitive or Protected Waterbodies

Wild and Scenic Rivers

The Obed River, in East Tennessee (Figure 14.1.4-1) is a federally designated National Wild and Scenic River in Tennessee. A total of 43.3 miles of the river are designated as wild, and 2.0 miles are designated as recreational. The Obed River has two main tributaries, Clear Creek and Daddys Creek that cut into the Cumberland Plateau of East Tennessee. The area is characterized by rugged scenery with whitewater flowing through deep canyons and sandstone bluffs. (National Wild and Scenic Rivers System, 2015a)

Since 1968, sections of 14 rivers have been designated as State Scenic Rivers by the Tennessee General Assembly (TDEC, 2015i). The State Scenic Rivers Program seeks to preserve valuable selected rivers in their free-flowing natural or scenic conditions and to protect their water quality and adjacent lands while preserving the rights of riparian landowners. These river areas include more than 400 miles of mountain streams and deep gorges of East Tennessee, pastoral rivers of Middle Tennessee and the swamp rivers of West Tennessee (TDEC, 2012a).

Outstanding National Resource Waters (ONRW)

Outstanding National Resource Waters (ONRW) are considered regionally important due to their unique recreational or ecological significance. "No new discharges, expansions of existing discharges, or water withdraws will be permitted unless it will not result in either measureable degradation or discernible effect." (TDEC, 2014c)

Tennessee ONRWs located within the Great Smoky Mountains National Park include the Little River, Abrams Creek, West Prong Little Pigeon River, and Little Pigeon River. In addition, the Big South Fork Cumberland River is a designated ONRW within Tennessee's Big South Fork National River and Recreation Area. The remaining ONRWs within the state include Reelfoot Lake (the Tennessee portion of the lake and associated wetlands) and the Obed River, which is also protected as a National Wild and Scenic River. (TDEC, 2014c)

14.1.4.5. Impaired Waterbodies

Several elements, including temperature, dissolved oxygen, suspended sediment, nutrients, metals, oils, observations of aquatic wildlife communities, and sampling of fish tissue, are used

[50] Hydropower: "electrical energy produced by falling or flowing water" (USEPA, 2015a).

to evaluate water quality. Under Section 303(d) of the Clean Water Act, states are required to assess water quality and report a listing of impaired waters,[51] the causes of impairment, and probable sources. Table 14.1.4-2 summarizes the water quality of Tennessee's assessed major waterbodies by category, percent impaired, designated use,[52] cause, and probable sources. Figure 14.1.4-2 shows the Section 303(d) waters in Tennessee as of 2014.

As shown in Table 14.1.4-2, and Figure 14.1.4-2, Tennessee's surface water is generally fair to good. Approximately half of the state's assessed rivers and streams are impaired and one-third of state lakes, reservoirs, and ponds are impaired. Designated uses of the impaired waters include irrigation, livestock watering, fish and aquatic life, and recreation. (USEPA, 2015b)

Table 14.1.4-2: Section 303(d) Impaired Waters of Tennessee, 2012

Water Type[a]	Amount of Waters Assessed[b] (Percent)	Amount Impaired (Percent)	Designated Uses of Impaired Waters	Top Causes of Impairment	Top Probable Sources for Impairment
Rivers and Streams	46.5%	48%	irrigation, livestock watering and wildlife, and fish and aquatic life	*E. coli*, sediment, habitat alterations	agricultural grazing, hydromodification (stream channel modifications), non-irrigated crop production
Lakes, Reservoirs, and Ponds	99%	32%	recreation, fish and aquatic life, and domestic water supply	polychlorinated biphenyls (PCBs), mercury, and dissolved oxygen	historic pollution/contaminated sediments, atmospheric deposition,[c] and industrial thermal discharges

Source: (USEPA, 2015b)

[a] Some waters may be considered for more than one water type.
[b] Tennessee has not assessed all waterbodies within the state.
[c] Atmospheric deposition: the process by which airborne pollutants settle onto to the earth's surface and pollutants travel from the air into the water through rain and snow ("wet deposition"), falling particles ("dry deposition"), and absorption of the gas form of the pollutants into the water (USEPA, 2015c).

Based on TDEC's most recent assessment of the state's lakes, reservoirs, and ponds, approximately 68 percent are fully supporting of their designated uses. Seventy percent of assessed reservoir and lake acres support recreational uses, and approximately 93 percent of assessed reservoir and lake acres support fish and aquatic life uses. For more information on Tennessee's water quality, visit TDEC Division of Water Resources: 305(b) Report found at http://www.tennessee.gov/assets/entities/environment/attachments/wr_wq_report-305b-2014.pdf. (TDEC, 2014c)

[51] Impaired waters: waterways that do not meet state water quality standards. Under the CWA, Section 303(d), states, territories, and authorized tribes are required to develop prioritized lists of impaired waters. (USEPA, 2015c)
[52] Designated Use: an appropriate intended use by humans and/or aquatic life for a waterbody. Designated uses may include recreation, irrigation, or drinking water supply. (USEPA, 2015c)

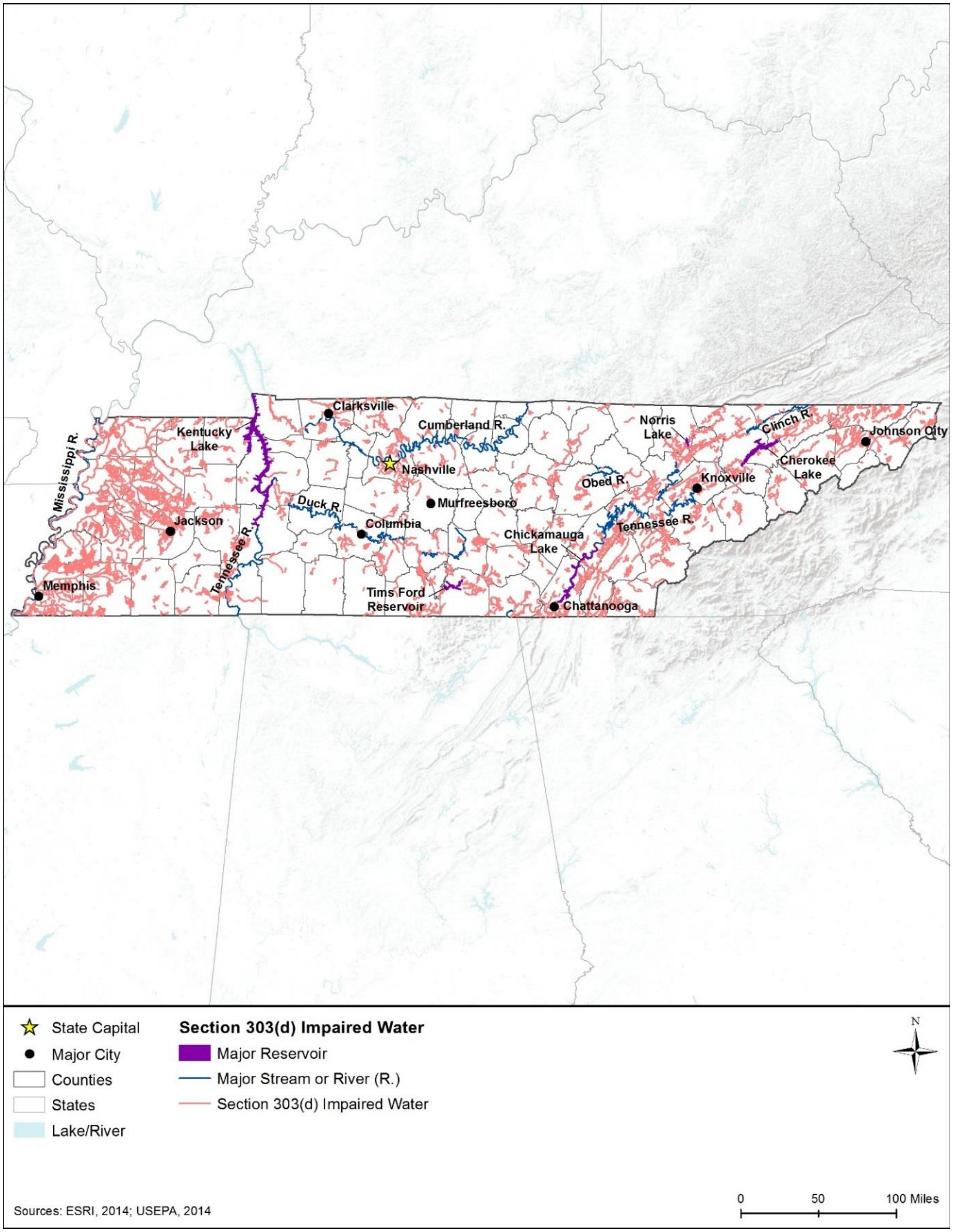


Figure 14.1.4-2: Section 303(d) Impaired Waters of Tennessee, 2014

14.1.4.6. Floodplains

The Federal Emergency Management Agency (FEMA) defines a floodplain or flood-prone area as "any land area susceptible to being inundated by water from any source" (44 Code of Federal Regulations [CFR] 59.1) (FEMA, 2000).[53] Through FEMA's flood hazard mapping program, the agency identifies flood hazards and risks associated with the 100-year flood, which is defined as "a flood that has a 1 percent chance of occurring in any given year," to allow communities to prepare and protect against flood events (FEMA, 2013).

Floodplains provide suitable and sometimes unique habitat for a wide variety of plants and animals, and are typically more biologically diverse than upland areas due to the combination of both terrestrial and aquatic ecosystems. Vegetation along stream banks provides shade, which helps to regulate water temperature for aquatic species. During flood events, sediment and debris settle out and collect on the floodplain, enriching the soil with additional nutrients. Pollutants from floodwater runoff are also filtered by floodplain vegetation and soils; thereby improving water quality. Furthermore, floodplains protect natural and built infrastructure by providing floodwater storage, erosion control, water quality maintenance, and groundwater recharge. Historically, floodplains have been favorable locations for agriculture, aquaculture, and forest production due to the relatively flat topography and nearby water supply. Floodplains can also offer recreational activities, such as boating, swimming, and fishing, as well as hiking and camping. (FEMA, 2014a)

Riverine and lake flooding is the primary type of floodplain in Tennessee, occurring along rivers, streams, or lakes where overbank flooding may occur, inundating adjacent land areas. In mountainous areas, such as the Smoky Mountains, floodwaters can build and recede quickly, with fast moving and deep water. Flooding in these areas can cause greater damage than typical riverine flooding due to the high velocity of water flow, the amount of debris carried, and the broad area affected by floodwaters. Whereas, flatter floodplains may remain inundated for days or weeks, covered by slow-moving and shallow water. (FEMA, 2014b)

Flooding is the leading cause for disaster declaration by the President in the U.S. and results in significant damage throughout the state annually (NOAA, 2015a). There are several causes of flooding in Tennessee, often resulting in loss of life and damage to property, infrastructure, agriculture, and the environment. These include severe rain events, rapid snowmelt, ice jams, and dam or levee failure (TEMA, 2015). Although some areas, such as floodplains, are more prone to flooding than others, no area in the state is exempt from flood hazards. Presidential Flood Disaster Declarations are more common in the western half of Tennessee within counties along major rivers, such as the Mississippi, Tennessee, Cumberland and Duck rivers (see Figure 14.1.4-1) (Tennessee Department of Economic and Community Development, 2010).

Local communities often have floodplain management or zoning ordinances that restrict development within the floodplain. FEMA provides floodplain management assistance, including mapping of 100-year floodplain limits, to approximately 399 communities in Tennessee through the National Flood Insurance Program (NFIP) (FEMA, 2015a). Established

[53] To search for and locate CFR records, see the Electronic Code of Federal Regulations (e-CFR): www.ecfr.gov.

to reduce the economic and social cost of flood damage, the NFIP encourages communities "to adopt and enforce floodplain management regulations and to implement broader floodplain management programs" and allows property owners in participating communities to purchase insurance protection against losses from flooding (FEMA, 2015b). As an incentive, communities can voluntarily participate in the NFIP Community Rating System (CRS), which is a program that rewards communities by reducing flood insurance premiums in exchange for doing more than the minimum NFIP requirements for floodplain management. As of May 2014, Tennessee had 18 communities participating in the CRS (FEMA, 2014c).[54]

14.1.4.7. Groundwater

Groundwater systems are sources of water that result from precipitation infiltrating the ground surface, and includes underground water that occupies pore spaces between sand, clay, or rock particles. An aquifer is a permeable geological formation that stores or transmits water to wells and springs. Groundwater is contained in either confined (bound by clays or nonporous bedrock) or unconfined (no layer to restrict the vertical movement of groundwater) aquifers. When the water table reaches the ground surface, groundwater will reappear as either streams, surface bodies of water, or wetlands. This exchange between surface water and groundwater is an important feature of the hydrologic (water) cycle (USGS, 1999).

Tennessee's principal aquifers consist of crystalline rock, carbonate-rock,[55] sandstone,[56] sand and gravel aquifers of alluvial and glacial origin,[57] and unconsolidated coastal-plain aquifers. Approximately 1.5 million residents rely on Tennessee's groundwater for their drinking water (many in the western half of the state). Approximately 300,000 people receive their drinking water from a public water system whose source is a combination of groundwater and surface water, and an additional 500,000 residents get their drinking water from private wells and springs. According to TDEC, the City of Memphis has one of the largest groundwater withdrawals (16 million gallons per day average production) of any municipality in the southeastern United States. (TDEC, 2014c)

Generally, the water quality of Tennessee's aquifers is suitable for drinking and daily water needs. Statewide, the most serious threats to groundwater quality include chlorinated solvents or degreasers and gasoline. Tennessee has an abundance of limestone rock types (approximately two-thirds of the state), referred to as "karst," which are highly susceptible to contamination. Section 14.1.3.8, Geological Hazards, has detailed information on karst geology in Tennessee.

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[54] A list of the 18 CRS communities can be found in the most recent FEMA CRS report dated May 1, 2014 (FEMA, 2014c) and additional program information is available from FEMA's NFIP CRS website (www.fema.gov/national-flood-insurance-program-community-rating-system).

[55] Carbonate-rock aquifers typically consist of limestone with highly variable water-yielding properties (some yield almost no water and others are highly productive aquifers) (Trapp, 1997).

[56] Sandstone aquifers form from the conversion of sand grains into rock caused by the weight of overlying soil/rock. The sand grains are rearranged and tightly packed, thereby reducing or eliminating the volume of pore space, which results in low-permeability rocks such as shale or siltstone. These aquifer types are highly productive in many places and provide large volumes of water. (USGS, 2015h)

[57] Sand and gravel aquifers of alluvial (sand, silt, or gravel materials left by river waters) and glacial origin are highly productive aquifers in the northern part of the country, consisting of mostly sand and gravel deposits formed by melting glaciers (USGS, 2015h).

In areas with karst geology, bacterial contamination from leaking septic tanks is a problem with private wells. (TDEC, 2014d)

Table 14.1.4-3 provides details on aquifer characteristics in the state; Figure 14.1.4-3 shows Tennessee's principal aquifers. Tennessee has no sole source aquifers. The Mississippi River alluvial aquifer situated in small portion of the western part of the state, as shown in Figure 14.1.4-3. This aquifer is more extensive in other states and represents a relatively small area within Tennessee, and thus is not discussed. For more information, see Arkansas Groundwater, Section 14.1.4.

Table 14.1.4-3: Description of Tennessee's Principal Aquifers

Aquifer Type and Name	Location in State	Groundwater Quality
Coastal Plain aquifer system in semiconsolidated sand Mississippi Embayment aquifer system and Southeastern Coastal Plain aquifer system Semiconsolidated sand, separated by three regional confining units of clay, mudstone, and chalk	Western part of the state	The most extensive and productive aquifer in Tennessee. Generally suitable for most uses. Contains moderately hard water with low concentrations of dissolved solids. Large iron concentrations may require pretreatment in some areas.
Pennsylvanian aquifers Sandstone and limestone	Central eastern Tennessee, ranging from the Kentucky border to the border with Alabama and Georgia	Water is soft to medium hard and used for domestic and agricultural supply.
Piedmont and Blue Ridge crystalline-rock aquifers Crystalline metamorphic and igneous (volcanic) rocks	Extreme eastern part of the state, along the border with North Carolina	Water quality is generally sufficient for drinking and other uses. The water is soft and slightly acidic. Water use includes industrial, agricultural, and domestic supplies.
Ordovician aquifer Carbonate	Central Tennessee, around Nashville	Generally suitable for most uses. Water is hard and may contain concentrations of dissolved solids such as sulfate and iron that exceed levels for safe drinking water. Water is used for public supply, industrial, mining, and thermoelectric power. Caves and sinkholes occur in some recharge areas, making this aquifer locally vulnerable to infiltration by surface contaminants.
Silurian-Devonian aquifers Dolomite and limestone	Scattered throughout the central and eastern parts of the state	Water is hard and generally is adequate or can be treated for high levels of fluoride and made adequate. Concentrations of dissolved solids and iron exceeded secondary maximum contaminant levels. Industrial, mining, and thermoelectric power uses are predominant.
Mississippian aquifers Limestone and sandstone (Carbonate)	North central part of the state just northwest of Nashville and central Tennessee	Suitable for most uses, with high concentrations of iron and sulfate in some locations. At depths of 300 feet or greater, dissolved solid concentrations can be high.

Aquifer Type and Name	Location in State	Groundwater Quality
Valley and Ridge carbonate rock aquifers Composed mostly of limestone.	Scattered throughout western part of state, ranging from the Virginia border to the border with Georgia	Water quality is generally sufficient for drinking and other uses. Water contains calcium and magnesium carbonate and dissolved solid concentrations are average. The water is very hard and slightly basic.
Valley and Ridge aquifers Carbonate rocks, share sandstone, and some coal-bearing beds	Scattered throughout western part of state, ranging from the Virginia border to the border with Georgia	Water quality is generally sufficient for drinking and other uses. Water contains calcium and magnesium carbonate and dissolved solid concentrations are average. The water is very hard and slightly basic.

Sources: (Moody, Carr, Chase, & Paulson, 1986) (Lloyd Jr. & Lyke, 1995a) (Lloyd Jr. & Lyke, 1995b) (Lloyd Jr. & Lyke, 1995c)

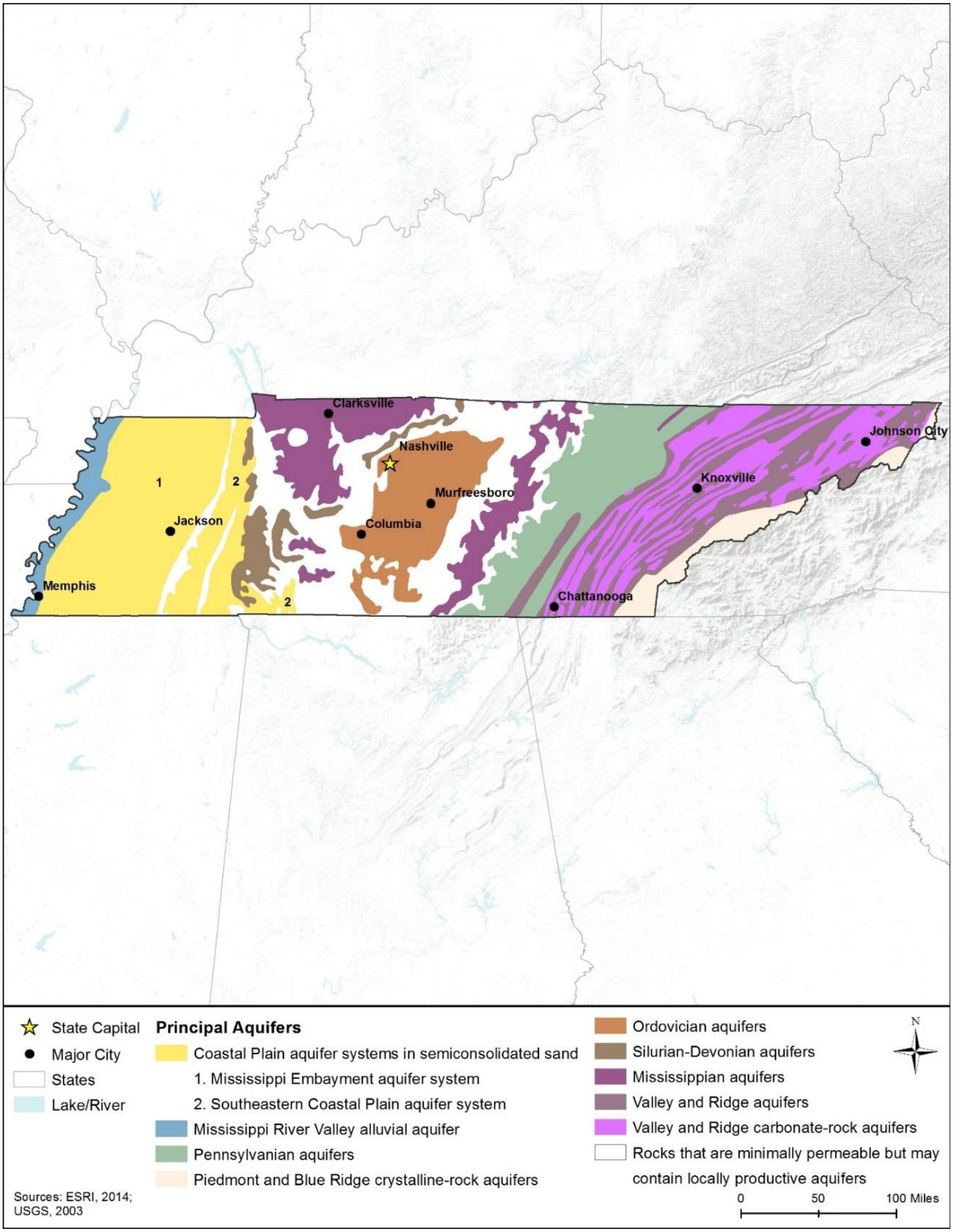

Figure 14.1.4-3: Principal Aquifers of Tennessee

14.1.5. Wetlands

14.1.5.1. Introduction

The Clean Water Act (CWA) defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (40 CFR 230.3(t), 1993).

The U.S. Environmental Protection Agency (USEPA) estimates that "more than one-third of the United States' threatened and endangered species live only in wetlands, and nearly half of such species use wetlands at some point in their lives" (USEPA, 1995). In addition to providing habitat for many plants and animals, wetlands also provide benefits to human communities. Wetlands store water during flood events, improve water quality by filtering polluted runoff, help control erosion by slowing water velocity and filtering sediments, serve as points of groundwater recharge, and help maintain base flow in streams and rivers. Additionally, wetlands provide recreation opportunities for people, such as hiking, bird watching, and photography. (USEPA, 1995)

14.1.5.2. Specific Regulatory Considerations

Appendix C, Environmental Laws and Regulations, describes the pertinent federal laws protecting wetlands in detail. Table 14.1.5-1 summarizes the major Tennessee state laws and permitting requirements relevant to the state's wetlands.

Table 14.1.5-1: Relevant Tennessee Wetlands Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
CWA Section 404 permit, NWP, Tennessee State Regional Conditions	USACE	Work must not commence without the USACE's approval for 12: Utility Line Activities, work involving more than 0.25 acres of fill in waters of the U.S or if located in outstanding resource streams; 27: Stream and Wetland Activities.
Tennessee Water Quality Control Act	TDEC/Tennessee Wildlife Resources Agency (TWRA)	Regulates activities that alter properties of waters of the state.
NPDES Program	TDEC	Regulates the discharge of pollutants in stormwater discharges associated with construction activities that disturb one or more acres.

Sources: (USACE, 2016) (Justia, 2016e) (Tennessee Department of Environment & Conservation, 2016b)

14.1.5.3. Environmental Setting: Wetland Types and Functions

The U.S. Fish and Wildlife Service's (USFWS) National Wetlands Inventory (NWI) mapping adopted a national Wetlands Classification Standard (WCS) that classifies wetlands according to shared environmental factors, such as vegetation, soils, and hydrology, as defined in (Cowardin, Carter, Golet, & LaRoe, 1979). The WCS includes five major wetland systems: Marine, Estuarine, Riverine, Lacustrine, and Palustrine. The first four of these include both wetlands and deepwater habitats but the Palustrine includes only wetland habitats (USFWS, 2017). Three of these systems are present in Tennessee as detailed in Table 14.1.5-2.

- "The Marine System consists of the open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean and the Water Regimes are determined primarily by the ebb and flow of oceanic tides. Salinities exceed 30 parts per thousand (ppt), with little or no dilution except outside the mouths of estuaries." Where wave energy is low, mangroves or mudflats may be present.
- "The Estuarine System consists of deepwater tidal habitats and adjacent tidal habitats that are usually semi enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and the ocean water is at least occasionally diluted by freshwater runoff from the land."
- "Riverine System includes all wetlands and deepwater habitats contained within a channel with two exceptions (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5 ppt."
- Lacustrine System includes inland waterbodies that are situated in topographic depressions, lack emergent trees and shrubs, have less than 30 percent vegetation cover, and occupy greater than 20 acres. Includes lakes, larger ponds, sloughs, lochs, bayous, etc.
- "Palustrine includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, or emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 percent." The System is characterized based on the type and duration of flooding, water chemistry, vegetation, or substrate characteristics (soil types). (Cowardin, Carter, Golet, & LaRoe, 1979) (FGDC, 2013)

In Tennessee, the main type of wetlands is palustrine (freshwater) wetlands, found on river and lake floodplains across the state, as shown in Figure 14.1.5-1. Table 14.1.5-2 uses 2014 NWI data to characterize and map Tennessee wetlands on a broad-scale.[58] The data is not intended for site-specific analyses and is not a substitute for field-level wetland surveys, delineations, or jurisdictional determinations, which may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work, at the site-specific level once those locations are known. The map codes and colorings in Table 14.1.5-2 correspond to the wetland types in the figures.

[58] The wetland acreages were obtained from the USFWS (2014) National Wetlands Inventory. Data from this inventory was downloaded by state at https://www.fws.gov/wetlands/. The wetlands data contains a wetlands classification code, which are a series of letter and number codes, adapted to the national wetland classification system in order to map from (e.g., PFO). Each of these codes corresponds to a larger wetland type; those wetland areas are rolled up under that wetlands type. The codes and associated acres that correspond to the deepwater habitats (e.g., those beginning with M1, E1, L1) were removed. The wetlands acres were derived from the geospatial datafile, by creating a pivot table to capture the sum of all acres under a particular wetland type. The maps reflect/show the wetland types/classifications and overarching codes; the symbolization used in the map is standard to these wetland types/codes, per the USFWS and Federal Geographic Data Committee.

Table 14.1.5-2: Tennessee Wetland Types, Descriptions, Location, and Amount, 2014

Wetland Type	Map Code and Color	Description[a]	Occurrence	Amount (acres)[b]
Palustrine forested wetland	PFO	PFO wetlands contain woody vegetation that are at least 20 feet tall. Floodplain forests and hardwood swamps are examples of PFO wetlands.	Forested lowlands within the state, concentrated on western half	731,171
Palustrine scrub-shrub wetland	PSS	Woody vegetation less than 20 feet tall dominates PSS wetlands. Thickets and shrub swamps are examples of PSS wetlands.	Throughout the state, often on river and lake floodplains	
Palustrine emergent wetlands	PEM	PEM wetlands have erect, rooted, green-stemmed, annual, water-loving plants present for most of the growing season in most years. PEM wetlands include freshwater marshes, wet meadows, fens,[c] prairie potholes, and sloughs.	Throughout the state, in depressions	49,380
Palustrine unconsolidated bottom	PUB	PUB and PAB wetlands are commonly known as freshwater ponds, and includes all wetlands with at least 25% cover of particles smaller than stones and a vegetative cover less than 30%.	Throughout the state	88,556
Palustrine aquatic bed	PAB	PAB wetlands include wetlands vegetated by plants growing mainly on or below the water surface line.		
Other Palustrine wetland	Misc. Types	Farmed wetland, saline seep,[d] and other miscellaneous wetlands are included in this group.	Abandoned fields, depressions (seeps), along hillsides and highways	983
Riverine wetland	R	Riverine systems include rivers, creeks, and streams. They are contained in natural or artificial channels periodically or continuously containing flowing water.	Throughout the state	5,208
Lacustrine wetland	L2	Lacustrine systems are lakes or shallow reservoir basins generally consisting of ponded waters in depressions or dammed river channels, with sparse or lacking persistent emergent vegetation, but including any areas with abundant submerged or floating-leaved aquatic vegetation. These wetlands are less than 8.2 feet deep.	Throughout the state	43,348
			TOTAL	**918,646**

Sources: (Cowardin, Carter, Golet, & LaRoe, 1979) (USFWS, 2015a) (USFWS, 2017)

[a] The wetlands descriptions are based on information from the Federal Geographic Data Committee (FGDC)'s Classification of Wetland and Deepwater Habitats of the United States. Based on Cowardin, et.al, 1979, some data has been revised based on the latest scientific advances. The USFWS uses these standards as the minimum guidelines for wetlands mapping efforts (FGDC, 2013).

[b] All acreages are rounded to the nearest whole number. The maps are prepared from the analysis of high altitude imagery. A margin of error is inherent in the use of imagery. The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted (USFWS, 2015b)

[c] Fens are nutrient-rich, grass- and sedge-dominated emergent wetlands that are recharged from groundwater and have continuous running water (Edinger, et al., 2014).

[d] Saline seep is an area where saline groundwater discharges at the soil surface. These wetland types are characterized by saline soils and salt tolerant plants (City of Lincoln, 2015).

Palustrine Wetlands

In Tennessee, palustrine wetlands include the majority of vegetated freshwater wetlands (bottomland hardwood forests, freshwater marshes, swamps, bogs, and ponds). Common species found in palustrine forested wetlands (PFO) in Tennessee are oaks *(Quecus* spp.*)*, red maple (*Acer rubrum*), and ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), sedges (*Cyperus* spp.), Devil's beggar-tick (*Bidens frondosa)* and various other native wildflowers and grass. Palustrine scrub-shrub wetlands (PSS) in Tennessee consist of dominant tree species such as silky dogwood *Cornus amomum*, red osier dogwood (*Cornus sericea*), buttonbush (*Cephalanthus occidentalis*), alder (*Alnus serrulata)*, willow (*Salix* spp.*)*, and elderberry (*Sambucus nigra* ssp. *canadensis*), and hardwood trees less than 15 feet tall. PFO and PSS are the most common type of palustrine wetlands within Tennessee. (TWRA, 2015a) (Morgan & Roberts, 1999)

Palustrine emergent wetlands (PEM), or freshwater marsh, fen, and slough,[59] in Tennessee support diverse plant and animal populations. Common PEM vegetation consists primarily of grasses and sedges with slender rush (*Juncus tenuis*), Joe pyeweed (*Eupatorium purpureum)*, jewelweed (*Impatiens capensis*), and boneset *(Eupatorium perfoliatum)*. Shallow emergent wetlands often have open water mixed with vegetation such as cattail (*Typha* spp.), soft rush (*Juncus effusus*), arrowhead (*Sagittaria latifolia*), bur reed (*Sparganium eurycarpum*), and subcordate water plantain *(Alisima subcordatum)*. (TWRA, 2015a) (Morgan & Roberts, 1999)

Palustrine aquatic (PAB/PUB) wetlands have water that is greater than 2 feet in depth and often contain water for an extended period during the growing season. Deep water marshes are primarily open water and are sparsely vegetated with floating plants such as water lily (*Nymphaea odorata*), duckweeds (*Lemna minor*), and pondweed (*Potamogeton natans*) and submerged aquatic plants such as pondweeds (*P. richardsonii*), coontail (*Ceratophyllum demersum*), water milfoil (*Myriophyllum spicatum*), and bladderwort (*Utricularia macrorhiza*). Deep-water marshes are not pond and lakes. These are the easiest wetlands to recognize and occur throughout the state. (TWRA, 2015a) (Morgan & Roberts, 1999)

TDEC estimates that there were 1,937,000 acres of palustrine wetlands in state, in the beginning of the twentieth century (TDEC, 2014c). Based on the USFWS NWI 2014 analysis, there are approximately 870,090 acres of palustrine wetlands in the state, for an approximate 55 percent loss of palustrine wetlands (USFWS, 2014a). Main threats to palustrine wetlands in Tennessee include agricultural conversion and urbanization (TDEC, 2014c).

[59] Slough: "swamp or shallow lake system, usually a backwater to a larger body of water" (NOAA, 2014).

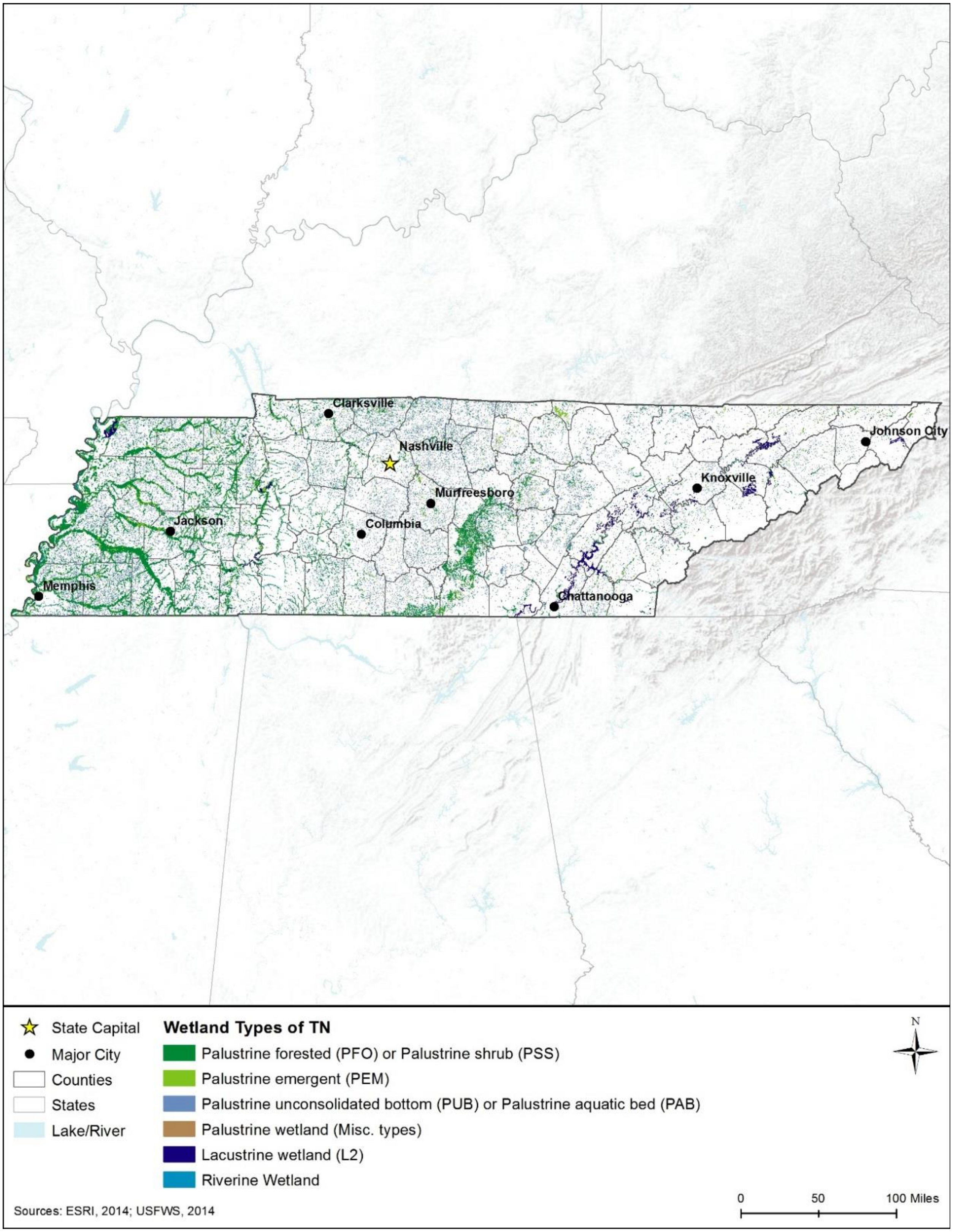

Figure 14.1.5-1: Wetlands by Type, in Tennessee, 2014

Lacustrine and Riverine Wetlands

Lacustrine and riverine wetland systems consist of aquatic beds consisting of floating and submersed aquatic plants, such as water lily and coontail, and nonpersistent-emergent wetlands consisting of plants such as pondweed and American lotus (*Nelumbo lutea)* are associated with Tennessee's rivers, lakes, and reservoirs (TWRA, 2015a) (Morgan & Roberts, 1999). Lacustrine and riverine wetlands comprise five and one percent, respectively, of Tennessee's total wetlands (USFWS, 2014a).

14.1.5.4. Wetlands of Special Concern or Value

In addition to protections under the state's regulations, and national CWA, Tennessee's antidegradation policy applies to wetlands as a category of waters of the state. The water quality standards specifically name Reelfoot Lake and adjacent wetlands as ONRWs and are considered high quality wetlands. Reelfoot Lake is a 15,000-acre lake in northwest Tennessee created by a serious of earthquakes in 1811 and 1812. The 18,000-acre natural area (lake and surrounding area) includes approximately 10,900 acres of open water and marshes, and about 7,100 acres of bottomland hardwood forests and cypress dominated bottoms and sloughs. The diverse communities provide valuable habitat for many bird species, as well as rare or endangered plants and animals in Tennessee (TDEC, 2015j). To learn more about Reelfoot Lake State Park, visit http://tnstateparks.com/parks/about/reelfoot-lake.

Other Important Wetland Sites in Tennessee

- Wildlife Management Areas in Tennessee are designated for outdoor recreation; these public lands vary in size from 53 acres to 625,000 acres, and many include wetlands. To learn more about state Wildlife Management Areas, visit https://www.tn.gov/twra/article/wildlife-management-area-regulations.
- National Natural Landmarks in Tennessee range in size from 9 acres to over 1,100 acres, and are owned by USFWS, U.S. Air Force, TDEC, and other conservation organizations and individuals (NPS, 2012a). Section 14.1.8, Visual Resources, describes the state's 13 National Natural Landmarks.
- Other wetlands protected under easements or agreements through voluntary government programs and resource conservation groups are found across the state. These include NRCS Agricultural Conservation Easement Program and easements managed by natural resource conservation groups such as state land trusts, The Nature Conservancy, Ducks Unlimited, and USFWS. According to the National Conservation Easement Database, a national electronic repository of government and privately held conservation easements (http://conservationeasement.us/), NRCS holds approximately 45,800 acres in conservation easements in Tennessee. (NCED, 2015)

14.1.6. Biological Resources

14.1.6.1. Introduction

This chapter describes the biological resources of Tennessee. Biological resources include terrestrial[60] vegetation, wildlife, fisheries and aquatic habitats,[61] threatened[62] and endangered[63] species as well as communities and species of conservation concern. Wildlife habitat and associated biological ecosystems are also important components of biological resources. Tennessee supports a wide diversity[64] of biological resources ranging including large contiguous tracts of hardwood forests, wetlands, bogs, prairies, and exceptional stream and river ecosystems. Each of these topics is discussed in more detail below.

14.1.6.2. Specific Regulatory Considerations

The federal laws relevant to the protection and management of biological resources in Tennessee are summarized in detail in Appendix C, Environmental Laws and Regulations, and Section 1.8, Overview of Relevant Federal Laws and Executive Orders. Table 14.1.6-1 summarizes major state laws relevant to the biological resources of Tennessee.

Table 14.1.6-1: Relevant Tennessee Biological Resources Laws and Regulations

Law/Regulation	Regulatory Agency	Applicability
Tennessee Endangered or threatened species list (T.C.A. 70-8-105.).	TWRA	Prohibits the buying, transporting, selling, importing, processing, and possession of state and federally endangered fish and wildlife species.
Rules and Regulations of Live Wildlife (Tennessee Administrative Register [TAR] 1660-1-18-.03)	TWRA	Requires transport permits for certain species and deems it illegal possess, propagate, buy, sell, barter, trade, transfer, loan, or release into public or private waters prohibited exotic species in order to protect against harmful invasive species and to ensure the health and viability of native and recreational species.
Pest Plant Regulations (TAR 0080-06-24-.01)	Tennessee Department of Agriculture	Stipulates that plants listed as pest plants “shall not be propagated, sold, offered for sale, or released within the state.”

Sources: (Michigan State University Animal Center, 2016) (Michigan State University Animal Center, 2015) (USDA, 2016a)

[60] Terrestrial: “Pertaining to the land” (USEPA, 2015a).
[61] Habitat: “The environment in which an organism or population of plants or animals lives; the normal kind of location inhabited by a plant or animal” (USEPA, 2015a).
[62] Threatened species are “any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range” (16 U.S.C §1532(20)).
[63] Endangered species are “any species which is in danger of extinction throughout all or a significant portion of its range” (16 U.S.C §1532(6)).
[64] Diversity: “An ecological measure of the variety of organisms present in a habitat” (USEPA, 2015a).

14.1.6.3. Terrestrial Vegetation

The distribution of flora within the state is a function of the characteristic geology,[65] soils, climate,[66] and water of a given geographic area and correlates with distinct areas identified as ecoregions.[67] Ecoregions are broadly defined areas that share similar characteristics, such as climate, geology, soils, and other environmental conditions and represent ecosystems contained within a region. The boundaries of an ecoregion are not fixed, but rather depict a general area with similar ecosystem types, functions, and qualities (National Wildlife Federation, 2015) (USDA, 2015a) (World Wildlife Fund, 2015).

Ecoregion boundaries often coincide with physiographic[68] regions of a state. In Tennessee, the three main physiographic regions include the Appalachian Highlands (Blue Ridge, Valley and Ridge, and Appalachian Plateaus Provinces), Interior Plains (Interior Low Plateaus Province), and Atlantic Plain (Coastal Plain Province) (USGS, 2003a). The ecoregions mapped by the USEPA are the most commonly referenced, although individual states and organizations have also developed ecoregions that may differ slightly from those designated by the USEPA.

The USEPA divides North America into 15 broad Level I ecoregions. These Level I ecoregions are further divided into 50 Level II ecoregions. These Level II ecoregions are further divided into 182 smaller Level III ecoregions. This Section provides an overview of the terrestrial vegetation resources for Tennessee at USEPA Level III. (USEPA, 2016a)

As shown in Figure 14.1.6-1, the USEPA divides Tennessee into eight Level III ecoregions. The eight ecoregions support a variety of different plant communities, and boundaries for these ecoregions are considered transitional. In general, the vegetation is more forested and the topography more rugged in the eastern portion of the state, and agricultural practices are more common in the central and western part of Tennessee. Table 14.1.6-2 provides a summary of the general abiotic[69] characteristics, vegetative communities, and the typical vegetation found within each of the eight Tennessee ecoregions.

[65] USGS defines geology as an interdisciplinary science with a focus on the following aspects of earth sciences: geologic hazards and disasters, climate variability and change, energy and mineral resources, ecosystem and human health, and groundwater availability.
[66] Climate: "The average weather conditions in a particular location or region at a particular time of the year. Climate is usually measured over a period of 30 years or more." (USEPA, 2015a)
[67] Ecoregion: "A relatively homogeneous ecological area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables" (USEPA, 2015a).
[68] Physiographic: "The natural, physical form of the landscape" (USEPA, 2015d).
[69] Abiotic: "Characterized by absence of life; abiotic materials include non-living environmental media (e.g., water, soils, sediments); abiotic characteristics include such factors as light, temperature, pH, humidity, and other physical and chemical influences" (USEPA, 2016b).

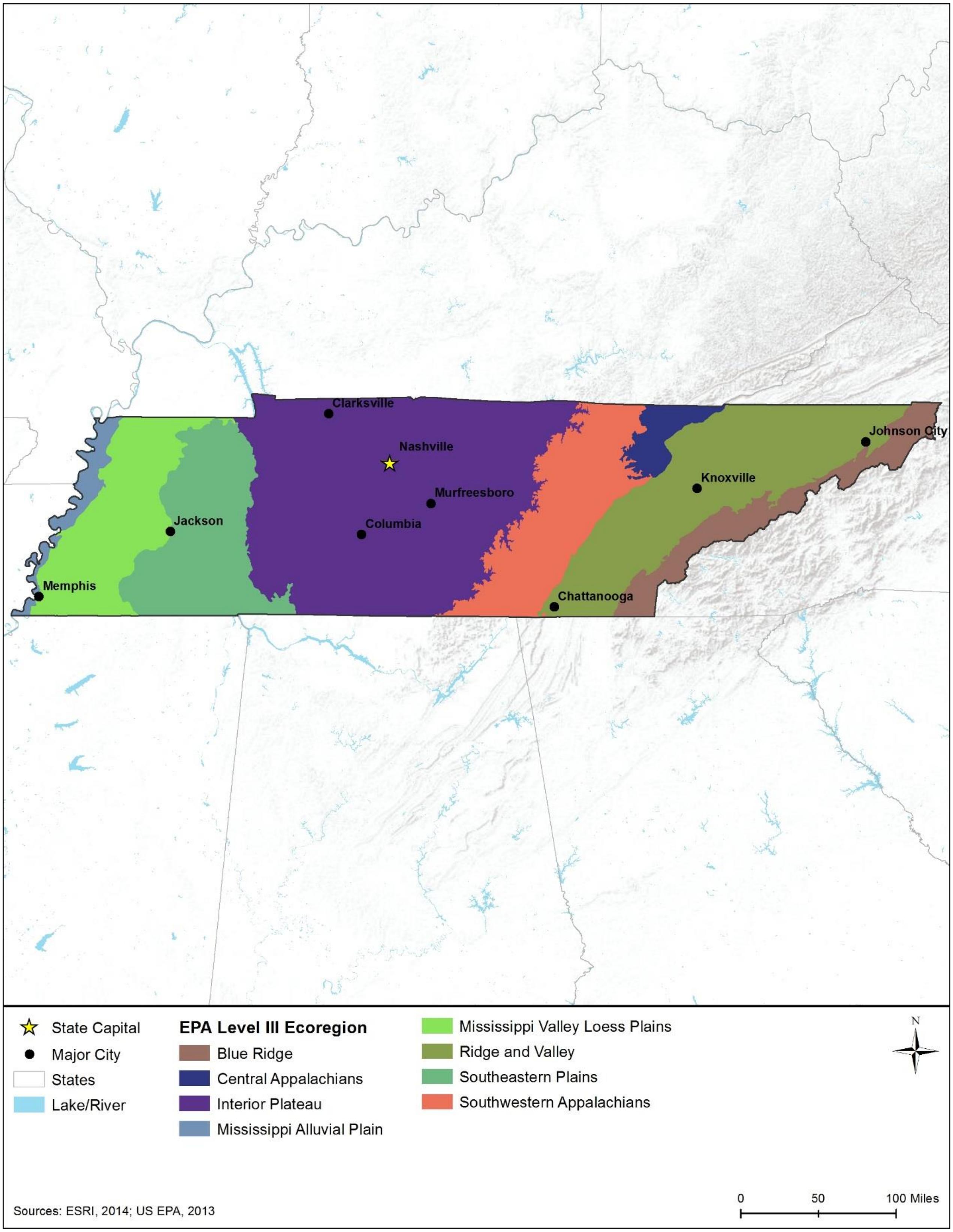

Figure 14.1.6-1: USEPA Level III Ecoregions in Tennessee

Table 14.1.6-2: USEPA Level III Ecoregions of Tennessee

Ecoregion Number	Ecoregion Name	Abiotic Characterization	General Vegetative Communities	Typical Dominant Vegetation
69	Central Appalachians	A predominately forested plateau[a] with rugged terrain and a cool climate with extensive rainfall. Siltation and acidification of streams is common from coal mining in the region. Higher than neighboring regions elevations range from 1,200 to 4,600 feet above sea level.	Appalachian Oak, Northern Hardwood Forest, and Spruce-Fir Forests	**Hardwood Trees –** red oak (*Quercus rubra*), black cherry (*Prunus serotina*), sugar maple (*Acer saccaharum*), hickory (*Carya* spp.), and red maple *(Acer rubrum)* **Conifer Trees –** eastern white pine *(Pinus stobus)*, eastern hemlock *(Tsuga canadensis)*, and red spruce (*Picea rubens*).
66	Blue Ridge	A combination of high plateaus transitioning to rugged mountains with elevations above 6,600 feet above sea level. A densely forested area with clear high-gradient streams. Precipitation can range from 100 to 40 inches annual depending on local relief.	Appalachian Oak Forest	**Hardwood Trees –** white oak (*Q. alba*) and red oak
68	Southwestern Appalachians	A low elevation mountainous region containing predominantly forestland with some cropland and pasture. The region stretches from Tennessee to Alabama and contains rougher topography with steep escarpments along the regions western border.	Mesophytic Forest and Mixed Oak Forest	**Hardwood Trees –** American beech (*Fagus grandifolia*), tulip-tree (*Liriodendron*), red oak, white oak, and sugar maple **Conifer Trees –** shortleaf pine (*Pinus echinata*)
67	Ridge and Valley	A low-lying region of forested ridges and agricultural valleys that run parallel from the southwest to the northeast. This region of approximately 50 percent forest cover is surrounded by mountainous regions at higher elevation. Elevation varies widely from 500 to 4,300 feet above sea level.	Appalachian Oak Forest and Hemlock Forest	**Hardwood Trees –** white oak, red oak, black oak (*Q. velutina*), hickory, and red maple. **Conifer Trees –** eastern white pine and eastern hemlock

Ecoregion Number	Ecoregion Name	Abiotic Characterization	General Vegetative Communities	Typical Dominant Vegetation
73	Mississippi Alluvial Plain	A broad flat alluvial plain with mild winters and hot summers. Southern floodplain forest are the dominant native vegetation, but today a large portion of this region has been converted to cropland.	Southern Floodplain Forest	**Hardwood Trees** – bald cypress (*Taxodium distichum*), black gum (*Nyssa sylvatica*), sweet gum (*Liquidambar styraciflua*), overcup oak (*Quercus lyrata*), water oak (*Q. nigra*), and willow oak (*Q. phellos*)
74	Mississippi Valley Loess Plains	A region of loess capped hills surrounded by the lower Mississippi Alluvial Plain. Oak-hickory forest is the dominant land cover.	Oak-Hickory Forest	**Hardwood Trees** – southern red oak (*Q. falcata*), white oak, and shagbark hickory (*Carya ovata*)
65	Southeastern Plains	Less elevation and relief than in Piedmont. Soils composed of sands, silts, and clays, unlike the metamorphic and igneous rocks found ecoregions to the north.	Mixed forest and oak-hickory-pine.	**Hardwood Trees –** turkey oak (*Q. laevis*), red oak, water oak, and shagbark hickory **Conifer Trees** - Longleaf pine (*Pinus palustris*), loblolly pine (*P. taeda*), shortleaf pine
71	Interior Plateau	An elevated plateau in the center of the state. Soils are primarily derived from loess and residuum of underlying sandstone, siltstone, shale, and limestone (glacial till uncommon). Remains mostly forested.	Oak-Hickory Forest	**Hardwood Trees –** black oak, white oak, bur oak (*Q. macrocarpa*), northern pin oak (*Q. ellipsoidalis*), chestnut oak (*Q. prinus*), pignut hickory (*Carya glabra*), bitternut hickory (*C. cordiformis*), shagbark hickory

Sources: (USEPA, 2010a) (USEPA, 2016c) (CEC, 2011)

[a] Plateau: "An elevated plain, tableland or flat-topped region of considerable extent" (USEPA, 2015c).

Communities of Concern

Currently, no vegetative communities of concern or rare natural communities are listed in Tennessee. The Tennessee State Wildlife Action Plan (SWAP) does list priority habitats that are associated with Species of Greatest Conservation Need (SGCN), but these habitats are not ranked based on rarity within the state. In addition, the SWAP also lists conservation opportunity areas that will be the focus of restoration and management efforts of these priority habitats (TWRA, 2015b).

Nuisance and Invasive Plants

There are a large number of undesirable plant species that are considered nuisance and invasive[70] plants. Noxious weeds are typically non-native species that have been introduced into an ecosystem inadvertently; however, on occasion native species can be considered a noxious weed. Noxious weeds greatly affect agricultural areas, forest management, natural, and other open areas (GPO, 2004). The U.S. government has designated certain plant species as noxious weeds in accordance with the Plant Protection Act of 2000 (7 U.S.C. 7701 et seq.). As of September 2014, 112 federally recognized noxious weed species have been catalogued in the U.S. (88 terrestrial, 19 aquatic, and 5 parasitic) (USDA, 2015b).

Tennessee maintains a plant pest list consisting of species that are considered injurious to the agricultural, horticultural, silvicultural, or other interests of the state. The Tennessee Exotic Pest Plant Council (TN-EPPC) is responsible for maintaining this list, though it has no regulatory authority. (TN-EPPC, 2009)

TN-EPPC developed a ranking system for plants based on field observations and research. The four different ranks, in order from least to greatest threat level, for invasive plants are (TN-EPPC, 2009):

- **Alert:** invasive plants that occupy habitats similar to those present in Tennessee. This rank includes 49 species (grass, aquatic, tree, forb/herb, and vine), such as morrows bush honeysuckle (*Lonicera morrowii*), bells honeysuckle (*Lonicera* x *bella*), small Chinese tallowtree (*Triadica sebifera* (L.)), and water nymph (*Najas minor*).
- **Lesser Threat:** at present, not considered a threat to native plant species and communities, but may proliferate on disturbed areas. This rank includes 23 species, such as wild parsnip (*Pstinaca sativa*) and wine raspberry (*Rubus pheonicolasius*).
- **Significant Threat:** species less likely to displace native species and communities. There are 37 species, including amur bush honeysuckle (*Lonicera maackii*) thorny olive (*Elaeagnus pungens*), and tropical soda apple (*Solanum viarum*).
- **Severe Threat:** when found, these species have been generally successful in displacing native plant species and communities. There are 26 species, including common privet (*Ligustrum vulgare*) and autumn olive (*Elaeagnus umbellata*). (TN-EPPC, 2009)

[70] Invasive: "These are species that are imported from their original ecosystem. They can out-compete native species as the invaders often do not have predators or other factors to keep them in check." (USEPA, 2015a)

14.1.6.4. Terrestrial Wildlife

This section discusses the terrestrial wildlife species in Tennessee, divided among mammals,[71] birds,[72] reptiles and amphibians,[73] and invertebrates.[74] Terrestrial wildlife consist of those species, and their habitats, that live predominantly on land. Terrestrial wildlife include common big game species, small game animals, furbearers, nongame animals, game birds, waterfowl, and migratory birds as well as their habitats within Tennessee. A discussion of non-native and/or invasive terrestrial wildlife species is also included within this section. Information regarding the types and location of native and non-native/invasive wildlife is useful for assessing the importance of any impacts to these resources or the habitats they occupy. Tennessee is home to approximately 77 mammal species, 56 reptile species, 70 amphibian species, 406 resident and migratory bird species, and a large number of invertebrates (TWRA, 2008) (Tennessee Ornithological Society, 2014).

Mammals

Common and widespread mammalian species in Tennessee include the white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), eastern cottontail (*Sylvilagus floridana*), woodchuck (*Marmota monax*), and eastern chipmunk (*Tamias striatus*). Mammals such as the bobcat (*Lynx rufus*) and fisher (*Martes pennanti*) are uncommon or rare in Tennessee due to restricted habitat or secretive behavior (TWRA, 2015b).

In Tennessee, white-tailed deer, black bear (*Ursus americanus*), and elk (*Cervus canadensis*) are classified as big game species, whereas small game species include small mammals (e.g., squirrels and rabbits), furbearers, [75] and upland and migratory game birds. The following 14 species of furbearers may be legally hunted or trapped in the Tennessee: raccoon, red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), opossum, coyote (*Canis latrans*), muskrat (*Ondatra zibethicus*), long-tailed weasel (*Mustella* spp.), striped skunk (*Mephitis mephitis*), spotted skunk (*Spilogale putorius*), groundhog (*Marmota monax*), beaver (*Castor canadensis*), mink (*Mustela vison*), bobcat, and river otter (*Lontra canadensis*). (TWRA, 2015c)

Tennessee has identified 22 mammals as Species of Greatest Conservation Need (SGCN). Five of these species are federally listed as under the Endangered Species Act (ESA). Section 14.1.6.6, Threatened and Endangered Species, identifies these protected species. The SGCN list consists of at-risk species that are rare or declining, and grants can provide funding for efforts to reduce their potential for listing as endangered. Although these species have been targeted for conservation they are not currently under legal protection, with the exception of those also listed

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[71] Mammals: "Warm-blooded vertebrates that give birth to and nurse live young; have highly evolved skeletal structures; are covered with hair, either at maturity or at some stage of their embryonic development; and generally have two pairs of limbs, although some aquatic mammals have evolved without hind limbs" (USEPA, 2015a).
[72] Birds: "Warm-blooded vertebrates possessing feathers and belonging to the class Aves" (USEPA, 2015a).
[73] Amphibian: "A cold-blooded vertebrate that lives in water and on land. Amphibians' aquatic, gill-breathing larval stage is typically followed by a terrestrial, lung-breathing adult stage." (USEPA, 2015a)
[74] Invertebrates: "Animals without backbones: e.g., insects, spiders, crayfish, worms, snails, mussels, clams, etc." (USEPA, 2015a)
[75] Furbearer is the name given to mammals that traditionally have been hunted and trapped primarily for fur.

under the ESA or the Tennessee ESA. The SGCN list is updated periodically for the state to focus their conservation efforts and to implement their SWAP (TWRA, 2015d).

Birds

The number of native bird species documented in Tennessee varies according to the timing of the data collection effort, changes in bird taxonomy,[76] and the reporting organization's method for categorizing occurrence and determining native versus non-native status. Further, the diverse ecological communities (i.e., forests, prairies, large rivers and lakes, plains, etc.) found in Tennessee support a large variety of bird species. Tennessee has 409 species of resident and migratory birds (Tennessee Ornithological Society, 2014). Among the 409 extant[77] species in Tennessee, 81 SGCN have been identified (TWRA, 2015d). One federally listed bird is in Tennessee; see Section 14.1.6.6, Threatened and Endangered Species.

Tennessee is located within the Mississippi Flyway. Covering the entire state, the Mississippi Flyway spans from the Gulf of Mexico to the Canadian boreal forest. Large numbers of migratory birds utilize this flyway and other migration corridors and pathways throughout the state each year during their annual migrations northward in the spring and southward in the fall. "The Migratory Bird Treaty Act (MBTA) makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations" (USFWS, 2013a). The USFWS is responsible for enforcing the MBTA and maintaining the list of protected species. The migratory bird species protected under the MBTA are listed in 50 CFR 10.13 (USFWS, 2013a).

Bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) are protected under the Bald and Golden Eagle Protection Act. Bald eagles are generally found near large rivers and lakes year round in Tennessee (eBird, 2015a) (TWRA, 2015b). In general, golden eagles can be year-round residents in the state, but, they are more abundant from mid-November to early March (eBird, 2015b) (TWRA, 2015b).

According to the National Audubon Society, there are 29 Important Bird Areas (IBAs) in Tennessee, including 3 complexes with 27 locations. Of these, 5 are global[78] and 22 are state[79] sites, as shown in Figure 14.1.6-2. IBAs include breeding ranges,[80] migratory stopovers, feeding, and over-wintering areas, and a variety of habitats such as forests, large rivers, and wetland/riparian[81] areas (The Audubon Society, 2015). The IBA program is an international bird conservation initiative with a goal of identifying the most important places for birds, and to

[76] Taxonomy: "A formal representation of relationships between items in a hierarchical structure" (USEPA, 2015a).
[77] Extant: "A species that is currently in existence (the opposite of extinct)" (USEPA, 2015a).
[78] Global IBAs include sites that meet at least one global criteria (i.e., sites with significant numbers of globally threatened species, sites supporting 1 percent or greater population of a waterbird simultaneously) (The Audubon Society, 2015).
[79] State IBAs include areas important to species only according to state-specific criteria (e.g., state-listed species) (The Audubon Society, 2015).
[80] Breeding range: "The area utilized by an organism during the reproductive phase of its life cycle and during the time that young are reared" (USEPA, 2015a).
[81] Riparian: "Referring to the areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands" (USEPA, 2015a).

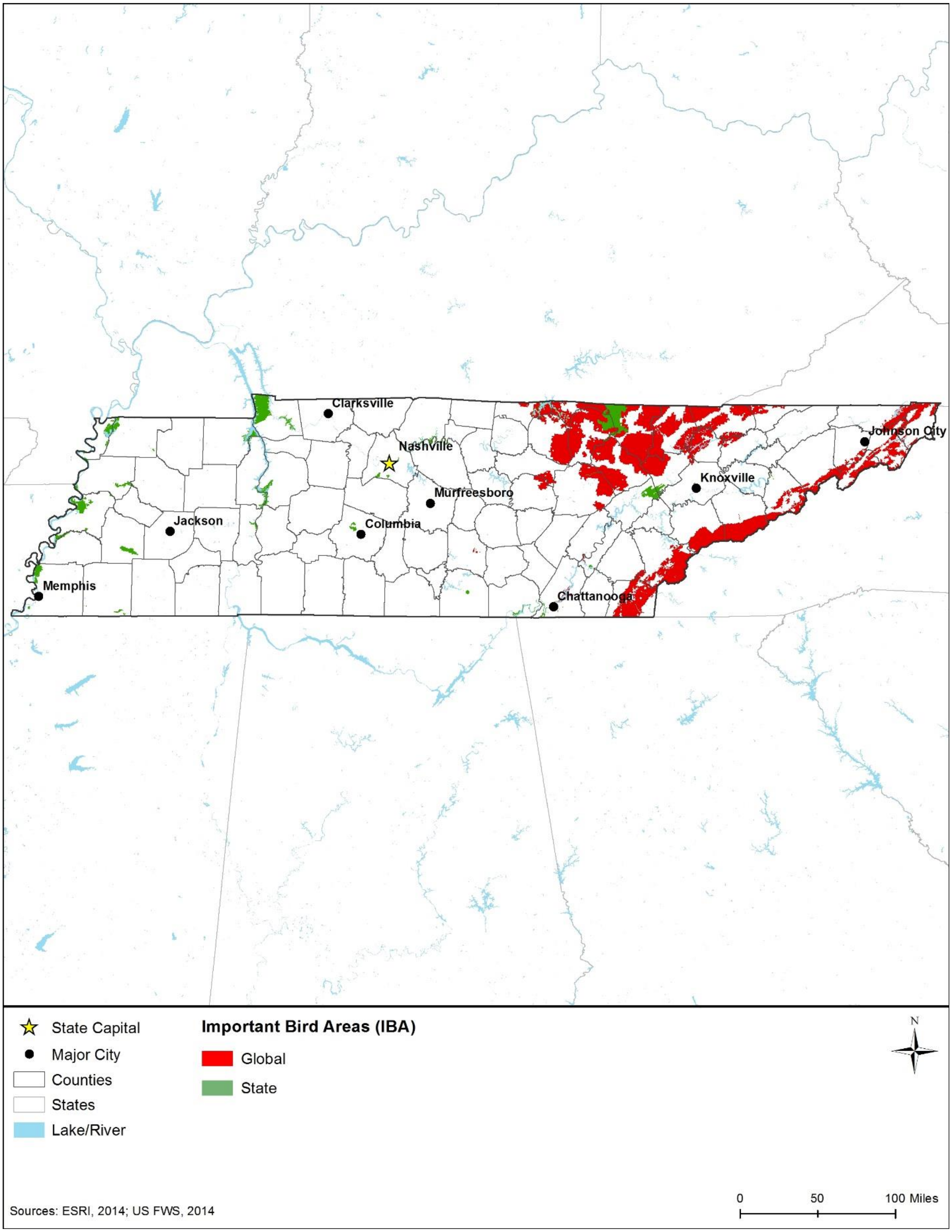


Figure 14.1.6-2: Important Bird Areas (IBA) of Tennessee

conserve these areas. IBAs are identified according to standardized, scientific criteria through a collaborative effort among state, national, and international conservation-oriented non-governmental organizations, state and federal government agencies, local conservation groups, academics, grassroots environmentalists, and birders. These IBAs link global and continental bird conservation priorities to local sites that provide critical habitat for native bird populations. IBA priority areas are based on a number of specific criteria. Generally, global IBAs are sites determined important for globally rare species or support bird populations at a global scale. Continental IBAs are sites determined important for continentally rare species or support bird populations at a continental scale, but do not meet the criteria for a global IBA. State IBAs are sites determined important for state rare species or support local populations of birds.

IBAs occur throughout the Tennessee, although the largest concentration of IBAs are located in the eastern and northeastern portions of the state. Many of these IBAs are existing National Wildlife Refuges within the state that contain large tracts of contiguous forests (The Audubon Society, 2015).

Reptiles and Amphibians

Tennessee is home to 59 native reptile and 73 amphibian species (not including subspecies), including 52 salamanders, 21 frogs and toads, 16 turtles, 9 lizards, and 34 snakes, 4 of which are venomous (TWRA, 2015b) (Tennessee Herpetological Society, 2016). Some of the state's reptiles and amphibians are widespread throughout the state, while some species are found only in specific environments. For example, the black mountain dusky salamander (*Desmognathus welteri*) is found only in the Cumberland Mountain area of the state (TWRA, 2016a), green frogs *(Rana clamitans)* are found in lakes, ponds, streams, and ditches throughout Tennessee (TWRA, 2016b), wood frogs (*Lithobates sylvatica*) are found in moist woodlands (TWRA, 2016c), and the spiny softshell turtle, (*Apalone spinifera*), is found throughout the state, usually in large rivers and streams (TWRA, 2016d). Of the 132 native reptile and amphibian species, 34 amphibian and 18 reptile SGCN have been identified (TWRA, 2015d). There are no threatened or endangered reptiles and amphibians in Tennessee, although the Berry cave salamander (*Gyrinophilus gulolineatus*) has been identified as a candidate species (USFWS, 2016a). Tennessee does not have specific regulations governing the collection and take of native reptile and amphibian species.

Invertebrates

Tennessee is home to a large number of invertebrates, including a wide variety of bees, hornets, wasps, butterflies, moths, beetles, flies, dragonflies, damselflies, spiders, mites, and nematodes. These invertebrates provide an abundant food source for mammals, birds, reptiles, amphibians, and other invertebrates. In the United States, one third of all agricultural output depends on pollinators[82]. In natural systems, the size and health of the pollinator population is linked to ecosystem health, with a direct relationship between pollinator diversity and plant diversity. "As a group, native pollinators are threatened by habitat loss, pesticides, disease, and parasites" (NRCS, 2009). As of 2015, Tennessee lists approximately 330 species of insects, arachnids, and

[82] Pollinators: "Animals or insects that transfer pollen from plant to plant" (USEPA, 2015a).

millipedes listed as SGCN (TWRA, 2015d). There are 49 threatened and endangered invertebrates in Tennessee, as discussed in Section 14.1.6.6, Threatened and Endangered Species.

Invasive Wildlife Species

Tennessee has adopted regulations that prohibit or regulate the possession, transport, importation, sale, purchase, and introduction of select terrestrial wildlife species. TWRA maintains a list of Class V species, which are considered injurious Tennessee. This list is presented in TAR 1660-1-18-.03-Rules and Regulations of Live Wildlife.

The two Class V invasive terrestrial species are the black-hooded parakeet (*Nandayus nenday*) and monk parakeet (*Myiopsitta monachus*). Invasive insects also pose a large threat to Tennessee's forest and agricultural resources. Some species, such as the gypsy moth (*Lymantria dispar*), hemlock woolly adelgid (*Adelges tsugae*), emerald ash borer (*Agrilus planipennis*), and Asian longhorn beetle (*Anoplophora glabripennis*), are known to cause irreversible damage to native forests. Tennessee has regulations and quarantines in place to regulate the transport and propagation of the emerald ash borer (TAR 0080-06-10) (Tennessee Department of State, 2011). Federal quarantines are also in place that restrict the transport of plant materials with the potential to contain the emerald ash borer (USDA, 2016b). Feral hogs (*Sus Scrofa*) are an invasive species in Tennessee that can causes extensive damage and disease threats to public property, native ecosystems, livestock health, and human health (USDA, 2016c). European starlings (*Sturnus vulgaris*) exist in Tennessee and can out-compete native birds for forage, especially during the winter (TWRA, 2016e).

14.1.6.5. Fisheries and Aquatic Habitats

This section discusses the aquatic wildlife species in Tennessee, including freshwater fish and invertebrates. A summary of non-native and/or invasive aquatic species is also presented. A distinctive feature of the Tennessee landscape with regard to aquatic wildlife is the large river ecosystem of the Ohio River. No essential fish habitat, identified by the Magnuson-Stevens Fishery Conservation and Management Act, exists in the state of Tennessee.[83]

Freshwater Fish

Tennessee is home to over three hundred species of freshwater fish species grouped into numerous families, ranging in size from small darters and minnows to larger species such as salmon and sturgeon. Tennessee's geology and discrete drainage basins created varied freshwater habitats, as a result, Tennessee has the "most diverse freshwater fauna of any state in the country" (Etnier & Starnes, 1993). Among these species are several important recreational and game fish, such as yellow perch, walleye, catfish, sunfishes, bass, northern pike, and several species of trout. Of the extant fish species in Tennessee, 108 are identified as SGCN. Eighteen

[83] NOAA's Essential Fish Habitat Mapper v 3.0 was used to identify "EFH areas of particular concern" and "EFH areas protected from fishing." As of July 2016, the procedure to use this interactive tool is as follows: 1) Visit http://www.habitat.noaa.gov/protection/efh/habitatmapper.html. 2) Select "EFH Mapper" under Useful Links. 3) After closing the opening tutorial, select the "Region" of interest from the drop-down menu. 4) Select the species under "Essential Fish Habitat" to view the areas in the selected region protected for the various life states (i.e., eggs, larvae, juvenile, adult, or all).

fish species are federally listed under the ESA, as identified in Section 14.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Shellfish and Other Invertebrates

There are 130 freshwater mussels are indigenous to the waters of Tennessee; however, a number of these have not been documented in the state for quite some time and are assumed to be extirpated from Tennessee waters (TWRA, 2015e). Freshwater mussels are an important food source for many wildlife species such as waterfowl, fish, muskrat, and other furbearers. Mussels are also important water quality indicators, since they often require streams with a high oxygen content that have not been degraded by sedimentation. In Tennessee, 87 species of freshwater mussels are listed as SGCN (TWRA, 2015d). River diversions, impoundments, and dredging activities are the primary threats to freshwater mussel species. Forty-nine mussel species known to exist in Tennessee are currently listed as federally endangered (TWRA, 2015e). Section 14.1.6.6, Threatened and Endangered Species, identifies these protected species.

Aside from a multitude of freshwater invertebrates whose adult forms are terrestrial insects (e.g., flies, beetles, etc.), other well-known Tennessee freshwater invertebrates include a variety of crayfish, fairy shrimp, amphipods, and pillbug species. There 85 species of crustaceans listed as SGCN in Tennessee (TWRA, 2015d).

Invasive Aquatic Species

In coordination with the National Invasive Species Act of 1996 and as an active member of the Mississippi River Basin Panel on Aquatic Nuisance Species, the state formed the Tennessee Aquatic Nuisance Species Task Force (TANSF) with governmental and non-governmental representatives. According to the Tennessee Aquatic Nuisance Species Management Plan, developed by TANSF in 2008, there are more than 79 nonnative plant and wildlife aquatic species reported in the state (Tennessee Aquatic Nuisance Species Task Force, 2008). Species were ranked to indicate the initial level of concern determined by the TANSF. Examples of the top ranked species per the Plan include (their rank in parenthesis, the lower the number, the greater concern):

- Aquatic Invertebrates – zebra mussels (rank 10) (*Dreissena polymorpha*), Asian clam (rank 21) (*Corbicula fluminea*), New Zealand Mud Snail (rank 11) (*Potamopyrgus antipodarum*), and Rusty Crayfish (rank 12) (*Orconectes* (*Procericambarus*) *rusticus*) (Tennessee Aquatic Nuisance Species Task Force, 2008); and
- Fish – Asian carp, which include bighead carp (rank 5) (*Hypophthalmichthys nobilis*), silver carp (rank 3) (*Hypophthalmichthys molitrix*), and black carp (rank 16) (*Mylopharyngodon piceus*), round goby (rank 9) (*Neogobius melanostomus*), western mosquitofish (rank 6) (*Gambusia affinis*), and redbreast sunfish (rank 13) (*Lepomis auritus*) (Tennessee Aquatic Nuisance Species Task Force, 2008).

14.1.6.6. Threatened and Endangered Species

The USFWS is responsible for administering the ESA (16 U.S.C. §1531 et seq.) in Tennessee. The USFWS has identified 75 federally endangered and 18 federally threatened species known to occur in Tennessee (USFWS, 2015c). One candidate species[84] was identified by USFWS as occurring within the state (USFWS, 2016a). Candidate species are not afforded statutory protection under the ESA. However, the USFWS recommends taking these species into consideration during environmental planning because they could be listed in the future. Of these 93 federally listed species, 33 of them have designated critical habitat[85] (as shown in Figure 14.1.6-3) (USFWS, 2015d). The 93 federally listed species include 5 mammals, 1 bird, 18 fish, 49 invertebrates, and 20 plants (USFWS, 2015c), and are discussed in detail under the following sections. Federal land management agencies maintain lists of species of concern for their landholdings; these lists are not discussed below as they are maintained independently from the ESA. For future site-specific analysis on those lands, consultation with the appropriate land management agency would be required.

Mammals

Four endangered and one threatened mammal species are federally listed for Tennessee as summarized in Table 14.1.6-3. Further information on the habitat, distribution, and threats to the survival and recovery of each of these species in Tennessee is provided below.

Table 14.1.6-3: Federally Listed Mammal Species of Tennessee

Common Name	Scientific Name	Federal Status	Critical Habitat in Tennessee	Habitat Description
Carolina Northern Flying Squirrel	*Glaucomys sabrinus coloratus*	Endangered	No	Northern hardwoods; found in the eastern portion of the state high in the Appalachian Mountains were climate is cool.
Gray Bat	*Myotis grisescens*	Endangered	No	Caves in limestone karst regions near rivers; found across the eastern and central region of the state.
Indiana Bat	*Myotis sodalis*	Endangered	Yes, in White Oak Blowhole Cave, Blount County.	Trees and snags, caves, and abandoned mines; found throughout the entire state.
Northern Long-eared Bat	*Myotis septentrionalis*	Threatened	No	Trees and snags, caves, and abandoned mines; found throughout the entire state.
Virginia Big-eared Bat	*Corynorhinus townsendii virginianus*	Endangered	No	Caves in karst regions with large presence of oak hickory beech, maple, or hemlock trees; found in the northeast corner of the state.

Source: (USFWS, 2015c) (USFWS, 2015d)

[84] Candidate species are plants and animals that the USFWS has "sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA, but for which development of a proposed listing regulation is precluded by other higher priority listing activities." (USFWS, 2014b)

[85] Critical habitat includes "the specific areas (i) within the geographic area occupied by a species, at the time it is listed, on which are found those physical or biological features (I) essential to conserve the species and (II) that may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by the species at the time it is listed upon determination that such areas are essential to conserve the species" (16 U.S.C §1532(5)(A)).

Carolina Northern Flying Squirrel. The Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*) is a nocturnal squirrel that can grow 10 to 12 inches in length and weigh 3 to 5 ounces. This species has grey with brownish to reddish fur along the back and greyish white fur in the front (USFWS, 2015f). The Carolina northern flying squirrel was listed as endangered in 1985 (50 Federal Register [FR] 26999 27002, July 01, 1985). Regionally, this squirrel is known to occur in North Carolina, Virginia, and Tennessee. In Tennessee, this species is known to occur in Carter, Loudon, Monroe, Sevier, and Unicoi counties in the eastern portion of the state along the Appalachian Mountains (USFWS, 2015f).

Photo credit: USFWS

Carolina northern flying squirrel

The primary habitat for the Carolina northern flying squirrel include northern hardwoods, such as yellow birch (*Betula alleghaniensis*), red spruce (*Picea rubens*), and fraser fir (*Abies fraseri*) found at high elevation habitats in the Appalachian Mountains were the climate is moist and cool. This species is active year-round and nests in tree cavities of northern hardwoods during the winter. Additionally, this squirrel feeds mainly on fungi, lichens, and occasionally eats nuts. Main threats include habitat destruction, fragmentation, clearing of forest, introduction of insect pest, and development. (USFWS, 1990a)

Gray Bat. The gray bat *(Myotis grisescens)* is an insectivorous[86] bat that weighs approximately 7 to 16 grams and is longer than any other species in the genus *Myotis*. Gray bats have dark gray fur after molting in July or August and then the fur transitions to a chestnut brown. This species was federally listed as endangered in 1976 (41 FR 17736 17740, April 28, 1976). Regionally, this species is known to occur in limited geographic regions of limestone karst within southeastern states from Kansas and Oklahoma east to Virginia and North Carolina (USFWS, 1997a) (USFWS, 2015g). In Tennessee, the gray bat is found in 77 counties across most of the central and eastern portions of the state (USFWS, 2015g).

Photo credit: USFWS **Gray bat**

Gray bats live in caves all year, hibernating in deep vertical caves in the winter and roosting in caves scattered along rivers the rest of the year. Most caves are in limestone karst regions and near rivers where these bats feed on flying aquatic and terrestrial insects. Current threats to this species include human disturbance, habitat loss, and degradation due to flooding, and commercialization of caves (e.g., such as adding gates that alter airflow, humidity, and temperature of caves) (USFWS, 1997a) (USFWS, 1982a).

[86] Insectivorous: "An animal that feeds on insects" (USEPA, 2015a).

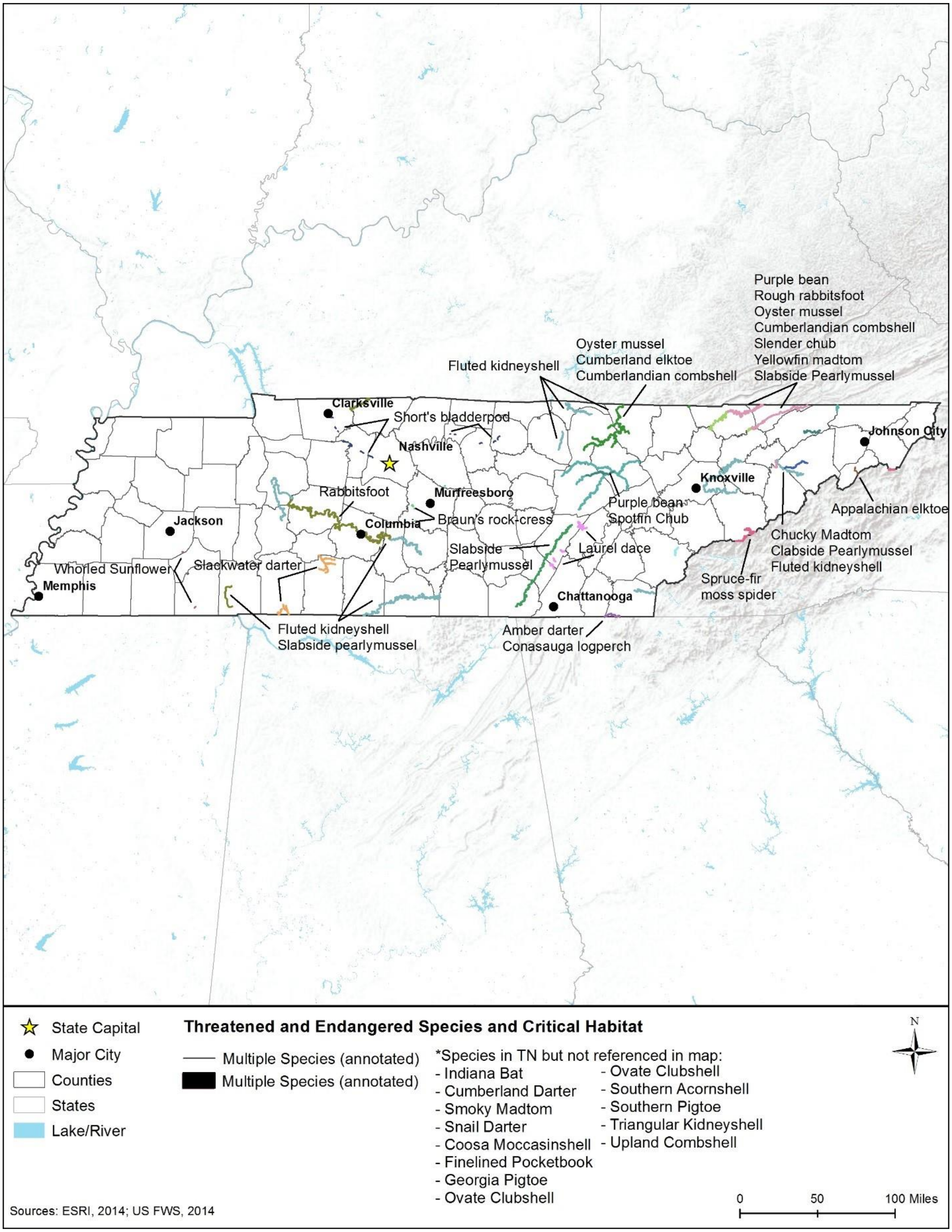


Figure 14.1.6-3: ESA Designated Critical Habitat in Tennessee

Indiana Bat. The Indiana bat (*Myotis. sodalis*) is a small, insectivorous mammal measuring approximately 3 to 3.5 inches in length with a wingspan of 9.5 to 10.5 inches. The Indiana bats have dull grayish chestnut fur and strongly resembles the more common little brown bat (*Myotis lucifugus*) (USFWS, 2006a) (VDGIF, 2015) (USFWS, 2015h). The Indiana bat was originally federally listed as "in danger of extinction" under early endangered species legislation in 1967 and was grandfathered into the ESA as an endangered species (32 FR 4001, March 11, 1967) (USFWS, 1967). In 2009, only 387,000 Indiana bats were known to exist in its range, less than half of the population of 1967 (USFWS, 2014c). Regionally, this species is currently found in the central portion of the eastern United States, from Vermont west to Wisconsin, Missouri, and Arkansas, and south and east to northwest Florida. In Tennessee, the Indiana bat is listed for all 95 counties in the state (USFWS, 2015h). Critical habitat has been defined for the species in Tennessee at one location, the White Oak Blowhole Cave, in Blount County (USFWS, 1977a).

In the fall, the Indiana bats migrate to their hibernation sites in caves and abandoned mines in order to mate and build up fat reserves for hibernation season in the winter. Upon emerging from hibernation, the bats feed near their hibernations sites (within 10 miles) before migrating to their summer habitats, where the females roost (USFWS, 2006a). Some of these summer habitats can be as far as 300 miles away from their hibernation areas (USFWS, 2004a). Indiana bats roost in trees during the day and feed at night in a variety of habitats, although streams, floodplain forests, ponds, and reservoirs are preferred. Females roost together in maternity colonies under the loose bark of dead or dying trees, or under the loose bark of shaggy-barked trees, although the physical characteristics of individual trees appear to be more of a factor than the species of tree. Nevertheless, tree species that have been noted as preferred by Indiana bat include shagbark hickory (*Carya ovata*), white oak (*Quercus alba*), silver maple (*Acer saccharinum*), sugar maple (*Acer saccharum*), green ash (*Fraxinus pennsylvanica*), eastern cottonwood (*Populus deltoides*), and American elm (*Ulmus rubra*) (USFWS, 2012a).

Threats to this species include the disturbance and intentional killing of hibernating and maternity colonies, habitat fragmentation and degradation, use of pesticides or other environmental contaminants, White Nose Syndrome, and commercialization of caves (e.g., adding gates that alter air flow, humidity, and temperature in caves) (USFWS, 2004a) (USFWS, 2015i). White Nose Syndrome is a rapidly spreading fungal disease that afflicts hibernating bats (USGS, 2015i).

Northern Long-eared Bat. The northern long-eared bat (*M. septentrionalis*) is a medium-sized brown furred, insectivorous bat. This bat is medium-sized, reaching a length of 3 to 3.7 inches, with long ears relative to other members of the genus *Myotis*, (USFWS, 2015j). The northern long-eared bat was listed as endangered in 2013 (78 FR 72058 72059, December 2, 2013) and was relisted as threatened in 2015 (80 FR 17973 18033, April 2, 2015). Its range includes most of the eastern and north central United States. In Tennessee, the species is known to occur in all 95 counties (USFWS, 2015k).

Northern long-eared bats hibernate during winter in caves and mines that exhibit constant temperatures and high humidity, which do not have air currents. In the summer, they roost singly or in colonies beneath bark, or in crevices or cracks of both live and dead trees. Although mating occurs in the fall, fertilization occurs after hibernation. Pregnant females then migrate to summer areas to roost in small colonies. (USFWS, 2015j)

White Nose Syndrome is the leading cause for the decline of this species. The numbers of northern long-eared bats in hibernacula has decreased by 99 percent in the northeast U.S. (USFWS, 2015k). Other threats include hibernacula impacts (e.g., temperature or air flow restrictions), habitat loss or fragmentation, habitat forest management practices that are incompatible with this species' habitat needs, and strikes with wind turbines (USFWS, 2015j).

Photo credit: USFWS

Northern long-eared bat

Virginia Big-eared Bat. The Virginia big-eared bat (*Corynorhinus townsendii virginianus*) is a light to dark brown furred, insectivorous mammal measuring 1.5 to 2 inches long and weighting 7 to 12 grams. This species was listed as endangered in 1979 (44 FR 69206 69208, November 30, 1979). Regionally, the Virginia big-eared bat is known to occur only in Kentucky, North Carolina, Tennessee, Virginia, and West Virginia. In Tennessee, it is known to occur in only Carter and Johnson counties in the northeast corner of the state (USFWS, 2015l). Critical habitat for the species has been defined in West Virginia, but not in Tennessee.

Virginia big-eared bats live in caves year-round, usually in karst regions with communities of oak and hickory trees or beech, maple, and hemlock trees. The species prefers cold area in the entrance of caves and in the winter during hibernation they move deeper in the caves (USFWS, 1984a). Primary threats to the species include disease (white-nose syndrome), loss of habitat, and human disturbances through vandalism and visitation of roosts and hibernacula (USFWS, 2011a) (USFWS, 2016b).

Birds

One endangered avian species is federally listed and known to occur in Tennessee as summarized in Table 14.1.6-4. The least tern (*Sterna antillarum*) is found in western Tennessee along the Mississippi River. Information on the habitat, distribution, and threats to the survival and recovery of this species in Tennessee is provided below.

Table 14.1.6-4: Federally Listed Bird Species of Tennessee

Common Name	Scientific Name	Federal Status	Critical Habitat in Tennessee	Habitat Description
Least Tern	*Sterna antillarum*	Endangered	No	Unvegetated sandbars near rivers, reservoirs and other open water habitat; known from 5 counties in western Tennessee along the Mississippi River.

Source: (USFWS, 2015c)

Least Tern. The smallest of the gull and tern family, the least tern is gray and white, and the heads have a distinctive black streak, although in yearlings the marking is not as noticeable. Approximately 9 inches long, least terns have narrow pointed wings and a forked tail. Least terns prey on small fish, for which they dive into the water. (USFWS, 2015m) The species was federally listed as endangered in 1985 (50 FR 21784 21792, May 28, 1985). The least tern is known to breed along the Mississippi River in on sandbars and dike fields and is known or believed to occur in Dyer, Lake, Lauderdale, Shelby, and Tipton counties along the western border of the state (along the Mississippi River) (USFWS, 1990b) (USFWS, 2015m).

Suitable habitat for least terns consists of relatively unvegetated sandbars near rivers, reservoirs and other open water habitat. The primary threat to this species is the destruction and degradation of habitat, as well as nest disturbance and predation. The primary causes of habitat loss historically have been dam construction, recreational activities, and the alteration of flow regimes along major river systems. (USFWS, 2013b)

Fish

Eleven endangered and seven threatened fish species are federally listed and known to occur in Tennessee, as summarized in Table 14.1.6-5. Further information on the habitat, distribution, and threats to the survival and recovery of each of these species in Tennessee is provided below.

Table 14.1.6-5: Federally Listed Fish Species of Tennessee

Common Name	Scientific Name	Federal Status	Critical Habitat in Tennessee	Habitat Description
Amber Darter	*Percina antesella*	Endangered	Yes, the Conasauga River in Bradley and Polk Counties.	Gentle riffle areas over sand and gravel substrate that becomes vegetated; known from the Conasauga River basin in Bradley and Polk Counties.
Blackside Dace	*Phoxinus cumberlandensis*	Threatened	No	Small upland headwaters and creeks with cool water pools and riparian vegetation; found in northern Tennessee in the upper Cumberland River basin.
Blue Shiner	*Cyprinella caerulea*	Threatened	No	Pool areas with flowing water and substrates of rubble, gravel and sand; found in Bradley and Polk Counties in the southeast corner of the state.

Common Name	Scientific Name	Federal Status	Critical Habitat in Tennessee	Habitat Description
Bluemask Darter	*Etheostoma* sp.	Endangered	No	Moderate to slow flows over sand and fine gravel; endemic to the upper Caney Fork River system.
Boulder Darter	*Etheostoma wapiti*	Endangered	No	It inhabits warm water river environments and is only found in moderate to fast current over boulder or slab rock substrate in water over 2 feet deep; listed in eight counties in the south-central portion of the state.
Chucky Madtom	*Noturus crypticus*	Endangered	Yes, 19.8 miles of Little Chucky Creek in Greene County.	Riffle areas with gravel, cobble, and boulder/bedrock, and sometimes shallow pools; endemic to Little Chucky Creek in in eastern Tennessee.
Conasauga Logperch	*Percina jenkinsi*	Endangered	Yes, in the Conasauga River from the confluence of Halfway Branch in Polk County downstream to Georgia.	Flowing pool areas and riffles over clean substrate of rubble, sand, and gravel; found in the Conasauga River in the southeast portion of the state.
Cumberland Darter	*Etheostoma susanae*	Endangered	Yes, in Jellico Creek and Capuchin Creek in Campbell and Scott Counties.	Pools and shallow areas of streams with sand, silt, or bedrock substrates and low- to moderate-gradient; known from Campbell and Scott Counties in northern Tennessee.
Duskytail Darter	*Etheostoma percnurum*	Endangered	No	Upland rocky areas in gently flowing pools that are one to four feet deep, and in large creeks and rivers; known from Blount, Monroe, and Scott counties in the eastern region of the state.
Laurel Dace	*Chrosomus saylori*	Endangered	Yes, in Bledsoe, Rhea, and Sequatchie Counties.	Pools and runs in small, clear, cool streams with a substrate of cobble, rubble, and boulders; known from nine counties in the east-central portion of the state.
Pallid Sturgeon	*Scaphirhynchus albus*	Endangered	No	Large-river obligate dwelling in bottom of dynamic channels of the Mississippi River; in Tennessee, known from the Mississippi River and lower Obion River in Dyer, Lake, Lauderdale, and Obion Counties along the western border of the state.

Common Name	Scientific Name	Federal Status	Critical Habitat in Tennessee	Habitat Description
Pygmy Madtom	*Noturus stanauli*	Endagered	No	Shoals with small gravel and sand substrates, and a strong current; known from the Duck River in Humphreys and Hickman Counties and the Clinch River in Hancock County.
Slackwater Darter	*Etheostoma boschungi*	Threatened	Yes, in the Buffalo River and its tributaries in Lawrence County, and the Cypress and Middle Cypress Creek and its tributaries in Wayne County.	Found in gentle riffles and slackwater areas of small to medium size shallow, upland tributary streams; known from seven counties in south-central Tennessee.
Slender Chub	*Erimystax cahni*	Threatened, Experimental Population	Yes, in Claiborne and Hancock Counties within the main channel of the Powell and Clinch Rivers.	Clear, warm, moderate to fast flowing shallow waters; found along the Clinch and Powell Rivers.
Smoky Madtom	*Noturus baileyi*	Endangered	Yes, in Citico Creek in Monroe County.	Shallow riffle areas with flat rocks, shallow pools with small gravel and flat rocks, and deep pools with sand and boulders; Loudon and Monroe Counties.
Snail Darter	*Percina tanasi*	Threatened	Yes, in the Little Tennessee River in Loudon County.	Larger creeks and small rivers, where it occurs in areas with moderate to swift flow over mixed sand and gravel; found in 25 counties in the eastern and central portion of the state.
Spotfin Chub	*Erimonax monachus*	Threatened, Experiemetal Population	Yes, in Cumberland, Fentress, Morgan, Hawkins, and Sullivan Counties.	Clear large creeks or medium size rivers up in mountain areas; found in 28 counties in central and eastern Tennessee.
Yellowfin Madtom	*Noturus flavipinnis*	Threatened	Yes, in Claiborne and Hancock Counties within the main channel of the Powell River.	Medium to large streams in gently flowing pools with rocks and stones; species is found in seven counties in eastern Tennessee.

Sources: (USFWS, 2015a) (USFWS, 2015b)

Amber Darter. The amber darter is a short, slender-bodied fish generally less than 2.5 inches in length with a golden brown upper body and dark saddle-like markings. The throats of breeding males are blue. This species was listed as endangered in 1985 (50 FR 31597 31604, August 5, 1985). In Tennessee, it is found in the Conasauga River basin in Bradley and Polk Counties in the southeastern portion of the state (USFWS, 1985a) (USFWS, 2015n). Designated critical habitat in Tennessee includes the Conasauga River in Bradley and Polk Counties from the U.S. 411 Bridge downstream to Georgia (USFWS, 1985a) (USFWS, 2015d).

The preferred habitats are gentle riffle areas over sand and loose gravel substrate, with aquatic vegetation in the summer season for feeding (USFWS, 1985a). Amber darters rarely occur in very shallow or low-velocity areas, or in areas with accumulated silt. "As a possible defensive mechanism, the fish often burrow into substrate" (GADNR, 2010a). Current threats to this species include increased forestry and timber harvest, and development within the watershed including road and bridge construction, and modification or impoundment of the stream channel (USFWS, 1985a).d

Blackside Dace. The blackside dace is a freshwater fish that grows to less than 3 inches long. This species has an olive to gold colored back with silver or red underline and a single black stripe along each side. During breeding season, the males are distinguished by the change of color on the belly to a bright red (USFWS, 1988). The blackside dace was listed and threatened in 1987 (52 FR 22580 22585, June 12, 1987). Regionally, this species is known to occur in Kentucky, Tennessee, and Virginia. In Tennessee, the blackside dace is known to occur in Anderson, Campbell, Claiborne, Morgan, and Scott Counties in the northern region of the state in the upper Cumberland River basin (USFWS, 2015o).

Photo credit: USFWS **Blackside dace**

Suitable habitats for the blackside dace consist of small upland headwaters and creeks. The blackside dace tends to occur more in cool water pools with bedrock, undercut banks, or brush and a dense canopy of riparian vegetation. This species feeds on algae on rocks or objects in the water and during the winter they feed on aquatic insects and other unidentified organisms. Current threats to the blackside dace include siltation from mining, agriculture, and road construction as well as unregulated acid mine drainage. (USFWS, 1988)

Blue Shiner. The blue shiner is a 4 inch long minnow with a dusky blue color and pale yellow fins. It has a distinct lateral line and diamond-shaped scales. This species was listed as threatened in 1992 (57 FR 14786 14790, April 22, 1992). In Tennessee, it is known to occur in Bradley and Polk Counties in the southeast corner of the state. (USFWS, 1992a) (USFWS, 2015p)

The preferred habitat for the blue shiner is "sand and gravel substrate among cobble in cool, clear water" (USFWS, 1992a). Blue shiner habitat is often submerged tree roots and fallen branches. Blue shiners are found in eddy currents downstream from water willow (*Justicia americana*) beds. Current threats to this species include water quality degradation, point- and non-point source water pollution, excessive turbidity, and dam construction (USFWS, 1995a).

Bluemask Darter. The bluemask darter is a straw-yellow to tan slender fish reaching 1.9 inches. It is faintly blue, with a white to dusky face, dark X-markings on the sides and small orange X-markings and spots extending to the back of the fish (USFWS, 1997b). This species was listed as endangered in 1993 (58 FR 68480 68486, December 27, 1993). The species is endemic to the Cumberland River watershed, specifically the Caney Fork River, and is found in nine counties in central Tennessee (USFWS, 2015q) (USFWS, 1997b).

Preferred habitat for the bluemask darter includes areas of moderate to slow flows over sand and fine gravel. The species is generally associated with the downstream end of riffles or near pond or run edges. Factors that are considered threats to the species include impoundments, impacts to habitat from dredging, and declining water quality from siltation and other pollutants (USFWS, 1997b).

Boulder Darter. The Boulder darter is a small fish, reaching a length of up to about 3 inches. Males are olive to gray in color, and females are slightly lighter in color. Both have a gray to black stripe below their eyes and a black spot behind the eyes. Unlike closely related species, the Boulder darter does not have red spots (USFWS, 1989a). The Boulder darter was federally listed as endangered in 1988 (53 FR 33996 33998, September 1, 1988). The Tennessee population is endangered in eight counties in the south-central portion of the state, additionally, a nonessential experimental population occurs in Lincoln and Giles counties (USFWS, 2015r).

This species can be found in fast-water runs in the Elk River system (a Tennessee River tributary) in Giles and Lincoln Counties, southern Tennessee, and Limestone County, northern Alabama. It "inhabits warm water river environments and is only found in moderate to fast current over boulder or slab rock substrate in water over [two] feet deep" (USFWS, 1989a). Threats to the Boulder darter include high levels of silt, cold water releases from the Tims Ford Reservoir, pesticides, toxic chemical spills, and mining. (USFWS, 1989a)

Chucky Madtom. The chucky madtom is a rare small catfish, measuring less than three inches long, endemic to Little Chucky Creek in eastern Tennessee (USFWS, 2011b) (USFWS, 2012b) (USFWS, 2015s). This species was listed as endangered in 2011 (76 FR 48722 48741, August 9, 2011), and is believed or known to occur in Cocke, Greene, Hamblen, Hawkins, and Jefferson counties (USFWS, 2015s). USFWS has designated critical habitat necessary for the continued survival and recovery of the chucky madtom in Tennessee, which consists of 19.8 miles of Little Chucky Creek in Green County (USFWS, 2012b).

The preferred habitats for the chucky madtom are not well understood, but they likely are similar to habitat preferred by other madtom species. This includes riffle areas with gravel, cobble, and boulder/bedrock, and shallow pools. Potential threats to the chucky madtom include reduced water quality resulting from sedimentation, habitat disturbance, and pollution. (USFWS, 2012b)

Conasauga Logperch. The Conasauga logperch is a larger darter, sometimes exceeding 6 inches in length, with vertical dark stripes over a yellow body. This species was listed as endangered in 1985 (50 FR 31597 31604, August 5, 1985). In Tennessee, it is found in the Conasauga River in Bradley and Polk counties the southeast portion of the state (USFWS, 1985a) (USFWS, 2015t). USFWS has designated critical habitat necessary for the continued survival and recovery of the

Conasauga logperch in Tennessee and Georgia (USFWS, 2015d). Critical habitat in Tennessee consists of the Conasauga River from the confluence of Halfway Branch in Polk County downstream to Georgia (USFWS, 1985a).

The preferred habitats are flowing pool areas and riffles over clean substrate of rubble, sand, and gravel (USFWS, 1985a). Current threats to this species include forestry management, construction of roads or bridges, channelization, dams or other water flow impediment, development or changes in land use that do not consider the protection and survival of the species (USFWS, 1985a). Threats to this species are severe as its range is extremely limited, consisting of 28 miles of river in the upper Coosa River basin. Minute changes, such as to the stream flow or water temperature resulting from the development of water storage basins, may adversely impact the species (GADNR, 2009a).

Cumberland Darter. The Cumberland darter is a medium darter. Approximately two inches long, with a yellow body and six brown saddles (USFWS, 2011b). This species was listed as endangered in 2011 (76 FR 48722 48741, August 9, 2011). In Tennessee, the species is known or believed to occur in Campbell and Scott Counties in northern Tennessee (USFWS, 2015u). USFWS has designated critical habitat necessary for the continued survival and recovery of the Cumberland darter in Jellico Creek and Capuchin Creek in Campbell and Scott Counties (USFWS, 2012b).

The preferred habitats for the Cumberland darter include pools and shallow areas of streams with sand, silt, or bedrock substrates and low- to moderate-gradient. Potential threats to the species include sedimentation, habitat disturbance, and changes to channel morphology. (USFWS, 2012b)

Duskytail Darter. The duskytail darter is a small fish that grows approximately 2.5 inches and has a straw to olive color body with white to light greyish belly and dark grey on top of head. It is difficult to distinguish the sex; however, during breeding season the males head tends to get darker and swollen (USFWS, 1994a). The duskytail darter was listed as endangered in 1993 (58 FR 25758 25763, April 27, 1993). Regionally, this species is known to occur in Kentucky, Tennessee, and Virginia. In 2002 and 2007, non-essential experimental populations were created in multiple regions of Tennessee. In Tennessee, it is known to occur in Blount, Monroe, and Scott counties in the eastern region of the state (USFWS, 2015v).

Suitable habitats for the duskytail darter are upland rocky areas in gently flowing pools that are one to four feet deep, and runs in large creeks and rivers. This species is an insectivore that feeds on microcrustaceans, chironomid larvae, and heptageniids. Current threats to this species include silt and runoff from agricultural activities and impoundment. (USFWS, 1994a)

Laurel Dace. The laurel dace is a minnow, approximately 2 inches long, that is white or silver with two dark lateral stripes (USFWS, 2011b). This species was listed as endangered in 2011 (76 FR 48722 48741, August 9, 2011). In Tennessee, the species is known or believed to occur in nine counties in the east-central portion of the state (USFWS, 2015w). USFWS designated critical habitat necessary for the continued survival and recovery of the laurel dace in Bledsoe, Rhea, and Sequatchie Counties, Tennessee (USFWS, 2012b).

The preferred habitats for the laurel dace include pools and runs in small, clear, cool streams with a substrate of cobble, rubble, and boulders. Potential threats to the species include sedimentation/siltation, habitat disturbance, invasive species (such as sunfish), small population size, and pollution. (USFWS, 2012b) (USFWS, 2015ac)

Pallid Sturgeon. The pallid sturgeon is a long, slender fish growing up to 6 feet in length and 80 pounds in weight (USFWS, 2015aq). The species is pale in coloration with a shovel shaped snout, armored body, and skeleton made of cartilage. The pallid sturgeon is one of two sturgeon species found east of the Continental Divide, and is the larger of the two species. The sturgeon was listed as endangered in 1990 (55 FR 36641 36647, September 6, 1990) and its range extends the length of the Missouri and Mississippi Rivers (USFWS, 2015x). In Tennessee, the pallid sturgeon is found in the Mississippi River and lower Obion River in Dyer, Lake, Lauderdale, and Obion Counties along the western border of the state (USFWS, 2014d) (USFWS, 2015x).

The Pallid sturgeon prefers large rivers with strong currents; they can withstand a wide range of turbidity[87] conditions. The key reason for this species' decline has been habitat fragmentation and alteration from the damming of major rivers and other large tributaries (USFWS, 2014e).

Pygmy Madtom. The pygmy madtom is a small catfish with a flat head, brown-grey body above its midline, and white to pale yellow below the midline (USFWS, 1994b). This species was listed as endangered in 1993 (58 FR 25758 25763, April 27, 1993). The species is endemic to Tennessee, but USFWS does not have specific county listings; the USFWS recovery plan indicates that the species is found in the Duck River in Humphreys and Hickman Counties and the Clinch River in Hancock County (USFWS, 1994b) (USFWS, 2015y).

The preferred habitats for the pygmy madtom includes shoals with small gravel and sand substrates, and a strong current. Potential threats to the species include impoundments, sedimentation/siltation, and pollution. (USFWS, 1994b)

Slackwater Darter. The slackwater darter is a medium sized darter reaching less than 2 inches in length, with a blue-black bar below its eye and three saddles on its back (USFWS, 1984b). The slackwater darter was federally listed as threatened in 1977 (42 FR 45526 45530, September 9, 1977) (USFWS, 2015z).

Slackwater darters can be found in gentle riffles and slackwater in shallow, upland tributary streams and is known or believed to occur in seven counties in south-central Tennessee. Critical habitat has been designated to include the Buffalo River and its tributaries in Lawrence County, and the Cypress and Middle Cypress Creek and its tributaries in Wayne County, Tennessee. The slackwater darter has distinct breeding and nonbreeding habitats. The nonbreeding habitat is small to moderately large streams with slow current, over silty gravel or mud. The breeding habitat is seepage water in open fields and woods that flows slowly into an adjacent stream. Threats to the slackwater darter include habitat loss due to urbanization, degradation of surface and groundwater, and conversion of breeding habitat to farm fish ponds. (USFWS, 1984b)

[87] Turbidity: "The cloudy appearance of water caused by the presence of suspended and colloidal matter. Turbidity indicates the clarity of water and is an optical property of the water based on the amount of light reflected by suspended particles" (USEPA, 2015a).

Slender Chub. The slender chub is a small fish with a brown body, white belly, and long snout. The chub grows to approximately 3 inches in length and has been known to feed on insects and mussels. The species was federally listed as threatened in 1977 and designated with critical habitat (42 FR 47840 47845, September 22, 1977). The slender chub typically inhabits the "clear, warm, moderate to fast flowing shallow water of the Clinch and Powell rivers in Tennessee and Virginia" (USFWS, 1983a). The species is found in 13 counties in eastern Tennessee. In 2007, an experimental population was established for the lower Holston River in Tennessee (72 FR 52434 52461, September 13, 2007) (USFWS, 2015aa). Figure 14.1.6-3 depicts these rivers and the slender chub's critical habitat (in Claiborne and Hancock Counties within the main channel of the Powell and Clinch Rivers).

Threats to species populations have to do with its specific habitat requirements in fine-gravel shoals. This fragile habitat has been compromised by dams, temperature changes from upstream water releases, coal mining operations, pollution, and sedimentation (USFWS, 1983a).

Smoky Madtom. The smoky madtom is a small catfish, up to two and a half inches in length, that is light-brown in color, with a large head (USFWS, 1985b). This species was listed as endangered in 1984 (49 FR 43065 43069, October 26, 1984). The species is currently endemic to Citico Creek and is known or believed to occur in Loudon and Monroe Counties. An experimental population has been established in the Tellico River in Monroe County (USFWS, 1985b) (USFWS, 2015ab). Critical habitat for the species has been designated in Citico Creek in Monroe County (USFWS, 1984c).

The preferred habitats for the smoky madtom includes shallow riffle areas with flat rocks, shallow pools with small gravel and flat rocks, and deep pools with sand and boulders. Potential threats to the species include sedimentation/siltation related to land disturbance and acid leaching from the native shale rock (USFWS, 1985b).

Snail Darter. The snail darter is approximately 3 inches long. "Background color above the lateral line is brown with occasional faint traces of green" (USFWS, 1983b). Four dark brown saddle-like marks cross the back of the fish and the lower part of its sides are lighter with dark blotches. Snail darters have a white belly, with dark brown coloring for the upper portion of their head. "The cheeks are mottled brown interspersed by traces of yellow" (USFWS, 1983b). This species was originally listed as endangered in 1975 but was reclassified as threatened in 1984 (49 FR 27510 27514, July 5, 1984). The species occurs in Tennessee River tributaries in Alabama, Georgia, Mississippi, and Tennessee. In Tennessee, it is found in 25 counties in the eastern and central portion of the state, with critical habitat defined within the Little Tennessee River in Loudon County (USFWS, 2015ad).

The preferred habitat for the snail darter is coldwater streams with rock shoals, small boulders, and some areas of mixed sand and gravel (USFWS, 1983b). Threats to this species include impoundment of the upper Tennessee River system, which has removed suitable habitat from most of the snail darter's native range. "Extensive impoundment of the upper Tennessee River system has removed suitable habitat from most of the snail darter's native range. Isolated populations survive in larger tributaries where the principal threat is stream habitat degradation resulting from failure to employ Best Management Practices (BMPs) for forestry and agriculture, failure to control soil erosion from construction sites and bridge crossings, and increased stormwater runoff from developing urban and industrial areas" (GADNR, 2009b). Threats from habitat degradation may be mitigated if the survival of the species is considered during project planning phases. (GADNR, 2009b)

Spotfin Chub. The spotfin chub is a medium-sized fish with an elongated body that grows to almost 3.5 inches in length. It has an olive colored body with silver on the sides and white at the bottom (USFWS, 1983c) (USFWS, 2015dg). This species was listed as threatened in 1977 (42 FR 45526 45530, September 9, 1977). It is known to occur in the states of Alabama, North Carolina, and Virginia with multiple non-essential experimental populations in Tennessee. In Tennessee, it is known to occur in 28 counties in the central and eastern portion of the state. Critical habitat has been defined for the species and includes streams in in Cumberland, Fentress, Morgan, Hawkins, and Sullivan Counties (USFWS, 1977b).

Suitable habitats for the spotfin chub consist of clear large creeks or medium size rivers in mountain areas having cool and warm water with moderate gradients and bottoms of gravel. The spotfin chub uses the gravel as protection when they lay their eggs between the rocks. Current threats to the survival of this species include dams or stream channelization that disrupt natural flow, temperature changes, overcollecting, competition with other species, and water quality degradation from siltation or industrial and urban runoff. (USFWS, 1983c) (IUCN, 2014)

Yellowfin Madtom. The yellowfin madtom is a small catfish, usually less than 3.6 inches in length. It has a yellowish tinge on the fins and paler areas, dark dorsal saddles, and a dark stripe at the dorsal fin. The fish is one of few poisonous freshwater fishes in the United States and has poison glands at the base of sharp spines protruding from its body. The species was listed as threatened in 1977 and designated with critical habitat (42 FR 47840 47845, September 22, 1977). The species is native to parts of the Upper Tennessee River Basin in Tennessee and Virginia. In Tennessee, the yellowfin madtom is found in seven counties in eastern Tennessee. (USFWS, 1983d). Figure 14.1.6-3 depicts these rivers and the yellowfin madtom's critical habitat (the Powell River main channel in Claiborne and Hancock Counties).

Suitable habitats for the yellowfin madtom include medium to large streams in gently flowing pools with rocks and stones. Major threats to this species have been the construction of dams, chemical spills, sedimentation of rivers, and pollution from mining operations (USFWS, 2012c).

Invertebrates

There are 46 endangered and 3 threatened invertebrate species that are federally listed and known to occur in Tennessee, as summarized in Table 14.1.6-6. Further information on the habitat, distribution, and threats to the survival and recovery of each of these species in Tennessee is provided below.

Table 14.1.6-6: Federally Listed Invertebrate Species of Tennessee

Common Name	Scientific Name	Federal Status	Critical Habitat In Tennessee	Habitat Description
Alabama Lampmussel	*Lampsilis virescens*	Endangered	No	Inhabits sand and gravel substrates in small to medium size streams, preferring tributary streams; known from 10 counties in central and eastern Tennessee.
Anthony's Riversnail	*Athearnia anthonyi*	Endangered, Experimental Population	No	Usually found on large submerged objects or gravelly substrate in shallow, moderately to fast-flowing water; known from the Tennessee River and lower Sequatchie River within 12 counties in eastern Tennessee, and an experimental population has been established in the French Broad and Holston Rivers in five counties in east Tennessee.
Appalachian Elktoe	*Alasmidonta raveneliana*	Endangered	Yes, in the Nolichucky River in Unicoi County.	Relatively shallow medium-sized creeks and rivers with cool, well-oxygenated, and moderate- to fast-flowing water; the species is endemic to the upper Tennessee River system in the mountains of western North Carolina.
Appalachian Monkeyface Pearlymussel	*Quadrula sparsa*	Endangered, Experimental Population	No	Shallow areas of fast flowing streams with sand and gravel bottoms; found along the Clinch and Powell Rivers in eastern Tennessee.
Birdwing Pearlymussel	*Lemiox rimosus*	Endangered, Experimental Population	No	Rivers of swift currents with sand and gravel substrates; found in Duck, Clinch, and Powell Rivers and is listed in 23 Tennessee counties.
Clubshell	*Pleurobema clava*	Endangered	No	River and streams with clean, loose sand, and gravel; found in 12 counties in central Tennessee.
Coosa Moccasinshell	*Medionidus parvulus*	Endangered	Yes; within the Conasauga River in Bradley and Polk Counties.	Sand/gravel/cobble shoals with moderate to strong currents in streams and small rivers. Found in Bradley and Polk Counties in the eastern portion of the state.
Cracking Pearlymussel	*Hemistena lata*	Endangered, Experimental Population	No	Medium-sized rivers with swift-moving, turbulent water over gravel and cobble bottoms; known from the Clinch, Powell, Elk, and Tennessee Rivers in 26 counties in the central and eastern portion of the state.
Cumberland Bean Pearlymussel	*Villosa trabalis*	Endangered	No	Small rivers and streams with clean fast flowing water and sand and gravel substrates in riffle and shoal areas; known from 22 counties in the central and eastern portion of the state.

Common Name	Scientific Name	Federal Status	Critical Habitat In Tennessee	Habitat Description
Cumberland Elktoe	*Alasmidonta atropurpurea*	Endangered	Yes, in Claiborne, Fentress, Morgan, and Scott Counties.	Medium-sized rivers with mud, sand, and gravel substrates; listed in 11 counties in the eastern portion of the state.
Cumberland Pigtoe	*Pleurobema gibberum*	Endangered	No	Main stems of small and medium-sized rivers with sand, gravel, and cobble substrates; endemic to the Caney Fork River System and is found in 15 counties in central Tennessee.
Cumberland Monkeyface	*Quadrula intermedia*	Endangered, Experimental Population	No	Rivers of swift currents with sand and gravel substrates in riffle and shoal areas; known from 28 counties in the central and eastern portion of the state.
Cumberland-ian Combshell	*Epioblasma brevidens*	Endangered, Experimental Population	Yes; in the Duck River, Powell River, Clinch River, Nolichucky River, and Big South Fork.	Rivers of swift currents with sand and gravel substrates in riffle and shoal areas; known from 32 counties in the central and eastern portion of the state.
Dromedary Pearlymussel	*Dromus dromas*	Endangered, Experimental Population	No	Shoal areas in rivers within moderately moving water, and with sand and gravel bottoms; known from 35 counties in the central and eastern portion of the state.
Fanshell	*Cyprogenia stegaria*	Endangered	No	Large rivers with sand and gravel and moderate current; known from 30 counties across the state.
Finelined Pocketbook	*Lampsilis altilis*	Threatened	Yes, in the Conasauga River in Bradley and Polk Counties.	Stable sand/gravel/ cobble substrate in moderate to swift currents in small streams; known from Bradley and Polk Counties.
Finerayed Pigtoe	*Fusconaia cuneolus*	Endangered, Experimental Population	No	Silt-free sand, gravel, and cobble substrates of free-flowing smaller streams; known from 28 counties in the central and eastern portion of the state.
Fluted Kidneyshell	*Ptychobranchus subtentum*	Endangered	Yes, in 12 defined critical habitat areas across central and eastern Tennessee.	Medium-sized creeks to large rivers; known from 25 counties across central and eastern Tennessee.
Georgia Pigtoe	*Pleurobema hanleyianum*	Endangered	Yes; in the Conasauga River in Bradley and Polk Counties.	Shallow runs and riffles with strong to moderate current and coarse sand–gravel–cobble bottoms; known from Bradley and Polk Counties in the southeastern portion of the state.
Green Blossom Pearlymussel	*Epioblasma torulosa gubernaculum*	Endangered	No	Fast-flowing freshwater over firm gravel and shoal areas; known from 17 counties in eastern Tennessee.

Common Name	Scientific Name	Federal Status	Critical Habitat In Tennessee	Habitat Description
Littlewing Pearlymussel	*Pegias fabula*	Endangered	No	Medium size rivers and streams with high gradient and cool clear water; known from 19 counties in the central and eastern portion of the state.
Nashville Crayfish	*Orconectes shoupi*	Endangered	No	Gravel-covered bedrock sections of runs and pools; only known from Mill Creek and several tributaries in Davidson, Rutherford, and Williamson Counties, Tennessee.
Orangefoot Pimpleback Pearlymussel	*Plethobasus cooperianus*	Endangered	No	Sand and gravel substrate of rivers; known from 46 counties across central and eastern Tennessee.
Ovate Clubshell	*Pleurobema perovatum*	Endangered	Yes; in the Conasauga River in Bradley and Polk Counties.	Sand and gravel shoals and runs of small rivers and large streams; known from Bradley and Polk Counties in the southeastern portion of the state.
Oyster Mussel	*Epioblasma capsaeformis*	Endangered, Experimental Population	Yes, in central and eastern Tennessee.	Medium-sized rivers and sometimes large rivers in areas with coarse sand; found in rivers within the Tennessee River system in central and eastern Tennessee.
Painted Snake Coiled Forest Snail	*Anguispira picta*	Threatened	No	Limestone outcrops with vegetative cover; known only from one cove in Franklin County in southeast Tennessee.
Pale Lilliput	*Toxolasma cylindrellus*	Endangered	No	Small rivers and streams in shallow, fast-flowing water with a stable, clean substrate; known from 17 counties in central Tennessee.
Pink Mucket	*Lampsilis abrupta*	Endangered	No	Major rivers and their tributaries with mud and sand in shallow riffle areas; known from 49 counties in central and eastern Tennessee.
Purple Bean	*Villosa perpurpurea*	Endangered	Yes, in Claiborne, Cumberland, Hancock, and Morgan Counties.	Headwater areas where medium- to high-speed freshwater currents occur over sandy or gravelly bottoms; known from 11 counties in east-central and northeast Tennessee.
Rabbitsfoot	*Quadrula cylindrica cylindrical*	Threatened	Yes, in the Duck River, Tennessee River, and Red River.	Shallow area of streams and rivers with sand and gravel along the banks; known from 29 counties in the central and eastern portion of the state.
Ring Pink	*Obovaria retusa*	Endangered, Experimental Population	No	Shallow water over silt-free sand and gravel bottoms of large rivers; known from 29 counties in central and eastern Tennessee.

Common Name	Scientific Name	Federal Status	Critical Habitat In Tennessee	Habitat Description
Rough Pigtoe	*Pleurobema plenum*	Endangered	No	Shoal areas of medium to large rivers with sand and gravel river bottoms; known from 33 counties in central and eastern Tennessee.
Rough Rabbitsfoot	*Quadrula cylindrica strigillata*	Endangered	Yes, in the Clinch and Powell Rivers.	Medium-sized to large rivers in moderate to swift current; known from 13 counties in northeastern Tennessee.
Royal Marstonia Snail	*Pyrgulopsis ogmorhaphe*	Endangered	No	Cave spring discharges; known from only two locations in Marion County, Tennessee.
Sheepnose Mussel	*Plethobasus cyphyus*	Endangered	No	Large rivers and streams with moderate to swift currents and shallow shoal habitats; known from 21 counties in central and eastern Tennessee.
Shiny Pigtoe	*Fusconaia cor*	Endangered, Experimental Population	No	Large streams with silt-free substrates of sand, gravel, and cobble; known from 20 counties in central and eastern Tennessee.
Slabside Pearlymussel	*Pleuronaia dolabelloides*	Endangered	Yes, in 8 rivers in the Tennessee River watershed.	Large creeks and rivers with sand and gravel bottoms and moderate current; known from the Clinch, Powell, Elk, Duck, and Hiwassee Rivers across 39 counties in central and eastern Tennessee.
Snuffbox mussel	*Epioblasma triquetra*	Endangered	No	Small to medium sized creeks, lakes, and rivers with shoal habitats and swift current; known from 25 counties in central and eastern Tennessee.
Southern Acornshell	*Epioblasma othcaloogensis*	Endangered	Yes; in the Conasauga River in Bradley and Polk Counties.	Gravel or sand substrates in medium to large rivers with moderate current; known from Bradley and Polk Counties in the southeast corner of the state.
Southern Pigtoe	*Pleurobema georgianum*	Endangered	Yes; in the Conasauga River in Bradley and Polk Counties.	Sand/gravel/cobble substrate in shoals and runs of small rivers and large streams; known from Bradley and Polk Counties in southeast Tennessee.
Spectaclecase	*Cumberlandia monodonta*	Endangered	No	Sheltered areas in large rivers; known from 35 counties across the central and eastern portions of the state.
Spruce-fir Moss Spider	*Microhexura montivaga*	Endangered	Yes, in Carter and Sevier Counties at high elevations.	Well-drained mosses growing on shady rocks in mountain forests with Fraser fir and red spruce; known from only Carter and Sevier Counties in the eastern portion of the state.
Tan Riffleshell	*Epioblasma florentina walkeri*	Endangered	No	Rivers of swift currents with sand and gravel substrates; known from Big South Fork, Hiwassee River, Duck River, Red River, and Stones River in 25 counties across central and eastern Tennessee.

Common Name	Scientific Name	Federal Status	Critical Habitat In Tennessee	Habitat Description
Triangular kidneyshell	*Ptychobranchus greenii*	Endangered	Yes; in the Conasauga River in Bradley and Polk Counties.	Sand/gravel/cobble substrate in shoals and runs of small rivers and large streams; known from Bradley and Polk Counties in southeast Tennessee.
Tubercled Blossom Pearlymussel	*Epioblasma torulosa*	Endangered	No	Gravel shoals and shallow sand of large rivers with rapid currents; known from 21 counties across central and eastern Tennessee
Turgid Blossom Pearlymussel	*Epioblasma turgidula*	Endangered	No	Shallow areas of streams with sand or gravel substrate and fast currents; known from 27 counties in the central and eastern portions of the state.
Upland Combshell	*Epioblasma metastriata*	Endangered	Yes; in the Conasauga River in Bradley and Polk Counties.	Stable sand, gravel, or cobble substrate in moderate to swift currents on shoals in rivers and large streams; known from Bradley and Polk Counties in southeast Tennessee.
White Wartyback Pearlymussel	*Plethobasus cicatricosus*	Endangered, Experimental Population	No	Gravel and sand substrate free of silt, in clean, fast-flowing water in large rivers; known from 24 counties in central and eastern Tennessee.
Yellow Blossom Pearlymussel	*Epioblasma florentina*	Endangered	No	Shallow areas of rivers with a sand or gravel substrate and rapid current. Last found in 1967 in Little Tennessee River and Citico Creek, Tennessee.

Source: (USFWS, 2015c) (USFWS, 2015d)

Alabama Lampmussel. The Alabama lampmussel, also known as the Alabama Lamp Pearly Mussel, is a freshwater mussel reaching less than 3 inches in length with a moderately thick tawny to greenish yellow shell, with an inner white shell. The Alabama lampmussel was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976) and a non-essential experimental population was established in 2001 (66 FR 32250 32264, June 14, 2001) (USFWS, 2015af).

The species is endemic to the Tennessee River system in northern Alabama and Tennessee and is found in 10 counties in central and eastern Tennessee (USFWS, 1985c) (USFWS, 2015af). Habitat for the Alabama Lampmussel is generally small to medium size streams, typically tributary streams, with sand and gravel substrates. Threats to the Alabama lampmussel include channelization, pollution (e.g., pesticides and fertilizers), dredging, impoundments, siltation, and habitat loss resulting from development (USFWS, 1985c).

Anthony's Riversnail. The Anthony's riversnail is a freshwater snail that grows a shell of about 1 inch in size. The shell is olive green to yellowish brown in color, with a shell whorl of purple or brown bands. Juveniles are equal in width and length, with the shell elongated as the snail gets older (USFWS, 1997c). The Anthony's riversnail was federally listed as endangered in 1994 (59 FR 17994 17998, April 15, 1994). A non-essential experimental population was established in Alabama and Georgia in 2001 (66 FR 32250 32264, June 14, 2001), and another non-essential experimental population was established in Tennessee in 2007 (72 FR 52434 52461, September 13, 2007).

The species is found in the Tennessee River and lower Sequatchie River within 12 counties in eastern Tennessee, and an experimental population has been established in the French Broad and Holston Rivers in five counties in east Tennessee (USFWS, 2015ag) (USFWS, 1997c). The Anthony's riversnail is found on large submerged objects, such as rocks, or gravelly substrate in shallow waters with moderate to fast currents. Main threats to the Anthony's riversnail include habitat fragmentation and water quality deterioration resulting from impoundments, sedimentation, pollutants, and channelization (USFWS, 1997c).

Appalachian Elktoe. The Appalachian elktoe's kidney-shaped shell is thin and sturdy. The shell is about 3.2 inches long, 1.4 inches high, and 1 inch wide. The periostracum (outer shell surface of clams and snails) of adult shells is dark brown, and the juvenile periostracum is yellowish brown. The posterior portion of the shell has green rays, which may or may not stand out. (USFWS, 1996a)

The Appalachian elktoe was federally listed as endangered in 1994 (59 FR 60324 60334 November 23, 1994). The species is endemic to the upper Tennessee River system in the mountains of western North Carolina and eastern Tennessee; in Tennessee, it is found in eight counties in the eastern portion of the state (USFWS, 1996a) (USFWS, 2015ah). In Tennessee, critical habitat has been defined for the species in the Nolichucky River (Unicoi County) (USFWS, 2002).

Suitable habitats for the Appalachian elktoe consist of moderate- to fast-flowing rivers and shallow medium-sized creeks. Waters within preferred habitat is generally cool and well-oxygenated. Main threats to the Appalachian elktoe include water quality and habitat degradation resulting from impoundments, stream channelization and dredging projects, and point and nonpoint sources of siltation and other pollutants. (USFWS, 1996a)

Appalachian Monkeyface (Pearlymussel). The Appalachian monkeyface is a mussel that grows up to 2 inches. Its shell is yellowish green to brown color with a bumpy texture on top (USFWS, 2011c). The Appalachian monkeyface mussel was federally listed as endangered in 1976 (41 FR 24062 24067, June 6, 1976). Regionally, this species is known or believed to occur in rivers and streams in Tennessee and Virginia. Within Tennessee, it is found only in the eastern region of the state in the Clinch and Powell Rivers and is believed or known to occur in ten counties (USFWS, 2011c) (USFWS, 2015ai). Experimental, non-essential populations have been established in the French Broad and Holston Rivers (USFWS, 2015ai).

Suitable habitats for the Appalachian monkeyface include shallow areas of fast flowing streams with sand and gravel substrate. This species is a filter feeder of bacteria, phytoplankton, algae, and diatoms. It is not known which species of fish serve as host fish for these mussels to complete the development of the larvae. Main threats to this species include impediments that disrupt the natural flow and water quality degradation from agricultural, coal mining, and natural gas extraction and processing runoff. (USFWS, 2011c)

Birdwing Pearlymussel. The birdwing pearlymussel is a Cumberlandian freshwater mussel of approximately 2 inches long and 1 inch wide. The shells are marked by irregular growth lines and are generally dark olive green to black in coloration (USFWS, 1984d). The species was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976) and was introduced as an experimental population in portions of Tennessee and Alabama in 2007 and 2001 respectively (USFWS, 2015aj). Historically, the species was found across the Cumberland and Tennessee River basins. In Tennessee, birdwing pearlymussel currently it is found in the Duck, Clinch, and Powell Rivers and is listed in 24Tennessee counties (USFWS, 2011d) (USFWS, 2015aj).

The birdwing pearlymussel is found in rivers with swift currents, sand and gravel substrates, in riffle and shoal areas (USFWS, 1984d). Though populations of the birdwing pearlymussel are declining in some locations, the species is stable, but it is isolated, and susceptible to fluctuations in water quality and temperature. The species has experienced decreasing water quality from coal mining, construction activities, and riverine development such as channelization and building of dams. Additional risk for the species include climate change, which has the potential to affect host fish species and habitats for the birdwing pearlymussel larvae (USFWS, 1984d).

Clubshell. The clubshell is a mussel with a yellow to brown shell exterior (USFWS, 1997d). It was federally listed as an endangered species in 1993 (58 FR 5638 5642, January 22, 1993). Regionally this species is known to occur from Michigan south to Tennessee and Illinois east to New York, with an experimental population in Alabama (66 FR 32250 32264, June 14, 2001) (USFWS, 2015ak). Although the USFWS Midwest Region notes the clubshell is extirpated from Tennessee, the USFWS ECOS list identifies that the clubshell may be found or is known to occur 12 counties in Tennessee generally in the central portion of the state (USFWS, 1997d) (USFWS, 2015ak).

Suitable habitat for the clubshell are small to medium streams and rivers with clean, loose substrate consisting of sand and gravel. This species can live for up to 50 years. The current threats to the clubshell include water quality degradation, sedimentation from development, agricultural runoff, and pollution. Additionally, invasive non-native species, such as the zebra mussels, are becoming a major threat as they “cover and suffocate native mussels” (USFWS, 1997d).

Coosa Moccasinshell. The Coosa moccasinshell is a think elongated mussel occasionally exceeding 1.6 inches in length. The outer shell is yellow to dark brown with green rays, with a blue inner shell. Historically, the species range included rivers and creeks across Alabama, Georgia, and Tennessee. In Tennessee, the species is known or believed to occur in Bradley and Polk Counties in the southeast portion of the state (USFWS, 2015al). Critical habitat is designated within three rivers in multiple counties in Tennessee (USFWS, 2015ae). The species was federally listed as endangered in 1993 (58 FR 14330 14340, March 17, 1993).

The Coosa moccasinshell inhabits small creeks and rivers with sand/gravel/cobble shoals having moderate to strong currents. Threats to this species include habitat modification, sedimentation, eutrophication, and water quality degradation. (USFWS, 2015ae) (USFWS, 2000a)

Cracking Pearlymussel. The cracking pearlymussel is a freshwater mussel with a stretched, "slightly inflated" shell. The outer shell is dark green to brown with green rays, and a light blue to purple inner shell (USFWS, 1991a). The cracking pearlymussel was federally listed as endangered in 1989 (54 FR 39850 39853, September 28, 1989). A non-essential experimental population was established in Alabama in 2001 (66 FR 32250 32264, June 14, 2001). Another non-essential experimental population was established in Tennessee in 2007 (72 FR 52434 52461, September 13, 2007). Regionally, the endangered population is found from the western stretch of Virginia to the northeastern area of Alabama (USFWS, 2015am). Within Tennessee, the cracking pearlymussel it is found in the Clinch, Powell, Elk, and Tennessee Rivers in 26 counties in the central and eastern portion of the state (USFWS, 1991a) (USFWS, 2015am).

Habitat for this species includes medium to large-sized swift, turbulent rivers over bottoms of sand, gravel, mud and cobble. Threats to the species include habitat degradation, coal mining activities, oil and gas well development activities, damming, water quality and degradation, and water flow rates. (USFWS, 1991a)

Cumberland Bean (pearlymussel). The Cumberland bean is a long, oval shaped freshwater mussel that grows to approximately 2.2 inches. Its shell is smooth and olive green, yellowish to brown, or blackish colored with dark green rays (USFWS, 2011e). The Cumberland bean was federally listed as endangered in 1976 (41 FR 24062 24067 June 14, 1976) and an experimental population was established in Alabama and Tennessee in 2001 and 2007 respectively. Regionally, this species is known to occur in Alabama, Kentucky, North Carolina, Tennessee, and Virginia. In Tennessee, the Cumberland bean it is found in 22 counties in the central and eastern portion of the state (USFWS, 2015an).

Suitable habitats for the Cumberland bean consist of small rivers and streams having clean fast-flowing water over sand and gravel substrates. Similar to other mussels, this species' reproduction cycle is tied to the fantail darter (*Etheostoma flabellare*) and striped darter (*Etheostoma virgatum*) as their host fish. Current threats to this species include channelization, impoundments, siltation, coal mining, potential competition from invasive species such as the zebra mussel, and pollution. (USFWS, 1984e) (USFWS, 2011e)

Cumberland Elktoe. The endangered Cumberland elktoe is a freshwater mussel with a thin shell and a yellow brown shell with green rays (USFWS, 2004b). The species was federally listed as endangered in 1997 (62 FR 1647 1658, January 10, 1997). The species is endemic to the Cumberland River system and is found in Kentucky and Tennessee; in Tennessee, it is listed in 11 counties in the eastern portion of the state (USFWS, 2016c). Critical habitat for the species has been designated in Rock Creek (McCreary County Kentucky), North White Oak Creek (Fentress County), Big South Fork and tributaries (Fentress, Morgan, and Scott Counties, Tennessee, and McCreary County, Kentucky), Sinking Creek (Laurel County, Kentucky), New River (Morgan and Fentress counties), Bone Camp Creek (Morgan county), Marsh Creek (McCreary County, Kentucky), and Laurel Fork (Claiborne County, Tennessee, and Whitley County, Kentucky) (USFWS, 2004c).

The Cumberland elktoe is found buried in the main stems of medium-sized rivers, in both shallow pool areas and areas with flowing water, with mud, sand, and gravel substrates. Threats to the species include potential competition from invasive species such as the zebra mussel, impoundments, sedimentation, coal and gravel mining activities, non-point source pollution, water withdrawals, and pollution. (USFWS, 2004b)

Cumberland Monkeyface (pearlymussel). The Cumberland monkeyface is a freshwater mussel of approximately 3 inches in length. This mussel has a green yellow outer shell with dark green dots and chevrons (USFWS, 1984f). The species was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976) and was introduced as an experimental population in portions of Tennessee and Alabama in 2007 and 2001 respectively (USFWS, 2015ao). Historically, the species was found across the Cumberland and Tennessee River basins. In Tennessee, it is found in 28 counties in the central and eastern portion of the state (USFWS, 2007a) (USFWS, 2015ao).

Suitable habitats for this species includes swift flowing rivers with sand and gravel bottoms in riffle and shoal areas (USFWS, 1984f). Threats include water quality degradation, pollution, sedimentation, water flow alterations, and nonnative (invasive) species, such as the Asian Clam and Zebra mussel (USFWS, 1984f) (Terwilliger, Tate, & Woodward, 1995).

Cumberland Pigtoe. The Cumberland pigtoe is a freshwater mussel of less than 3 inches in length. The shells are heavy, triangular, and yellow-brown to dark brown in color (USFWS, 1992b). The species was federally listed as endangered in 1991 (56 FR 21084 21087, May 7, 1991). The species is endemic to the Caney Fork River System and is found in 15 counties in central Tennessee (USFWS, 1992b) (USFWS, 2015ap).

The Cumberland pigtoe is found buried in the main stems of small and medium-sized rivers with sand, gravel, and cobble substrates. Threats to the species include “impoundments and the general deterioration of water quality resulting from domestic and industrial waste outfalls” (USFWS, 1992b).

Cumberlandian Combshell. The Cumberlandian combshell is a freshwater mussel of approximately two to three inches in length. The yellow shells are marked by lines of fine green broken dots and dashes (USFWS, 2004d). The species was federally listed as endangered in 1997 (62 FR 1647 1658, January 10, 1997) and was designated with critical habitat in 2004 (69 FR 53136 53180, August 31, 2004). In 2001 and 2007, experimental populations were introduced in portions of the Tennessee River valley of Alabama and Tennessee. In addition to Tennessee, it is now found in Alabama, Kentucky, Mississippi, and Virginia (USFWS, 2015ar). Historically, the species was found across the Cumberland and Tennessee River basins. In Tennessee, it is found in 32 counties in the central and eastern portion of the state (USFWS, 2015ar). Critical habitat in Tennessee was designated for the Duck River (Maury and Marshall Counties), Powell River (Claiborne and Hancock Counties), Clinch River (Hancock County), Nolichucky River (Hamblen and Cocke Counties), and Big South Fork (Fentress, Morgan, and Scott Counties) (USFWS, 2004e).

Suitable habitats for the Cumberlandian combshell are shoals in fast moving rivers having sand, cobble, and gravel substrates (USFWS, 2004d) (USFWS, 2015ar). Historically, the species experienced significant challenges to water quality degradation from gravel mining, construction activities, riverine development (such as channelization and building of dams), sedimentation, and pollution, and potential competition from invasive species such as the zebra mussel (USFWS, 2004d).

Dromedary Pearlymussel. The dromedary pearlymussel is a freshwater mussel named for its mid-shell hump observed on larger specimens, reaching a length of approximately 3.5 inches long. The shell is mostly round, with a lighter brown color interspersed by green discolorations and streaks, whose growth lines are often bumpy. The dromedary pearlymussel was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976). In addition to Tennessee, the species is found regionally in Virginia and Alabama, with a non-essential experimental population established in Tennessee in 2007. In Tennessee, it is found in 35 counties in the central and eastern portion of the state (Terwilliger, Tate, & Woodward, 1995) (USFWS, 1983e) (USFWS, 2015as).

Suitable habitat for the species consists of the shoals in rivers within moderately moving rivers having sand and gravel bottoms. It has also been found in deeper, slower moving portions of rivers. Threats to the dromedary pearlymussel include pollution from coal mining and coal production which has resulted in habitat degradation. Additional threats include competition from exotic species such as the Asian clam and zebra mussel (Terwilliger, Tate, & Woodward, 1995).

Fanshell. The fanshell is a freshwater mussel having a light green to yellow shell with green rays. The inside of the shell is white (USFWS, 1991b). It was federally listed as endangered in 1990 (55 FR 25591 25595, June 21, 1990). This species is known to occur in Alabama, Illinois, Indiana, Kentucky, Ohio, Tennessee, Virginia and West Virginia with a non-essential experimental population established in Tennessee in 2007. In Tennessee, it is found in 30 counties across the state (USFWS, 1991b) (USFWS, 2015at).

Suitable habitat for the fanshell consists of large moderate flowing rivers with sand and gravel bottoms. This species needs a stable substrate to bury itself in, leaving only its feeding siphons and the edge of its shell exposed. Fanshells require a host fish to complete their larvae development as the fanshell larvae attach to the host’s gill. Threats to the fanshell include habitat alteration from dams and reservoirs, water quality degradation, siltation, pollution, and industrial runoff. (USFWS, 1997e)

Finelined Pocketbook. The finelined pocketbook is a mussel approximately 4 inches in length. The outer shell is yellow-brown with black fine rays, with a white iridescent inner shell. The species was federally listed as threatened in 1993 (58 FR 14330 14340, March 17, 1993). Its range is believed to be in Alabama, Georgia, and Tennessee. In Tennessee, the species is found in Bradley and Polk Counties in the southeast portion of the state (USFWS, 2015au). Designated critical habitat in Tennessee is within the Conasauga River in Bradley and Polk Counties (USFWS, 2015ae).

The finelined pocketbook was historically found in large rivers to small creeks. Threats include channelization, mining, impoundment, and other activities that change the stream slope. Remaining populations are threatened by pollutants and competition from non-native species. (USFWS, 2004f)

Finerayed Pigtoe. The finerayed pigtoe is a pearly mussel, distinguishable by its thin outer shell with green rays over a yellow-green to brown coloration (USFWS, 1984g). The finerayed pigtoe was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976). In 1984, only seven populations were known to exist within its range in Virginia, Tennessee, and Alabama. Since then, two of the seven populations have been considered extirpated.[88] Nonessential experimental populations were created in 2001 in Alabama in the free-flowing reach of the Tennessee River, and in 2007 in Tennessee in portions of the French, Broad, and Holston rivers (USFWS, 2015av). Despite long-term decline, the overall status of the species is currently considered to be stable. This is primarily due to its Clinch River, Virginia population (USFWS, 2013c). In Tennessee, this species can be found in 28 counties in the central and eastern portion of the state (USFWS, 2015av).

Suitable habitat for the finerayed pigtoe consists of silt-free sand, gravel, and cobble substrates of free-flowing smaller streams (USFWS, 1984g). Since the early 1900s, land use changes from industrial and agricultural development caused declines in this species. Threats to this species are habitat alteration, potential competition from invasive species such as the zebra mussel, and pollution (USFWS, 2013c).

Fluted Kidneyshell. The fluted kidneyshell is a mussel reaching up 5 inches in length, with a greenish yellow and brownish color (USFWS, 2013d) (USFWS, 2015aw). The fluted kidneyshell was federally listed as endangered in 2013 and designated a critical habitat (78 FR 59269 59287, October 28, 2013), as shown in Figure 14.1.6-3. "The local range for the species is the Cumberland and Tennessee river system, which includes 25 counties across central and eastern Tennessee" (USFWS, 2015aw). The mussel currently occurs in less than 50 percent of its historical range, and the current overall population of the species range wide is declining (USFWS, 2013d).

The mussel is found "in medium-sized creeks to large rivers, inhabiting sand and gravel substrates in relatively shallow riffles and shoals with fast or swift current" (USFWS, 2013d). Species threats include dams/impoundments, mining activities, poor water quality, excessive sedimentation, and environmental contaminants (USFWS, 2013d).

Georgia Pigtoe. The Georgia pigtoe grows 2 to 2.5 inches in length is oval and somewhat inflated. The surface of the shell is yellowish-tan to reddish-brown and may have concentric green rings, whereas the inner shell is white to light bluish-white (USFWS, 2015ax). The species was federally listed as endangered in 2010 (75 FR 67512 67550, November 2, 2010). The Georgia pigtoe was historically found in large creeks and rivers of the Coosa River drainage of Alabama, Georgia, and Tennessee. In Tennessee, the species is found in Bradley and Polk Counties in the southeastern portion of the state (USFWS, 2015ax). Designated critical habitat for the Georgia pigtoe in Tennessee is in Conasauga River in Bradley and Polk Counties (USFWS, 2015d).

The Georgia pigtoe occurs in areas with shallow runs and riffles having strong to moderate current, and coarse sand/gravel/cobble substrates. Threats to the species include range

[88] Locally extinct.

curtailment (only inhabits 27 miles), dams and impoundments, water and habitat quality, and climate change (vulnerability to drought, severe storm events, and other potential effects) (USFWS, 2014e).

Green Blossom (Pearlymussel). The green blossom is an irregularly oval-shaped mussel which has a more flattened shell in comparison to its relative species, with a yellow tinge and faint green streaks (USFWS, 1984h). The green blossom was federally listed in 1976 (41 FR 24062 24067, June 14, 1976). Historically, this species was found within the Tennessee River watershed, reaching north of Knoxville, Tennessee into the western-most corner of Virginia. The local range for the species includes 17 counties in eastern Tennessee (USFWS, 1984h) (USFWS, 2015ay).

Green blossom pearlymussel are generally found in fast flowing freshwater over firm gravel and shoal areas. Threats to the green blossom include damming, the buildup of sediments, and pollution, which result in habitat degradation for the species (USFWS, 1984h).

Littlewing Pearlymussel. The littlewing pearlymussel is a freshwater mussel that grows up to 1.5 inches. The shell of this species is light green or dark yellowish with dark rays, with a chalky appearance (USFWS, 2015az). The littlewing pearlymussel was federally listed as endangered 1988 (53 FR 45861 45865, November 14, 2015). Historically, the littlewing pearlymussel was found in numerous rivers associated to the Tennessee and Cumberland River systems. In addition to Tennessee, it can now be found in Alabama, Kentucky, North Carolina, and Virginia. In Tennessee, it is found in 19 counties in the central and eastern portion of the state (USFWS, 1989b) (USFWS, 2015ba).

Suitable habitats for the littlewing pearlymussel consist of medium sized rivers and streams with cool clear water. Usually, these mussels are found behind large rocks. Threats to the species include dams, dredging, and water quality degradation (water flow and temperature). (USFWS, 1989b) (USFWS, 2015az)

Nashville Crayfish. The Nashville crayfish is a dark brown to green crayfish, growing to sizes up to 7 inches long with orange and black colored pincers. (USFWS, 1989c). The Nashville crayfish was federally listed in 1986 (51 FR 34410 34412, September 26, 1986). The species is only known from Mill Creek and several tributaries Davidson, Rutherford, and Williamson Counties, Tennessee (USFWS, 1989c) (USFWS, 2015bb).

Preferred habitats for the Nashville crayfish include gravel-covered bedrock sections of runs and pools, with vegetated stream banks providing canopy cover over the stream. Threats to the species include "siltation, stream alterations, and general water quality deterioration resulting from urban development pressures" (USFWS, 1989c).

Orangefoot Pimpleback (pearlymussel). The orangefoot pimpleback, also known as the orange-footed pearlymussel, is a mussel that measures between 3.5 and 4 inches long, with a large and heavy shell marked by irregular growth rings and numerous bumps on its yellowish brown to chestnut brown surface. (USFWS, 1984i) It was among the first invertebrate species to gain federal protection in 1976, under the ESA (41 FR 24062 24067, June 14, 1976). A non-essential experimental population was established in 2007 (72 FR 52434 52461, September 13, 2007).

In addition to Tennessee, this species is known or believed to occur in Alabama, Illinois, and Kentucky, with a non-essential experimental population in Tennessee. In Tennessee, it can be found in 46 counties across central and eastern Tennessee (USFWS, 2015bc). The orangefoot pimpleback buries itself in the substrate of rivers in sand and gravel areas and only its feeding siphons and the edge of its shell are exposed. As larvae, it is parasitic and attaches itself to the gills of a host fish until it has grown a shell (USFWS, 2015bd). Threats to this species include dams and reservoirs, which separate upstream and downstream populations and eliminate sand and gravel substrate, siltation from industrial activity and development, and pollution from agricultural and industrial runoff (USFWS, 1984i) (USFWS, 2015bd).

Ovate Clubshell. The ovate clubshell grows up to 2 inches in length. The oval-shaped shell has an outer skin color of yellow to dark brown with occasional broad green rays, and a white interior (USFWS, 2000b). The ovate clubshell was federally listed as endangered in 1993 (58 FR 14330 14340, March 17, 1993).

In addition to Tennessee, this species is found regionally in Alabama and Mississippi. In Tennessee, it is found in Bradley and Polk Counties in the southeastern portion of the state (USFWS, 2015be). Critical habitat was designated in 2004 in the Conasauga River in Bradley and Polk Counties in Tennessee (USFWS, 2004g). It inhabits sand and gravel shoals and runs of small rivers and large streams. Threats to the ovate clubshell include water quality degradation, channelization, household and agricultural runoff, and channel erosion (USFWS, 2000b).

Oyster Mussel. The oyster mussel is distinguishable by its dull to sub-shiny, yellowish-green shell with numerous narrow dark green streaks (62 FR 1647 1658, January 10, 1997) (USFWS, 2004d). The inside of the shell is whitish to bluish-white in color. The oyster mussel was federally listed as endangered in 1997 (62 FR 1647 1658, January 10, 1997) and critical habitat was designated in 2004 (69 FR 53136 53180, August 31, 2004). The species historically occurred throughout much of the "Cumberlandian" region of the Tennessee and Cumberland River drainages in Alabama, Kentucky, Tennessee, and Virginia. By 1991, the oyster mussel was considered to be extremely rare, with small populations in only three streams of the Tennessee River system in Tennessee and Virginia (USFWS, 2004d). Nonessential experimental populations were as created in 2001 in Alabama in the free-flowing reach of the Tennessee River, and in 2007 in Tennessee in portions of the French, Broad, and Holston rivers. The local range for the species includes rivers in 30 Tennessee counties (USFWS, 2015bf). Critical habitat has been designated for the Oyster mussel in Duck River (Maury and Marshall Counties), Powell River (Claiborne and Hancock Counties), Clinch River and its tributaries (Hancock County), Nolichucky River (Hamblen and Cocke Counties), and Big South Fork River and its tributaries (Fentress, Morgan, and Scott Counties) (USFWS, 2004h).

The oyster mussel prefers swift to moderate currents, and generally occurs in small to medium rivers, although occasionally it is found in large rivers. The species prefers substrate consisting of coarse sand to boulders. Species threats include habitat loss from human-induced water quality degradation, including dams/impoundments, channelization, and mining activities, resulting in deforestation, industrial contamination, sedimentation in the upper Tennessee River system, and potential competition from invasive species such as the zebra mussel. (USFWS, 2004d)

Painted Snake Coiled Forest Snail. The painted snake coiled forest snail is less than an inch wide with a white shell having flame markings along the shell ridges (USFWS, 1982b). The painted snake coiled forest snail was federally listed in 1978 (43 FR 28932 28935, July 3, 1978). The species is known only from Buck Creek Cove in Franklin County, Tennessee (USFWS, 1982b) (USFWS, 2015bg).

Because the species is so limited in distribution, little is known about its specific habitat requirements, though it generally consists of limestone outcrops with vegetative cover. Threats to the species include habitat loss or destruction from human activity, forestry practices, and quarrying activities. (USFWS, 1982b)

Pale Lilliput (pearlymussel). The pale lilliput is a freshwater mussel growing up to 1.7 inches in length. It has a relatively thin and slightly compressed shell that is tawny to yellowish green and lacking any rays. The interior shell color ranges from purple to coppery, and the shell is egg-shaped and somewhat cylindrical (USFWS, 1984j). The pale lilliput was federally listed as endangered in 1976 (41 FR 24062 24067, June 4, 1976) (USFWS, 2015bh).

In Tennessee, the species believed or known to occur in 17 counties (USFWS, 2015bh). It is usually found in small rivers and streams in shallow, fast-flowing water with a stable, clean substrate of rubble, gravel, or sand. Threats to the pale lilliput include impoundment, siltation, and pollution, due to industrial and agricultural development of the Tennessee Valley (USFWS, 1984j).

Pink Mucket (pearlymussel). The pink mucket has a smooth yellowish-brown round shell that is approximately 4 inches long. This species was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976). The pink mucket was historically known to occur from Oklahoma east to Virginia and Illinois south to Louisiana; however, due to different factors the populations of these species have decreased and are now only known to occur in small populations in Alabama, Arkansas, Illinois, Kentucky, Louisiana, Missouri, Ohio, Virginia, and West Virginia. In Tennessee, it is found in 49 counties in the central and eastern portions of the state (USFWS, 1985d) (USFWS, 1997f) (USFWS, 2015bi).

Suitable habitat for the pink mucket consists of moderate to fast-flowing rivers and their tributaries with mud and sand in shallow riffle areas. Threats to the survival of this species include dams that disrupt the natural flow of water (which in turn changes the composition of sediments and likely disrupts the normal quantity and variety of host fish), impoundment, and water quality degradation. (USFWS, 1997f)

Purple Bean. The purple bean is a freshwater mussel with a compacted, and broad shell. The outside shell color ranges from dark green to green-black with green rays, and its inside coloring ranges from light to dark purple, sometimes accented by a pink coloring (Terwilliger, Tate, & Woodward, 1995) (USFWS, 2004i). The purple bean was federally listed as endangered in 1997 (62 FR 1647 1658, January 10, 1997) and critical habitat was established in 2004 in Tennessee along the Tennessee River basin, including the Powell, Clinch, and Obed Rivers (in Cumberland, Morgan, Claiborne, and Hancock counties) and Beech Creek (Hawkins County) (69 FR 53136 53180, August 8, 2004). The purple bean mussel has a relatively limited regional range, from the western area of Virginia south to the eastern half of Tennessee. The species is known or believed to occur 10 counties in Tennessee (USFWS, 2016d) (Terwilliger, Tate, & Woodward, 1995).

Purple bean habitat is primarily constrained to headwater areas, where medium- to high-speed freshwater currents occur over sandy or gravelly bottoms, and beneath larger rocks which may provide protection. Threats to the species include "silt from agricultural land-use and logging, oil and gas exploration, and the cutting of riparian vegetation along stream banks," along with potential competition from invasive species such as the zebra mussel. (Terwilliger, Tate, & Woodward, 1995)

Rabbitsfoot. The rabbitsfoot is a freshwater mussel that can grow up to 6 inches in length. The shell of the rabbitsfoot mussel is generally yellowish, greenish, or olive in color and turns yellowish brown with age. The rabbitsfoot was federally listed as threatened in 2013 (78 FR 57076 57097, September 17, 2013). It has been estimated that these mussels have been eliminated from about 64 percent of its existing historical range and only about 10 of the populations that exists are considered to be large enough to be viable for long term (USFWS, 2011f) (USFWS, 2015bj). It occurs in 13 states, and in Tennessee, is found in 29 counties in the central and eastern portion of the state (USFWS, 2015bk). The rabbitsfoot is a sedentary filter feeder that obtains its oxygen and food from the water column. The rabbitsfoot prefers the shallow area of streams and rivers with sand and gravel along the banks. These mussels seldom burrow and instead use the gravel along the banks as refuge in fast moving rivers and streams. For reproduction this species prefers a stable and undisturbed habitat with a sufficient population of host fish including several genera of shiners (*Cyprinella, Luxilus,* and *Notropis*) (USFWS, 2011f).

Critical habitat designation occurred in 2015 at 31 stream segments where the mussels are known to occur (80 FR 24691 24774, April 30, 2015). In Tennessee, critical habitat includes the Duck River (Marshall, Hickman, Perry, and Maury Counties), the Tennessee River (Hardin County), and the Red River (Montgomery and Robertson Counties) (USFWS, 2015bl). The current threats to the rabbitsfoot include the loss of habitat due to channelization, impoundments, pollution, isolation of populations, sedimentation, climate change; and potential competition from invasive species such as the zebra mussel. (USFWS, 2011f).

Ring Pink Mussel. The ring pink mussel is a freshwater mussel with a thick oval shell measuring about 3 to 4 inches in length and height, and living up to 50 years or more. The yellow-green to brown-black outer shell is darker colored in older specimens and does not have rays. The color of the inside of the shell varies from pink to deep purple and has a white border (USFWS, 2004j). The ring pink mussel was federally listed as endangered in 1989 (54 FR 40109 40112, September 29, 1989), with a non-essential experimental population established in 2007 (72 FR 52434 52461, September 13, 2007) (USFWS, 2015bm).

The experimental population occurs in specified portions of the French Broad and Holston Rivers in Tennessee. In Tennessee, the species is believed or known to occur in 29 counties in the eastern and southern portion of the state (USFWS, 2015bm). It inhabits large rivers with shallow water, preferring silt-free sand and gravel bottoms. Threats to the ring pink mussel result from its restricted range and small population numbers, dams, gravel dredging of rivers, and pollution (USFWS, 2015bn).

Rough Pigtoe. The rough pigtoe is a thick-shelled, triangular-shaped freshwater mussel. The mussel appears inflated, and has a dirty-yellow or rust-colored shell marked by uneven growth markings. The rough pigtoe was federally listed in 1976 (41 FR 24062 24067, June 14, 1976). It is known to occur in only five streams around the Mississippi watershed, including the Tennessee, Cumberland, Clinch, Green, and Barren Rivers (USFWS, 2014f). Regionally, in addition to Tennessee, the rough pigtoe is known or believed to occur in Virginia, Alabama, Kentucky, and Indiana. In Tennessee, it is found in 33 counties in the central and eastern portion of the state (USFWS, 2015bo).

The rough pigtoe is primarily observed in shoal areas of medium to large rivers, burying itself in the sand or gravel river bottom. Threats to the rough pigtoe include damming, the buildup of sediments, and pollution which result in habitat degradation for the species (USFWS, 1984k). A recent threat includes suffocation and competition from the zebra mussel which reproduces rapidly and at a high rate (USFWS, 2015bp).

Rough Rabbitsfoot. The rough rabbitsfoot is an oval-shaped, bumpy-shelled freshwater mussel, sometimes with knobs on the backside of the shell. The outer layer of the shell is usually yellow-green in color, with green patterns and discolorations throughout. The interior color transitions from silver to a shiny iridescent white at the back of the shell (USFWS, 2004i). The species was listed as endangered in 1997 (62 FR 1647 1658, January 10, 1997), and is considered endemic to the upper Tennessee River system, specifically within the "Cumberlandian" region. The species is found in 13 counties in northeastern Tennessee (USFWS, 2015bq). Critical habitat was established for rough rabbitsfoot within the Clinch and Powell rivers (in Handcock and Claiborne counties) (USFWS, 2004e) (USFWS, 2004i), shown in Figure 14.1.6-3.

Rough rabbitsfoot exists primarily in areas of the Tennessee River with "moderate to swift current but often exists in areas close to, but not in, the swiftest current" (USFWS, 2004i), laying on its side upon sediments in mid-river whirlpools. Main threats water/habitat changes from the installation of dams, channels, and pollution, and potential competition from invasive species such as the zebra mussel. (USFWS, 2004i)

Royal Marstonia Snail. The royal marstonia snail, also known as the royal snail, is an aquatic snail, approximately 0.2 inches in size (USFWS, 1995b). The royal marstonia snail was federally listed in 1994 (59 FR 17994 17998, April 15, 1994). The species is known or believed to occur in Grundy, Marion, and Sequatchie Counties (USFWS, 1995b) (USFWS, 2015br).

Because the species is so limited in distribution, little is known about its specific habitat requirements. The habitat where the species is known consists of cave spring discharges where it is found in "the diatomaceous 'ooze' and on leaves and twigs in the quieter pools downstream from the spring source" (USFWS, 1995b). Threats to the species include water quality degradation from non-point source pollution (primarily from coal mining activities and land use practices), chemical spills, or vandalism (USFWS, 1995b).

Sheepnose Mussel. The sheepnose mussel grows about 5 inches with a light yellow to dull yellowish brown color shell having darker ridges (USFWS, 2012d). After multiple status reviews since 2004, the USFWS listed the sheepnose mussel as endangered in 2012 (77 FR 14914 14949, March 13, 2012). This species historically occurred mostly along the Mississippi River, and in addition to Tennessee, populations are now known of believed to occur in Alabama, Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Ohio, Pennsylvania, Virginia, and Wisconsin (USFWS, 2012d) (USFWS, 2015bs). In Tennessee, it can be found in 21 counties in the central, eastern and southern portions of the state (USFWS, 2015bt).

The sheepnose mussel lives in large rivers and streams with rough substrates and moderate to swift currents where they feed on suspended algae, bacteria, detritus, and microscopic animals. This species prefers shallow shoal habitats above coarse sand and gravel but has been observed in deeper waters of large rivers have bottoms of mud, cobble or boulders. For reproduction the sheepnose prefers a stable undisturbed habitat with the presence of sauger (*Sander Canadensis*), its only host fish in the wild. Threats include sedimentation, dams that disturb natural flow, habitat reduction through sedimentation, population fragmentation, dredging, channelization, road construction, water quality degradation from pollutants, contaminations of nutrients, and invasive species of zebra mussels (USFWS, 2012d).

Shiny Pigtoe. The shiny pigtoe is a freshwater mussel which grows to approximately two inches long. The species' shell is yellow-brown with very dark green streaks and is irregularly oval-shaped (USFWS, 1984l). The shiny pigtoe was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976). The species' range extends from the western region of Virginia across Tennessee to the northern regions of Alabama. The listing indicates experimental populations in various portions of the Tennessee River, reaching just south of the western border of Virginia, and a protected area is indicated within the Clinch River around Pendleton Island. Within Tennessee, the species is found in 20 counties in the central and eastern portion of the state (USFWS, 2015bu).

The shiny pigtoes are found in "relatively silt-free substrates of sand, gravel, and cobble in good flows of larger streams" (USFWS, 2015bu). Since the species is a filter feeder, the primary threat is water quality degradation due to pollution and mining development. Water flow alterations and damming practices are also threats to the species (USFWS, 1984l).

Slabside Pearlymussel. The slabside pearlymussel has brownish colored shells with green rays and grows to about 3.3 inches (USFWS, 2012e). After multiple status reviews, the USFWS listed the slabside pearlymussel as endangered in 2013 (78 FR 25041 25044, April 29, 2013). Regionally, this species is known to occur only in the Tennessee and Cumberland River systems within Tennessee, Alabama, Kentucky, Mississippi, and Virginia. In Tennessee, it can be found in the Clinch, Powell, Nolichucky, Elk, Duck, Buffalo, Sequatchie, and Hiwassee Rivers across 39 counties in central and eastern sections of the state. Critical habitat was designated in these and other rivers associated with the Tennessee River system, in Bedford, Bledsoe, Claiborne, Cocke, Franklin, Giles, Greene, Hamblen, Hancock, Hickman, Humphreys, Lincoln, Marion, Marshall, Maury, Moore, Perry, Polk, and Sequatchie Counties (see Figure 14.1.6-3). (USFWS, 2012e) (USFWS, 2015bv) (USFWS, 2013d)

The preferred habitat for the slabside pearlymussel consists of large creeks and rivers with sand and gravel bottoms and moderate current. The slabside pearlymussel, are found at the bottom of relatively shallow creeks and rivers feeding on diatoms, phytoplankton, and other microorganisms. The slabside pearlymussel is a summer brooder; once larvae are released from the females starting in mid-May to August, they must attach to a fish host to be fully developed by mid-summer. (USFWS, 2012e)

The primary threat to the slabside pearlymussel is the loss and degradation of suitable habitats. River impoundments are the major cause of this decline. These activities change the temperature of water, alter the natural flow, and decrease the abundance of host fish. Water quality degradation from instream gravel mining, coal mining, polluted discharges, and siltation are also threatening the survival of the species (USFWS, 2012e).

Snuffbox Mussel. The snuffbox mussel grows from 1.8 to 2.8 inches in length with a yellow, green, or brown triangular to oval shell having with green rays (USFWS, 2012f). This species was federally listed as endangered in 2012 (77 FR 8632 8665, February 14, 2012) (USFWS, 2015bw). The snuffbox total population has reduced by 62 percent from its historical range. Currently this species only occurs in 79 streams and lakes in 14 states and Ontario, Canada compared to 210 streams and lakes in its historical range (USFWS, 2012e). In Tennessee, it is found in 25 counties in the central and eastern portion of the state (USFWS, 2015bt).

The snuffbox mussel typically prefers small to medium sized creeks, lakes, and rivers and feed on suspended algae, bacteria, and dissolved organic material. The species has also been observed in Lake Erie and in some large rivers. This species prefers shoal habitats with swift current over sand and gravel as they usually burrow deep in sand. For reproduction a stable and undisturbed habitat is require with a sufficient population of host fish such as logperch (*Percina caprodes*) and several other darters. Current threats to this species include sedimentation, pollution, and water quality degradation, dams that restrict natural flow, and invasive non-native zebra mussels (USFWS, 2012e).

Southern Acornshell. The southern acornshell is a freshwater mussel with an oval shell that grows up to about 1.3 inches in length. The outside shell is glossy yellow, and rarely has rays. The interior shell color is usually white (GADNR, 2008). The southern acornshell was federally listed as endangered in 1993 (58 FR 14330 14340, March 17, 1993).

This species is believed to occur in Bradley and Polk Counties in southeastern Tennessee, but many experts believe it is actually extinct (USFWS, 2015bx). Although its habitat has not been well documented, it has been observed in gravel or sand substrates in medium to large rivers with moderate current (GADNR, 2008). Critical habitat was designated in 2004 (69 FR 40084 40171, July 1, 2004) in the Conasauga River in Bradley and Polk Counties. Threats to the southern acornshell include limited habitat, small population size, exotic species invasion, land use runoff pollution, and sedimentation (USFWS, 2004k).

Southern Pigtoe. The southern pigtoe is a freshwater mussel with yellow to yellow-brown elliptical shells that grows to about 2.4 inches in length (USFWS, 2000a). The species was federally listed as endangered in 1993 (58 FR 14330 14340, March 17, 1993). The species is believed to occur in Alabama, Georgia, and Tennessee. In Tennessee, the species is found in Bradley and Polk Counties in the southeastern portion of the state (USFWS, 2015by). Critical habitat in Tennessee has been designated within the Conasauga River in Bradley and Polk Counties (USFWS, 2015ae).

Habitat for the southern pigtoe is shoals and runs with sand to cobble substrate in small-sized rivers to large-sized streams. The southern pigtoe has declined due to habitat modification, impoundment, water quality degradation, sedimentation and eutrophication. Continued threats include runoff from agriculture and development and recreational activities. (USFWS, 2000a) (USFWS, 2015by)

Spectaclecase (Mussel). The spectaclecase mussel is a large (up to nine inches long) freshwater mussel. Its brownish to black shell is large with a somewhat curved appearance and moderate inflation (USFWS, 2012g). This species was first listed as federally endangered in 2012 (77 FR 14914 14949, April 12, 2012). The spectaclecase mussel has suffered a 55 percent decrease in distribution and only occurs in 20 of the 44 streams it historically inhabited. Most populations are now fragmented and limited to short reaches of streams in 11 states: Alabama, Arkansas, Illinois, Iowa, Kentucky, Minnesota, Missouri, Tennessee, Virginia, West Virginia, and Wisconsin (USFWS, 2012g) (USFWS, 2015bz). In Tennessee, the species is found in 35 counties across the central and eastern portions of the state (USFWS, 2015bz).

Suitable habitat for the spectaclecase mussel includes sheltered areas in large rivers. This species seeks out areas that are sheltered from the force of the river current such as beneath rock slabs, firm mud banks, and in-between tree roots. Spectaclecase mussels are long-lived and spend their entire adult lives partially or completely embedded in river bottom substrate; some specimens have been estimated to be up to 70 years old. This species of mussel has a parasitic life stage and is dependent on a host fish for successful rearing and relocation of larvae young. The current major threat to the survival of this species is dam construction. Dams alter the natural flow and temperature regime of rivers, blocking fish passage which is necessary to prevent fragmentation and connect populations. Sedimentation of rivers, pollution, channelization, and invasive zebra mussels also pose threats to this species. (USFWS, 2012g)

Spruce-fir Moss Spider. The spruce-fir moss spider is one of the smallest members of tarantulas, measuring 0.10 to 0.15 inch. The spider ranges from light brown to darker reddish browns. The species was federally listed as endangered in 1995 (60 FR 6968 6974, February 06, 1995). Historically, the spruce-fir moss spider lived throughout the mountains of southern Appalachia and today is present on few mountain tops in western North Carolina, eastern Tennessee, and southwest Virginia (USFWS, 1998a). In Tennessee, the species is found in only Sevier Counties in the eastern portion of the state (USFWS, 2015ca). Critical habitat was designated in Carter and Sevier Counties (USFWS, 2015ca).

Typical habitat for this spider is damp and well-drained mosses growing on shady rocks in mountain forests of Fraser fir and red spruce. However, Fraser fir trees in the Southern

Appalachian Mountains have suffered from infestation by the balsam wooly adelgid (*Adelges piceae)*. Death and thinning of the tree canopy results in substantial changes in the forest, such as increased temperatures and decreased moisture, which directly affects suitable habitats for this species. Additional threats include habitat destruction from logging operations, wildfires, drought, and storm damage. (USFWS, 1998a)

Tan Riffleshell. The tan riffleshell is a dull green mussel with faint green and white rings around its shell that can grow to about two and a half inches. It was federally listed as endangered in 1977 (42 FR 42351 42353, August 23, 1977). Historically, the species was found across the Cumberland and Tennessee River basins (USFWS, 1984m). Currently, in Tennessee, the tan riffleshell is found in the Big South Fork and is believed to occur in 25 counties across Tennessee (USFWS, 2013e) (USFWS, 2015cc).

Generally, the tan riffleshell is found in rivers of swift currents with sand and gravel substrates in riffle areas (USFWS, 1984m). The restricted population has experienced significant challenges to water quality from chemical spills and sedimentation from construction and mining activities. Additional threats include riverine development (such as channelization and building of dams) and climate change which has the potential to affect host fish species and habitat for riffleshell larvae (USFWS, 2013e).

Triangular Kidneyshell. The triangular kidneyshell is a freshwater mussel with shells that are straw-yellow color in juveniles and yellow-brown in adults. The maximum adult shell length is about 4 inches (USFWS, 2000a). The species was federally listed as endangered in 1993 (58 FR 14330 14340, March 17, 1993). The species is known, or believed to occur, in Alabama, Georgia, and Tennessee. In Tennessee, the species is found in Bradley and Polk Counties in the southeastern portion of the state (USFWS, 2015cb). Critical habitat was designated in in Tennessee in the Conasauga River in Bradley and Polk Counties (USFWS, 2004f).

The triangular kidneyshell inhabits “sand/gravel/cobble shoals and runs in small rivers and large streams.” Current threats to this species are habitat modification, dams and other water flow impediments, sedimentation, eutrophication, and degradation of water quality from development, industrial, and agricultural runoff, mine drainage, and other point and non-point sources. (USFWS, 2000a) (USFWS, 2015cb)

Tubercled-Blossom (Pearlymussel). The tubercled-blossom mussel grows to about three inches, and has a yellowish to brown thick shell (USFWS, 2015ce) (Illinois Natural History Survey, 2015). The tubercled-blossom mussel was first listed as endangered in 1976 (41 FR 24062 24067, June, 14, 1976) and non-essential experimental populations were established for Alabama, Illinois, Kentucky, and West Virginia in 2001 (66 FR 32250 32264, June 14, 2001). In Tennessee, the species is found in 21 counties across central and eastern Tennessee (USFWS, 2015cd).

Suitable habitats for the tubercled-blossom mussel consist of gravel shoals and shallow sand of large rivers with rapid currents. It is believed that deforestation and the progression of intense agriculture caused the decline of these species (USFWS, 2015ce).

Turgid Blossom (pearlymussel). The turgid blossom is a freshwater mussel with an oval-shaped shell, reaching up to 1.6 inches in length. The outside surface of the shell is shiny and yellowish-green in color, with fine green rays and irregular growth lines (USFWS, 1985e). The turgid blossom was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976), and a non-essential experimental population was established in 2001 in Alabama (66 FR 32250 32264, June 14, 2001). The historic range of the turgid blossom consists of 26 counties in eastern and central Tennessee and one county in Arkansas. As of 2007, this species is presumed extirpated from its historic range and is likely to be extinct (USFWS, 2007b) (USFWS, 2015cf).

Turgid blossom pearlymussels occur in shallow areas of streams with sand or gravel substrate and fast currents. Threats to the turgid blossom include habitat loss or modification due to impoundments, siltation, and runoff pollution (USFWS, 1985e).

Upland Combshell. The upland combshell is a freshwater mussel with a squarish shaped shell and grows up to 2.4 inches in length. The outside of the shell is yellowish-brown to tawny in color, and can have broken green rays or small green spots (USFWS, 2000a). The upland combshell was federally listed as endangered in 1993 (58 FR 14330 14340, March 17, 1993). The historical range of this species was parts of the Mobile River Basin in Alabama, Georgia, and Tennessee. In Tennessee, the species is found in Bradley and Polk Counties in the southeastern portion of the state. However, recent surveys have failed to find any evidence of the species, and the upland combshell is now considered to be extinct by many experts (USFWS, 2015cg). Critical habitat was designated in 2004 (69 FR 40084 40171, July 1, 2004) in the Conasauga River in Bradley and Polk Counties, Tennessee (USFWS, 2004l).

It inhabits stable sand, gravel, or cobble substrate in moderate to swift currents on shoals in rivers and large streams above a rapid change in elevation. The biggest threat to the upland combshell is water quality degradation due to urban and agricultural runoff, and sedimentation (USFWS, 2000a).

White Wartyback (pearlymussel). The white wartyback is a freshwater mussel with a thick, almost egg-shaped shell that has growth lines and a row of bumps on the middle part of the shell. The outer skin of the shell is a greenish-yellow or yellowish-brown color with no rays. The inside of the shell is white and iridescent (USFWS, 1984n). The white wartyback was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976), and a non-essential experimental population was established in 2007 (72 FR 52434 52461, September 13, 2007). The experimental population of this species occurs in Tennessee. In Tennessee, it is believed or known to occur in 24 counties in the central and eastern portions of the state (USFWS, 2015ch).

It inhabits gravel and sand substrate free of silt, in clean, fast-flowing water in large rivers. It buries itself in the sand or gravel between ledges of bedrock. Threats to the white wartyback include impoundments which flood its habitat; siltation due to mining, logging, and farming; and pollution due to agricultural and industrial runoff. (USFWS, 2015ci)

Yellow Blossom (pearlymussel). The yellow blossom is a freshwater mussel with an elliptical or egg-shaped shell growing up to 2.4 inches in length. The outside skin of the shell is somewhat shiny and is yellow, honey yellow, brownish yellow, or whitish in color with green rays across the surface. The inside color of the shell is bluish white and iridescent (USFWS, 1985f). The yellow blossom was federally listed as endangered in 1976 (41 FR 24062 24067, June 14, 1976) with a non-essential experimental population established in 2001 (66 FR 32250 32264, June 14, 2001).

The endangered population of this species is known or believed to occur in Alabama and Tennessee, and the experimental population is known or believed to occur in Alabama. Within Tennessee, the species is not listed in any specific counties but historically was widespread in the Tennessee and Cumberland Rivers and tributaries to the Tennessee River (USFWS, 1985f) (USFWS, 2015cj). It inhabits shallow areas of rivers with a sand or gravel substrate and rapid current. Threats to the yellow blossom include impoundments, siltation, and pollution (USFWS, 1985f). Mussel experts believe that the yellow blossom is likely extinct, as the last known specimen of the yellow blossom was recorded in the Little Tennessee River and Citico Creek, Tennessee, in 1967, and has not been found alive or recently dead since (USFWS, 2007c).

Plants

There are 13 endangered and 7 threatened plant species that are federally listed and known to occur in Tennessee, as summarized in Table 14.1.6-7. Further information on the habitat, distribution, and threats to the survival and recovery of each of these species in Tennessee is provided below.

Table 14.1.6-7: Federally Listed Plant Species of Tennessee

Common Name	Scientific Name	Federal Status	Critical Habitat in Tennessee	Habitat Description
American Hart's-tongue Fern	*Asplenium scolopendrium* var. *americanum*	Threatened	No	Grows on or next to limestone in entrances to pit caves; known only from Marion County in the southeast portion of the state.
Blue Ridge Goldenrod	*Solidago spithamaea*	Threatened	No	Rock outcrops, ledges, cliffs, and balds at high elevations; known only from Carter County in the northeastern portion of the state.
Braun's Rock-cress	*Arabis perstellata*	Endangered	Yes, in Wilson and Rutherford Counties.	Slopes of calcareous mesophysic and sub-xeric forest types, often around rock outcrops; known only from Rutherford and Wilson counties in the central portion of the state just east of Nashville.
Cumberland Rosemary	*Conradina verticillata*	Threatened	No	Sandy or gravelly stream banks, sandbars, and gravel/boulder bars associated with floodplains or islands; known from Cumberland, Fentress, Morgan, Scott, and White Counties in the north-central portion of the state.
Cumberland Sandwort	*Arenaria cumberlandensis*	Endangered	No	Sandstone rock ledges and sandstone "rock houses" within the Big South Fork watershed; known from Fentress, Morgan, Pickett, and Scott Counties in the north-central portion of the state.

Common Name	Scientific Name	Federal Status	Critical Habitat in Tennessee	Habitat Description
Large-flowered Skullcap	*Scutellaria montana*	Threatened	No	Rocky, submesic to xeric, well-drained, slightly acidic slope, ravine and stream bottom forests; in Georgia, the species is found in Bledsoe, Hamilton, Marion, and Sequatchie Counties in the southeastern corner of the state.
Leafy Prairie-clover	*Dalea foliosa*	Endangered	No	Prairie remnants on thin soil over limestone; known from seven counties in the central portion of the state.
Morefield's Leather Flower	*Clematis morefieldii*	Endangered	No	Rocky limestone woods near seeps or springs, usually on the south and southwest facing slopes of mountains; known from Franklin and Grundy Counties in the south-central part of the state.
Price's Potato-bean	*Apios priceana*	Threatened	No	Open, wooded areas, in forest gaps and in open, low areas near streams and rivers; known from 12 counties across the central portion of the state.
Pyne's Ground-plum	*Astragalus bibullatus*	Endangered	No	Cedar glades with exposed limestone, shallow soils, and lack of vegetative overstory; known only from Rutherford County in the central portion of the state.
Roan Mountain Bluet	*Hedyotis purpurea* var. *montana*	Endangered	No	Rocky exposures at high elevations; found in the Appalachian Mountains, known only from Carter County in the northeast corner of the state.
Rock Gnome Lichen	*Gymnoderma lineare*	Endangered	No	Rocky exposures at high elevations; found in the Appalachian Mountains, known only from Carter County in the northeast corner of the state.
Ruth's Golden Aster	*Pityopsis ruthii*	Endangered	No	Crevices of phyllite and greywacke outcrops; known only from the Hiwassee and Ocoee Rivers in Polk County in the southeast corner of the state.
Short's Bladderpod	*Physaria globosa*	Endangered	Yes, in in Cheatham, Davidson, Jackson, Montgomery, Smith, and Trousdale Counties, Tennessee.	Steep, rocky wooded slopes, fragmented rock areas, and along the tops, bases, and ledges of cliffs and bluffs; known from 7 counties in the north-central portion of the state.
Small Whorled Pogonia	*Isotria medeoloides*	Threatened	No	Hardwood stands that include beech, birch, maple, oak, hemlock, and hickory; known from Carter and Hamilton Counties in the southeast portion of the state.
Spreading Avens	*Geum radiatum*	Endangered	No	Rocky outcrops, steep slopes, and on gravelly talus on high-elevation cliffs in full sun with shallow acidic soils;

Common Name	Scientific Name	Federal Status	Critical Habitat in Tennessee	Habitat Description
				known from Carter and Sevier Counties in the eastern portion of the state.
Spring Creek Bladderpod	*Lesquerella perforata*	Endangered	No	Floodplain fields, frequently disturbed, with little vegetative canopy, including pastures and cultivated fields; known only from Spring Creek, Bartons Creek, and Cedar Creek in Wilson County in the central area of the state.
Tennessee Yellow-eyed Grass	*Xyris tennesseensis*	Endangered	No	Wet spring meadows with open, sunny conditions, and calcareous bedrock; known only from Lewis County in the central portion of the state.
Virginia Spiraea	*Spiraea virginiana*	Threatened	No	Rocky often flood scoured banks of high velocity streams and rivers; known from 11 counties in eastern and central Tennessee.
Whorled Sunflower	*Helianthus verticillatus*	Endangered	Yes, in McNairy and Madison Counties.	Moist, prairie-like remnants, as openings in woodlands and adjacent to creeks; known from McNairy and Madison Counties in western Tennessee.

Source: (USFWS, 2015c) (USFWS, 2015d)

American Hart's-tongue fern. The American Hart's-tongue fern is an evergreen fern with oblong fronds that grow from 5 to 17 inches long, 0.75 to 1.75 inches wide, and are lobed at the base. Its green stem is 1 to 5 inches long with scales that are cinnamon in color. The fronds grow up from a short, creeping horizontal rhizome that is also characterized by cinnamon colored scales (USFWS, 1993a). The American Hart's-tongue fern was federally listed as threatened in 1989 (54 FR 29726 29730, July 14, 1989) (USFWS, 2015ck).

Regionally, this species is known or believed to occur in Alabama, Michigan, New York, and Tennessee. In Tennessee, it is known or believed to occur in Marion County in the southeast portion of the state (USFWS, 2015ck). It grows on or next to limestone in entrances to vertical shaft caves. It needs high humidity, substrate moisture, and some shade to grow. Threats to the American Hart's-tongue fern include "shading from invasive plants, trampling and habitat alteration or destruction caused by timber removal, quarrying, and residential development" (USFWS, 1993a).

Blue Ridge Goldenrod. The threatened Blue Ridge goldenrod is a perennial herb that grows to 4 to 8 inches tall, and usually covered with whitish hairs. The flowers are yellow and flat-topped, and bloom from July to September (USFWS, 1987). Blue Ridge goldenrod was listed as threatened in 1985 (50 FR 12306 12309, March 28, 1985). The species is endemic to a limited area in the Blue Ridge Mountains of North Carolina and eastern Tennessee (USFWS, 1987). In Tennessee, the species is known or believed to occur only in Carter County in the northeastern portion of the state (USFWS, 2015cl).

Suitable habitat for this species consists of rock outcrops, ledges, and cliffs at high elevations (generally above 4,600 feet above sea level) in acidic, shallow (less than 40 cm) soils. Threats to the Blue Ridge goldenrod include disturbance from construction and development, trampling, and atmospheric pollution (i.e., acidic rain). (USFWS, 1987)

Braun's Rock-cress. The endangered Braun's rock-cress (*Arabis perstellata*) is a perennial plant endemic to northcentral Kentucky and northcentral Tennessee. The species reaches approximately 31 inches in height with leaves up to 2 inches long and small white or lavender flowers. The plant flowers from March to May (USFWS, 1997g). Braun's rock-cress was listed as endangered in 1995 (60 FR 56 61, January 3, 1995). In Tennessee, the species is known or believed to occur in Rutherford and Wilson counties in the central portion of the state just east of Nashville; critical habitat for the species has been identified at five locations within those counties (USFWS, 2015cm).

Suitable habitat for this species consists of temperate forests with a well-balanced moisture regime and limestone "slopes" (USFWS, 1997g). The plants are more frequently found around rock outcrops. Threats to Braun's rock-cress include disturbance from construction/development, competition from invasive/exotic plants, and grazing or other direct disturbance (USFWS, 1997g).

Cumberland Rosemary. The threatened Cumberland rosemary is an evergreen shrub known from the Cumberland Plateau province in Kentucky and Tennessee. The species is in the mint family and has aromatic leaves and pinkish flowers (USFWS, 1996b). Cumberland rosemary was listed as threatened in 1991 (56 FR 60937 60941, November 29, 1991). In Tennessee, the species is found in Cumberland, Fentress, Morgan, Scott, and White Counties in the north-central portion of the state between Nashville and Knoxville (USFWS, 2015cn).

Suitable habitat for this species consists of "sandy or gravelly stream banks, sandbars, and gravel/boulder bars associated with floodplains or islands" (USFWS, 1996b). Threats to Cumberland rosemary include dam construction (and loss of periodic flooding), human disturbance from recreation and coal/oil/gas mining, and natural disturbances/competition (USFWS, 1996b).

Cumberland Sandwort. The endangered Cumberland sandwort is a perennial plant known from the Cumberland Plateau province in Kentucky and Tennessee. The species grows to 6 inches tall in tufts, with white flowers and narrow leaves up to about 1 inch long. The species flowers in July through August (USFWS, 1996c). Cumberland sandwort was listed as endangered in 1988 (53 FR 23745 23748, June 23, 1988). In Tennessee, the species is found in Cumberland, Fentress, Morgan, White, and Scott counties in the north-central portion of the state northwest of Knoxville (USFWS, 2015co).

Suitable habitat for this species consists of sandstone rock ledges and sandstone "rock houses" within the Big South Fork watershed. Threats to Cumberland sandwort include human disturbance from recreation and timber activities. (USFWS, 1996c)

Large-flowered Skullcap. The large-flowered skullcap is a perennial herb with solitary, erect, square stems, usually from 12 to 20 inches tall. Leaves are narrow and pointed on each end, egg-shaped (wider toward the base of the leaf) and hairy on the top and bottom of the leaf. Flowers is 1 – 1.4 inches long, blue and white in color, and near the top of the calyx.[89] Flowers bloom from mid-May to early June, while fruit ripens in June to early July (USFWS, 1996d). The large-flowered skullcap was listed as threatened in 1986 (51 FR 22521 22524, June 20, 1986). The species is known to occur in northwestern Georgia and southeastern Tennessee; in Tennessee, the species is found in Bledsoe, Hamilton, Marion, and Sequatchie Counties in the southeastern portion of the state (USFWS, 2015cq).

Suitable habitat for this species includes dry and well-drained forests in northwestern Georgia and adjacent areas in southeastern Tennessee, preferring areas that have slightly acidic and rocky soils (USFWS, 1996d). Threats include quarrying, silviculture, cattle ranching, land development, overbrowsing by deer, and competition by invasive plants including the Japanese honeysuckle (*Lonicera japonica*) (GADNR, 2010b).

Leafy Prairie-clover. Leafy prairie-clover is a perennial that flowers from mid-July to late August, producing 1 to 10 lavender flowering structures (USFWS, 1996e). Leaves are small, 0.2 to 0.5 inches long, and have compound leaflets (USFWS, 1997h). It was listed as endangered in 1991 (56 FR 19953-19959, May 1, 1991). Its habitat type is dolomite prairie, and the leafy prairie-clover favors a wet spring and fall and a dry summer (USFWS, 1997h). In Tennessee, this plant is found in seven counties in the central portion of the state (USFWS, 2015cr).

The biggest threat to this clover is loss of habitat through land development, including commercial and residential development, off-road vehicles, wild animal grazing, and road construction (USFWS, 1997h).

Morefield's Leather Flower. The Morefield's leather flower is a perennial vine in the buttercup family that has urn-shaped, pinkish colored, 0.8 to 1 inch long flowers growing singly, or in few flowered groups, between the leaf and stem. The hairy, one-seeded fruits grow in clusters (USFWS, 1994c). The Morefield's leather flower was federally listed as endangered in 1992 (57 FR 21562 21564, May 20, 1992) (USFWS, 2015cs).

Regionally, this species is known or believed to occur in Alabama and Tennessee. In Tennessee, it is known or believed to occur in Franklin and Grundy Counties in the south-central part of the state (USFWS, 2015cs). It inhabits rocky limestone woods near seeps or springs, usually on the south and southwest facing slopes of mountains. Threats to the Morefield's leather flower include habitat loss due to residential development, herbicide use, and vulnerability due to its small range and limited population sizes (USFWS, 1994c).

Price's Potato-bean. The Price's potato-bean is a perennial vine with leaves measuring 8 to 12 inches long, alternate, and composed of 5 to 9 leaflets 1.6 to 4 inches long. The greenish-white or brownish pink flowers are tipped with magenta and measure 0.4 inches long, blooming from mid-July to mid-August (USFWS, 1993b). The Price's potato-bean was listed as threatened in 1990 (55 FR 429 433, January 5, 1990). Its habitat is comprised of open, wooded areas, in forest gaps and in open, low areas near streams and rivers, and prefers lightly disturbed area (USFWS, 1993b) (USFWS, 2015ct). Regionally, this species can be found in Alabama, Illinois, Kentucky,

[89] Calyx: "Outer whorl of flowering plants; collective term for all the sepals of a flower" (USEPA, 2015a).

Mississippi, and Tennessee. In Tennessee, it is found in 12 counties across the central portion of the state (USFWS, 2015cu).

The narrow habitat requirements of this species mean that habitat succession and lack of regular, light disturbance threaten populations. Major threats to this species include cattle, which graze and trample the plant, timber harvesting, diseases and predation by native insects, competition from invasive plants (such as the crown vetch (*Coronilla varia),* and herbicides, especially in ROWs where this species has been known to flourish. (USFWS, 1993b) (USFWS, 2015ct)

Pyne's ground-plum. The endangered Pyne's ground-plum (formerly known as Guthrie's ground-plum) is a perennial plant endemic to the Interior Low Plateau in middle Tennessee. The species grows to 6 inches tall, and has rings of numerous purple flowers. The plant flowers from April to May (USFWS, 2011g). Pyne's ground-plum was listed as endangered in 1991 (56 FR 48748 48751, September 26, 1991). The species is known or believed to occur only in Rutherford County in the central portion of the state (USFWS, 2015cp).

Suitable habitat for this species consists of cedar glades with exposed limestone, shallow soils, and lack of vegetative overstory. Threats to Pyne's ground-plum include habitat loss (from development, recreation, livestock grazing, and ROW maintenance), and potentially extended droughts (USFWS, 2011g).

Roan Mountain Bluet. The endangered Roan Mountain bluet contains funnel-shaped red-purple flowers, small oval leaves, with small round fruit (USFWS, 2011h). Roan Mountain bluet was listed as endangered in 1996 (55 FR 12793 12797, April 5, 1996). The Roan Mountain bluet is known or believed to occur in the high mountains of North Carolina, Tennessee, and Virginia. In Tennessee, the Roan Mountain bluet is known or believed to occur in Carter County in the northeast corner of the state (USFWS, 2015cv).

Suitable habitat includes rocky exposures at high elevations above 4,000 feet above sea level. Threats to the species include development, and human recreational activities at trail-side locations (USFWS, 2011h).

Rock Gnome Lichen. The endangered rock gnome lichen grows in dense colonies and contain small narrow blue-grey oblong lobes (USFWS, 2015cw). The rock gnome lichen was listed as endangered in 1995 (60 FR 3557 3562, January 18, 1995). This species is known to occur throughout the Appalachian Mountains (USFWS, 2015cw). In Tennessee, the rock gnome lichen is known or believed to occur only in Carter County in the northeast corner of the state (USFWS, 2015cx).

Habitat for the rock gnome lichen is limited to vertical rock faces where water seeps flow during wet periods. It generally occurs in areas of high elevation and with high humidity but has been observed in "deep gorges at lower elevations" (USFWS, 2015cw). The greatest threat to the rock gnome lichen is from human activities in recreational trail areas, as well as development, and lack of canopy shading (USFWS, 2015cw).

Ruth's Golden Aster. Ruth's golden aster is a perennial herb that grows to approximately 12 inches tall, is tufted, and has numerous golden yellow flowers. The plant flowers from July through September and then until the first frost (USFWS, 1992c). Ruth's golden aster was listed as endangered in 1985 (50 FR 29341 29345, July 18, 1985). The species is known only from the Hiwassee and Ocoee Rivers in Polk County in the southeast corner of the state (USFWS, 1992c) (USFWS, 2015cy).

Suitable habitat for this species is limited to crevices of metamorphic rock outcrops along the Hiwassee and Ocoee Rivers. Threats to Ruth's golden aster include competition from other species, changes in water flow, and human disturbance (from forestry activities or trampling) (USFWS, 1992c).

Short's Bladderpod. The Short's bladderpod (*Physaria globosa*) is a plant in the mustard family that can grow up to 20 inches in height. It gets its name from the globe-shaped fruits it produces. Small yellow flowers grow in clusters on top of solitary or groups of stems from April to June (USFWS, 2015cz). The Short's bladderpod was federally listed as endangered in 2014 (79 FR 44712 44718, August 1, 2014). Regionally, this species is known or believed to occur in Indiana, Kentucky, and Tennessee. In Tennessee, it is found in 7 counties in the north-central portion of the state (USFWS, 2015da). Critical habitat was established in 2014 (79 FR 50989 51039, August 26, 2014) in Cheatham, Davidson, Dickson, Jackson, Montgomery, Smith, and Trousdale Counties, Tennessee (USFWS, 2014g).

It inhabits steep, rocky wooded slopes, fragmented rock areas, and along the tops, bases, and ledges of cliffs and bluffs. It usually grows near rivers or streams and on south to west facing slopes. Threats to the Short's bladderpod include construction and maintenance of roads, soil erosion due to flooding and water level manipulation, shading due to forest succession, and competition due to invasive, nonnative place species (USFWS, 2014h).

Small Whorled Pogonia. The small whorled pogonia is a member of the orchid family which grows between 10 to 14 inches in height with greenish yellow flowers (USFWS, 2008). The small whorled pogonia was federally listed as endangered in 1982 (47 FR 39827 39831, September 9, 1982) and in 1994 was reclassified as threatened (59 FR 50852 50857, October 6, 1994). Regionally, this species is known to occur in sparse distributions from Maine south to Georgia and west to Illinois and Missouri. In Tennessee, the small whorled pogonia is known or believed to occur in Carter and Hamilton Counties in the southeast portion of the state (USFWS, 2015db).

The small whorled pogonia occurs in hardwood stands that include beech, birch, maple, oak, hemlock, and hickory that have an open understory, preferring acidic soils along small streams that have a thick layer of litter (USFWS, 2008). One distinct feature of this species is that it can remain dormant underground for multiple years before reappearing (USFWS, 1992d). Current threats to small whorled pogonia include habitat loss due to urban expansion, recreational activities, and forestry practices (USFWS, 2008).

Spreading Avens. The endangered spreading avens is a tall perennial herb growing 8 to 20 inches tall. From June to September, the spreading avens has distinguishing one inch wide bright yellow flowers. The fruits appear in August and mature in October (USFWS, 2011i). Spreading avens was listed as endangered in 1990 (55 FR 12793 12797, April 5, 1990). The species is known to occur only on high mountain peaks in western North Carolina and eastern

Tennessee; in Tennessee, the species is found in Carter and Sevier Counties in the eastern portion of the state (USFWS, 2011i) (USFWS, 2015dc).

The habitat of spreading avens includes rocky outcrops, steep slopes, and on gravelly talus[90] on high-elevation cliffs in full sun with shallow acidic soils. Threats to the species include trampling from recreational land use, air pollution, including acid precipitation, and degradation of adjacent fir forest habitat from the invasive balsam woolly adelgid (*Adelges piceae*). Degradation of adjacent forest habitat is a contributing cause of soil erosion and alters the landscape to create drier and hotter conditions. (USFWS, 2011i)

Spring Creek Bladderpod. The endangered Spring Creek bladderpod is an annual plant that grows to 6 inches tall, with white flowers that generally bloom from March to April (USFWS, 2006b). Spring Creek bladderpod was listed as endangered in 1996 (61 FR 67493 67497, December 23, 1996). The species is known only to occur near Spring Creek, Bartons Creek, and Cedar Creek in Wilson County in the central area of the state (USFWS, 2006b) (USFWS, 2015dd).

Suitable habitat for this species includes floodplain fields, frequently disturbed, with little vegetative canopy, including pastures and cultivated fields. The primary threats to Spring Creek bladderpod are conversion of agricultural lands either to residential/commercial development or pasture. (USFWS, 2006b)

Tennessee Yellow-eyed Grass. The Tennessee yellow-eyed grass is "a perennial which typically occurs in clumps of few to many bulbous based individuals. The soft, bulbous bases are comprised of small, dark outer scales and fleshy, white to rose or purplish inner scales. The leaves are all basal; the outermost ones are short and scalelike, whereas the others are linear, 9 to 45 centimeters (cm), or 3.5 to 18 inches (in.) long, and 0.15 to 1.0 cm (0.06 to 0.4 in.) wide" (USFWS, 1994d). The plant has leafless, unbranched, flowering stalks each bearing a terminal, cone like inflorescence comprised of spirally arranged bracts[91] enclosing small flowers with yellow or occasionally white petals (USFWS, 1994d). The species was listed as endangered in 1991 (56 FR 34151 34154, July 26, 1991). The species is currently known or believed to occur in Alabama, Georgia, and Tennessee; in Tennessee, the species is known or believed to occur only in Lewis County in the central portion of the state (USFWS, 2015de).

"Suitable habitat for long-term survival of this species appears to be very limited. Populations are located in spring meadows or along small streams" (USFWS, 1994d). Threats to the species include timber management, drainage of lowland wetlands and conversion to agricultural fields, the impoundment of wetlands, herbicide spraying for weed control, and off-road vehicles (USFWS, 1994d).

Virginia Spiraea. The threatened Virginia spiraea is a perennial shrub species with many branches. The shrub ranges in height from three to seven feet tall with elliptic leaves two to four inches long. The shrub's white flowers appear in June and July at the ends of branches (WVDNR, 2015). The Virginia spiraea was first listed as threatened by endangered species

[90] Talus: "Pile of rock or rubble below a cliff or chute" (USGS, 2015j).
[91] Bract: "A small leaf or scale-like structure associated with and subtending an inflorescense or cone" (USEPA, 2015a).

legislation in 1990 (55 FR 24241 24247, June 15, 1990). Regionally the species occurs along 24 stream systems in Georgia, Tennessee, North Carolina, Kentucky, West Virginia, Virginia, and Ohio. In Tennessee, it is found in 11 counties in eastern and central Tennessee (USFWS, 2015df).

The Virginia spiraea inhabits rocky often flood scoured banks of high velocity streams and rivers. It is believed that scour is important to the species as it discourages tree growth and prevents canopy closure. Flood frequency and intensity have a large influence on development of suitable habitat for the species. Major threats to the species include dam and reservoir construction that remove or eliminate the species habitat altogether. Damage to the plants from people using rivers where the Virginia spiraea are growing for recreation is another common threat, as well as physical damage to the plant stems from hikers, fishermen, boaters, and rafters has been observed at many documented sites of Virginia spiraea. (WVDNR, 2015) (USFWS, 2015df).

Whorled Sunflower. The whorled sunflower (*Helianthus verticillatus*) "is a perennial arising from horizontal, tuberous-thickened roots with slender rhizomes. The stems are slender, erect, and up to 2 meters (m) (6 feet) tall. The leaves are opposite on the lower stem, verticillate (whorled) in groups of 3 to 4 at the mid-stem, and alternate or opposite in the inflorescence at the end. Individual leaves are firm in texture and have a prominent mid-vein, but lack prominent lateral veins found in many members of the genus. The flowers are arranged in a branched inflorescence typically consisting of 3 to 7 heads" (USFWS, 2014b). The species was listed as endangered in 2014 (79 FR 44712 44718, August 1, 2014). This species is a member of the sunflower family known or believed to occur in Cherokee County, Alabama; Floyd County, Georgia; and McNairy and Madison Counties, Tennessee at the time of listing (USFWS, 2014b) (USFWS, 2015e). Critical habitat for the whorled sunflower has been designated in Alabama, Georgia, and Tennessee; in Tennessee, the critical habitat is within McNairy and Madison Counties in western Tennessee (USFWS, 2014i).

Suitable habitat includes "moist, prairie-like remnants, which in a more natural condition exist as openings in woodlands and adjacent to creeks" (USFWS, 2014b). Threats to the whorled sunflower include vegetation removal and herbicide use for forestry on privately owned land, ROW maintenance, or agriculture; "shading and competition resulting from vegetation succession; limited distribution and small population sizes" (USFWS, 2014b).

14.1.7. Land Use, Recreation, and Airspace

14.1.7.1. Introduction

The following summarizes major land uses, recreational venues, and airspace considerations in Tennessee, characterizing existing, baseline conditions for use in evaluating the potential environmental consequences resulting from implementing the Proposed Action or Alternatives.

Land Use and Recreation

Land use is defined as "the arrangements, activities, and inputs people undertake in a certain land cover type to produce, change, or maintain it" (FAO, 2017) . A land use designation can include one or more pieces of land, and multiple land uses may occur on the same piece of land. Land use also includes the physical cover, observed on the ground or remote sensing and mapping, on the earth's surface; land cover includes vegetation and manmade development (USBR, 2001).

Recreational uses are activities in which residents and visitors participate. They include outdoor activities, such as hiking, fishing, boating, athletic events (e.g., golf), and other attractions (e.g., historic monuments and cultural sites) or indoor activities, such as museums and historic sites. Recreational resources can include trails, lakes, forests, beaches, recreational facilities, museums, historic sites, and other areas/facilities (OECD, 2003). Federal, state, county, or local governments typically manage recreational resources.

Descriptions of land uses are presented in three primary categories: forest and woodlands, agricultural, and developed. Descriptions of land ownership are presented in four main categories: private, federal, state, and tribal. Descriptions of recreational opportunities are presented in a regional fashion.

Airspace

Airspace is generally defined as the space lying above the earth, above a certain area of land or water, or above a nation and the territories that it controls, including territorial waters (Merriam Webster Dictionary, 2015a). Airspace is a finite resource that can be defined vertically and horizontally, as well as temporally, when discussing it in relation to aircraft activities. Airspace management addresses how and in what airspace aircraft fly. Air flight safety considers aircraft flight risks, such as aircraft mishaps and bird/animal-aircraft strikes. The Federal Aviation Administration (FAA) is charged with the safe and efficient use of the nation's airspace and has established criteria and limits to its use.

The FAA operates a network of airport towers, air route traffic control centers, and flight service stations. The FAA also develops air traffic rules, assigns use of airspace, and controls air traffic in U.S. airspace. "The Air Traffic Organization (ATO) is the operational arm of the FAA responsible for providing safe and efficient air navigation services to approximately 30.2 million square miles of airspace. This represents more than 17 percent of the world's airspace and includes all of the U.S. and large portions of the Atlantic and Pacific Oceans and the Gulf of Mexico" (FAA, 2014). The ATO is comprised of Service Units (organizations) that support the operational requirements.

The FAA Air Traffic Services Unit (the Unit) manages the National Airspace System (NAS) and international airspace assigned to U.S. control and is responsible for ensuring efficient use, security, and safety of the nation's airspace. FAA field and regional offices (e.g., Aircraft Certification Offices, Airports Regional Offices, Flight Standards District Offices [FSDO], Regional Offices & Aeronautical Center, etc.) assist in regulating civil aviation to promote safety, and develop and carry out programs that control aircraft noise and other environmental effects (e.g., air pollutants) attributed from civil aviation (FAA, 2015b). The FAA works with state aviation officials and airport planners, military airspace managers, and other organizations in deciding how best to use airspace.

14.1.7.2. Specific Regulatory Considerations

Land use planning in Tennessee is the primary responsibility of local governments (i.e., county). The main planning tools for local governments include the comprehensive plan, zoning ordinance, and subdivision ordinance. The land use code for each county sets forth the authority for each of these tools, as granted to the counties by state-enabling legislation. The comprehensive plan proposes land uses and locations of public facilities and utilities and projects long-term population growth. The zoning ordinance sets forth the rules used to govern the land by dividing localities into zoning districts and establishes allowable uses within the districts (e.g., agriculture, industry, commercial use). The subdivision ordinance manages the process for dividing large land parcels into smaller lots.

Because federal laws govern the Nation's airspace, there are no specific Tennessee state laws that would alter the existing conditions relating to airspace for this PEIS. State statutes that address aviation are in Tennessee Code, Title 42 – Aeronautics (State of Tennessee, 2015a).

14.1.7.3. Land Use and Ownership

For the purposes of this analysis, Tennessee is classified into primary land use groups based on coverage types as forest and woodlands, agricultural, and developed land. Land ownership within Tennessee is classified into four main categories: private, federal, state, and tribal land.

Land Use

Table 14.1.7-1 identifies the major land uses by coverage type in Tennessee. Forests and woodlands comprise the largest portion of land use, with 53 percent of the land area in Tennessee occupied by this category (Table 14.1.7-1 and Figure 14.1.7-1). Agricultural land is the second largest area of land use, with 31 percent of the total land area. Developed areas account for approximately nine percent of the total land area in Tennessee. The remaining percentage of land includes public land, surface water, and other land covers, shown in Figure 14.1.7-1, that are not associated with specific land uses (USGS, 2011).

Table 14.1.7-1: Major Land Uses in Tennessee by Coverage Type

Land Use	Square Miles	Percent of Land
Forest and Woodland	22,053	53%
Agricultural Land	12,680	31%
Developed Land	3,588	9%

Source: (USGS, 2011)

Forest and Woodland

Forest and woodland areas can be found throughout the state, many of them interspersed with, and adjacent to, agricultural areas. The largest concentrations of forested areas are located in the eastern and central portions of the state in the Blue Ridge, Cumberland Plateau, and Highland

Rim. These areas are comprised of mountainous regions covered by deciduous and coniferous forests (Figure 14.1.7-1). Section 14.1.6 presents additional information about terrestrial vegetation (USGS, 2011).

National Forests

National forest land in Tennessee comprises approximately five percent of the state's total forestland, and includes one national forest, the Cherokee National Forest. This national forest occurs along the eastern border of the state, covering 1,016 square miles (USGS, 2014i). The forest is managed for multiple uses and values, including recreation activities (e.g., camping, hiking), timber production, and maintenance of fish and wildlife habitat.

State Forests

The Tennessee Department of Agriculture (TDA) manages 15 state forests, which are scattered across the state and cover approximately 262.5 square miles. These forests are managed for multiple uses and values, including timber production, hiking, wildlife viewing, hunting, fishing, and habitat protection (TDA, 2015a). Table 14.1.7-2 presents the names and associated square miles of each of the 15 state forests.

Table 14.1.7-2: Tennessee State Forests

State Forest	Square Miles
Bledsoe State Forest	12.9
Cedars of Lebanon State Forest	12.5
Chickasaw State Forest	19.9
Chuck Swan State Forest	38.6
Franklin State Forest	12.1
Lewis State Forest	2
Lone Mountain State Forest	5.6
Martha Sundquist State Forest	3.1
Natchez Trace State Forest	57.3
Pickett State Forest	32.6
Prentice Cooper State Forest	38.6
Scott State Forest	4.4
Standing Stone State Forest	13
Stewart State Forest	6.6
John Tully State Forest	3.3
Total	**262.5**

Source: (TDA, 2015a)

Private Forest and Woodland

The large majority of Tennessee's forests and woodlands (approximately 84 percent) are owned by private individuals and companies (USFS, 2015a). Private forestlands indirectly provide some public benefit, including forest products, wildlife habitat, scenic beauty, and outdoor recreation opportunities. Scattered throughout the state, forests and woodlands on private lands often border agricultural fields, suburban neighborhoods, and national forests. For additional information regarding forest and woodland areas, see Section 14.1.6, Biological Resources, and Section 14.1.8, Visual Resources.

Agricultural Land

Agricultural land exists throughout the state on 12,680 square miles, or 30 percent of the total land area (Figure 14.1.7-1) (USGS, 2011). Approximately 68,050 farms exist in Tennessee, with an average size of 0.25 square miles (USDA, 2012a). Tennessee's top agricultural products are grains, oilseeds, beans, and peas (36 percent of total agricultural receipts); cattle and calves (20 percent of total agricultural receipts); poultry and eggs (15 percent of total agricultural receipts); and nursery, greenhouse, floriculture, and sod (8 percent of total agricultural receipts) (USDA, 2012b).

Developed Land

Developed land in Tennessee is concentrated within major metropolitan areas and surrounding cities, towns, and suburbs (Figure 14.1.7-1). Although only nine percent of Tennessee's land is developed, these areas are highly utilized for residential, commercial, industrial, recreational, and government purposes. Table 14.1.7-3 lists the top five developed metropolitan areas within the state and their associated population estimates.

Table 14.1.7-3: Top Five Developed Metropolitan Areas

Metropolitan Area	Population Estimate
Nashville-Davidson, TN	990,870
Memphis, TN	897,778
Knoxville, TN	567,583
Chattanooga, TN	306,920
Clarksville, TN	140,791
Total Population of Metropolitan Areas	**2,903,942**
Total State Population[a]	**6,549,352**

Source: (U.S. Census Bureau, 2010)

[a] Estimated population in 2016 was 6,651,194 (U.S. Census Bureau, 2017x)

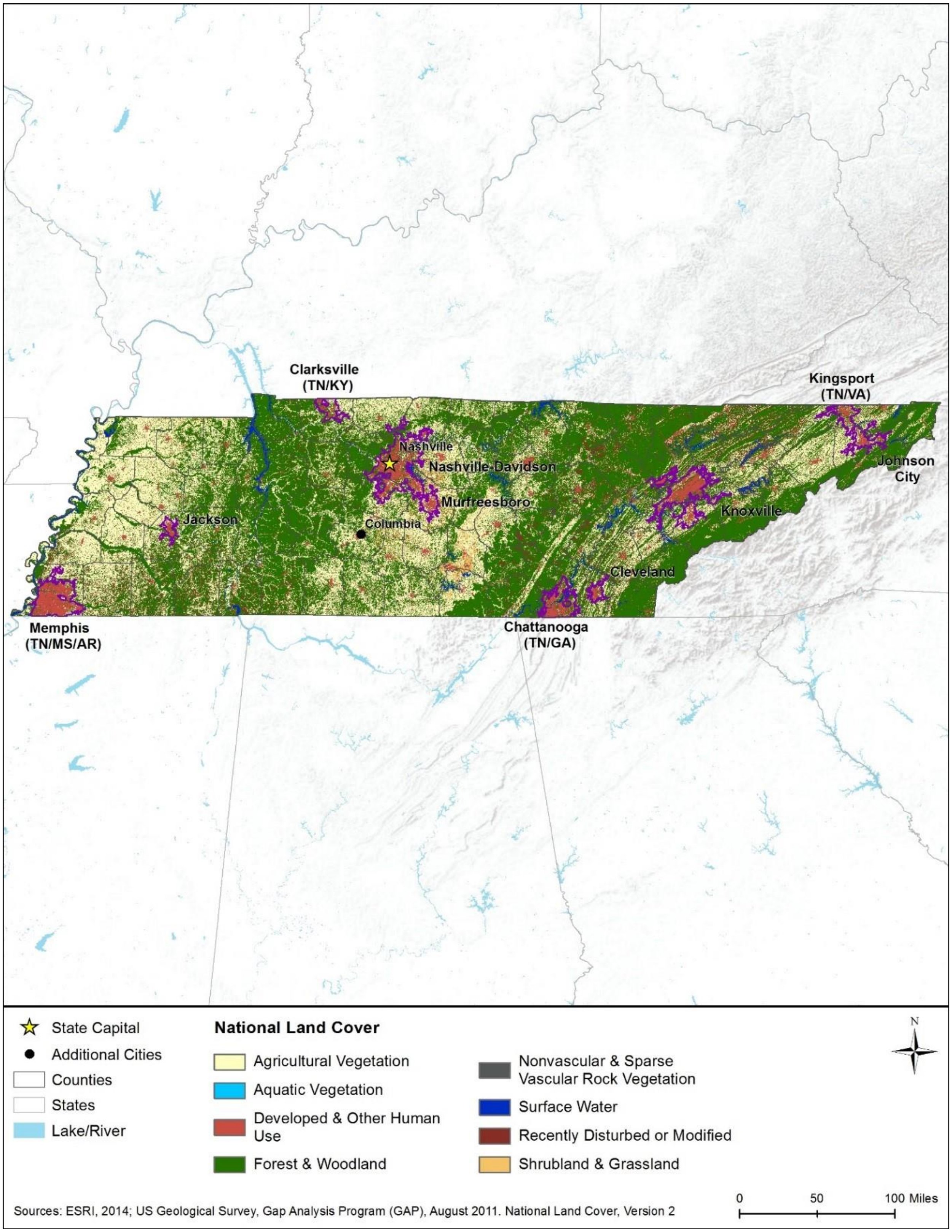


Figure 14.1.7-1: Major Land Use Distribution in Tennessee by Coverage Type

Land Ownership

Land ownership within Tennessee has been classified into four main categories: private, federal, state, and tribal (Figure 14.1.7-2).[92]

Private Land

The majority of land in Tennessee is privately owned (approximately 36,243 square miles or 88 percent of the total land in the state) (Figure 14.1.7-2), with most of this land falling under the land use categories of agricultural, forest and woodland, and developed (Figure 14.1.7-1) (USGS, 2014j). Highly developed, urban, metropolitan areas transition into suburban, agriculture, and woodland areas, which then transition into more wild and remote areas. Private land exists in all regions of the state.[93]

Federal Land

The federal government manages 2,577 square miles, or approximately six percent, of land in Tennessee, including national forests, national and historic parks, national wildlife refuges, and military facilities (Figure 14.1.7-2) (USGS, 2014i). Table 14.1.7-4 identifies the federal agencies managing federal lands through the state (USGS, 2014j). Five federal agencies manage the majority of federal lands throughout the state (Table 14.1.7-4 and Figure 14.1.7-2). There may be other federal lands, but they are not shown on the map due to their small size relative to the entire state.

Table 14.1.7-4: Major[a] Federal Land in Tennessee

Agency	Square Miles	Representative Type
U.S. Forest Service	1,097	Forests and Wilderness
National Park Service[b]	561	National, Historic, and Military Parks and Recreation Areas
Department of Defense	482	Military Installations and Lakes
Tennessee Valley Authority	306	Lakes
U.S. Fish and Wildlife Service	131	Wildlife Refuges
Total	**2,577**	

Source: (USGS, 2014j)

[a] Not all federal agency land is depicted in Figure 14.1.7-4 given the small size of some of the land acreage.
[b] Additional trails and corridors pass through Tennessee that are part of the National Park System.

[92] Land ownership data were retrieved from the Protected Areas Database of the United States (PAD-US), produced by USGS (http://gapanalysis.usgs.gov/padus/). This dataset categorizes lands across the U.S. by conservation, land management, planning, recreation, and ownership, as well as other uses. It is an extensive dataset that contains large quantities of information relevant to the Proposed Action. The data was queried to show Owner and used USGS' PAD-US ownership symbolization for consistency. The PADUS 1.3 geodatabase was downloaded in the summer of 2015, and used consistently throughout all these maps for each state and D.C.
[93] Total acreage of private land could not be obtained for the state.

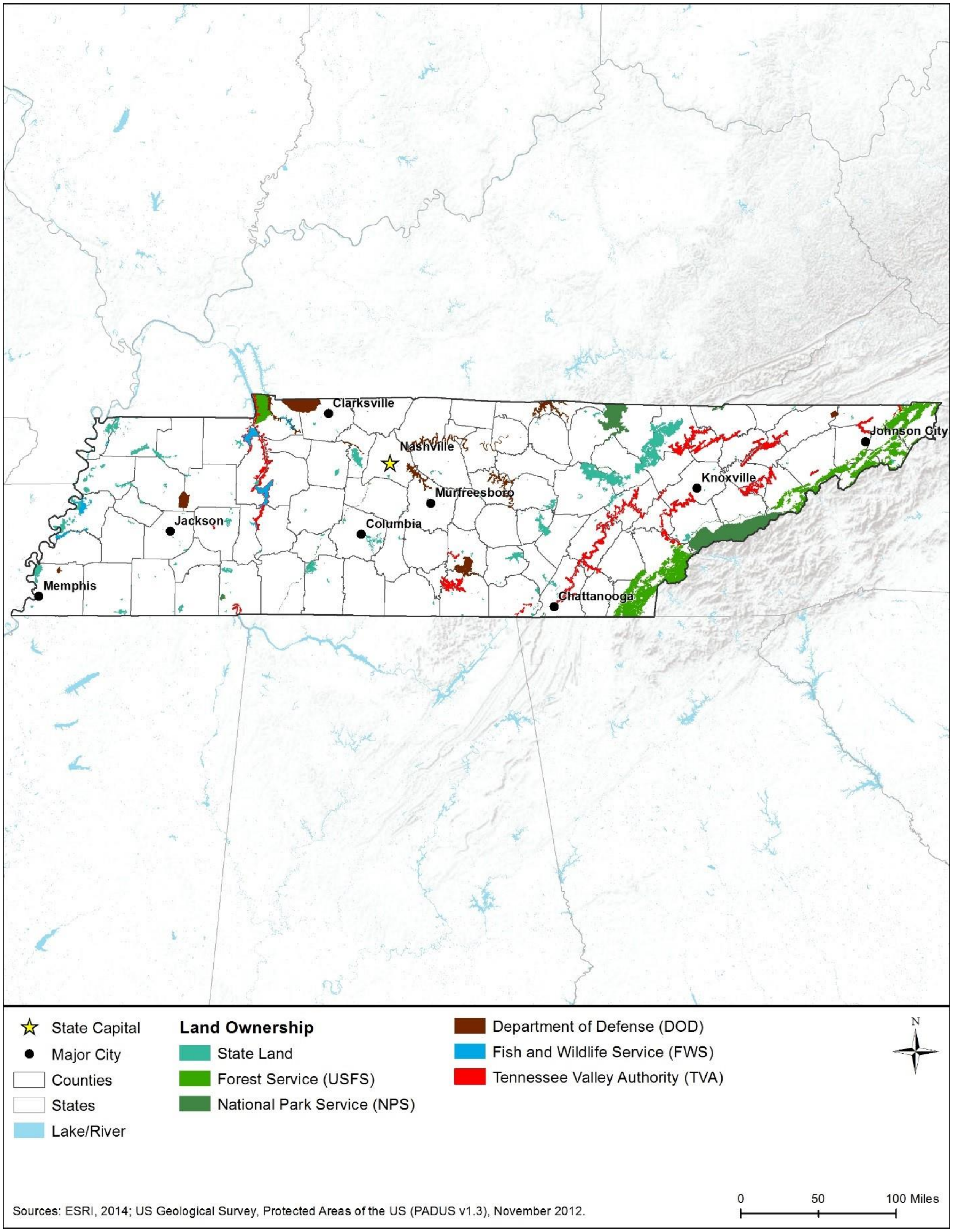


Figure 14.1.7-2: Land Ownership Distribution

The following is a brief description of federal land ownership in Tennessee:

- The U.S. Forest Service (USFS) manages 1,097 square miles of land comprised of the Cherokee National Forest and the Land Between the Lakes National Recreation Area (USGS, 2014j).
- The National Park Service (NPS) manages 561 square miles of land comprised of the Great Smoky Mountains National Park, Big South Fork National River and Recreation Area, Shiloh National Military Park, Chickamauga and Chattanooga National Military Park, and Cumberland Gap National Historic Park (USGS, 2014j).
- The Department of Defense (including the Army Corps of Engineers) manages 482 square miles of land and surface water comprised of the Memphis Naval Air Station, Milan Arsenal and Wildlife Management Area, Fort Donelson National Battlefield, Fort Campbell and seven lakes (Barkley, J. Percy Priest, Cheetham, Old Hickory, Center Hill, Cordell Hull, and Dale Hollow Lakes) (USGS, 2014j).
- The Tennessee Valley Authority manages 306 square miles of surface water comprised of 20 lakes: Kentucky, Beech, Pickwick, Normandy, Tims Ford, Nickajack, Woods, Chickamauga, Ocoee, Watts Bar, Tallico, Melton Hill, Fort Loudoun, Norris, Cherokee, Davy Crockett, Douglas, Boone, South Holston, and Watauga Lakes (USGS, 2014j).
- The USFWS manages 131 square miles of land comprised of seven national wildlife refuges: Chickasaw, Hatchie, Lower Hatchie, Reelfoot, Lake Isom, Tennessee, Cross Creeks National Wildlife Refuges (USGS, 2014j).

State Land[94]

Tennessee owns, leases or manages approximately 862 square miles of land, or approximately 2 percent of the total land in the state (Figure 14.1.7-2) (USGS, 2014j). Primarily the TDA, TWRA, and Tennessee State Parks manage these lands. The TDA manages 15 state forests, which are scattered across the state and cover 262.5 square miles (TDA, 2015a). These forests are managed for multiple uses and values, including timber production, hiking, wildlife viewing, hunting, fishing, and fish and wildlife habitat protection. The TWRA manages approximately 328 square miles of wildlife management areas and wildlife refuges (TWRA, 2015f). Tennessee State Parks manages approximately 61 square miles of land comprised of 56 state parks that are scattered throughout the state (TDEC, 2015k).

Tribal Land

There are no federally recognized American Indian tribes or reservations currently located in the state.

[94] State land use data for tables and narrative text were derived from specific state sources and may not correspond directly with USGS data that was used for developing maps and figures.

14.1.7.4. Recreation

Tennessee terrain rolls from the river delta farmlands along the Mississippi River to the central hills, and on to the mountainous regions in the east. The Tennessee River forms near Knoxville, flows southwest to Chattanooga, loops briefly through Alabama and Mississippi, and then returns to the state flowing on to Kentucky to join the Ohio River. The Cumberland River, originates in Kentucky, loops through central Tennessee before also joining the Ohio River back in Kentucky. These extensive rivers have many dammed sections that have created huge reservoirs and lakes. Water-based recreation and camping opportunities in Tennessee are greatly enhanced by these resources. On the community level, cities and towns provide an assortment of indoor and outdoor recreational facilities including community and recreation centers, theaters, museums, athletic fields and courts, golf courses, multi-use trails, playgrounds, picnicking areas, theme/amusement parks, boat launches and marinas. Availability of community-level facilities is typically commensurate to the population's distribution and interests, and the natural resources prominent in the vicinity.

Tennessee has 56 State Parks (TDEC, 2015k) and over 61,075 river miles and many lakes that make water-based recreation very popular with residents and visitors. Just over 43-miles of the Obed River is classified as "wild and scenic" (National Wild and Scenic Rivers System, 2015b). There are 35 National Recreation Trails in the state (American Trails, 2015). Revolutionary and Civil War sites are numerous across Tennessee. Federally, the NPS, U.S. Forest Service, U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers manage areas in Tennessee with substantial recreational attributes.

This section discusses key recreational opportunities and activities representative of various regions of Tennessee. The state can be categorized by three distinct recreational regions, each of which are presented in the following sub-sections. For information on visual resources such as National Scenic Byways and state-designated Byways, see Section 14.1.8, Visual Resources; and for information on culturally/historically significant resources (e.g., National Historic Sites, National Historic Landmarks, sites on the National Register of Historic Places, and Natural Heritage Areas), see Section 14.1.11, Cultural Resources.

West Region

The West Region is bounded by the Mississippi River and Arkansas to the west, the western section of the Tennessee River to the east, Kentucky to the north, and Mississippi to the south. Much of this region is rural with the exception of Memphis, the largest city in the state (Figure 14.1.7-3).[95] Beale Street and Elvis Presley's "Graceland" attract visitors from around the world and celebrate this city's historical fame for the music genres of blues and rock 'n' roll. There are music museums, recording studios, and live music venues throughout the city. The Mississippi

[95] Recreational area data was retrieved from the Protected Areas Database of the United States (PAD-US), produced by USGS (http://gapanalysis.usgs.gov/padus/). This dataset categorizes lands across the U.S. by conservation, land management, planning, recreation, and ownership, as well as other uses. It is an extensive dataset that contains large quantities of information relevant to the Proposed Action. The data was queried to show the Primary Designation Type of area. To show these in the map, recognizable symbols (e.g., varying shades of green for National Parks and Forests) were used as PAD-US does not have a standard symbolization for recreational resources. The PADUS 1.3 geodatabase was downloaded in the summer of 2015, and used consistently throughout all these maps for each state and D.C.

River Museum and Mud Island River Park highlight the mighty river that has also been such a prominent feature of this region's history. The Great River Road National Scenic Byway follows the river the entire length of the state's western border. Art, cultural, and history museums, galleries, performing arts and sports venues are all present in this large metro area. (TDTD, 2015a)

In the northern part of this region, Reelfoot Lake State Park is a unique flooded cypress tree woodland that attracts bald eagles and birders. Kentucky Lake, Lake Barkley, and the Land Between the Lakes National Recreation Area between them, provides an expansive area with excellent opportunities for water-based recreation, as well as camping, hiking, hunting, fishing, biking, horse and Off-Highway Vehicle (OHV) riding, and golfing. Other popular tourist attractions are the Discovery Park of America in Union City; the "World's Biggest Fish Fry" in Paris, the West Tennessee Strawberry Festival in Humboldt, and the Tennessee River Freshwater Pearl Farm in Camden (TDTD, 2015b). The southwest part of this region is rich in Civil War history, especially as displayed at Shiloh National Military Park (TDTD, 2015c).

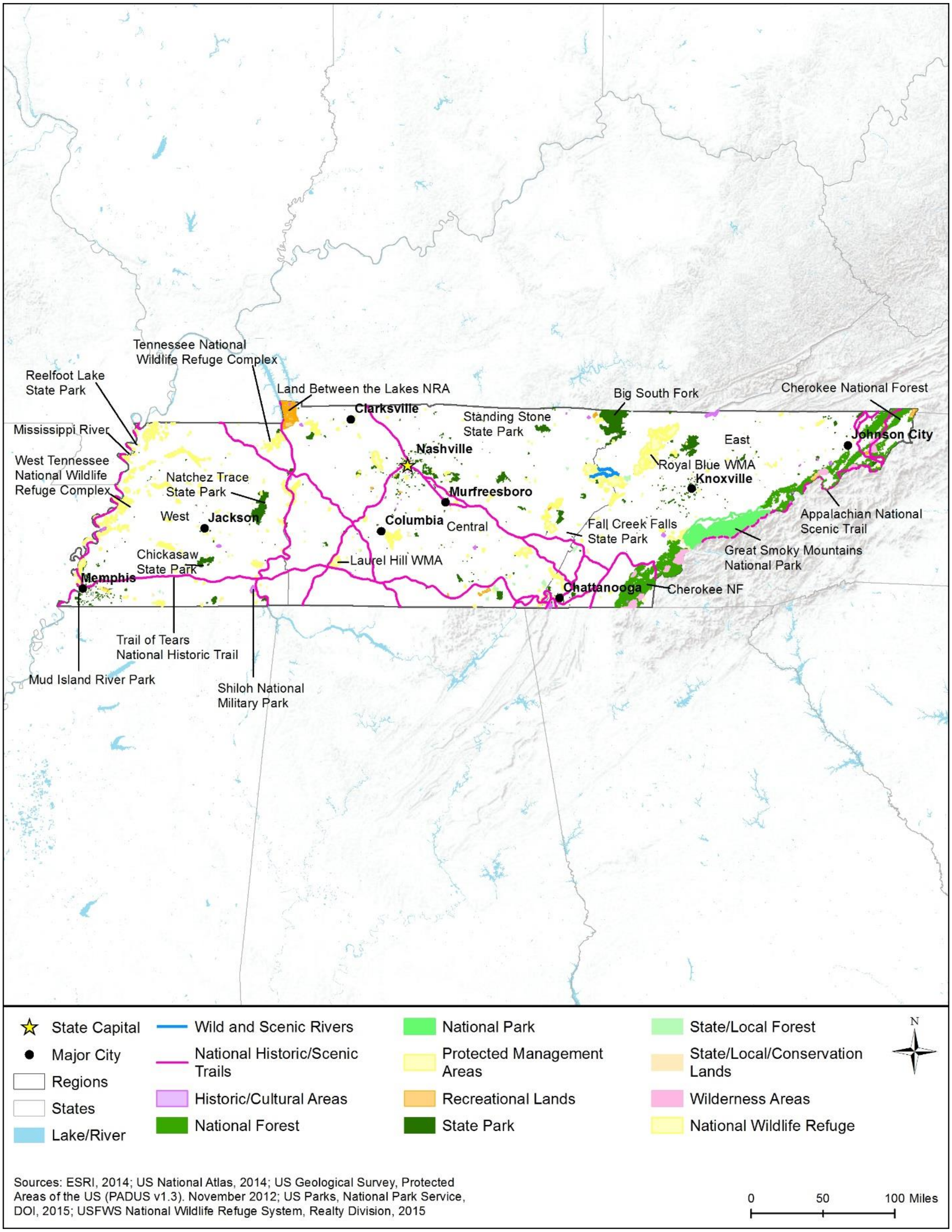


Figure 14.1.7-3: Tennessee Recreation Resources

Middle Region

The Middle Region lies between the western section of the Tennessee River and the western edge of the Cumberland Plateau (roughly located between the Big South Fork National River and Recreation Area (Figure 14.1.7-3), and the cities of Crossville, and Winchester). Alabama lies to the south and Kentucky to the north. The capital, Nashville has more than 120 live music venue destinations for visitors, as well as sites such as the famous Grand Ole Opry, Johnny Cash Museum, and Country Music Hall of Fame. Arts, culture, and sports event centers are present across the metro area. The 444-mile Natchez Trace Parkway leads travelers from Nashville to the Gulf of Mexico in Louisiana, tracing the path used by pioneers and early settlers. Today it is a beautiful sightseeing drive (also popular for bicycling) with campgrounds and numerous historical interpretive sites to visit. (TDTD, 2015d)

This region's terrain is composed of heavily forested rolling hills, bluffs, rock cliffs, gorges, rivers, and waterfalls. The Cumberland River, Percy Priest, Old Hickory, Center Hill, Dale Hollow, and Tim's Ford Lakes are prominent natural features in this region that are heavily utilized for outdoor recreational activities. State parks are abundant, sited along these lakes and tributary rivers. Ninety miles of the South Fork of the Cumberland River passes through the scenic valleys and gorges of the Big South Fork National River and Recreation Area. Cumberland Caverns near McMinnville, is the state's largest cave. In addition to typical tours and spelunking trips, they have developed one of the caverns that is more than 300 feet underground into an amphitheater called "Bluegrass Underground" where musicians perform live radio shows. Other tourist attractions in this region are the smaller rural towns where craft artists produce traditional Appalachian as well as contemporary goods. Lynchburg's Jack Daniels whiskey distillery is the best known of several Tennessee distilleries, which are popular visitor attractions. (TDTD, 2015e)

East Region

The East Region lies roughly between the Cumberland Plateau on the west to the eastern border of North Carolina, with Virginia to the north, and Georgia to the south. The Appalachian Mountains, Great Smoky Mountains National Park, and Cherokee National Forest are also on the eastern border Lakes (Figure 14.1.7-3). The eastern portion of the Tennessee River and large lakes like Cherokee, Douglas, Norris, Tellico, Watts Bar, and Chickamauga provide plenty of diverse opportunities for water-based recreation, camping, hunting, fishing, and access to multi-use trails. Knoxville has urban recreational opportunities and entertainment typical of a large metropolitan city, along with the added venues that serve the students attending University of Tennessee's largest campus there. The nearby Department of Energy's Oak Ridge National Laboratory has tours of its American Museum of Science and Energy available for visitors. Pigeon Forge's "Dollywood" amusement park and Gatlinburg's presence as the entrance to the Great Smoky Mountain National Park, bring many tourists to the region (TDTD, 2015f). With more than 800 miles of maintained trails, and 70 miles of the Appalachian National Scenic Trail, the National Park is a hiker's paradise. There are also plenty of opportunities for cycling, horseback riding, and whitewater boating, and camping (TDTD, 2015g). The Motor Speedway and Dragway in Bristol is renowned to national stock car and hot rod racing fans. The

"Appalachian Quilt Trail" is an interesting interpretive driving route where heritage quilt patterns are painted on historically significant barns (TDTD, 2015h).

Chattanooga in the southeast portion of this region, is another large metropolitan area of Tennessee, and is located on the state border with Georgia, on the Tennessee River. Festivals and activities are centered at the riverfront, including museums, arts and shopping districts, and sports venues. The city's railroad and Civil War histories also have associated tourist destinations that draw many visitors. The nearby Ocoee River was the site 1996 Olympic whitewater competitions, and enthusiasts still practice their sports there; and Foster Falls provides challenges for rock climbers (TDTD, 2015i). Fall Creek Falls State Park (largest and most visited in the state) has a 256-foot waterfall, one of the highest in the eastern U.S. (TDEC, 2015l).

14.1.7.5. Airspace

The FAA uses the NAS to provide for aviation safety. The NAS includes Special Use Airspace (SUA) consisting of Restricted Areas, Warning Areas, and Military Operation Areas (MOA). The FAA controls the use of the NAS with various procedures and practices (such as established flight rules and regulations, airspace management actions, and air traffic control procedures) to ensure the safety of aircraft and protection of the public.

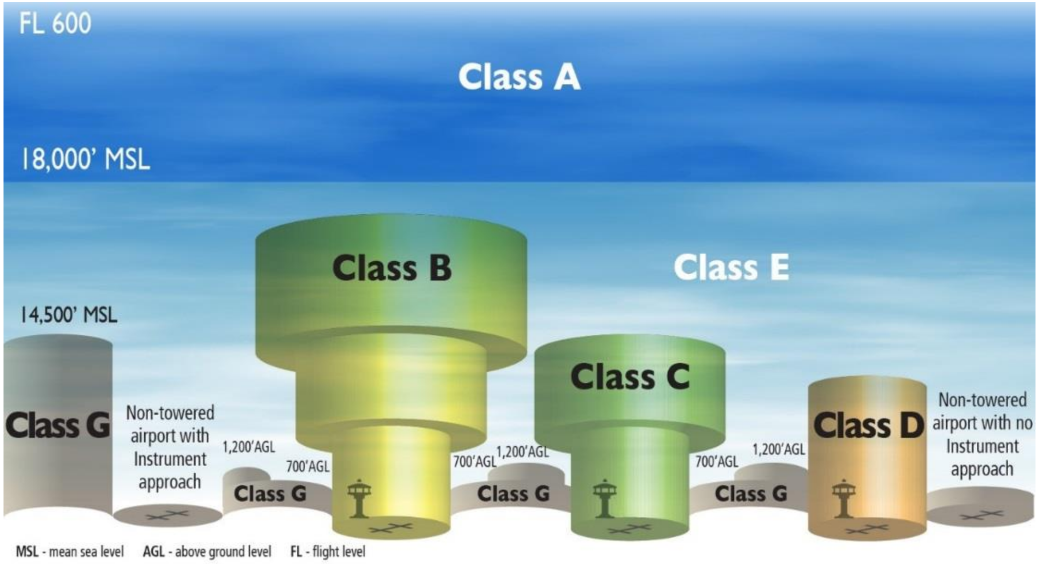
Airspace Categories

There are two categories of airspace or airspace areas:

1) **Regulatory airspace** consists of controlled airspace (Class A, B, C, D, and E airspace areas in descending order of restrictive operating rules), and restricted and prohibited areas.
2) **Non-regulatory airspace** consists of MOAs, warning areas, alert areas, and controlled firing areas.

Within each of these two categories, there are four types of airspace: controlled, uncontrolled, special use, and other airspace. The categories and types of airspace are dictated by the complexity or density of aircraft movements, the nature of the operations conducted within the airspace, the level of safety required, and the national and public interest. Figure 14.1.7-4 depicts the different classifications and dimensions for controlled airspace. Air Traffic Control (ATC)[96] service is based on the airspace classification (FAA, 2008).

[96] ATC – Approved authority service to provide safe, orderly and expeditious flow of air traffic operations (FAA, 2015c).



Source: Derived from (FAA, 2008)

Figure 14.1.7-4: National Air Space Classification Profile

Controlled Airspace

- **Class A:** Airspace from 18,000 feet to 60,000 feet Mean Sea Level (MSL)[97]. Includes the airspace over waters off the U.S. coastlines (48 contiguous States and Alaska) within 12 Nautical Miles (NM). All operations must be conducted under Instrument Flight Rules (IFR).[98]
- **Class B:** Airspace from the surface up to 10,000 feet MSL near the busiest airports with heavy traffic operations. The airspace is tailored to the specific airport in several layers. An ATC clearance is required for all aircraft to operate in this area.
- **Class C:** Airspace from the surface to 4,000 feet above the airport elevation surrounding the airport. Applies to airports with an operational control tower, serviced by a radar approach control, and certain number of IFR operations or total number of passengers boarding aircrafts. Airspace is tailored in layers, but usually extends out to 10 NM from 1,200 feet to 4,000 feet above the airport elevation. Entering Class C airspace requires radio contact with the controlling ATC authority, and an ATC clearance is ultimately required for landing.
- **Class D:** Airspace from the surface to 2,500 feet above the airport elevation surrounding airports with an operational control tower. Airspace area is tailored. Aircraft entering the airspace must establish and maintain radio contact with the controlling ATC.
- **Class E:** Controlled airspace not designated as Class A, B, C, or D. Class E airspace extends upward from the surface or a designated altitude to the overlying or adjacent controlled airspace (FAA, 2008).

[97] MSL – The average level of for the surface of the ocean; "The height of the surface of the sea midway between the average high and low tides" (Merriam Webster Dictionary, 2015b).
[98] IFR – Rules for the conduct of flights under instrument meteorological conditions (FAA, 2015d).

Uncontrolled Airspace

Class G: No specific definition. Refers generally to airspace not designated as Class A, B, C, D, or E. Class G airspace is from the surface to the base of Class E airspace.

Special Use Airspace

SUA designates specific airspace that confines or imposes limitations on aircraft activities (See Table 14.1.7-5).

Table 14.1.7-5: SUA Designations

SUA Type	Definition
Prohibited Areas	"Airspace of defined dimensions identified by an area on the surface of the earth within which the flight of aircraft is prohibited. Such areas are established for security or other reasons associated with the national welfare. These areas are published in the Federal Register and are depicted on aeronautical charts."
Restricted Areas	"Airspace identified by an area on the surface of the earth within which the flight of aircraft, while not wholly prohibited, is subject to restrictions. Activities within these areas must be confined because of their nature or limitations imposed upon aircraft operations that are not a part of those activities or both. Restricted areas denote the existence of unusual, often invisible, hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. Penetration of restricted areas without authorization from the using or controlling agency may be extremely hazardous to the aircraft and its occupants. Restricted areas are published in the Federal Register and constitute 14 CFR Part 73."
Warning Areas	"Airspace of defined dimensions, extending from three NM from the U.S. coast, which contains activity that may be hazardous to nonparticipating aircraft. The purpose of such warning areas is to warn non-participating pilots of the potential danger. A warning area may be located over domestic or international waters or both."
MOAs	"Airspace of defined vertical and lateral limits established for separating certain military activities (e.g., air combat maneuvers, air intercepts, testing, etc.) from IFR traffic. Whenever an MOA is in use, non-participating IFR traffic may be cleared through a MOA if IFR separation can be provided by ATC. Otherwise, ATC will reroute or restrict nonparticipating IFR traffic."
Alert Areas	"Depicted on aeronautical charts to inform non-participating pilots of areas that may contain a high volume of pilot training or an unusual type of aerial activity. Pilots should be particularly alert when flying in these areas. All activity within an alert area must be conducted in accordance with CFRs, without waiver, and pilots of participating aircraft and pilots transiting the area are responsible for collision avoidance."
Controlled Firing Areas (CFA)	"Activities that, if not conducted in a controlled environment, could be hazardous to nonparticipating aircraft. The distinguishing feature of the CFA, as compared to other special use airspace, is that its activities are suspended immediately when spotter aircraft, radar, or ground lookout positions indicate an aircraft might be approaching the area. There is no need to chart CFAs since they do not cause a nonparticipating aircraft to change its flight path."
National Security Areas (NSA)	"Airspace of defined vertical and lateral dimensions established at locations where there is a requirement for increased security and safety of ground facilities. Pilots are requested to voluntarily avoid flying through the depicted NSA. When it is necessary to provide a greater level of security and safety, flight in NSAs may be temporarily prohibited by regulation under the provisions of 14 CFR Section 149.7. Regulatory prohibitions are issued by System Operations, System Operations Airspace and Aeronautical Information Manual (AIM) Office, Airspace and Rules, and disseminated via Notices to Airmen (NOTAM). Inquiries about NSAs should be directed to Airspace and Rules."

Sources: (FAA, 2015c) (FAA, 2008)

Other Airspace Areas

Other airspace areas, explained in Table 14.1.7-6, include Airport Advisory, Military Training Routes (MTR), Temporary Flight Restrictions (TFR), Parachute Jump Aircraft Operations, published Visual Flight Rules (VFR) and IFRs, and Terminal Radar Service Areas.

Table 14.1.7-6: Other Airspace Designations

Type	Definition
Airport Advisory	There are three types: • Local Airport Advisory – Operated within 10 statute miles of an airport where there is a Flight Service Station (FSS) located on an airport, but no operational control tower. The FSS advises the arriving and departing aircraft on particular conditions. • Remote Airport Advisory – Operated within 10 statute miles for specific high activity airports with no operational control tower. • Remote Airport Information Service – Used for short-term special events.
MTRs	MTRs are for use by the military for training, specifically low level combat tactics where low altitudes and high speed are needed.
TFRs	TFRs are established to: • Protect people and property from a hazard; • Provide safety for disaster relief aircraft during operations; • Avoid unsafe aircraft congestion associated with an incident or public interest event; • Protect the U.S. President, Vice President, and other public figures; • Provide safety for space operations; and • Protect in the State of Hawaii declared national disasters for humanitarian reasons. Only those TFRs annotated with an ending date and time of "permanent" are included in this Final PEIS, since it indicates a longer, standing condition of the airspace. Other TFRs are typically a shorter duration of for a one-time specific event.
Parachute Jump Aircraft Operations	Parachute jump area procedures are in 14 CFR Part 105, while the U.S. parachute jump areas are contained in the regional Airport/Facility Directory.
Published VFRs and IRs	These are established routes for moving around and through complex airspace, like Class B airspace. VFRs are procedures used to conduct flights under visual conditions. IFRs are procedures used to conduct flights with instruments and meteorological conditions.
Terminal Radar Service Areas	Airspace areas that are not one of the established U.S. airspace classes. These areas provide additional radar services to pilots.

Sources: (FAA, 2015c) (FAA, 2008)

14.1.7.6. Aerial System Considerations

Unmanned Aircraft Systems

Unmanned Aircraft Systems (UAS) are widely used by the military, private entities, public service, educational institutions, federal/state/local governments, and other agencies. The FAA's Unmanned Aircraft Systems Integration Office integrates UAS into the NAS. The *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap of 2013* addresses the actions and considerations needed to integrate UAS into the NAS "without reducing existing capacity, decreasing safety, negatively impacting current operators, or increasing the risk to airspace users or persons and property on the ground any more than the integration of comparable new and novel technologies" (FAA, 2013).

UAS at airports is a complex operational challenge with the need to separate UAS flight operations from mainstream air traffic. Separation can be achieved with specific UAS launch windows, special airports, or off-airport locations that allow the UAS to easily launch and recover. Special aviation procedures are applied to UAS flights. There must be the capability of Sense and Avoid (SAA) and Control and Communication (C2) during UAS operations. An Unmanned Aircraft (UA) must be able to see (or sense) other aircraft in the area and avoid the aircraft through corrected flight path changes. General equipment and operational requirements can include aircraft anti-collision lights, an altitude encoding transponder, cameras, sensors, and collision avoidance maneuvers. The C2 of the UA occurs with the pilot/operator, the UAS control station, and ATC. Research efforts, a component of the FAA's UAS roadmap, continue to mature the technology for both SAA and C2 capabilities.

Balloons

Moored balloons and unmanned free balloons cannot be operated in a prohibited or restricted area unless approval is obtained from the controlling agency. Balloons also cannot be operated if they pose a hazard to people and their property.

14.1.7.7. Obstructions to Airspace Considerations

The Airports Division of the FAA is responsible for the evaluation and analysis of proposed construction or alterations on airports. The FAA Air Traffic Office is responsible for determining obstructions to air navigation as a result of construction off airports that may affect the safe and efficient use of navigable airspace and the operation of planned or existing air navigation and communication facilities. Such facilities include air navigation aids, communication equipment, airports, federal airways, instrument approach or departure procedures, and approved off-airway routes. An Obstruction Evaluation and Airport Airspace Analysis (OE/AAA) is required when there is the potential for airport construction/alteration of a facility that may impinge upon the NAS. Per 14 CFR Part 77.9, the FAA is to be notified about construction or alterations when:

- "Any construction or alteration exceeding 200 feet above ground level
- Any construction or alteration:
  - within 20,000 feet of a public use or military airport which exceeds a 100:1 surface from any point on the runway of each airport with its longest runway more than 3,200 feet
  - within 10,000 feet of a public use or military airport which exceeds a 50:1 surface from any point on the runway of each airport with its longest runway no more than 3,200 feet
  - within 5,000 feet of a public use heliport which exceeds a 25:1 surface

- Any highway, railroad, or other traverse way whose prescribed adjusted height would exceed the above noted standards
- When requested by the FAA
- Any construction or alteration located on a public use airport or heliport regardless of height or location" (FAA, 2015e).

Construction or alternative facilities (such as towers) that are subject to FCC licensing requirements are also required to have an OE/AAA performed by the FAA Airport Division.

14.1.7.8. Tennessee Airspace

The Tennessee Aeronautics division is a component of the TDOT. The division is "responsible for licensing public airports, monitoring compliance with federal grants and providing flight services for branches of state government. It performs engineering services, aviation planning studies, airport improvement, and project design consultation to local airports. It insures the operational safety and efficiency of the state aviation facilities system" (TDOT, 2015c). The Division is comprised the administration, engineering/program development, flight services, finance/grant management, and planning/programming offices. The Tennessee Aeronautics Commission furthers aviation for the state via policy planning and approval/disapproval of changes to the state airport system plan pursuant to the authority granted in Tennessee Code (TDOT, 2015d). Two FAA FSDOs are located in Memphis and Nashville (FAA, 2015b).

Tennessee airports are classified as those included in the State Aviation System Plan (SASP) and those that are not part of the SASP. The SASP addresses the strategic planning and future development for the state's airport system, as well as addressing key associated with their airports (National Association of State Aviation Officials, 2015). Figure 14.1.7-5 presents the different aviation airports/facilities residing in Tennessee, while Figure 14.1.7-6 and Figure 14.1.7-7 present the breakout by public and private airports/facilities. There are approximately 327 airports within Tennessee as presented in Table 14.1.7-7 and Figure 14.1.7-5 through Figure 14.1.7-7 (USDOT, 2015).

Table 14.1.7-7: Type and Number of Tennessee Airports/Facilities

Type of Airport or Facility	Public	Private
Airport	77	131
Heliport	0	113
Seaplane	0	1
Ultralight	0	3
Balloonport	0	0
Gliderport	2	0
Total	**79**	**248**

Sources: (USDOT, 2015)

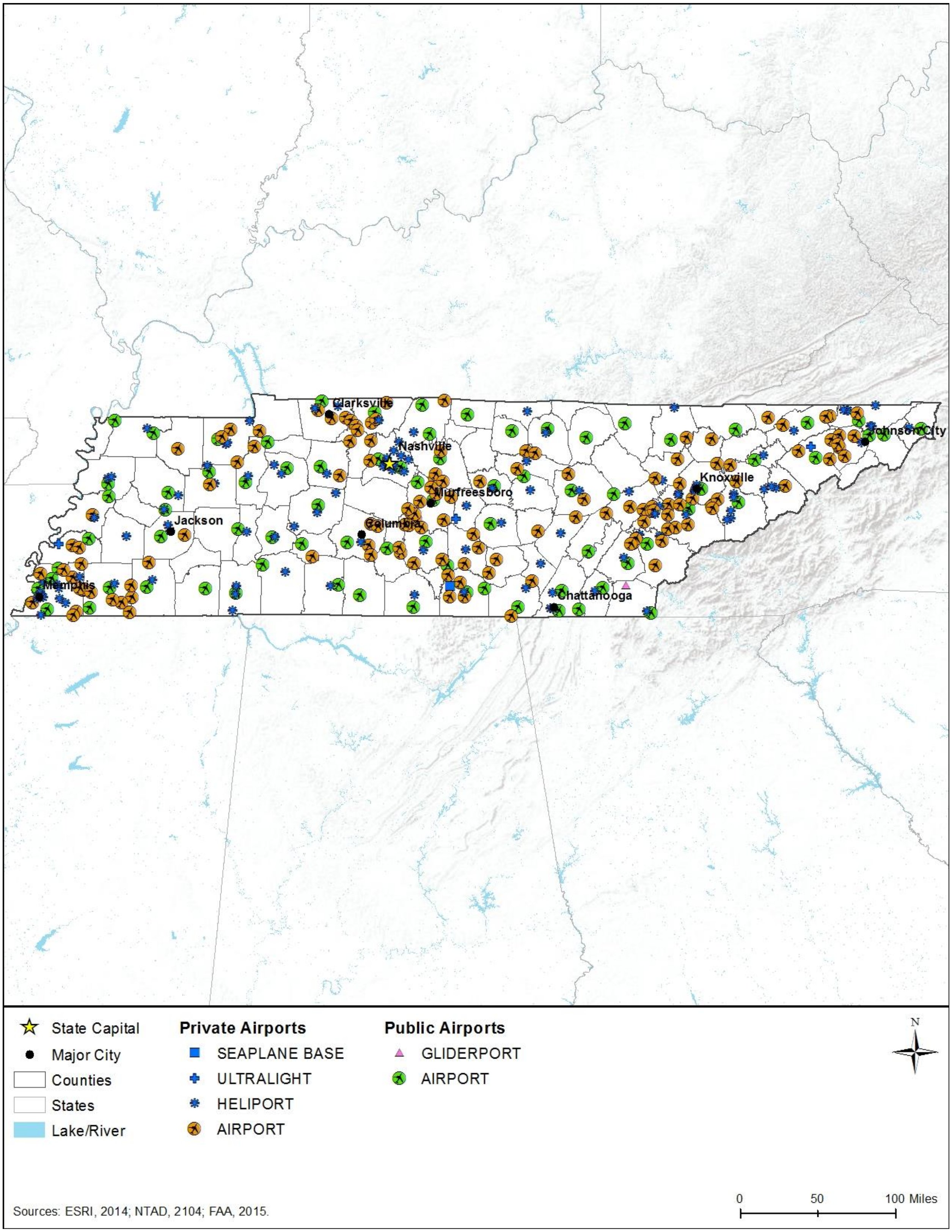


Figure 14.1.7-5: Composite of Tennessee Airports/Facilities

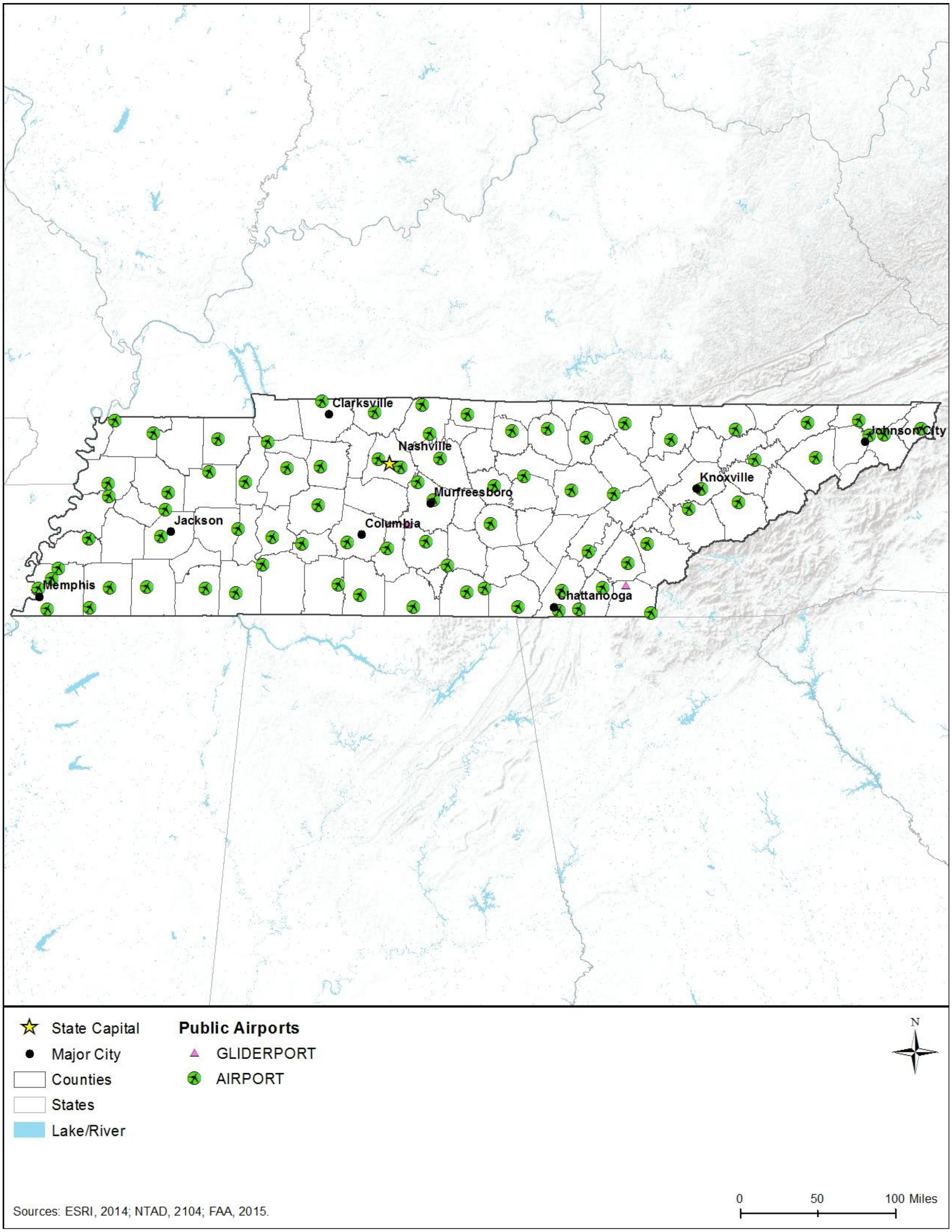


Figure 14.1.7-6: Public Tennessee Airports/Facilities

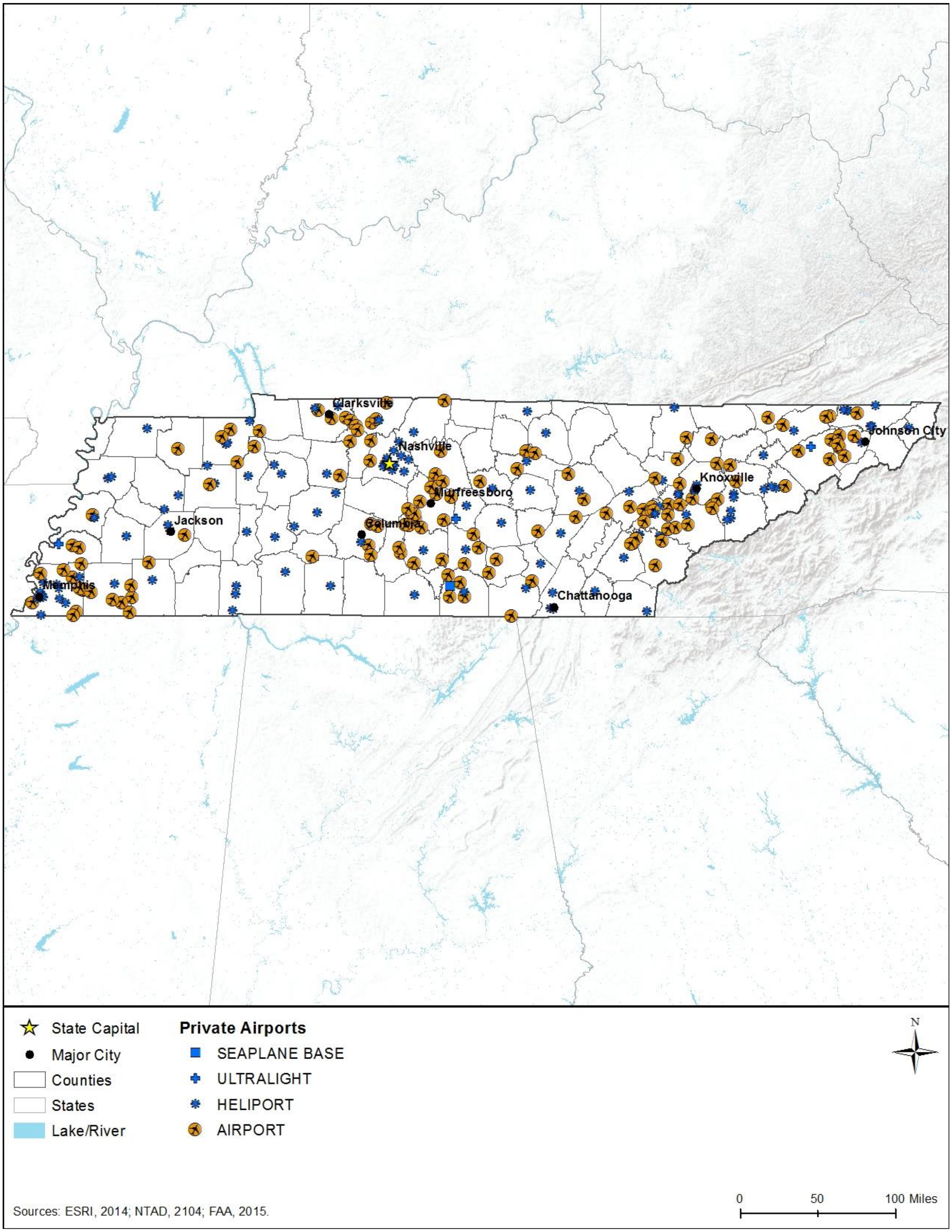


Figure 14.1.7-7: Private Tennessee Airports/Facilities

There are Class B, Class C, and Class D controlled airports in Tennessee as follows:

- One Class B –
  - Memphis International
- Three Class C –
  - Lovell Field, Chattanooga
  - McGhee Tyson Airport, Knoxville
  - Nashville International, Nashville
- Four Class D –
  - McKellar-Sipes Regional, Jackson
  - Memphis Naval Air Station/Millington Municipal Airport, Millington
  - Smyrna Airport
  - Tri-Cities Regional Airport, Tri-Cities (FAA, 2015f)

SUAs (i.e., one MOA and one NSA) located in Tennessee follow. The one MOA is:

- Snowbird – 11,000 feet MSL to, but not including, Flight Level (FL) 180 (FAA, 2016a)

The MOA of Columbus 4 in Mississippi, associated with the 14th Flying Training Wing of Columbus Air Force Base, extends into the lower western portion of the state. (FAA, 2016a)

The SUAs for Tennessee are presented in Figure 14.1.7-8. There is one Alert Area in the northern portion of the state around Clarksville associated with Fort Campbell (See Figure 14.1.7-8) – A- 371 (Surface to 2,000 feet MSL) (FAA, 2016a). There are no TFRs (See Figure 14.1.7-8) (FAA, 2015g). There is National Security Area (NSA 0011)[99] located in Oak Ridge (See Figure 14.1.7-8) (FAA, 2016a). The restrictions associated with this NSA, when active, may impact the airspace in the area. MTRs in Tennessee, presented in Figure 14.1.7-9, consist of ten Visual Routes, twelve Instrument Routes, and three Slow Routes.

UAS Considerations

The NPS signed a policy memorandum on June 20, 2014 that "directs superintendents nationwide to prohibit launching, landing, or operating unmanned aircraft on lands or waters administered by the National Park Service" (NPS, 2014a). There is one National Park in Tennessee that must comply with this agency directive (NPS, 2015c).

[99] National Security Area (NSA) consists of defined vertical and lateral dimensions in the airspace where there is increased security of ground facilities. Pilots are expected to voluntarily avoid flying through the NSA. Additional security levels may result in further restrictions of the NSA, which FAA Headquarters would issue and disseminate with a NOTAM. (FAA, 2015h)

Obstructions to Airspace Considerations

Several references in Tennessee statues address airspace hazards. As defined in the Tennessee Code (Title 42, Chapter 6, §101), an airport hazard is "any structure or tree or use of land that obstructs the airspace required for the flight of aircraft in landing or taking off at an airport or is otherwise hazardous to such landing or taking off of aircraft" (State of Tennessee, 2015b). Enforcement of airport hazard areas is addressed in Title 42, Chapter 6, §103, whereby Tennessee counties and municipalities can manage potential or established airport hazards and address zoning "specify the land uses permitted and prohibited and regulated and restrict the height to which structures and trees may be erected or allowed to grow; provided, that these regulations are solely for the purposes of preventing airport hazards" (State of Tennessee, 2015c).

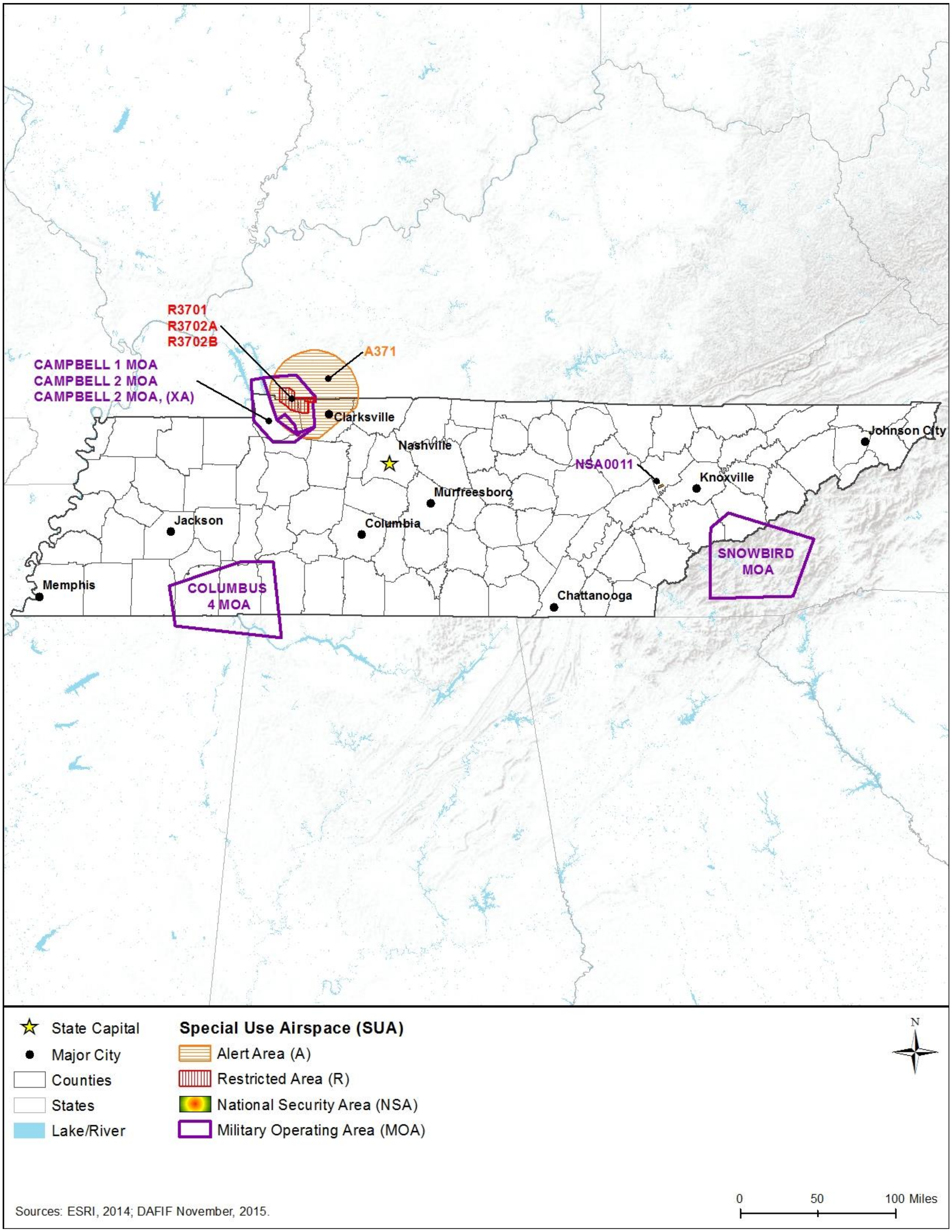


Figure 14.1.7-8: SUAs in Tennessee

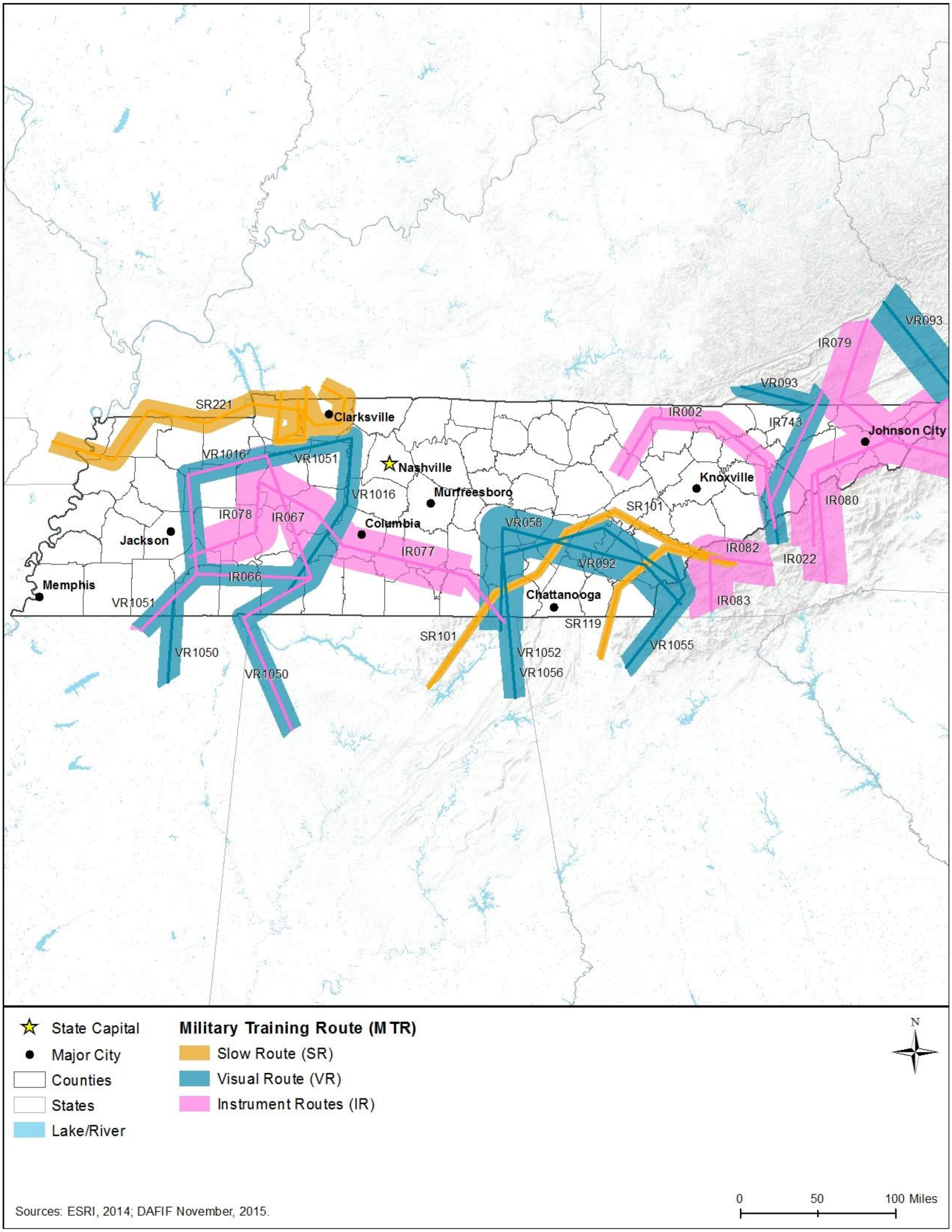


Figure 14.1.7-9: MTRs in Tennessee

14.1.8. Visual Resources

14.1.8.1. Introduction

Visual resources influence the human experience of a landscape. Various aspects combine to create visual resources, such as color, contrast, texture, line, and form. Features (e.g., mountain ranges, city skylines, ocean views, unique geological formations, rivers) and constructed landmarks (e.g., bridges, memorials, cultural resources, or statues) are considered visual resources. For some, cityscapes are valued visual resources, whereas others prefer natural areas. While many aspects of visual resources are subjective, evaluating potential impacts on the character and continuity of the landscape is a consideration when evaluating proposed actions for NEPA and NHPA compliance. The federal government does not have a single definition of what constitutes a visual resource; therefore, this PEIS will use the general definition of visual resources used by the Bureau of Land Management, "the visible physical features on a landscape (e.g., land, water, vegetation, animals, structures, and other features)." (BLM, 1984).

14.1.8.2. Specific Regulatory Considerations

Table 14.1.8-1 presents state and local laws and regulations that relate to visual resources.

Table 14.1.8-1: Relevant Tennessee Visual Resources Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Tenn. Code Ann. § 11-3, Part 1	TDEC	"Every park under this part shall be preserved in a natural condition so far as may be consistent with its human use and safety, and all improvements shall be of such character as not to lessen its inherent recreational value."
Tenn. Code Ann. § 11-4 Part 1, Tennessee Forestry Act	Department of Agriculture	"To establish a state forestry organization that is responsible for the development and administration of those programs and services that ensure effective protection, management, and reforestation of Tennessee's forests."
Tenn. Code Ann. § 11-11 Part 1. Tennessee Trails System Act	TDEC	"To provide for the ever increasing outdoor recreation needs of an expanded population and in order to promote public access to, travel within, and enjoyment and appreciation of the outdoor, natural and remote areas of the state, trails should be established: **(1)** In natural, scenic areas of the state; and **(2)** In and near urban areas."
Tenn. Code Ann. § 11-13 Part 1, The Tennessee Scenic Rivers Act of 1968	TDEC	"For aesthetic as well as ecological and other scientific reasons, priority and especial emphasis shall be given to the preservation of natural, unspoiled, undeveloped river areas."

State Law/Regulation	Regulatory Agency	Applicability
Tenn. Code Ann. § 11-14 Part 1, Natural Areas Preservation Act of 1971	TDEC	"…the countryside of Tennessee there are areas possessing scenic, scientific, including biological, geological and/or recreational values, and which are in prospect and peril of being destroyed or substantially diminished by actions such as dumping of refuse, commercialization, construction, changing of population densities or similar actions, there being either no regulations by the state or by local governments or regulations which are inadequate or so poorly enforced as not to yield adequate protection to such areas. It is the intention of the general assembly to provide protection for such areas."

Sources: (Justia, 2016f) (Justia, 2016g) (Justia, 2016h) (Justia, 2016i) (Justia, 2016j)

In addition to the state laws and regulations, local zoning laws may apply related to visual resources. Viewsheds and scenic vistas are increasingly important to the state's towns and cities as they look at the future planning of their municipalities.

14.1.8.3. Character and Visual Quality of the Existing Landscape

Tennessee is a state with rich scenic resources including the high Blue Ridge Mountains and the wide Mississippi and Tennessee River Valleys. The Smoky Mountains National Park on the eastern border contains the highest point in the state, 6,643-foot Clingmans Dome. The Mississippi River on the western border contains the lowest point in the state of 178 feet (USGS, 2009b) (USGS, 2017a). The landscape in between varies from forested, rolling hills and river valleys, to waterfalls, rocky outcrops, swamps, and farmland. Historic Civil War Battlefields, homesteads, plantations, towns, and American Indian cultural sites are plentiful in Tennessee. The capital city of Nashville is near the center of the state along the Cumberland River, Memphis sits aside the Mississippi River in the southwestern corner of the state, Chattanooga is in southeast, Knoxville is in the northeast, and both cities are adjacent to the Tennessee River (TDOT, 2015e) (USGS, 2017b).

One aspect of importance for visual resources is to maintain the character of the area. For example, in a farm community, keeping the character of the town consistent with farm-style houses, barns, and silos would be key in maintaining the character of the community. In a more metropolitan area, there may be many different visual styles within each neighborhood, but keeping the character of the neighborhood is important to maintain if new development were to occur. Section 14.1.7 discusses land use and contains further descriptions of land cover within the state.

Tennessee has considered the management and protection of scenic resources in many of their land use and planning policies (Table 14.1.8-1). While the state and many municipalities have some regulation of scenic and visual resources, not all scenic areas within the state have been identified or have policy or regulations for management or protection by the state. The areas listed below have some measure of management, significance, or protection through state or federal policy, as well as being identified as a visually significant area.

14.1.8.4. Visually Important Historic Properties and Cultural Resources

Visual and aesthetic qualities of historic properties can contribute to the overall importance of a particular site. Such qualities relate to the integrity of the appearance and setting of these properties or resources. Viewsheds (the natural and manmade environment visible from one or more viewing points) can also contribute to the significance of historic properties or cultural resources (NASA, 2013). Viewsheds containing historic properties and cultural resources may be considered important because of their presence in the landscape. Figure 14.1.8-1 shows areas that are included in the National Register of Historic Places (NRHP) that may be considered visually sensitive. In Tennessee, there are 2,054 NRHP listed sites, which include 30 National Historic Landmarks (NHLs), 2 National Battlefields, 2 National Military Parks, 1 National Historic Site, and 1 National Heritage Area (NPS, 2014b). Some state historic sites, state heritage areas, and state historic districts may also be included in the NRHP, whereas others are not designated at this time.

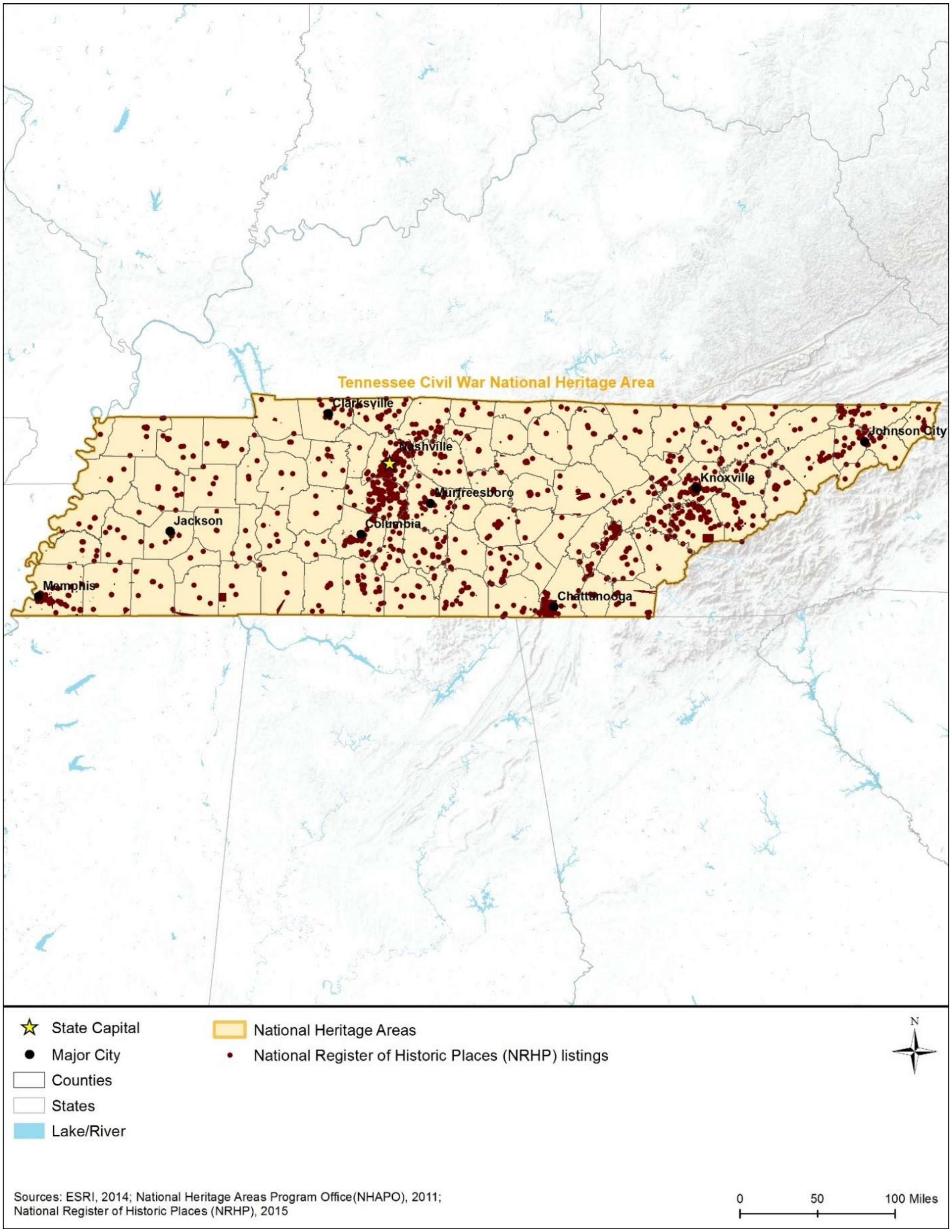


Figure 14.1.8-1: Representative Sample of Some Historic and Cultural Resources that May be Visually Sensitive

The Secretary of the Interior's Standards for the Treatment of Historic Properties addresses four aspects: preservation, rehabilitation, restoration, and reconstruction, whereas The Guidelines for the Treatment of Cultural Landscapes, both authored by the NPS, provides guidance for applying protections to all aspects of the historic and cultural landscape, such as forests, gardens, trails, structures, ponds, and farming areas, to meet the Standards (NPS, 1995). The Standards "require retention of the greatest amount of historic fabric, including the landscape's historic form, features, and details as they have evolved over time," which directly protects historic properties and the visual resources therein (NPS, 1995).

World Heritage Sites

Sites are designated World Heritage sites if they reflect "the world's cultural and natural diversity of outstanding universal value" (UNESCO, 2015). For inclusion on the World Heritage List, sites must meet 1 of 10 criteria reflecting cultural, natural, or artistic significance. World Heritage sites are diverse and range from archaeological remains, national parks, islands, buildings, city centers, and cities. The importance of World Heritage-designated properties can be attributed to cultural or natural qualities that may be considered visual resources or are visually sensitive at these sites. In Tennessee, the Great Smoky Mountains National Park is a designated natural World Heritage site (Figure 14.1.8-1) (UNESCO, 2015). More information on this and other NPS units is presented in Section 14.1.8.6.

National Historic Landmarks

NHLs are defined as "nationally significant historic places designated by the U.S. Secretary of the Interior because they possess exceptional value or quality in illustrating or interpreting the heritage of the United States" (NPS, 2015d). NHLs may include "historic buildings, sites, structures, objects, and districts" (NPS, 2016b). Other types of historic properties include battlefields and canals. The importance of NHL-designated properties can be attributed to scenic or aesthetic qualities, among other attributes, that may be considered visual resources or visually sensitive at these sites. In Tennessee, NHLs are comprised of historic buildings such as residences, churches, taverns, and institutional buildings. Other types of historic properties include forts, battlefields, historic districts, and plantations. The importance of NHL-designated properties can be attributed to scenic or aesthetic qualities that may be considered visual resources or visually sensitive at these sites. The scenic and visual resources of these landmarks and surrounding areas are managed for consistency with the historic resource and aesthetics of the landscape. There are 30 NHLs in Tennessee, which include a variety of historic structures and historic locations (Figure 14.1.8-1). By comparison, there are over 2,500 NHLs in the United States (NPS, 2015e). Figure 14.1.8-1 provides a representative sample of some historic and cultural resources that may be visually sensitive.

The following sites have been designated as NHLs in Tennessee:

- Beale Street Historic District
- Chucalissa Site
- Fort Loudoun
- Franklin Battlefield
- Graceland (Home of Elvis Presley)
- Hiram Masonic Lodge No. 7
- Long Island of the Holston
- Montgomery Bell Tunnel
- Old First Presbyterian Church
- Polk, James K., House
- Rhea County Courthouse
- Shiloh Indian Mounds Site
- Sun Record Company
- Tennessee State Capitol
- X-10 Reactor, Oak Ridge National Laboratory
- Blount, William, Mansion
- Delta Queen (River Steamboat)
- Fort Pillow
- George Peabody College for Teachers
- Hermitage, The
- Jubilee Hall, Fisk University
- Moccasin Bend Archeological District
- Mountain Branch, National Home for Disabled Volunteer Soldiers
- Pinson Mounds
- Rattle And Snap
- Ryman Auditorium
- Siege And Battle of Corinth Sites (Also in Mississippi)
- Sycamore Shoals
- Wynnewood
- York, Alvin Cullom, Farm

Source: (NPS, 2015f)

National Historic Sites

There is one National Historic Site in Tennessee, the Andrew Johnson National Historic Site, and National Cemetery (Figure 14.1.8-1). This historic site consists of four locations: a Visitor Center, the Early Home, the Homestead, and the Cemetery. The National Cemetery has scenic vistas of the mountains from the open grassy areas and historic gravesites. (NPS, 2015g)

National Heritage Areas

National Heritage Areas (NHA) are “places where natural, cultural, and historic resources combine to form a cohesive, nationally important landscape” (NPS, 2011). These areas help tell the history of the United States. Based on this criteria, NHAs in Tennessee may contain scenic or aesthetic areas considered visual resources or visually sensitive. NHAs are not National Parks or under NPS ownership, but the NPS does provide funding and support to the NHAs. Tennessee has one National Heritage Area, the Tennessee Civil War NHA (Figure 14.1.8-1) (NPS, 2012b).

The Tennessee Civil War NHA spans the entire state, encompassing the scenic resources within Tennessee, along with the historic battlefields, memorials, and historic structures (NPS, 2015h).

National Historic Parks and Other Historic Sites

There are several other NPS historic parks throughout Tennessee: the Cumberland Gap National Historical Park, the Chickamauga and Chattanooga National Military Park, the Shiloh National Military Park, Fort Donelson National Battlefield, and Stones River National Battlefield (Figure 14.1.8-3).

Cumberland Gap National Historic Park within Kentucky, Virginia, and Tennessee highlights 24,000 acres of scenery along with the historic and cultural resources in this park (Figure 14.1.8-2). High overlooks, forests, geologic formations, waterfalls, and mountains are some of the many visual resources within the park. (NPS, 2015i)

Source: (NPS, 2015j)

Figure 14.1.8-2: Cumberland Gap National Historical Park

Chickamauga and Chattanooga National Military Park, the Shiloh National Military Park, Fort Donelson National Battlefield, and Stones River National Battlefield contain scenic historic sites along with beautiful landscapes with forests, lakes, creeks, waterfalls, open parklike areas, and mountains (NPS, 2015c).

National Historic Trails

National Historic Trails are defined under Section 5 of the National Trails System Act (16 U.S.C. 1241-1251, as amended) as extended trails that "follow as closely as possible and practicable the original trails or routes of travel of national historic significance" (NPS, 2012c). There are two National Historic Trails in Tennessee, the Trail of Tears, and Overmountain Victory (Figure 14.1.8-3). The scenic resources along the trails may be protected within the various agencies' jurisdictions. (NPS, 2012d)

The Trail of Tears National Historic Trail follows the 2,200 mile route taken by the Cherokee people from nine states (Alabama, Arkansas, Georgia, Illinois, Kentucky, Missouri, North Carolina, Oklahoma, and Tennessee) as they were forced to settle in Indian Territory (Oklahoma today). In Tennessee, the trail continues from North Carolina in the mountains south of Great Smoky Mountains National Park and traverses the state in many directions into adjacent states. Visual resources along the trail include historic sites, geologic features, mountains, lush forests, and rushing streams. (NPS, 2015c)

The Overmountain Victory National Historic Trail crosses four states (North Carolina, South Carolina, Tennessee, and Virginia). The 330-mile trail can be driven, or hiked for 87 miles. The trail winds from North Carolina through the Blue Ridge Mountains in Tennessee, north to Virginia with scenic vistas of forested hillsides, mountains, waterfalls, and historic sites. (NPS, 2015k)

State Historic Parks

There are eight State Historic Parks throughout Tennessee (Figure 14.1.8-3). Most of these sites have historic homes, structures, or historic features from the Civil War. The landscapes surrounding these sites contain river views, manicured gardens, rolling hills, forests, and open parklands.

Table 14.1.8-2: State Historic Parks

Park Name	Acres	Visual Resources
Cordell Hull Birthplace	58	Historic home, manicured garden, forest
Davy Crockett Birthplace	105	Historic home, river, forest
Fort Loudon	1,200	Historic fort, forest, river, lake
Fort Pillow	1,642	Historic fort, forest, river
Johnsonville	2,000	Historic Civil War site, river, creek, forest
Red Clay	263	Historic structures, valleys, natural spring, creek, forest
Sergeant Alvin C. York	NA	Historic farm, mill, home, river
Sycamore Shoals	NA	Historic settlement, river, forest

Source: (TDEC, 2015k)

14.1.8.5. Parks and Recreation Areas

Parks and recreation areas include National Parks, National Recreation Areas, Forest Service, or other public lands; state parks, forests, or trails; and other protected areas used for recreational activities (Figure 14.1.8-3).[100] Public lands under federal ownership are subject to NEPA, and visual and aesthetic resources are considered in their NEPA analysis. Public lands, parks and recreation areas often contain scenic resources and are visited because of their associated visual or aesthetic qualities. For additional information about recreation areas, including national and state parks, see Section 14.1.7, Land Use, Recreation, and Airspace.

[100] The natural areas data were retrieved from the Protected Areas Database of the United States (PAD-US), produced by USGS (http://gapanalysis.usgs.gov/padus/). This dataset categorizes lands across the U.S. by conservation, land management, planning, recreation, and ownership, as well as other uses. It is an extensive dataset that contains large quantities of information relevant to the Proposed Action. The data was queried and further combined by the Primary Designation Type into classifications that fit the multiple types of land applicable for Natural Areas. For this map, recognizable symbols (e.g., varying shades of green for National Parks and Forests) were used as PAD-US does not have a standard symbolization for natural areas. The PADUS 1.3 geodatabase was downloaded in the summer of 2015, and used consistently throughout all these maps for each state and D.C.

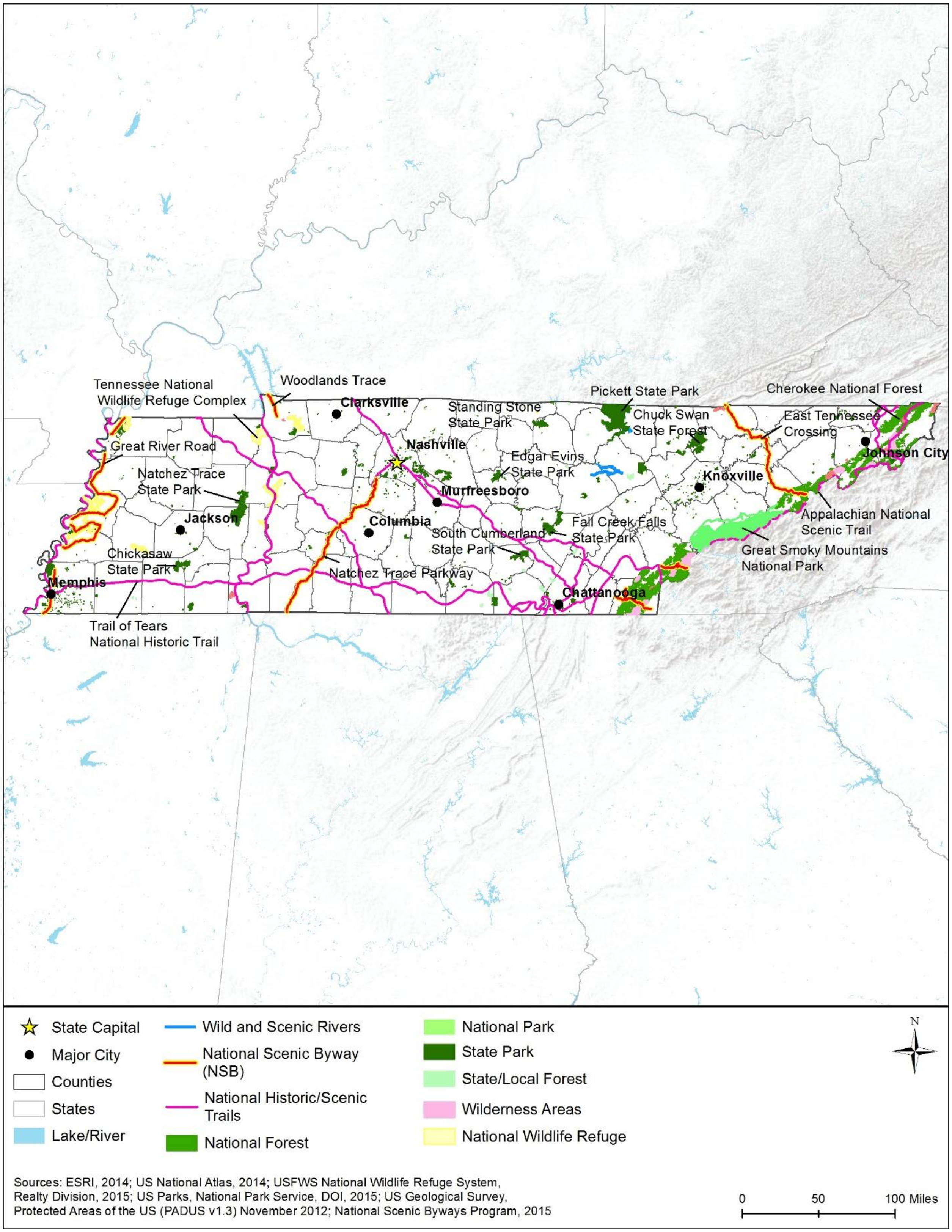
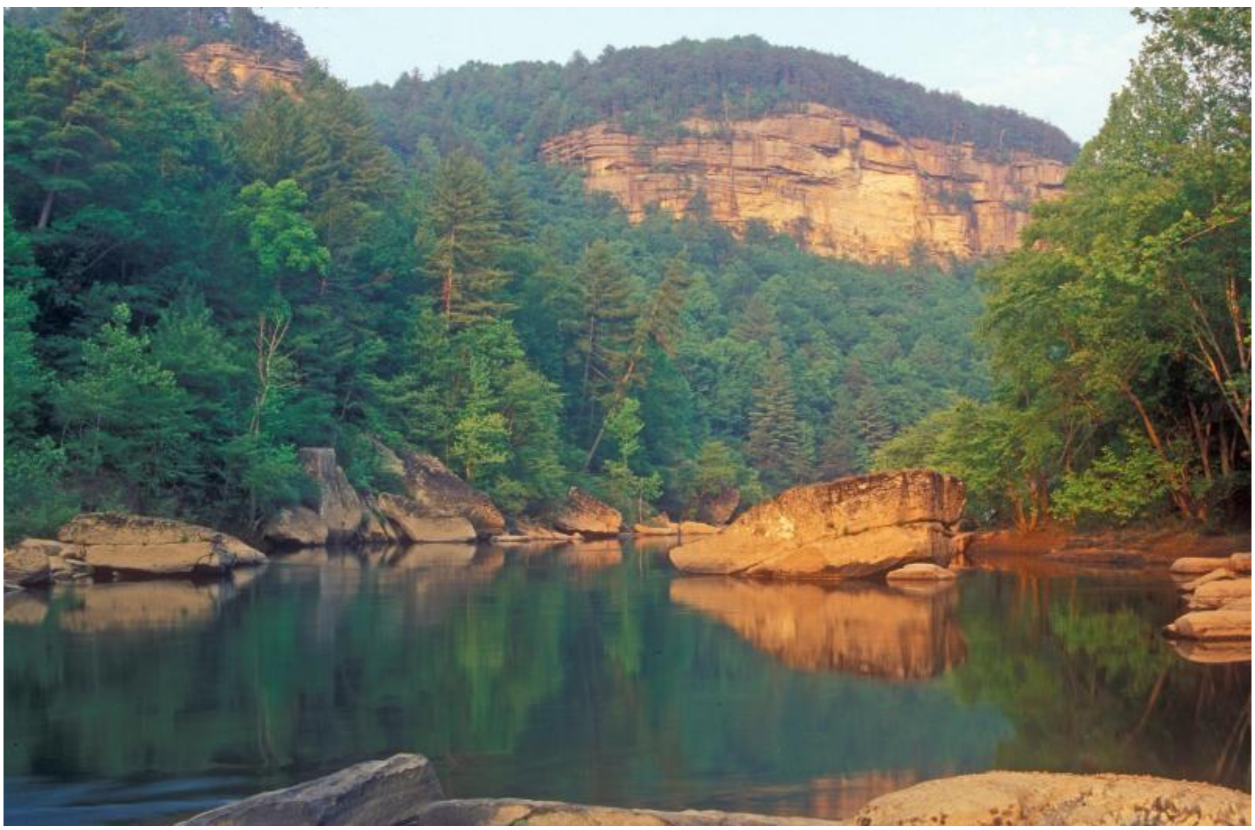


Figure 14.1.8-3: Natural Areas that May be Visually Significant

NPS: National Parks and National Recreation Areas

The NPS owns and manages National Parks and National Recreation Areas. These areas contain natural, visual, ecological, and recreational resources of significance to the nation and are maintained for the public's use. There is one National Park (Great Smoky Mountains) and one National Recreation Area/National River (Big South Fork) in Tennessee (Figure 14.1.8-3) (NPS, 2015c).

The scenic resources of Great Smoky Mountains National Park are famous. As identified in Section 14.1.8.4, this National Park is a designated natural World Heritage Site and is considered a natural treasure with universal value (NPS, 2015l). The 522,427-acre Great Smoky Mountains National Park is the most visited National Park in the U.S. The park's visual resources include waterfalls, hardwood forest, cascading streams, mountain peaks as high as 6,600 feet, mountaintop views, and historic structures (NPS, 2015m). The 125,000-acre Big South Fork National River and National Recreation Area within Kentucky and Tennessee Figure 14.1.8-4) is the first combined National River and National Recreation Area (NPS, 2015n). This scenic river canyon has outstanding vistas of steep cliffs, forests, waterfalls, streams, and geologic formations (NPS, 2015o).



Source: (NPS, 2015p)

Figure 14.1.8-4: Big South Fork National River and National Recreation Area

National Forests

There is one National Forest and one National Recreation Area managed by the USFS in Tennessee (Figure 14.1.8-3) (USFS, 2015b). The USFS conducts inventories of the forest lands and assigns scenic resource categories from which they manage for scenic and visual resources in their land and resource planning efforts (about every 10-15 years) (USFS, 1995). The scenic inventories are used to manage the forest landscape and to protect areas of high scenic integrity (USFS, 1995).

The Cherokee National Forest covers 650,000 acres in eastern Tennessee within the southern Appalachian Mountains. Streams, rivers, lakes, waterfalls, valleys, mountains, deciduous forest, mountaintop vistas, canyons, and cliffs are some of the scenic highlights of the forest. (USFS, 2015c)

The Land Between the Lakes National Recreation Area covers 170,000 acres within western Kentucky and Tennessee. The landscape encompasses forest, wetlands, lakes, valleys, and scenic vistas. (USFS, 2015d)

Army Corps of Engineers Recreation Areas

There are 75 U.S. Army Corps of Engineers (USACE) recreation areas, facilities, and flood risk management areas within the state (Recreation.gov, 2015). These areas are specifically managed by the USACE for scenic and aesthetic qualities in their planning guidance in addition to managing risks for floods (USACE, 1997).

Tennessee Valley Authority Recreation Areas

The Tennessee Valley Authority (TVA) is the land and water steward for 18 reservoirs and recreation areas in the state. The TVA considers the impacts of activities on the environment “to ensure the unique and beautiful Valley resources [are] preserved” (Recreation.gov, 2015). The TVA “manages public lands for multiple benefits” and “protects natural resources while providing recreational opportunities across the Valley” (TVA, 2008). In addition, the TVA manages recreational, natural, and cultural resources in these areas to improve water quality, shoreline conditions, recreation, and biodiversity (TVA, 2008). For additional information regarding parks and recreation areas, see Section 14.1.7, Land Use, Recreation, and Airspace.

Federal and State Trail Systems

Designated under Section 5 of the National Trails System Act (16 U.S.C. 1241-1251, as amended), National Scenic Trails are defined as extended trails that “provide for maximum outdoor recreation potential and for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas though which they pass” (NPS, 2012c). The Appalachian Trail is the only National Scenic Trail that crosses Tennessee. The Appalachian Trail spans 2,185 miles from Georgia to Maine and passes through 12 other states along the way. The trail is designated by Congress under the National Trails System Act (16 U.S.C. 1241-1251, as amended), and is protected under those provisions. Scenic resources along the trail in Tennessee are some of the finest in the state. The trail passes through Great Smoky

Mountains National Park and the Blue Ridge Mountains along the North Carolina border, showcasing high, mountaintop vistas, rich forests, waterfalls, meadows, and historic structures. (NPS, 2015q)

There are 35 National Recreation Trails in Tennessee (National Recreation Trails, 2015a). "National Recreation Trails may be designated by the Secretary of Interior or the Secretary of Agriculture to recognize exemplary trails of local and regional significance in response to an application from the trail's managing agency or organization" (National Recreation Trails, 2015b). In Tennessee, several federal agencies or local governments manage over 350 miles of trails. Table 14.1.8-3 identifies the trails and managing agency with trail length in miles.

Table 14.1.8-3: National Recreation Trails

Name and Managing Agency	Miles
Anderson Road Fitness Trail (USACE)	1.00
Bearaller Gap Hiking (USACE)	6.00
Big Hill Pond (TDEC)	8.30
Blue Beaver (NPS)	10.50
Bluff Trail (NPS)	4.50
Chickasaw Nature (USFWS)	1.10
Cordell Hull Lake (USACE)	22.00
Dale Hollow Dam Area (USACE)	0.60
East Lakeshore Trail (TVA)	21.00
Forest City (TVA)	0.10
Fort Henry Hiking (USFS)	29.00
Hemlock Bluff (TVA)	5.00
Honey Creek (Bowaters Southern Paper Company)	5.00
Honeysuckle Trail (TDEC)	0.50
John Muir (USFS)	20.70
Keel Spring Nature Trail (Westvaco Corporation)	1.10
Lady Finger Bluff (TVA)	2.70
Laurel-Snow (East TN Natural Areas)	8.00
Little Tennessee River Greenway (Little Tennessee River Greenway)	4.50
North Ridge Trail (City of Oak Ridge)	7.70
Obey River Canoe (USACE)	8.00
Old Hickory (USACE)	1.70
Piney River (Bowaters Southern Paper Company)	10.00
River Bluff (TVA)	3.10
South Cumberland (TN Department of Conservation)	60.00
Tennessee River Blueway (NPS, state, local, non-profits)	50.00
Third Creek Bicycle (City of Knoxville Recreation Department)	4.50
Three Hickories Nature (USACE)	1.60
Turkey Creek Nature (USACE)	2.80
Twin Arches (NPS)	6.00
Urban Wilderness South Loop Trail (City of Knoxville)	28.40
Virgin Falls (Bowaters Southern Paper Company)	8.00
Warriors Passage (USFS)	6.20
Warriors' Path State Park Mountain Bike Trail System (Tennessee State Parks)	9.50

Name and Managing Agency	Miles
Wolf River Greenway Trail (City of Memphis)	1.67
Total	**351.27**

Source: (National Recreation Trails, 2015a)

State Parks

TDEC manages 56 state parks, state recreation areas, and natural areas that encompass the wide range of scenic resources available throughout the state. Each park features scenic resources ranging from sandy beaches, to pristine mountain ranges, or wide-open vistas of rivers, and lakes. State parks in Tennessee include:

- Bicentennial Mall
- Big Cypress Tree
- Big Hill Pond
- Big Ridge
- Bledsoe Creek
- Booker T. Washington
- Burgess Falls
- Cedars of Lebanon
- Chickasaw
- Cordell Hull Birthplace (BP)
- Cove Lake
- Cumberland Mountain
- Cumberland Trail
- Cummins Falls
- David Crockett
- Davy Crockett BP
- Dunbar Cave
- Edgar Evins
- Fall Creek Falls
- Fort Loudoun
- Fort Pillow
- Frozen Head
- Harpeth River
- Harrison Bay
- Henry Horton
- Hiwassee/Ocoee
- Indian Mountain
- Johnsonville
- Long Hunter
- Meeman-Shelby Forest
- Montgomery Bell
- Mousetail Landing
- Natchez Trace
- Nathan Bedford Forrest
- Norris Dam
- Old Stone Fort
- Panther Creek
- Paris Landing
- Pickett
- Pickwick Landing
- Pinson Mounds
- Port Royal
- Radnor Lake
- Red Clay
- Reelfoot Lake
- Roan Mountain
- Rock Island
- Rocky Fork
- Seven Islands
- Sgt. Alvin C. York
- South Cumberland
- Standing Stone
- Sycamore Shoals
- T. O. Fuller
- Tims Ford
- Warriors' Path

State Forests

There are over 14 million acres of forest covering Tennessee (TDA, 2015b). The Tennessee Division of Forestry manages 15 forests throughout the state for timber harvest, natural resources, wildlife habitat, and primitive recreation such as hiking and hunting. The scenic resources within the following state forests include high mountains, wide river valleys, steep cliffs, waterfalls, lakes, rocky outcrops, and a variety of forest types:

- Chickasaw
- Natchez Trace
- Stewart
- Lewis
- Cedars of Lebanon
- Franklin
- Prentice Cooper
- Standing Stone
- Pickett
- Scott
- Lone Mountain
- Chuck Swan
- Martha Sundquist
- John Tully
- Bledsoe

14.1.8.6. Natural Areas

The abundance of natural areas varies by state depending on the amount of public or state lands managed within each state. Although many natural areas may not be managed specifically for visual resources, these areas are allowed protection for their natural resources and the resulting management protects these scenic resources. Figure 14.1.8-3 identifies natural areas that may have sensitive visual resources.

Rivers Designated as National or State Wild, Scenic or Recreational

The Obed River in Tennessee has 45.3 miles designated as wild (43.3 miles) and recreational (2.0 miles) (Figure 14.1.8-3) (National Wild and Scenic Rivers System, 2015a). National wild, scenic, or recreational rivers are those rivers designated by Congress or the Secretary of the Interior in accordance with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. 1271-1287). The scenic resources of these rivers are protected by the federal designations. The designated sections of the Obed River are managed entirely by the NPS (NPS, 2015c).

Tennessee has a state Scenic Rivers System with designated river segments similar to the National System. The following rivers are included in Tennessee's Scenic Rivers Program:

- Blackburn Fork
- Buffalo
- Clinch
- Collins
- Conasauga
- Duck
- French Broad
- Harpeth
- Hatchie
- Hiwassee
- Obed
- Roaring
- Spring Creek
- Tuckahoe Creek

National Wildlife Refuges and State Wildlife Management Areas

National Wildlife Refuges (NWR) are a network of lands and waters managed by the U.S. Fish and Wildlife Service. These lands and waters are "set aside for the conservation, management and, where appropriate, restoration of fish, wildlife, and plant resources and their habitats" (USFWS, 2015dh). There are seven NWRs in Tennessee:

- Chickasaw
- Cross Creeks
- Hatchie
- Lake Isom
- Lower Hatchie
- Reelfoot
- Tennessee

These refuges protect hundreds of thousands of acres of habitat and the visual resources within and surrounding the refuges (USFWS, 2015dh).

National Natural Landmarks

National Natural Landmarks (NNL) are sites designated by the U.S. Secretary of the Interior that "contain outstanding biological and/or geological resources, regardless of land ownership, and are selected for their outstanding condition, illustrative value, rarity, diversity, and value to science and education" (NPS, 2012a). These landmarks may be considered visual resources or visually sensitive. There are 13 NNLs in Tennessee covering over 49,000 acres owned and managed by a variety of federal, state, and private entities (Figure 14.1.8-3). Many of these areas are caves with geologic features, delicate ecosystems, paleontological resources, and historic sites. Table 14.1.8-4 displays a list of NNLs, their size, and some of the scenic resources protected within these areas (NPS, 2012a).

Table 14.1.8-4: National Natural Landmarks with Scenic Resources

National Natural Landmarks	Acres	Visual Resources
Arnold Engineering Development Center Natural Areas	311	Swamp forest, marsh
Big Bone Cave	259	Subterranean caverns, historic relics
Cedar Glades Natural Area	1,141	Native forest community
Conley Hole	97	Pit cave
Cumberland Cavern (Higginbotham and Henshaw Caves)	471	Subterranean caverns
Dick Cove	274	Forest, rolling hills
Grassy Cove Karst Area	10,500	Subterranean caverns, farmland, forest, rolling hills
Lost Sea (Craighead Caverns)	334	Subterranean cavern, underground lake
May Prairie	113	Unique ecosystem, prairie, forest
McAnulty's Woods	9	Forest
Piney Falls	205	Forest, stream, waterfalls
Reelfoot Lake	23,178	Swamp, lake, wetland
Savage Gulf State Natural Area	14,150	Forest, hilltop views
Total	**49,119**	

Source: (NPS, 2012a)

Tennessee Natural Areas

The Tennessee Natural Areas Program "provides oversight and management of Tennessee designated state natural areas. The Program administers the Natural Areas Preservation Act of 1971 (T.C.A. 11-14-101). The Act provides statutory authority for the protection in perpetuity of designated state natural areas" (TDEC, 2015m). There are 85 natural areas throughout the state that are designed as areas to protect natural communities and the plants and animals within these areas. Many of the NNLs listed in Table 14.1.8-4, such as Big Bone Cave and May Prairie, are managed under the natural areas program (TDEC, 2015m).

National Wilderness Areas

There are 11 designated wilderness areas covering over 66,500 acres throughout the state; all are managed under the jurisdiction of the USFS (Table 14.1.8-5) (Wilderness.net, 2015). In 1964, Congress enacted the Wilderness Act of 1964 as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain" (NPS, 2015r). A designation as a National Wilderness Area is the highest level of conservation protection given by Congress to federal lands. This Act defined wilderness as land untouched by man and primarily affected only by the "forces of nature" and as that which "may also contain ecological, geological, or other features of scientific, education, scenic, or historical value" (NPS, 2015r). Over 106 million acres of federal public lands across the U.S. have been designated as wilderness areas. Twenty-five percent of these federal lands are located in 47 national parks (44 million acres) and are part of National Park System. These designated wilderness areas are managed by USFS, Bureau of Land Management, U.S. Fish and Wildlife Service, and NPS (NPS, 2015r).

Table 14.1.8-5: Congressionally Designated Wilderness in Tennessee

Wilderness Area	Acres
Bald River Gorge Wilderness	3,791
Big Frog Wilderness	7,996
Big Laurel Branch Wilderness	6,365
Citico Creek Wilderness	16,213
Cohutta Wilderness	1,746
Gee Creek Wilderness	2,559
Joyce Kilmer-Slickrock Wilderness	3,820
Little Frog Mountain Wilderness	4,961
Pond Mountain Wilderness	6,943
Sampson Mountain Wilderness	7,967
Unaka Mountain Wilderness	4,472
Total	**66,833**

Source: (Wilderness.net, 2015)

14.1.8.7. Additional Areas

National and State Scenic Byways

National Scenic Byways are resources designated specifically for scenic or aesthetic areas or qualities which would be considered visual resources or visually sensitive. The USDOT FHWA manages the National Scenic Byways Program. There are five nationally recognized byways in Tennessee (FHWA, 2015b):

- Cherohala Skyway is 43 miles long, crosses North Carolina and Tennessee, and passes through the Appalachian National Forest. The Forest provides hiking, picnic locations, as well as noted scenery during the fall when the leaves change color.
- East Tennessee Crossing is 83 miles long through northeastern Tennessee, and provides many historic and cultural learning opportunities.
- Great River Road is 2,069 miles, and passes through Arkansas, Illinois, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Tennessee, and Wisconsin. The Great River Road passes many sites of cultural importance, including the Underground Railroad, and travels through many little towns and villages, as well as big cities.
- Natchez Trace Parkway is 444 miles long and passes through Alabama, Mississippi, and Tennessee. "Native Americans, Kaintuck boatmen, post riders, government officials, and soldiers all moved across this trail, creating a vital link between the Mississippi Territory and

the fledgling United States. Pass through forests, cypress swamps, and farmland to meander through the rock-studded hills of Tennessee, cotton fields in Alabama, and Mississippi's rural countryside" (FHWA, 2015b).

- Woodlands Trace is 43 miles long and passes through the wooded and lake areas of Kentucky and Tennessee. The Byway is known for its scenic landscape, educational signage, and outdoor recreation opportunities.

TDOT designates and manages the state's 15 State Scenic Byways, which are roads with statewide interest (TN Trails and Byways, 2015). See Section 14.1.1, Infrastructure, for a list of the State Scenic Byways.

14.1.9. Socioeconomics

14.1.9.1. Introduction

NEPA requires consideration of socioeconomics; specifically, Section 102(A) of NEPA requires federal agencies to "insure the integrated use of the natural and social science…in planning and in decision making" (42 U.S.C. § 4332(A)). Socioeconomics refers to a broad, social science-based approach to understanding a region's social and economic conditions. It typically includes population, demographic descriptors, economic activity indicators, housing characteristics, property values, and public revenues and expenditures.. When applicable, it includes qualitative factors such as community cohesion. Socioeconomics provides important context for analysis of FirstNet projects, and in addition, FirstNet projects may affect the socioeconomic conditions of a region.

The choice of socioeconomic topics and depth of their treatment depends on the relevance of potential topics to the types of federal actions under consideration. FirstNet's mission is to provide public safety broadband and interoperable emergency communications coverage throughout the nation. Relevant socioeconomic topics include population density and growth, economic activity, housing, property values, and state and local taxes. The financial arrangements for deployment and operation of the FirstNet network have socioeconomic implications. This socioeconomics section provides some additional, broad context, including data and discussion of state and local government revenue sources that FirstNet may affect.

Environmental justice is a related topic that specifically addresses the presence of minority populations (defined by race and Hispanic ethnicity) and low-income populations, in order to give special attention to potential impacts on those populations, per Executive Order (EO) 12898.[101] This PEIS addresses environmental justice in a separate section (Section 14.1.10). This PEIS also addresses the following topics, sometimes included within socioeconomics, in separate sections: land use, recreation, and airspace (Section 14.1.7), infrastructure (Section 14.1.1), and aesthetic considerations (Section 14.1.8).

Wherever possible, this section draws on nationwide datasets from federal sources such as the U.S. Census Bureau (Census Bureau) and U.S. Bureau of Labor Statistics (BLS). This ensures consistency of data and analyses across the states examined in this PEIS.[102] In all cases, this section uses the most recent data available for each geography at the time of writing. At the county, state, region, and United States levels, the data are typically for 2013 or 2014. For smaller geographic areas, this section uses data from the Census Bureau's American Community Survey (ACS). The ACS is the Census Bureau's flagship demographic estimates program for years other than the decennial census years. This PEIS uses the 2009-2013 ACS, which is based on surveys (population samples) taken across that five-year period; thus, it is not appropriate to attribute its data values to a specific year. It is a valuable source because it provides the most accurate and consistent socioeconomic data across the nation at the sub-county level (U.S. Census Bureau, 2016).

The remainder of this section addresses the following subjects: regulatory considerations specific to socioeconomics in the state, communities and populations, economic activity, housing, property values, and taxes.

[101] See https://www.epa.gov/laws-regulations/summary-executive-order-12898-federal-actions-address-environmental-justice.

[102] For U.S. Census Bureau sources, a URL (see references section) that begins with "http://factfinder.census.gov" indicates that the American FactFinder (AFF) interactive tool can be used to retrieve the original source data via the following procedure. If the reference's URL begins with "http://dataferrett.census.gov," significant socioeconomic expertise is required to navigate this interactive tool to the specific data. However, the data can usually be found using AFF. As of May 24, 2016, the AFF procedure is as follows: 1) Go to http://factfinder.census.gov. 2) Select "Advanced Search," then "Show Me All." 3) Select from "Topics" choices, select "Dataset," then select the dataset indicated in the reference; e.g., "American Community Survey, 2013 1-Year Estimates" or "2012 Census of Governments." Click "Close." Note: ACS is the abbreviation in the AFF for the American Community Survey. SF is the abbreviation used with the 2000 and 2010 "Summary Files." For references to the "2009-2013 5-Year Summary File," choose "2013 ACS 5-year estimates" in the AFF. 4) Click the "Geographies" box. Under "Select a geographic type," choose the appropriate type; e.g., "United States – 010" or "State – 040" or "..... County – 050" then select the desired area or areas of interest. Click "Add to Your Selections," then "Close." For Population Concentration data, select "Urban Area - 400" as the geographic type, then select 2010 under "Select a version" and then choose the desired area or areas. Alternatively, do not choose a version, and select "All Urban Areas within United States." Regional values cannot be viewed in the AFF because the regions for this PEIS do not match Census Bureau regions. All regional values were developed by downloading state data and using the most mathematically appropriate calculations (e.g., sums of state values, weighted averages, etc.) for the specific data. 5) In "Refine your search results," type the table number indicated in the reference; e.g., "DP04" or "LGF001." The dialogue box should auto-populate with the name of the table(s) to allow the user to select the table number/name. Click "Go." 6) In the resulting window, click the desired table under "Table, File, or Document Title" to view the results. If multiple geographies were selected, it is often easiest to view the data by clicking the "Download" button above the on-screen data table. Choose the desired comma-delimited format or presentation-ready format (includes a Microsoft Excel option). In some cases, the structure of the resulting file may be easier to work with under one format or another. Note that in most cases, the on-screen or downloaded data contains additional parameters besides those used in the FirstNet PEIS report table. Readers must locate the FirstNet PEIS-specific data within the Census Bureau tables. In many cases, the FirstNet PEIS report tables contain data from multiple Census Bureau tables and sometimes incorporate other sources.

14.1.9.2. Specific Regulatory Considerations

Research for this section did not identify any specific state, local, or tribal laws or regulations that are directly relevant to socioeconomics for this PEIS.

14.1.9.3. Communities and Populations

This section discusses the population and major communities of Tennessee (TN). It includes the following topics:

- Recent and projected statewide population growth;
- Current distribution of the population across the state; and
- Identification of the largest population concentrations in the state.

Statewide Population and Population Growth

Table 14.1.9-1 presents the 2014 population and population density of Tennessee in comparison to the South region[103] and the nation. The estimated population of Tennessee in 2014 was 6,549,352. The population density was 153.9 persons per square mile (sq. mi.), which is higher than the population density of both the region (114 persons/sq. mi.) and the nation (90 persons/sq. mi.). In 2014, Tennessee was the 17th largest state by population among the 50 states and the District of Columbia (D.C.), 34th largest by land area, and had the 21st greatest population density (U.S. Census Bureau, 2015a) (U.S. Census Bureau, 2015d).

Table 14.1.9-1: Land Area, Population, and Population Density of Tennessee

Geography	Land Area (sq. mi.)	Estimated Population 2014	Population Density 2010 (persons/sq. mi.)
Tennessee	41,235	6,549,352	153.9
South Region	914,471	104,109,977	114
United States	3,531,905	318,857,056	90

Sources: (U.S. Census Bureau, 2015a) (U.S. Census Bureau, 2015d)

Population growth is an important subject for this PEIS given FirstNet's mission. Table 14.1.9-2 presents the population growth trends of Tennessee from 2000 to 2014 in comparison to the South region and the nation. The state's annual growth rate decreased in the 2010 to 2014 period compared to 2000 to 2010, from 1.10 percent to 0.79 percent. The growth rate of Tennessee in the 2010 to 2014 period was lower than the growth rate of the region, at 1.14 percent, and nearly matched the nation's growth rate of 0.81 percent.

[103] The South region is comprised of the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, New Mexico, Oklahoma, South Carolina, Tennessee, and Texas. Throughout the socioeconomics section, figures for the South region represent the sum of the values for all states in the region, or an average for the region based on summing the component parameters. For instance, the population density of the South region is the sum of the populations of all its states, divided by the sum of the land areas of all its states.

Table 14.1.9-2: Recent Population Growth of Tennessee

Geography	Population			Numerical Population Change		Rate of Population Change (AARC)[a]	
	2000	2010	2014 (estimated)	2000 to 2010	2010 to 2014	2000 to 2010	2010 to 2014
Tennessee	5,689,283	6,346,105	6,549,352	656,822	203,247	1.10%	0.79%
South Region	86,516,862	99,487,696	104,109,977	12,970,834	4,622,281	1.41%	1.14%
United States	281,421,906	308,745,538	318,857,056	27,323,632	10,111,518	0.93%	0.81%

Sources: (U.S. Census Bureau, 2015a) (U.S. Census Bureau, 2015e)

[a] AARC = Average Annual Rate of Change (compound growth rate)

Demographers prepare future population projections using various population growth modeling methodologies. For this nationwide PEIS, it is important to use population projections that apply the same methodology across the nation. It is also useful to consider projections that use different methodologies, since no methodology is a perfect predictor of the future. The Census Bureau does not prepare population projections for the states. Therefore, Table 14.1.9-3 presents projections of the 2030 population from two sources that are national in scope and use different methodologies: the University of Virginia's Weldon Cooper Center for Public Service and ProximityOne, a private sector demographic and economic data and analysis service. The table provides figures for numerical change, percentage change, and annual growth rate based on averaging the projections from the two sources. The average projection indicates Tennessee's population will increase by nearly 900,000 people, or 13.7 percent, from 2014 to 2030. This reflects an average annual projected growth rate of 0.81 percent, which is very similar to the historical growth rate from 2010 to 2014 of 0.79 percent. The projected growth rate of the state is less than that of the region (0.97 percent) and is similar to the projected growth rate of the nation (0.80 percent).

Table 14.1.9-3: Projected Population Growth of Tennessee

Geography	Population 2014 (estimated)	Projected 2030 Population			Change Based on Average Projection		
		UVA Weldon Cooper Center Projection	Proximity One Projection	Average Projection	Numerical Change 2014 to 2030	Percent Change 2014 to 2030	Rate of Change (AARC)[a] 2014 to 2030
Tennessee	6,549,352	7,463,025	7,433,347	7,448,186	898,834	13.7%	0.81%
South Region	104,109,977	122,323,551	120,794,020	121,558,786	17,448,809	16.8%	0.97%
United States	318,857,056	360,978,449	363,686,916	362,332,683	43,475,627	13.6%	0.80%

Sources: (U.S. Census Bureau, 2015a) (ProximityOne, 2015) (UVA Weldon Cooper Center, 2015)
[a] AARC = Average Annual Rate of Change (compound growth rate)

Population Distribution and Communities

Figure 14.1.9-1 presents the distribution and relative density of the population of Tennessee. Each brown dot represents 500 people, and massing of dots indicates areas of higher population density – therefore, areas that are solid in color are particularly high in population density. The map uses ACS estimates based on samples taken from 2009 to 2013 (U.S. Census Bureau, 2015f).

This map also presents the 10 largest population concentrations in the state, outlined in purple. These population concentrations reflect contiguous, densely developed areas as defined by the Census Bureau based on the 2010 census (U.S. Census Bureau, 2012a; U.S. Census Bureau, 2015g). These population concentrations often include multiple incorporated areas as well as some unincorporated areas. Other groupings of brown dots on the map represent additional, but smaller, population concentrations. The map shows many smaller population centers. Dispersed dots indicate dispersed population across the less densely settled areas of the state.

Table 14.1.9-4 provides the populations of the 10 largest population concentrations in Tennessee, based on the 2010 census. It also shows the changes in population for these areas between the 2000 and 2010 censuses.[104] In 2010, the largest population concentration was the Nashville-Davidson area, which had nearly 1 million people. The state had two other areas with populations between 500,000 and 1 million (Knoxville and Memphis), four areas with populations between 100,000 and 200,000, and two areas with populations less than 100,000. The smallest of these 10 population concentrations was the Cleveland area, with a 2010 population of 66,777. The fastest growing area, by average annual rate of change from 2000 to 2010, was the Tennessee portion of the Clarksville area, with an annual growth rate of 3.25 percent. Four other areas had growth rates over 1.00 percent (the Cleveland, Johnson City, Knoxville, and Nashville-Davidson areas). The Murfreesboro area experienced a population decline during this period.

Table 14.1.9-4 also shows that the top 10 population concentrations in Tennessee accounted for 52.9 percent of the state's population in 2010. Further, population growth in the 10 areas from 2000 to 2010 amounted to 73.6 percent of the entire state's growth. These figures indicate that the populations within these 10 areas are growing at a somewhat faster rate than the population in the remainder of the state.

Table 14.1.9-4: Population of the 10 Largest Population Concentrations in Tennessee

Area	Population				Population Change 2000 to 2010	
	2000	2010	2009–2013	Rank in 2010	Numerical Change	Rate (AARC)[a]
Chattanooga (TN/GA) (TN Portion)	277,769	302,748	306,920	4	24,979	0.86%
Clarksville (TN/KY) (TN Portion)	100,494	138,309	140,791	5	37,815	3.25%
Cleveland	58,192	66,777	67,250	10	8,585	1.39%
Jackson	65,086	71,880	71,705	9	6,794	1.00%

[104] Census Bureau boundaries for these areas are not fixed. Area changes from 2000 to 2010 may include accretion of newly developed areas into the population concentration, Census Bureau classification of a subarea as no longer qualifying as a concentrated population due to population losses, and reclassification by the Census Bureau of a subarea into a different population concentration. Thus, population change from 2000 to 2010 reflects change within the constant area and change as the overall area boundary changes. Differences in boundaries in some cases introduce anomalies in comparing the 2000 and 2010 populations and in calculation of the growth rate presented in the table.

Area	Population				Population Change 2000 to 2010	
	2000	2010	2009–2013	Rank in 2010	Numerical Change	Rate (AARC)[a]
Johnson City	102,456	120,415	123,438	7	17,959	1.63%
Kingsport (TN/VA) (TN Portion)	93,989	102,428	100,212	8	8,439	0.86%
Knoxville	419,830	558,696	567,583	3	138,866	2.90%
Memphis (TN/MS/AR) (TN Portion)	868,248	891,481	897,778	2	23,233	0.26%
Murfreesboro	135,855	133,228	135,698	6	(2,627)	-0.20%
Nashville-Davidson	749,935	969,587	990,870	1	219,652	2.60%
Total for Top 10 Population Concentrations	**2,871,854**	**3,355,549**	**3,402,245**	**NA**	**483,695**	**1.57%**
Tennessee (statewide)	**5,689,283**	**6,346,105**	**6,402,387**	**NA**	**656,822**	**1.10%**
Top 10 Total as Percentage of State	**50.5%**	**52.9%**	**53.1%**	**NA**	**73.6%**	**NA**

Sources: (U.S. Census Bureau, 2012a; U.S. Census Bureau, 2015h; U.S. Census Bureau, 2015i)

[a] AARC = Average Annual Rate of Change (compound growth rate)

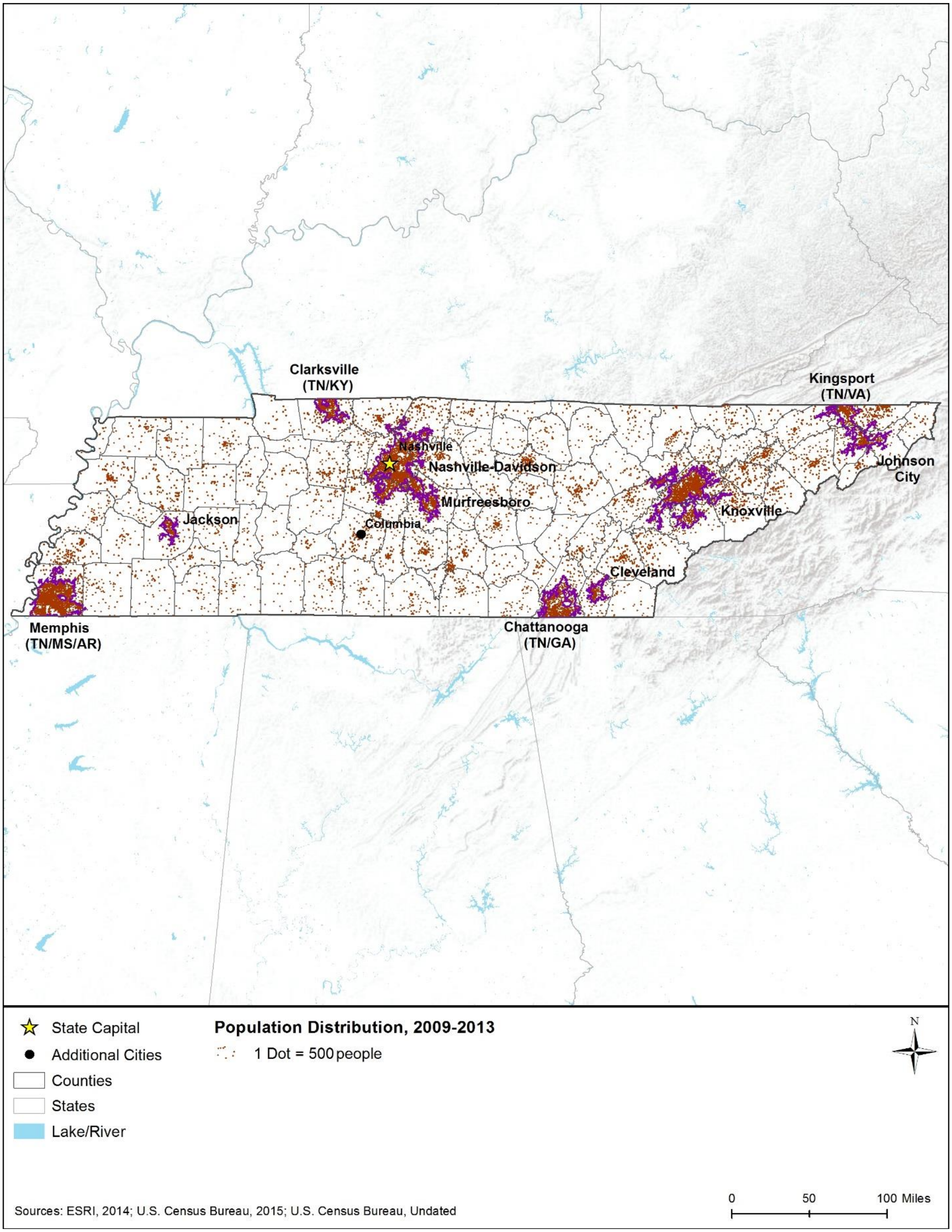


Figure 14.1.9-1: Population Distribution in Tennessee, 2009–2013

14.1.9.4. Economic Activity, Housing, Property Values, and Government Revenues

This section addresses other socioeconomic topics that are potentially relevant to FirstNet. These topics include:

- Economic activity;
- Housing;
- Property values; and
- Government revenues.

Social institutions – educational, family, political, public service, military, and religious – are present throughout the state. The institutions most relevant to FirstNet projects are public services such as medical and emergency medical services and facilities. This PEIS addresses public services in Section 14.1.1, Infrastructure. Project-level NEPA analyses may need to examine other institutions, depending on specific locations and specific types of actions.

Economic Activity

Table 14.1.9-5 compares several economic indicators for Tennessee to the South region and the nation. The table presents two indicators of income[105] – per capita and median household – as income is a good measure of general economic health of a region.

Per capita income is total income divided by the total population. As a mathematical average, the very high incomes of a relatively small number of people tend to bias per capita income figures upwards. Nonetheless, per capita income is useful as an indicator of the relative income level across two or more areas. As shown in Table 14.1.9-5, the per capita income in Tennessee in 2013 ($24,678) was $333 lower than that of the region ($25,011), and $3,506 lower than that of the nation ($28,184).

Household income is a useful measure, and often used instead of family income, because in modern society there are many single-person households and households composed of non-related individuals. Median household income (MHI) is the income at which half of all households have higher income, and half have lower income. Table 14.1.9-5 shows that in 2013, the MHI in Tennessee ($44,268) was $2,294 lower than that of the region ($46,562), and $7,982 lower than that of the nation ($52,250).

[105] The Census Bureau defines income as follows: "'Total income' is the sum of the amounts reported separately for wage or salary income; net self-employment income; interest, dividends, or net rental or royalty income or income from estates and trusts; Social Security or Railroad Retirement income; Supplemental Security Income (SSI); public assistance or welfare payments; retirement, survivor, or disability pensions; and all other income. Receipts from the following sources are not included as income: capital gains, money received from the sale of property (unless the recipient was engaged in the business of selling such property); the value of income "in kind" from food stamps, public housing subsidies, medical care, employer contributions for individuals, etc.; withdrawal of bank deposits; money borrowed; tax refunds; exchange of money between relatives living in the same household; gifts and lump-sum inheritances, insurance payments, and other types of lump-sum receipts." (NASAO, 2015)

Employment status is a key socioeconomic parameter because employment is essential to the income of a large portion of the adult population. The federal government calculates the unemployment rate as the number of unemployed individuals who are looking for work divided by the total number of individuals in the labor force. Table 14.1.9-5 compares the unemployment rate in Tennessee to the South region and the nation. In 2014, Tennessee's statewide unemployment rate of 6.7 percent was higher than the rate for the region (6.1 percent) and the nation (6.2 percent).[106]

Table 14.1.9-5: Selected Economic Indicators for Tennessee

Geography	Per Capita Income 2013	Median Household Income 2013	Average Annual Unemployment Rate 2014
Tennessee	$24,678	$44,268	6.7%
South Region	$25,011	$46,562	6.1%
United States	$28,184	$52,250	6.2%

Sources: (BLS, 2015b; U.S. Census Bureau, 2015j; U.S. Census Bureau, 2015k; U.S. Census Bureau, 2015l)

Figure 14.1.9-2 and Figure 14.1.9-3 show how MHI in 2013 (U.S. Census Bureau, 2015j) and unemployment in 2014 (BLS, 2015b) varied by county across the state. These maps also incorporate the same population concentration data as Figure 14.1.9-1 (U.S. Census Bureau, 2012a; U.S. Census Bureau, 2015g). Following these two maps, Table 14.1.9-6 presents MHI and unemployment for the 10 largest population concentrations in the state. The table reflects survey data taken from 2009 to 2013. Thus, its figures are not directly comparable to those on the maps. Nonetheless, both the maps and the table help portray differences in income and unemployment across Tennessee.

Figure 14.1.9-2 shows that, in general, Tennessee had very few counties with MHI levels above the national median. These counties were located around Nashville, Murfreesboro, Memphis, and Knoxville. The remainder of the state had MHI levels below the national average. MHI levels were very low (less than $37,092) in more than a third of Tennessee counties. Table 14.1.9-6 shows that MHI in six of the 10 areas was above the state average. MHI was highest in the Murfreesboro and Nashville-Davidson areas. It was lowest in the Cleveland, Jackson, and Johnson City areas, which are the first, second, and fourth smallest of the areas shown in the table.

Figure 14.1.9-3 presents variations in the 2014 unemployment rate across the state, by county. It shows that counties with unemployment rates below the national average (that is, better employment performance) were located around Nashville, Murfreesboro, Columbia, Knoxville, and Cleveland, and in the south-central part of Tennessee (north of Huntsville, Alabama). Counties in the remainder of the state had unemployment rates above the national average, particularly in the western third of the state. When comparing unemployment in the population concentrations to the state average (Table 14.1.9-6), the Clarksville (Tennessee portion),

[106] The timeframe for unemployment rates can change quarterly.

Cleveland, Jackson, and Memphis (Tennessee portion) areas had 2009–2013 unemployment rates that were higher than the state average.

Detailed employment data provide useful insights into the nature of a local, state, or national economy. Table 14.1.9-7 provides figures on employment percentages by type of worker and by industry based on surveys conducted in 2013 by the Census Bureau. By class of worker (type of worker: private industry, government, self-employed, etc.), the percentage of private wage and salary workers was somewhat lower in Tennessee than in the South region and the nation. The percentage of government workers in the state was slightly lower than in the region and similar to the nation. Self-employed workers were a higher percentage in the state compared to the region and nation.

By industry, Tennessee has a mixed economic base and some notable figures in the table are as follows. Tennessee in 2013 had a similar percentage (within two percentage points) of workers in nearly all industries compared to the region and nation. It had a considerably higher percentage of persons working in "manufacturing" than did the region or the nation.

Table 14.1.9-6: Selected Economic Indicators for the 10 Largest Population Concentrations in Tennessee, 2009–2013

Area	Median Household Income	Average Annual Unemployment Rate
Chattanooga (TN/GA) (TN Portion)	$45,729	9.5%
Clarksville (TN/KY) (TN Portion)	$48,171	11.1%
Cleveland	$38,755	13.0%
Jackson	$38,262	14.1%
Johnson City	$36,982	7.6%
Kingsport (TN/VA) (TN Portion)	$41,097	9.5%
Knoxville	$47,556	7.7%
Memphis (TN/MS/AR) (TN Portion)	$45,283	12.1%
Murfreesboro	$53,105	9.2%
Nashville-Davidson	$53,056	8.1%
Tennessee (statewide)	$44,298	10.1%

Source: (U.S. Census Bureau, 2015m)

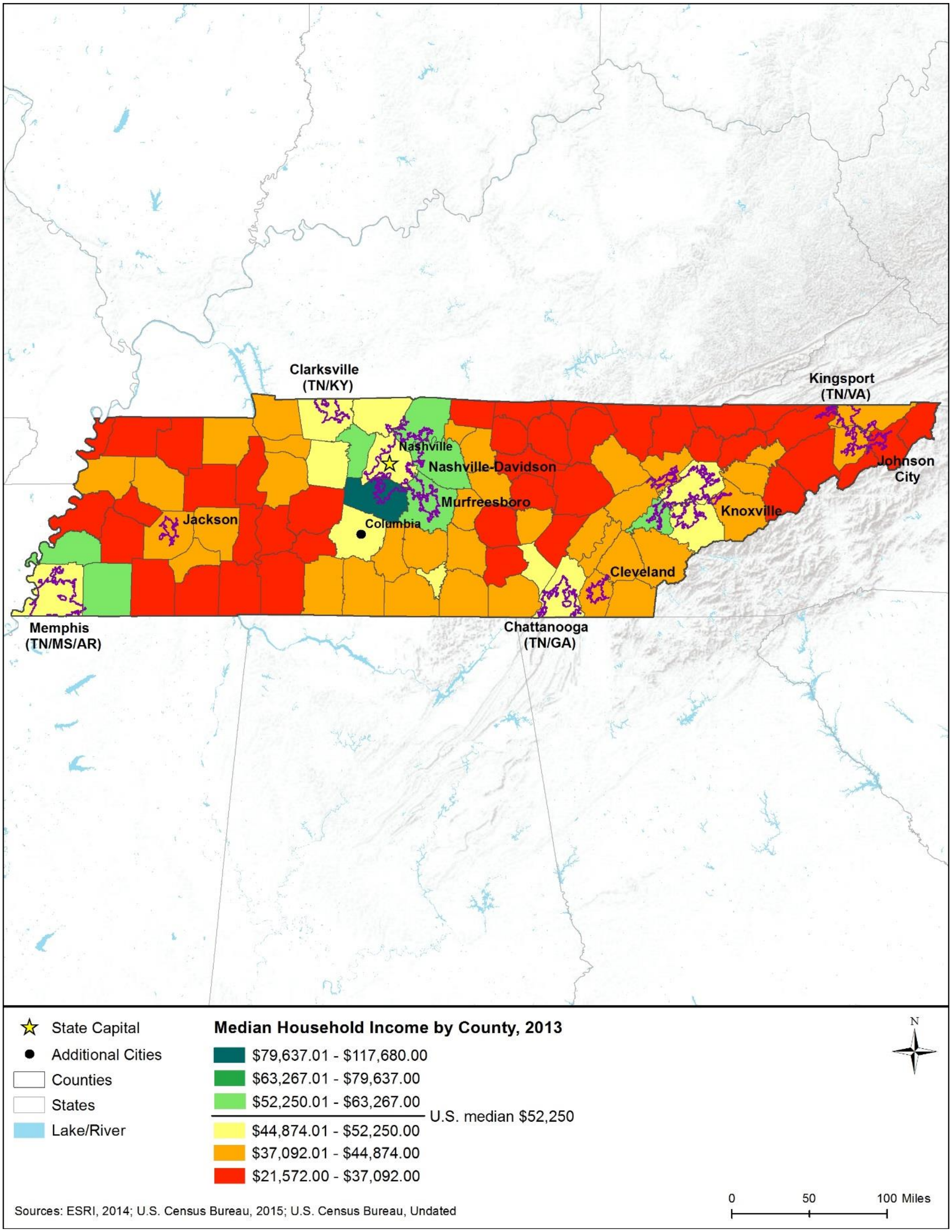


Figure 14.1.9-2: Median Household Income in Tennessee, by County, 2013

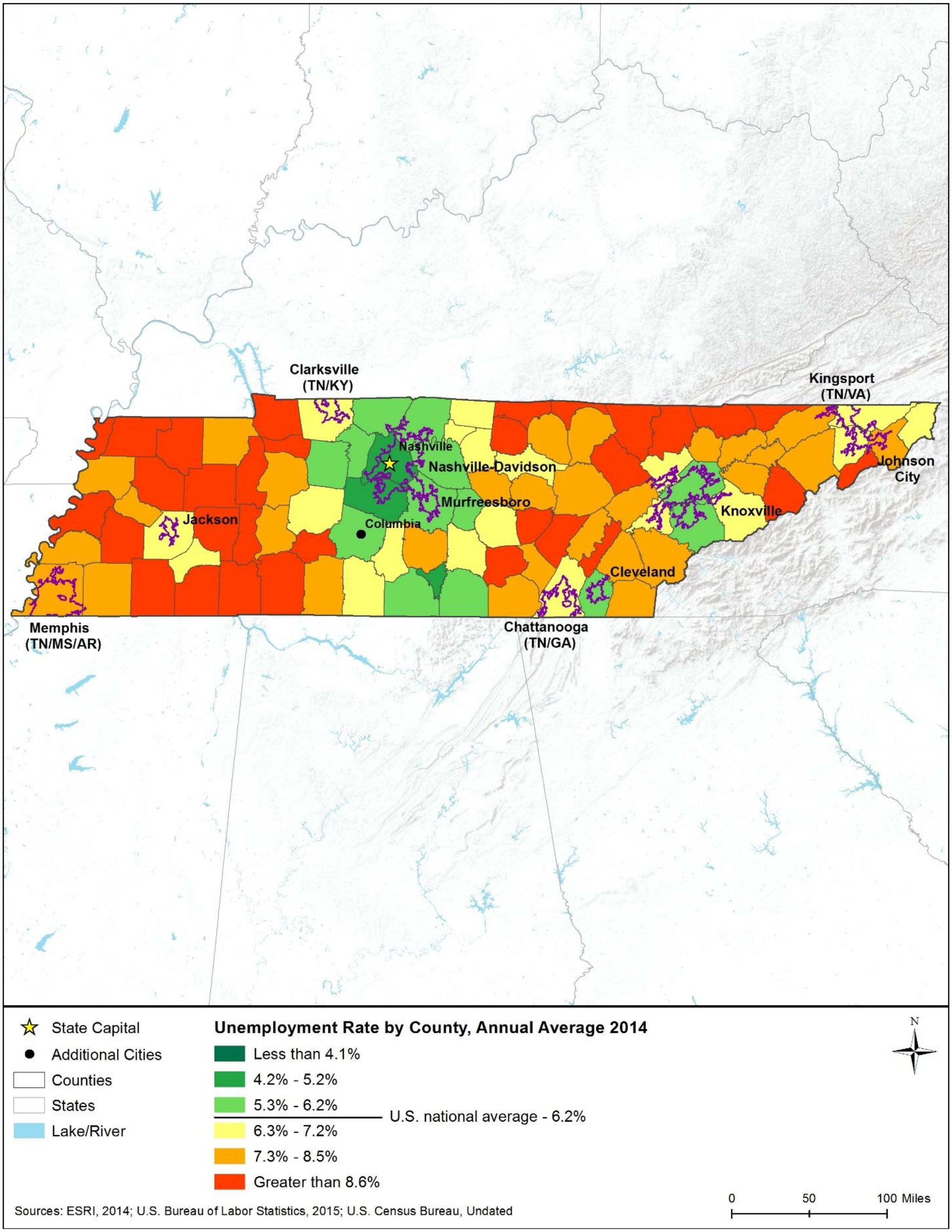


Figure 14.1.9-3: Unemployment Rates in Tennessee, by County, 2014

Table 14.1.9-7: Employment by Class of Worker and by Industry, 2013

Class of Worker and Industry	Tennessee	South Region	United States
Civilian Employed Population 16 Years and Over	2,881,431	45,145,155	145,128,676
Percentage by Class of Worker			
Private wage and salary workers	78.8%	79.4%	79.7%
Government workers	14.2%	14.5%	14.1%
Self-employed in own not incorporated business workers	6.8%	5.9%	6.0%
Unpaid family workers	0.2%	0.2%	0.2%
Percentage by Industry			
Agriculture, forestry, fishing and hunting, and mining	0.9%	2.4%	2.0%
Construction	6.4%	6.9%	6.2%
Manufacturing	12.9%	9.9%	10.5%
Wholesale trade	2.7%	2.8%	2.7%
Retail trade	12.2%	12.1%	11.6%
Transportation and warehousing, and utilities	6.2%	5.2%	4.9%
Information	1.9%	1.9%	2.1%
Finance and insurance, and real estate and rental and leasing	5.5%	6.3%	6.6%
Professional, scientific, management, administrative, and waste management services	9.7%	10.5%	11.1%
Educational services, and health care and social assistance	22.5%	22.0%	23.0%
Arts, entertainment, and recreation, and accommodation and food services	9.2%	9.9%	9.7%
Other services, except public administration	5.1%	5.2%	5.0%
Public administration	4.7%	4.8%	4.7%

Source: (U.S. Census Bureau, 2015n)

Table 14.1.9-8 presents employment shares for selected industries for the 10 largest population concentrations in the state. The table reflects survey data taken by the Census Bureau from 2009 to 2013. Thus, its figures for the state are slightly different from those in Table 14.1.9-7 for 2013.

Table 14.1.9-8: Employment by Selected Industries for the 10 Largest Population Concentrations in Tennessee, 2009–2013

Area	Construction	Transportation and Warehousing, and Utilities	Information	Professional, Scientific, Management, Administrative and Waste Management Services
Chattanooga (TN/GA) (TN Portion)	5.9%	6.7%	1.9%	9.8%
Clarksville (TN/KY) (TN Portion)	5.0%	4.3%	1.9%	8.6%
Cleveland	5.1%	5.1%	1.7%	6.9%
Jackson	4.8%	3.7%	1.4%	7.3%

Area	Construction	Transportation and Warehousing, and Utilities	Information	Professional, Scientific, Management, Administrative and Waste Management Services
Johnson City	5.5%	3.4%	1.9%	7.5%
Kingsport (TN/VA) (TN Portion)	6.8%	3.9%	2.2%	6.8%
Knoxville	6.3%	4.5%	2.3%	12.6%
Memphis (TN/MS/AR) (TN Portion)	4.7%	11.3%	1.6%	10.3%
Murfreesboro	4.7%	4.5%	3.5%	7.8%
Nashville-Davidson	5.6%	4.5%	3.2%	12.0%
Tennessee (statewide)	6.5%	6.2%	2.0%	9.2%

Source: (U.S. Census Bureau, 2015m)

Housing

The housing stock is an important socioeconomic component of communities. The type, availability, and cost of housing in an area reflect economic conditions and affect quality of life. Table 14.1.9-9 compares Tennessee to the South region and nation on several common housing indicators.

As shown in Table 14.1.9-9, in 2013, Tennessee had a higher percentage of housing units that were occupied (87.7 percent) than the region (85.2 percent) or nation (87.6 percent). Of the occupied units, Tennessee had a higher percentage of owner-occupied units (66.4 percent) than the region (64.6 percent) or nation (63.5 percent). Tennessee also had a considerably higher percentage of detached single-unit housing (also known as single-family homes) in 2013 (68.9 percent) compared to the region (63.8 percent) and nation (61.5 percent). The homeowner vacancy rate in Tennessee (2.1 percent) was similar to the rates for the region (2.2 percent) and the nation (1.9 percent). This rate reflects "vacant units that are 'for sale only'" (U.S. Census Bureau, 2015o). The vacancy rate among rental units in Tennessee (7.9 percent) was lower than in the region (8.5 percent) and higher than in the nation (6.5 percent).

Table 14.1.9-9: Selected Housing Indicators for Tennessee, 2013

Geography	Total Housing Units	Housing Occupancy & Tenure				Units in Structure
		Occupied Housing	Owner-Occupied	Homeowner Vacancy Rate	Rental Vacancy Rate	1-Unit, Detached
Tennessee	2,840,998	87.7%	66.4%	2.1%	7.9%	68.9%
South Region	44,126,724	85.2%	64.6%	2.2%	8.5%	63.8%
United States	132,808,137	87.6%	63.5%	1.9%	6.5%	61.5%

Source: (U.S. Census Bureau, 2015p)

Table 14.1.9-10 provides housing indicators for the largest population concentrations in the state by survey data taken from 2009 to 2013. Thus, its figures are not directly comparable to the more recent data in the previous table. However, it does present variation in these indicators for population concentrations across the state and compared to the state average for the 2009 to 2013 period.

Table 14.1.9-10: Selected Housing Indicators for the 10 Largest Population Concentrations in Tennessee, 2009–2013

Area	Total Housing Units	Housing Occupancy & Tenure				Units in Structure
		Occupied Housing	Owner-Occupied	Homeowner Vacancy Rate	Rental Vacancy Rate	1-Unit, Detached
Chattanooga (TN/GA) (TN Portion)	137,222	89.2%	62.8%	2.5%	8.0%	67.4%
Clarksville (TN/KY) (TN Portion)	57,960	87.7%	56.2%	4.7%	10.9%	69.1%
Cleveland	28,194	89.2%	58.7%	3.5%	8.0%	67.4%
Jackson	31,074	83.4%	60.7%	4.0%	14.6%	70.5%
Johnson City	57,404	90.1%	61.5%	2.2%	6.3%	61.5%
Kingsport (TN/VA) (TN Portion)	47,748	90.7%	71.0%	3.0%	6.7%	71.2%
Knoxville	254,315	91.9%	65.2%	1.9%	5.7%	67.0%
Memphis (TN/MS/AR) (TN Portion)	386,492	85.8%	58.3%	2.7%	12.9%	66.1%
Murfreesboro	55,046	92.9%	58.9%	2.1%	8.2%	62.7%
Nashville-Davidson	418,858	91.4%	61.4%	2.3%	7.4%	60.3%
Tennessee (statewide)	2,821,797	87.7%	67.8%	2.3%	8.9%	68.8%

Source: (U.S. Census Bureau, 2015q)

Property Values

Property values have important relationships to both the wealth and affordability of communities.

Table 14.1.9-11 provides indicators of residential property values for Tennessee and compares these values to values for the South region and nation. The figures on median value of owner-occupied units are from the Census Bureau's ACS, based on owner estimates of how much their property (housing unit and land) would sell for if it were for sale (U.S. Census Bureau, 2015o).

The table shows that the median value of owner-occupied units in Tennessee in 2013 ($140,300) was somewhat higher than the corresponding value for the South region ($137,752) and lower than that of the nation ($173,900).

Table 14.1.9-11: Residential Property Values in Tennessee, 2013

Geography	Median Value of Owner-Occupied Units
Tennessee	$140,300
South Region	$137,752
United States	$173,900

Source: (U.S. Census Bureau, 2015p)

Table 14.1.9-12 presents residential property values for the largest population concentrations in the state. The table reflects survey data taken from 2009 to 2013. Thus, its figures are not directly comparable to the more recent data in the previous table. However, it does show variation in property values for population concentrations across the state and compared to the state average for the 2009 to 2013 period. The areas with median values that were higher than the state median value ($139,200) were the Chattanooga (Tennessee portion), Knoxville, Murfreesboro, and Nashville-Davidson areas, with median values ranging from $152,100 to $181,700. All other population concentrations had property values below the state value. The lowest value was in the Jackson area ($113,400), which also had the second lowest median household income (Table 14.1.9-6).

Table 14.1.9-12: Residential Property Values for the 10 Largest Population Concentrations in Tennessee, 2009–2013

Area	Median Value of Owner-Occupied Units
Chattanooga (TN/GA) (TN Portion)	$152,100
Clarksville (TN/KY) (TN Portion)	$138,600
Cleveland	$130,100
Jackson	$113,400
Johnson City	$132,100
Kingsport (TN/VA) (TN Portion)	$128,300
Knoxville	$157,900
Memphis (TN/MS/AR) (TN Portion)	$128,300
Murfreesboro	$169,800
Nashville-Davidson	$181,700
Tennessee (statewide)	$139,200

Source: (U.S. Census Bureau, 2015q)

Government Revenues

State and local governments obtain revenues from many sources. FirstNet projects may affect flows of revenue sources between different levels of government due to program financing and intergovernmental agreements for system development and operation. Public utility taxes are a subcategory of selective sales taxes that includes taxes on providers of land and mobile telephone, telegraph, cable, and internet services (U.S. Census Bureau, 2006). These service providers may obtain new taxable revenues from operation of components of the public safety broadband network. These revenue streams are typically highly localized and therefore are best considered in the deployment phase of FirstNet.

Table 14.1.9-13 presents total and selected state and local government revenue sources as reported by the Census Bureau's 2012 Census of Governments. It provides both total dollar figures (in millions of dollars) and figures per capita (in dollars), based on total population for each geography. The per capita figures are particularly useful in comparing the importance of certain revenue sources in the state relative to other states in the region and the nation. State and local governments may obtain some additional revenues related to telecommunications infrastructure. General and selective sales taxes may change, reflecting expenditures during system development and maintenance.

Table 14.1.9-13 shows that the Tennessee state government received less total revenue in 2012 on a per capita basis than its counterpart governments in the region and nation. Tennessee local governments received more total revenue than their counterparts in the region and less total revenue than counterparts in the nation. Additionally, in comparison to counterpart governments in the region and nation, per capita levels of intergovernmental revenues[107] were higher for Tennessee's state government, but lower for its local governments. For most types of tax revenue listed, Tennessee state and local governments obtained lower revenues per capita than state and local governments in the region and nation. (Notably, the state government reported no revenue from property taxes and minimal revenue from public utility taxes, and Tennessee local governments reported no revenue from individual and corporate income taxes.) The only exceptions to this pattern were for general sales taxes and corporate income taxes. Both state and local governments in Tennessee obtained somewhat higher revenue per capita from general sales taxes than did counterparts in the region and nation. Corporate income tax revenues, on a per capita basis, were higher for the Tennessee state government, than for state governments in the region and nation.

[107] Intergovernmental revenues are those revenues received by one level of government from another level of government, such as shared taxes, grants, or loans and advances (U.S. Census Bureau, 2006).

Table 14.1.9-13: State and Local Government Revenues, Selected Sources, 2012

Type of Revenue		Tennessee		Region		United States	
		State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount	State Govt. Amount	Local Govt. Amount
Total Revenue	($M)	$30,803	$31,209	$524,374	$449,683	$1,907,027	$1,615,194
	Per capita	$4,771	$4,834	$5,148	$4,414	$6,075	$5,145
Intergovernmental from Federal	($M)	$11,199	$908	$160,706	$18,171	$514,139	$70,360
	Per capita	$1,735	$141	$1,578	$178	$1,638	$224
Intergovernmental from State	($M)	$0	$6,745	$0	$115,088	$0	$469,147
	Per capita	$0	$1,045	$0	$1,130	$0	$1,495
Intergovernmental from Local	($M)	$70	$0	$2,815	$0	$19,518	$0
	Per capita	$11	$0	$28	$0	$62	$0
Property Taxes	($M)	$0	$5,134	$2,073	$109,687	$13,111	$432,989
	Per capita	$0	$795	$20	$1,077	$42	$1,379
General Sales Taxes	($M)	$6,512	$2,005	$82,651	$25,836	$245,446	$69,350
	Per capita	$1,009	$311	$811	$254	$782	$221
Selective Sales Taxes	($M)	$2,450	$450	$41,447	$9,394	$133,098	$28,553
	Per capita	$379	$70	$407	$92	$424	$91
Public Utilities Taxes	($M)	$9	$89	$5,101	$4,745	$14,564	$14,105
	Per capita	$1	$14	$50	$47	$46	$45
Individual Income Taxes	($M)	$182	$0	$38,637	$1,226	$280,693	$26,642
	Per capita	$28	$0	$379	$12	$894	$85
Corporate Income Taxes	($M)	$1,226	$0	$8,099	$114	$41,821	$7,210
	Per capita	$190	$0	$80	$1	$133	$23

Sources: (U.S. Census Bureau, 2015r; U.S. Census Bureau, 2015s)

Note: This table does not include all sources of government revenue. Summation of the specific source rows does not equal total revenue.

14.1.10. Environmental Justice

14.1.10.1. Introduction

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, issued in 1994, sets out principles of environmental justice and requirements that federal agencies should follow to comply with the EO (see Section 1.8, Overview of Relevant Federal Laws and Executive Orders). The fundamental principle of environmental justice is, "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (USEPA, 2016d). Under the EO, each federal agency must "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (Executive Office of the President, 1994). In response to the EO, the

Department of Commerce developed an Environmental Justice Strategy in 1995, and published an updated strategy in 2013 (DOC, 2013).

In 1997, the Council on Environmental Quality (CEQ) issued *Environmental Justice: Guidance under the National Environmental Policy Act (NEPA)* to assist federal agencies in meeting the requirements of the EO (CEQ, 1997). Additionally, the USEPA's Office of Environmental Justice (USEPA, 2015e) offers guidance on Environmental Justice issues and provides an "environmental justice screening and mapping tool," EJSCREEN (USEPA, 2015f).

The CEQ guidance provides several important definitions and clarifications that this PEIS utilizes:

- Minority populations consist of "Individual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic" (CEQ, 1997).
- Low-income populations consist of individuals living in poverty, as defined by the U.S. Census Bureau (Census Bureau).
- Environmental effects include social and economic effects. Specifically, "Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment" (CEQ, 1997).

In 2014, the USEPA issued the Policy on Environmental Justice for Working with Federally Recognized Tribes and Indigenous Peoples, which establishes principles to ensure that achieving environmental justice is part of the USEPA's work with federally recognized tribes and Indigenous Peoples in all areas of the U.S. and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands, and others living in Indian country. The policy, which is based on Executive Order 12898 as well as USEPA strategic plan and policy documents, contains 17 principles pertaining to the policy's four focus areas. These four focus areas are:

- Direct implementation of federal environmental programs in Indian country, and throughout the U.S.;
- Work with federally recognized tribes/tribal governments on environmental justice;
- Work with Indigenous Peoples (state recognized tribes, tribal members, etc.) on environmental justice; and
- Coordinate and collaborate with federal agencies and others on environmental justice issues of tribes, Indigenous Peoples, and others living in Indian country.

The policy includes accountability for the implementation of the policy, a definitions section, and an appendix that contains a list of implementation tools available (USEPA, 2014a).

14.1.10.2. Specific Regulatory Considerations

TDEC defines environmental justice as:

- "protection of the health of the people of Tennessee and its environment,
- equity in the administration of the state's environmental programs, and
- provision of adequate opportunities for meaningful involvement of all people with respect to the development, implementation and enforcement of environmental laws, regulations and policies." (TDEC, 2015n)

TDEC also emphasizes its commitment to "…ensuring all management staff, contractors, and service beneficiaries are aware of the provisions of and responsibilities associated with Title VI of the Civil Rights Act of 1964" (TDEC, 2015n). TDEC reviews and comments on NEPA documents (TDEC, 2015n), including environmental justice aspects. Costin Shamble, the TDEC Title VI/Environmental Justice Coordinator, stated that, "…while NEPA documents… do address environmental justice, TDEC reviews draft NEPA documents as a whole and does not specifically focus on one element, such as environmental justice" (Shamble, 2015). Federal laws relevant to environmental justice are described in Section 1.8, Overview of Relevant Federal Laws and Executive Orders.

14.1.10.3. Environmental Setting: Minority and Low-Income Populations

Table 14.1.10-1 presents 2013 data on the composition of Tennessee's population by race and by Hispanic origin. The state's population has a percentage of individuals who identify as Black/African American (17.0 percent) that is lower than that of the South region (18.4 percent) and higher than that of the nation (12.6 percent). For all other minority racial groups, Tennessee's population has percentages that are lower than the corresponding percentages of both the South region and the nation. The state has a larger percentage of persons identifying as White (77.9 percent) than the South region (72.3 percent) or the nation (73.7 percent).

The percentage of the population in Tennessee that identifies as Hispanic (4.8 percent) is considerably smaller than in the South region (18.8 percent) and the nation (17.1 percent). Hispanic origin is a different category than race; persons of any race may identify as also being of Hispanic origin.

The category All Minorities consists of all persons who consider themselves Hispanic or of any race other than White. Tennessee's All Minorities population percentage (25.2 percent) is considerably lower than that of the South region (42.3 percent) and the nation (37.6 percent).

Table 14.1.10-2 presents the percentage of the population living in poverty in 2013, for the state, region, and nation. The figure for Tennessee (17.8 percent) is slightly lower than that for the South region (18.2 percent) and higher than the figure for the nation (15.8 percent).

Table 14.1.10-1: Population by Race and Hispanic Status, 2013

Geography	Total Population (estimated)	Race							Hispanic	All Minorities[a]
		White	Black/ African Am	Am. Indian/ Alaska Native	Asian	Native Hawaiian /Pacific Islander	Some Other Race	Two or More Races		
Tennessee	6,549,352	77.9%	17.0%	0.2%	1.5%	0.0%	1.4%	1.9%	4.8%	25.2%
South Region	102,853,019	72.3%	18.4%	0.9%	2.6%	0.1%	3.3%	2.4%	18.8%	42.3%
United States	316,128,839	73.7%	12.6%	0.8%	5.1%	0.2%	4.7%	3.0%	17.1%	37.6%

Source: (U.S. Census Bureau, 2015t)

[a] "All Minorities" is defined as all persons who consider themselves Hispanic or of any race other than White. Because some Hispanics identify as both Hispanic and of a non-White race, "All Minorities" is less than the sum of Hispanics and non-White races.

Table 14.1.10-2: Percentage of Population (Individuals) in Poverty, 2013

Geography	Percent Below Poverty Level
Tennessee	17.8%
South Region	18.2%
United States	15.8%

Source: (U.S. Census Bureau, 2015u)

14.1.10.4. Environmental Justice Screening Results

Analysis of environmental justice in a NEPA document typically begins by identifying potential environmental justice populations in the project area. Appendix D, Environmental Justice Methodology, presents the methodology used in this PEIS to screen each state for the presence of potential environmental justice populations. The methodology builds on CEQ guidance and best practices used for environmental justice analysis. It uses data at the census-block group level; block groups are the smallest geographic units for which regularly updated socioeconomic data are readily available at the time of writing. (See footnote 104 in Socioeconomics for futher information on how data was calculated.)

Figure 14.1.10-1 visually portrays the results of the environmental justice population screening analysis for Tennessee. The analysis used block group data from the Census Bureau's American Community Survey 2009-2013 5-Year Estimates (U.S. Census Bureau, 2015f; U.S. Census Bureau, 2015v; U.S. Census Bureau, 2015w; U.S. Census Bureau, 2015x) and Census Bureau urban classification data (U.S. Census Bureau, 2012a; U.S. Census Bureau, 2015g).

Figure 14.1.10-1 shows that Tennessee has a high proportion (approximately 50 percent of block groups) of high potential areas for environmental justice populations. The distribution of these high potential areas is fairly even across the state, but high potential areas are slightly less prevalent in the central portion of the state surrounding the Nashville area. High potential areas occur both within and outside of the 10 largest population concentrations. The distribution of areas with moderate potential for environmental justice populations is also fairly even across the state.

It is important to understand how the data behind Figure 14.1.10-1 affect the visual impact of this map. Block groups have similar populations (hundreds to a few thousand individuals) regardless of population density. In sparsely populated areas, a single block group may cover tens or even hundreds of square miles, while in densely populated areas, block groups each cover much less than a single square mile. Thus, while large portions of the state outside the areas defined as large population concentrations show moderate or high potential for environmental justice populations, these low density areas reflect modest numbers of minority or low-income individuals compared to the potential environmental justice populations within densely populated areas. The overall effect of this relative density phenomenon is that the map visually shows large areas of the state having environmental justice potential, but this over-represents the presence of environmental justice populations.

It is also very important to note that Figure 14.1.10-1 does not definitively identify environmental justice populations. It indicates degrees of likelihood of the presence of populations of potential concern from an environmental justice perspective. Two caveats are important. First, environmental justice communities are often highly localized. Block group data may under- or over-represent the presence of these localized communities. For instance, in the large block groups in sparsely populated regions of the state, the data may represent dispersed individuals of minority or low-income status rather than discrete, place-based communities. Second, the definition of the moderate potential category draws a wide net for potential environmental justice populations. As discussed in Appendix D, the definition includes some commonly used thresholds for environmental justice screening that tend to over-identify environmental justice potential. Before FirstNet deploys projects, additional site-specific analyses to identify specific, localized environmental justice populations may be warranted. Such analyses could tier-off the methodology of this PEIS.

This map also does not indicate whether FirstNet projects would have actual impacts on environmental justice populations. An environmental justice effect on minority or low-income populations only occurs if the effect is harmful, significant (according to significance criteria), and "appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group" (CEQ, 1997). The Environmental Consequences section (Section 14.2) addresses the potential for disproportionately high and adverse environmental or human health impacts on environmental justice populations.

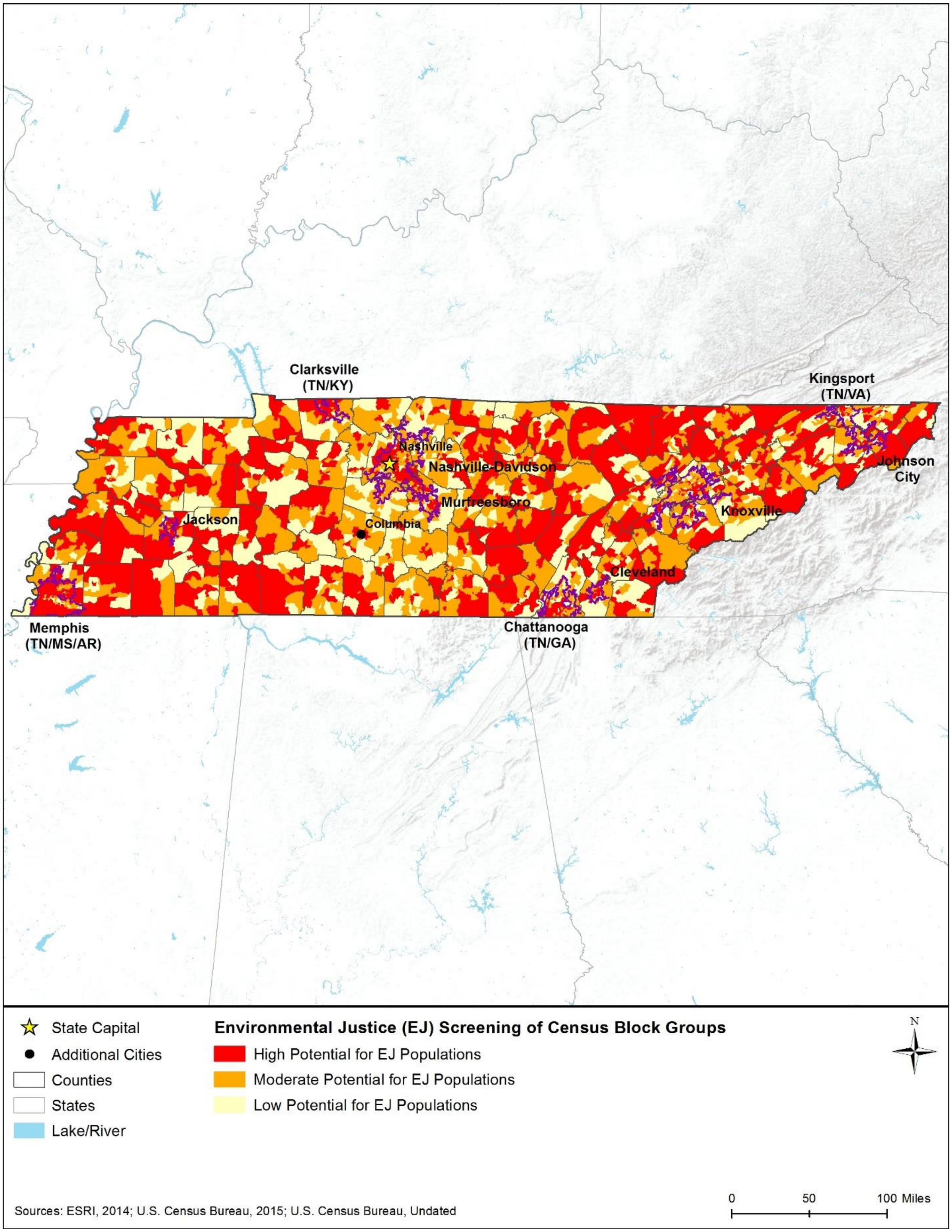


Figure 14.1.10-1: Potential for Environmental Justice Populations in Tennessee, 2009–2013

14.1.11. Cultural Resources

14.1.11.1. Introduction

For the purposes of this PEIS, Cultural Resources are defined as:

> Natural or manmade structures, objects, features, locations with scientific, historic, and cultural value, including those with traditional religious or cultural importance and any prehistoric or historic district, site, or building included in, or eligible for inclusion in, the NRHP.

This definition is consistent with the how cultural resources are defined in:

- The statutory language and implementing regulations for Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), formerly 16 U.S.C. 470a(d)(6)(A) (now 54 U.S.C. 306131(b)) and 36 CFR 800.16(l)(1);
- The statutory language and Implementing regulations for the Archaeological Resources Protection Act of 1979 (ARPA), 16 U.S.C. 470cc(c) and 43 CFR 7.3(a);
- The statutory language and implementing regulations for the Native American Graves Protection and Repatriation Act, 25 U.S.C. 3001(3)(D) and 43 CFR 10.2(d);
- The NPS program support of public and private efforts to identify, evaluate, and protect America's historic and archeological resources (NPS, 2015s); and
- Advisory Council on Historic Preservation's (ACHP) guidance for protection and preservation of sites and artifacts with traditional religious and cultural importance to American Indian tribes or Native Hawaiian organizations (ACHP, 2004).

14.1.11.2. Specific Regulatory Considerations

The Proposed Action must meet the requirements of NEPA and other applicable laws and regulations. Applicable federal laws and regulations that apply to Cultural Resources include the NHPA (detailed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders), the American Indian Religious Freedom Act (AIRFA), ARPA, and NAGPRA. Appendix C, Environmental Laws and Regulations, summarizes these pertinent federal laws.

Tennessee does not have state laws and regulations that are similar to those for NHPA or NEPA. While federal agencies may take into account compatible state laws and regulations, their actions that are subject to federal environmental review under NEPA and NHPA are not subject to compliance with such state laws and regulations. Table 14.1.11-1 presents the state law relates to cultural resources.

Table 14.1.11-1: Relevant Tennessee Cultural Resources Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
State Historian and Historical Commission, T.C.A. 4-11-102	Tennessee Historical Commission	Establishes the Tennessee Historical Commission as the State Historic Preservation Office (SHPO) for Tennessee.
Tennessee State Burial Site Statutes, T.C.A. 39-17-311, 39-17-312, and 46-4-101-104	Tennessee Division of Archaeology (TDOA) and local law enforcement	These laws prohibit the physical abuse or mistreatment of human remains, a burial, grave markers, and associated objects. If a burial is uncovered during development or construction, work must stop immediately in the area and local law enforcement should be notified. Following determination that the site does not constitute a crime scene and the remains are a prehistoric or historic human burial, the Division may assist the project proponent, developer, and/or landowner in contacting appropriate parties, considering options to avoid the burial(s), and advising on the legal process for potentially moving the remains.

Source: (Justia, 2016k) (Justia, 2016l) (Tennessee State Government, 2016) (Justia, 2016m)

14.1.11.3. Cultural Setting

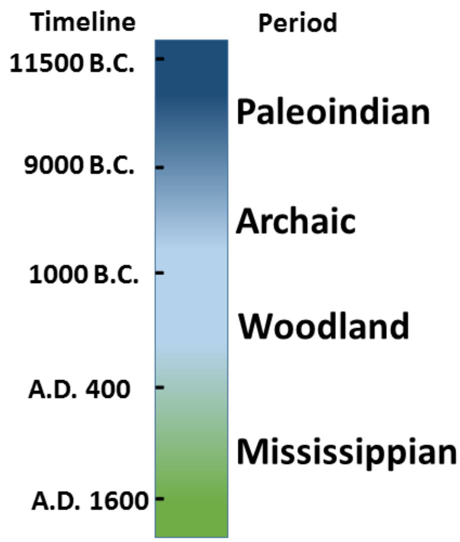
The Tennessee region has been inhabited for more than 13,000 years. While much of the archaeological evidence recovered in the state consists of surface remains, a major part of prehistory may still be buried under layers of deposits, if it has not been destroyed, by either natural or human actions (Driskell, Meeks, & Sherwood, 2012). The most notable remains left by the prehistoric people of Tennessee are large mounds used for religious, political, and habitation purposes. These mounds, which first appeared in Tennessee during the Middle Woodland Period, became a focus of early archaeological and cultural interpretation by European-American settlers (Chapman, 2009). Amongst the thousands of archaeological sites in Tennessee, 109 are listed on the NRHP (NPS, 2015c).

Tennessee is divided into five physiographic provinces (Appalachian Plateaus, Blue Ridge, Coastal Plain, Interior Low Plateaus, Valley and Ridge), which are contained within the Appalachian Highlands, Atlantic Plain, and Interior Plains Regions; refer to Figure 14.1.3-1. While each province had its own defining characteristics, archaeological evidence shows that practices pertaining to food procurement, tool manufacture, and habitation did not vary by a very large degree across the state (Koerner, Braly, & Harle, 2014).

The following sections examine Tennessee’s prehistory (11500 B.C. to A.D. 1540) and the historic period since European exploration and contact in the 1500s. Section 14.1.11.4 presents an overview of the initial human habitation in Tennessee and the cultural development that occurred before European contact. Section 14.1.11.5 discusses the federally recognized American Indian Tribes with a cultural affiliation to the state. Section 14.1.11.6 provides a current list of significant archaeological sites in Tennessee and tools that the state has developed to ensure their preservation. Section 14.1.11.7 documents the historic context of the state since European contact, and Section 14.1.11.8 summarizes the architectural context of the state during the historic period.

14.1.11.4. Prehistoric Setting

Archaeologists divide the prehistory of Tennessee into four periods: the Paleoindian Period (11500 – 8000 B.C.), Archaic Period (8000 – 1000 B.C.), Woodland Period (1000 B.C. – A.D. 400), and Mississippian Period (400 – A.D. 1540). Figure 14.1.11-1 shows a timeline representing the periods of early human habitation in the region. Tennessee is affiliated with the Mississippian culture of North America. Due to the varied ecologies and landscapes of Tennessee, many archaeologists divide each period by physiographic regions (Chapman, 2009). This section, however, focuses on the four major prehistoric periods and of Tennessee as a whole, with references to the locations of certain cultures.



Sources: (Walbert, 2009) (Chapman, 2009) (Koerner, Braly, & Harle, 2014)

Figure 14.1.11-1: Timeline of Prehistoric Human Occupation

Paleoindian Period (11500 – 8000 B.C.)

The Paleoindian Period represents the earliest human habitation in present-day Tennessee. People of this period were nomadic hunter-gatherers who can be described as "generalized foragers who supplemented their diet of plant foods and small game with an occasional opportunistic killing of a mastodon" (Chapman, 2009). Bands of these nomadic people moved seasonally, following the migrations of the mastodon and exploiting the seasonal availability of flora and fauna. These Paleoindian hunters and gatherers used chipped-stone tools, including the "fluted javelin head" arrow and spear points, also referred to as the Clovis or Folsom fluted projectile points. More than 1,000 early Clovis fluted points have been found across the state, and over 100 Early Paleoindian sites have been identified and recorded (Chapman, 2009). Later Paleoindian points include smaller fluted and unfluted lanceolate forms regularly referred to as Dalton style points (Sullivan, 2001). The quantity of points in the region leads archaeologists to believe that the Middle Tennessee River was a migration route and staging area for the colonization of eastern North America, in part, due to the easily accessible blue/green Fort Payne chert, an exceptionally high quality tool-making material found in shoals throughout the region (Sullivan, 2001).

What is known of Paleoindian subsistence patterns comes from sites such as the Coats-Hines Site in present-day Williamson County in central Tennessee. Thirty-four stone artifacts were found with the remains of a juvenile mastodon with the presence of stone tool cut marks along with thoracic vertebra (Chapman, 2009). Tools included in the artifact assemblage comprise 24 re-sharpened flakes, a prismatic blade, bifacial knife fragment, 2 gravers, 2 uniface side scrapers, and 2 scrapers/cores (Miller, Broster, Baker, & McMillan, 2014).

During the Late Paleoindian Period, there was a shift in subsistence from larger megafauna to smaller mammals and avian species, and the assemblage of projectile point changes from the large Clovis-style to the smaller lanceolate forms (Driskell, Meeks, & Sherwood, 2012). The upper region of Tennessee is mainly covered in floodplains, and any Paleoindian Period sites in this area are likely buried or destroyed by flood events (Smith, 1996).

Archaic Period (8000 – 1000 B.C.)

The early Archaic Period in the Middle Tennessee valley is marked by the introduction of early side-notched projectile points that can be identified in a chronological order. The styles recorded during this period generally include “side-notched, corner-notched, and bifurcated base styles in approximate chronological order from oldest to youngest” (Driskell, Meeks, & Sherwood, 2012). At the Dust Cave archaeological site near Florence, AL (culturally affiliated with the inhabitants of Tennessee), Big Sandy style projectile points were found almost exclusively in stratigraphic layers predating Dalton projectile points, providing strong support for the chronological distinctions between the progressions of different tool styles.

As populations of Tennessee inhabitants increased throughout the Archaic Period, aboriginal bands established territories within river valleys (Chapman, 2009). With the emergence of a sedentary lifestyle, social stratification and hierarchy developed. By the Late Archaic Period, archaeological evidence indicates that certain kinship groups were “accorded more power and prestige than others” as evidenced by “increased ceremonialism and marked differences between the way some individuals were treated” (Chapman, 2009). Material culture became more diverse, with a myriad of stone and bone tools used for a variety of tasks. What remains of Archaic Period dwelling sites includes postholes, depressions, hearths, and storage pits in settlement areas that appear to have been long-term base camps and temporary extraction camps (McMillan, Miller, Vogel, & Baker, 2014).

Throughout the Archaic Period in Tennessee, white-tailed deer was a major source of animal protein, supplemented by black bear, turkeys, pigeons, waterfowl, and a wide variety of fish and mussels (Chapman, 2009). As the people of the Middle Archaic continued gathering practices, plant foods such as nuts and acorns remained an important part of their diet. Hickory nuts, in particular, require no specialized processing prior to eating (Chapman, 2009). Despite differences in physiological regions, nut collection remained the most important sustained activity throughout the entire region (Driskell, Meeks, & Sherwood, 2012).

During the Late Archaic Period, fiber tempered pottery technology was practiced in the southwestern portion of the Tennessee region (Welborn, Yerka, & Barry, 2014). However, it is not until the Woodland Period that a dramatic increase in widespread use and stylistic design in ceramics is seen in archaeological assemblages.

Woodland Period (1000 B.C. – A.D. 1000)

The Woodland Period is marked by two coinciding factors: the beginning of the global cooling trend in the Northern Hemisphere connected to a severe volcanic eruption and by the rise in ceramic technology (Welborn, Yerka, & Barry, 2014). The advancement in technology during the Woodland Period is broken down into Early, Middle, and Late. The Early Woodland Period is marked by the increase in sedentary populations and the beginnings of tribal egalitarian organization (Chapman, 2009). The Middle Woodland Period sees an increase in "artifacts and earthen constructions associated with ceremonialism and long-distance trade" (Welborn, Yerka, & Barry, 2014); and the Late Woodland Period is understood in the context of a collapse of the interregional exchange systems established during the Middle Woodland (Yerka, Welborn, Barry, & Hollenbach, 2014).

The emergence and growth in pottery over the course of the Woodland Period indicates that settlements became permanent, as the pottery was heavy and cumbersome to transport and time-consuming to make (Chapman, 2009). Archaeologists postulate that the advent of pottery in the Early Woodland Period allowed for the longer-term storage of plant materials and food as populations increased (Welborn, Yerka, & Barry, 2014). The ceramic vessels, in their earliest forms, include large conical jars that have been found in deep, cylindrical storage pits, further indicating a decreased mobility and increased sedentary lifestyle of populations at this time. By the Middle Woodland Period, ceramic vessels were created to serve a larger variety of purposes, and styles and manufacturing techniques reflected regional differences among Tennessee Woodland cultures (Chapman, 2009).

During the Early Woodland Period, stemmed biface projectile points were narrow and thick, and were eventually replaced by narrow straight-stemmed types with the additional introduction of the triangular point (Peregrine & Ember, 2001). As projectile point manufacturing technologies became more refined, the points were also used as ceremonial objects as they begin to appear in the context of human burials (Welborn, Yerka, & Barry, 2014). It is not clear when the bow and arrow were introduced to the Tennessee region, but it is clear that the average projectile point size decreased throughout the Woodland Period.

Archaeologists postulate that some form of horticulture was taking place by the Late Archaic Period and that these practices increased substantially by the Early Woodland Period with the rise in sedentary populations (Chapman, 2009). By the Middle Woodland Period, floodplain horticulture allowed for the domestication of plants like sunflower and sumpweed. At this time, corn may have been introduced to the aboriginal diet, but it was not until the Late Woodland Period that it became a staple food supply (Chapman, 2009).

With the stabilization of larger populations, trade networks begin to emerge. By the Middle Woodland Period the development of a trade network from Florida to west of the Mississippi

River allowed for the exchange of items considered either socially or spiritually valuable (Yerka, Welborn, Barry, & Hollenbach, 2014). The first mounds were built in the Tennessee region during the Middle Woodland Period, and they were primarily used for the ceremonial interment of human remains. While the construction of mounds began as early as the Late Archaic in southeastern regions of the United States, it is not until large-scale trade networks emerge that mounds in the Tennessee region appear. In areas of South Central Tennessee, burial mounds have a variety of artifacts that are not native to the region, including copper beads, ear spools, breastplates, celts, gorgets, and arrays of galena crystals, greenstone celts, and marine shell cups. (Peregrine & Ember, 2001)

Mississippian Period (A.D. 1000 – 1600)

The Mississippian Period is marked by the emergence of chiefdoms. Mound centers appeared as large towns with associated outlying hamlets and farmsteads, some extending several hectares (Chapman, 2009). In a Mississippian village of this period, activities and ceremonies brought together clan members from surrounding mound centers. Stone, shell, textiles, and copper became a means to depict important symbolic concepts (Chapman, 2009). The intensification of agriculture and the dependence on corn developed for the first time in this region (Koerner, Braly, & Harle, 2014). The Mississippian Period in Tennessee is marked by the development of elaborate ceremonial traditions and the growth of wealth and culture diversity.

As mentioned above, mound platforms were first built in Tennessee during the Woodland Period. By the Mississippian Period, however, the function of these platforms expanded from ceremonial to residential purposes (Koerner, Braly, & Harle, 2014). In eastern Tennessee, community buildings were built atop small platform mounds, and used by priests and chiefs to conduct ceremonies and rituals (Schroedl, 2009). Evidence of palisades around villages is common throughout the region as the need for protection from warfare became prevalent by the Late Mississippian Period (Chapman, 2009). The large villages, or mound centers, housed hundreds of people. Houses within the villages were simple, square buildings erected with wattle and daub walls. In a typical Mississippian Period mound settlement, there was a primary ceremonial mound in the center, and an additional mound for mortuary functions near the primary mound (Schroedl, 2009).

Ceramics during the Mississippian Period gradually began to change in functionality, style, and manufacture. In the Early Mississippian Period, limestone tempered pottery technology was replaced by shell tempering (Koerner, Braly, & Harle, 2014). By the Late Mississippian Period, beakers and hooded bottles were being made, bowls were painted in elaborate curved patterns with red oxide, and animal patterns were commonly represented on ceramic vessels (Schroedl, 2009).

The lithic assemblages at the Martin Farm Site, on the Little Tennessee River, include an array of chipped stone tools, including side scrapers, end scrapers, perforators, projectile points, and drills. A third of all chert tools documented at the site were heat-treated to improve chipping (Koerner, Braly, & Harle, 2014). Other artifacts found at the Martin Farm site included bone awls, turtle shell rattles, and shell beads. In addition to the different types of lithic artifacts found at the Martin Farm site, Dover chert in western Tennessee was carefully crafted during the Mississippian period into elaborate stone knives, swords, and discs used in ritual practices (Schroedl, 2009).

Historic Period (A.D. 1540 to the Present)

After the first arrival of European explorers in the sixteenth century, substantial changes occurred in local American Indian communities. Beginning with the Spanish, a number of European explorers, traders, and settlers would follow. These European contacts disrupted the political order and social alliances of Mississippian cultures throughout the region (Chapman, 2009).

With minor exception, most American Indian communities ended in the Tennessee region between 1830 and 1838 with the enforcement of the Indian Removal Act of 1830. In 1838, federal troops forced thousands of American Indians, such as the area's Cherokee Indians, into the newly allocated Indian Territory west of the Mississippi River. This passage, now known as the Trail of Tears, was designated as National Historic Trail in 1987.

About 1,000 Cherokees escaped into eastern in Tennessee and western North Carolina during the removal and managed to gain recognition in 1866 through the federal government. Today they are recognized as the Eastern Band of Cherokee Indians (NPS, 2015t), with their tribal land located in the state of North Carolina.

14.1.11.5. Federally Recognized Tribes of Tennessee

According to the Bureau of Indian Affairs and the National Conference of State Legislators, Tennessee does not have any federally recognized tribes. As mentioned above, the Indian Removal Act of 1830, implemented by President Andrew Jackson, forcibly moved more than 16,000 American Indians from homelands in Tennessee, Alabama, North Carolina, and Georgia to Oklahoma, which was then referred to as Indian Territory. The closest federally recognized tribe to Tennessee is the Eastern Band of Cherokee Indians in North Carolina (National Conference of State Legislators, 2015; GPO, 2015). Figure 14.1.11-2 shows the general historic location of officially federally recognized tribes that were known to exist in this region of the United States, but are no longer present in the state.

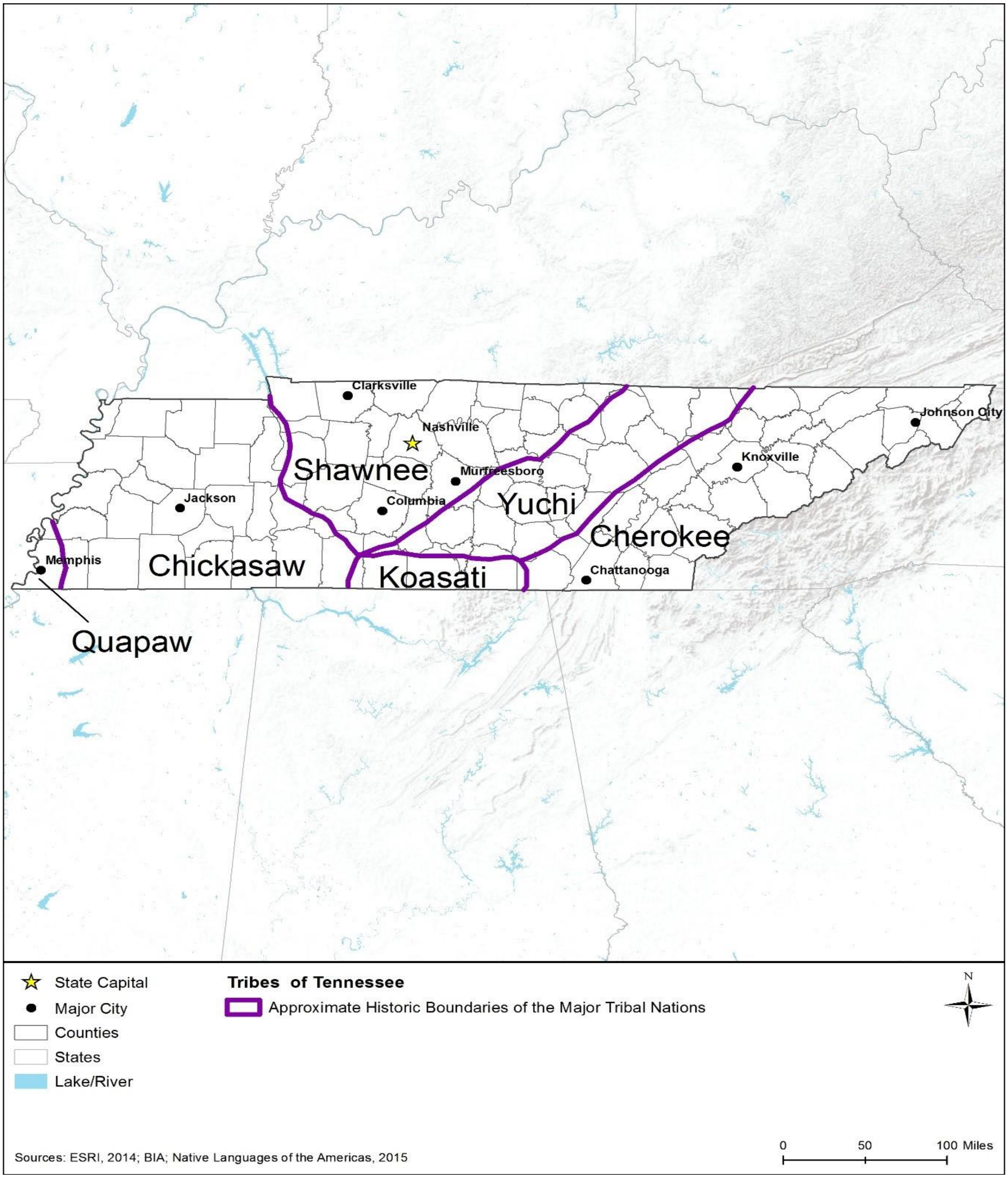


Figure 14.1.11-2: Approximate Historic Boundaries of the Major Tribal Nations in Tennessee[108]

[108] Figure 14.1.11-2 is provided for context and is not intended to be exact as the various sources that were consulted contain varying ancestral territory boundaries. Instead, this figure and corresponding ancestral territory boundaries are provided to show that the historic ancestral territories and the current ancestral interests of a given tribe within a given state are often times complex as ancestral territory boundaries shifted and overlapped over time.

14.1.11.6. Significant Archaeological Sites of Tennessee

As previously mentioned there are 109 archaeological sites in Tennessee listed on the NRHP. Table 14.1.11-2 lists the names of the sites, the city they are closest to, and type of site. The list includes both prehistoric and historic archaeological sites. The number of archaeological sites may increase with the discovery of new sites. A current list of NRHP sites are listed on the NPS NRHP website at http://www.nps.gov/nr/ (NPS, 2015u).

Table 14.1.11-2: NRHP Listed Archaeological Sites in Tennessee

Closest City	Site Name	Type of Site
Aetna	New Aetna Furnace Historic District (40HI149)	Historic
Aetna	Old Aetna Furnace (40HI148)	Historic
Arrington	Triune Fortification	Military
Ashland City	Indian Town Bluff	Historic - Aboriginal, Prehistoric
Ashland City	Sycamore Mills Site	Historic
Bath Springs	Decatur Furnace (40DR84)	Historic
Bath Springs	Tanyard Branch Furnace (40HR121)	Historic
Bone Cave	Big Bone Cave	Prehistoric, Military
Brentwood	Fewkes Group Archeological Site	Prehistoric
Brentwood	Fewkes Group Archeological Site (Boundary Increase)	Prehistoric
Bucksnort	Lee and Gould Furnace (40HI125)	Historic
Bulls Gap	Bulls Gap Fortification	Historic, Military
Bumpus Mills	Bellwood Furnace (40SW210)	Historic
Bumpus Mills	Saline Furnace (40SW218)	Historic
Burns	Laurel Furnace (40DS4)	Historic
Carthage	Battery Knob Earthworks	Military
Castalian Springs	Bledsoe’s Station	Historic
Charlotte	Bellview Furnace (40DS23)	Historic
Charlotte	Valley Forge (40DS28)	Historic
Chattanooga	Audubon Acres Site (40HA84)	Historic - Aboriginal
Chattanooga	East Tennessee Iron Manufacturing Company Blast Furnace	Historic
Chattanooga	Hampton Place Archeological Site (40HA146)	Historic - Aboriginal
Chattanooga	Mallards Dozen Archeological Site (40HA147)	Prehistoric
Chattanooga	Moccasin Bend Archeological District	Historic, Historic - Aboriginal, Prehistoric, Military
Chattanooga	Stringer Ridge Historic District	Historic, Military
Chattanooga	Vulcan Archeological Site (40HA140)	Prehistoric
Chattanooga	Woodland Mound Archeological District	Prehistoric
Clarksville	Gracey--Woodward Furnace (40MT378)	Historic
Clarksville	Riverview Mounds Archeological Site (40MT44)	Prehistoric
Cleveland	Blue Springs Encampments and Fortifications	Historic, Military
Cumberland City	Brunsoni Furnace (40SW219)	Historic

Closest City	Site Name	Type of Site
Cumberland City	Rough and Ready Furnace (40SW215)	Historic
Cumberland Furnace	Cumberland Furnace Historic District (40DS22)	Historic
Cumberland Furnace	Upper Forge (40DS32)	Historic
Dayton	Hiwassee Garrison Site	Historic, Military
Decaturville	Brownsport II Furnace	Historic
Decaturville	Brownsport II Furnace (40DR86) (Boundary Increase)	Historic
Denmark	Denmark Mound Group	Prehistoric
Dixon Springs	Fortified Town at the Mouth of Dixon Creek--Beasley Mounds	Prehistoric
Dover	Bear Spring Furnace (40SW207)	Historic
Dover	Dover Flint Quarries	Prehistoric
Dover	Fort Donelson National Battlefield	Military
Dover	Fort Henry Site	Military
Eagle Creek	Marion Furnace (40WY61)	Historic
Excell	Washington Furnace and Forge (40MT382)	Historic
Fernvale	Harpeth Furnace (40WM83)	Historic
Franklin	Anderson Site	Prehistoric
Franklin	Coats--Hines Archeological Site	Prehistoric
Franklin	Franklin Battlefield	Military
Franklin	Old Town Archeological Site (40WM2)	Prehistoric
Gainesboro	Fort Blount-Williamsburg Site	Military
Greenfield Bend	Shelby Bend Archeological District	Prehistoric
Gumdale	Brownsport I Furnace (40DR85)	Historic
Halls Creek	Fairchance Furnace (40HS168)	Historic
Harpeth Valley	Jones Creek Forge (40DS30)	Historic
Hartsville	Hartsville Battlefield	Historic, Military
Hurley	Shiloh Indian Mounds Site	Prehistoric
Hurricane Mills	Link Farm Site	Prehistoric
Indian Mound	Cross Creek Furnace (40SW217)	Historic
Jonesboro	Plum Grove Archaeological Site	Historic - Aboriginal, Prehistoric
Key	Cherry Creek Mound	Prehistoric
Kingston Springs	Mound Bottom	Prehistoric
Kingston Springs	Patterson Forge (40CH87)	Historic
Kingston Springs	Turnbull Forge (40CH97)	Historic
Knoxville	U. T. Agriculture Farm Mound	Prehistoric
Lawrenceburg	Davenport, T. D., Forge (40LR7)	Historic
Lebanon	Sellars Indian Mound	Prehistoric
Lenoir City	Bussell Island Site	Historic - Aboriginal, Prehistoric
Lillamay	Patterson Forge (40CH87) (Boundary Increase)	Historic
Linden	Cedar Grove Furnace	Historic
McAllister’s Crossroads	Tennessee Furnace (40MT383)	Historic

Closest City	Site Name	Type of Site
McKinnon	Eclipse Furnace (40SW213)	Historic
McKinnon	LaGrange Furnace (40SW214)	Historic
McMinnville	Myers Mound	Prehistoric
Murfreesboro	Fortress Rosecrans Site	Military
Napier	Napier Furnaces Historic District (40LS14)	Historic
Napier	Steele’s Iron Works (40LS15)	Historic
Nashville	Archeological Site No. 40DV35	Historic
Nashville	Brick Church Mound and Village Site	Prehistoric
Nashville	Sandbar Village	Prehistoric
Needmore	Poplar Spring Furnace (40MT376)	Historic
Needmore	Yellow Creek Furnace and Forge (40MT371)	Historic
New Providence	Fort Defiance Confederate States Army/Fort Bruce USA	Historic, Military
Nunnelly	Standard Furnace (40HI145)	Historic
Onward	Indian Cave Petroglyphs	Prehistoric
Paris	Obion Mounds	Prehistoric
Parker’s Crossroads	Parker’s Crossroads Battlefield	Historic, Prehistoric
Pinson	Pinson Mounds	Prehistoric
Pocahontas	Davis Bridge Battlefield	Historic, Military
Pocahontas	Wray’s Bluff Fortification	Historic, Military
Pope	Cedar Grove Furnace (40PY77)(Boundary Increase)	Historic
Prospect	Elk River Fortification	Historic, Military
Rockdale	Rockdale Furnace Historic District (40MU487)	Historic
Shiloh	Sailor’s Rest Furnace (40MT375)	Historic
Slayden	Louisa Furnace (40MT379)	Historic
Southside	Lafayette Furnace (40MT372)	Historic
Standing Rock	Clark Furnace (40SW212)	Historic
Strawberry Plains	Strawberry Plains Fortification	Historic, Military
Texas Hollow	Oakland Furnace and Forge (40HI146)	Historic
Union	Cardwell Mountain	Prehistoric
Vonore	Chota and Tanasi Cherokee Village Sites	Historic - Aboriginal, Military
Vonore	Chota and Tanasi Cherokee Village Sites (Boundary Increase)	Historic - Aboriginal, Military
Vonore	Citico Site	Historic - Aboriginal, Prehistoric
Vonore	Icehouse Bottom Site	Prehistoric
Vonore	Mialoquo Site	Historic - Aboriginal, Military
Vonore	Tomotley Site	Historic - Aboriginal
Vonore	Toqua Site	Historic - Aboriginal, Prehistoric
Waynesboro	Forty-eight Forge (40WY63)	Historic
White Bluff	White Bluff Forge (40DS27)	Historic

Source: (NPS, 2015u)

Tennessee State Cultural Resources Database and Tools

Tennessee Department of Environment and Conservation (TDEC)

The archaeology division of the Department of Environment and Conservation works with outside agencies to protect and manage cultural resources on state lands. The Department also provides technical assistance to state and federal agencies, law enforcement, municipalities, and the general public, and conducts research and publishes reports on archaeological subjects (TDOT, 2015e). Information on their cultural resources services is available on their website (https://www.tn.gov/environment/section/arch-archaeology).

Tennessee Historical Commission (THC)

The Tennessee Historical Commission (THC) serves as the State Historic Preservation Office (SHPO) for Tennessee. The mission of the THC is to "protect, preserve, interpret, maintain, and administer historic places" in Tennessee. The THC also encourages the study of historic places and events, assists in publication projects; and comments on and identifies projects that could potentially impact historic properties. The THC is an independent state agency attached to the TDEC. (State of Tennessee, 2016)

Tennessee Council for Professional Archaeology

The Tennessee Council for Professional Archaeology is a non-profit organization that promotes archaeological awareness and stewardship opportunities, assists government agencies, and provides forums to address technical, ethical, and administrative issues concerning cultural resource protection and preservation. Information of how to become a member is available at https://tennesseearchaeologycouncil.wordpress.com (State of Tennessee, 2015d).

Tennessee Archaeology Network

Tennessee Archaeology Network (http://capone.mtsu.edu/kesmith/TNARCH/index.html) is based in the Department of Sociology and Anthropology at Middle Tennessee State University, publicizes contributions and significance of archaeological research in Tennessee. (TNDOH, 2015a).

14.1.11.7. Historic Context

In 1541, Spanish explorer and conquistador Hernando de Soto ventured into present day Tennessee in search of gold, followed by two additional Spanish expeditions by Juan Pardo in the 1560s. English and French exploration of the Tennessee region commenced in the early 17th century. The French briefly entered western Tennessee along the Mississippi River near Memphis as part of the 1673 expedition of Father Jacques Marquette, a Jesuit missionary, and fur trader Louis Joliet. The English began their exploration of the eastern Tennessee region when Virginians James Needham and Gabriel Arthur sought trade relations with the Cherokees in 1673. Later another French expedition under Rene-Robert Cavelier, Sieur de La Salle, came to western Tennessee at the Mississippi River in 1682 and French fur traders began set up trading posts along the Cumberland River in the 1690s.

France and England both sought to control Tennessee, and established relations with the American Indian populations based around the fur trade. Fortifications were built by France and England, and in 1754, tensions resulted in the outbreak of the French and Indian War. The war was concluded in 1762, with England gaining control of all lands east of the Mississippi, and "by the early 1770s, four different communities had been established in northeastern Tennessee – on the Watauga River, the North Holston, the Nolichucky, and in Carter's Valley" (Tennessee Department of State, 2014b).

During the American Revolution, the Cherokee Indians sided with England. The indigenous population was decimated during the conflict, with American settlers playing key roles in defeating both British and American Indian fighters in the area. In 1769, the seasonal trading post of French Lick was established by French-Canadian fur trader Jacques-Timothee Boucher, Sieur de Montbrun (Anglicized to "Timothy Demonbrun") on the Cumberland River, and would later grow to become Nashville. In 1790, North Carolina, which controlled Tennessee as one of its counties, relinquished control and the "Territory of the United States, South of the River Ohio, more commonly known as the Southwest Territory," was created (Tennessee Department of State, 2014b). On June 1, 1796, Tennessee was admitted to the Union as the 16th state (Tennessee Department of State, 2014b).

Tennessee was heavily involved in agriculture for much of its early history, with cotton and tobacco being the primary cash crops. Industry emerged during the early 19th century, with the iron industry being important because it "supplied blacksmiths, mill owners, and farmers with the metal they needed and laid the groundwork for future industrial development" (Tennessee Department of State, 2014b). During the War of 1812, General Andrew Jackson, a Tennessee resident who would go onto win decisive victories against the British, and serve as the 7th President, defeated the Creek Indians (Tennessee Department of State, 2014b). In 1838 and 1839, as part of Andrew Jackson's Indian removal policy, the Cherokee nation, as well as other Southern and Southeastern tribes, were forced to give up lands east of the Mississippi River and migrate to areas in present-day Oklahoma. This journey, parts of which traversed the state, is known as the "Trail of Tears," and became a cultural memory for the Cherokee and other removed tribes because of its devastating physical and cultural effects (NPS, 2016c). During the Civil War, Tennessee was bitterly divided between those that wanted to remain in the Union and others that wanted to secede. A vote for secession in February 1861 was initially rejected, but in June 1861 a second vote was successful. As a border state, Tennessee was the site of numerous battles – such as at Shiloh (1862), Chattanooga (1863), and Franklin (1864) – with several strategically important waterways (Tennessee Department of State, 2014b).

Tennessee experienced turbulent times after the Civil War related to both the destruction and racial tensions caused by the war. The Ku Klux Klan emerged during this time, and recently freed African Americans began moving to urban areas in search of work, sparking growth in cities like Nashville, Chattanooga, and Memphis. The early 20th century was marked by conflict between modernization and the state's historically agricultural culture. Moonshiners came under attack during the temperance movement and prohibition. During World War I, around "100,000 of the state's young men volunteered or were drafted into the armed services, and a large proportion of those actually served with the American Expeditionary Force in Europe," including one of the war's most decorated heroes, Sergeant Alvin C. York. (Tennessee Department of State, 2014b)

Tennessee residents in both urban and rural areas suffered during the Great Depression, and, like many other states, relied heavily on New Deal programs. "One hundred thousand farmers statewide participated in the crop reduction program of the Agricultural Adjustment Act, while 55,250 young men enlisted in one of the 35 Civilian Conservation Corps (CCC) camps in the state" (Tennessee Department of State, 2014b). Chartered in 1933, the TVA was tasked with developing the Tennessee River Valley for electricity generations, which accounted for the largest amount of federal money expended during this time. The TVA constructed hydroelectric dam and coal-fired power plants bringing electricity to many areas for the first time. Word War II (WWII) brought economic relief, as industrial and agricultural production rose with ordinance and aircraft production, as well as the development of the Oak Ridge community, which is where elements of the first atomic bombs were developed. Following WWII, Tennessee continued to struggle with race relations and Civil Rights Leader, Dr. Martin Luther King Jr., was assassinated in Memphis in 1968 (Tennessee Department of State, 2014b). Tourism has grown during the second half of the 20th century, relating to the states various cultural resources, such as the history of the country music scene in Nashville.

Tennessee has 2,054 NRHP listed sites, as well as 30 NHLs (NPS, 2014b). The entire state is designated as a NHA, called the Tennessee Civil War National Heritage Area (NPS, 2015v). Figure 14.1.11-3 shows the location of NHA and NRHP sites within the state.[109]

[109] See Section 14.1.7 for a more in-depth discussion of additional historic resources as they relate to recreational resources.

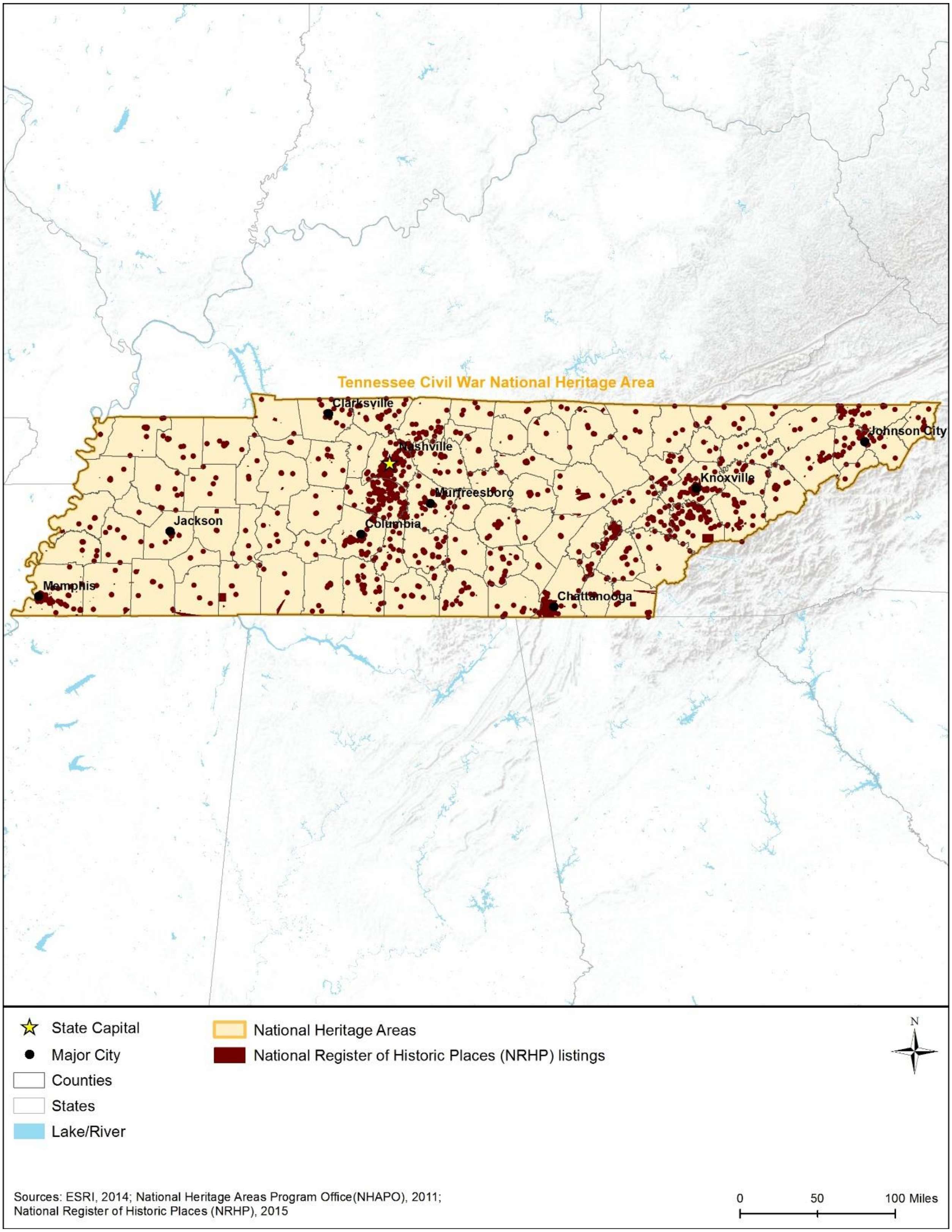


Figure 14.1.11-3: National Heritage Area and National Register of Historic Places Sites in Tennessee

14.1.11.8. Architectural Context

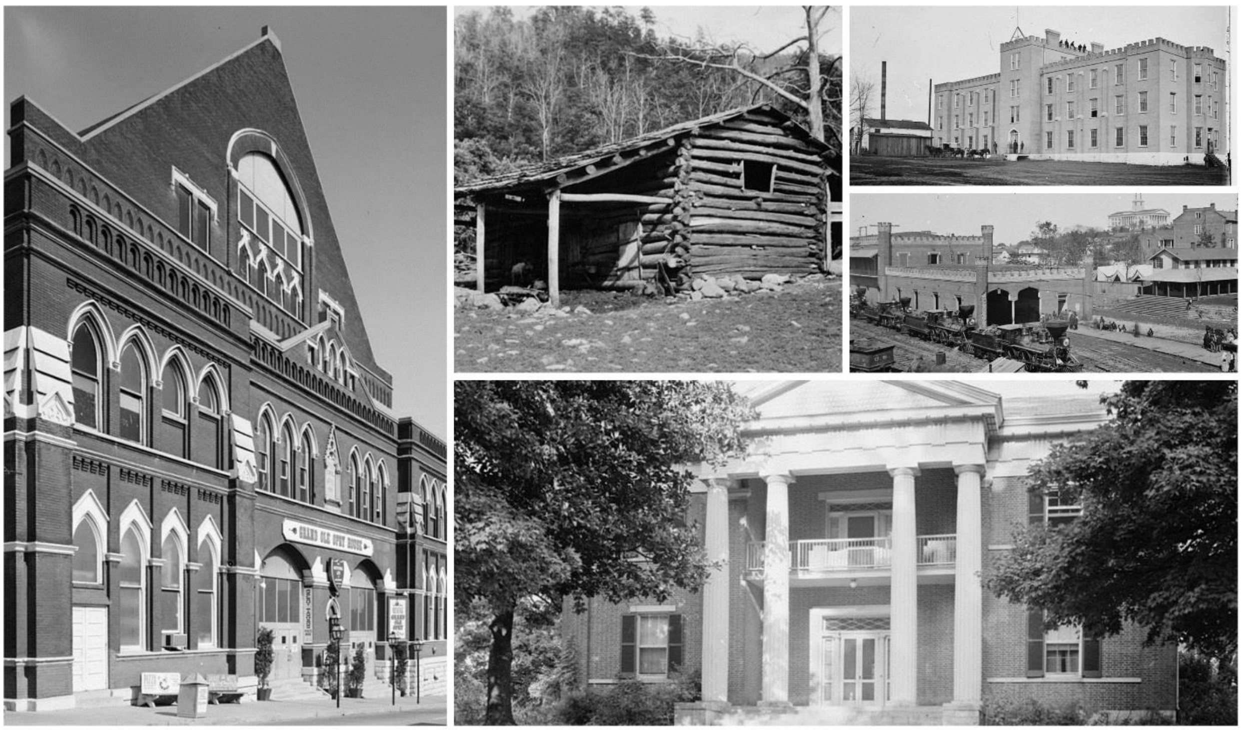
France and England built the first European architecture in Tennessee, which was largely related to the protection of colonial fur trapping interests, and frequently took the form of simple military outposts and garrisons. These structures were built of logs, heavy timber framing, or stone. Some early structures were post-in-ground, while others employed stone foundations. Most remaining architecture from the late 18th century exhibits styles transplanted from Virginia and North Carolina, exhibiting an English influence. Hall and parlor, central passage, and single-pen houses were common, as were single-pen and dogtrot structures. Tennessee remained largely rural for much of its history, and as a result, many of these early structures more commonly occur in the countryside, rather than in urban areas. Wood framing was common, as was the use of stone, with log being popular in rural vernacular structures. The wood-frame John Carter House in Elizabethton in eastern Tennessee was built between 1775 and 1780 and is the oldest surviving house in the state. (Patrick, 1981)

During the late 18th century, the Federal style was popular, while in the second quarter of the 19th century, Greek Revival grew in popularity and was implemented when constructing nearly all types of buildings, including residences, churches, mills, civic buildings, and others. Tulip Grove and The Hermitage, outside of Nashville, are two examples of grand plantation buildings dating to the mid-1830s exhibiting Greek Revival architecture. As Romanticism came into style towards the middle of the 19th century, Gothic Revival structures were built. While Gothic Revival waned in popularity following the Civil War, it was used in church architecture into the 20th century. Following the Civil War, which resulted in mass destruction in Tennessee, towns were rebuilt in Victorian Era styles. These included Italianate, Second Empire, Queen Anne, Folk Victorian, Richardsonian Romanesque, and many others. In commercial architecture, early skyscrapers appeared in larger cities, with classicism making a resurgence in these buildings, which were made possible by the implementation of modern materials such as cast iron, concrete, and steel. (Patrick, 1981)

During the early 20th century, revival style architecture began to grow in popularity, as did neoclassicism. Tudor Revival, Cape Cod Revival, Colonial Revival, and English Cottage Revival are a few examples of houses that were built in early suburbs. Additional housing types include Pyramid roofed houses until the 1930s, and bungalows and Foursquares up until WWII. Just prior to and following WWII, minimal traditional houses were built, with ranch houses and split levels being built during the Midcentury years (Tennessee Encyclopedia of History and Culture, 2015). Modern building styles also appeared in Tennessee, including the International style, Art Deco, Art Moderne, and Streamline Moderne (McAlester, 2013).

Agricultural properties are common in Tennessee, as the state was heavily involved in agriculture for much of its history. These include a variety of barns and outbuildings. Civil War battle sites are common and are preserved through various state and federal programs. As reported above, the entire state is designated as the Tennessee Civil War National Heritage Area (Tennessee Department of State, 2014b) (NPS, 2015v). Dating from the 20th century, projects associated with New Deal work programs can be found, such as rural architecture, park amenities, and hiking trails constructed by CCC workers. Blue Ridge State Park and Great

Smoky Mountains National Park are two parks that were worked on by CCC workers. In the Tennessee Valley, the TVA constructed numerous dams and power plants that are still in use today and were instrumental to the development of the area. The Oak Ridge community is historically significant as well, as it was one of the locations in the development of the first atomic weapons. Tennessee was heavily involved in the Civil Rights movement of the 1950s and 1960s, with perhaps the most well-known building related to this being the Lorraine Motel, where Dr. Martin Luther King (Tennessee Department of State, 2014b).



Left – Ryman Auditorium (Nashville, TN) – (Historic American Buildings Survey, 1933a)
Top Center – Walker Family Farm (Gatlinburg, TN) – (Historic American Buildings Survey, 1933b)
Top Right – Lindsley Hall (Nashville, TN) – (Barnard, Hospital for Federal officers, 1864a)
Right Middle – Railroad Yard and Depot (Nashville, TN) – (Barnard, LC-DIG-cwpb-02111, 1864b)
Bottom Left – Tulip Grove (Hermitage, TN) – (Historic American Buildings Survey, 1933c)

Figure 14.1.11-4: Representative Architectural Styles of Tennessee

14.1.12. Air Quality

14.1.12.1. Introduction

Air Quality in a geographic area is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography[110] of the area, and the prevailing weather and climate conditions. The levels of pollutants and pollutant concentrations in the atmosphere are typically expressed in units of parts per million (ppm)[111] or micrograms per cubic meter ($\mu g/m^3$) determined over various periods of time (averaging time).[112] This section discusses the existing air quality in Tennessee. USEPA designates areas within the United States as attainment,[113] nonattainment,[114] maintenance,[115] or unclassifiable[116] depending on the concentration of air pollution relative to ambient air quality standards. Information is presented regarding national and state ambient air quality standards and nonattainment areas that would be potentially more sensitive to impacts from implementation of the Proposed Action or alternatives.

Tennessee has five separate and distinct air regulatory authorities: the Tennessee Department of Environment and Conservation Division of Air Pollution Control, the Nashville and Davidson County Health Department Air Pollution Control Program, the Chattanooga-Hamilton County Air Pollution Control Bureau, the Knox County Air Quality Management Division, and the Shelby County Health Department Pollution Control Section. The Tennessee Department of Environment and Conservation Division of Air Pollution Control "serves 91 counties within the state and overseas and assists in the actions of [the four other local authorities,] which have their own local air pollution control programs." (TDEC, 2015o)

14.1.12.2. Specific Regulatory Considerations for the TDEC Division of Air Pollution Control

National and State Ambient Air Quality Standards

The Clean Air Act (CAA) establishes National Ambient Air Quality Standards (NAAQS) for six criteria pollutants: Carbon monoxide (CO), lead, nitrogen dioxide (NO_2), particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), and sulfur dioxide (SO_2). The NAAQS establish various standards, either primary[117] or secondary,[118] for each pollutant with varying averaging times.

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110 Topography: The unique features and shapes of the land (e.g., valleys and mountains).
111 Equivalent to 1 milligram per liter (mg/L).
112 Averaging Time: "The period over which data are averaged and used to verify proper operation of the pollution control approach or compliance with the emissions limitation or standard" (USEPA, 2015g).
113 Attainment areas: Any area that meets the national primary or secondary ambient air quality standard for the pollutant (USEPA, 2015h).
114 Nonattainment areas: Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant (USEPA, 2015h).
115 Maintenance areas: An area that was previously nonattainment, but has met the national primary or secondary ambient air quality standards for the pollutant, and has been designated as attainment (USEPA, 2015h).
116 Unclassifiable areas: Any area that cannot be classified on the basis of available information as meeting the national primary or secondary air quality standard for a pollutant (USEPA, 2015h).
117 Primary standard: The primary standard is set to provide public health protection, including protecting the health of sensitive populations such as asthmatics, children, and the elderly (State Historical Society of Iowa, 2013).
118 Secondary standards: The secondary standard is set to provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (State Historical Society of Iowa, 2013).

Standards with short averaging times (e.g., 1-hour, 8-hour, and 24-hour) were developed to prevent the acute health effects from short-term exposure at high concentrations. Longer averaging periods (e.g., 3 months or annual) are intended to prevent chronic health effects from long-term exposure (USEPA, 2013a).

In addition to the NAAQS, there are standards for hazardous air pollutants (HAP), which are those typically associated with specific industrial processes such as chromium electroplating (hexavalent chromium), dry cleaning (perchloroethylene), and solvent degreasing (halogenated solvents). HAPs can have severe adverse impacts on human health and the environment, including increased risk of cancer, reproductive issues, or birth defects. HAPs are federally regulated under the CAA via the National Emission Standards for Hazardous Air Pollutants (NESHAPs). USEPA developed the NESHAPs for sources and source categories emitting HAPs that pose a risk to human health (USEPA, 2016e).

In conjunction with the federal NAAQS, Tennessee maintains its own air quality standards. Table 14.1.12-1 presents an overview of the Tennessee Ambient Air Quality Standards as defined by the TDEC.

Table 14.1.12-1: Tennessee Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standard		Secondary Standard		Notes
		µg/m³	ppm	µg/m³	ppm	
Total Suspended Particulates	24-hour	-	-	150	-	Maximum. Not to be exceeded more than once per year.
PM10	Annual	50	-	Same as Primary		Arithmetic mean. Not to be exceeded more than once per year.
	24-hour	150	-	Same as Primary		Maximum. Not to be exceeded more than once per year.
SO2	Annual	80	0.03	-	-	Arithmetic mean. Not to be exceeded more than once per year
	24-hour	365	0.14	-	-	Maximum. Not to be exceeded more than once per year.
	3-hour	-	-	1,300	0.5	Maximum. Not to be exceeded more than once per year.
CO	8-hour	10,000	9.0	Same as Primary		Maximum. Not to be exceeded more than once per year.
	1-hour	40,000	35.0	Same as Primary		Maximum. Not to be exceeded more than once per year.
O3	1-hour	235	0.12	Same as Primary		Maximum. Not to be exceeded more than once per year.
NO2	Annual	100	0.05	Same as Primary		Arithmetic mean. Not to be exceeded more than once per year.
Lead	Calendar Quarter	1.5	-	Same as Primary		Maximum. Not to be exceeded.
Fluorides (Gaseous)	30-days	-	-	1.2	0.0015	Expressed as Hydrogen Fluoride. Maximum concentrations, not to be exceeded more than once per year.
	7-days	-	-	1.6	0.0020	
	24-hour	-	-	2.9	0.0035	
	12-hour	-	-	3.7	0.0045	

Pollutant	Averaging Time	Primary Standard		Secondary Standard		Notes
		μg/m³	ppm	μg/m³	ppm	
Hydrogen Chloride	24-hour	70.0	-	-	-	Used as a guidance level in assessing air quality impact.

Source: (TDEC, 2006)

Title V Operating Permits/State Operating Permits

Tennessee has authorization to issue CAA Title V operating permits on behalf of the USEPA, as outlined in 40 CFR 70. The Title V program refers to Title V of the CAA that governs permitting requirements for major industrial air pollution sources and consolidates all CAA requirements for the facility into one permit (USEPA, 2015i). The overall goal of the Title V program is to "reduce violations of air pollution laws and improve enforcement of those laws" (USEPA, 2015i). Tennessee Air Pollution Control Regulations chapter 1200-03-09-.02(11)(c) describes the applicability of Title V operating permits. Tennessee requires Title V operating permits for any major source if it emits or has the potential to emit pollutants in excess of the major source thresholds (see Table 14.1.12-2). The permit issued to a facility contains both state and federal portions and incorporates a reporting schedule (USEPA, 2014b).

Table 14.1.12-2: Major Air Pollutant Source Thresholds

Pollutant	Tons per year (TPY)
Any Criteria Pollutanta	100
Single HAP	10
Total/Cumulative HAPs	25

Source: (USEPA, 2014b)

[a] Sources in nonattainment areas will have lower thresholds for some criteria pollutants depending on the classification of the nonattainment area.

Exempt Activities

Under Tennessee Air Pollution Control Regulations chapter 1200-03-09-.04(4)(d), the following select activities or emission units are considered exempt from being listed in construction or operating permits:

- "Fuel burning equipment of less than 500,000 Btu per hour capacity…
- Sources within the counties of Shelby, Davidson, Hamilton, and Knox until such time as the Board shall determine that air pollution is not being controlled in such county to a degree at least as stringent as the substantive provisions of the Tennessee Air Quality Act and regulations adopted pursuant thereto. This exemption does not apply to any air contaminant source in those counties if the local regulation is less stringent than the applicable state regulation…
- Mobile sources such as: automobiles, trucks, buses, locomotives, planes, boats, and ships. This exemption only applies to the emissions from the internal combustion engines used exclusively to propel such vehicles…

- Fuel burning sources that are either gas fired or #2 oil fired with a heat input rate under 10 million Btu/hour, where the combined total heat input rate at each location does not exceed 10 million Btu/hour…" (TDEC, 2015p).

Under Tennessee Air Pollution Control Regulations chapter 1200-03-09-.04(5)(f), the following select activities are considered insignificant, and exempt from being included as part of major source permit applications if the potential to emit each regulated pollutant (other than HAPs) is less than 5 tpy and each HAP is less than 1,000 pounds per year:

- "Unpaved roadways and parking areas unless permits have specific conditions limiting fugitive emissions…
- Paved roadways and parking areas unless permits have specific conditions limiting fugitive emissions…
- The following equipment, when used exclusively for emergency replacement or standby service:
- Internal combustion engines burning natural gas, gasoline, or diesel fuel including stationary reciprocating engines, internal combustion engine driven compressors, internal combustion engine driven electric generator sets…
- Electric stations, including transformers, and substations…" (TDEC, 2015p).

Under Tennessee Air Pollution Control Regulations chapter 1200-03-09-.04(5)(g), the following select activities are considered insignificant, and exempt from being included as part of major source permit applications:

- "Combustion emissions from propulsion of mobile sources…
- Portable electrical generators that can be moved by hand from one location to another…" (TDEC, 2015p).

Temporary Emissions Sources Permits

Major source operating permits, under Tennessee Air Pollution Control Regulations chapter 1200-03-09-.02(11)(e)(5), contain provisions allowing for permitting of temporary emission sources. The Division of Air Pollution Control "may issue a single permit authorizing emissions from similar operations by the same source owner or operator at multiple temporary locations. The operation must be temporary and involve at least one change of location during the term of the permit." (TDEC, 2015p)

State Preconstruction Permits

Tennessee Air Pollution Control Regulations chapter 1200-03-09-.01(1)(a) requires construction permits for any new or modified source that could result in an increased discharge of air contaminants. (TDEC, 2015p)

General Conformity

Established under Section 176(c)(4) of the CAA, "the General Conformity Rule ensures that the actions taken by federal agencies in nonattainment and maintenance areas do not interfere with a state's plans to meet national standards for air quality" outlined in the state implementation plan

(SIP) (USEPA, 2013b). An action in designated nonattainment and maintenance areas would be evaluated for the emission of those particular pollutants under the General Conformity Rule through an applicability analysis. Pursuant to Title 40 CFR 93.153(d)(2) and (e), Federal actions "in response to emergencies which are typically commenced on the order of hours or days after the emergency" and actions "which are part of part of a continuing response to emergency or disaster" that are taken up to 6 months after beginning response activities, will be exempt from any conformity determinations (GPO, 2010).

The estimated pollutant emissions are compared to *de minimis*[119] levels. These values are the minimum thresholds for which a conformity determination must be performed (see Table 14.1.12-3). As a result, lower *de minimis* thresholds for Volatile Organic Compounds (VOC) and NO_2 could apply depending on the attainment status of a county.

Table 14.1.12-3: *De Minimis* Levels

Pollutant	Area Type	TPY
Ozone (VOC or NO_x)	Serious Nonattainment	50
	Severe Nonattainment	25
	Extreme Nonattainment	10
	Other areas outside an Ozone Transport Region (OTR)	100
Ozone (NO_X)	Maintenance	100
Ozone (VOC)	Maintenance outside an OTR	100
CO, SO_2, NO_2	All Nonattainment and Maintenance	100
PM_{10}	Serious Nonattainment	70
	Moderate Nonattainment and Maintenance	100
$PM_{2.5}$ (Direct Emissions) (SO_2) (NO_X (unless determined not to be a significant precursor)) (VOC or ammonia (if determined to be significant precursors))	All Nonattainment and Maintenance	100
Lead	All Nonattainment and Maintenance	25

Source: (GPO, 2010)

If an action does not result in an emissions increase above the *de minimis* levels in Table 14.1.12-3, then a conformity determination is not required. If the applicability analysis shows that the total direct and indirect emissions are above the *de minimis* levels in Table 14.1.12-3, then the action must undergo a conformity determination. The federal agency must first show that the action would meet all SIP control requirements and that any new emissions would not cause a new violation of the NAAQS (USEPA, 2010b). To demonstrate conformity,[120] the agency would have to fulfill one or more of the following:

[119] de minimis: USEPA states that "40 CFR 93 § 153 defines de minimis levels, that is, the minimum threshold for which a conformity determination must be performed, for various criteria pollutants in various areas" (USEPA, 2015g).
[120] Conformity: Compliance with the State Implementation Plan.

- Show any emissions increase is specifically identified and accounted for in the respective state's SIP;
- Receive acknowledgement from the state that any increase in emissions would not exceed the SIP emission budget;
- Receive acknowledgement from the state to revise the SIP and include emissions from the action;
- Show the emissions would be fully offset by implementing reductions from another source in the same area; and
- Conduct air quality modeling that demonstrates the emissions would not cause or contribute to new violations of the NAAQS, or increase the frequency or severity of any existing violations of the NAAQS (USEPA, 2010b).

State Implementation Plan Requirements

The Tennessee SIP is composed of many related actions to ensure ambient air concentrations of the six criteria pollutants comply with the NAAQS. Tennessee's SIP is a conglomeration of separate actions taken for each of the pollutants. All of Tennessee's SIP actions are codified under 40 CFR Part 52 Subpart RR. USEPA provides a list of the Tennessee SIP on their website: http://www3.epa.gov/region4/air/sips/tn/contents.htm.

14.1.12.3. Specific Regulatory Considerations for the Nashville and Davidson County Health Department Air Pollution Control Program

National and State Ambient Air Quality Standards

In conjunction with the federal NAAQS, Nashville and Davidson County maintains its own air quality standards (Metropolitan Council of Nashville and Davidson County, 2014). Table 14.1.12-4 presents an overview of the local ambient air quality standards as defined by the Metropolitan Council of Nashville and Davison County, Tennessee.

Table 14.1.12-4: Nashville and Davidson County Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standard		Secondary Standard		Notes
		μg/m³	ppm	μg/m³	ppm	
PM10	Annual	50	-	Same as Primary		Arithmetic mean. Not to be exceeded more than once per year.
	24-hour	150	-	Same as Primary		Maximum. Not to be exceeded more than once per year.
SO2	Annual	-	0.03	-	-	Arithmetic mean. Not to be exceeded more than once per year
	24-hour	-	0.14	-	-	Maximum. Not to be exceeded more than once per year.
	3-hour	-	-	-	0.5	Maximum. Not to be exceeded more than once per year.
CO	8-hour	-	9.0	Same as Primary		Maximum. Not to be exceeded more than once per year.
	1-hour	-	35.0	Same as Primary		Maximum. Not to be exceeded more than once per year.

Pollutant	Averaging Time	Primary Standard		Secondary Standard		Notes
		μg/m³	ppm	μg/m³	ppm	
O3	1-hour	-	0.12	Same as Primary		Maximum. Not to be exceeded more than once per year.
NO2	Annual	100	-	Same as Primary		Arithmetic mean. Not to be exceeded more than once per year
Lead	Calendar Quarter	1.5	-	Same as Primary		Maximum. Not to be exceeded.
Fluorides (Gaseous)	30-days	-	-	-	0.0015	Expressed as Hydrogen Fluoride. Maximum concentrations, not to be exceeded more than once per year.
	7-days	-	-	-	0.0020	
	24-hour	-	-	-	0.0035	
	12-hour	-	-	-	0.0045	

Source: (Metropolitan Council of Nashville and Davidson County, 2014)

Title V Operating Permits/State Operating Permits

The Metropolitan Health Department Division of Pollution Control, Regulation No. 13 (Part 70 Operating Permit Program), outlines the applicability of Title V operating permits for major sources in Davidson County. Davidson County requires Title V operating permits for any major source if it emits or has the potential to emit pollutants in excess of the major source thresholds (see Table 14.1.12-2). For minor sources requiring operating permits in Davidson County, the Code of Laws of the Metropolitan Government of Nashville and Davison County, Tennessee, Chapter 10.56.040, provides applicability requirements. New or modified sources that already possess a construction permit, but do not emitted enough to require a Title V operating permit, are required to obtain a local/state operating permit from the Davison County Division of Pollution Control (Metropolitan Council of Nashville and Davidson County, 2014).

Exempt Activities

Under Chapter 10.56.050 of the Code of Laws, these select activities are exempt from both construction and operating permits. The following are exempt from all provisions within the chapter:

- "Natural gas or fuel oil burning equipment of less than five hundred thousand British thermal unit (BTU) input per hour. This exemption shall not apply when the total capacity of such equipment operated by one person exceeds 2.0 million BTU input per hour…
- Mobile sources such as automobiles, trucks, buses, locomotives, planes, and boats" (Metropolitan Council of Nashville and Davidson County, 2014).

The following are exempt from construction and operating permit requirements:

- "Fuel burning equipment that are fired with liquid petroleum gas, natural gas or No. 2 fuel oil with a heat input of less than 10 million BTU per hour where the combined total heat input rate at the facility does not exceed 20 million BTU per hour. This exemption does not apply to gas-fired turbines…
- Any process emitting less than 0.1 pounds per hour of any non-hazardous air pollutant except for those regulated by Regulation No. 5, (Standards of Performance for New Stationary Sources)…" (Metropolitan Council of Nashville and Davidson County, 2014)

Temporary Emissions Sources Permits

Only with the approval from the chief administrative officer of the Metropolitan Board of Health can construction and operating permits be transferred between facilities. For temporary major source operating permits, under Regulation No. 13 (Part 70 Operating Permit Program), are issued as "…a single [Part 70 operating] permit authorizing emissions from similar operations by the same source owner or operator at multiple temporary locations." (Metropolitan Health Department Division of Pollution Control, 2010)

State Preconstruction Permits

Under Chapter 10.56.020.A.1 of the Code of Laws, construction permits are required for any installation, construction, reconstruction, alteration, or addition of fuel-burning equipment, such as "any fuel-burning equipment, incinerator, process equipment, control device, or any equipment pertaining thereto, or any stack or chimney connected therewith, or to make or cause to be made any alteration or repairs which increases the amount of air contaminant emitted by such source or which results in the emission of any air contaminant not previously emitted" (Metropolitan Council of Nashville and Davidson County, 2014). However, this is not applicable to "fuel oil equipment of [500,000] BTU input or less or to internal combustion engines" (Metropolitan Council of Nashville and Davidson County, 2014).

General Conformity

Davidson County has not established its own General Conformity requirements. See Section 14.1.12.2 for a general discussion of the Federal General Conformity laws used by TDEC (Metropolitan Council of Nashville and Davidson County, 2014).

State Implementation Plan Requirements

Davidson County is attainment for all criteria pollutants, and therefore does not require a SIP (Metropolitan Council of Nashville and Davidson County, 2014).

14.1.12.4. Specific Regulatory Considerations for the Chattanooga-Hamilton County Air Pollution Control Bureau

National and State Ambient Air Quality Standards

Chattanooga and Hamilton County maintains its own air quality standards in addition to the Federal NAAQS. Table 14.1.12-5 presents an overview of the local ambient air quality standards as defined by the Chattanooga-Hamilton County Air Pollution Control Bureau.

Table 14.1.12-5: Chattanooga-Hamilton County Ambient Air Quality Standards

Pollutant	Averaging Time	Primary Standard		Secondary Standard		Notes
		$\mu g/m^3$	ppm	$\mu g/m^3$	ppm	
CO	8-hour	10,000	9	Same as Primary		Arithmetic mean. Not to be exceeded more than once per year.
	1-hour	40,000	35	Same as Primary		Maximum. Not to be exceeded more than once per year.
Lead	Calendar Quarter	1.5	-	Same as Primary		Maximum. Not to be exceeded.
NO2	Annual	100	0.05	Same as Primary		Arithmetic mean. Not to be exceeded more than once per year.
PM10	Annual	50	-	Same as Primary		Arithmetic mean. Not to be exceeded more than once per year.
	24-hour	150	-	Same as Primary		Maximum. Not to be exceeded more than once per year.
PM2.5	Annual	15.0	-	Same as Primary		Arithmetic mean. Not to be exceeded more than once per year.
	24-hour	65	-	-	-	Maximum. Not to be exceeded more than once per year.
O3	8-hour	-	0.08	Same as Primary		Maximum. Not to be exceeded more than once per year.
	1-hour	-	0.12	Sam as Primary		Maximum. Not to be exceeded more than once per year.
SO2	Annual	80	0.03	-	-	Arithmetic mean. Not to be exceeded more than once per year.
	24-hour	365	0.14	-	-	Maximum. Not to be exceeded more than once per year.
	3-hour	-	-	1,300	0.5	Maximum. Not to be exceeded more than once per year.
Fluorides (Gaseous)	30-days	-	-	1.2	0.0015	Expressed as Hydrogen Fluoride. Maximum concentrations, not to be exceeded more than once per year.
	7-days	-	-	1.6	0.0020	
	24-hour	-	-	2.9	0.0035	
	12-hour	-	-	3.7	0.0045	

Source: (Chattanooga-Hamilton County Air Pollution Control Bureau, 2015a)

Title V Operating Permits/State Operating Permits

Chattanooga Air Pollution Control Ordinance serves as the basis for all local air pollution control regulations. Similar regulations have been adopted by Hamilton County and the cities of Collegedale, East Ridge, Lakesite, Lookout Mountain, Red Bank, Ridgeside, Signal Mountain, Soddy Daisy, and Walden. This section presents the requirements for Chattanooga, and there may be slight variation from jurisdiction to jurisdiction so check with other local ordinances before constructing, modifying, or operating emission sources. (Chattanooga-Hamilton County Air Pollution Control Bureau, 2015b)

Chattanooga has authorization to issue Title V operating permits on behalf of the state as outlined in Section 4-52 of the Chattanooga City Code. For major sources in Hamilton County, the applicability of Title V operating permits is presented in Section 4-54 of the Chattanooga City Code. Hamilton County requires Title V operating permits for any major source if it emits or has the potential to emit pollutants in excess of the major source thresholds (see Table 14.1.12-2). For minor sources, Hamilton County requires certificates of operation, under section 4-8(c), prior to the operation of any new or modified fuel-burning source (Chattanooga-Hamilton County Air Pollution Control Bureau, 2015a).

Exempt Activities

In accordance with Chattanooga City Code, section 4-56(a)(11), the following select activities are exempt from the requirements to obtain an installation permit:

- "Mobile sources such as: automobiles, trucks, buses…planes, boats, and ships…exclusively used to propel such vehicles…
- Unpaved roadways and parking areas not regularly used for traffic unless permits have specific conditions limiting fugitive emissions…" (Chattanooga-Hamilton County Air Pollution Control Bureau, 2015a).

Temporary Emissions Sources Permits

Under Chattanooga City Code, section 4-57(e), certain provisions to Title V operating permits allow for the permitting of temporary sources with "…a single permit authorizing emissions from similar operations by the same source owner or operator at multiple temporary locations. The operation must be temporary and involve at least one change in location during the term of the permit" (Chattanooga-Hamilton County Air Pollution Control Bureau, 2015a).

State Preconstruction Permits

Under Chattanooga City Code, section 4-8, the city requires an installation permit prior to any "construction, installation, or beginning any modification, alteration, or reconstruction of any fuel-burning, refuse-burning, process or air pollution control equipment" (Chattanooga-Hamilton County Air Pollution Control Bureau, 2015a). Additionally, installation permits cannot be transferred between people, air pollution sources, or locations. (Chattanooga-Hamilton County Air Pollution Control Bureau, 2015a)

General Conformity

Hamilton County has not established its own General Conformity requirements (Chattanooga-Hamilton County Air Pollution Control Bureau, 2015a). See Section 14.1.12.2 for a general discussion of the Federal General Conformity laws used by TDEC.

State Implementation Plan Requirements

Chattanooga has not developed its own state or local implementation plan, and therefore adheres to the requirements within the Tennessee SIP (Chattanooga-Hamilton County Air Pollution Control Bureau, 2015a) (see Section 14.1.12.2).

14.1.12.5. Specific Regulatory Considerations for the Knox County Air Quality Management Division

National and State Ambient Air Quality Standards

Knox County has not established its own ambient air quality standards, but rather adopts the NAAQS, as well as the Tennessee state standards for gaseous fluoride and hydrogen chloride. (Knox County Air Quality Management, 2013)

Title V Operating Permits/State Operating Permits

Knox County has authorization to issue Title V operating permits on behalf of the state of Tennessee as outlined in Section 25.70 of the Knox County Air Quality Management Regulations. For major sources in Knox County, the applicability of Title V operating permits is presented in Section 25.70.C of the Air Quality Management Regulations. Knox County requires Title V operating permits for any major source if it emits or has the potential to emit pollutants in excess of the major source thresholds (see Table 14.1.12-2). For minor sources, Knox County requires operating permits, under section 25.3, prior to the operation of any new or modified fuel-burning source that has a construction permit. (Knox County Air Quality Management, 2015)

Exempt Activities

Under section 25.6 of the Knox County Air Quality Management Regulations, the following select air contaminant sources are not "required to obtain or file a request for a permit due to ownership, operation, construction or modification…

- Fuel-burning sources which have no emissions other than the products of combustion that are either natural gas fired or #2 fuel fired, propane fired, or #2 fuel oil fired with a heat input rate under 5 million BTU/hour, where the combined total heat input at each location does not exceed 5 million BTU/hour…
- Emergency generators burning natural gas, propane, or #2 fuel oil with a total heat input of 4,500,000 BTU/hour or less, and operating less than 500 hours per year…" (Knox County Air Quality Management, 2015)

Temporary Emissions Sources Permits

Under section 25.70.F.5 of the Knox County Air Quality Management Regulations, certain provisions to Title V operating permits allow for the permitting of temporary sources with "…a single permit authorizing emissions from similar operations by the same source owner or operator at multiple temporary locations. The operation must be temporary and involve at least one change of location during the term of the permit…" (Knox County Air Quality Management, 2015)

State Preconstruction Permits

Knox County, in accordance with Section 25.1 of the Knox County Air Quality Management Regulations, requires construction permits for any new or modified source that could result in an increased discharge of air contaminants (Knox County Air Quality Management, 2015).

General Conformity

Knox County has not established its own General Conformity requirements (Knox County Air Quality Management, 2015). See Section 14.1.12.2 for a general discussion of the Federal General Conformity laws used by TDEC.

State Implementation Plan Requirements

Knox County has not developed its own state or local implementation plan, and therefore adheres to the requirements within the Tennessee SIP (Knox County Air Quality Management, 2015) (see Section 14.1.12.2).

14.1.12.6. Specific Regulatory Considerations for the Shelby County Health Department Pollution Control Section

National and State Ambient Air Quality Standards

Shelby County has not established its own air quality standards, but instead chooses to adopt the Tennessee State Ambient Air Quality Standards (see Table 14.1.12-1). (Shelby County Health Department, 2015a)

Title V Operating Permits/State Operating Permits

Shelby County adopts the TDEC regulations for state and Title V operating permits (see Section 14.1.12.2). (Shelby County Health Department, 2015b)

Exempt Activities

Shelby County adopts the TDEC regulations for construction and operating permit exemptions (see Section 14.1.12.2). (Shelby County Health Department, 2015b)

Temporary Emissions Sources Permits

Shelby County adopts the TDEC regulations for permitting temporary emission sources (see Section 14.1.12.2). (Shelby County Health Department, 2015b)

State Preconstruction Permits

Shelby County adopts the TDEC regulations for construction and preconstruction permitting (see Section 14.1.12.2). (Shelby County Health Department, 2015b)

General Conformity

Shelby County has not established its own General Conformity requirements (Shelby County Health Department, 2015b). See Section 14.1.12.2 for a general discussion of the Federal General Conformity laws used by TDEC.

State Implementation Plan Requirements

Shelby County has not developed its own state or local implementation plan, and therefore adheres to the requirements within the Tennessee SIP (Shelby County Health Department, 2015b) (see Section 14.1.12.2).

14.1.12.7. Environmental Setting: Ambient Air Quality

Nonattainment Areas

The USEPA classifies areas as attainment, nonattainment, maintenance, or unclassifiable for six criteria pollutants. When evaluating an area's air quality against regulatory thresholds (i.e., permitting and general conformity), maintenance areas are often combined with nonattainment, while unclassifiable areas are combined with attainment areas (USEPA, 2016f). Figure 14.1.12-1 and Table 14.1.12-6 present the nonattainment areas in Tennessee as of January 30, 2015. The year(s) listed in the table for each pollutant indicate when USEPA promulgated an ambient air quality standard for that pollutant. Note certain pollutants have more than one standard in effect (e.g., lead, $PM_{2.5}$, O_3, and SO_2). Table 14.1.12-6 contains a list of the counties and their respective current nonattainment status for each criteria pollutant. Unlike Table 14.1.12-6, Figure 14.1.12-1 does not differentiate between standards for the same pollutant. Additionally, given that particulate matter is the criteria pollutant of concern, $PM_{10,}$ and $PM_{2.5}$ merge in the figure to count as a single pollutant.

Table 14.1.12-6: Tennessee Nonattainment and Maintenance Areas by Pollutant Standard and County

County	Pollutant and Year USEPA Implemented Standard										
	CO	Lead		NO_X	PM_{10}	$PM_{2.5}$		O_3		SO_2	
	1971	1978	2008	1971	1987	1997	2006	1997	2008	1971	2010
Anderson						X-4	X-4	M	M		
Benton										M	
Blount						X-4	X-4	M	M		
Cocke								M			
Fayette		M									
Hamilton						X-4					
Humphreys										M	
Jefferson								M			
Knox						X-4	X-4	M	M		
Loudon						X-4	X-4	M			
Montgomery								M			
Polk										M	
Roane						X-4	X-4				
Sevier								M			
Shelby	M	M						M	X-5		
Sullivan			X-6								X-6
Williamson		M									

Source: (USEPA, 2015j)

X-1 = Nonattainment Area (Extreme)
X-2 = Nonattainment Area (Severe)
X-3 = Nonattainment Area (Serious)
X-4 = Nonattainment Area (Moderate)
X-5 = Nonattainment Area (Marginal)
X-6 = Nonattainment Area (Unclassified)
M = Maintenance Area

Air Quality Monitoring and Reporting

The TDEC, along with the assistance of local air pollution control agencies, measure air pollutants at more than 75 sites across the state as part of the National Air Monitoring Stations Network and the State and Local Air Monitoring Stations Network (TDEC, 2012b).

Air Quality Control Regions

USEPA classified all land in the United States as a Class I, Class II, or Class III Federal Air Quality Control Region (AQCR) (42 U.S.C. § 7470). Class I areas include international parks, national wilderness areas which exceed 5,000 acres in size, national memorial parks which exceed 5,000 acres in size, and national parks which exceed 6,000 acres in size. Class I areas cannot be re-designated as Class II or Class III and are intended to maintain pristine air quality. Although USEPA developed the standards for a Class III AQCR, to date they have not actually classified any area as Class III. Therefore, any area that is not classified as a Class I area is, by default, automatically designated as a Class II AQCR (42 U.S.C. § 7470).

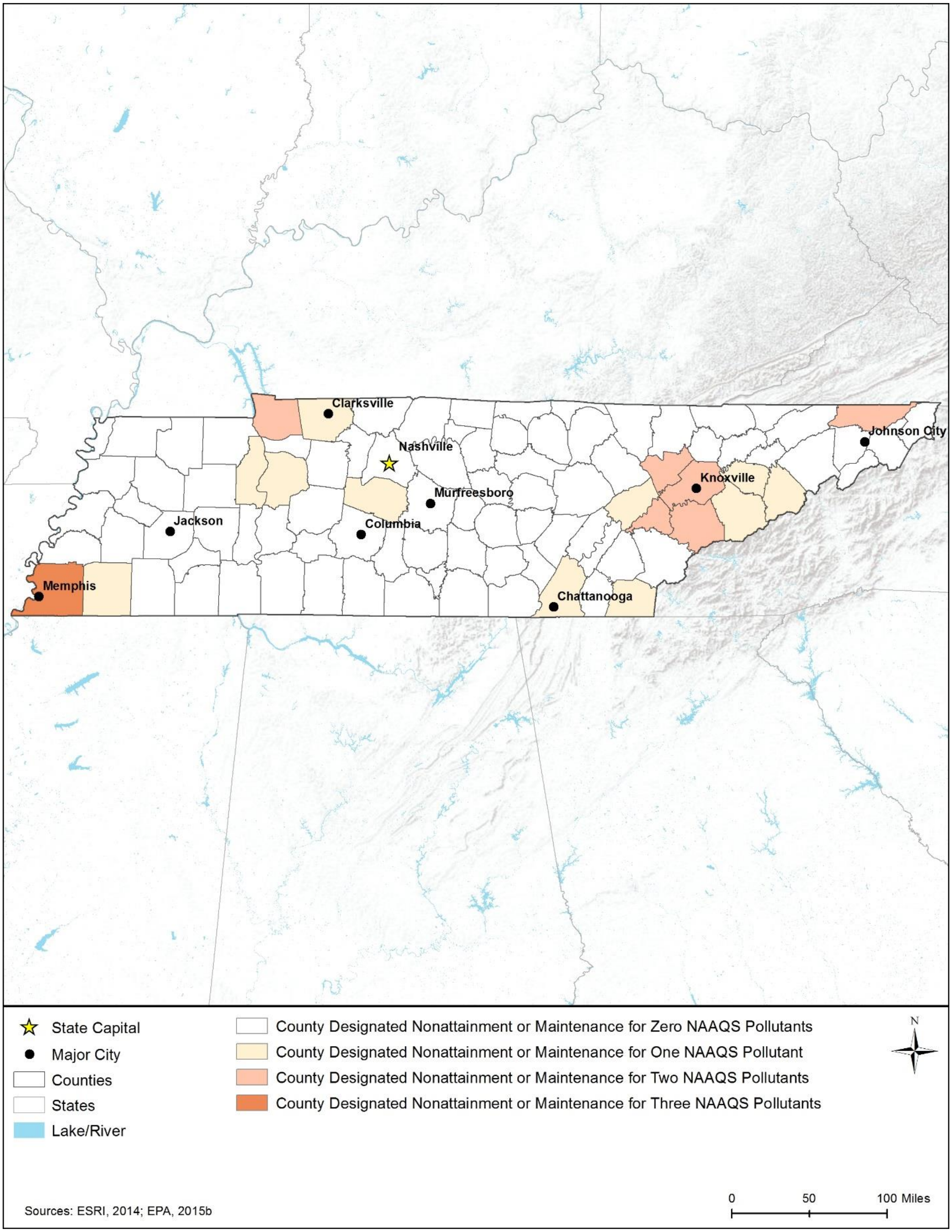


Figure 14.1.12-1: Nonattainment and Maintenance Counties in Tennessee

In a 1979 USEPA memorandum, the Assistant Administrator for Air, Noise, and Radiation (USEPA, 1979) advised USEPA Regional Offices to provide notice to the Federal Land Manager (FLM) of any facility subject to the Prevention of Significant Deterioration (PSD) permit requirements and within 100 kilometers[121] of a Class I area. "The USEPA's policy is that FLMs should be notified by the Regional Office about any project that is within 100 kilometers of a Class I area. For sources having the capability to affect air quality at greater distances, notification should also be considered for Class I areas beyond 100 kilometers" (Page, 2012). The 2005 USEPA guidelines for air quality modeling do not provide a precise modeling range for Class I areas.

PSD applies to new major sources or major modifications at existing sources for pollutants where the source is in an attainment or unclassifiable area. An air quality analysis is required for sources subject to PSD requirements and generally consists of using a dispersion model to evaluate emission impacts to the area. "Historically, the USEPA guidance for modeling air quality impacts under the PSD program has tended to focus more on the requirements for a Class II modeling analysis. Such guidance has provided that applicants need not model beyond the point of significant impact or the source or 50 kilometers[122] (the normal useful range of USEPA-approved Gaussian plume models" (USEPA, 1992).

Tennessee contains three Federal Class I areas; all other land within the state is classified as Class II (USEPA, 2012a). If an action is considered major source and consequently subject to PSD requirements, the air quality impact analysis need only to analyze the impacts to air quality within 100 kilometers from the source (USEPA, 1992). North Carolina, Georgia, Alabama, Kentucky, and Missouri, also contain Class I areas where the 100-kilometer buffer intersects a few Tennessee counties. Any PSD-applicable action within these counties would require FLMs notification from the appropriate Regional Office (USEPA, 2012a). Figure 14.1.12-2 provides a map of Tennessee highlighting all relevant Class I areas and all areas within the 100-kilometer radiuses. The numbers next to each of the highlighted Class I areas in Figure 14.1.12-2 correspond to the numbers and Class I areas listed in Table 14.1.12-7.

Table 14.1.12-7: Relevant Federal Class I Areas

#[a]	Area	Acreage	State
1	Great Smoky Mountains National Park	514,758	TN/NC
2	Joyce Kilmer Slickrock National Wilderness Area	14,033	TN/NC
3	Cohutta Wilderness Area	33,776	TN/GA
4	Shining Rock Wilderness Area	13,350	NC
5	Linville Gorge National Wilderness Area	7,575	NC
6	Sipsey National Wilderness Area	12,646	AL
7	Mammoth Cave National Park	51,303	KY
8	Mingo National Wilderness Area	8,000	MO

Source: (NPS, 2015c)

[121] The memorandum and associated guidance use kilometers. 100 kilometers is equal to about 62 miles.
[122] The memorandum and associated guidance use kilometers. 50 kilometers is equal to about 31 miles.

[a] The numbers correspond to the shaded regions in

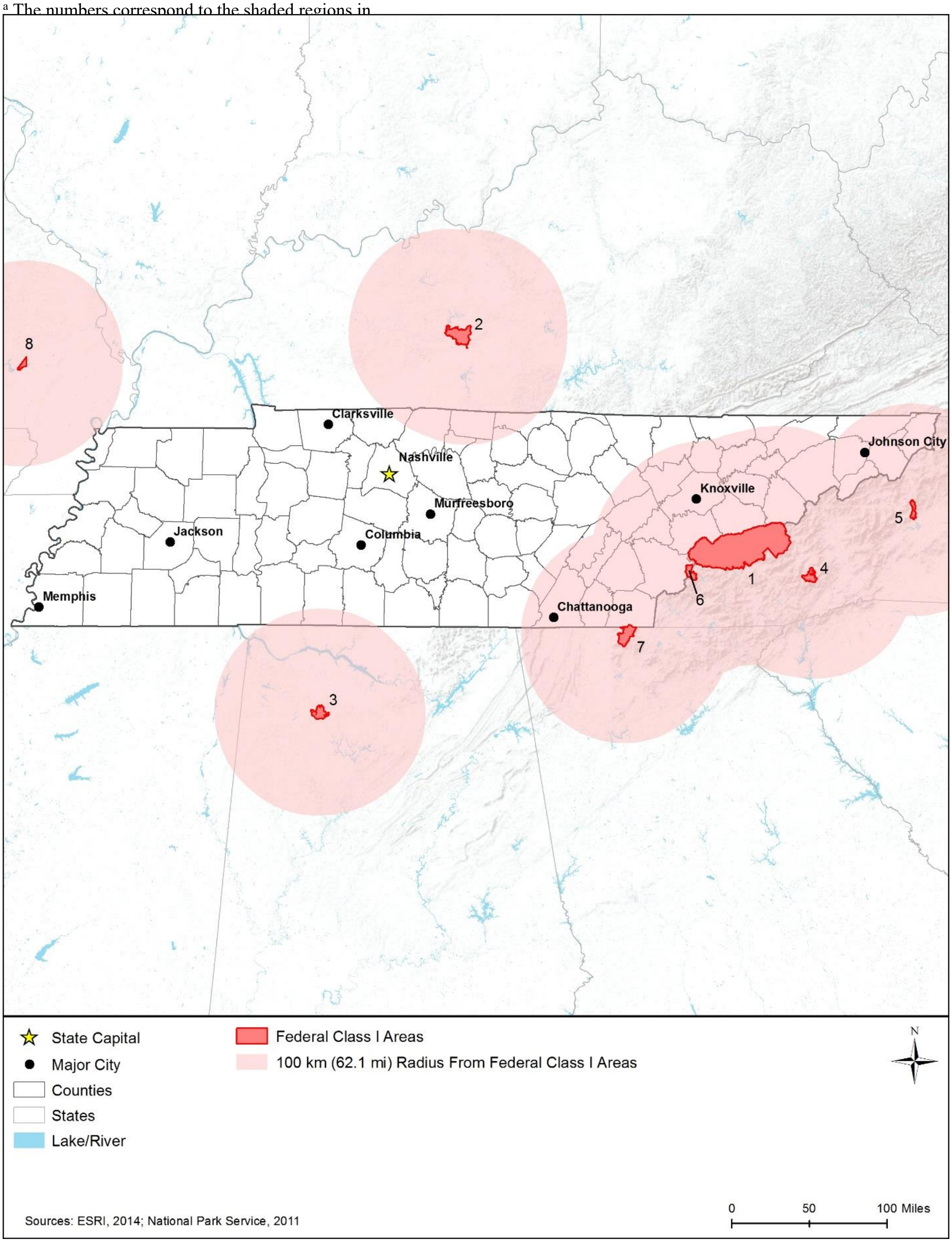


Figure 14.1.12-2.

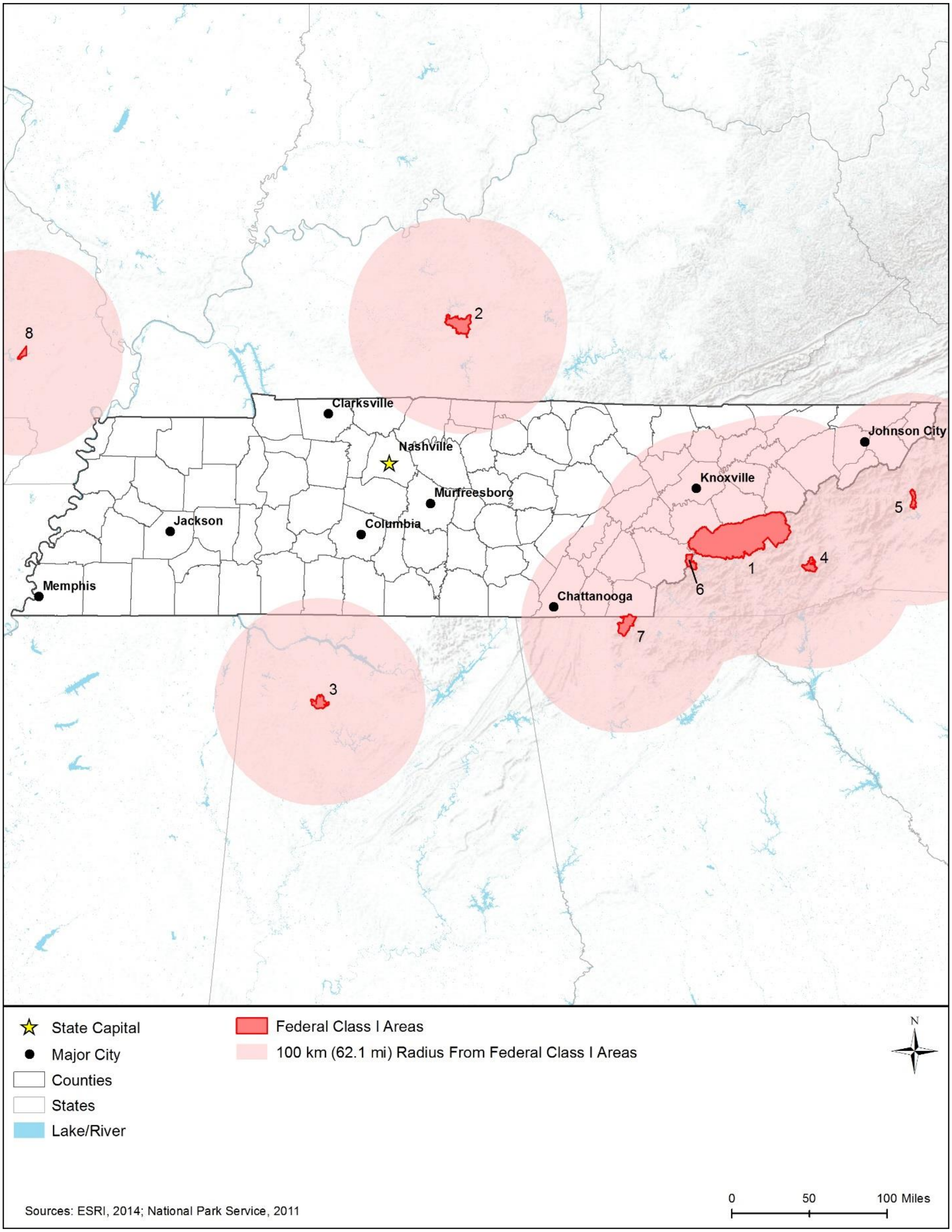


Figure 14.1.12-2: Federal Class I Areas with Implications for Tennessee

14.1.13. Noise and Vibrations

This section presents a discussion of a basic understanding of environmental noise, background/ambient noise levels, noise standards, vibrations, and guidelines.

14.1.13.1. Introduction

Noise is a form of sound caused by pressure variations that the human ear can detect and is often defined as unwanted sound (USEPA, 2012b). Noise is one of the most common environmental issues that interferes with normal human activities and otherwise diminishes the quality of the human environment. Typical sources of noise that result in this type of interference in urban and suburban surroundings includes interstate and local roadway traffic, rail traffic, industrial activities, aircraft, and neighborhood sources like lawn mowers, leaf blowers, etc.

Physiological effects such as hearing loss and anxiety. The effects of noise can be classified into three categories:

- Noise events that result in annoyance and nuisance;
- Interference with speech, sleep, and learning; and
- Physiological effects such as hearing loss and anxiety.

Ground-borne vibrations, which in many instances can be caused by tools or equipment that generate noise, can also result from roadway traffic, rail traffic, and industrial activities as well as from some construction-related activities such as blasting, pile-driving, vibratory compaction, demolition, and drilling. Unlike noise, most ground-borne vibrations are not typically experienced every day by most people because the existing environment does not include a significant number of perceptible ground-borne vibration events.

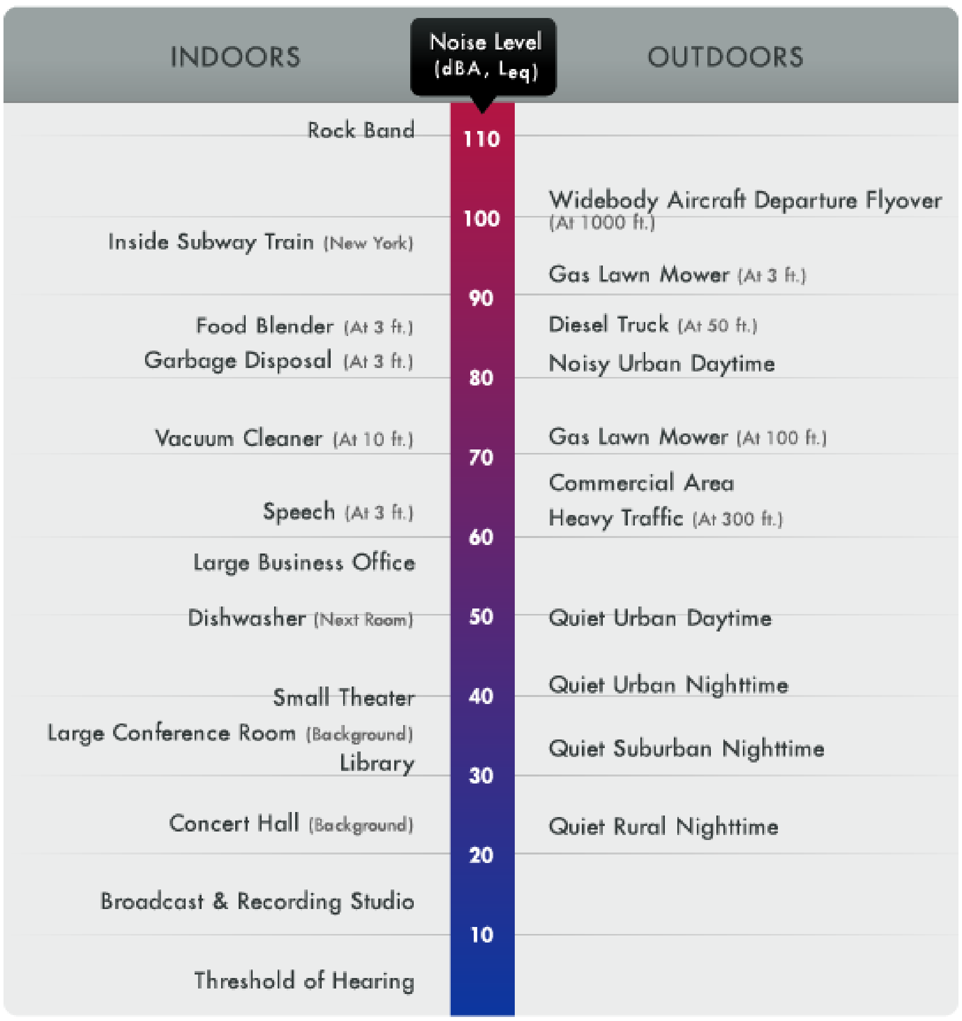
Fundamentals of Noise and Vibrations

For environmental noise analyses, a noise metric refers to the unit that quantitatively measures the effect of noise on the environment. The unit used to describe the intensity of sound is the decibel (dB). Audible sounds range from 0 dB ("threshold of hearing") to about 140 dB ("threshold of pain") (OSHA, 2016a). The vibration frequency characteristics of the sound, measured as sound wave cycles per second [Hertz (Hz)], determines the pitch of the sound (FTA, 2006). The normal audible frequency range is approximately 20 Hz to 20 kHz (FAA, 2015i). The A-weighted scale, denoted as dBA, approximates the range of human hearing by filtering out lower frequency noises, which are not as damaging as the higher frequencies. The dBA scale is used in most noise ordinances and standards (OSHA, 2016a).

Measurements and descriptions of noise (i.e., sounds) are based on various combinations of the following factors (FTA, 2006):

- The total sound energy radiated by a source, usually reported as a sound power level;
- The actual air pressure changes experienced at a particular location, usually measured as a sound pressure level (SPL) (the frequency characteristics and SPL combine to determine the loudness of a sound at a particular location);
- The duration of a sound; and
- The changes in frequency characteristics or pressure levels through time.

Figure 14.1.13-1 presents the sound levels of typical events that occur on a daily basis in the environment. For example, conversational speech is measured at about 55 to 60 dBA, whereas a band playing loud music may be as high as 120 dBA.



Source: (Sacramento County Airport System, 2015)
Prepared by: Booz Allen Hamilton
Leq: Equivalent Continuous Sound Level

Figure 14.1.13-1: Sound Levels of Typical Sounds

Because of the logarithmic unit of measurement, sound levels cannot be added or subtracted linearly. However, several methods of estimating sound levels can be useful in determining approximate sound levels. First, if two sounds of the same level are added, the sound level increases by approximately three dB (for example: 60 dB + 60 dB = 63 dB). Secondly, the sum of two sounds of a different level is slightly higher than the louder level (for example: 60 dB + 70 dB = 70.4 dB).

The changes in human response to changes in dB levels is categorized as follows (FTA, 2006):

- A 3-dB change in sound level is considered a barely noticeable difference;
- A 5-dB change in sound level will typically result in a noticeable community response; and
- A 10-dB change, which is generally considered a doubling of the sound level, almost certainly cause an adverse community response.

In general, ambient noise levels are higher during the day than at night and typically this difference is about 10 dB (USEPA, 1973). Ambient noise levels can differ considerably depending on whether the environment is urban, suburban, or rural.

Related to noise, vibration is a fluctuating motion described by displacement with respect to a reference point. Depending on the intensity, vibrations may create perceptible ground shaking and the displacement of nearby objects as well as rumbling sounds. Table 14.1.13-1 lists vibration source levels produced by typical construction machinery and activities at a distance of 25 feet in units of vibration decibels (VdB). The vibration thresholds for human perceptibility and potential building damage are 65 and 100 VdB, respectively (FTA, 2006).

Table 14.1.13-1: Vibration Source Levels for Select Construction Equipment (VdB)

Equipment[a]	VdB at 25 feet away
Pile Driver (impact type)	104-112
Pile Driver (sonic or vibratory type)	93-105
Vibratory Roller	94
Hoe Ram	87
Large Bulldozer	87
Caisson Drilling	87
Loaded Trucks	86
Jackhammer	79
Small Bulldozer	58

Source: (FTA, 2006)

VdB = vibration decibels

[a] The types of equipment listed in this table are included for reference purposes only. It is possible that not all equipment types listed here would be used in the deployment and operation of the Proposed Action.

14.1.13.2. Specific Regulatory Considerations

As identified in Appendix C, Environmental Laws and Regulations, the Noise Control Act of 1972, along with its subsequent amendments (e.g., Quiet Communities Act of 1978 [42 U.S.C. Parts 4901−4918]), delegates authority to the states to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Although no federal noise regulations exist, the USEPA has promulgated noise guidelines (USEPA, 1974). Similarly, most states have no quantitative noise-limit regulations.

Tennessee does not have any statewide noise regulations that would apply to the Proposed Action. However, many cities and towns may have local noise ordinances to manage community noise levels. The noise limits specified in such ordinances are typically applied to define noise sources and specify a maximum permissible noise level. Large cities and towns, such as Memphis, Nashville, Knoxville, and Chattanooga, are likely to have different regulations than rural or suburban communities largely due to the population density and difference in ambient noise levels (FHWA, 2011).

14.1.13.3. Environmental Setting: Ambient Noise

The range and level of ambient noise in Tennessee varies widely based on the area and environment of the area. The population of Tennessee can choose to live and interact in areas that are large cities, rural communities, and national and state parks. Figure 14.1.13-1 illustrates noise values for typical community settings and events that are representative of what the population of Tennessee may experience on a day-to-day basis. These noise levels represent a wide range and are not specific to Tennessee. As such, this section describes the areas where the population of Tennessee can potentially be exposed to higher than average noise levels.

- **Urban Environments:** Urban areas are likely to have higher noise levels on a daily basis due to highway traffic (70 to 90 dBA), construction noise (90 to 120 dBA), and outdoor conversations (e.g., small/large groups of people) (60 to 90 dBA) (DOI, 2008b). The areas that are likely to have the highest ambient noise levels in the state are: Memphis (and its neighboring boroughs and cities), Nashville, Knoxville, and Chattanooga.
- **Airports:** Areas surrounding airports tend to be more sensitive to noise due to aircraft operations that occur throughout the day. A jet engine aircraft can produce between 130 to 160 dBA in its direct proximity (FAA, 2007). However, commercial aircraft are most likely to emit noise levels between 70 to 100 dBA depending of the type of aircraft and associated engine (FAA, 2012). This noise will be perceived differently based on the altitude of the aircraft and its distance to the point of measurement. Airport operations are primarily arrivals and departures of commercial aircraft but, based on the type of airport, can include touch-and-go operations that are typical of general aviation airports and military airfields. The location of most commercial airports are in the proximity of urban communities; therefore, aircraft operations (arrivals/departures) can result in noise exposure in the surrounding areas to be at higher levels with the potential for increased noise levels during peak operation times (early morning and evenings), when there is an increase in air traffic. The noise levels in areas surrounding commercial airports can have significantly higher ambient noise levels than in other areas. In Tennessee, Memphis International Airport

(MEM), Nashville International Airport (BNA), McGhee Tyson Airport (TYS), and Chattanooga Metropolitan Airport (CHA) have more than 547,000 annual operations combined (FAA, 2015j). These operations result in increased ambient noise levels in the surrounding communities. See Section 14.1.1, Public Safety Infrastructure, and Figure 14.1.7-6 for more information about airports in the state.

- **Highways:** Communities near major highways also experience higher than average noise levels when compared to areas that are not in close proximity to a highway (FHWA, 2015c). There are a number of major highways within the state that may contribute to higher ambient noise levels for residents living in those areas. The major highways in the state tend to have higher than average ambient noise levels on nearby receptors, ranging from 52 to 75 dBA (FHWA, 2015c). See Section 14.1.1, Public Safety Infrastructure, and Figure 14.1.1-1 for more information about the major highways in the state.
- **Railways:** Like highways, railways tend to have higher than average ambient noise levels for residents living in close proximity (FTA, 2006). Railroad operations can produce noise ranging from 70 dBA for an idling locomotive to 115 dBA when the locomotive engineer rings the horn while approaching a crossing (Federal Railroad Administration, 2015). Tennessee has multiple rail corridors with high levels of commercial and commuter rail traffic. These major rail corridors include lines that extend mainly from Nashville and Memphis to other cities in Tennessee, Virginia, North Carolina, Kentucky, Georgia, Alabama, and Mississippi, such as the Nashville and Eastern Railroad and the Tennessee Southern Railroad. There are also a number of other rail corridors that join these major rail lines and connect with other cities (TDOT, 2005b). See Section 14.1.1, Public Safety Infrastructure, and Figure 14.1.1-1 for more information about rail corridors in the state.
- **National and State Parks:** The majority of national and state parks are likely to have lower than average ambient noise levels given their size and location in wilderness areas. National and state parks, historic areas, and monuments are protected areas. These areas typically have lower noise levels, as low as 30 to 40 dBA (NPS, 2014c). Tennessee has one National Park and 13 National Natural Landmarks (NPS, 2015c). Visitors to these areas expect lower ambient noise conditions than the surrounding urban areas. See Section 14.1.8, Visual Resources for more information about national and state parks for Tennessee.

14.1.13.4. Sensitive Noise and Vibration Receptors

Noise-and vibration sensitive receptors include residences, schools, medical facilities, places of worship, libraries, churches, nursing homes, concert halls, playgrounds, and parks. Sensitive noise receptors are typically areas where the intrusion of noise can disrupt the use of the environment. A quiet urban area usually has a typical noise level in the daytime of 50 dBA, and 40 dBA during the evening. Noise levels in remote wilderness and rural nighttime areas are usually 30 dBA (BLM, 2014). Most cities and towns in Tennessee have at least one school, church, or park, in addition to likely having other noise or vibration-sensitive receptors. There are most likely thousands of sensitive receptors throughout the state.

14.1.14. Climate Change

14.1.14.1. Introduction

Climate change, according to the Intergovernmental Panel on Climate Change (IPCC), is defined as "…a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or human activity." (IPCC, 2007)

Accelerated rates of climate change are linked to an increase in atmospheric concentrations of greenhouse gas (GHG) caused by emissions from human activities such as burning fossil fuels to generate electricity (USEPA, 2012c). The IPCC is now 95 percent certain that humans are the main cause of current global warming (IPCC, 2013). Human activities result in emissions of four main GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and halocarbons (a group of gases containing fluorine, chlorine, or bromine) (IPCC, 2007). The common unit of measurement for GHGs is metric tons of CO_2-equivalent (MT CO_2e),[123] which equalizes for the different global warming potential of each type of GHG. Where this document references emissions of CO_2 only, the units are in million metric tons (MMT) CO_2. Where the document references emissions of multiple GHGs, the units are in MMT CO_2e.

The IPCC reports that "global concentrations of these four GHGs have increased significantly since 1750" with "atmospheric concentrations of CO_2 increased from 280 parts per million (ppm) of carbon in 1750 to 379 ppm of carbon in 2005" (IPCC, 2007). The atmospheric concentration of CH_4 and N_2O have increased from pre-industrial values of about 715 and 270 parts per billion (ppb) to 1774 and 319 ppb, respectively, in 2005 (IPCC, 2007). In addition, the IPCC reports that human activities are causing an increase in various hydrocarbons from near-zero pre-industrial concentrations (IPCC, 2007).

Both the GHG emissions effects of the Proposed Action and Alternatives, and the relationships of climate change effects to the Proposed Action and Alternatives, are considered in this PEIS (see Section 14.2.14, Environmental Consequences). Existing climate conditions in the project area are described first by state and sub-region, where appropriate, and then by future projected climate scenarios. The discussion focuses on the following climate change impacts: 1) temperature; 2) precipitation/drought; and 3) severe weather events.

14.1.14.2. Specific Regulatory Considerations

The pertinent federal laws relevant to the protection and management of climate change are summarized in Appendix C, Environmental Laws and Regulations. The Council on Environmental Quality (CEQ) published draft National Environmental Policy Act (NEPA) guidance on the consideration of the effects of climate change and greenhouse gas in February of 2010. Revised draft guidance was published in December 2014 and in August 2016 (after

[123] CO_2e refers to Carbon Dioxide Equivalent, "A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). Carbon dioxide equivalents are commonly expressed as million metric tons of carbon dioxide equivalents ($MMTCO_2e$). The carbon dioxide equivalent for a gas is derived by multiplying the tons of the gas by the associated GWP. $MMTCO_2e$ = (million metric tons of a gas) * (GWP of the gas)." (USEPA, 2016g)

publication of the Draft PEIS) CEQ published its final guidance. This guidance is applicable to all federal agency actions and is meant to facilitate compliance within the legal requirements of NEPA. The CEQ guidance describes how federal agency actions should evaluate GHG and climate change effects in their NEPA reviews, using GHG emissions as a proxy for assessing a proposed action's potential effect on climate change. CEQ defines GHGs to include CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, which is in accordance with Section 19 (m) of *Executive Order 13693*. The final CEQ guidance suggests that agencies consider "(1) the potential effects of a proposed action on climate change as indicated by assessing GHG emissions (e.g. to include, where applicable, carbon sequestration); and (2) the effects of climate change on a proposed action and its environmental impacts." The final guidance recommends that agencies quantify an action's projected direct and indirect GHG emissions when data inputs are reasonably available to support calculations. The final guidance states that "agencies should be guided by the principle that the extent of the analysis should be commensurate with the quantity of the projected GHG emissions and take into account available data and GHG quantification tools that are suitable for and commensurate with the proposed agency action." In addition, CEQ recommends agencies evaluate project emissions and changes in carbon sequestration and storage, when appropriate, in assessing a proposed action's potential climate change impacts. The analysis should assess direct and indirect climate change effects of a proposed project including connected actions, the cumulative impacts of its proposed action, and reasonable alternatives. CEQ advises that climate change effects on the environmental consequences of a proposed action should be described based on available studies, observations, interpretive assessments, predictive modeling, scenarios, and other empirical evidence. The temporal bounds should be limited by the expected lifetime of the proposed project. Mitigation and adaptation measures should be considered in the analysis for effects that occur immediately and in the future. Tennessee has not established goals and regulations to reduce GHG emissions to combat climate change.

14.1.14.3. Tennessee Greenhouse Gas Emissions

Estimates of Tennessee's total GHG emissions vary. The Department of Energy's (DOE) Energy Information Agency (EIA) collects and disseminates national-level emissions data on other GHGs such as CH_4 and nitrous oxide (NO_x), but not at the state level (EIA, 2011). The USEPA also collects and disseminates national-level GHG emissions data, but by economic sector, not by state (USEPA, 2014c). Individual states have developed their own GHG inventories, which are updated with different frequencies and trace GHG in a variety of ways.

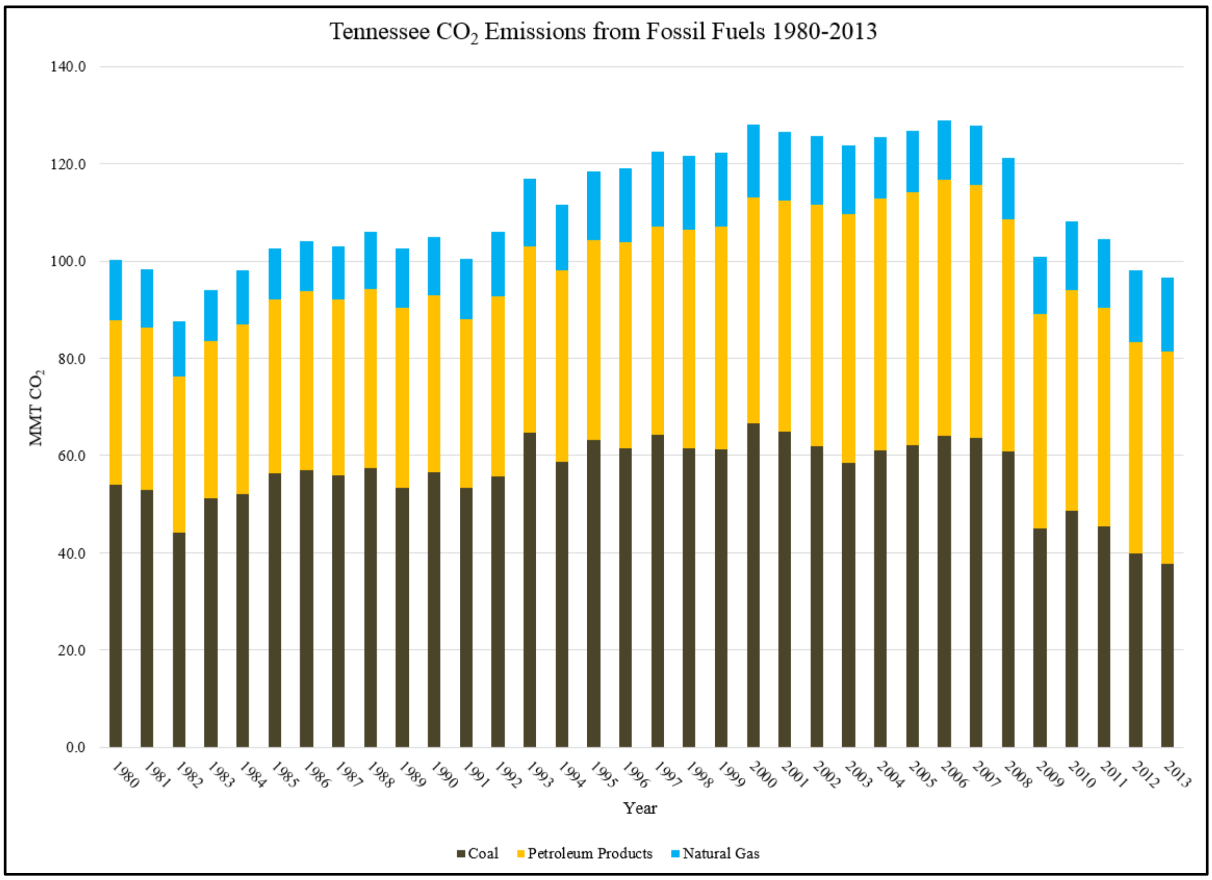
For the purposes of this PEIS, the EIA data on CO_2 emissions are used as the baseline metric to ensure consistency and comparability across the 50 states. However, if additional data sources are available for a given state, including other GHGs such as CH_4, they are described and cited.

According to the EIA, Tennessee emitted 103.5 MMT of CO_2 in 2014 (EIA, 2014a). The transportation and electric power sectors together accounted for approximately 76 percent of total CO_2 emissions, at 41.4 and 37.1 MMT respectively. Transportation emissions accounted for almost all the emissions from petroleum products, while the electric power sector accounted for a significant portion of the emissions from coal (Table 14.1.14-1) (EIA, 2014a). Annual emissions between 1980 and 2013 are presented in Figure 14.1.14-1 (EIA, 2014a). Between 1980 and 2006, Tennessee's CO_2 emissions increased by approximately 29 percent to a high of 129.6 MMT. Emissions have generally declined since 2006. Most of the declines were led by reductions in emissions from coal (EIA, 2014a). In 2014, Tennessee was ranked 28th among the states and the District of Columbia for per-capita energy-related CO_2 emissions and 19th for total CO_2 emissions (EIA, 2014b).

Table 14.1.14-1: Tennessee CO_2 Emissions from Fossil Fuels by Fuel Type and Sector, 2014

Fuel Type (MMT)		Source (MMT)	
Coal	40.3	Residential	4.7
Petroleum Products	46.6	Commercial	3.8
Natural Gas	16.6	Industrial	16.6
		Transportation	41.4
		Electric Power	37.1
TOTAL	**103.5**	**TOTAL**	**103.5**

Source: (EIA, 2014a)



Source: (EIA, 2014a)

Figure 14.1.14-1: Tennessee CO_2 Emissions from Fossil Fuels by Fuel Type 1980-2013

Tennessee does not have an official state-level greenhouse gas emission inventory. As a large producer and consumer of electricity from hydropower and nuclear assets owned by the

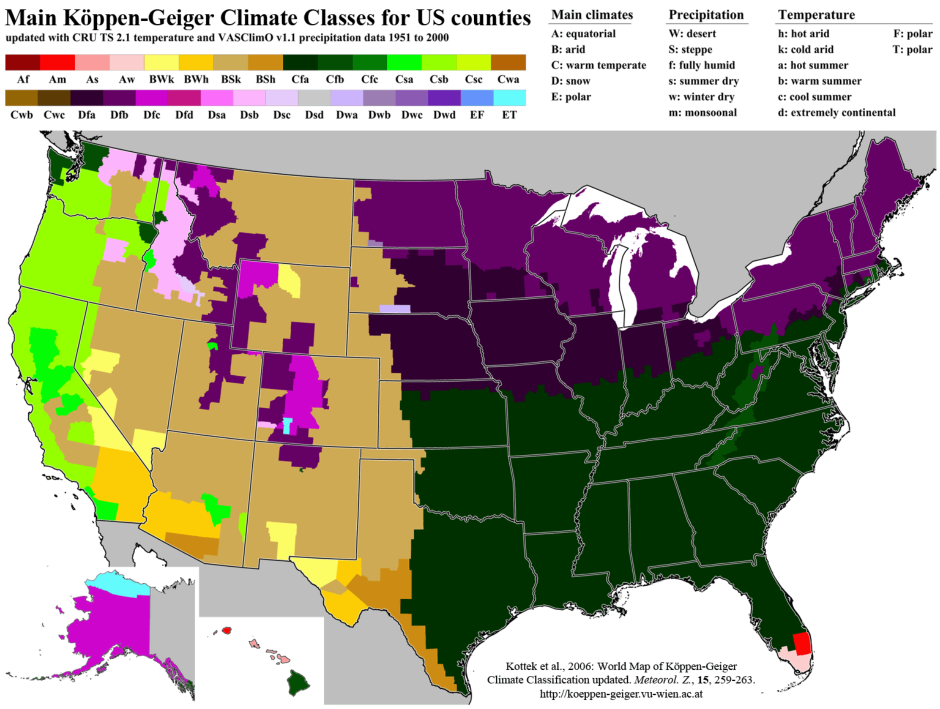
Tennessee Valley Authority, CO_2 (and thereby GHG) emissions are lower than they would be, considering the high per-capita electricity consumption in the state (EIA, 2015c). Tennessee is among the bottom ten states in regards to resource production: it is not a large producer of crude oil, natural gas, or coal, and imports most of the coal used in the state by industry and the electric power sector from other states, including Wyoming, Illinois, Colorado, Kentucky, Indiana, and West Virginia (EIA, 2015c). Tennessee does not currently produce large quantities of natural gas; however, it may start exploring the Chattanooga Shale for natural gas to substitute for coal in its power plants, as well as supply demand from the industrial sector, which is a large natural gas consumer (EIA, 2015c). This may decrease CO_2 and N_2O emissions from coal in the future, while increasing CO_2 emissions from natural gas.

14.1.14.4. Environmental Setting: Existing Climate

The National Weather Service (NWS) defines climate as “The composite or generally prevailing weather conditions of a region, throughout the year, averaged over a series of years.” (NWS, 2009). The widely accepted division of the world into major climate categories is referred to as the Köppen-Geiger climate classification system. Climates within this system are classified based “upon general temperature profiles related to latitude” (NWS, 2011). The first letter in each climate classification details the climate group. The Köppen-Geiger system further divides climates into smaller sub-categories based on precipitation and temperature patterns. The secondary level of classification details the seasonal precipitation, degree of aridity, and presence or absence of ice. The tertiary levels distinguish different monthly temperature characteristics (NWS, 2006).

The entirety of Tennessee is located within the climate classification group C. Climates classified as C are generally warm, with humid summers and mild winters. During winter months, the mean climate feature is the mid-latitude cyclone (NWS, 2011) (NWS, 2006). Tennessee has one sub-climate category, which is described in the following paragraphs.

Cfa – The Köppen-Geiger climate classification system classifies areas of Tennessee, such as Nashville, as Cfa. Cfa climates are generally warm, with humid summers and mild winters. In this climate classification zone, the secondary classification indicates year-round rainfall, but it is highly variable; thunderstorms are dominant during summer months. In this climate classification zone, the tertiary classification indicates mild, hot summers with average temperature of warm months over 72 °F. Average temperatures of the coldest months are under 64 °F. (NWS, 2011), (NWS, 2006)



Source: (Kottek, World Map of the Köppen-Geiger Climate Classification, 2006)

Figure 14.1.14-2: Köppen-Geiger Climate Classes for U.S. Counties

This section discusses the current state of Tennessee's climate with regard to air temperature, precipitation, and extreme weather events (e.g., flooding, severe thunderstorms, and tornadoes) in the state's climate region, Cfa.

Air Temperature

Temperatures in Tennessee vary according to the state's topography. For example, areas of higher elevation, such as the Cumberland Plateau, typically average lower annual temperatures than areas with lower elevation, such as the Great Valley of eastern Tennessee. Statewide, average annual temperatures range from approximately 62 °F in southwestern areas of the state, to approximately 45 °F in mountainous areas of the state. With increasing elevation, summers in the state "become cooler and more pleasant while winters become colder and more blustery" (NCDC, 2015).

Flat, low-lying plains of western Tennessee are typically the warmest areas of the state, with temperatures averaging approximately 62 °F. The highest temperature to occur in Tennessee was on July 29, 1930 and August 9, 1930 with a record high of 113 °F (SCEC, 2015). The lowest temperature to occur in Tennessee was on December 30, 1917 with a record low of negative 32 °F (SCEC, 2015) (Logan, 2015).

Cfa – Nashville, the capital of Tennessee, is located within north central Tennessee. The average annual temperature in Nashville is approximately 59.4 °F; 39.9 °F during winter months; 78.0 °F during summer months; 58.8 °F during spring months; and 60.5 °F during autumn months (NOAA, 2015b). Memphis, located in far western Tennessee, is also within the climate classification zone Cfa. The average annual temperature in Memphis is approximately 63.1 °F; 43.4 °F during winter months; 81.5°F during summer months; 62.9 °F during spring months; and 64.1 °F during autumn months (NOAA, 2015b).

Precipitation

Average annual precipitation in flat, low-lying plains of western Tennessee typically reach between 46 and 54 inches. Average annual precipitation totals increase even more towards Memphis. Northeastern areas of the state are typically the driest, with annual precipitation totals averaging below 46 inches. East central regions of the state are the wettest, with annual precipitation totals averaging 54 to 62 inches. The Cumberland Plateau, located in central Tennessee, records some of the highest precipitation averages in the state, "although they are not as high as the Smoky Mountains" (Logan, 2015).

Snowfall is also common within the Cumberland Plateau, "while it would normally be raining in the rest of Middle Tennessee" (Logan, 2015). For example, Nashville, located in the states Central Basin, averages approximately 5.4 inches in annual snowfall, while Crossville, located within the Cumberland Plateau averages approximately 14.4 inches of annual snowfall (Logan, 2015). The Central Basin is also the direst region of the state, with Nashville receiving approximately 47 inches in precipitation, while surrounding areas receive above 50 inches. In eastern Tennessee, the climate is "dominated by the rain shadow effect, offered by the unique geography of the Cumberland Plateau and the Appalachian Mountains" (Logan, 2015). Both the highest and lowest rainfall accumulation totals are found within this area, with Bristol averaging approximately 41 inches of rainfall per year and the Great Smoky Mountains averaging approximately 85 inches of rainfall per year. (Logan, 2015)

The greatest 24-hour precipitation accumulation total to occur in Tennessee was on September 13, 1982 with a total of 13.6 inches (SCEC, 2015). The greatest 24-hour snowfall accumulation total to occur in Tennessee was on March 14, 1993 with a total of 30 inches (SCEC, 2015). (Logan, 2015)

Cfa – Nashville, the capital of Tennessee, is located within north central Tennessee. The average annual precipitation accumulation in Nashville is 47.25 inches; 11.93 inches during winter months; 10.95 inches during summer months; 13.61 inches during spring months; and 10.76 inches during autumn months (NOAA, 2015b). Memphis, located in far western Tennessee, is also within the climate classification zone Cfa. The average annual precipitation accumulation in Memphis is 53.68 inches; 14.11 inches during winter months; 11.10 inches during summer months; 15.91 inches during spring months; and 12.56 inches during autumn months (NOAA, 2015b).

Severe Weather Events

The most severe flooding season in Tennessee is during the winter and early spring, "when the frequent migratory storms bring general rains of high intensity" (NCDC, 2015). During this period, widespread flooding and localized flash flooding can occur. During summer months, severe thunderstorms frequently result in localized flash flooding. During autumn months, thunderstorms and heavy rainfalls are rare; the majority of flooding events during autumn months are due to tropical storm remnants. (NCDC, 2015)

The East Tennessee Flood of 1867 was "the most significant flood ever recorded in east Tennessee" (NWS, 2015a). Upper areas of the Tennessee Valley were particularly susceptible to flooding, due to their geographical location between the Great Smoky Mountains and the Cumberland Plateau. Data from 1867 shows that upwards of 12 inches fell across the area, which in combination with rapid seasonal snowmelt, flooded much of the Valley (NWS, 2015a).

More recently in 2010, heavy rainfall in combination with a tropical air mass from the Gulf of Mexico caused record flooding in Nashville. Across the area, rainfall totals range from 12 to 20 inches, "with many rivers setting new record crests" (NWS, 2015a). In total, 22 people were killed (18 in Middle Tennessee and 4 in western Tennessee). Monetary losses were also high, with over $2 billion in damages in the Nashville metro area alone, and approximately $3 billion statewide (NWS, 2015a).

The following year in 2011, heavy rainfall and springtime snowmelt lead to prolific flooding along the Mississippi River. "In Tennessee, much of the flooding occurred along the Mississippi River and its tributaries from the North Tennessee state line southward to the north boundary of Bolivar County, MS" (NWS, 2015a). Although the exact cost of this flooding event is unknown, the government estimates it was likely hundreds of millions of dollars (NWS, 2015a).

In 2011, Tennessee experienced record flooding, severe storms, and deadly tornadoes, resulting in five presidentially declared disasters, the most of any other state that year. In total, 37 people were killed and the state incurred approximately $100 million damages across 66 of the state's 95 counties. (NWS, 2012)

Geographically, Tennessee is not located within "tornado alley," but "its geographical location still allows for a relatively high frequency of tornado occurrences" (NOAA, 2015c). Tornadoes have been reported in nearly every county in Tennessee. The counties of Knox, Bradley, and McMinn experience the greatest number of tornadoes annually. Tornadoes occur more frequently between the months of March and May, accounting for 63 percent of the state's annual tornadoes. Historically, the month of April experiences the greatest number of tornadoes annually. September is the state's least active month. Since 1950, only one tornado has been reported during the month of September (Presnall & Hotz, 2015).

In Memphis, 613 tornadoes were reported between 1950 and 1993, with an average of 14 per year. In total, these tornadoes killed 227 people. During this period, "tornadoes occurred during each of the 44 years, during every month of the year, and at all hours of the day" (NWS, 2015b). Approximately 80 percent of the tornadoes to occur were reported in Shelby County. Shelby County is the area's most populous county within the Memphis metropolitan area. Of the 613 tornadoes reported between 1950 and 1993, "6060 have been assigned F-scale ratings" (NWS, 2015b). "Of this total, 51.7% (313 tornadoes) were classified as weak, 44.2% (268 tornadoes) as strong and 4.1% (25 tornadoes) as violent" (NWS, 2015b). Since 1950, only one F5 tornado has been reported, striking Fayette County on March 21, 1952; killing seven and injuring 50. Since

1830, 469 tornadoes have occurred within Middle Tennessee. In the past 10 years, Middle Tennessee has averaged approximately 16 tornadoes annually. (NWS, 2015b) (NOAA, 2015c)

Severe hail has also been reported in the Memphis metropolitan area, occurring most frequently between March and June. Approximately 74 percent of all hail reports occur during this period. (NWS, 2015b)

14.1.15. Human Health and Safety

14.1.15.1. Introduction

The existing environment for health and safety is defined by occupational and environmental hazards likely to be encountered during the deployment, operation, and maintenance of towers, antennas, cables, utilities, and other equipment and infrastructure at existing and potential FirstNet telecommunication sites. There are two human populations of interest within the existing environment of health and safety, (1) telecommunication occupational workers and (2) the general public near telecommunication sites. Each of these populations could experience different degrees of exposure to hazards as a result of their relative access to FirstNet telecommunication sites and their function throughout the deployment of the FirstNet telecommunication network infrastructure.

The health and safety issues reviewed in this section include occupational safety for telecommunications workers, contaminated sites, and manmade or natural disaster sites. This section does not evaluate the health and safety risks associated with radio frequency (RF) emissions, addressed in Section 2.4. Vehicle traffic and the transportation of hazardous materials and wastes evaluated in Section 14.1.1.

There are unique infectious diseases throughout the continental U.S. Because of the great variety of diseases, as well as the variables associated with contracting them, this PEIS will not be evaluating infectious diseases. For information on Infectious Diseases, please visit the Center for Disease Control and Prevention website at www.CDC.gov.

14.1.15.2. Specific Regulatory Considerations

Federal organizations, such as the Occupational Safety and Health Administration (OSHA), USEPA, the U.S. Department of Health and Human Services, and others protect human health and the environment. In Tennessee, the Tennessee Department of Labor and Workforce Development (TNDLWD), TDEC, and Tennessee Department of Health (TNDOH) regulate this resource area. Federal OSHA regulations apply to workers through either OSHA, or stricter state-specific plans that must be approved by OSHA. Occupational health is regulated by TOSHA and public health is regulated by TNDOH.

Federal laws relevant to protecting occupational and public health and safety are summarized in Appendix C, Environmental Laws and Regulations, and Section 1.8, Overview of Relevant Federal Laws and Executive Orders. Table 14.1.15-1 below summarizes the major Tennessee laws relevant to the state's occupational health and safety programs.

Table 14.1.15-1: Relevant Tennessee Human Health and Safety Laws and Regulations

State Law/Regulation	Regulatory Agency	Applicability
Tennessee Code, Title 50, Chapter 3	TNDLWD	Established the Tennessee Occupational Safety and Health Act of 1972 to promote occupational safety and health; provide education to public sector employees and employers; investigate occupational injuries, illnesses, and deaths; and specify reporting requirements.
Tennessee Code, Title 68, Chapter 212, Part 2, Section 224	TDEC	Encourages voluntary cleanup of brownfield sites and provides funding mechanisms to undertake the rehabilitation, removal, and cleanup of sites.
Tennessee Code, Title 50, Chapter 3, Part 10	TNDLWD	Establishes occupational safety requirements for work conducted near high-voltage overhead lines.

Sources: (Justia, 2016n) (Justia, 2016o) (Justia, 2016p)

14.1.15.3. Environmental Setting: Existing Telecommunication Sites

There are many inherent health and safety hazards at telecommunication sites. Telecommunication site work is performed indoors, below ground level, on building roofs, over waterbodies, and on communication towers. Tasks may also be performed at dangerous heights, or confined spaces, while operating heavy equipment, on energized equipment near underground and overhead utilities, and while using hazardous materials, such as flammable gases and liquids. Because telecommunication workers are often required to perform work outside, heat and cold exposure, precipitation, and lightning strikes also present hazard and risks depending on the task, occupational competency, and work-site monitoring (OSHA, 2016b). A summary description of the health and safety hazards present in the telecommunication occupational work environment is listed below.

Working from height, overhead work, and slips, trips, or falls – At tower and building-mount sites, workers regularly climb structures using fixed ladders or step bolts to heights up to 2,000 feet above the ground's surface (OSHA, 2015a). In addition to tower climbing hazards, telecommunication workers have restricted workspace on rooftops or work from bucket trucks parked on uneven ground. Cumulatively, these conditions present fall and injury hazards to telecommunication workers, and the public who may be observing the work or transiting the area (International Finance Corporation, 2007).

Trenches and confined spaces – Installation of underground utilities, building foundations, and work in utility manholes[124] are examples of when confined space work is necessary. Installation of telecommunication activities involves laying conduit and in small trenches (generally 6 to 12 inches in width). Confined space work can involve poor atmospheric conditions, requiring ventilation and rescue equipment. Additionally, when inside a confined space, worker movement is restricted and may prevent a rapid escape or interfere with proper work posture and ergonomics. (OSHA, 2016c)

[124] Manholes may be used for telecommunications activities, especially in cities and urban areas, depending on the location of other utilities. In cities, power, water, and telecommunication lines are often co-located; if access is through a manhole in the street, that access will be used.

Heavy equipment and machinery – New and replacement facility deployment and maintenance can involve the use of heavy equipment and machinery. During the lifecycle of a telecommunication site, heavy equipment such as bulldozers, backhoes, dump trucks, cement trucks, and cranes are used to prepare the ground, transport materials and soil, and raise large sections of towers and antennas. Telecommunication workers may be exposed to the additional site traffic and often work near heavy equipment to direct the equipment drivers and to accomplish work objectives. Accessory machinery such as motorized pulley systems, hydraulic metal shears, and air driven tools present additional health and safety risks as telecommunication work sites. These pieces of machinery can potentially sever skin and bone, or cause other significant musculoskeletal injuries to the operator. (OSHA, 2016c)

Energized equipment and existing utilities – Electrical shock from energized equipment and utilities is an elevated risk at telecommunication sites due to the amount of electrical energy required for powering communication equipment and broadcasting towers. Telecommunication cables are often co-located with underground and overhead utilities, which can further increase occupational risk during earth-breaking and aerial work (International Finance Corporation, 2007).

Optical fiber safety – Optical fiber cable installation and repair presents additional risks to telecommunications workers, including potential eye or tissue damage, through ingestion, inhalation, or other contact with glass fiber shards. The shards are generated during termination and splicing activities, and can penetrate exposed skin (International Finance Corporation, 2007). Additionally, fusion splicing (to join optical fibers) in confined spaces or other environments with the potential for flammable gas accumulation (e.g., manholes) presents risk of fire or explosion (Fiber Optic Association, 2010).

Noise and Vibrations– Sources of excess noise and vibrations at telecommunication sites include heavy equipment operation, electrical power generators and other small engine equipment, air compressors, electrical and pneumatic power tools, and road vehicles, such a diesel engine work trucks. The cumulative noise environment has the potential to exceed the OSHA acceptable level of 85 dB per 8-hour time weighted average (see Section 14.1.13, Noise) (OSHA, 2002). Fugitive noise may emanate beyond the telecommunication work site and impact the public living in the vicinity, observing the work, or transiting through the area (OSHA, 2016c).

Hazardous materials and hazardous waste – Work at telecommunication sites may require the storage and use of hazardous materials such as fuel sources for backup power generators and compressed gases used for welding and metal cutting (new towers only). In some cases, telecommunication sites require treatments, such as pesticide application. Secondary hazardous materials, like exhaust fumes, may be a greater health risk than the primary hazardous material (i.e., diesel fuel). Furthermore, the use of hazardous materials creates down-stream potential to generate hazardous waste. While it is unlikely that any FirstNet activities would involve the generation or storage of hazardous waste, older existing telecommunication structures and sites could have hazardous materials present, such as lead-based (exterior and interior) paint at outdoor structures or asbestos tiles and insulation in equipment sheds. The public, unless a telecommunication work site allows unrestricted access, are typically shielded from hazardous materials and hazardous wastes that are components of telecommunication site work. (OSHA, 2016c)

Aquatic environments – Installation of telecommunication lines may include laying, burying, or boring lines under wetlands and waterways, including lakes, rivers, ponds, and streams. Workers responsible for these activities operate heavy equipment from soft shorelines, boats, barges, and other unstable surfaces. There is potential for equipment and personnel falls, as well as drowning in waterbodies. Wet work conditions also increase risks of electric shock and hypothermia. (OSHA, 2016c)

Outdoor elements – Weather conditions have the potential to quickly and drastically reduce safety, and increase hazards at telecommunication work sites. Excessive heat and cold conditions impact judgement, motor skills, hydration, and in extreme cases may lead to hyper- or hypothermia. Precipitation, such as rain, ice, and snow, create slippery climbing conditions and wet or muddy ground conditions. Lightning strikes are risks to telecommunication workers climbing towers or working on top of buildings. (OSHA, 2016c)

Public Health and Safety

The public are not likely to encounter occupational hazards at telecommunication sites, due to limited access. Tennessee has not recorded incidents of injuries from the public to these sites, but collects fatality data among the public through Health Information Tennessee (TNDOH, 2015b). The same data are reported with more specificity at the federal level through the Centers for Disease Control and Prevention (CDC) Wide-ranging Online Data for Epidemiologic Research (WONDER). While the WONDER database cannot be searched for cases specific to telecommunication sites, many available injury categories are consistent with risks present at telecommunication sites. For example, in Tennessee, between 1999 and 2013, there were 172 fatalities due to a fall from, out of, or through a building or structure; 29 fatalities due to exposure to electric transmission lines; and 36 fatality due to being caught, crushed, jammed or pinched in or between objects (CDC, 2015a). Among the public, trespassers entering telecommunication sites would be at the greatest risk for exposure to health and safety hazards.

14.1.15.4. Environmental Setting: Contaminated Properties at or near Telecommunication Sites

Existing and surrounding land uses, including landfills or redeveloped brownfields, near telecommunication sites have the potential to impact human health and safety. Furthermore, undocumented environmental practices of telecommunication site occupants, including practices before current environmental laws, could result in environmental contamination, affecting the quality of soil, sediments, groundwater, surface water, and air.

Contaminated property is typically classified by the federal environmental remediation or cleanup programs that govern them, such as sites administered through the Superfund Program[125]

[125] The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) enacted in 1980, commonly referred to as the Superfund Program, governs abandoned hazardous waste sites, and collects a tax on chemical and petroleum industries. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986; see Appendix C, Environmental Laws and Regulations. (BLS, 2013a)

or listed on the National Priorities List (NPL), as well as the Resource Conservation and Recovery Act (RCRA) Corrective Action sites and Brownfields. These regulated cleanup sites are known to contain environmental contaminants at concentrations exceeding acceptable human health exposure thresholds. Contact with high concentrations of contaminated media can result in adverse health effects, such as dermatitis, pulmonary and cardiovascular events, organ disease, central nervous system disruption, birth defects, and cancer. It generally requires extended periods of exposure over a lifetime for the most severe health effects to occur.

Tennessee's Superfund Program is managed by the TDEC, Division of Remediation (TDEC, 2015q). As of November 2015, Tennessee had 58 RCRA Corrective Action sites,[126] 150 brownfield sites, and 16 proposed or final Superfund/NPL sites (USEPA, 2015d). Based on a November 2015 search of USEPA Cleanups in My Community (CIMC) database, there are no Superfund sites and one RCRA Corrective Action site (Velsicol Chemical Company in Toone, TN) in Tennessee where contamination has been detected at an unsafe level, or a reasonable human exposure risk still exists (USEPA, 2015k).

Brownfield sites in Tennessee may enroll in a variety of programs managed by the TDEC, Division of Remediation, including the State Brownfield Remediation Program; Voluntary Cleanup, Oversight and Assistance Program; Dry Cleaner Environmental Response Program; and Methamphetamine Laboratory Cleanup Program. One example of a brownfield site is the former 350-acre Alcoa Aluminum Co. West Plant in Alcoa, TN. Between 1920 and 1989, Alcoa Aluminum Co. manufactured various aluminum products, contaminating the area with volatile organic compounds, metals, PCBs and hydrocarbons. The City of Alcoa and the Alcoa School District entered into a Brownfield Voluntary Agreement with TDEC and redeveloped the land for a 170,000 square foot Alcoa High School. Cleanup efforts at the school site included infrastructure demolition (including underground storage tanks), 104,000 gallons of sludge removal, and soil excavation to five feet. (TDEC, 2015r)

In addition to contaminated properties, certain industrial facilities are permitted to release toxic chemicals into the air, water, or land. One such program is the Toxics Release Inventory (TRI), administered by the USEPA under the Emergency Planning and Community Right to Know Act (EPCRA) of 1986. The TRI database is a measure of the industrial nature of an area and the over-all chemical use, and can be used to track trends in releases over time. The "releases" do not necessarily equate to chemical exposure by humans or necessarily constitute to quantifiable health risks because the releases include all wastes generated by a facility – the majority of which are disposed of via managed, regulated processes that minimize human exposure and related health risks (e.g., in properly permitted landfills or through recycling facilities). As of November 2015, Tennessee had 585 TRI reporting facilities. The identification of a TRI facility does not necessarily indicate that the facility is actively releasing to the environment; the majority of TRI reports involve permitted disposal facilities. According to the USEPA, in 2013, the most recent data available, Tennessee released 78.9 million pounds of toxic chemicals through onsite and offsite disposal, transfer, or other releases, largely from chemicals industries.

[126] Data gathered using USEPA's Cleanups in My Community (CIMC) search on November 11, 2015, for all sites in Tennessee, where cleanup type equals 'RCRA Hazardous Waste – Corrective Action,' and excludes sites where cleanup phase equals 'Construction Complete' (i.e., no longer active) (BLS, 2013b).

This accounted for 1.92 percent of total nationwide TRI releases, ranking Tennessee 10th in the nation based on total releases per square mile. (USEPA, 2013c)

Another USEPA program is the NPDES, which regulates the quality of stormwater and sewer discharge from industrial and manufacturing facilities. Permitted discharge facilities are potential sources of toxic constituents that are harmful to human health or the environment. As of November 2015, Tennessee had 159 major NPDES permitted facilities registered with the USEPA Integrated Compliance Information System (USEPA, 2015l).

The National Institutes of Health, U.S. National Library of Medicine, provides an online mapping tool called TOXMAP, which allows users to “visually explore data from the USEPA’s TRI and Superfund Program” (National Institutes of Health, 2015). Figure 14.1.15-1 provides an overview of potentially hazardous sites in Tennessee.

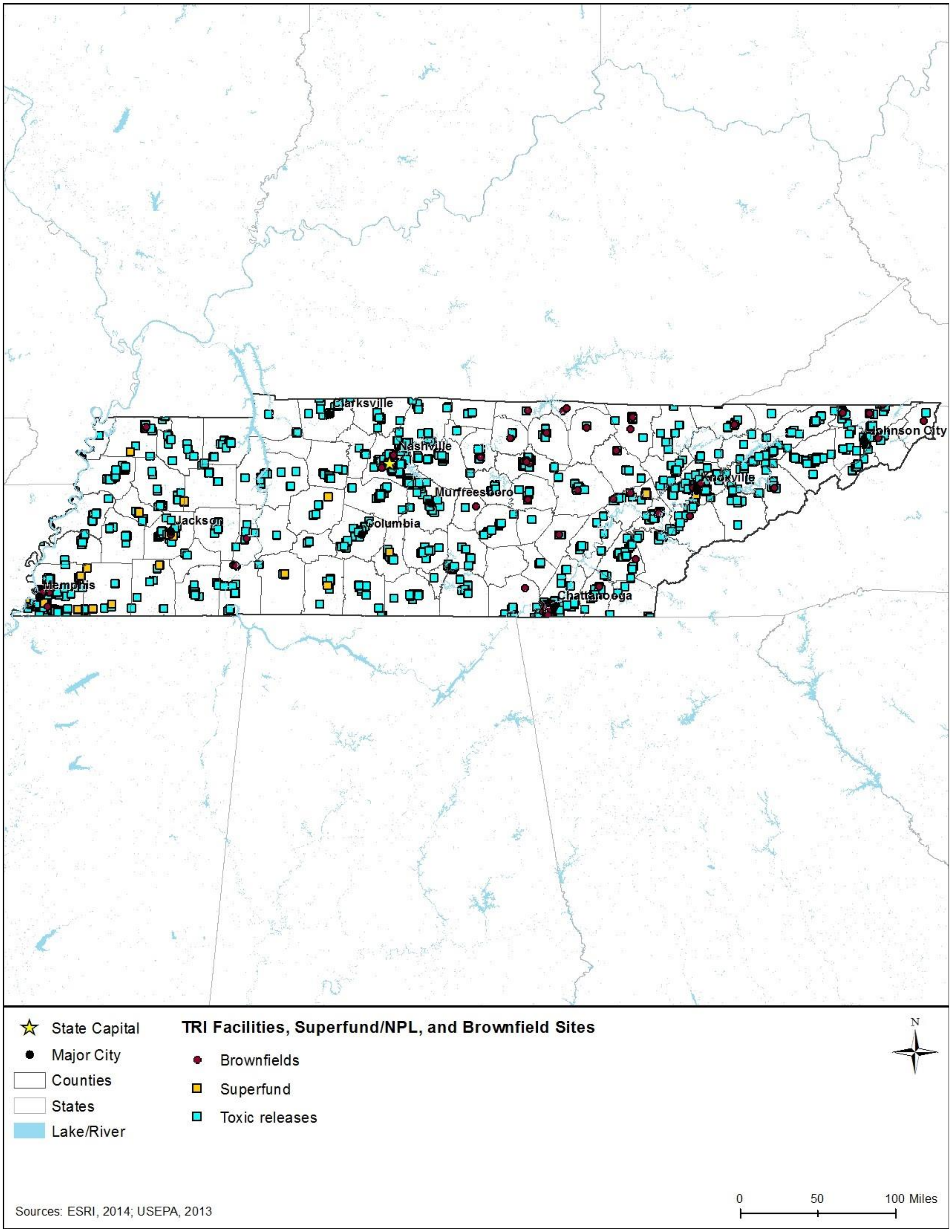
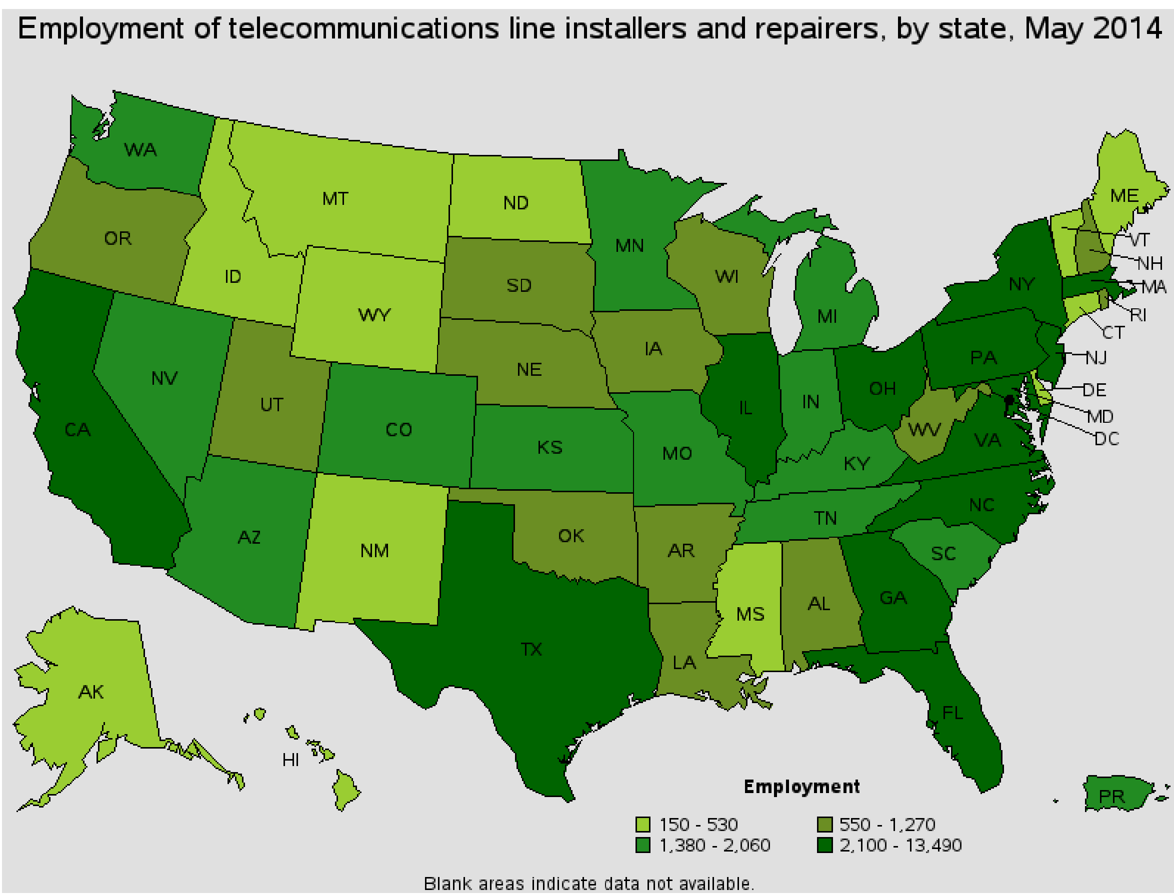


Figure 14.1.15-1: TOXMAP Superfund/NPL and TRI Facilities in Tennessee (2013)

Telecommunication Worker Occupational Health and Safety

The BLS uses established industry and occupational codes to classify telecommunications workers. For industry classifications, BLS uses the North American Industry Classification System (NAICS) codes, which identify the telecommunications industry (NAICS code 517XX) as being within the information industry (NAICS code 51). For occupational classifications, BLS uses the Standard Occupational Classification (SOC) system to identify workers as belonging to one of 840 occupations. Telecommunications occupations are identified as either telecommunication equipment installers or repairers, except line installers (SOC code 49-2022), or telecommunication line installers and repairers (SOC code 49-9052). Both occupations are reported under the installation, maintenance and repair occupations (SOC code 49-0000). As of May 2014, there were 5,230 telecommunication equipment installers and repairers, and 1,790 telecommunication line installers and repairers (Figure 14.1.15-2) working in Tennessee (BLS, 2015a). In 2013, the most recent year data are available, Tennessee had 4.3 cases of nonfatal occupational injuries or illnesses in the telecommunications industry per 100 full-time workers (BLS, 2013a). By comparison, there were 1.9 nonfatal occupational injury cases nationwide in both 2012 and 2013 per 100 full-time workers in the telecommunications industry (BLS, 2013b).



Source: (BLS, 2015c)

Figure 14.1.15-2: Number of Telecommunication Line Installers and Repairers Employed per State, May 2014

Nationwide in 2013, there were 18 fatalities reported across the telecommunications industry (5 due to violence and other injuries by persons or animals; 3 due to transportation incidents; and 7 due to slips, trips, or falls), with an hours-based fatal injury rate of 7.9 per 100,000 full-time equivalent workers (BLS, 2013c). This represents 45 percent of the broader information industry fatalities (40 total), and less than 1 percent of total occupational fatalities (4,585 total). By comparison, Tennessee had three fatalities in 2003 within the telecommunications industry and one fatality in 2012 within the telecommunications line installers and repairers occupation (SOC code 49-9052) (BLS, 2015d).

Telecommunication Worker Occupational Health and Safety

Telecommunications sites may be on or near contaminated land, industrial discharge facilities, or sites presenting additional hazards. Occupational exposure to contaminated environmental media can occur during activities like soil excavating, trenching, other earthwork, and working over waterbodies. Indoor air quality may also be impacted from vapor intrusion infiltrating indoors from contaminated soil or groundwater that are present beneath a building's foundation. As of November 2015, there are 56 USEPA-regulated telecommunications sites in Tennessee (USEPA, 2015m). These sites are regulated under one or more environmental programs including NPDES compliance, Superfund/NPL status, and TRI releases.

According to BLS data, Tennessee had five occupational fatalities in 2010 within the installation, maintenance, and repair occupations (SOC code 49-0000) from exposure to "harmful substances or environments," although these were not specific to telecommunications (BLS, 2015e). In 2014, BLS reported 19 fatalities within the telecommunications line installers and repairers occupation (SOC code 49-9052), and three fatalities within the telecommunications equipment installers and repairers occupation (SOC code 49-2022) due to exposure to harmful substances or environments (BLS, 2014).

Public Health and Safety

As described earlier, access to telecommunications sites is nearly always restricted to occupational workers. Although site access control is one of the major reasons telecommunications sites present an inherent low risk to non-occupational workers, the public could be potentially exposed to contaminants and other hazards in a variety of ways. One example would be if occupational workers disturb contaminated soil while digging, causing hazardous chemicals to mix with an underlying groundwater drinking water sources. If a contaminant enters a drinking water source, the surrounding community could inadvertently ingest or absorb the contaminant when using that source of water for drinking, cooking, bathing, and swimming. By trespassing on a restricted property, a trespasser may come in contact with contaminated soil or surface water, or by inhaling harmful vapors.

The TNDOH, Division of Environmental Epidemiology conducts environmental public health assessments and consultations to identify and assess human exposure risks at contaminated sites. The program is funded through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry's (ATSDR) Partnership to Promote Localized Efforts to Reduce Environmental Exposure (TNDOH, 2015a). The public health assessments are available through the Division of Environmental Epidemiology website (TNDOH, 2015c). At the federal level, the CDC, National Environmental Public Health Tracking Network, provides health, exposure, and hazard information, including known chemical contaminants, chronic diseases, and conditions based on geography. In 2011, the most recent year data are available, Tennessee reported a rate of two injuries and fatalities due to reported acute toxic substance release incidents per 100,000 population (CDC, 2015b).

14.1.15.5. Environmental Setting: Abandoned Mine Lands at or near Telecommunications Sites

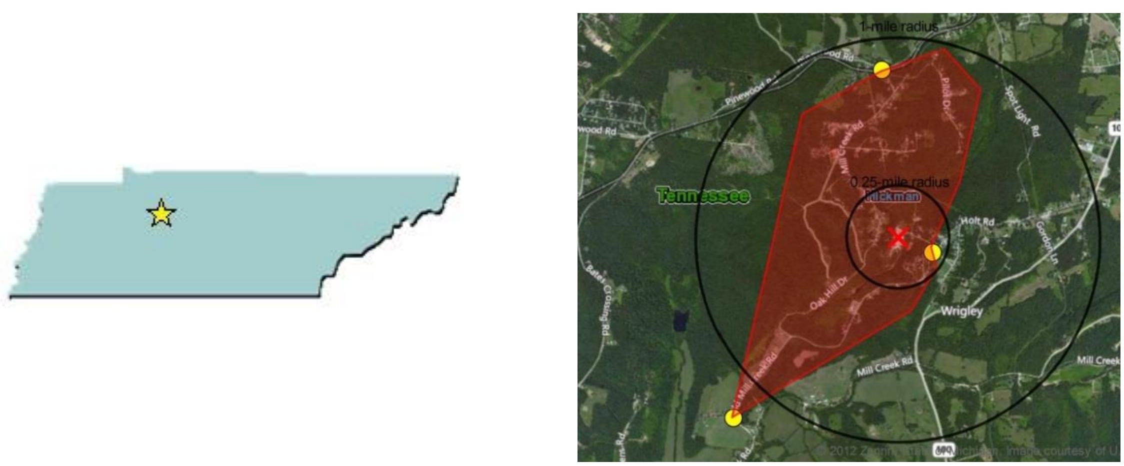
Another health and safety hazard in Tennessee includes surface and subterranean mines. In 2014, the Tennessee mining industry ranked 24th for non-fuel minerals (primarily crushed stone, zinc, portland cement, construction sand and gravel, and industrial sand and gravel), generating a value of $1.31B (USGS, 2014c). In 2013, Tennessee had 13 coalmining operations (5 underground and 9 surface) (EIA, 2013).

Health and safety hazards at active mines and abandoned mine lands (AML) include falling into open shafts, cave-ins from unstable rock and decayed support, deadly gases and lack of oxygen inside the mine, unused explosives and toxic chemicals, horizontal and vertical openings, high walls, and open pits (Federal Mining Dialogue, 2015). Gradual settling or sudden sinking of the Earth's surface, also known as subsidence, presents additional risks and is further discussed in Section 14.1.3, Geology. Tennessee does not have its own state mining regulatory program, therefore, the U.S. Department of the Interior's (DOI) Office of Surface Mining and Reclamation and Enforcement (OSMRE) acts as the primary regulator in the state for the Tennessee AML Program (OSMRE, 2015a). TDEC's Land Reclamation Section is responsible for administering the AML program, and has reclaimed over 4,200 acres of AMLs since 1981 (TDEC, 2015s). Figure 14.1.15-4 shows the distribution of High Priority (Priority 1, 2 and adjacent Priority 3) AMLs in Tennessee, where Priority 1 and 2 sites pose a significant risk to human health and safety, and Priority 3 sites pose a risk to the environment. As of November 2015, Tennessee had 547 Priority 1 and 2 AMLs, with 230 unfunded problem areas (OSMRE, 2015b).

Spotlight on Tennessee Superfund Sites: Wrigley Charcoal Plant

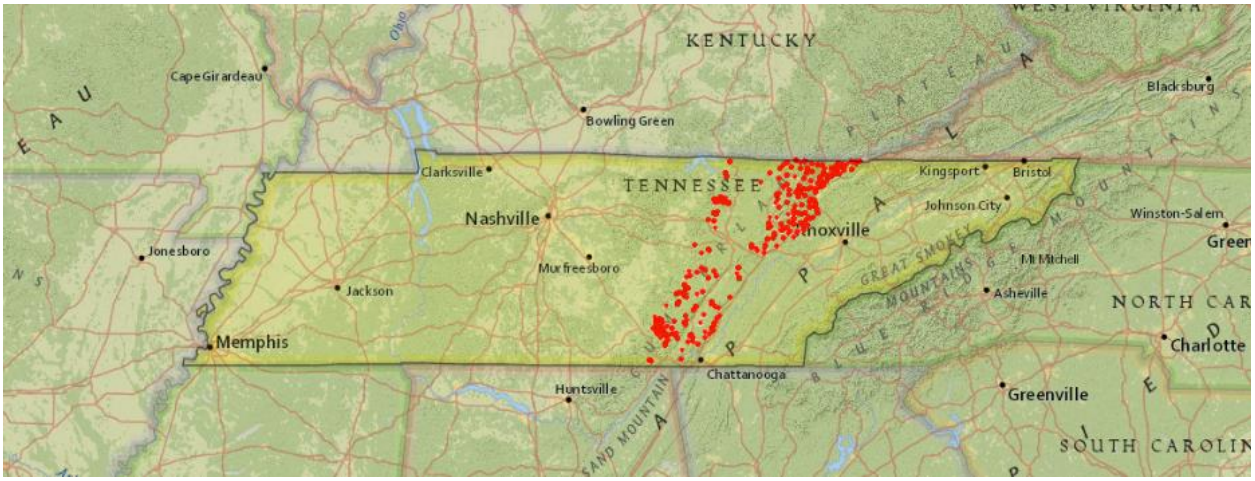
The Wrigley Charcoal Plant is a former industrial site composed of seven distinct areas (the 35-acre facility site, known as the Primary Site, plus six peripheral waste locations) in Wrigley, TN. Between 1880 and 1996, the Primary Site was used to manufacture iron, charcoal, and wood distillation products, as well as for metals machining, waste storage, and copper recovery operations. Byproducts included wood alcohol, pig iron, tar, coke, charcoal, acetic acid, wood oils, and pitch. Most recently, Industrial Plastics Recycling operated a metals and plastic recycling facility at the Primary Site until 2013. The peripheral waste locations include storage and disposal areas, irrigation fields, and slag piles from the Primary Site. In 1989, the site was added to the NPL after detecting volatile organic compounds (e.g., toluene, benzene, phenol, polycyclic aromatic hydrocarbons) in debris, groundwater, and soils from leachate and wastes (USEPA, 2015n). Following an interim cleanup action in 1995, the Agency for Toxic Substances & Disease Registry (ATSDR) conducted a public health assessment and concluded there were no significant public health hazards, however, the community remains concerned (ATSDR, 2004).

Remedial actions included excavating tar wastes and contaminated soil, treating contaminated groundwater, and installing groundwater monitoring wells (USEPA, 2015n). On December 18, 2013, a catastrophic fire occurred at the Industrial Plastics facility, igniting five acres of plastics and buildings. The resulting toxic fumes forced a community evacuation and school closure (Figure 14.1.15-3). In a follow-up health assessment, ATSDR recommended that TDEC conduct surface soil and private drinking water well sampling (ATSDR, 2014). USEPA has not conducted a Five Year Review of the site; therefore, current exposure risks are undetermined. USEPA plans to conduct additional sampling in 2015 and 2016, develop a revised cleanup plan to the 2003 Record of Decision, and assess vapor intrusion in buildings for effects on residents and workers (USEPA, 2015n).



Source: (ATSDR, 2014)

Figure 14.1.15-3: Map of Modified Evacuation Area (in red) Downgradient for Industrial Plastics Site, Wrigley, TN, December 19 -20, 2013



Source: (OSMRE, 2015c)

Figure 14.1.15-4: High Priority Abandoned Mine Lands in Tennessee (2015)

Telecommunication Worker Occupational Health and Safety

Telecommunications sites may be on or near AMLs or coalmine fires, presenting occupational exposure risks from fire, toxic gases, and subsidence during FirstNet deployment, operation, and maintenance activities. Because the locations of many abandoned mines are unknown or hidden, these mines pose a risk to telecommunications workers because they may be encountered during deployment operations.

Public Health and Safety

Subterranean mines present additional health and safety risks to the public, by generating toxic combustible gases, which can penetrate the surface through ground fractures, potentially seeping into residential structures. Additionally, mine fires can consume enough sub-surface material, that risk of subsidence increases. As a result, AMLs and mine fires in particular, can result in evacuations of entire communities (OSMRE, 2015c).

14.1.15.6. Environmental Setting: Natural & Manmade Disaster Sites

Natural and manmade disaster events can create health and safety risks, as well as present unique hazards, to telecommunication workers and the public. Telecommunications, including public safety communications, can be unavailable (temporarily or permanently) during disaster events. Examples of manmade disasters are train derailments, refinery fires, or other incident involving the release of hazardous constituents. A common example of a natural disaster is flooding. Floodwaters damage transportation infrastructure (roads, railways, etc.) and utility lines (sewer, water, electric power, broadband, natural gas lines, etc.). Hazardous chemicals and sanitary wastes often contaminate floodwaters, which can cause headaches, skin rashes, dizziness, nausea, excitability, weakness, fatigue, and disease to exposed workers. (OSHA, 2003)

Physical hazards may also be present at disaster sites, such as downed utility lines, debris blockage or road washout conditions, which increases exposure risks to telecommunication workers. Climbing and working from tower structures damaged by wind increases the risk of slips, trips, or falls. During natural and manmade disasters, access to the telecommunication sites can be obstructed by debris.

Telecommunication Worker Occupational Health and Safety

Telecommunication workers are often called upon to provide support to natural and manmade disaster response efforts because of the critical need to restore and maintain telecommunication capabilities. The need to enter disaster areas as part of the recovery effort exposes telecommunication workers to elevated risks because chemical, biological, and physical hazards might not have not been fully identified or assessed. Transportation infrastructure and utilities in the affected areas are often compromised and present unknown chemical and biologic hazards. Correspondingly, if telecommunication workers are injured during response and repair operations, their rescue and treatment might over-extend first responder staff and medical facilities that are delivering care to victims of the initial incident.

Currently, the TNDLWD and BLS do not report data specific to injuries or fatalities among telecommunication workers responding to natural or manmade disasters. However, the National Response Center (NRC), managed by the U.S. Coast Guard, compiles reports for oil spills, chemical releases, or other maritime security incidents and contains incident reports related to occupational health and safety. Of the 397 NRC-reported incidents for Tennessee in 2015 with known causes, only seven were attributed to natural disaster (e.g., earthquake, flood, lightning, tornado, or other natural phenomenon), while the majority (390) were attributed to manmade disasters (e.g., derailment, dumping, equipment failure, operator error, over pressuring, suicide, transport accident, or trespasser) or other indeterminate causes (U.S. Coast Guard, 2015). For example, Middle Tennessee experienced a significant ice storm from February 20-21, 2015, exacerbating the already icy conditions (e.g., ice on trees and power lines) from previous winter storms two days before. The freezing rain and additional snowfall damaged 700 utility poles and caused 35,000 outages (NWS, 2015c). Such incidents present unique, hazardous challenges to telecommunication workers responding during natural disasters.

Public Health and Safety

Hazards present during natural and manmade disasters are often far-reaching, affecting large geographic areas and affecting all populations living within the area. Similar to telecommunication workers, the public faces risks during these types of disasters, such as compromised transportation infrastructure and utilities, potential for exposure to unknown chemical and biologic hazards, and inadequate medical support. In 2014, Tennessee had six weather-related fatalities (two due to flood, two due to tornado, and two due to high wind) and five injuries. (Fiber Optic Association, 2010). By comparison, in 2010 when the historic flooding occurred, Tennessee had 53 fatalities (22 due to flooding). Nationwide, 384 weather-related fatalities, and 2,203 injuries were reported in 2014 (NWS, 2010a).

Spotlight on Tennessee Natural Disaster Sites: 2010 Nashville Flood

From May 1-2, 2010, the western and middle portions of Tennessee, including Nashville, TN (Figure 14.1.15-5), experienced a catastrophic flood that caused resulted $2B of damages and 11 fatalities in the metropolitan area. The historic rainfall exceeded "maximum observed rainfall associated with Hurricane Katrina landfall," with a daily average of 14-15 inches of precipitation (NWS, 2010b).

Nashville Electric Service's West Center lost 37 service trucks and 30 percent of the materials and tools that linemen use to restore power (Nashville Electric Service, 2010). The floodwater posed an extremely dangerous environment for occupational workers repairing and reenergizing the lines at Nashville Electric Service's three submerged power stations (Nashville Electric Service, 2015). In addition, a water treatment plant, wastewater treatment plant, pumping facilities, and other wastewater infrastructure owned by Metro Water Services in Nashville were significantly damaged (Nashville Electric Service, 2015).

TDEC issued mandatory water conservation and boil water advisories for residents, and many power companies had unknown restoration times for 5,800 residents without power (TDEC, Air Pollution Control Division et al, 2010). Wireless networks and communications were also impacted, including AT&T's Central Office, which flooded in three feet of water (AT&T, 2010) (AT&T, 2015). More than 23,000 state and local first responders provided aid in rescue and recovery (DHS, Office of Emergency Communications, 2015).

Source: (FEMA, 2014d)

Figure 14.1.15-5: Aerial photo of Nashville, TN, during the 2010 flood

14.2. Environmental Consequences

This section describes the potential environmental impacts, beneficial, or adverse, resulting from the Proposed Action and Alternatives. As this is a programmatic evaluation, site- and project-specific issues are not assessed. The specific deployment activity and where the deployment will take place will be determined based on location-specific conditions and the results of site-specific environmental reviews.

At the programmatic level, the categories of impacts are defined as *potentially significant, less than significant with mitigation measures incorporated, less than significant,* or *no impact*. Each resource area identifies the range of possible impacts on resources for the Proposed Action and Alternatives, include the No Action Alternative. The No Action Alternative provides a comparison to describe the effects of environmental resources of the existing conditions to the proposed Alternatives.

NEPA requires agencies to assess the potential direct and indirect impacts each alternative could have on the existing environment (as characterized earlier in this section). Direct impacts are those impacts that are caused by the Proposed Action and occur at the same time and place, such as soil disturbance. Indirect impacts are those impacts related to the Proposed Action but result from an intermediate step or process, such as changes in surface water quality because of soil erosion.

For each resource, the potential impact is assessed in terms of context of the action and the intensity of the potential impact, per CEQ regulations (40 CFR §1508.27). *Context* refers to the timing, duration, and where the impact could potentially occur (i.e., local vs. national; pristine vs. disturbed; common species vs. protected species). In terms of duration of potential impact, context is described as short or long term. *Intensity* refers to the magnitude or severity of the effect as either beneficial or adverse. Resource-specific significance rating criteria are provided at the beginning of each resource area section.

14.2.1. Infrastructure

14.2.1.1. Introduction

This section describes potential impacts to infrastructure in Tennessee associated with construction, deployment, and operation of the Proposed Action and Alternatives. Chapter 16, Best Management Practices (BMPs) and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.1.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on infrastructure were evaluated using the significance criteria presented in Table 14.2.1-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined, at the programmatic level, as *potentially significant*, *less than significant with mitigation meaures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to infrastructure addressed in this section are presented as a range of possible impacts.

Table 14.2.1-1: Impact Significance Rating Criteria for Infrastructure at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Transportation system capacity and safety	Magnitude or Intensity	Creation of substantial traffic congestion/delay and/or a substantial increase in transportation incidents (e.g., crashes, derailments).	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Minimal change in traffic congestion/delay and/or transportation incidents (e.g., crashes, derailments).	*No effect* on traffic congestion or delay, or transportation incidents.
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Permanent: Persisting indefinitely.		Short-term effects will be noticeable for up to the entire construction phase or a portion of the operational phase.	NA
Capacity of local health, public safety, and emergency response services	Magnitude or Intensity	Impacted individuals or communities cannot access health care and/or emergency services, or access is delayed, due to the project activities.	Effect is *potentially significant*, but with mitigation is *less than significant*.	Minor delays to access to care and emergency services that do not impact health outcomes.	*No impacts* on access to care or emergency services.
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a county or county-equivalent geographical extent, could extend to state).		Impacts only at a local/neighborhood level.	NA
	Duration or Frequency	Duration is constant during construction and deployment phase.		Rare event during construction and deployment phase.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Modifies existing public safety response, physical infrastructure, telecommunication practices, or level of service in a manner that directly affects public safety communication capabilities and response times	Magnitude or Intensity	Substantial adverse changes in public safety response times and the ability to communicate effectively with and between public safety entities.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Minimal change in the ability to communicate with and between public safety entities.	No perceptible change in existing response times or the ability to communicate with and between public safety entities.
	Geographic Extent	Local/City, County/Region, or State/Territory.		Local/City, County/Region, or State/Territory.	Local/City, County/Region, or State/Territory.
	Duration or Frequency	Permanent or perpetual change in emergency response times and level of service.		Change in communication and/or the level of service is perceptible but reasonable to maintaining effectiveness and quality of service.	NA
Effects to commercial telecommunication systems, communications, or level of service	Magnitude or Intensity	Substantial adverse changes in level service and communications capabilities.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Minor changes in level of service and communications while transitioning to the new system.	No perceptible effect to level of service or communications while transitioning to the new system.
	Geographic Extent	Local/City, County/Region, or State/Territory.		Local/City, County/Region, or State/Territory.	Local/City, County/Region, or State/Territory.
	Duration or Frequency	Persistent, long-term, or permanent effects to communications and level of service.		Minimal effects to level of service or communications lasting no more than a short period (minutes to hours) during the construction and deployment phase.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects to utilities, including electric power transmission facilities and water and sewer facilities	Magnitude or Intensity	Substantial disruptions in the delivery of electric power or to physical infrastructure that results in disruptions, including frequent power outages or drops in voltage in the electrical power supply system ("brownouts"). Disruption in water delivery or sewer capacity, or damage to or interference with physical plant facilities that impact delivery of water or sewer systems.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Minor disruptions to the delivery of electric power, water, and sewer services, or minor modifications to physical infrastructure that result in minor disruptions to delivery of power, water, and sewer services.	There would be no perceptible impacts to delivery of other utilities and no service disruptions.
	Geographic Extent	Local/City, County/Region, or State/Territory.		Local/City, County/Region, or State/Territory.	Local/City, County/Region, or State/Territory.
	Duration or Frequency	Effects to other utilities would be seen throughout the entire construction phase.		Effects to other utilities would be of short duration (minutes to hours) and would occur sporadically during the entire construction phase.	NA

NA = Not Applicable

14.2.1.3. Description of Environmental Concerns

Transportation System Capacity and Safety

The primary concerns for transportation system capacity and safety related to FirstNet activities would primarily occur during the construction phases of deployment. Depending on the exact site locations and placement of new assets in the field, temporary impacts on traffic congestion, railway use, airport or river port operations, or use of other transportation corridors could occur if site locations were near or adjacent to roadways and other transportation corridors, requiring temporary closures (lane closures on roadways, for example). Coordination would be necessary with the relevant transportation authority (i.e., departments of transportation, airport authorities, railway companies, and river masters) to ensure proper coordination during deployment. Based on the impact significance criteria presented in Table 14.2.1-1, at the programmatic level, such impacts would be *less than significant* due to the temporary nature of the deployment activities, even if impacts would be realized at one or more isolated locations. These impacts would be noticeable during the deployment phase, but would be short-term, with no anticipated impacts continuing into the operational phase, unless any large-scale maintenance would become necessary during operations.

Capacity of Local Health, Public Safety, and Emergency Response Services

The capacity of local health, public safety, and emergency response services would experience *less than significant* impacts at the programmatic level during deployment or operation phases. During deployment and system optimization, existing services would likely remain operational in a redundant manner ensuring continued operations and availability of services to the public. The only potential impact would be extremely rare, if emergency response services were using transportation infrastructure to respond to an emergency at the exact time that deployment activities were taking place. This type of impact would be isolated at the local or neighborhood level, and the likelihood of such an impact would be extremely low. Once operational, the new network would provide beneficial impacts to the capacity of local health, public safety, and emergency response services through enhanced communications infrastructure, thereby increasing capacity for and enhancing the ability of first responders to communicate during emergency response situations. Based on the impact significance criteria presented in Table 14.2.1-1, potential negative impacts would be *less than significant* at the programmatic level. Substantial beneficial impacts are likely to result from implementation.

Modifies Existing Public Safety Response Telecommunication Practices, Physical Infrastructure, or Level of Service in a manner that directly affects Public Safety Communication Capabilities and Response Times

The Proposed Action and Alternatives contemplated by FirstNet would not cause negative impacts to existing public safety response telecommunication practices, physical infrastructure, or level of service in a manner that directly affects public safety communication capabilities and response times. Based on the impact significance criteria presented in Table 14.2.1-1, any potential impacts would be *less than significant* during deployment. As described above, during deployment and system optimization, existing services would likely remain operational in a redundant manner ensuring continued operations and availability of services to the public. Once operational, state, and local public safety organizations would need to evaluate telecommunication practices and standard operating procedures (SOPs). FirstNet's mission is to complement such practices and SOPs in a positive manner; therefore, only beneficial or complementary impacts would be anticipated. Public safety communication capabilities and response times would be expected to also experience beneficial impacts through enhanced communications abilities. It is possible that FirstNet would be upgrading physical telecommunications infrastructure, thus the infrastructure would also experience a positive and beneficial impact. Disposal or reuse of old public safety communications infrastructure would also likely need to be considered once the specifics are known. Any negative impacts would be expected to be *less than significant* given the short-term nature of the deployment activities.

Effects to Commercial Telecommunication Systems, Communications, or Level of Service

Commercial assets would be using a different spectrum for communications; as such, commercial telecommunication systems, communications, or level of service would experience *no impacts*. FirstNet has exclusive rights to use of the assigned spectrum, and only designated public safety organizations would be authorized to connect to FirstNet's network. Depending on the use patterns of FirstNet's spectrum, such spectrum use may be over-built or under-utilized.[127] Anticipated impacts would be *less than significant* due to the limited extent and temporary nature of deployment.

Effects to Utilities, including Electric Power Transmission Facilities, and Water and Sewer Facilities

The activities proposed by FirstNet would have *less than significant* impacts on utilities, including electric power transmission facilities, and water and sewer facilities. Depending on the specific project contemplated, installation of new equipment could require connection with local electric sources, and use of site-specific local generators, on a temporary or permanent basis. Also, depending on the specific project contemplated, the draw or use of power from the transmission facilities may need to be examined; however, it is not anticipated that such use of power would have negative impacts, due to the local nature of the proposed activities and the widespread availability and use of the power grid in the United States.

14.2.1.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment, and operation activities.

[127] Telecommunications equipment for specific spectrum use can be built where other equipment for other spectrum use already exists. If the new equipment and spectrum is not fully utilized, the geographic region may experience "over-build," where an abundance of under-utilized equipment may exist in that geographic location. This situation can be caused by a variety of factors including changes in current and future use patterns, changes in spectrum allocation, changes in laws and regulations, and other factors.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to infrastructure and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level, in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to infrastructure under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to infrastructure resources at the programmatic level since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes or disruption of transportation, telecommunications, or utility services.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would have *no impacts* to infrastructure resources because there would be no ground disturbance and no interference with existing utility, transportation, or communication systems.
  - New Build – Submarine Fiber Optic Plant: At the programmatic level, the installation of cables in or near bodies of water would not impact infrastructure resources because there would be no local infrastructure to impact, other than harbor operations. Impacts to infrastructure resources associated with the construction of landings and/or facilities on shore or the banks of water bodies that accept the submarine cable are addressed below, and depend on the proximity of such infrastructure to the landing site.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to infrastructure at the programmatic level. The section below addresses potential impacts to infrastructure if construction of new boxes, huts, or other equipment is required near or adjacent to local infrastructure assets.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the use of portable devices that use satellite technology would not impact infrastructure resources because there would be no change to the built or natural environment from the use of portable equipment. Installation of satellite-enabled equipment would not be expected to have any impacts to infrastructure resources, given that construction activities would occur on existing structures, would not be expected to interfere with existing equipment, and transportation capacity and safety, and access to emergency services would not be impacted.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the Nationwide Public Safety Broadband Network (NPSBN); however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact infrastructure resources at the programmatic level, it is anticipated that this activity would have *no impact* on infrastructure resources.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to infrastructure as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur as a result of direct interface with existing infrastructure, most notably existing telecommunication infrastructure. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to infrastructure include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence (POPs), [128] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to infrastructure resources, depending on the specific assets connected on either end of the buried fiber. If a fiber optic plant is being used to tie into existing telecommunications assets, then localized impacts to telecommunications sites could occur during the deployment phase; however, it is anticipated that this tie-in would cause *less than significant* impacts at the programmatic level as the activity would be temporary and minor.
  - New Build – Aerial Fiber Optic Plant: Installation of a new aerial fiber optic plant could impact new telecommunications infrastructure through the installation of new or replacement of existing telecommunications poles.
  - Collocation on Existing Aerial Fiber Optic Plant: Similar to new build activities (above), collocation on existing aerial fiber optic plant could include installation of new or replacement towers requiring ground disturbance.
  - New Build – Submarine Fiber Optic Plant: As stated above, the installation of cables in or near bodies of water would not impact infrastructure resources because there would be no local infrastructure to impact. However, impacts to infrastructure resources could

[128] Points of Presence are connections or access points between two different networks, or different components of one network.

potentially occur as result of the construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable, depending on the exact site location and proximity to existing infrastructure.
    - Installation of Optical Transmission or Centralized Transmission Equipment: As stated above, if installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to infrastructure. However, if installation of transmission equipment such as small boxes or huts, or access roads required ground disturbance, then the activities could potentially impacts infrastructure. Impacts could include disruption of service in transportation corridors, disruption of service to telecommunications infrastructure, or other temporary impacts.
- Wireless Projects
    - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads might result in temporary or unintended impacts to current utility services during installation or interconnection activities. Generally, however, these deployment activities would be independent and would not be expected to interfere with other existing towers and structures. In addition, installation activities would have beneficial impacts due to expansion of infrastructure at a local level. Such activities could enhance public safety infrastructure, and other telecommunications as the site could potentially be available for subsequent collocation.
    - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would result in localized impacts to that tower and tower site such as minor disruptions in services. As a result of collocation of equipment, the potential addition of power units, structural hardening, and physical security measures could potentially have beneficial impacts on existing infrastructure assets, depending on the site-specific plans.
    - Deployable Technologies: Deployable technologies such as COWs, COLTs, and SOWs are comprised of cellular base stations, sometimes with expandable antenna masts, and generators that connect to utility power cables. Connecting the generators to utility power cables has the potential to disrupt electric power utility systems or cause power outages; however, this is expected to be temporary and minor. Some staging or landing areas (depending on the type of technology) could require minor construction and maintenance within public road ROWs and utility corridors, heavy equipment movement, and minor excavation and paving near public roads, which have the potential to impact transportation capacity and safety as these activities could increase transportation congestion and delays. Implementation of deployable technologies could result in potential impacts to infrastructure resources in terms of infrastructure expansion, if deployment requires paving of previously unpaved surfaces or other new infrastructure build to accommodate the deployable technology. Also, beneficial impacts could be realized, as deployable technologies are used when other infrastructure is impaired in some way; so deployable technologies could provide continuity of service during

emergency events. Where deployable technologies would be implemented on existing paved surfaces and the acceptable load on those paved surfaces is not exceeded, or where aerial deployable technologies may be utilized but launched from existing paved surfaces, it is anticipated that there would be *no impacts* to infrastructure resources because there would be no disturbance of the natural or built environment.

In general, the abovementioned activities could potentially impact infrastructure resources in different ways, resulting in both potentially negative and potentially positive impacts. Potential negative impacts to infrastructure associated with deployment could include temporary disruption of various types of transportation corridors, temporary impacts on existing or new telecommunications sites, and more permanent impacts on utilities, if new infrastructure required tie-in to the electric grid. These impacts are expected to be *less than significant* at the programmatic level as the deployment activities will likely be of short duration (generally a few hours to a few months depending on the activity), would be regionally based around the on-going phase of deployment, and minor. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Positive impacts to infrastructure resources may result from the expansion of public safety and commercial telecommunications capacity and an improvement in public safety telecommunications coverage, system resiliency, response times, and system redundancy.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned deployment impacts. It is anticipated that there would be *no impacts* to infrastructure at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors, or if further construction related activities are required along public road and utility ROWs, increased traffic congestion, current telecommunication system interruption, and utility interruptions could occur. These potential impacts would be expected to be minor and temporary as explained above and therefore, *less than significant* at the programmatic level.

Numerous beneficial impacts would be associated with operation of the NPSBN. The new system is intended to result in substantial improvements in public safety response times and the ability to communicate effectively with and between public safety entities, and would also likely result in substantial improvements in level of service and communications capabilities at the programmatic level. Operation of the NPSBN is intended to involve high-speed data capabilities, location information, images, and eventually streaming video, which would likely significantly improve communications and the ability of the public safety community to effectively engage and respond. The NPSBN is also intended to have a higher level of redundancy and resiliency than current commercial networks to support the public safety community effectively, even in events of extreme demand. This improvement in the level of resiliency and redundancy is intended to increase the reliability of systems, communications, and level of service, and also minimize disruptions and misinformation resulting from limited or disrupted service. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.1.5. Alternatives Impact Assessment

The following section assesses potential impacts to infrastructure associated with the Deployable Technologies Alternative and the No Action Alternative. [129]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to infrastructure as a result of implementation of this Alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could, at the programmatic level, result in *less than significant* impacts to infrastructure at the programmatic level even if deployment requires expansion of infrastructure, such as paving of previously unpaved surfaces or other new infrastructure built to support deployment. This is primarily due to the small amount of paving or new infrastructure that might have to be constructed to accommodate the deployables. The site-specific location of deployment would need to be considered, and any local infrastructure assets (transportation, telecommunications, or utilities) would need to be considered, planned for, and managed accordingly to try and avoid any negative impacts to such resources at the programmatic level. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Beneficial impacts could be realized at the programmatic level, as deployable technologies are used when other infrastructure is impaired in some way; so deployable technologies could provide continuity of service during emergency events. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet

[129] As mentioned above and in Section 2.1.2 Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* at the programmatic level to infrastructure resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. At the programmatic level, if usage of heavy equipment, as part of routine maintenance or inspection occurs off an established access road or utility ROW, or if additional maintenance-related construction activities occur within public road and utility ROWs, *less than significant* impacts would likely still occur to transportation systems or utility services at the programmatic level due to the limited amount of new infrastructure needed to accommodate the deployables. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated deployment or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to infrastructure as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.1, Infrastructure. The state also would not realize positive, beneficial impacts to infrastructure resources described above.

14.2.2. Soils

14.2.2.1. Introduction

This section describes potential impacts to soil resources in Tennessee associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.2.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on soil resources were evaluated using the significance criteria presented in Table 14.2.2-1. As described in Section 14.2, Environmental Consequences, The categories of impacts are defined, at the programmatic level, as *potentially significant*, *less than significant with mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to soil resources addressed in this section are presented as a range of possible impacts.

Table 14.2.2-1: Impact Significance Rating Criteria for Soils at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Soil erosion	Magnitude or Intensity	Severe, widespread, and observable erosion in comparison to baseline, high likelihood of encountering erosion-prone soils.	Effect that is *potentially significant*, but with mitigation is *less than significant.*	Perceptible erosion in comparison to baseline conditions; low likelihood of encountering erosion-prone soil types.	No perceptible change in baseline conditions.
	Geographic Extent	State or territory.		Region or county.	NA
	Duration or Frequency	Chronic or long-term erosion not likely to be reversed over several years.		Isolated, temporary, or short-term erosion that that is reversed over few months or less.	NA
Topsoil mixing	Magnitude or Intensity	Clear and widespread mixing of the topsoil and subsoil layers.	Effect that is *potentially significant*, but with mitigation is *less than significant.*	Minimal mixing of the topsoil and subsoil layers has occurred.	No perceptible evidence that the topsoil and subsoil layers have been mixed.
	Geographic Extent	State or territory.		Region or county.	NA
	Duration or Frequency	NA		NA	NA
Soil compaction and rutting	Magnitude or Intensity	Severe and widespread, observable compaction and rutting in comparison to baseline.	Effect that is *potentially significant*, but with mitigation is *less than significant.*	Perceptible compaction and rutting in comparison to baseline conditions.	No perceptible change in baseline conditions.
	Geographic Extent	State or territory.		Region or county.	NA
	Duration or Frequency	Chronic or long-term compaction and rutting not likely to be reversed over several years.		Isolated, temporary, or short term compaction and rutting that is reversed over a few months or less.	No perceptible change in baseline conditions.

NA = Not Applicable

14.2.2.3. Description of Environmental Concerns

Soil Erosion

Soil erosion is an environmental concern for nearly every construction activity that involves ground disturbance. Construction erosion typically only occurs in a small area of land with the actual removal of vegetative cover from construction equipment or by wind and water erosion. Of concern in Tennessee and other states with similar geography and weather patterns is the erosion of construction site soils to natural waterways, where the sediment could impair water and habitat quality, and potentially affect aquatic plants and animals (NRCS, 2000). Areas exist in Tennessee that have steep slopes (i.e., greater than 20 percent) or where the erosion potential is medium to high, including locations with Aqualfs, Aquents, Aquepts, Aquerts, Aquolls, Aquults, Fluvents, Udalfs, Udepts, Udolls, and Udults (see Section 14.1.2.4, Soil Suborders and Figure 14.1.2-2).

Based on the impact significance criteria presented in Table 14.2.2-1, building of some of FirstNet's network deployment sites could cause *potentially significant* erosion at locations with highly erodible soil and steep grades. For the majority of projects, impacts to soils would be expected to be *less than significant* at the programmatic level given the short-term and temporary duration of construction activities.

To the extent practicable, FirstNet would attempt to minimize ground-disturbing construction in areas with high erosion potential due to steep slopes or soil type. Where construction is required in areas with a high erosion potential, FirstNet could implement BMPs and mitigation measures, where practicable and feasible, to avoid or minimize impacts, and minimize the periods when exposed soil is open to precipitation and wind (see Chapter 16).

Topsoil Mixing

The loss of topsoil (i.e., organic and mineral topsoil layers) by mixing is a potential impact at all ground disturbing construction sites, including actions requiring clearing, excavation, grading, trenching, backfilling, or site restoration/remediation work.

Based on impact significance criteria presented in Table 14.2.2-1, and due to the relatively small-scale (less than 1 acre) of most FirstNet project sites, *less than significant* impacts from the minimal topsoil mixing is expected at the programmatic level. Additionally, implementation of BMPs and mitigation measures (Chapter 16), could further reduce potential impacts.

Soil Compaction and Rutting

Soil compaction and rutting at construction sites could involve heavy land clearing equipment such as bulldozers and backhoes, trenchers and directional drill rigs to install buried fiber, and cranes to install towers and aerial infrastructure. Soils with the highest potential for compaction or rutting were identified by using the STATSGO2 database (see Section 14.1.2.3, Soil Suborders). The most compaction susceptible soil suborders in Tennessee are hydric soils with poor drainage conditions, which include Aqualfs, Aquents, Aquepts, Aquerts, Aquolls, Aquults, and Udepts. These suborders constitute approximately 27 percent of Tennessee's land area,[130] and are found across the state (see Figure 14.1.2-2). The potential for compaction or rutting impact would be generally low at FirstNet network deployment sites where other soil types predominate.

Based on impact significance criteria presented in Table 14.2.2-1, the risk of soil compaction and rutting resulting from FirstNet deployment activities would be *less than significant* at the programmatic level due to the extent of susceptible soils in the state and the relatively small-scale (less than one acre) of most FirstNet projects. Potential impacts could be further reduced with the implementation of BMPs and mitigation measures..

14.2.2.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could deploy various types of facilities or infrastructure. Depending on the physical nature and location of FirstNet facilities or infrastructure and the specific action, some activities would result in potential impacts to soil resources and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to soil resources under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of fiber optic cable in existing conduit through existing hand-holes, pulling vaults, junction boxes, huts, and POP structures and would have no impact on soil resources at the programmatic level because it would not produce perceptible changes to soil resources.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would be conducted electronically through existing infrastructure, with *no impacts* to soil resources at the programmatic level. If physical access is required to light dark fiber, it would be through existing hand holes, pulling vaults, junction boxes, huts, and similar existing structures. Impacts to soil resources associated with the construction of new poles to accept aerial fiber or on shore to accept submarine cable are addressed below, and would depend on the proximity of such infrastructure to the landing site.

[130] This percentage was calculated by dividing the acres of soils that fall within the suborders listed above by the total soil land cover for the state.

- New Build – Submarine Fiber Optic Plant: The installation of cables in or near bodies of water would have *no impacts* on soil resources at the programmatic level because there would be no ground disturbance associated with this activity (see Section 14.2.4, Water Resources, for a discussion of potential impacts to water resources). Impacts to soil resources associated with the construction of landings or facilities on shore to accept submarine cable are addressed below.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to soils at the programmatic level. The section below addresses potential impacts to soils if construction of new boxes, huts, or other equipment is required.
- Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant on existing utility poles and other structures would have *no impact* on soils at the programmatic level because there would be no ground disturbance for pole/structure installation, and heavy equipment use would be typically limited to bucket trucks operated from existing paved, gravel, or dirt roads. Impacts to soils associated with the construction of new poles to accept aerial fiber or on shore to accept submarine cable are addressed below.

- Wireless Projects
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation is the mounting or installing of new equipment on existing structures (such as antennas on an existing tower). This activity would have *no impact* on soil resources at the programmatic level because there would be no ground disturbance. Potential impacts to soil resources from structural hardening, addition of power units, or security measures are addressed below
  - Deployable Technologies: Where technologies such as Cell on Wheels (COW), Cell on Light Trucks (COLT), or System on Wheels (SOW) are deployed on existing paved surfaces or dirt or gravel areas, there would be *no impacts* to soil resources at the programmatic level because there would be no ground disturbance. Potential impacts associated with paving of previously unpaved surfaces or other ground disturbing activities are addressed below.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: Deployment of temporary or portable equipment that use satellite technology, including COWs, COLTs, SOWs, satellite phones, and video cameras, would have *no impact* on soil resources at the programmatic level because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact soil resources, it is anticipated that this activity would have *no impact* on soil resources at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Implementation of the Preferred Alternatives could include potential deployment-related impacts to soil resources resulting from ground disturbance activities, including soil erosion, topsoil mixing, and soil compaction and rutting. The types of deployment activities that could be part of the Preferred Alternative and result in potential impacts to soil resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: New fiber optic cable installation usually requires trenching, plowing (including vibratory plowing), or directional boring, as well as construction of hand holes, pulling vaults, junction boxes, huts, and POP structures that require ground disturbance. Impacts from fiber optic plant installation and structure construction, as well as associated grading and restoration of the disturbed ground when construction is completed, could result in soil erosion, topsoil mixing, or soil compaction and rutting.
  - New Build – Aerial Fiber Optic Plant: Installation of new utility poles, and replacement/upgrading of existing poles and structures could potentially impact soil resources resulting from ground disturbance for pole/structure installation (soil erosion and topsoil mixing), and heavy equipment use from bucket trucks operating on existing gravel or dirt roads (soil compaction and rutting). Potential impacts to soils are anticipated to be small-scale and short-term.
  - Collocation on Existing Aerial Fiber Optic Plant: As stated above, collocation with no ground disturbance would result in *no impacts* to soil resources at the programmatic level. However, topsoil removal, soil excavation, and excavated material placement during the replacement of poles and structural hardening could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in soil compaction and rutting.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: As stated above, lighting up of dark fiber in existing conduits or cables would have *no impact* on soil resources at the programmatic level, however, if installation of new huts or equipment we necessary, the activitycould result in soil erosion and topsoil mixing during grading or excavation activities. This activity could also require the short-term use of heavy equipment for grading or other purposes, which could result in soil compaction and rutting.
  - New Build – Submarine Fiber Optic Plant: As stated above, the installation of cables in or near bodies of water would not impact soil resources at the programmatic level because there would be no soils to impact. However, installation of fiber optic plants in limited nearshore and inland bodies of water could potentially impact soil resources at and near the landings or facilities on shores or the banks of waterbodies that accept the submarine cable. Soil erosion and topsoil mixing could potentially occur as result of grading, foundation excavation, or other ground disturbance activities. Perceptible soil compaction and rutting could potentially occur due to heavy equipment use during these activities depending on the duration of the construction activity.

- Installation of Optical Transmission or Centralized Transmission Equipment: As stated above, if installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to soils at the programmatic level. However, installation of optical transmission equipment or centralized transmission equipment, including associated new utility poles, hand holes, pulling vault, junction box, hut, and POP structure installation, would require ground disturbance that could potentially impact soil resources. Potential impacts to soils resulting from soil erosion, topsoil mixing, soil compaction, and rutting are anticipated to be small-scale and short-term.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures, such as generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads, or access roads could result in impacts to soil resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in soil erosion or topsoil mixing, and heavy equipment use during these activities could result in soil compaction and rutting.
  - Collocation on Existing Wireless Tower, Structure, or Building: As stated above, collocation that would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to soils. However, if additional power units, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to soil resources could occur, including soil erosion and topsoil mixing, as well as soil compaction and rutting associated with heavy equipment use.
  - Deployable Technologies: As stated above, if deployment occurred on paved surfaces or previously disturbed land, there would be *no impact* on soil resources, however, implementation of deployable technologies could result in potential impacts to soil resources depending on the technology and location for deployment. Potential impacts may result if deployment of vehicles (i.e., SOWs, COWs, or COLTs) occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities may result in soil compaction and rutting. In addition, implementation of deployable technologies themselves could result in soil compaction and rutting if deployed in unpaved areas.In general, the abovementioned activities could potentially involve land/vegetation clearing, topsoil removal, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to soil resources associated with deployment of this infrastructure could include soil erosion, topsoil mixing, or soil compaction and rutting. These impacts are expected to be *less than significant* at the programmatic level as the activity would likely be short term,

localized to the deployment locations, and those locations would return to normal conditions as soon as revegetation occurs, often by the next growing season. It is expected that heavy equipment would utilize existing roadways and utility ROWs for deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described earlier, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that there would be *no impacts* to soil resources at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections because there would be no ground disturbance. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if the acceptable load of the surface is exceeded, soil compaction and rutting impacts could result as explained above. The impacts are expected to be *less than significant* at the programmatic level due to the temporary nature and small-scale of operations activities with the potential to create impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.2.5. Alternatives Impact Assessment

The following section assesses potential impacts to soils associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to soil resources as a result of implementation of this Alternative could be as described below.

Deployment Impacts

Impacts to soils could occur on paved surfaces if the acceptable load of the surface is exceeded. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities may result in soil compaction and rutting. In addition, implementation of deployable technologies themselves could also result in soil compaction and rutting if deployed in unpaved areas. However, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale and short term nature of the deployment. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to soil resources at the programmatic level associated with routine inspections of deployable assets, assuming that the same access roads used for deployment are also used for inspections because there would be no ground disturbance. At the programmatic level, if usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if the acceptable load of the surface is exceeded, *less than significant* soil compaction and rutting impacts could result as previously explained above. Finally, if deployable technologies are parked and operated with air conditioning for extended periods, the condensation water from the air conditioner could result in minimal soil erosion. However, it is anticipated that the potential soil erosion would result in *less than significant* impacts at the programmatic level, as described above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed. Therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to soil resources as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.2, Soils.

14.2.3. Geology

14.2.3.1. Introduction

This section describes potential impacts to Tennessee geology resources associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.3.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on geological resources resources were evaluated using the significance criteria presented in Table 14.2.3-1. As described in Section 14.2, Environmental Consequences, The categories of impacts are defined, at the programmatic level, as *potentially significant*, *less than significant with mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to geological resources addressed in this section are presented as a range of possible impacts.

Table 14.2.3-1: Impact Significance Rating Criteria for Geology at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Seismic Hazard	Magnitude or Intensity	High likelihood that a project activity could be located within a high-risk earthquake hazard zone or active fault.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Low likelihood that a project activity could be located within an earthquake hazard zone or active fault.	No likelihood of a project activity being located in an earthquake hazard zone or active fault.
	Geographic Extent	Hazard zones or active faults are highly prevalent within the state/territory.		Earthquake hazard zones or active faults occur within the state/territory, but may be avoidable.	Earthquake hazard zones or active faults do not occur within the state/territory.
	Duration or Frequency	NA		NA	NA
Volcanic Activity	Magnitude or Intensity	High likelihood that a project activity could be located near a volcano lava or mud flow area of influence.	Effect that *is potentially significant*, but with mitigation is *less than significant*.	Low likelihood that a project activity could be located near a volcanic ash area of influence.	No likelihood of a project activity located within a volcano hazard zone.
	Geographic Extent	Volcano lava flow areas of influence are highly prevalent within the state/territory.		Volcano ash areas of influence occur within the state/territory, but may be avoidable.	Volcano hazard zones do not occur within the state/territory.
	Duration or Frequency	NA		NA	NA
Landslide	Magnitude or Intensity	High likelihood that a project activity could be located within a landslide area.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Low likelihood that a project activity could be located within a landslide area.	No likelihood of a project activity located within a landslide hazard area.
	Geographic Extent	Landslide areas are highly prevalent within the state/territory.		Landslide areas occur within the state/territory, but may be avoidable.	Landslide hazard areas do not occur within the state/territory.

Type of Effect	Effect Characteristics	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
	Duration or Frequency	NA		NA	NA
Land Subsidence	Magnitude or Intensity	High likelihood that a project activity could be located within an area with a hazard for subsidence (e.g., karst terrain).	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Low likelihood that a project activity could be located within an area with a hazard for subsidence.	Project activity located outside an area with a hazard for subsidence.
	Geographic Extent	Areas with a high hazard for subsidence (e.g., karst terrain) are highly prevalent within the state/territory.		Areas with a high hazard for subsidence occur within the state/territory, but may be avoidable.	Areas with a high hazard for subsidence do not occur within the state/territory.
	Duration or Frequency	NA		NA	NA
Potential Mineral and Fossil Fuel Resource Impacts	Magnitude or Intensity	Severe, widespread, observable impacts to mineral and/or fossil fuel resources.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Limited impacts to mineral and/or fossil resources.	No perceptible change in mineral and/or fossil fuel resources.
	Geographic Extent	Regions of mineral or fossil fuel extraction areas are highly prevalent within the state/territory.		Mineral or fossil fuel extraction areas occur within the state/territory, but may be avoidable.	Mineral or fossil fuel extraction areas do not occur within the state/territory.
	Duration or Frequency	Long-term or permanent degradation or depletion of mineral and fossil fuel resources.		Temporary degradation or depletion of mineral and fossil fuel resources.	NA
Potential Paleontological Resources Impacts	Magnitude or Intensity	Severe, widespread, observable impacts to paleontological resources.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Limited impacts to paleontological and/or fossil resources.	No perceptible change in paleontological resources.

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Geographic Extent	Areas with known paleontological resources are highly prevalent within the state/territory.		Areas with known paleontological resources occur within the state/territory, but may be avoidable.	Areas with known paleontological resources do not occur within the state/territory.
	Duration or Frequency	NA		NA	NA
Surface Geology, Bedrock, Topography, Physiography, and Geomorphology	Magnitude or Intensity	Substantial and measurable degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphological processes.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Minor degradation or alteration of surface geology, bedrock, topography that do not result in measurable changes in physiographic characteristics or geomorphological processes.	No degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphologic processes.
	Geographic Extent	State/territory.		State/territory.	NA
	Duration or Frequency	Permanent or long-term changes to characteristics and processes.		Temporary degradation or alteration of resources that is limited to the construction and deployment phase.	NA

NA = Not Applicable

14.2.3.3. Description of Environmental Concerns

Environmental concerns regarding geology can be viewed as two distinct types, those that would potentially provide impacts on the project, such as seismic hazards, and landslidesand those that would have impacts from the project, such as land subsidence and effects on mineral and fossil fuel resources, paleontological resources, surface geology, bedrock, topography, physiography, and geomorphology. These concerns and their impacts on geological resources are discussed below.

Seismic Hazard

A concern related to deployment is placement of equipment in highly active seismic zones. Equipment that is exposed to earthquake activity is subject to misalignment, alteration, or, in extreme cases, destruction; all of these activities could result in connectivity loss. As discussed in Section 14.1.3.8, Tennessee is not at risk to significant earthquake events. As shown in Figure 14.1.3-4, western Tennessee, including Memphis and Jackson, and eastern Tennessee, including Knoxville, are at a higher risk to earthquakes throughout the state. Based on the impact significance criteria presented in Table 14.2.3-1, seismic impacts from deployment or operation of the Proposed Action would have *no impact* on seismic activity at the programmatic level; however, seismic impacts to the Proposed Action could be *potentially significant* at the programmatic level if FirstNet's deployment locations were within high-risk earthquake hazard zones. Given the potential for minor earthquakes in or near Tennessee, some amount of infrastructure could be subject to earthquake hazards. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Volcanic Activity

Volcanoes do not occur in Tennessee; therefore, volcanoes do not present a hazard to the state.

Landslides

Similar to seismic hazards, another concern would be placement of equipment in areas that are highly susceptible to landslides. Equipment that is exposed to landslides is subject to misalignment, alteration, or, in extreme cases, destruction; all of these activities could result in connectivity loss.

As discussed in Section 14.1.3.8, eastern Tennessee has high landslide incidence (>15 percent), and far western Tennessee is highly susceptible to landsliding and has low to moderate incidence. Based on the impact significance criteria presented in Table 14.2.3-1, potential impacts to landslides from deployment or operation of the Proposed Action would have *less than significant* impacts at the programmatic level as it is likely that the project would attempt to avoid areas that are prone to landslides; however, landslide impacts to the Proposed Action could be *potentially significant* if FirstNet's deployment locations were within areas in which landslides are highly prevalent. To the extent practicable, FirstNet would likely avoid deployment in areas that are susceptible to landslide events. The highest potential for landslides in Tennessee is in the Appalachian Highlands Region in the far eastern portion of the state. Given that several of Tennessee's major cities, including Memphis, Chattanooga, Knoxville, and Johnson City, are in areas that experience landslides with moderate to high frequency, some amount of infrastructure may be subject to landslide hazards. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Land Subsidence

Equipment that is exposed to land subsidence, such as sinkholes created by karst topography is subject to misalignment, alteration, or, in extreme cases, destruction. All of these activities could result in connectivity loss.

As discussed in Section 14.1.3.8, portions of Tennessee are vulnerable to land subsidence due to karst topography. Based on the impact significance criteria presented in Table 14.2.3-1, at the programmatic level, potential impacts to soil subsidence from deployment or operation of the Proposed Action would have *less than significant* impacts; however, subsidence impacts to the Proposed Action could be *potentially significant* if FirstNet's deployment locations were within areas at high risk to karst topography. To the extent practicable, FirstNet would likely avoid deployment in known areas of karst topography. However, given that karst topography exists in many counties throughout the state, some amount of infrastructure may subject to subsidence hazards, in which case BMPs and mitigation measures could help avoid or minimize the potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Mineral and Fossil Fuel Resource Impacts

Equipment deployment near mineral and fossil fuel resources is not likely to affect these resources. Rather the new construction is only likely to limit access to extraction of these resources. To the extent practicable, FirstNet would likely avoid construction in areas where these resources exist. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Paleontological Resource Impacts

Equipment installation and construction activities that require ground disturbance could damage existing paleontological resources, which are both fragile and irreplaceable. Based on the impact significance criteria presented in Table 14.2.3-1, impacts to paleontological resources could be *potentially significant* if FirstNet's buildout/deployment locations uncovered paleontological resources during construction activities. As discussed in Section 14.1.3.8, fossils are found throughout Tennessee. Site- specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Additionally, it is anticipated that potential impacts to specific areas known to contain paleontological resources would be avoided, minimized, or mitigated, and any potential impacts would be limited and localized, thus potential impacts would be *less than significant* at the programmatic level.. Implementation of BMPs and mitigation measures could further help avoid or minimize the potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Surface Geology, Bedrock, Topography, Physiography, and Geomorphology

Equipment installation and construction activities that degrade or alter surface geology, bedrock, or topography could cause measurable changes in physiographic characteristics of an area's geology, topography, physiography, or geomorphology. Based on the impact significance criteria presented in Table 14.2.3-1, impacts would be *less than significant* if FirstNet's deployment is unlikely to cause substantial and measurable degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphological processes. Construction activities related to the Proposed Action and Alternatives are likely to be minor and *less than significant* at the programmatic level as the proposed activities are not likely to require removal of significant volumes of terrain and any rock ripping would likely occur in discrete locations and would be unlikely to result in large-scale changes to the geologic, topographic, or physiographic characteristics. When ground disturbance is required, BMPs and mitigation measures could be implemented to help avoid or minimize the potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.3.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities have the potential to be impacted by geologic hazards, some activities could result in potential impacts to geology, and other activities would have *no impacts*. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level, in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to geology under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. There would be *no impacts* to geologic resources at the programmatic level since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes. The section below addresses potential impacts if entry/exit points are installed in coastal locations that are susceptible to land subsidence.
  - Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant on existing utility poles and other structures would have *no impact* on geologic resources at the programmatic level because there would be no ground disturbance for pole/structure installation, and heavy equipment use would be typically limited to bucket trucks operated from existing paved, gravel, or dirt roads. Impacts to geologic resources associated with the construction of new poles to accept aerial fiber or on shore to accept submarine cable are addressed below.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to geologic resources at the programmatic level because there would be no ground disturbance. The section below addresses potential impacts if ground disturbing activities associated with new huts or structures were to occur in locations that are susceptible to specific geologic hazards.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to geologic resources at the programmatic level. The section below addresses potential impacts if the boxes/huts are installed in locations that are susceptible to specific geologic hazards (e.g., land subsidence, landslides, or earthquakes).
- Wireless Projects
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would result in *no impacts* to geologic resources at the programmatic level if no ground disturbance were associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact geologic resources if this activity did not require ground disturbance. The section below addresses potential impacts if ground disturbing activities occur in locations that are susceptible to specific geologic hazards.
  - Deployable Technologies: Where deployable technologies would be implemented on existing paved surfaces, there would be *no impacts* to/from geologic resources at the programmatic level because there would be no ground disturbance and mobile technologies could be moved to avoid geologic hazards. Potential impacts associated with site preparation for staging or landing areas is discussed below.
- Satellites and Other Technologies
  - Satellite -Enabled Devices and Equipment: In most cases, installation of permanent equipment on existing structures, adding equipment to satellites being launched for other

purposes, and the use of portable devices that use satellite technology would *not impact* geologic resources at the programmatic level because those activities would not require ground disturbance. The section below addresses potential impacts if ground disturbance activities occur in locations that are susceptible to specific geologic hazards.
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN, however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact geologic resources, it is anticipated that this activity would have *no impact* on geologic resources at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to geologic resources, or resulting from geologic hazards due to implementation of the Preferred Alternative, would encompass a range of impacts that could occur as a result of ground disturbance activities, including loss of mineral and fuel resources and paleontological resources. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to geologic resources, or impacts from geologic hazards, include the following:

- Wired Projects
    - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POP huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to geologic resources due to associated ground disturbance, such as impacts to fuel and mineral resources or paleontological resources. Where equipment is installed in locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
    - New Build – Aerial Fiber Optic Plant: Installation of new utility poles, and associated use of heavy equipment during construction, could result in potential impacts to geologic resources due to associated ground disturbance. Where equipment is installed in locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
    - Collocation on Existing Aerial Fiber Optic Plant: As stated above, if collocation does not require new utility poles or ground disturbance, there would be *no impacts* to geologic resources. However, replacement of utility poles and structural hardening, and associated use of heavy equipment during construction, could result in potential impacts to geologic resources due to associated ground disturbance. Where equipment is installed in locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: As stated above, although lighting up of dark fiber would have *no impacts* to geologic resources at the programmatic level, installation of new associated huts or equipment, if required, could result in ground disturbance during grading or excavation activities.

Where equipment is installed in locations that are susceptible to specific geologic hazards, it is possible that equipment could be affected by that hazard.

- Use of Existing Conduit – New Buried Fiber Optic Plant: As stated above, disturbance associated with the installation of fiber optic cable in existing conduit have *no impacts* to geologic resources at the programmatic level. However, if fiber were installed in locations susceptible to landslides, earthquakes, or other geologic hazards, it is possible that the equipment could be affected by that hazard.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water is not expected to impact geologic resources including marine paleontological resources. However, where landings and/or facilities for submarine cable are installed at locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
- Installation of Optical Transmission or Centralized Transmission Equipment: As stated above, if installation of equipment were to take place in existing facilities, there would be *no impact* to/from geologic resources. However, if installation of transmission equipment would occur in existing boxes or huts and require ground disturbance in locations that are susceptible to geologic hazards (e.g., land subsidence, landslides, or earthquakes), it is possible that they could be affected by that hazard.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to geologic resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in erosion or disturbance of geologic resources. Where equipment is installed in locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
  - Collocation on Existing Wireless Tower, Structure, or Building: As stated above, collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in ground disturbance. However, if additional power units, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to geologic resources could occur due to ground disturbance. Where equipment is installed in locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that equipment could be affected by that hazard.
  - Deployable Technologies: As stated above, where deployable technologies would be implemented on existing paved surfaces, there would be *no impacts* to/from geologic resources because there would be no ground disturbance and mobile technologies could be moved to avoid geologic hazards. However, implementation of deployable technologies could result in potential impacts to geologic resources depending on the technology and location proposed for deployment. Potential impacts may result if deployment of vehicles (i.e., SOWs, COWs, or COLTs) occurs in unpaved areas, or if the

implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. Satellites and Other Technologies

- o Satellite-Enabled Devices and Equipment: As stated above, the installation of permanent equipment on existing structures, adding equipment to satellites launched for other purposes, or the use of portable devices that use satellite technology would have *no impact* on geologic resources because those activities would not require ground disturbance. Where equipment is permanently installed in locations that are susceptible to landslides, earthquakes, and other geologic hazards, it is possible that they could be affected by that hazard. The use of portable satellite-enabled devices would not impact geologic resources nor would it be affected by geologic hazards because there would be no ground disturbance nor any impact to the built or natural environment.

In general, the abovementioned activities could potentially involve ground disturbance resulting from land/vegetation clearing, topsoil removal, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to geological resources associated with deployment could result in incidental removal of bedrock or mineral resources, or adverse impacts to installed equipment resulting from geologic hazards (e.g., seismic hazards, landslides, and land subsidence). Specific FirstNet Proposed Actions are likely to be small-scale; correspondingly, disturbance to geologic resources for those types of projects with the potential to impact geologic resources is also expected to be small-scale. As a result, these potential impacts are expected to be *less than significant* at the programmatic level. For the same reason, impacts to deployment from geologic hazards are likely to be *less than significant* at the programmatic level as well. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be *no impacts* to geological resources at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections because there would be no ground disturbance.

The operation of the Preferred Alternative could be affected by to geologic hazards including seismic activity, volcanic activity, landslides, and land subsidence. However, potential impacts would be anticipated to be *less than significant* at the programmatic level as it is anticipated that deployment locations would avoid, as practicable and feasible, locations that are more likely to be affected by potential seismic activity, landslides, or land subsidence. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.3.5. Alternatives Impact Assessment

The following section assesses potential impacts to geology associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to geology as a result of implementation of this alternative could be as described below.

Deployment Impacts

Implementation of deployable technologies on existing paved surfaces would result in *no impacts* to geologic resources (or from geologic hazards) at the programmatic level as there would be no ground disturbance and mobile technologies could be moved to avoid geologic hazards. Potential impacts may result if deployment of vehicles (i.e., SOWs, COWs, or COLTs) occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These impacts are expected to be *less than significant* at the programmatic level due to the minor amount of paving or new infrastructure needed to accommodate the deployables. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to geologic resources (or from geologic hazards) at the programmatic level associated with routine inspections of the Preferred Alternative because there would be no ground disturbance.

The operation of the Deployable Technologies Alternative could be affected by to geologic hazards including seismic activity, volcanic activity, landslides, and land subsidence. However, potential impacts would be anticipated to be *less than significant* at the programmatic level as the deployment would be temporary and likely would attempt to avoid locations that are subject to increased seismic activity, landslides, and land subsidence. Chapter 16, BMPs and Mitigation

Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure, or satellites and other technologies. As a result, there would be *no impacts* to geologic resources (or from geologic hazards) as a result of the No Action Alternative. . Environmental conditions would therefore be the same as those described in Section 14.1.3, Geology.

14.2.4. Water Resources

14.2.4.1. Introduction

This section describes potential impacts to water resources in Tennessee associated with deployment and operation of the Proposed Action. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to water resources. Implementation of BMPs, as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 16, BMPs and Mitigation Measures.

14.2.4.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on water resources were evaluated using the significance criteria presented in Table 14.2.4-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant, less than significant with mitigation measures incorporated, less than significant,* or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to water resources addressed in this section are presented as a range of possible impacts.

Table 14.2.4-1: Impact Significance Rating Criteria for Water Resources at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Water Quality (groundwater and surface water) - sedimentation, pollutants, nutrients, water temperature	Magnitude or Intensity	Groundwater contamination creating a drinking quality violation, or otherwise substantially degrade groundwater quality or aquifer; local construction sediment water quality violation, or otherwise substantially degrade water quality; water degradation poses a threat to the human environment, biodiversity, or ecological integrity; violation of various regulations including: CWA, Safe Drinking Water Act (SDWA).	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level.	Potential impacts to water quality, but potential effects to water quality would be below regulatory limits and would naturally balance back to baseline conditions.	No changes to water quality; no change in sedimentation or water temperature, or the presence of water pollutants or nutrients.
	Geographic Extent/Context	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons.		The impact is temporary, lasting no more than six months.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Floodplain degradation[a]	Magnitude or Intensity	The use of floodplain fill, substantial increases in impervious surfaces, or placement of structures within a 500-year flood area that will impede or redirect flood flows or impact floodplain hydrology; high likelihood of encountering a 500-year floodplain within a state or territory.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level.	Activities occur inside the 500-year floodplain, but do not use fill, do not substantially increase impervious surfaces, or place structures that will impede or redirect flood flows or impact floodplain hydrology, and do not occur during flood events. Low likelihood of encountering a 500-year floodplain within a state or territory.	Activities occur outside of floodplains and therefore do not increase fill or impervious surfaces, nor do they impact flood flows or hydrology within a floodplain.
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons.		The impact is temporary, lasting no more than one season or water year, or occurring only during an emergency.	NA
Drainage pattern alteration	Magnitude or Intensity	Alteration of the course of a stream of a river, including stream geomorphological conditions, or a substantial and measurable increase in the rate or amount of surface water or changes to the hydrologic regime.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level.	Any alterations to the drainage pattern are minor and mimic natural processes or variations.	Activities do not impact drainage patterns.
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Impact occurs in perennial streams, and is ongoing and permanent.		The impact is temporary, lasting no more than six months.	NA

Type of Effect	Effect Characteristics	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
Flow alteration	Magnitude or Intensity	Consumptive use of surface water flows or diversion of surface water flows such that there is a measurable reduction in discharge.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level.	Minor or no consumptive use with negligible impact on discharge.	Activities do not impact discharge or stage of waterbody.
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Impact occurs in perennial streams, and is ongoing and permanent.		Impact is temporary, not lasting more than six months.	NA
Changes in groundwater or aquifer characteristics	Magnitude or Intensity	Substantial and measurable changes in groundwater or aquifer characteristics, including volume, timing, duration, and frequency of groundwater flow, and other changes to the groundwater hydrologic regime.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant* at the programmatic level.	Any potential impacts to groundwater or aquifers are temporary, lasting no more than a few days, with no residual impacts.	Activities do not impact groundwater or aquifers.
	Geographic Extent	Watershed level, and/or within multiple watersheds.		Watershed or subwatershed level.	NA
	Duration or Frequency	Impact is ongoing and permanent.		Potential impact is temporary, not lasting more than six months.	NA

NA = Not Applicable
[a] Since public safety infrastructure is considered a critical facility, project activities should avoid the 500-year floodplain wherever practicable, per the Executive Orders on Floodplain Management (EO 11988 and EO 13690). (See http://www.archives.gov/federal-register/codification/executive-order/11988.html and https://www.federalregister.gov/articles/2015/02/04/2015-02379/establishing-a-federal-flood-risk-management-standard-and-a-process-for-further-soliciting-and).

14.2.4.3. Description of Environmental Concerns

Potential Water Quality Impacts

Water quality impaired waterbodies are those waters that have been identified as not supporting their appropriate uses. Projects in watersheds of impaired waters may be subject to heightened permitting requirements. For example, the CWA requires states to assess and report on the quality of waters in their state. Section 303(d) of the CWA requires states to identify impaired waters. For these impaired waters, states must consider the development of a Total Maximum Daily Load or other strategy to reduce the input of the specific pollutant(s) restricting waterbody uses, in order to restore and protect such uses.

As shown in Table 14.1.4-2 and Figure 14.1.4-2, Tennessee's surface water is generally fair to good. Approximately half of the state's assessed rivers and streams are impaired and one-third of state lakes, reservoirs, and ponds are impaired. Designated uses of the impaired waters include irrigation, livestock watering, fish and aquatic life, and recreation (USEPA, 2015b). Generally, the groundwater quality of Tennessee's aquifers is suitable for drinking and daily water needs (TDEC, 2014c).

Deployment activities could contribute pollutants in a number of ways but the primary likely manner is increased sediment in surface waters. Vegetation removal on site exposes soils to rain and wind that could increase erosion. Impacts to water quality may occur from post construction vegetation management, such as herbicides, that may leach into groundwater or move to surface waters through soil erosion or runoff, spray drift, or inadvertent direct overspray. Fuel, oil, and other lubricants from equipment could contaminate groundwater and surface waters if carried in runoff. Other water quality impacts could include changes in temperature, pH or dissolved oxygen levels, water odor, color, or taste, or addition of suspended solids.

Soil erosion or the introduction of suspended solids into waterways from implementation of the Preferred Alternative could contribute to degradation of water quality. If the Proposed Action and Alternatives would disturb more than 1 acre of soil, a Tennessee or USEPA NPDES Construction General Permit (CGP) would be required. As part of the permit application for the CGP, a stormwater pollution prevention plan (SWPPP) would need to be prepared containing BMPs that would be implemented to prevent, or minimize the potential for, sedimentation and erosion. Adherence to the CGP and the BMPs could help prevent sediment and suspended solids from entering the waterways and ensure that effects on water quality during construction would not be adverse.

Deployment activities associated with the Proposed Action have the potential to increase erosion and sedimentation around construction and staging areas. Grading activities associated with construction would potentially result in a temporary increase in the amount of suspended solids running off construction sites. If a storm event were to occur, construction site runoff could result in sheet erosion of exposed soil. If not adequately controlled, water runoff from these areas would have the potential to degrade surface water quality. Implementing BMPs could reduce potential impacts to surface water quality.

Expected deployment activities would not violate applicable state, federal (e.g., CWA and Safe Drinking Water Act), and local regulations, cause a threat to the human environment, biodiversity, or ecological integrity through water degradation, or cause a sediment water quality violation from local construction, or otherwise substantially degrade water quality. Therefore, based on the impact significance criteria presented in Table 14.2.4-1, water quality impacts would likely be *less than significant* at the programmatic level and could be further reduced if BMPs and mitigation measures were to be incorporated where practicable and feasible.

During implementation of the Proposed Action and Alternatives, there is the potential to encounter shallow groundwater due to clearing and grading activities, shallow excavation, or relocation of utility lines. This is unlikely, as trenching is not expected to exceed a 48-inch depth. However, groundwater contamination may exist in areas directly within or near the project area. If trenching[131] or tower construction were to occur near or below the existing water table (depth to water), then dewatering would be anticipated at the location. Residual contaminated groundwater could be encountered during dewatering activities. Construction activities would need to comply with Tennessee dewatering requirements. Any groundwater extracted during dewatering activities, or subject to the terms of a dewatering permit, may be required to be treated prior to discharge or disposed of at a wastewater treatment facility.

Due to the abundance of limestone rock type aquifers within Tennessee (approximately two-thirds of the state), there is potential for contamination to enter groundwater within a watershed or multiple watersheds. However, trenching would not likely introduce new contamination in Tennessee's aquifers. Therefore, it is unlikely that the majority of FirstNet's deployment locations would result in a drinking quality violation, or otherwise substantially degrade groundwater quality or aquifer, and based on the impact significance criteria presented in Table 14.2.4-1, there would likely be *less than significant* impacts at the programmatic level on groundwater quality within most of the state. In areas where groundwater is close to the surface, site- specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Furthermore, BMPs and mitigation measures could be implemented to further reduce potential impacts.

Floodplain Degradation

Floodplains are low-lying lands next to rivers and streams. When left in a natural state, floodplain systems store and dissipate floods without adverse impacts on human beings, buildings, roads and other infrastructure. The 500-year floodplain is the area of minimal flood hazard, where there is a 0.2-percent-annual-chance flood. Some projects may be outside of a floodplain, but still be in an area with known flooding history.

Based on the impact significance criteria presented in Table 14.2.4-1, floodplain degradation impacts would be *less than significant* at the programmatic level since the majority of FirstNet's likely deployment activities, on the watershed or subwatershed level, would use minimal fill, would not substantially increase impervious surfaces, structures would not impede or redirect

[131] Telecommunications activities involve laying conduit, with minimal trenching. Trenching activities would likely be at a minimal depth (less than 36 inches) and width (6 to 12 inches).

flood flows or impact floodplain hydrology, and would not occur during flood events with the exception of deployable technologies which may be deployed in response to an emergency. Additionally, any effects would be temporary, lasting no more than one season or water year, [132] or occur only during an emergency.

Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts to floodplain degradation.

Examples of activities that, at the programmatic level, would have *less than significant* impacts include:

- Construction of any structure in the 500-year floodplain but is built above base flood elevation pursuant to floodplain management regulations;
- Land uses that include pervious surfaces such as gravel parking lots;
- Land uses that do not change the flow of water or drainage patterns; and
- Limited clearing or grading activities.

Implementation of BMPs and mitigation measures could reduce the risk of additional impacts to floodplain degradation (see Chapter 16).

Drainage Pattern Alteration

Flooding and erosion from land disturbance could change drainage patterns. Stormwater runoff causes erosion while construction activities and land clearing could change drainage patterns. Clearing or grading activities, or the creation of walls or berms could alter water flow in an area or cause changes to drainage patterns. Drainage could be directed to stormwater drains, storage, and retention areas designed to slow water and allow sediments to settle out. Improperly handled drainage could cause increased erosion, changes in stormwater runoff, flooding, and damage to water quality. Existing drainage patterns could be modified by channeling (straightening or restructuring natural watercourses); creation of impoundments (detention basins, retention basins, and dams); stormwater increases; or altered flow patterns.

According to the significance criteria in Table 14.2.4-1, any temporary (lasting less than six months) alterations to drainage patterns that are minor and mimic natural processes or variations within the watershed or subwatershed level would be considered *less than significant* at the programmatic level.

Example of projects that could have minor changes to the drainage patterns include:

- Land uses with pervious surfaces that create limited stormwater runoff.
- Where stormwater is contained on site and does not flow to or impact surface waterbodies offsite on other properties.
- Activities designed so that the amount of stormwater generated before construction is the same as afterwards.
- Activities designed using low impact development techniques for stormwater.

[132] A water year is defined as "the 12-month period October 1, for any given year through September 30, of the following year. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months." (USGS, 2016c)

Since the proposed activities would not substantially alter drainage patterns in ways that alter the course of a stream or river; create a substantial and measurable increase in the rate and amount of surface water; or change the hydrologic regime; and any effects would be short-term; impacts to drainage patterns would be *less than significant* at the programmatic level. BMPs and mitigation measures could be implemented to further reduce potentialimpacts.

Flow Alteration

Flow alteration refers to the modification of flow characteristics, relative to natural conditions. Human activities may change the amount of water reaching a stream, divert flow through artificial channels, or alter the shape and location of streams. Surface water and groundwater withdrawals could alter flow by reducing water volumes in streams. Withdrawals may return to the surface/groundwater system at a point further downstream, be removed from the watershed through transpiration by crops, lawns or pastures, or be transferred to another watershed altogether (e.g., water transferred to a different watershed for drinking supply). Altered flow could increase flooding and introduce more erosion and potential for pollution. Alternatively, if water is diverted from its normal flow, the opposite may occur; wetlands and streams may not receive as much water as necessary to maintain the ecology and previous functions.

Activities that do not impact discharge or stage of waterbody (stream height) are not anticipated to have an impact on flow, according to Table 14.2.4-1. Projects that include minor consumptive use of surface water with *less than significant* impacts on discharge (do not direct large volumes of water into different locations) on a temporary (no more than six months) are likely to have *less than significant* impacts at the programmatic level on flow alteration, on a watershed or subwatershed level. Examples of projects likely to have *less than significant* impacts include:

- Construction of any structure in a 100-year or 500-year floodplain that is built above base flood elevation pursuant to floodplain management regulations;
- Land uses that are maintaining or increasing pervious surfaces;
- Land uses that do not change the flow of water or drainage patterns off site or into surface waterbodies that have not received that volume of stormwater previously; and
- Minor clearing or grading activities.

Since the proposed activities would not likely alter flow characteristics or change the hydrologic regime, impacts would be *less than significant* impacts at the programmatic level to flow alteration. BMPs and mitigation measures could be implemented to further reduce any impacts.

Changes in Groundwater or Aquifer Characteristics

As described in Section 14.1.4.7, approximately 1.5 million residents rely on Tennessee's groundwater for their drinking water (many in the western half of the state) (TDEC, 2014c). Generally, the water quality of Tennessee's aquifers is suitable for drinking and daily water needs. Within the state, groundwater varies from soft to hard, and slightly acidic to basic (TDEC, 2014c). Once a groundwater supply is exhausted or contaminated, it is very expensive, and sometimes impossible, to replace. Water supply demand from the deployment activities is unlikely to exceed safe and sustainable withdrawal capacity rate of the local supply or aquifer.

Storage of generator fuel over groundwater or an aquifer would be unlikely to cause *significant* impacts to water quality due to the expected small volume of these materials. Activities that may cause changes is groundwater or aquifer characteristics include:

- Excavation, mining, or dredging during or after construction;
- Any liquid waste, including but not limited to wastewater, generation; and
- Storage of petroleum or chemical products.

Private and public water supplies often use groundwater as a water source. To maintain a sustainable system, the amount of water withdrawn from these groundwater sources must be balanced with the amount of water returned to the groundwater source (groundwater recharge).

Deployment activities should be *less than significant* at the programmatic level since they would not substantially deplete supplies of potable groundwater, as any construction dewatering would be short-term. The siting of deployment activities should be considered to avoid areas that would extract groundwater from potable groundwater sources in the area. According to Table 14.2.4-1, *potentially significant* impacts to groundwater or aquifer characteristics would only occur if actions resulted in substantial and measurable changes in groundwater or aquifer characteristics, including volume, timing, duration, and frequency of groundwater flow, and other changes to the groundwater hydrologic regime on a watershed or within multiple watersheds that is ongoing and permanent. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.4.4. Potential Impacts of the Preferred Alternative at the Programmatic Level

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to water resources and others would not. In addition, and as explained in this section, the various types of Preferred Alternative Infrastructure could result in a range of *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. The impact on the water resources that could be affected would depend on the watershed, duration (chronic or short-term) and frequency (many years or a few months) the resource would be used, and the water resource’s current use (sole source for drinking water, considered exceptional value for recreation, or provides critical habitat for a species).

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Infrastructure, the following are likely to have *no impacts* to water resources at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to water resources at the programmatic level since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable*:* Lighting up of dark fiber would have *no impacts* to water resources at the programmatic level because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact water resources because those activities would not require ground disturbance, construction in floodplains, or use of motorized equipment near streams.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact water resources, it is anticipated that this activity would have *no impact* on water resources at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential construction/deployment-related impacts to water resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities, including in-stream construction work, resulting primarily in sediments entering streams, but also potentially to near-shore or inland waters, as well as the potential for other impacts to water quality and floodplains. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to water resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to water resources. Ground disturbance and heavy equipment use associated with plowing, trenching, or directional boring as well as land/vegetation clearing, excavation activities, and landscape grading associated with construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in stream sedimentation, construction of impervious surfaces and

structures in floodplains, stream channel alteration, and accidental spills of fuels or lubricants to waterbodies. New Build – Buried Fiber Optic Plant projects could present a higher risk to water resources because of their relatively high degree of soil disturbance compared to the other types of projects. Implementing BMPs and mitigation measures could reduce impact intensity.

- o New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water could potentially impact water quality due to disruption of sediments on the floor of the waterbody. Impacts to water resources could also potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Sediments entering limited near-shore or inland waterbodies could potentially occur as result of grading, foundation excavation, or other ground disturbance activities. Construction of facilities in floodplains could potentially impact floodplain functionality and drainage patterns.
- o New Build – Aerial Fiber Optic Plant: Soil exposure from installation of new poles or construction of new roads, POPs, huts, or other facilities near waterbodies could result in ground disturbance, potentially resulting in sediment deposition and increased turbidity in nearby waterbodies. The use of heavy equipment during the installation of new poles and cables could result in potential soil disturbance and the resulting potential sedimentation impacts to streams, disturbance of riparian vegetation, leaching of PCPs, and accidental spills of fuels or lubricants to waterbodies.
- o Collocation on Existing Aerial Fiber Optic Plant: Ground disturbance during the replacement of poles and structural hardening could result in potential soil erosion and sedimentation impacts to streams, particularly where this work would be done in proximity to waterbodies. Collocation on Existing Aerial Fiber Optic Plant projects could present a lower risk to water resources because of their relatively low degree of soil disturbance compared to the other types of projects.
- o Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required grading or other ground disturbance to install small boxes or huts, or access roads, there could potentially be direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites. The amount of impact depends on the land area affected, installation technique, and location. Trenching would not be expected to occur near or below the existing water table (depth to water). If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to water resources at the programmatic level.

- Wireless Projects
  - o New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites. The amount of impact depends on the land area affected, installation technique, and location. Trenching would not be expected to occur near or below the existing water table (depth to water). Implementing BMPs

could reduce impact intensity. If a new roadway were built, additional impervious surface would not be expected to impact water resources or the overall amount of runoff and nonpoint pollution.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to water resources because there would be no ground disturbance or in-water construction associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact water resources if this activity would not require ground disturbance or in-water construction. However, if the on-site delivery of additional power units, structural hardening, and physical security measures required travel through streams or ground disturbance, such as grading or excavation activities near streams, potential impacts to water resources could occur including stream sedimentation and physical disturbance associated with heavy equipment use.

- Deployable Technologies
  - Implementation of land-based deployable technologies could result in potential impacts to water resources if deployment involves movement of equipment through streams, occurs in riparian or floodplain areas, occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites or deployment in unpaved areas. The amount of impact depends on the land area affected, installation technique, and location. Implementing BMPs and mitigation measures could reduce impact intensity. The activities could also result in indirect impacts on water quality if fuels leak into surface or groundwater. Where deployable technologies would be implemented on existing paved surfaces, or where aerial and vehicular deployable technologies may be used on existing paved surfaces, it is anticipated that there would be *no impacts* to water resources at the programmatic level because there would be no ground disturbance.
  - Deployment of drones, balloons, blimps, or piloted aircraft could have indirect impacts on water quality if fuels spill or other chemicals seep into ground or surface waters. In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to water resources associated with deployment of this infrastructure could include water quality impacts, but are expected to be *less than significant* at the programmatic level due to the small scale of individual activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers or poles; installation of security/safety lighting and fencing; and deployment of aerial platforms.

Potential impacts to water resources associated with deployment of this infrastructure would likely be *less than significant* at the programmatic level due to the limited geographic scale of individual activities and would likely return to baseline conditions once revegetation of disturbed areas is complete. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that there would be *no impacts* to water resources at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections, and assuming that all refueling and vehicle maintenance BMPs and mitigation measures are followed. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors and near waterbodies, the resulting ground disturbance could increase sedimentation in waterbodies, potentially impacting water quality. It is assumed that routine maintenance would not include operation of vehicles or equipment in waterbodies. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.4.5. Alternatives Impact Assessment

The following section assesses potential impacts to water resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to water resources as a result of implementation of this Alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts to water resources at the programmatic level if those activities occurred on paved surfaces if there is any runoff into the surface water. Some staging or launching/landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving; however, these activities would be isolated and short term, and would likely return to baseline conditions once revegetation was complete. Additionally, project activities could result in direct and indirect impacts to water quality from a temporary increase in the amount of suspended solids running off construction sites and from fuels leaking into surface or groundwater. However, spills from vehicles or machinery used during deployment tend to be associated with re-fueling operations, and as such, would likely be a few gallons or less in volume and would likely be easily contained or cleaned up, and therefore would have *less than significant* impacts at the programmatic level. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Deployable Technologies Alternative would consist of routine maintenance and inspection of the deployable technologies. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The water resources impacts would depend on the watershed, duration (chronic or short-term) and frequency (many years or a few months) the resource would be used, and the water resource's current use (sole source for drinking water, considered exceptional value for recreation, or provides critical habitat for a species).

It is anticipated that there would *no impacts* to water resources at the programmatic level associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors and near waterbodies, the resulting ground disturbance could increase sedimentation in waterbodies, potentially impacting water quality. It is assumed that routine maintenance would not include operation of vehicles or equipment in waterbodies. Finally, if ground-based deployable technologies are parked and operated with air conditioning for extended periods of time, the condensation water from the air conditioner could result in soil erosion that could potentially impact waterbodies if the deployables are located adjacent to waterbodies; however, due to the limited and temporary nature of the deployable activities, it is anticipated that these potential impacts would be *less than significant* at the programmatic level. Site maintenance, including mowing or herbicides, may result in *less than significant* effects to water quality at the programmatic level, due to the small-scale of expected FirstNet activities in any particular location. In addition, the presence of new access roads could increase the overall amount of impervious surface in the area, and increase runoff effects on water resources, as explained above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to water resources as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.4, Water Resources.

14.2.5. Wetlands

14.2.5.1. Introduction

This section describes potential impacts to wetlands in Tennessee associated with deployment and operation of the Proposed Action and Alternatives. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to wetland resources. Implementation of BMPs, as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 16, BMPs and Mitigation Measures.

14.2.5.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on wetlands were evaluated using the significance criteria presented in Table 14.2.5-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant, less than significant with mitigation measures incorporated, less than significant,* or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to wetlands addressed in this section are presented as a range of possible impacts.

Table 14.2.5-1: Impact Significance Rating Criteria for Wetlands at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	Less than Significant with BMPs and Mitigation Measures Incorporated	Less than Significant	No Impact
Direct wetland loss (fill or conversion to non-wetland)	Magnitude[a] or Intensity	Substantial loss of high-quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.); violations of Section 404 of the CWA.	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity).	No direct loss of wetlands.
	Geographic Extent/Context	USGS watershed level, and/or within multiple watersheds.		USGS watershed or subwatershed level.	NA
	Duration or Frequency	Long-term or permanent loss, degradation, or conversion to non-wetland.		Periodic and/or temporary loss reversed over 1-2 growing seasons with or without active restoration.	NA
Other direct effects: vegetation clearing; ground disturbance; direct hydrologic changes (flooding or draining); direct soil changes; water quality degradation (spills or sedimentation)	Magnitude or Intensity	Substantial and measurable changes to hydrological regime of the wetland impacting salinity, pollutants, nutrients, biodiversity, ecological integrity, or water quality; introduction and establishment of invasive species to high quality wetlands.	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	Impacts to lower quality wetlands affecting the hydrological regime including salinity, pollutants, nutrients, biodiversity, ecological integrity, or water quality; introduction and establishment of invasive species to high quality wetlands.	No direct impacts to wetlands affecting vegetation, hydrology, soils, or water quality.
	Geographic Extent	USGS watershed level, and/or within multiple watersheds.		USGS watershed or subwatershed level.	NA

Type of Effect	Effect Characteristics	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
	Duration or Frequency	Long-term or permanent alteration that is not restored within 2 growing seasons, or ever.		Periodic and/or temporary loss reversed over 1-2 growing seasons with or without active restoration.	NA
Indirect Effects: [b] Change in Function(s)[c] Change in Wetland Type	Magnitude or Intensity	Changes to the functions or type of high quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.).	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity).	No changes in wetland function or type.
	Geographic Extent	USGS watershed level, and/or within multiple watersheds.		USGS watershed or subwatershed level.	NA
	Duration or Frequency	Long-term or permanent change in function or type that is not restored within two growing seasons, or ever.		Periodic and/or temporary loss reversed over 1-2 growing seasons with or without active restoration.	NA

NA = Not Applicable
[a] "Magnitude" is defined based on the type of wetland impacted, using USACE wetland categories. Category 1 are the highest quality, highest functioning wetlands.
[b] Indirect effects are those resulting from direct effects, but they occur elsewhere in space and/or time. Includes indirect hydrologic effects (wetting or drying) that in turn alters wetland function or type.
[c] Wetland functions include hydrologic, ecological, geomorphic, and social functions typically assessed for wetlands as part of USACE compensatory mitigation planning. Typical functions assessed may include flood attenuation, bank stabilization, water quality, organic matter input/transport, nutrient processing, wildlife habitat, threatened and endangered species habitat, biodiversity, recreational/social value.

14.2.5.3. Description of Environmental Concerns

Potential Direct Wetland Loss (Fill or Conversion to Non-Wetland)

Construction-related impacts from several of the deployment activities have the potential for direct wetland impacts such as filling, draining, or conversion to a non-wetland. Examples include placement of fill in a wetland to construct a new tower, trenching through a wetland or directly connected waterway to install a cable, and placement of a structure (tower, building) within the wetland.

Wetlands regulate the quality and quantity of surface and groundwater supplies, reduce flood hazards by serving as retention basins for surface runoff, and maintain water supplies after floodwaters subside. If wetlands were filled, the entire area may be at risk for increased flooding. There could be a loss of open space to be enjoyed by the community, and decreased wildlife populations may be observed due to displacement and increased noise, vibrations, light, and other human disturbance. To the extent practicable or feasible, FirstNet and/ or their partners would avoid filling wetlands or altering the hydrologic regime so that wetlands would not be lost or converted to non-wetlands. Loss of high and low-quality wetlands would be *less* than significant at the programmatic level given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

There are approximately 918,646 acres of wetlands throughout Tennessee (USFWS, 2014a). Palustrine (freshwater) wetlands are found on forested lowlands in western Tennessee and on river and lake floodplains across the state, as shown in Figure 14.1.5-1.

Based on the impact significance criteria presented in Table 14.2.5-1, the deployment activities would most likely have *less than significant* direct impacts on wetlands at the programmatic level. Additionally, the deployment activities would be unlikely to violate applicable federal, state, and locally required regulations.

In Tennessee, as discussed in Section 14.1.5.4, Wetlands, Reelfoot Lake and adjacent wetlands are designated as ONRWs and high quality wetlands according to the state’s water quality standards. If any of the proposed deployment activities were to occur in these high quality wetlands, *potentially significant* impacts could occur. High quality wetlands that occur throughout the state are not always included on state maps; therefore, site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work to avoid *potentially signficant* impacts to wetlands. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Other Direct Effects

Other direct impacts consist of altering the chemical, physical, or biological components of a wetland to the extent that changes to the wetland functions occur. However, other direct impacts would not result in a loss of total wetland acreage. Changes, for example, could include conversion of a forested wetland system to a non-forested state through chemical, mechanical, or hydrologic manipulation; altered hydrologic conditions (increases or decreases) such as stormwater discharges or water withdrawals that alter the functions of the wetlands.

Construction-related deployment activities that result in long-term or permanent, substantial, and measurable changes to hydrological regime of the wetland (i.e., changes in salinity, pollutants, nutrients, biodiversity, ecological integrity, or water quality) could cause *potentially significant* impacts. In addition, introduction and establishment of invasive species to high quality wetlands within a watershed or multiple watersheds could be *potentially significant*. Based on the impact significance criteria presented in Table 14.2.5-1, other direct effects to high- and low-quality wetlands would be *less than significant* at the programmatic level given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities and the application of federal, state, and locally required wetlands regulations. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Examples of activities that could have other direct effects to wetlands in Tennessee include:

- *Vegetation Clearing*: removing existing vegetation by clearing forest and herbaceous vegetation during construction activities, grading, seeding, and mulching. Clearing and grading may include increased soil erosion and a decrease in the available habitat for wildlife.
- *Ground Disturbance*: Increased amounts of stormwater runoff in wetlands could alter water level response times, depths, and duration of water detention. Reduction of watershed infiltration capacity could cause wetland water depths to rise more rapidly following storm events.
- *Direct Hydrologic Changes (flooding or draining)*: Greater frequency and duration of flooding could destroy native plant communities, as could depriving them of their water supply. Hydrologic changes could make a wetland more vulnerable to pollution. Increased water depths or flooding frequency could distribute pollutants more widely through a wetland. Sediment retention in wetlands is directly related to flow characteristics, including degree and pattern of channelization, flow velocities, and storm surges.

- *Direct Soil Changes*: Changes in soil chemistry could lead to degradation of wetlands that have a specific pH range and/or other parameter, such as the acidic conditions of bogs and alkaline conditions of fens.
- *Water Quality Degradation (spills or sedimentation)*: The loss of wetlands results in a depletion of water quality both in the wetland and downstream. Filtering of pollutants by wetlands is an important function and benefit. High levels of suspended solids (sedimentation) could reduce light penetration, dissolved oxygen, and overall wetland productivity. Toxic materials in runoff could interfere with the biological processes of wetland plants, resulting in impaired growth, mortality, and changes in plant communities.

Indirect Effects:[133] Change in Function(s)[134] or Change in Wetland Type

Indirect effects to wetlands could include change in wetland function or conversion of a resource to another type (i.e., wetland to an open body of water). The construction of curb and gutter systems diverts surface runoff and could cause flooding or wetlands to dry out, depending on the direction of diversion. Indirect effects to high- and low-quality wetlands would be *less than significant* at the programmatic level given the amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities and the application of federal, state, and locally required wetlands regulations. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Examples of functions related to wetlands in Tennessee that could potentially be impacted from construction-related deployment activities include:

- *Flood Attenuation:* Wetlands provide flood protection by holding excess runoff after storms, before slowly releasing it to surface waters. While wetlands may not prevent flooding, they could lower flood peaks by providing detention of storm flows. Correspondingly, disturbance of the wetlands (e.g., dredging or filling) could proportionately reduce water storage function.
- *Bank Stabilization:* By reducing the velocity and volume of flow, wetlands provide erosion control, floodwater retention, and reduce stream sedimentation.
- *Water Quality:* Water quality impacts on wetland soils could eventually threaten a wetland's existence. Where sediment inputs exceed rates of sediment export and soil consolidation, a wetland would gradually become filled.
- *Nutrient Processing:* Wetland forests retain ammonia during seasonal flooding. Wetlands absorb metals in the soils and by plant uptake via the roots. They also allow metabolism of

[133] Indirect effects are those resulting from direct effects, but they occur elsewhere in space and/or time. Includes indirect hydrologic effects (wetting or drying) that in turn alters wetland function or type.

[134] Wetland functions include hydrologic, ecological, geomorphic, and social functions typically assessed for wetlands as part of USACE compensatory mitigation planning. Typical functions assessed may include flood attenuation, bank stabilization, water quality, organic matter input/transport, nutrient processing, wildlife habitat, threatened and endangered species habitat, biodiversity, recreational/social value.

oxygen-demanding materials and reduce fecal coliform populations. These pollutants are often then buried by newer plant material, isolating them in the sediments.

- *Wildlife Habitat:* Impacts on wetland hydrology and water quality affect wetland vegetation. While flooding could harm some wetland plant species, it promotes others. Shifts in plant communities because of hydrologic changes could have impacts on the preferred food supply and animal cover.
- *Recreational Value:* Wetlands provide recreation opportunities for people, such as hiking, bird watching, and photography.
- *Groundwater Recharge:* Wetlands retain water, allowing time for surface waters to infiltrate into soils and replenish groundwater.

According to the significance criteria defined in Table 14.2.5-1, impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity), would be considered *less than significant* at the programmatic level. Since the majority of the 918,646 acres of wetlands in Tennessee are not considered high quality, deployment activities could have *less than significant* indirect impacts at the programmatic level on wetlands in the state.

In areas of the state with high quality wetlands, such as along Reelfoot Lake, there could be *potentially significant* impacts at the project level that may require site-specific analysis depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. If avoidance were not possible, potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.5.4. Potential Impacts of the Preferred Alternative at the Programmatic Level

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to wetlands and others would not. In addition, and as explained in this section, the same type of Preferred Alternative Infrastructure could result in a range of *no impacts* to *potentially significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to wetlands at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to wetlands at the programmatic level since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to wetlands at the programmatic level because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures, adding equipment to satellites being launched for other purposes, and the use of portable devices that use satellite technology is not likely to impact wetlands since there would be no ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would not impact wetlands, it is anticipated that this activity would have *no impact* on wetlands at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to wetlands because of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct effects, other direct effects, and indirect effects on wetlands. The types of deployment activities that could be part of the Preferred Alternative and result in potential impacts to wetlands include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to wetlands. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct and indirect impacts to wetlands. The amount of impact depends on the land area affected, installation technique, proximity to wetlands, and type of wetland that could be affected (e.g., high quality). Any ground disturbance could cause direct and indirect impacts wetlands, depending on the proximity to wetlands and type of wetlands that could be affected. Implementing BMPs and mitigation measures could reduce impact intensity.

- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water would potentially impact wetlands found along shorelines. Additional project-specific environmental reviews would be required to assess potential impacts to wetland environments, including coastal and marine environments.
- New Build – Aerial Fiber Optic Plant: Potential impacts would be similar to Buried Fiber Optic Plant. Any ground disturbance could cause direct and indirect impacts wetlands, depending on the proximity to wetlands and type of wetlands that could be affected.
- Collocation on Existing Aerial Fiber Optic Plant: Any ground disturbance could cause direct and indirect impacts to wetlands from increased suspended solids and runoff from activities, depending on the proximity to wetlands and type of wetlands that could be affected.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required grading or other ground disturbance to install small boxes or hunts, or access roads, there could potentially be direct and indirect impacts to wetlands. The amount of impact from a temporary increase in the amount of suspended solids running off construction sites and into wetlands, depends on the land area affected, installation technique, and location. If trenching were to occur near wetlands, it could cause impacts on wetlands. Implementing BMPs and mitigation measures could reduce impact intensity.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could potentially cause direct and indirect impacts to wetlands. The activities could cause a temporary increase in the amount of suspended solids running off construction sites and into wetlands, depending on their proximity. The amount of impact depends on the land area affected, installation technique, and proximity to wetlands, and wetland type. If trenching were to occur near wetlands, it could cause impacts on wetlands. Implementing BMPs and mitigation measures could reduce impact intensity.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to wetlands. However, if additional power units, structural hardening, and physical security measures required ground disturbance, such as grading, or excavation activities, impacts to wetlands could occur near wetlands, it could cause impacts on wetlands. Implementing BMPs and mitigation measures could reduce impact intensity.
- Deployable Technologies
  - Implementation of deployable technologies could result in potential impacts to wetlands if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. The amount of impact depends on the land area affected, installation technique, and location. Implementing BMPs and mitigation measures could reduce impact intensity. The

activities could also result in other direct impacts on wetlands if fuels leak into nearby waterbodies or wetlands. Deployment of drones, balloons, blimps, or piloted aircraft could have other direct impacts on wetlands if fuels spill or other chemicals seep into nearby waterbodies or wetlands.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or underwater cables; installation of security/safety lighting and fencing; and deployment of aerial platforms. Depending on the deployment activity for this infrastructure, potential impacts to wetlands may occur. The amount of impact depends on the land area affected, installation technique, proximity to wetlands, and type of wetland that could be affected (e.g., high quality). Any ground disturbance could cause direct and indirect impacts wetlands, depending on the proximity to wetlands and type of wetlands that could be affected. These impacts are expected to be *less than significant* at the programmatic level due to the small amount of land disturbance (generally less than one acre) and the short timeframe of deployment activities. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid or minimize potential impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned potential deployment impacts. . Depending on the proximity to wetlands, it is anticipated that there could be ongoing other potential direct impacts to wetlands if heavy equipment is used for routine operations or maintenance or if application of herbicides occurs to control vegetation along ROWs and near structures. The intensity of the impact depends on the amount of herbicides used, frequency, and location of nearby sensitive wetlands. These impacts are not expected to be *less than significant* at the programmatic level due to the limited nature of deployment activities. It is anticipated that there would be *no impacts* at the programmatic level to wetland resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections, and assuming that all federal, state, and local requirements associated with refueling and vehicle maintenance are followed. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid, or minimize potential impacts.

14.2.5.5. Alternatives Impact Assessment

The following section assesses potential impacts to water resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to wetlands as a result of implementation of this Alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts to wetlands at the programmatic level. Some staging or launching/landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in direct and indirect impacts to wetlands from a temporary increase in the amount of suspended solids running off construction sites to nearby surface waters. The amount of impact depends on the land area affected, installation technique, and proximity to wetlands, and wetland type; however, impacts are expected to be *less than significant* at the programmatic level due to the small scale and temporary duration of expected FirstNet deployment activities in any one location. Potential wetlands impacts could be further reduced by implementing BMPs and mitigation measures. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid or minimize potential impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Deployable Technologies Alternative would consist of routine maintenance and inspection of the deployable technologies. Any major infrastructure replacement as part of ongoing system maintenance could result in impacts similar to the abovementioned deployment impacts. The wetlands impacts would depend on the watershed, duration (chronic or short-term) and frequency (many years or a few months) the resource would be used, and the wetland's quality and function.

It is anticipated that there would be *less than significant* impacts at the programmatic level to wetlands associated with routine inspections of the Deployable Technologies Alternative as it is likely existing roads and utility rights-of-way would be utilized for maintenance and inspection activities. Site maintenance, including mowing or herbicides, is anticipated to result in *less than significant* impacts to wetlands at the programmatic level due to the limited nature of site maintenance activities, including mowing and application of herbicides. In addition, the presence of new access roads could increase the overall amount of impervious surface in the area, and increase runoff effects on wetlands, as explained above. To minimize any potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, state, and local permits. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partners would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to wetlands from the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.5, Wetlands.

14.2.6. Biological Resources

14.2.6.1. Introduction

This Chapter describes potential impacts to terrestrial vegetation, wildlife, fisheries and aquatic habitat, and threatened and endangered species in Tennessee associated with deployment and operation of the Proposed Action and its Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid, or minimize potential impacts.

14.2.6.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on terrestrial vegetation, wildlife, fisheries, and aquatic habitats were evaluated using the significance criteria presented in Table 14.2.6-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined, at the programmatic level, as *potentially significant*, *less than significant with mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to terrestrial vegetation, wildlife, and fisheries and aquatic habitat addressed in Sections 14.2.6.3, 14.2.6.4, and 14.2.6.5, respectively, are presented as a range of possible impacts. Refer to Section 14.2.6.6 for impact assessment methodology and significance criterial associated with threatened and endangered species in Tennessee.

Table 14.2.6-1: Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, Fisheries, and Aquatic Habitats at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
Direct Injury/Mortality	Magnitude or Intensity	Population-level or sub-population injury /mortality effects observed for at least one species depending on the distribution and the management of said species. Events that may impact endemics, or concentrations during breeding or migratory periods. Violation of various regulations including: MBTA and Bald and Golden Eagle Protection Act (BGEPA).	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*.	Individual mortality observed but not sufficient to affect population or sub-population survival.	No direct individual injury or mortality would be observed.
	Geographic Extent	Regional effects observed within Tennessee for at least one species. Anthropogenic[a] disturbances that lead to exclusion from nutritional or habitat resources, or direct injury or mortality of endemics or a significant portion of the population or sub-population located in a small area during a specific season.		Effects realized at one location when population is widely distributed, and not concentrated in affected area.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within one to three years.	NA

Type of Effect	Effect Characteristics	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
Vegetation and Habitat Loss, Alteration, or Fragmentation	Magnitude or Intensity	Population-level or sub-population effects observed for at least one species or vegetation cover type, depending on the distribution and the management of the subject species. Impacts to terrestrial, aquatic, or riparian habitat or other sensitive natural community vital for feeding, spawning/breeding, foraging, migratory rest stops, refugia, or cover from weather or predators. Violation of various regulations including: MBTA and BGEPA.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*.	Habitat alteration in locations not designated as vital or critical for any period. Temporary losses to individual plants within cover types, or small habitat alterations take place in important habitat that is widely distributed and there are no cover type losses or cumulative effects from additional projects.	Sufficient habitat would remain functional to maintain viability of all species. No damage or loss of terrestrial, aquatic, or riparian habitat from project would occur.
	Geographic Extent	Regional effects observed within Tennessee for at least one species. Anthropogenic disturbances that lead to the loss or alteration of nutritional or habitat resources for endemics or a significant portion of the population or sub-population located in a small area during a specific season.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within one to three years.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Indirect Injury/Mortality	Magnitude or Intensity	Population-level or sub-population effects observed for at least one species depending on the distribution and the management of said species. Exclusion from resources necessary for the survival of one or more species and one or more life stages. Anthropogenic disturbances that lead to mortality, disorientation, the avoidance, or exclusion from nutritional or habitat resources for endemics or a significant portion of the population or sub-population located in a small area during a specific season. Violation of various regulations including: MBTA and BGEPA.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*.	Individual injury/mortality observed but not sufficient to affect population or sub-population survival. Partial exclusion from resources in locations not designated as vital or critical for any given species or life stage, or exclusion from resources that takes place in important habitat that is widely distributed. Anthropogenic disturbances are measurable but minimal as determined by individual behavior and propagation, and the potential for habituation or adaptability is high given time.	No stress or avoidance of feeding or important habitat areas. No reduced population resulting from habitat abandonment.
	Geographic Extent	Regional or site-specific effects observed within Tennessee for at least one species. Behavioral reactions to anthropogenic disturbances depend on the context, the time of year age, previous experience, and activity. Anthropogenic disturbances that lead to startle responses of large groupings of individuals during haulouts, resulting in injury or mortality.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within one to three years.	NA

Type of Effect	**Effect Characteristics**	**Impact Level**			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects to Migration or Migratory Patterns	Magnitude or Intensity	Population-level or sub-population effects observed for at least one species depending on the distribution and the management of said species. Temporary or long-term loss of migratory pattern/path or rest stops due to anthropogenic activities. Violation of various regulations including: MBTA and BGEPA.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*.	Temporary loss of migratory rest stops due to anthropogenic activities take place in important habitat that is widely distributed and there are no cumulative effects from additional projects.	No alteration of migratory pathways, no stress, or avoidance of migratory paths/patterns due to project.
	Geographic Extent	Regional effects observed within Tennessee for at least one species. Anthropogenic disturbances that lead to exclusion from nutritional or habitat resources during migration, or lead to changes of migratory routes for endemics or a significant portion of the population or sub-population located in a small area during a specific season.		Effects realized at one location when population is widely distributed, and not concentrated in affected area.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within one to three years.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	Less than Significant with BMPs and Mitigation Measures Incorporated	Less than Significant	No Impact
Reproductive Effects	Magnitude or Intensity	Population or sub-population level effects in reproduction and productivity over several breeding/spawning seasons for at least one species depending on the distribution and the management of said species. Violation of various regulations including: MBTA and BGEPA.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*.	Effects to productivity are at the individual rather than population level. Effects are within annual variances and not sufficient to affect population or sub-population survival.	No reduced breeding or spawning success.
	Geographic Extent	Regional effects observed within Tennessee for at least one species. Anthropogenic disturbances that lead to exclusion from prey or habitat resources required for breeding/spawning or stress, abandonment, and loss of productivity for endemics or a significant portion of the population or sub-population located in a small area during the breeding/spawning season.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several breeding/spawning seasons for at least one species.		Temporary, isolated, or short-term effects that are reversed within one breeding season.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Invasive Species Effects	Magnitude or Intensity	Extensive increase in invasive species populations over several seasons.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*.	Mortality observed in individual native species with no measurable increase in invasive species populations.	No loss of forage and cover due to the invasion of exotic or invasive plants introduced to project sites from machinery or human activity.
	Geographic Extent	Regional impacts observed throughout Tennessee.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term changes not likely to be reversed over several years or seasons.		Periodic, temporary, or short-term changes that are reversed over one or two seasons.	NA

NA = Not Applicable
[a] Anthropogenic: "Made by people or resulting from human activities. Usually used in the context of emissions that are produced as a result of human activities." (USEPA, 2016h)

14.2.6.3. Terrestrial Vegetation

Impacts to terrestrial vegetation occurring in Tennessee are discussed in this section.

Description of Environmental Concerns

Direct Injury/Mortality

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from interactions associated with the Proposed Action. The most common direct injuries are permanent or temporary loss or disturbance of individual plants. Based on the impact significance criteria presented in Table 14.2.6-1, direct injury or mortality impacts could be significant at the programmatic level if population-level or sub-population effects were observed for at least one species depending on the distribution and the management of the subject species. Although unlikely, direct mortality/injury to plants could occur in construction zones from land clearing, excavation activities, or vehicle traffic; however, these events are expected to be relatively small in scale and therefore would have *less than significant* impacts. The implementation of standard BMPs, mitigation measures, and avoidance measures could help to minimize or altogether avoid potential impacts to plant population survival. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid, or minimize potential impacts.

Vegetation and Habitat Loss, Alteration, or Fragmentation

Habitat impacts are primarily physical disturbances that result in alterations in the amount or quality of a habitat. As with all of the effects categories, the magnitude of the potential impact depends on the duration, location, and spatial scale of the system and associated activities. Habitat fragmentation is the loss or breaking down of continuous and connected habitat. About 34 percent of Tennessee has experienced extensive land use change due to cropland and pastureland creation and about 12 percent of the state has experienced extensive land use change due to urbanization. However, a large portion of the state, about 44 percent, remains as relatively unfragmented forest, particularly the Great Smoky Mountains National Park and Catoosa Wildlife Management Area. (NRCS, 2010)

Construction of new infrastructure and long-term facility maintenance would result in the alteration of the type of vegetative communities in these localized areas, and in some instances the permanent loss of vegetation. In general, these impacts are expected to be *less than significant* due to the short-term, localized nature of the deployment activities. Further, some limited amount of infrastructure may be built in sensitive or rare regional vegetative communities, in which case BMPs and mitigation measures could be recommended and consultation with the appropriate resource agencies, if required, could be undertaken to minimize or avoid potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid, or minimize potential impacts.

Comments received on other regional Draft PEIS documents for the Proposed Action expressed concerns related to the potential impacts to vegetation from RF emissions. Some studies have indicated the potential for *adverse effects* to vegetation from RF emissions. As explained in Section 2.4, Radio Frequency Emissions, as well as the Wildlife portion of this Biological Resources Section, additional, targeted research needs to be conducted to more fully document the nature and effects of RF exposure, including the potential impacts to vegetation.

Indirect Injury/Mortality

Indirect effects are effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (40 CFR 1508.8[b]). Indirect injury/mortality could include stress related to disturbance. The alteration of soils or hydrology within a localized area could result in stress or mortality of plants. Construction activities that remove large quantities of soil in the immediate vicinity of trees could cause undue stress to trees from root exposure, although this is unlikely due to the small size of expected FirstNet activities. Indirect injury/mortality impacts vary depending on the species, time of year and duration of construction or deployment. Overall, these impacts are expected to be *less than significant* at the programmatic level due to the short-term and small-scale nature of deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid, or minimize potential impacts.

Effects to Migration or Migratory Patterns

No effects to the long-term migration or migratory patterns for terrestrial vegetation (e.g., forest migration) are expected as a result of the Proposed Action given the small-scale of deployment activities.

Reproductive Effects

No reproductive effects to terrestrial vegetation are expected as a result of the Proposed Action given the small-scale of deployment activities.

Invasive Species Effects

When human activity results in a species entering an ecosystem new to it, the species is classified as introduced or, depending on its ability to spread rapidly and outcompete native species, invasive. The introduction of invasive species could have a dramatic effect on natural resources and biodiversity.

As described in Section 14.1.6.4, when non-native species are introduced into an ecosystem in which they did not evolve, their populations sometimes increase rapidly. The potential to introduce invasive plants within construction zones and during long-term site maintenance could occur from vehicles and equipment being transported from one region to another, or when conducting revegetation of a site after deployment activities are complete. Overall, these impacts are expected to be *less than significant* at the programmatic level due to the small-scale and localized nature of likely FirstNet activities. BMPs and mitigation measures (see Chapter

16) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to vegetation as a result of the introduction of invasive species.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to terrestrial vegetation resources and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result in a range impacts, from *no impacts* to *less than significant* impacts, depending on the deployment scenario or site-specific conditions. The terrestrial vegetation that would be affected would depend on the ecoregion, the species' phenology,[135] and the nature as well as the extent of the habitats affected. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid, or minimize potential impacts.

<u>Activities Likely to Have No Impacts at the Programmatic Level</u>

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have *no impacts* to terrestrial vegetation under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Although terrestrial vegetation could be impacted, it is anticipated that effects to vegetation would be minimal since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to terrestrial vegetation because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures, attaching equipment to satellite launches for other purposes, and the use of portable devices that use satellite technology would not

[135] Phenology is the seasonal changes in plant and animal lifecycles, such as emergence of insects or migration of birds.

impact terrestrial vegetation because those activities would not require ground disturbance.

- o Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact biological resources, it is anticipated that this activity would have *no impact* on terrestrial vegetation.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to terrestrial vegetation as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; indirect injury/mortality; and invasive species effects. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to terrestrial vegetation include the following:

- Wired Projects
  - o New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to terrestrial vegetation. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects BMPs and mitigation measures could help to avoid or minimize potential impacts.
  - o New Build – Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public ROWs or private easements as well as the construction of access roads, POPs, huts, or facilities to house outside plant equipment could result in potential impacts to terrestrial vegetation. Impacts may vary depending on the number or individual poles installed, but could include direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects BMPs and mitigation measures could help to avoid or minimize potential impacts.
  - o Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.
  - o New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would not impact terrestrial vegetation. However, impacts to terrestrial vegetation could potentially occur as a result of the construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cables as a result of land clearing, excavation activities, and heavy equipment use. Effects could include direct or indirect injury to plants; the loss, alteration, or fragmentation of

vegetative communities; and invasive species effects BMPs and mitigation measures could help to avoid or minimize potential impacts.
- o Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct or indirect injury to plants, vegetation loss, and invasive species effects.

- Wireless Projects
  - o New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads), microwave facilities, or access roads could result in impacts to terrestrial vegetation. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects.
  - o Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower which would not result in impacts to terrestrial vegetation. However, if new power units, replacement towers, structural hardening, and physical security measures require land clearing or excavation activities, impacts would be similar to new wireless construction.
  - o Deployable Technologies: Implementation of deployable technologies including COWs, COLTs, or SOWs could result in direct impacts to terrestrial vegetation if deployment occurs on vegetated areas, or the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects. Deployment of drones, balloons, blimps, or piloted aircraft could potentially impact terrestrial vegetation if launching or recovery occurs on vegetated areas. Impacts would be similar to deployment of COWs, COLTs, and SOWs.

In general the abovementioned activities could potentially involve land/vegetation clearing; topsoil removal; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or cables; heavy equipment movement; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to terrestrial vegetation associated with deployment of this infrastructure, depending on their scale, could include direct or indirect injury/mortality to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species depending on the ecoregion, the species' phenology, and the nature and extent of the vegetation affected. Despite the variability, these impacts are expected to be *less than significant* at the programmatic level due to the small scale and limited geographic scope of expected deployment activities. Chapter 16, BMPs and

Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The terrestrial vegetation that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated that there would be *no impacts* to terrestrial vegetation at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections because there would be no ground disturbance. Site maintenance, including mowing or herbicides, may result in *less than significant* effects at the programmatic level due to the small-scale of expected activities. These potential impacts could result from accidental spills from maintenance equipment or release of herbicides and because these areas would not be allowed to revert to a more natural state. If usage of heavy equipment or land clearing activities occurs off established roads or corridors as part of routine maintenance or inspections, direct or indirect injury/mortality to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species could occur to terrestrial vegetation; however, impacts are expected to be *less than significant* at the programmatic level due to the small-scale of expected activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential impacts to terrestrial vegetation associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to terrestrial vegetation as a result of implementation of this Alternative could be as described below.

Deployment Impacts

As described above, at the programmatic level, implementation of deployable technologies could result in *less than significant* impacts at the programmatic level from land/vegetation clearing, excavation, and paving activities. These activities could result in direct or indirect injury to plants; the loss, alteration, or fragmentation of vegetative communities; and invasive species effects. Greater frequency and duration of deployments could change the magnitude of impacts. Nonetheless, impacts are expected to remain *less than significant* at the programmatic level due to the relatively small-scale of FirstNet activities at individual locations. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operational Impacts

As described above, operational activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. The impacts could vary greatly among species, vegetative community, and geographic region, but are expected to remain *less than significant* at the programmatic level. As with the Preferred Alternative, it is anticipated that there would be *less than significant* impacts at the programmatic level to terrestrial vegetation associated with routine operations and maintenance due to the relatively small-scale of likely FirstNet project sites. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid, or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to terrestrial vegetation as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.6.3, Terrestrial Vegetation.

14.2.6.4. Wildlife

Impacts to amphibians and reptiles, terrestrial mammals, marine mammals, birds, and invertebrates occurring in Tennessee are discussed in this section. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Description of Environmental Concerns

Direct Injury/Mortality

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from interactions associated with the Proposed Action. The most common direct injuries are entanglement, vehicle or vessel strike, problems associated with accidental ingestion, and injuries incurred by sensitive animals from disturbance events.

Based on the impact significance criteria presented in Table 14.2.6-1, *less than significant* impacts would be anticipated at the programmatic level given that the majority of proposed deployment activities are likely to be small-scale and would be dependent on the location and type of deployment activity. Although anthropogenic disturbances may be measurable (although minimal) for some FirstNet projects, impacts to individual behavior of animals would be short-term and direct injury or mortality impacts at the population-level or sub-population effects would not likely be observed. Therefore, impacts are generally expected to be *less than significant* (except for birds, as discussed further below) at the programmatic level, as discussed further below (except for birds which would be *less than significant with BMPs and mitigation measures incorporated*). Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partners would require, as practicable or feasible, to avoid or minimize potential impacts.

Terrestrial Mammals

Vehicle strikes are common sources of direct mortality or injury to both small and large mammals in Tennessee. Mammals are attracted to roads for a variety of reasons including use as a source of minerals, foraging, and migration (FHWA, 2009). Individual injury or mortality as a result of vehicle strikes associated with the Proposed Action could occur.

Entanglement in fences or other barriers could be a source of mortality or injury to terrestrial mammals, though entanglements would likely be isolated, individual events. For example, if bats — particularly maternity colonies — are present at a site location, removal of trees during land clearing activities could result in direct injury/mortality if bats are utilizing them as roost trees or for rearing young. The scale of this impact would be expected to be small scale and would be dependent on the location and type of deployment activity, and the amount of tree removal. Site avoidance measures could be implemented to avoid disturbance to bats.

Birds

Mortalities from collisions or electrocutions with manmade cables and wires are environmental concerns for avian species. Generally, collision events occur to night-migrating birds, "poor" fliers (e.g., ducks), heavy birds (e.g., swans and cranes), and birds that fly in flocks; while species susceptible to electrocution are birds of prey, ravens, and thermal soarers, typically having large wing spans (Gehring, Kerlinger, & Manville, 2011).

Avian mortalities or injuries could also result from vehicle strikes, although typically occur as isolated events.

Direct injury and mortality of birds could occur to ground-nesting birds when nests are either disturbed or destroyed during land clearing, excavation and trenching, and other ground disturbing activities. Removal of trees during land clearing activities, could also result in direct injury/mortality to forest dwelling birds if they are utilizing them as roost trees for resting or shelter from predators and inclement weather, or as nest trees for rearing young. The scale of this impact would be associated with the amount of tree removal and the abundance of forest-dwelling birds roosting/nesting in the area. These impacts could be particularly pronounced in

IBAs within the state as these areas provide them with essential habitat that supports various life stages (Hill, et al., 1997).

Direct mortality and injury to birds of Tennessee are not likely to be widespread or affect populations of species as a whole due to the small size of the likely FirstNet actions, however, DOI comments dated October 11, 2016[136] state that communication towers are "currently estimated to kill between four and five million birds per year", although collisions with towers have the potential to impact a large number of birds unless BMPs and mitigation measures are incorporated, tower collisions are unlikely to cause population-level impacts (Regulations.gov, 2016). Of particular concern is avian mortality due to collisions with towers at night, when birds can be attracted to tower obstruction lights. Research has shown that birds are attracted to steady, non-flashing red lights and are much less attracted to flashing lights, which can reduce migratory bird collisions by as much as 70%. The FAA has issued requirements to eliminate steady-burning flashing obstruction lights and use only flashing obstruction lights (FAA, 2016b) (FAA, 2016c) (FCC, 2017a). Additionally, on Jan. 6, 2017, the FCC issued a notice titled Opportunities to Reduce Bird Collisions with Communications Towers While Reducing Tower Lighting Costs (FCC, 2017b). See Chapter 16, BMPs and Mitigation Measures, for BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential impacts to birds from tower lighting. Site-specific analysis and/or consultation with FWS may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.If siting considerations, BMPs, and mitigation measures are implemented (Chapter 16), potential impacts could be minimized. Applicable BMPs and mitigation measures, as defined through consultation with USFWS for MBTA or BGEPA, if required, could help to avoid or minimize any potential impacts (including possible "take"). Environmental consequences pertaining to federally listed species will be discussed in Section 14.2.6.6, Threatened and Endangered Species.

Reptiles and Amphibians

In Tennessee, reptile and amphibian species occur in a wide variety of habitats throughout the state. Either direct mortality to amphibians or reptiles could occur in construction zones by excavation activities or by vehicle strikes; however, these effects are expected to be temporary and isolated, affecting only individual animals.

Invertebrates

Ground disturbance or land clearing activities as well as use of heavy equipment could result in direct injury or mortality to invertebrates. However, deployment activities are expected to be temporary and isolated, thereby limiting the potential for direct mortality and likely affecting only a small number of invertebrates. The invertebrate populations of Tennessee are so widely distributed that injury/mortality events are not expected to affect populations of species as a whole.

[136] See Appednix F, Draft PEIS Public Comments, for the full text of the Department of Interior comments.

Vegetation and Habitat Loss, Alteration, or Fragmentation

As described in Section 14.2.6.3, habitat loss could occur through exclusion, directly or indirectly, preventing an animal from accessing an optimal habitat (e.g., breeding, forage, or refuge), either by physically preventing use of a habitat or by causing an animal to avoid a habitat, either temporarily or long-term. It is expected that activities associated with the Proposed Action would cause exclusion effects only in very special circumstances, as in most cases an animal could fly, swim, or walk to a nearby area that would provide refuge.

In general, potential effects of vegetation and habitat loss, alteration, or fragmentation are expected to be *less than significant* at the programmatic level because of the small-scale nature and limited grographix scope of expected deployment activities. Additionally, FirstNet would attempt to avoid these areas. These potential impacts are described for Tennessee's wildlife species below. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts

Terrestrial Mammals

Mammals occupy a wide range of habitats throughout Tennessee and may experience localized effects of habitat loss or fragmentation. Removal or loss of vegetation may impact large mammals (e.g., black bear) by decreasing the availability of forest for cover from predators or foraging. Loss of cover may increase predation on both breeding adults as well as their young. The loss, alteration, or fragmentation of forested habitat would also impact some small mammals (e.g., bats, foxes) that utilize these areas for roosting, foraging, sheltering, and for rearing their young. Loss of habitat or exclusions from these areas could be avoided or minimized by BMPs and mitigation measures (see Chapter 16).

Birds

The direct removal of migratory bird nests is prohibited under the MBTA. The USFWS and the TWRA provide regional guidance on the most critical periods (e.g., breeding season) to avoid vegetation clearing. The removal and loss of vegetation could affect avian species directly by loss of nesting, foraging, stopover, and cover habitats.

Noise and vibration disturbance, and other human activity, as discussed previously, could directly restrict birds from using their preferred resources. Greater human activity of longer duration would increase the likelihood that birds would avoid the area, possibly being excluded from essential resources. These impacts could be particularly pronounced in IBAs within the state as birds may temporarily avoid these areas, which provide them with essential habitat that supports various life stages (Hill, et al., 1997).

The degree to which habitat exclusion affects birds depends on many factors. The impact to passerine[137] species from disturbance or displacement from construction activities is likely to be short-term with minor effects from exclusion. Exclusion from resources concentrated in a small

[137] Passerines are an order of "perching" birds that have four toes, three facing forward, and one backward, which allows the bird to easily cling to both horizontal and nearly vertical perches.

migratory stop area during peak migration could have major impacts to species that migrate in large flocks and concentrate at stop overs (e.g., shorebirds). BMPs and mitigation measures, including nest avoidance during construction-related activities, would help to avoid or minimize the potential impacts to birds from exclusion of resources.

Reptiles and Amphibians

Important habitats for Tennessee's amphibians and reptiles typically consist of wetlands and, in some cases, the surrounding upland forest. Impacts are expected to be *less than significant* at the programmatic level given the short-term nature and limited geographic scope of individual activities. If proposed project sites were unable to avoid sensitive areas, BMPs and mitigation measures (see Chapter 16) would be implemented to avoid or minimize the potential impacts.

Filling or draining of wetland breeding habitat (see Section 14.2.4, Water Resources) and alterations to ground or surface water flow from development associated with the Proposed Action may also have effects to Tennessee's amphibian and reptile populations, though BMPs and mitigation measures would help to avoid or minimize the potential impacts.[138]

Invertebrates

Habitat loss and degradation are the most common causes of invertebrate species' declines; however, habitat for many common invertebrates is generally assumed to be abundant and widely distributed across the state, therefore no significant effects to invertebrates are expected at the programmatic level. Impacts to sensitive invertebrate species are discussed below in Section 14.2.6.6, Threatened and Endangered Species and Species of Concern.

Indirect Injury/Mortality

Indirect injury/mortality impacts vary depending on the species, time of year and duration of deployment. Overall, potential impacts are expected to remain *less than significant* at the programmatic level (except for birds and bats due to potential exposure to RF emissions, see below), due to the short-term nature and limited geographic scope of expected activities. Additionally, FirstNet would attempt to avoid these areas, though BMPs and mitigation measures could further help to avoid or minimize the potential impacts. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Terrestrial Mammals

Stress from repeated disturbances during critical time periods (e.g., roosting and mating) could reduce the overall fitness and productivity of young and adult terrestrial mammals. Indirect effects could occur to roosting bats from noise, vibrations, light, or human disturbance causing them to leave their roosting locations or excluding them from their summer roosting/maternity colony roosts. For example, some bat species establish summer roosting or maternity colonies in the same general area that they return to year and after year. The majority of FirstNet

[138] See Chapter 14.2.5, Wetlands, for a discussion of BMPs for wetlands.

deployment activities would be short-term in nature, and therefore repeated disturbances would not occur. Depending on the project type and location, individual species may be disturbed resulting in *less than significant* impacts at the programmatic level (except for bats, see below).

There are no published studies that document physiological or other *adverse effects* to bats from radio frequency (RF) exposure. However, because bats are similar ecologically and physiologically to birds, they have the potential to be affected by RF exposure in similar ways to birds (see the birds subsection below). One study demonstrated that foraging bats avoided areas exposed to varying levels of electromagnetic radiation compared with control sites, and attributed this behavior to the increased risk of overheating and echolocation interference caused by electromagnetic field exposure (Nicholls & Racey, 2009). As stated below, experts emphasize that targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on bats and other wildlife, and the implications of those effects on populations over the long term (Manville, 2015) (Manville, 2016a) (Appendix G). FirstNet recognizes that RF exposure has the potential to adversely impact bats, particularly bats that communally roost or breed and nurture young in areas with RF exposure, and concurs with the need for further research. As such, and as a precaution, FirstNet would implement BMPs and mitigation measures that focus on siting towers away from known communal bat use areas to the extent practicable or feasible (described in Chapter 16, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

<u>Birds</u>

Repeated disturbance, especially during the breeding and nesting season, could cause stress to individuals lowering fitness and productivity. These impacts could be particularly pronounced in IBAs within the state. The majority of FirstNet deployment activities would be short-term in nature, and repeated disturbances would not occur. Depending on the Proposed Action type and location, individual species may be disturbed resulting in *less than significant* impacts at the programmatic level.

Research indicates that RF exposure may adversely affect birds. A comment letter on the Draft Programmatic Environmental Impact Statement for this region, presented by Dr. Albert Manville, former USFWS agency lead on avian-structural impacts, summarizes the state of scientific knowledge of the potential effects of RF exposure on wildlife, particularly migratory birds; the comment letter is presented in its entirety in Appendix G. RF exposure may result in adverse impacts on wildlife, although a distinct causal relationship between RF exposure and responses in wild animal populations has not been established. Further, important scientific questions regarding the mechanisms of impact, the exposure levels that trigger *adverse effects*, and the importance of confounding factors in the manifestation of effects, among other questions, remain unanswered (Manville, 2016b) (Appendix G).

Research conducted to date under controlled laboratory conditions has identified a wide range of physiological and behavioral changes in avian and mammalian subjects, including embryonic mortality in bird eggs, genetic abnormalities, cellular defects, tumor growth, and reproductive and other behavioral changes in adult birds and rodents (Wyde, 2016) (Levitt & Lai, 2010) (DiCarlo, 2002) (Grigor'ev, 2003) (Panagopoulos, 2008).

Few studies of the effects of RF exposure on wild animal populations have been conducted due to the difficulty of performing controlled studies on wild subjects. Those that have been conducted are observational in nature (i.e., documenting of reproductive success and behavior in birds near RF-emitting facilities). These studies lack controls on exposure levels or other potentially confounding factors. Nevertheless, findings from these studies indicate reduced survivorship at all life stages; physiological problems related to locomotion and foraging success; and behavioral changes that resulted in delayed or unsuccessful mating in several species of nesting birds (Balmori, 2005) (Balmori, 2009)*;* (Balmori & Hallberg, 2007)*;* (Manville, 2016b) (Appendix G). Balmori (2005) documented effects as far as 1,000 feet from an RF source consisting of multiple cellular phone towers. Another study of wild birds conducted by Engels et al. (2014) documented that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise,[139] which can disrupt migration or send birds off course, potentially resulting in reduced survivorship.

Experts emphasize that targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on birds and other wildlife and the implications of those effects on wildlife populations over the long term (Manville, 2015) (Manville, 2016b) Appendix G). Such studies should be conducted over multiple generations and include controls to more clearly establish causal relationships, identify potential chronic effects, and determine threshold exposure levels. FirstNet recognizes that RF exposure may adversely impact wildlife, particularly birds that nest, roost, forage, or otherwise spend considerable time in areas with RF exposure, and concurs with the need for further research. As such, and as a precaution, FirstNet would implement BMPs and mitigation measures that focus on siting towers away from high bird use areas to the extent practicable or feasible (described in Chapter 16, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Reptiles and Amphibians

Changes in water quality, especially during the breeding seasons, could cause stress resulting in lower productivity. The majority of FirstNet deployment activities would be short-term in nature, and repeated disturbances would not occur at the programmatic level.

Invertebrates

Invertebrates could experience chronic stress, either by changes in habitat composition or competition for resources, resulting in lower productivity. Due to the large number of invertebrates distributed throughout the state, and given the short-term nature of most of the deployment activities, this impact would likely be *less than significant* at the programmatic level.

139 Urban electromagnetic noise is a term used to describe an area with a concentration of cell phone towers and users, which by sheer volume and level of use, creates a zone of electromagnetic noise.

Effects to Migration or Migratory Patterns

Migration is the regular movement of animals from one region to another and back again. Migratory patterns vary by species and sometimes within the same species. Overall, potential impacts are anticipated to be *less than significant* at the programmatic level due to the small-scale and localized nature of expected activities, which would be unlikely to result in long-term avoidance. Additionally, FirstNet would attempt to avoid areas of known migratory pathways. Potential effects to migration patterns of Tennessee's amphibians and reptiles, terrestrial mammals, birds, and invertebrates are described below. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts. See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Terrestrial Mammals

Some large mammals (e.g., black bears) will perform short seasonal migrations between foraging/breeding habitats and denning habitats. Some small mammals (e.g., bats) also have migratory routes that include spring and fall roosting areas between their summer maternity roosts and hibernacula.[140]

Any clearance, drilling, and construction activities needed for network deployment, including noise and vibrations associated with these activities, has the potential to divert mammals from these migratory routes. Impacts could vary depending on the species, time of year of construction/operation, and duration, but are generally expected to be *less than significant* at the programmatic level. BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Birds

Because many birds have extremely long migrations, protection efforts for critical sites along migratory routes must be coordinated over distances often involving many different countries. For example, as a group, shorebirds migrating through Tennessee undertake some of the longest-distance migrations of all animals. According to the National Audubon Society, Tennessee has 29 IBAs (The Audubon Society, 2015). These IBAs are distributed throughout the state, as shown in Figure 14.1.6-2, with the largest concentration of IBAs are located in the eastern and northeastern portions of the state. Many migratory routes are passed from one generation to the next. Impacts could vary (e.g., mortality of individuals or abandonment of stopover sites by whole flocks) depending on the species, time of year of construction/operation, and duration, and impacts are expected to be less than significant at the programmatic level. Additionally, there is some evidence in the scientific literature that RF emissions could affect bird migration. Engels et al. (2014) documented that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise, which can disrupt migration or send birds off course, potentially resulting in reduced survivorship. It is unlikely that the limited amount of infrastructure, the amount of RF emissions generated by Project infrastructure, and the temporary

[140] A location chosen by an animal for hibernation.

nature of the deployment activities would result in impacts to large populations of migratory birds, but more likely that individual birds could be impacted. Chapter 16, BMPs and Mitigation Measures, provides a list of BMPs and mitigation measures that FirstNet and/or its partners would require, as practicable or feasible, to avoid or minimize potential effects to migratory pathways.

Reptiles and Amphibians

Several species of salamanders and frogs are known to seasonally migrate. For example, wood frogs use diverse vegetation types from grassy meadows to open forests. After they emerge from dormancy, wood frogs migrate up 900 feet to breeding pools, where they breed rapidly in early spring in permanent or ephemeral water (Homan, Atwood, Dunkle, & Karr, 2010). Mortality and barriers to movement could occur as result of the Proposed Action (Berven & Grudzien, 1990) (Calhoun & DeMaynadier, 2007).

Species that use streams as dispersal or migratory corridors may be impacted if these waterways are restricted or altered, but impacts are expected to be *less than significant*. BMPs would help to avoid or minimize the potential impacts.

Invertebrates

The proposed deployment activities would be expected to be short-term or temporary in nature. *No effects* to migratory patterns of Tennessee's invertebrates are expected as a result of the Proposed Action.

Reproductive Effects

Reproductive effects are considered those that either directly or indirectly reduce an animal's ability to produce offspring or reduce the rates of growth, maturation, and survival of offspring, which could affect the overall population of individuals. Overall, potential impacts are anticipated to be *less than significant* at the programmatic level due to the short-term and limited nature of expected activities (except for birds and bats which are anticipated to be *less than significant with BMPs and mitigation measures incorporated,* see below), as FirstNet would attempt to avoid these areas. Chapter 16, BMPs and Mitigation Measures, provides a listing of the BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts. See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

Terrestrial Mammals

Restricted access to important winter hibernacula or summer maternity roosts for bats and dens for large mammals, such as the black bear, has the potential to negatively affect body condition and reproductive success of mammals in Tennessee. For example, pregnant black bears select habitats that allow for more effective defense of their cubs from predators (FWC, 2015).

There are no published studies that document *adverse effects* to bats from RF exposure. As stated above, experts emphasize that targeted field research needs to be conducted to more fully document the nature and extent of effects of RF exposure on bats and other wildlife, and the implications of those effects on populations over the long term (Manville, 2015) (Manville, 2016a) (Appendix G). FirstNet recognizes that RF exposure has the potential to adversely impact bats, particularly bats that communally roost or breed and nurture young in areas with RF exposure, and concurs with the need for further research. As such, and as a precaution, FirstNet would implement BMPs and mitigation measures that focus on siting towers away from known communal bat use areas to the extent practicable or feasible (described in Chapter 16, BMPs and Mitigation Measures). See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts

Disturbance from deployment and operations could also result in the abandonment of offspring leading to reduced survival, although these activities are expected to be small-scale and impacts are expected to be *less than significant* at the programmatic level. Reproductive effects as a result of displacement and disturbance could be minimized through the use of BMPs and mitigation measures.

Birds

Impacts due to Proposed Action deployment and operations could include abandonment of the area and nests due to disturbance. Disturbance (visual, vibrations, and noise) may displace birds into less suitable habitat and thus reduce survival and reproduction. These impacts could be particularly pronounced in IBAs within the state if birds temporarily avoid those areas, since they provide essential habitat for various life stages (Hill, et al., 1997). Research conducted to date under controlled laboratory conditions has identified a wide range of physiological and behavioral changes in avian subjects, including embryonic mortality in bird eggs and reproductive changes in adult birds (Wyde, 2016) (Levitt & Lai, 2010) (DiCarlo, 2002) (Grigor'ev, 2003) (Panagopoulos, 2008). Laboratory studies conducted with domestic chicken embryos have shown that emissions at the same frequency and intensity as that used in cellular telephones have appeared to result in embryonic mortality (DiCarlo, 2002) (Manville, 2007). These studies suggest that RF emissions at low levels (far below the existing exposure guidelines for humans) (see Section 2.4.2, RF Emissions and Humans) may be harmful to wild birds; however, given the controlled nature of the studies and potential exposure differences in the wild, it is unclear how this exposure would affect organisms in the wild.

As such, and as a precaution, FirstNet would implement BMPs and mitigation measures that focus on siting towers away from high bird use areas to the extent practicable or feasible (described in Chapter 16, BMPs and Mitigation Measures) to help reduce bird mortalities associated with both RF emissions and tower collisions. See Section 2.4, Radio Frequency Emissions, for additional information on potential RF exposure impacts.

The majority of FirstNet deployment or operation activities are likely to be small scale in nature. BMPs and mitigation measures as defined through consultation with USFWS for compliance with MBTA or BGEPA, or another appropriate regulatory agency, if required, could help to avoid or minimize any potential impacts. Environmental consequences pertaining to federally listed species will be discussed in Section 14.2.6.6, Threatened and Endangered Species.

Reptiles and Amphibians

Reproductive effects to reptile nests may occur through direct loss or disturbance of nests. For example, the spiny softshell turtle will lay its eggs in exposed soil in late spring or summer (USGS, 2015k).

Reproductive effects to sub-populations of amphibians and reptiles may occur through the direct loss of vernal pools as breeding habitat if deployment activities occur near breeding pools, or alter water quality through sediment infiltration or obstruction of natural water flow to pools, though BMPs would help to avoid or minimize the potential impacts. Overall, impacts to reptiles and amphibians are expected to be *less than significant* at the programmatic level due to the limited extent and temporary nature of the deployment.

Invertebrates

The majority of FirstNet deployment or operation activities are likely to be short-term in nature; therefore, no reproductive effects to invertebrates are expected as a result of the Proposed Action.

Invasive Species Effects

When human activity results in a species entering an ecosystem new to it, the species is classified as introduced or invasive. The introduction of invasive species could have a dramatic effect on natural resources.

FirstNet deployment or operation activities could result in short-term or temporary changes to specific project sites; although these sites are expected to return to their natural state in a year or two. Invasive species are not expected to be introduced to project sites as part of the deployment activities from machinery or construction workers. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities.

Potential invasive species effects to Tennessee's wildlife are described below.

Terrestrial Mammals

In Tennessee, feral hogs adversely impact wildlife and vegetation. They feed on young mammals, destroy native vegetation resulting in erosion and water resource concerns, and could carry/transmit disease to livestock and humans (TWRA, 2015g).

FirstNet deployment activities are not expected to introduce terrestrial mammal species to project sites as these activities are temporary and would not provide a mechanism for transport of invasive terrestrial mammals to project sites from other locations. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 16) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to mammals as a result of the introduction of invasive species.

Birds

Invasive pest species such as European starlings could impact native birds by aggressively competing for habitat like tree cavities (University of Florida, Institute of Food and Agricultural Sciences, 2012). FirstNet deployment activities could result in short-term or temporary changes to specific project sites; these sites are expected to return to their natural state in a year or two. Invasive bird species are not expected to be introduced at project sites as part of the deployment activities from machinery or construction workers. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 16) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to birds as a result of the introduction of invasive species.

Reptiles and Amphibians

No invasive reptiles or amphibians are regulated in the state, although non-native reptiles and amphibians are known to occur there. Non-native reptiles and amphibians tend to be highly adaptable and could threaten native wildlife by competing with them for food sources and spread disease.

Although FirstNet deployment activities could result in short-term or temporary changes to specific project sites, these sites are expected to return to their natural state in a year or two. Invasive reptile or amphibian species are not expected to be introduced at project sites from machinery or laborers during deployment operations. Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 16) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to reptiles and amphibians as a result of the introduction of invasive species.

Invertebrates

Invertebrate populations are susceptible to invasive plant species that may change or alter the community composition of specific plants on which they depend. Effects from invasive plant species to invertebrates would be similar to those described for habitat loss and degradation.

Invasive insects could pose a threat to Tennessee’s forest and agricultural resources. Species such as the hemlock woolly adelgid, emerald ash borer, and Asian longhorn beetle are known to cause irreversible damage to native forests. The potential to introduce invasive invertebrates within construction zones and during long-term site maintenance could occur from vehicles and equipment being transported from one region to another, or when conducting revegetation of a site after deployment activities are complete.Overall, these potential impacts are expected to be *less than significant* at the programmatic level due to the small-scale, localized nature of deployment activities. BMPs and mitigation measures (see Chapter 16) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed

Action as well as minimize effects to invertebrates as a result of the introduction of invasive species.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to wildlife resources and others would not. In addition, and as described in this section, infrastructure developed under the Preferred Alternative could result, at the programmatic level, in a range of impacts, from *no impacts to less than significant impacts with BMPs and mitigation measures added*, depending on the deployment scenario or site-specific conditions. The wildlife that would be affected would depend on the ecoregion, the species' phenology and the nature and extent of the habitats affected. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

<u>Activities Likely to Have No Impacts at the Programmatic Level</u>

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have *no impacts* to wildlife resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Noise and vibrations generated by equipment required to install fiber would be infrequent and of short duration, and unlikely to produce measurable changes in wildlife behavior. At the programmatic level, it is anticipated that effects to wildlife would be temporary and would not result in any perceptible change.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* on wildlife resources at the programmatic level because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures, attaching equipment to satellites launched for other purposes, and the use of portable devices that use satellite technology would not impact wildlife if those activities would not require ground disturbance.

- o Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact wildlife resources, it is anticipated that this activity would have *no impact* on wildlife resources at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to wildlife resources as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; reproductive effects; and invasive species effects. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to wildlife resources include the following:

- Wired Projects
  - o New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to wildlife resources. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct injury/mortalities of wildlife that are not mobile enough to avoid construction activities (e.g., reptiles, small mammals, and young individuals), that utilize burrows (e.g., ground squirrels), or that are defending nest sites (such as ground-nesting birds). Disturbance, including noise and vibrations, associated with the above activities involving heavy equipment or land clearing could result in habitat loss, effects to migration patterns, indirect injury/mortality, reproductive effects, and invasive species effects. Implementation of BMPs and mitigation measures could help to avoid or minimize potential impacts.
  - o New Build – Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public ROWs or private easements as well as the construction of access roads, POPs, huts, or facilitates to house outside plant equipment could result in potential impacts to wildlife resources. Impacts may vary depending on the number or individual poles installed and the extent of ground disturbance, but could include direct injury/mortality of individuals as described above; habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; and invasive species effects.
  - o Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct injury/mortality, habitat loss or alteration, effects to migratory patterns, indirect injury/mortality, and invasive species effects. Noise and vibration disturbance from heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in migratory effects and indirect injury/mortality.
  - o New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water and construction of landings and/or facilities on shores or the

banks of waterbodies that accept the submarine cables could potentially impact wildlife (see Section 14.2.4, Water Resources, for a discussion of potential impacts to water resources). Potential effects could include direct injury/mortality; habitat loss, alteration, or fragmentation depending on the site location. If activities occurred during critical time periods, effects to migratory patterns as well as reproductive effects and indirect injury/ mortality could occur.

  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct injury/mortality of wildlife as described for other New Build activities. Habitat loss, alteration and fragmentation; effects to migration or migratory patterns, indirect injury/mortality, and invasive species effects could occur as a result of construction and resulting disturbance.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (e.g., generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to wildlife resources. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct injury/mortality, habitat loss, alteration or fragmentation, and effects to migratory patterns. Security lighting and fencing could result in direct and indirect injury or mortality, effects to migratory patterns, as well as reproductive effects. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to wildlife. However, if new power units, replacement towers, or structural hardening are required, impacts would be similar to new wireless construction. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
  - Deployable Technologies: Implementation of deployable technologies including COWs, COLTs, or SOWs could result in direct injury/mortalities to wildlife on roadways from vehicular movement. If external generators are used, noise and vibration disturbance could potentially impact migratory patterns of wildlife. RF hazards could result in indirect injury or mortality as well as reproductive effects depending on duration and magnitude of operations. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions. Deployment of drones, balloons, blimps, or piloted aircraft could potentially impact wildlife by direct or indirect injury/mortality from collision, entanglement or ingestion and effects to migratory patterns and reproductive effects from disturbance and/or displacement due to noise and vibrations. The magnitude of these effects depends on the timing and frequency of deployments. However, deployment activities are expected to be temporary and isolated, and likely affecting only a small number of wildlife.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers or poles; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to wildlife resources associated with deployment of this infrastructure are anticipated to be *less than significant* at the programmatic level given the small-scale of likely individual FirstNet projects with the exception of impacts to birds and bats, which are expected to be *less than significant with BMPs and mitigation measures incorporated.* Some deployment activities could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and effects of invasive species depending on the project type, location, ecoregion, the species' phenology, and the nature and extent of the habitats affected. As stated above, these impacts would likely be limited to individual wildlife species and unlikely to cause population-level impacts, and are therefore expected to remain *less than significant* at the programmatic level. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The wildlife that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

At the programmatic level, it is anticipated that there would be *less than significant* impacts to wildlife resources at the programmatic level associated with routine inspections of the Preferred Alternative. Site maintenance would be infrequent, including mowing or limited application of herbicides, may result in *less than significant* effects to wildlife at the programmatic level including direct injury/mortality to less mobile wildlife, or exposure to contaminants from accidental spills from maintenance equipment or release of pesticides. Potential spills of these materials would be expected to be in small quantities.

During operations, direct injury/mortality of wildlife could occur from collisions and/or entanglements with transmission lines, towers, and aerial platforms. In particular, collisions with new cell towers that may be installed as part of the Preferred Alternative could increase avian mortality. As stated above, these impacts would likely be limited to individual wildlife species. DOI comments dated October 11, 2016[141] state communication towers are "currently estimated to kill between four and five million birds per year" (Regulations.gov, 2016), although collisions with towers have the potential to impact a large number of birds unless BMPs and mitigation measures are incorporated, tower collisions are unlikely to cause population-level impacts.

[141] See Appendix F, Draft PEIS Public Comments, for the full text of the Department of Interior comments.

Therefore, impacts to birds may be *less than significant with BMPs and mitigation measures added*.

Wildlife resources could still be affected by the reduction in habitat quality associated with habitat fragmentation from the presence of access roads, transmission corridors, and support facilities. These features could also continue to disrupt movements of terrestrial wildlife, particularly during migrations between winter and summer ranges or in calving areas.

In addition, the presence of new access roads and transmission line ROWs may increase human use of the surrounding areas, which could increase disturbance to wildlife resulting in effects to migratory pathways, indirect injury/mortalities, reproductive effects, as well as the potential introduction and spread of invasive species as explained above. As stated above, these impacts would likely be limited to individuals and unlikely to cause population-level impacts, and therefore would likely be *less than significant* at the programmatic level given the short-term nature and limited geographic scope for individual activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential impacts to wildlife resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to fisheries and aquatic habitats as a result of implementation of this Alternative could be as described below.

<u>Deployment Impacts</u>

As explained above, implementation of deployable technologies could result, at the programmatic level, in *less than significant* impacts from habitat loss, alteration, and fragmentation; indirect injury/mortality, and invasive species effects. Greater frequency and duration of deployments could change the magnitude of impacts depending on species, life history, and region of the state. However, impacts are expected to remain *less than significant* at the programmatic level because deployment activities are expected to be temporary and localized, likely affecting only a small number of wildlife. Chapter 16, BMPs and Mitigation

Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operational Impacts

As explained above, operational activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *less than significant* impacts at the programmatic level because deployable activities are expected to be temporary and likely affecting only a small number of wildlife. Proposed FirstNet actions at specific individual sites may have a higher level of impacts due to location-specific conditions, and therefore those proposed activities would undergo site-specific environmental review. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the nationwide, interoperable, public safety broadband network would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to wildlife resources as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.6.4, Terrestrial Wildlife.

14.2.6.5. Fisheries and Aquatic Habitats

Impacts to fisheries and aquatic habitats occurring in Tennessee are discussed in this section. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Description of Environmental Concerns

Direct Injury/Mortality

The most common direct injuries are entanglement, vessel strike, problems associated with accidental ingestion, and injuries incurred by sensitive animals from disturbance events. (USEPA, 2012d)

Based on the impact significance criteria presented in Table 14.2.6-1, *less than significant* impacts would be anticipated at the programmatic level given that the majority of proposed deployment activities are likely to be small-scale and would be dependent on the location and type of deployment activity. Although anthropogenic disturbances may be measurable (although minimal) for some FirstNet projects, direct injury or mortality impacts at the population-level or sub-population effects would not likely be observed. BMPs and mitigation measures could help to avoid or minimize potential impacts to fisheries and aquatic invertebrate population survival.

Vegetation and Habitat Loss, Alteration, or Fragmentation

As with all of the effects categories, the magnitude of the impact depends on the duration, location, and spatial scale of the system and associated activities. Habitat fragmentation is the breaking down of continuous and connected habitat, and impeding access to resources and mates.

Depending on the location, construction of new infrastructure and long-term facility maintenance could result in the shoreline habitat alteration in localized areas; in some instances, the permanent loss of riparian vegetation could occur, which could lead to water quality impacts and in turn aquatic habitat alteration. Habitat loss is not likely to be widespread or affect populations of species as a whole; fish species would be expected to swim to a nearby location, depending on the nature of the deployment activity. Therefore, potential impacts are expected to be *less than significant* at the programmatic level. Additionally, deployment activities with the potential for impacts to sensitive aquatic habitats could be addressed through BMPs and mitigation measures (see Chapter 16) or as defined through consultation with the appropriate resource agency.

Indirect Injury/Mortality

Erosion or sedimentation from land clearing and excavation activities near or within riparian areas, floodplains, wetlands, streams, and other aquatic habitats could have potential impacts on water quality. Exposure to contaminants from accidental spills from vehicles and equipment could also potentially affect water quality. These potential effects could result in changes to habitat, food sources, or prey resulting in indirect mortality/injury to fish and aquatic invertebrates. Indirect injury/mortality impacts vary depending on the species, time of year, and duration of deployment. Nonetheless, these impacts are expected to be *less than significant* at the programmatic level due to the short-term nature and limited geographic scope of deployment activities. BMPs and mitigation measures to protect water resources (see Section 14.2.4, Water Resources) could help to minimize or avoid potential impacts.

Effects to Migration or Migratory Patterns

Migration is the regular movement of animals from one region to another and back again. Migratory patterns vary by species and sometimes within the same species. For example, restrictions or alterations to waterways could alter migration patterns, limit fish passage, or affect foraging and spawning site access. Impacts would vary depending on the species, time of year, and duration of deployment, but would be localized and at a small-scale, and therefore are expected to be *less than significant* at the programmatic level. BMPs and mitigation measures could help to further avoid or minimize the potential impacts.

Reproductive Effects

Reproductive effects are those that either directly or indirectly reduce an animal's ability to produce offspring or reduce the rates of growth, maturation, and survival of offspring, which could affect the overall population of individuals. Restrictions to spawning/breeding areas for fish and aquatic invertebrates and the alteration of water quality through sediment infiltration, obstruction of natural water flow, or loss of submerged vegetation resulting from the deployment of various types of infrastructure, are not anticipated, and therefore impacts are expected to be *less than significant* at the programmatic level. BMPs and mitigation measures could help to further avoid or minimize any potential impacts.

Invasive Species Effects

FirstNet deployment activities could result in *less than significant* impacts to aquatic populations at the programmatic level due to introduction of invasive species. The potential to introduce invasive plant (and plant seeds) and pest species (e.g., invasive insects) within construction zones could occur from vehicles and equipment being transported from one region to another, or when conducting revegetation of a site after deployment activities are complete. FirstNet deployment activities could result in short-term or temporary changes to specific project sites however, these sites are expected to return to their natural state in a year or two. Invasive species are not expected to be introduced to project sites as part of the deployment activities from machinery or construction workers. Impacts are expected to be *less than significant* at the programmatic level due to the limited extent and temporary nature of the deployment. BMPs and mitigation measures (see Chapter 16) would help to avoid or minimize the potential for introducing invasive species during implementation of the Proposed Action as well as minimize effects to fisheries and aquatic habitats as a result of the introduction of invasive species. Should invasive species be found on a site, BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented to minimize invasive species effects to fisheries and aquatic species.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to fisheries and aquatic habitats and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level, in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions. The fisheries and aquatic habitats that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have *no impacts* to fisheries and aquatic habitats under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance, including noise and vibrations, associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that effects to fisheries and aquatic habitats would be temporary and would not result in any perceptible change.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to fisheries and aquatic habitats at the programmatic level because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact fisheries and aquatic habitats if those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact fisheries, it is anticipated that this activity would have *no impact* on the aquatic environment at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential /deployment-related impacts to fisheries and aquatic habitats as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; reproductive effects; and invasive species effects. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to fisheries and aquatic habitats include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to fisheries and aquatic habitats. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities, particularly if they occur adjacent to water resources that support fish, could result in habitat loss, alteration and fragmentation; indirect injury/mortality; and invasive species effects.
  - New Build – Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public ROWs or private easements as well as the construction of access roads, POPs, huts, or facilitates to house

outside plant equipment could result in potential impacts to fisheries and aquatic habitats if activities occur near water resources that support fish. Impacts may vary depending on the number or individual poles installed or if access roads or stream crossings are needed, but could include habitat loss, alteration and fragmentation; indirect injury/mortality; and invasive species effects.

- Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening, if conducted near water resources that support fish, could result in habitat loss, alteration and fragmentation; indirect injury/mortality; and invasive species effects.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore and inland bodies of water and construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cables could result in direct injury/mortalities of fisheries and aquatic invertebrates that are not mobile enough to avoid construction activities (e.g., mussels), that utilize burrows (e.g., crayfish), or that are defending nest sites (some fish). Disturbance, including noise and vibrations, associated with the above activities could result in habitat loss, effects to migration patterns, indirect injury/mortality, reproductive effects, and invasive species effects.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required construction of access roads, trenching, and/or land clearing, particularly near water resources that support fish, such disturbance could result in habitat loss, alteration and fragmentation; indirect injury/mortality, and invasive species effects.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to fisheries and aquatic habitats, if such actions were deployed near water resources. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads, particularly if they occur near waterbodies, could result in habitat loss or indirect injury/mortality, and invasive species effects, although highly unlikely. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower which would not result in impacts to fisheries and aquatic habitats. However, if new power units, replacement towers, structural hardening, or physical security measures required ground disturbance, impacts would be similar to new wireless construction. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
  - Deployable Technologies: Implementation of deployable technologies including COWs, COLTs, or SOWs could result in habitat loss, alteration and fragmentation; indirect injury/mortality, and invasive species effects if new access roads or other ground

disturbing activities are necessary that generate erosion, sedimentation, or water quality impacts. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions. Deployment of drones, balloons, blimps, or piloted aircraft could potentially impact fisheries and aquatic habitat if deployment occurs within or adjacent to water resources. The magnitude of these effects depends on the timing and frequency of deployments, and could result in result in habitat loss, alteration, and fragmentation; indirect injury/mortality, and invasive species effects.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or underwater cables; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to fisheries and aquatic habitats associated with deployment of this infrastructure could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and effects of invasive species depending on the ecoregion, the species' phenology, and the nature and extent of the habitats affected. These impacts are anticipated to be less significant at the programmatic level due to the small scale and localized nature of deployment activities that have the potential to impact aquatic habitats. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. The fisheries and aquatic habitats that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated, at the programmatic level, that there would be *less than significant* impacts to fisheries and aquatic habitats associated with routine inspections of the Preferred Alternative. At the programmatic level, site maintenance activities that might include accidental spills from maintenance equipment or pesticide runoff near fish habitat are expected to result in *less than significant* effects to fisheries and aquatic habitats due to the limited nature of such activities and the likely small quantities of potentially harmful liquids used.

Fisheries and aquatic habitat could still be affected by the reduction in habitat quality associated with habitat fragmentation from the presence of access roads, transmission corridors, and support facilities. These features could also continue to disrupt movements of fish passage. In addition, the presence of new access roads and transmission line ROWs near water resources that support fish may increase human use of the surrounding areas, which could increase disturbance to fisheries and aquatic habitats resulting in effects to migratory pathways, indirect injury/mortalities, reproductive effects, as well as the potential introduction and spread of invasive species as explained above. Fisheries and aquatic habitat may also be impacted if increased access leads to an increase in the legal or illegal take of biota. However, impacts are expected to be *less than significant* at the programmatic level due to the small-scale of expected activities with the potential to affect fisheries and aquatic habitat. As a result of the small scale, only a limited number of individuals are anticipated to be impacted, furthermore, habitat impacts would also be minimal in scale. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential impacts to fisheries and aquatic habitats associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to fisheries and aquatic habitats as a result of implementation of this Alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts from habitat loss, alteration, and fragmentation; indirect injury/mortality, and invasive species effects. Greater frequency and duration of deployments could change the magnitude of impacts depending on species, life history, and region of the state. However, impacts are expected to remain *less than significant* at the programmatic level due to the limited nature of expected deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operational Impacts

Operational activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. At the programmatic level, as with the Preferred Alternative, impacts could vary greatly among species and geographic region but they are expected to remain *less than significant* despite this potential variability. Nonetheless, it is anticipated that there would be *less than significant* impacts to fisheries and aquatic habitats at the programmatic level associated with routine operations and maintenance due to the limited nature of expected deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the nationwide, interoperable, public safety broadband network would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to fisheries and aquatic habitats as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.6.5, Fisheries and Aquatic Habitats.

14.2.6.6. Threatened and Endangered Species

This section describes potential impacts to threatened and endangered species in Tennessee associated with deployment and operation of the Proposed Action and Alternatives. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on threatened and endangered species and their habitat were evaluated using the significance criteria presented in Table 14.2.6-2. The categories of impacts for threatened and endangered species and their habitats are defined as *may affect*, *likely to adversely affect*; *may affect, not likely to adversely affect*; and *no effect*. These impact categories are comparable to those defined in the *Endangered Species Consultation Handbook* and are described in general terms below (USFWS, 1998b):

- *No effect* means that no listed resources would be exposed to the action and its environmental consequences.
- *May affect, not likely to adversely affect* means that all effects are beneficial, insignificant, or discountable. Beneficial effects have contemporaneous positive effects without any *adverse effects* to the species or habitat. Insignificant effects relate to the size of the impact and include those effects that are undetectable, not measurable, or cannot be evaluated. Discountable effects are those extremely unlikely to occur.
- *May affect, likely to adversely affect* means that listed resources are likely to be exposed to the action or its environmental consequences and would respond in a negative manner to the exposure.

At the programmatic level, characteristics of each effect type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes across the state, the potential impacts to threatened and endangered species addressed below are presented as a range of possible impacts.

Table 14.2.6-2: Impact Significance Rating Criteria for Threatened and Endangered Species at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level		
		May Affect, Likely to Adversely Affect	**May Affect, Not Likely to Adversely Affect**	**No Effect**
Injury/Mortality of a Listed Species	Magnitude or Intensity	As per the ESA, this impact threshold applies at the individual level so applies to any mortality of a listed species and any impact that has more than a negligible potential to result in unpermitted take of an individual of a listed species. Excludes permitted take.	Does not apply in the case of mortality (any mortality unless related to authorized take falls under *likely to adversely affect* category). Applies to a negligible injury that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect. Includes permitted take.	No measurable effects on listed species.
	Geographic Extent	Any geographic extent of mortality or any extent of injury that could result in take of a listed species.	Any geographic extent that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect. Typically applies to one or very few locations.	
	Duration or Frequency	Any duration or frequency that could result in take of a listed species.	Any duration or frequency that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect. Typically applies to infrequent, temporary, and short-term effects.	
Reproductive Effects	Magnitude or Intensity	Any reduction in breeding success of a listed species.	Changes in breeding behavior (e.g., minor change in breeding timing or location) that are not expected to result in reduced reproductive success.	No measurable effects on listed species.
	Geographic Extent	Reduced breeding success of a listed species at any geographic extent.	Changes in breeding behavior at any geographic extent that are not expected to result in reduced reproductive success of listed species. Typically applies to one or very few locations.	
	Duration or Frequency	Any duration or frequency that could result in reduced breeding success of a listed species.	Infrequent, temporary, or short-term changes in breeding behavior that do not reduce breeding success of a listed species within a breeding season.	
Behavioral Changes	Magnitude or Intensity	Disruption of normal behavior patterns (e.g., breeding, feeding, or sheltering) that could result in take of a listed species.	Minor behavioral changes that would not result in take of a listed species.	No measurable effects on listed species.

Type of Effect	Effect Characteristics	Impact Level		
		May Affect, Likely to Adversely Affect	**May Affect, Not Likely to Adversely Affect**	**No Effect**
	Geographic Extent	Any geographic extent that could result in take of a listed species.	Changes in behavior at any geographic scale that are not expected to result in take of a listed species. Typically applies to one or very few locations.	
	Duration or Frequency	Any duration or frequency that could result in take of a listed species.	Infrequent, temporary, or short-term changes that are not expected to result in take of a listed species.	
Loss or Degradation of Designated Critical Habitat	Magnitude or Intensity	Effects to any of the essential features of designated critical habitat that would diminish the value of the habitat for the survival and recovery of the listed species for which the habitat was designated.	Effects to designated critical habitat that would not diminish the functions or values of the habitat for the species for which the habitat was designated.	No measurable effects on designated critical habitat.
	Geographic Extent	Effects to designated critical habitat at any geographic extent that would diminish the value of the habitat for listed species. Note that the *likely to adversely affect* threshold for geographic extent depends on the nature of the effect. Some effects could occur at a large scale but still not appreciably diminish the habitat function or value for a listed species. Other effects could occur at a very small geographic scale but have a large *adverse effect* on habitat value for a listed species.	Effects realized at any geographic extent that would not diminish the functions and values of the habitat for which the habitat was designated. Typically applies to one or few locations within a designated critical habitat.	
	Duration or Frequency	Any duration or frequency that could result in reduction in critical habitat function or value for a listed species.	Any duration or frequency that would not diminish the functions and values of the habitat for which the habitat was designated. Typically applies to Infrequent, temporary, or short-term changes.	

Description of Environmental Concerns

Injury/Mortality of a Listed Species

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from interactions associated with the Proposed Action. The most common direct injuries are entanglement, vehicle strike, problems associated with accidental ingestion, and injuries incurred by sensitive animals from disturbance events.

Based on the impact significance criteria presented in Table 14.2.6-2, any direct injury or mortality of a listed species at the individual-level, as well as any impact that has the potential to result in unpermitted take of an individual species at any geographic extent, duration, or frequency, *may affect and likely adversely affect* a listed species. Direct injury/mortality environmental concerns pertaining to federally listed terrestrial mammals, birds, fish, invertebrates, and plants with known occurrence in Tennessee are described below. There are no federally listed reptiles or amphibians in Tennessee, therefore, there would be no potential impacts from FirstNet proposed actions on these species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Mammals

Four endangered and one threatened mammal species are federally listed and known to occur in Tennessee; they are the Carolina northern flying squirrel, gray bat, Indiana bat, northern long-eared bat, and Virginia big-eared bat.

Direct mortality or injury to the federally listed Carolina northern flying squirrel, Indiana bat, or northern long-eared bat could occur if tree clearing activities occurred while there species were present (USFWS, 1990c) (USFWS, 2012a). Direct mortality or injury to the federally listed gray bat or Virginia big-eared bat could occur if caves were flooded or blocked off while bats were present (USFWS, 1984a) (USFWS, 1997a). While projects would not likely directly affect winter hibernacula (e.g., caves), human disturbance in and around these sites when bats are present could lead to effects to these species; when disturbed by noise, vibrations, or light, bats awaken resulting in a loss of body fat needed to help them survive in the spring (USFWS, 1997a). Impacts would likely be isolated, individual events and therefore, at the programmatic level, *may affect, but are not likely to adversely affect*, listed mammal species.

BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Birds

One endangered bird species is federally listed and known to occur in Tennessee, the least tern. Habitat for least terns consists of relatively unvegetated sandbars near rivers, reservoirs and other open water habitat. The majority of FirstNet deployment projects would not occur in an aquatic environment or along riverbanks; therefore, the proposed projects are unlikely to cause direct mortality or injury to these birds from electrocutions with manmade cables and wires, or by disturbance or destruction of nests during ground disturbing activities. Therefore, these potential impacts, at the programmatic level, *may affect, but are not likely to adversely affect*, listed bird species as FirstNet would attempt to avoid deployment activities in areas where they are known to nest. If proposed project sites are unable to avoid sensitive areas, BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Fish

Eleven endangered and seven threatened fish species are federally listed and known to occur in Tennessee, as summarized in Table 14.1.6-5. Direct mortality or injury to federally listed species such as the yellowfin madtom could occur from entanglements resulting from the Proposed Action, but are unlikely as the majority of FirstNet deployment projects would not occur in an aquatic environment. Therefore, at the programmatic level, potential impacts *may affect, but are not likely to adversely affect*, listed fish species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Invertebrates

There are 46 endangered and three threatened invertebrate species that are federally listed and known to occur in the state of Tennessee, as summarized in Table 14.1.6-6. Forty-six of these species are mollusks, one of these species is a crayfish, and two of these species are invertebrates. Direct mortality or injury could occur to invertebrate species such as the spruce-fir moss spider if land clearing or excavation activities associated with the Proposed Action occur in an area inhabited by one of these species. FirstNet would attempt to avoid areas where these species may occur.

The majority of FirstNet deployment projects would not occur in an aquatic environment. Direct mortality or injury to this species are unlikely but could occur from changes in water quality from ground disturbing activities causing stress and lower productivity for federally listed mollusks or the Nashville crayfish resulting from the Proposed Action. Potential impacts, at the programmatic level, *may affect, but are* not *likely to adversely affect*, listed invertebrate species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Plants

Thirteen endangered and seven threatened plant species are federally listed and known to occur in the state of Tennessee as summarized in Table 14.1.6-7. Direct mortality to federally listed plants could occur if land clearing or excavation activities associated with the Proposed Action occur in an area inhabited by one of these species. FirstNet would attempt to avoid areas where these species may occur; therefore, at the programmatic level, potential impacts *may affect, but are not likely to adversely affect*, listed plant species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Reproductive Effects

Reproductive effects are considered those that either directly or indirectly reduce the breeding success of a listed species either by altering its breeding timing or location, or reducing the rates of growth, maturation, and survival of offspring, which could affect the breeding success. Potential effects to federally listed terrestrial mammals, birds, fish, invertebrates, and plants with known occurrence in Tennessee are described below. There are no federally listed reptiles and amphibians in Tennessee, therefore, there would be no potential impacts from FirstNet proposed actions on these species.

Mammals

Noise, vibrations, light, and other human disturbances associated with the Proposed Action could affect federally listed terrestrial mammals within or in the vicinity of Project activities. Impacts would be directly related to the frequency, intensity, and duration of these activities; however, they are anticipated to be small-scale and localized. FirstNet would attempt to avoid these areas. Therefore, at the programmatic level, potential impacts *may affect, but are not likely to adversely affect*, listed mammal species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Birds

Noise, vibrations, light, or other human disturbance within nesting areas could cause least terns to abandon their nests, relocate to less desirable locations, or cause stress to individuals reducing survival and reproduction. FirstNet would attempt to avoid these areas. Therefore, at the programmatic level, potential impacts *may affect, but are not likely to adversely affect*, the least tern. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Fish

Deployment activities resulting in increased disturbance (e.g., humans, noise, vibrations), especially during spawning activity, and changes in water quality could cause stress resulting in lower productivity (see Section 14.2.4, Water Resources, for a discussion of potential impacts to water resources). Impacts to reproduction for federally listed fish species in Tennessee are unlikely as the majority of FirstNet deployment projects would not occur in an aquatic environment and FirstNet would attempt to avoid these areas. Therefore, at the programmatic level, potential impacts *may affect, but are not likely to adversely affect*, listed fish species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

<u>Invertebrates</u>

Changes in water quality from ground disturbing activities could cause stress resulting in lower productivity for federally listed mollusks and crayfish species known to occur in Tennessee. In addition, introduction of invasive aquatic species could indirectly affect mollusks as a result of fish populations that they rely on for their reproductive cycle being altered (USFWS, 1997i). Impacts to food sources utilized by the federally listed invertebrates could lead to potential *adverse effects* on these species (USFWS, 2015dj). Potential impacts to federally listed invertebrate species, at the programmatic level, *may affect, but are not likely to adversely affect*, those species, as the majority of FirstNet activities would not occur in the aquatic environment and FirstNet would attempt to avoid these areas. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

<u>Plants</u>

Potential impacts could occur from ground-disturbing activities to listed plant species as a result of the Proposed Action. However, FirstNet would attempt to avoid these areas. Therefore, at the programmatic level, potential impacts *may affect, but are not likely to adversely affect*, these plant species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Behavioral Changes

Effects to normal behavior patterns that could lead to disruptions in breeding, feeding, or sheltering, resulting in take of a listed species would be considered *potentially significant* at the programmatic level. Potential effects to federally listed terrestrial mammals, birds, fish, invertebrates, and plants with known occurrence in Tennessee are described below. There are no federally listed reptiles and amphibians in Tennessee, therefore, there would be no potential impacts from FirstNet proposed actions on these species.

<u>Mammals</u>

Habitat loss or alteration, particularly from fragmentation or invasive species, could affect breeding and foraging sites of the federally listed terrestrial mammals, resulting in reduced survival and productivity. However, the localized nature of disturbances during deployment activities are not anticipated to stress federally listed terrestrial mammals. Ground disturbing activities could impact food sources for the federally listed terrestrial mammals in Tennessee. Further, increased human disturbance, noise, vibrations, and vehicle traffic could cause stress to these species causing them to abandon breeding locations or alter migration patterns. Terrestrial mammals, such as the gray bat, have the capacity to divert from sound sources during feeding and migration. Additionally, FirstNet would attempt to avoid areas where these species are known to occur; therefore, at the programmatic level, potential impacts *may affect, but would likely not adversely affect*, listed mammal species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Birds

Because many birds have extremely long migrations, protection efforts for critical sites along migratory routes must be coordinated over distances often involving many different countries. For example, the least tern breeds along the Mississippi River in Tennessee and winters in central and southern America. Disturbance in stopover, foraging, or breeding areas (visual, vibrations, or noise) or habitat loss/fragmentation could cause stress to individuals causing them to abandon areas for less desirable habitat and potentially reduce overall fitness and productivity. Activities related to the Proposed Action, such as aerial deployment or construction activities, could result in effects to the least tern. FirstNet would attempt to avoid areas where this species is known to occur; therefore, at the programmatic level, potential impacts *may affect, but are not likely to adversely affect*, listed bird species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Fish

Changes in water quality as a result of ground disturbing activities could impact food sources for the federally listed fish species in Tennessee. Further, increased human disturbance, noise, vibrations, and vessel traffic could cause stress to these species causing them to abandon spawning locations or altering migration patterns. Behavioral changes to federally listed fish species are unlikely as the majority of FirstNet deployment projects would not occur in an aquatic environment. Therefore, at the programmatic level, potential impacts *may affect, but are not likely to adversely affect*, listed fish species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Invertebrates

Changes in water quality, habitat loss or alternation, and introduction of aquatic invasive species could impact food sources for federally listed mussels resulting in lower productivity. Disturbances to food sources utilized by the federally listed terrestrial species, especially during the breeding season, could impact foraging behavior. FirstNet would attempt to avoid areas where these species are known to occur; therefore, at the programmatic level, potential impacts *may affect, but are not likely to adversely affect*, listed invertebrate species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

<u>Plants</u>

No behavioral effects to federally listed plants are expected as a result of the Proposed Action.

Loss or Degradation of Designated Critical Habitat

Effects to designated critical habitat and any of its essential features that could diminish the value of the habitat for the listed species or its survival and recovery would be considered an *adverse effect* and could be *potentially significant*. Depending on the species or habitat, the *adverse effect* threshold would vary for geographic extent. In some cases, large-scale impacts could occur that would not diminish the functions and values of the habitat, while in other cases, small-scale changes could lead to *potentially significant* effects, such as impacts to designated critical habitat for a listed species that is only known to occur in one specific location geographically. Potential effects to federally listed terrestrial mammals, fish, invertebrates, and plants with designated critical habitat in Tennessee are described below. There are no federally listed reptiles and amphibians in Tennessee, and no designated critical habitat within the state for the federally listed bird. Therefore, there would be no potential impacts from FirstNet proposed actions on these species.

<u>Terrestrial Mammals</u>

One of the federally listed terrestrial mammals in Tennessee, the Indiana bat, has designated critical habitat. Critical habitat for the Indiana bat was designated in White Oak Blowhole Cave in Blount County. Land clearing, excavation activities, and other ground disturbing activities in these critical habitats in Tennessee could lead to habitat loss or degradation, which could lead to effects to the Indiana bat depending on the duration, location, and spatial scale of the associated activities. FirstNet would attempt to avoid areas where this species is known to occur; therefore, at the programmatic level, potential impacts *may affect, but would likely not adversely affect*, designated critical habitat for the Indiana bat. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

No critical habitat has been designated for the other federally listed terrestrial mammal species in Tennessee; therefore, *no effect* to these species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Fish

Eleven of the federally listed fish species in Tennessee have federally designated critical habitat, as summarized in Table 14.1.6-5. Proposed FirstNet deployment activities near water would likely occur onshore with limited activities in the water, and therefore would likely not disturb critical habitat. FirstNet would attempt to avoid areas where these species are known to occur; therefore, at the programmatic level, potential impacts *may affect, but would likely not adversely affect*, designated critical habitat for the listed fish. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

No critical habitat has been designated for the other federally listed fish species in Tennessee; therefore, *no effect* to these species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Invertebrates

Eighteen of the federally listed invertebrate species in Tennessee have federally designated critical habitat, as summarized in Table 14.1.6-6. Land clearing, excavation activities, and other ground disturbing activities in these regions of Tennessee could lead to habitat loss or degradation, which could affect these invertebrates depending on the duration, location, and spatial scale of the associated activities. FirstNet would attempt to avoid areas where these species are known to occur; therefore, potential impacts, at the programmatic level, *may affect, but would likely not adversely affect*, designated critical habitat for listed invertebrates. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

No critical habitat has been designated for the other federally listed invertebrate species in Tennessee; therefore, *no effect* to these species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Plants

Three of the federally listed plant species in Tennessee have federally designated critical habitat. Critical habitat for the Braun's rock-cress was designated in Wilson and Rutherford counties. Critical habitat for the Short's bladderpod was designated in Cheatham, Davidson, Dickson, Jackson, Montgomery, Smith, and Trousdale counties. Critical habitat for the whorled sunflower was designated in McNairy and Madison counties in Tennessee.

Land clearing, excavation activities, and other ground disturbing activities in this region of Tennessee could lead to habitat loss or degradation, which could affect to these plants depending on the duration, location, and spatial scale of the associated activities. FirstNet would attempt to avoid areas where these species are known to occur; therefore, at the programmatic level, potential impacts *may affect, but would likely not adversely affect*, designated critical habitat for the listed plant species. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

No critical habitat has been designated for the other federally listed plant species in Tennessee; therefore, *no effect* to these species from the loss or degradation of designated critical habitat is expected as a result of the Proposed Action.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operational activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential effects to threatened and endangered species and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level, in a range of *no effects* to *not likely to adversely affect* depending on the deployment scenario or site-specific conditions. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. The threatened and endangered species that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

<u>Activities Likely to Have No Effect at the Programmatic Level</u>

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have *no effect* on threatened and endangered species or their habitat under the conditions described below:

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance, including noise and vibrations, associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Although threatened and endangered species and their habitat could be impacted, it is anticipated that effects to threatened and endangered species would be temporary, infrequent, and likely not conducted in locations designated as vital or critical for any period.
    - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts*, at the programmatic level, to threatened and

endangered species or their habitat because there would be no ground disturbance and very limited human activity.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would have *no effect* on threatened and endangered species because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to affect protected species, it is anticipated that this activity would have *no effect* on protected species at the programmatic level.

<u>Activities with the Potential to Affect Listed Species at the Programmatic Level</u>

Potential deployment-related effects to threatened and endangered species and their habitats as a result of implementation of the Preferred Alternative would encompass a range of effects that could occur, including direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential effects to threatened and endangered species include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in potential effects to threatened and endangered species. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct injury/mortalities of threatened and endangered species that are not mobile enough to avoid construction activities (e.g., mollusks, small mammals, and young), that utilize burrows (e.g., ground squirrels), or that are defending nest sites (e.g., ground-nesting birds). Disturbance, including noise and vibrations, associated with the above activities could result in direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat.
  - New Build – Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public ROWs or private easements as well as the construction of access roads, POPs, huts, or facilitates to house outside plant equipment could result in potential effects to threatened and endangered species and their habitat. Impacts may vary depending on the number or individual poles installed, but could include direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat.
  - Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat to threatened and endangered species. Noise and vibration disturbance from

heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in reproductive effects or behavior changes.

- o New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water and construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cables could potentially affect threatened and endangered species and their habitat, particularly aquatic species (see Section 14.2.4, Water Resources, for a discussion of potential impacts to water resources). Effects could include direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. If activities occurred during critical time periods, reproductive effects and behavioral changes could occur.
- o Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts, there would be *no impacts* to threatened and endangered species or their habitats at the programmatic level. If installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct injury/mortality of threatened and endangered species as described for other New Build activities. Reproductive effects, behavioral changes, and loss/degradation of designated critical habitat could also occur as a result of construction and resulting disturbance.

- Wireless Projects
  - o New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to threatened and endangered species and their habitat. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. Security lighting and fencing could result in direct injury/mortality, disruption of normal behavior patterns, as well as reproductive effects. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
  - o Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower; FirstNet activities would be infrequent, temporary, or short-term in nature and are unlikely to result in direct injury/mortality or behavioral changes to threatened and endangered species. However, if replacement towers, or structural hardening are required, effects would be similar to new wireless construction. Hazards related to security/safety lighting and fencing may produce direct injury/mortality, reproductive effects, and behavioral changes. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
  - o Deployable Technologies: Implementation of land-based deployable technologies including COWs, COLTs, or SOWs could result in direct injury/mortalities to threatened and endangered species on roadways. If external generators are used, noise and vibration disturbance could potentially result in reproductive effects or behavioral changes to

threatened and endangered species. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions. Deployment of drones, balloons, blimps, or piloted aircraft could potentially impact threatened and endangered species by direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. The magnitude of these effects depends on the timing and frequency of deployments.

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers, poles, or underwater cables; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to threatened and endangered species associated with deployment of this infrastructure could include direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat depending on the species' phenology and the nature and extent of the habitats affected. FirstNet would attempt to avoid areas where these species are known to occur; therefore, potential impacts *may affect, but are not likely to adversely affect* protected species at the programmatic level. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operational activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts.

It is anticipated that operational impacts *may affect, but are not likely to adversely affect* threatened and endangered species at the programmatic level due to routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Site maintenance, including mowing or application of herbicides, *may affect, but are not likely to adversely affect* threatened and endangered species at the programmatic level, as they would be conducted infrequently, and BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

During operations, direct injury/mortality of threatened and endangered species could occur from collisions and/or entanglements with transmission lines, towers, and aerial platforms. FirstNet would attempt to avoid areas where these species are known to occur. Therefore, listed species may be affected, but are not likely to be adversely affected at the programmatic level. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Threatened and endangered species may be affected, but are not likely to be adversely affected at the programmatic level, by the reduction in habitat quality associated with habitat fragmentation from the presence of access roads, transmission corridors, and support facilities. These features could also continue to disrupt movements of some species, particularly during migrations between winter and summer ranges. FirstNet would attempt to avoid areas where these species are known to occur. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

Alternatives Impact Assessment

The following section assesses potential effects to threatened and endangered species associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential effects to threatened and endangered species as a result of implementation of this Alternative could be as described below.

<u>Deployment Impacts</u>

As explained above, implementation of deployable technologies *may affect, but is not likely to adversely affect,* threatened and endangered species at the programmatic level through direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat. Greater frequency and duration of deployments could change the magnitude of impacts depending on species, life history, and region of the state. FirstNet would attempt to avoid areas where these species are known to occur. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

<u>Operational Impacts</u>

As explained above, operational activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that activities *may affect, but are not likely to adversely affect*, threatened and endangered species and their habitats at the programmatic level as a result of routine operations, management, and monitoring. FirstNet would attempt to avoid areas where these species are known to occur. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented. Additional BMPs and mitigation measures, as defined in Chapter 16, may be implemented as appropriate to further minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the nationwide, interoperable, public safety broadband network would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no effects* to threatened and endangered species as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

14.2.7. Land Use, Recreation, and Airspace

14.2.7.1. Introduction

This section describes potential impacts to land use, recreation, and airspace resources in Tennessee associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.7.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on land use, recreation, and airspace resources were evaluated using the significance criteria presented in Table 14.2.7-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined, at the programmatic level, as *potentially significant, less than significant with mitigation measures incorporated, less than significant,* or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to land use, recreation, and airspace resources addressed in this section are presented as a range of possible impacts.

Table 14.2.7-1: Impact Significance Rating Criteria for Land Use, Recreation, and Airspace at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Direct land use change	Magnitude or Intensity	Change in designated/permitted land use that conflicts with existing permitted uses, and/or would require a change in zoning. Conversion of prime or unique agricultural lands.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Minimal changes in existing land use, or change that is permitted by-right, through variance, or through special exception.	No changes to existing development, land use, land use plans, or policies. No conversion of prime or unique agricultural lands.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Permanent: Land use altered indefinitely.		Short-Term: Land use altered for as long as the entire construction phase or a portion of the operations phase.	NA
Indirect land use change	Magnitude or Intensity	New land use directly conflicts with surrounding land use pattern, and/or causes substantial restriction of land use options for surrounding land uses.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	New land use differs from, but is not inconsistent with, surrounding land use pattern; minimal restriction of land use options for surrounding land uses.	No conflicts with adjacent existing or planned land uses.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Permanent: Land use altered indefinitely.		Short-Term: Land use altered for as long as the entire construction phase or a portion of the operations phase.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Loss of access to public or private recreation land or activities	Magnitude or Intensity	Total loss of access to recreation land or activities.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Restricted access to recreation land or activities.	No disruption or loss of access to recreational lands or activities.
	Geographic Extent	Most or all recreational land/sites in a state or territory; recreational lands/sites that are of national significance.		Effects realized at one or multiple isolated locations; recreational lands that are not nationally significant, but that are significant within the state/territory.	NA
	Duration or Frequency	Persists during the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA
Loss of enjoyment of public or private recreation land (due to visual, noise, vibrations, or other impacts that make recreational activity less desirable)	Magnitude or Intensity	Total loss of enjoyment of recreational activities; substantial reduction in the factors that contribute to the value of the recreational resource, resulting in avoidance of activity at one or more sites.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Small reductions in visitation or duration of recreational activity.	No loss of enjoyment of recreational activities or areas; no change to factors that contribute to the value of the resource.
	Geographic Extent	Most or all recreational land/sites in a state or territory; recreational lands/sites that are of national significance.		Effects realized at one or multiple isolated locations; recreational lands that are not nationally significant, but that are significant within the state/territory.	NA
	Duration or Frequency	Persists during or beyond the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Use of airspace	Magnitude or Intensity	Measurable, substantial change in flight patterns and/or use of airspace.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Alteration to airspace usage is minimal.	No alterations in airspace usage or flight patterns.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Permanent: Airspace altered indefinitely.		Short-Term: Airspace altered for as long as the entire construction phase or a portion of the operations phase.	NA

NA = Not Applicable

14.2.7.3. Description of Environmental Concerns

Direct Land Use Change

Changes in land use could be influenced by the deployment, operation, and maintenance of facilities or other infrastructure, and the acquisition of ROWs or easement. The deployment, operation, and maintenance of structures, towers, roads, and other permanent features could conflict with exiting development or land use. The installation of poles, towers, structures, or other above-ground facilities or assets could have short- or long-term effects to existing development or land use based on the characteristics of the structures or facilities, such as the location, type, or height. In addition, the acquisition of ROWs or easements and the construction of roads to access facilities and locations could influence changes in land use. The effects from these actions would depend on the geographic location; compatibility with existing land uses; and characteristics of the ROW, easement, or access road. These characteristics, such as the length, width, and location could change the existing land use to another category or result in the short- or long-term loss of the existing land use.

Based on the impact significance criteria presented in Table 14.2.7-1, *less than significant* at the programmatic level impacts would be anticipated given the size and nature of the majority of the proposed deployment activities. Direct land use changes would be minimized and isolated at specific locations and all required permits would be obtained; only short-term impacts during the construction phase would be expected.

Indirect Land Use Change

Changes in surrounding land use patterns and options for surrounding land uses could be influenced by the deployment, operation, and maintenance of facilities and the acquisition of ROWs or easement. The deployment, operation, and maintenance of structures, towers, roads, and other permanent features could conflict with surrounding land use patterns and options for surrounding land uses. The installation of poles, towers, structures, or other above-ground facilities or assets could have short- or long-term effects to surrounding land use patterns or options for surrounding land uses based on the characteristics of the structures or facilities, such as the location, type, or height. In addition, the acquisition of ROWs or easements and the construction of roads to access facilities and locations could influence changes in surrounding land uses. The effects from these actions would depend on the geographic location; compatibility with surrounding land uses; and characteristics of the ROW, easement, or access road. These characteristics, such as the length, width, and location could conflict with surrounding land use patterns or restrict options for surrounding land uses.

Based on the impact significance criteria presented in Table 14.2.7-1, *less than significant* impacts at the programmatic level would be anticipated as any new land use would be small-scale; only short-term impacts during the construction phase would be expected.

Loss of Access to Public or Private Recreation Land or Activities

The deployment, operation, and maintenance of facilities and the acquisition of ROWs or easement could influence access to public or private recreation land or activities. Localized, short-term accessibility to recreation land or activities could be impacted by the deployment and maintenance of structures, towers, roads, and other permanent features. In the long-term, the deployment and installation of poles, towers, structures, or other above ground facilities could alter the types and locations of recreation activities.

Based on the impact significance criteria presented in Table 14.2.7-1, *less than significant* impacts at the programmatic level would be anticipated as restricted access or a loss of access to recreation areas would not occur; only short-term impacts or small-scale limitations during the construction phase would be expected.

Loss of Enjoyment of Public or Private Recreation Land

The deployment of new towers, and the resulting built tower, could influence the enjoyment of public or private recreation land. Crews accessing the site during the deployment and maintenance of structures, towers, roads, and other permanent features could temporarily impact enjoyment of recreation land. The deployment of poles, towers, structures, or other above ground facilities could affect the enjoyment of recreational land based on the characteristics of the structures or facilities, including permanent impacts to scenery, short-term noise and vibration impacts, and the presence of deployment or maintenance crews.

Based on the impact significance criteria presented in Table 14.2.7-1, *less than significant* impacts at the programmatic level would be anticipated as only small reductions, if any, in recreational visits or durations would occur due to the relatively small-scale nature of likely FirstNet activities. Only short-term impacts during the construction phase would be expected.

Use of Airspace

Primary concerns to airspace include the following: if aspects of the Proposed Action would result in violation of FAA regulations; undermine the safety of civilian, military, or commercial aviation; or infringe on flight activity and flight corridors. Potential impacts could include air routes or flight paths, available flight altitudes, disruption of normal flight patterns, and restrictions to flight activities. Construction of new towers or alternations to existing towers could, but are not likely to, obstruct navigable airspace in the state. Use of aerial technologies could result in SUA considerations.

Based on impact significance criteria presented in Table 14.2.7-1, airspace impacts are not likely to change or alter flight patterns or airspace usage. As drones, balloons, and piloted aircraft would likely only be deployed in an emergency and for a short period, FirstNet would be unlikely to have a significant impact on airspace resources. Therefore the potential impacts to Airspace is expected to be *less than significant* at the programmatic level.

14.2.7.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure, and the specific deployment requirements, some activities would result in *potential impacts* to land use, recreation, and airspace resources and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to further avoid or minimize potential impacts.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to land use, recreation, and airspace resources under the conditions described below:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring alongside the road in utility corridors or within public road ROWs.
    - Land Use: See *Activities with the Potential to Have Impacts* below.
    - Recreation: See *Activities with the Potential to Have Impacts* below.
    - Airspace: *No impacts* at the programmatic level to airspace would be anticipated since the activities would not affect flight patterns or cause obstructions that would require FAA and/or state review based on Federal Aviation Regulation (FAR) 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 14.1.7.5 Obstructions to Airspace Considerations).
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas.
    - Land Use: It is anticipated that there would be *no impacts* at the programmatic level to land use since the activities that would be conducted would not directly or indirectly result in changes to existing and surrounding land uses.
    - Recreation: See *Activities with the Potential to Have Impacts* below.
    - Airspace: It is anticipated that there would be *no impacts* at the programmatic level to airspace since the activities would not affect flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 14.1.7.5 Obstructions to Airspace Considerations).

- New Build – Aerial Fiber Optic Plant: Installing new poles and hanging cables on previously disturbed or new (undisturbed) ROWs or easements and the potential construction of access roads.
  - Land Use: See *Activities with the Potential to Have Impacts* below.
  - Recreation: See *Activities with the Potential to Have Impacts* below.
  - Airspace: Installation of new poles would have *no impact* at the programmatic level on airspace because utility poles are an average of 40 feet in height and do not intrude into useable airspace.
- Collocation on Existing Aerial Fiber Optic Plant: Installation of new fiber on existing poles would be limited to previously disturbed areas.
  - Land Use: It is anticipated that there would be *no impacts* at the programmatic level to land use since the activities that would be conducted would not directly or indirectly result in changes to existing and surrounding land uses.
  - Recreation: *No impacts* at the programmatic level to recreation would be anticipated since the activities that would be conducted would not cause disruption or loss of access to recreational lands or activities or the enjoyment of those lands or activities.
  - Airspace: *No impacts* at the programmatic level are anticipated to airspace from collocations.
- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber and installation of new equipment in existing huts.
  - Land Use: It is anticipated that there would be *no impacts* at the programmatic level to land use since the activities would not directly or indirectly result in changes to existing and surrounding land uses.
  - Recreation: Use of existing dark fiber would *not impact* at the programmatic level recreation because it would not impede access to recreational resources.
  - Airspace: Lighting of dark fiber would have *no impacts* at the programmatic level to airspace.
- New Build – Submarine Fiber Optic Plant: Installing cables in limited nearshore or inland bodies of water and the constructing landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable.
  - Land Use: See *Activities with the Potential to Have Impacts* below.
  - Recreation: See *Activities with the Potential to Have Impacts* below.
  - Airspace: The installation of cables in limited nearshore or inland bodies of water and construction of landings/facilities would *not impact* at the programmatic level flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 14.1.7.5 Obstructions to Airspace Considerations).
- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment would occur in existing boxes or huts. The section below addresses potential impacts to land use, recreation resources, and airspace if deployment of new boxes, huts, or access roads is required.
  - Land Use: See *Activities with the Potential to Have Impacts* below.
  - Recreation: See *Activities with the Potential to Have Impacts* below.

    - Airspace: *No impacts* at the programmatic level to airspace would be anticipated since the activities would not affect flight patterns or cause obstructions that would require FAA and/or state review based on FAR 14 CFR, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace* (See Section 14.1.7.5 Obstructions to Airspace Considerations).
- Wireless Projects
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, structure, or building.
    - Land Use: There would be *no impacts* at the programmatic level to existing and surrounding land uses. The potential addition of power units, structural hardening, and physical security measures would not impact existing or surrounding land uses.
    - Recreation: See *Activities with the Potential to Have Impacts* below.
    - Airspace: See *Activities with the Potential to Have Impacts* below.
- Deployable Technologies
  - Deployable Technologies: These technologies would be used where permanent, fixed infrastructure cannot be deployed due to a variety of factors such as the need to supplement coverage or to avoid or mitigate permanent impacts to sensitive resources or receptors.
    - Land Use: It is anticipated that there would be *no impacts* at the programmatic level to existing or surrounding land uses because these technologies would be temporarily located in areas compatible with other land uses.
    - Recreation: *No impacts* at the programmatic level to recreation are anticipated as deployable technologies would not affect the use or enjoyment of recreational lands.
    - Airspace: See *Activities with the Potential to Have Impacts* below.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: Installation of permanent equipment on existing structures and the use of portable devices that use satellite technology.
    - Land Use: It is anticipated that there would be *no impacts* to existing or surrounding land uses because these technologies would be temporarily located in areas compatible with other land uses.
    - Recreation: See *Activities with the Potential to Have Impacts* below.
    - Airspace: See *Activities with the Potential to Have Impacts* below.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact to land use, recreation, or airspace, it is anticipated, at the programmatic level, that this activity would have no impact on land use, recreation, or airspace.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to land use, recreation resources, or airspace as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur, including changes to existing and surrounding land uses. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to land use resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring alongside the road in utility corridors or within public road ROWs.
    - Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations.
    - Recreation: It is anticipated that plowing, trenching, or directional boring may cause temporary, localized restrictions to recreational land or activities, which may persist during the deployment phase. It is reasonable to anticipate that small reductions in visitation to localized areas may occur during the deployment phase.
    - Airspace: *No impacts* at a programmatic level are anticipated – see previous section.
  - New Build – Aerial Fiber Optic Plant: Installing new poles and hanging cables on previously disturbed or new (undisturbed) ROWs or easements and the potential construction of access roads.
    - Land Use: These activities could result in term potential impacts at a programmatic level to land uses. Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New structures, poles, or access roads on previously undisturbed ROWs or easements could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new structures with existing and surrounding land uses.
    - Recreation: Deployment activities may cause temporary, localized restricted access to recreation land or activities, which may persist for the duration of the deployment phase. Small reductions to visitation during the deployment phase may be anticipated.
    - Airspace: *No impacts* at a programmatic level are anticipated – see previous section.
  - New Build – Submarine Fiber Optic Plant: Installing cables in limited nearshore or inland bodies of water and the constructing landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable.
    - Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New landings and/or facilities on shore could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new facilities with existing and surrounding land uses.
    - Recreation: Deployment may temporarily restrict recreation on or within limited nearshore or inland bodies of water and the surrounding area during the deployment phase. Reductions in visitation may result during deployment.
    - Airspace: *No impacts* at a programmatic level are anticipated – see previous section.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of equipment including construction of new boxes, huts, or access roads.

    - Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New boxes, huts, or access roads could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new facilities with existing and surrounding land uses.
    - Recreation: Deployment of installation equipment and the construction of boxes, huts, or access roads may restrict access to recreation land or activities. Reductions in visitation during deployment may occur.
    - Airspace: *No impacts* at a programmatic level are anticipated – see previous section.
- Wireless Projects
  - New Wireless Communication Towers: Installing new wireless towers, associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads.
    - Land Use: Construction activities could temporarily restrict existing and surrounding land uses at isolated locations. New wireless towers, associated structures, or access roads could have long-term impacts to existing and surrounding land uses. The magnitude of the impact would depend on the specific location and the compatibility of the new facilities with existing and surrounding land uses.
    - Recreation: Deployment of new towers and associated structures could result in temporary, localized restricted access for recreation land or activities for the duration of the deployment phase. Reductions in visitation or duration of recreational activity may result from restricted access.
    - Airspace: Installation of new wireless towers could result in impacts to airspace if towers exceed 200 feet AGL or meets the other criteria listed in Section 14.1.7.5 Obstructions to Airspace Considerations. An OE/AAA could be required for the FAA to determine if the proposed construction does affect navigable airways or flight patterns of an airport if the aerial fiber optic plant is located in proximity to one of Tennessee's airports.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower.
    - Land Use: *No impacts* at a programmatic level are anticipated – see previous section.
    - Recreation: Installation of antennas or microwaves to existing towers may cause temporary, localized restricted access to recreation lands or activities during installation, which may cause small reductions in visitation for the duration of installation.
    - Airspace: Collocation of mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, addition of power units, structural hardening, and physical security measures could result in impacts if located near airports or air navigation facilities.

- Deployable Technologies
  - Deployable Technologies: These technologies would be used where permanent, fixed infrastructure cannot be deployed due to a variety of factors such as the need to supplement coverage or to avoid or mitigate permanent impacts to sensitive resources or receptors.
    - Land Use: *No impacts* at a programmatic level are anticipated – see previous section.
    - Recreation: *No impacts* at a programmatic level are anticipated – see previous section.
    - Airspace: Implementation of deployable aerial communications architecture could result in temporary or intermittent impacts to airspace. Deployment of tethered systems (such as balloons or blimps) could pose an obstruction hazard if deployed above 200 feet and near Tennessee airports (see obstruction criteria in Section 14.1.7.5 Obstructions to Airspace Considerations). Potential impacts to airspace (such as SUAs and MTRs) may be possible depending on the planned use of drones, piloted aircraft, untethered balloons, and blimps (e.g., frequency of deployment, altitudes, proximity to airports and airspaces classes/types, length of deployment, etc.). Coordination with the FAA would be required to determine the actual impact and the required certifications. It is expected that FirstNet would attempt to avoid changes to airspace and the flight profiles (boundaries, flight altitudes, operating hours, etc.).
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of permanent equipment on existing structures and the use of portable devices that use satellite technology.
    - Land Use: *No impacts* at a programmatic level are anticipated – see previous section
    - Recreation: It is anticipated the installation of equipment on existing structures may cause temporary, localized restricted access to recreation lands or activities during installation, which may cause small reductions in visitation for the duration of installation.
    - Airspace: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology *may impact* airspace if equipment creates an obstruction.

In general, the abovementioned activities could potentially involve construction activities. Potential impacts to land uses associated with deployment of this infrastructure could include temporary restrictions to existing and surrounding land uses in isolated locations. Potential impacts to recreation land and activities could include temporary, localized restricted access and reductions in visitation or duration of recreational activities. Potential impacts to airspace could include obstructions. These potential impacts are expected to be *less than significant* at the programmatic level due to the temporary and small-scale nature of deployment activities. Additionally, FirstNet (or its network partners), would prepare an OE/AAA for any proposed tower that might affect navigable airways or flight patterns of an airport. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be *no impacts* at a programmatic level to land use, recreation resources, or airspace at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for temporary, short-term inspections because there would be no ground disturbance, no airspace activity, and no access restrictions to recreational lands at the programmatic level. If routine maintenance or inspection activities would conflict with existing or surrounding land uses, impact recreation resources, or conflict with airspace, impacts could result as explained above.

Operation of the Deployable Technologies options of the Preferred Alternative could result in the temporary presence of deployable vehicles and equipment (including airborne equipment), potentially for up to two years in some cases. Operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. It is anticipated that there would be *no impacts* at a programmatic level to land use, recreation resources, or airspace at the programmatic level associated with routine inspections, assuming that the same access roads used for deployment are also used for inspections.

The degree of change in the visual environment (see Section 14.2.8, Visual Resources)—and therefore the potential indirect impact on a landowner's ability to use or sell of their land as desired—would be highly dependent on the specific deployment location and length of deployment. Once deployment locations are known, the location would be subject to an environmental review to help ensure environmental concerns are identified. The use of deployable aerial communications architecture could temporarily add new air traffic or aerial navigation hazards. The magnitude of these effects would depend on the specific location of airborne resources along with the duration of their use. FirstNet would coordinate with the FAA to review required certifications. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.7.5. Alternatives Impact Assessment

The following section assesses potential impacts to land use, recreation resources, and airspace associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to land use, recreation, and airspace resources as a result of implementation of this Alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result *in less than significant* impacts at a programmatic level to land use at the programmatic level. While a single deployable technology may have imperceptible impact, multiple technologies operating in close proximity for longer periods could impact existing and surrounding land uses. There could be impacts to recreation activities during the deployment of technologies if such deployment were to occur within or near designated recreation areas. Enjoyment of activities dependent upon the visibility of wildlife or scenic vistas may be affected; however, impacts would be *less than significant* due to the temporary nature of likely deployment activities. If deployment triggers any obstruction criterion or result in changes to flight patterns and airspace restrictions, FirstNet (or its partners) would consult with the FAA to determine how to proceed. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* at a programmatic level to land use, recreation resources, or airspace associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. Operation of deployable technologies would result in land use, land ownership, airspace, and recreation (access and enjoyment) similar in type to those described for the Preferred Alternative. The frequency and extent of those potential impacts would be greater than for the Proposed Action because under this Alternative, deployable technologies would be the only options available. As a result, this alternative would require a larger number of terrestrial and airborne deployable vehicles and a larger number of deployment locations in—all of which would potentially affect a larger number of properties and/or areas of airspace. Overall, these potential impacts would be *less than significant* due to the temporary nature of deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure, or satellites and other technologies. As a result, there would be *no impacts* at a programmatic level to land use, recreation resources, or airspace. Environmental conditions would therefore be the same as those described in Section 14.1.7, Land Use, Recreation, and Airspace.

14.2.8. Visual Resources

14.2.8.1. Introduction

This section describes potential impacts to visual resources in Tennessee associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.8.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on visual resources were evaluated using the significance criteria presented in Table 14.2.8-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined, at the programmatic level, as *potentially significant, less than significant with mitigation measures incorporated, less than significant,* or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to visual resources addressed in this section are presented as a range of possible impacts.

Table 14.2.8-1: Impact Significance Rating Criteria for Visual Resources at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Adverse change in aesthetic character of scenic resources or viewsheds	Magnitude or Intensity	Fundamental and irreversibly negative change in aesthetic character.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Intermittently noticeable change in aesthetic character that is marginally negative.	No visible effects.
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated locations.	No visible effects.
	Duration or Frequency	Permanent or persistent changes to aesthetic character lasting throughout or beyond the construction or deployment phase.		Persisting through the construction and deployment phase, but aesthetics of the area would be returned to original state following the construction and deployment phase.	Transient or no visible effects.
Nighttime lighting	Magnitude or Intensity	Lighting dramatically alters night-sky conditions.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Lighting alters night-sky conditions to a degree that is only intermittently noticeable.	Lighting does not noticeably alter night-sky conditions.
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated locations.	No visible effects.
	Duration or Frequency	Permanent or persistent changes to night-sky conditions lasting throughout or beyond the construction or deployment phase.		Persisting through the construction and deployment phase, but lighting would be removed and night-sky conditions would be returned to original state following the construction and deployment phase.	Transient or no visible effects.

14.2.8.3. Description of Environmental Concerns

Adverse Change in Aesthetic Character of Scenic Resources or Viewsheds

A primary concern during and following construction of structures, towers, roads or other permanent features is the long-term disruption of scenery and viewsheds. In Tennessee, residents and visitors travel to many National Historic Landmarks, National Parks, and state historic parks, such as the Johnsonville State Historic Park to enjoy forest, river, and creek views and tour the historic Civil War site. If lands considered visually significant or scenic were subject to vegetation loss or removal, short- or long-term effects to viewsheds or scenic resources could occur. Bare ground or interruption of a landscape due to vegetation removal could be considered an adverse change in the aesthetic character of scenic resources or viewsheds. New towers or structures constructed within scenic areas could disrupt the perceived aesthetic character or scenery of an area. If new towers were constructed to a height that required lighting, nighttime vistas could be affected in areas where the night skies do not have light disruptions or are within unpopulated areas.

Tennessee regulates impacts to visual resources for parks, forests, scenic rivers, and natural areas within the state through TDEC (State of Tennessee, 2015d).

Based on the impact significance criteria presented in Table 14.2.8-1, impacts to the aesthetic character of scenic resources or viewsheds would be considered *potentially significant* at a programmatic level if landscapes were permanently removed or fragmented, or if damage to historic or cultural resources occurred. The majority of FirstNet deployment activities would not cause negative impacts to the aesthetic character to a noticeable degree. However, some projects, such a towers, facilities, or infrastructure could cause a negative impact on the aesthetic character of local viewsheds depending on their size and location. However, given the small scale of likely FirstNet activities, impacts are expected to be *less than significant* at the programmatic level.

Nighttime Lighting

If new towers or facilities were constructed to a height that required lighting, nighttime vistas could be affected in areas where the night skies do not have light disruptions or are within unpopulated areas. If nighttime lighting were necessary for the operation or function of a facility that caused regional impacts or permanent changes to night sky conditions, those effects could be considered *potentially significant* at the programmatic level.

Based on the impact significance criteria presented in Table 14.2.8-1, lighting that illuminates the night sky, diminishes night sky viewing over long distances, and persists over the long-term could be considered *potentially significant* at a programmatic level. Although likely FirstNet actions are expected to be small-scale, certain discrete locations may experience *potentially significant* impacts to night skies, although potentially minimized to *less than significant with implementation of BMPs and mitigation measures,* as defined in Chapter 16, BMPs and Mitigation Measures. BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would be implemented.

14.2.8.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts at a programmatic level to visual resources and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level, in a range of *no impacts* to *less than significant impacts with BMPs and mitigation measures incorporated* depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to visual resources under the conditions described below:

- Wired Projects
  - Collocation on Existing Aerial Fiber Optic Plant: While the addition of new aerial fiber optic plant to an existing aerial fiber optic transmission system would likely be visible, the change associated with this option is so small as to be essentially imperceptible. This option would involve no new nighttime lighting and pole replacement would be limited and therefore *no impact* at the programmatic level
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* at a programmatic level to visual resources since the activities would be conducted at small entry and exit points and are not likely to produce perceptible changes, and would not require nighttime lighting.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* at a programmatic level to visual resources because there would be no ground disturbance, would not require nighttime lighting, and would not produce any perceptible changes.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would *not impact* visual resources since those activities would not require ground disturbance or vegetation removal.

- o Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact visual resources, it is anticipated that this activity would have no impact on visual resources at the programmatic level.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to visual resources as a result of implementation of the Preferred Alternative would encompass a range of impacts that could occur as a result of ground disturbance, vegetation removal, or installation of permanent structures if development occurs in scenic areas. The types of deployment activities that could be part of the Preferred Alternative and result in potential impacts to visual resources include the following:

- Wired Projects
  - o New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs , huts, or other associated facilities or hand-holes to access fiber could result in potential impacts at a programmatic level to visual resources. The degree of impact would depend on the timing, location, and type of project; installation of a hut or POP would be permanent, whereas ground disturbing activities would be short-term. In most cases, development located next to existing roadways would not affect visual resources unless vegetation were removed or excavation occurred in scenic areas.
  - o New Build – Aerial Fiber Optic Plant: Construction and installation of new or replacement poles and hanging cables could result in impacts to the aesthetic character of scenic resources or viewsheds depending on the location of the installation. In most cases, development in public ROWs would not affect visual resources unless vegetation were removed or construction occurred in scenic areas. If new lighting were necessary, impacts to night skies could occur. Construction of new roadways could result in linear disruptions to the landscape, surface disturbance, and vegetation removal; all of which could impact the aesthetic character of scenic resources or viewsheds, depending on the location of the installation.
  - o New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would have *no impact* at a programmatic level visual resources. However, impacts to the aesthetic character of scenic resources or viewsheds could potentially occur as result of the construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable.
  - o Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment required grading, vegetation removal, or other ground disturbance to install small boxes or huts, or access roads, potential impacts to visual resources could occur but effects would be temporary and localized and are anticipated to be *less than significant* at the programmatic level.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads *could result in impacts* to visual resources. Land/vegetation clearing, excavation activities, landscape grading, and other surface disturbing activities during the installation of new wireless towers and associated structures or access roads could result in the degradation of the aesthetic character of scenic resources or viewsheds. Impacts may be experienced by viewers if new towers were located in or near a NPS unit or other sensitive area. If new towers were constructed to a height that required aviation lighting, nighttime vistas could be impacted in areas where the night skies do not have light disruptions or are within unpopulated areas. If nighttime lighting were necessary for the operation or function of a facility, impacts to night sky conditions could be *potentially significant* at the programmatic level.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower and would likely have *no impacts* to visual resources. However, if additional power units, structural hardening, or physical security measures required ground disturbance or removal of vegetation, potential impacts to the aesthetic character of scenic resources or viewsheds could occur.
  - Deployable Technologies: Implementation of deployable technologies could result in *potential impacts* to visual resources if long-term deployment occurs in scenic areas, or if the implementation requires minor construction of staging or landing areas and results in vegetation removal, areas of surface disturbance, or additional nighttime lighting.

In general, the abovementioned activities could potentially involve land/vegetation clearing, and potential scenic intrusion of towers, poles, roads, infrastructure, and other structures. Potential impacts to visual resources associated with deployment could include interruptions of landscapes, degradation of the aesthetic character of scenic resources or viewsheds, and overall changes in valued scenic resources, particularly for permanent fixtures such as towers or facilities. These impacts are expected to be *less than significant* at a programmatic level due to the temporary and small-scale nature of deployment activities. As discussed above, potential impacts to night skies from lighting are expected to be *less than significant with BMPs and mitigation measures incorporated*. Chapter 16, BMPs and Mitigation Measures provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that there would be *no impacts* at a programmatic level to visual resources at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Nighttime lighting in isolated rural areas or if sited near a national park would be *less than significant with BMPs and mitigation measures incorporated* during operations. Additionally, FirstNet would work closely with the NPS to address any concerns they might have if a tower needed to be placed in an area that might affect the nighttime sky at a NPS unit. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.8.5. Alternatives Impact Assessment

The following section assesses potential impacts to visual resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, *potential impacts* to infrastructure as a result of implementation of this Alternative could be as described below.

Potential Deployment Impacts at the Programmatic Level

As explained above, implementation of deployable technologies could result in *potential impacts* to visual resources if long-term deployment occurs in scenic areas. If staging or landing areas (depending on the type of technology) require surface disturbance or vegetation clearing, or if these areas were within scenic landscapes or required new nighttime lighting, impacts could occur to the aesthetic character of scenic resources or viewsheds. These impacts are expected to be *less than significant* at the programmatic level as generally they would be limited to the deployment location and could often be screened or otherwise blocked from view. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Operation Impacts at the Programmatic Level

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to visual resources at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. The potential visual impacts—including aesthetic conditions and nighttime lighting—of the operation of deployable technologies would be *less than significant* at the programmatic level given the limited geographic scope for individual activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* at a programmatic level to visual resources as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.8, Visual Resources.

14.2.9. Socioeconomics

14.2.9.1. Introduction

This section describes potential impacts to socioeconomics in Tennessee associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.9.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on socioeconomics were evaluated using the significance criteria presented in Table 14.2.9-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined, at the programmatic level, as *potentially significant*, *less than significant with mitigation measures incorporated*, *less than significant*, or *no impact.* Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to socioeconomics addressed in this section are presented as a range of possible impacts.

Table 14.2.9-1: Impact Significance Rating Criteria for Socioeconomics at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Impacts to real estate (could be positive or negative)	Magnitude or Intensity	Changes in property values and/or rental fees, constituting a significant market shift.	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	Indiscernible impact to property values and/or rental fees.	*No impacts* to real estate in the form of changes to property values or rental fees.
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated locations, as opposed to throughout the state or territory.	NA
	Duration or Frequency	Persists during the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA
Changes to spending, income, industries, and public revenues	Magnitude or Intensity	Economic change that constitutes a market shift.	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	Indiscernible economic change.	No change to spending, income, industries, and public revenues.
	Geographic Extent	Regional impacts observed throughout the state/ territory.		Effects realized at one or multiple isolated cities/towns, as opposed to throughout the state or territory.	NA
	Duration or Frequency	Persists during or beyond the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA
Impacts to employment	Magnitude or Intensity	High level of job creation at the state or territory level.	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	Low level of job creation at the state/territory level.	No job creation due to project activities at the state/territory level.
	Geographic Extent	Regional impacts observed throughout the state/territory.		Effects realized at one or multiple isolated cities/towns, as opposed	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
				to throughout the state or territory.	
	Duration or Frequency	Persists during the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA
Changes in population number or composition	Magnitude or Intensity	Substantial increases in population, or changes in population composition (age, race, gender).	Effect that is *potentially significant*, but with mitigation is less than significan at the programmatic level t.	Minor increases in population or population composition.	No changes in population or population composition.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or multiple isolated locations, as opposed to throughout the state or territory.	NA
	Duration or Frequency	Persists during the life of the project.		Persists for as long as the entire construction phase or a portion of the operations phase.	NA

NA = Not Applicable

14.2.9.3. Description of Environmental Concerns

This section discusses at a high level the types of socioeconomic impacts that could result from deployment of the NPSBN. Socioeconomic impacts could be negative or positive. Subsections below address socioeconomic impacts in four general areas, following the breakdown of the significance rating criteria in the table above:

- Impacts to Real Estate;
- Economic Benefits or Adverse Impacts Related to Changes in Spending, Income, Industries, and Public Revenues;
- Impacts to Employment; and
- Changes in Population Number or Composition.

In addition to the specific impacts noted below, the Proposed Action would likely have broad, beneficial impacts to all four areas in times of disaster, by improving the response of public safety personnel. Reduced damages and faster recovery would result. This would support property values; maintain corporate income, personal income, and government revenues; preserve jobs; and reduce disruptions to populations.

Impacts to Real Estate

Deployment of the NPSBN has the potential to improve property values in areas that have reduced property values due to below average public safety communication services. Improved services would reduce response times and improve responses. These effects would reduce the potential for economic losses and thus support investments in property and greater market value for property. Any increases in property values are most likely in areas that have low property values and below average public safety communication services. Increases are less likely in areas that already have higher property value. As discussed in Affected Environment, property values vary across Tennessee. Median values of owner-occupied housing units in the 2009–2013 period ranged from over $181,000 in the greater Nashville-Davidson area, to just over $113,000 in the Jackson area. These figures are general indicators only. Property values are probably both higher and lower in specific localities. Any property value effects of deployment of the NPSBN would occur at a localized level.

Some telecommunications infrastructure, such as wireless communications towers, may adversely affect property values, depending on infrastructure location and other characteristics. Researchers believe these negative impacts relate to perceptions of the aesthetics of towers, or fears over electromagnetic radiation. Economists and appraisers have studied this issue and use a statistical analysis methodology known as hedonic pricing, or hedonic modelling, to assess how different attributes of properties such as distance from a tower affect property value (Bond, Sims, & Dent, 2013). Essentially, analysts compare the value of multiple properties while statistically controlling for differences in property attributes, in order to isolate the effect of a specific attribute such as proximity of a communications tower.

A recent literature review examined such studies in the United States, Germany, and New Zealand (Bond, Sims, & Dent, 2013). These studies all focused on residential properties. One study identified a positive effect on price in one neighborhood due to the presence of a wireless communications tower. Most studies identified negative effects on price. Generally, these negative effects were small: an approximately two percent decrease in property price. In one case, the average reduction in price was 15 percent. In all cases, the effects declined rapidly with distance, with some cases showing *no effect* beyond 100 meters (328 feet) and one case showing effects up to about 300 meters (984 feet).

Based on review of the particulars of each study, the literature review authors hypothesize that many additional factors regarding communications towers, besides distance, may affect property value. These include the type, height, size, and appearance of communication towers; grouping of towers; the level of activity in the property market at the time properties are listed or sold; and the level of negative local media focus on potential health effects of communication towers at the time properties are listed or sold.

Economic Benefits or Adverse Impacts Related to changes in Spending, Income, Industries, and Public Revenues

Developing the NPSBN may increase economic activity as governments and partners make expenditures to deploy, operate, and maintain telecommunications and broadband infrastructure. Funds for such expenditures would come primarily from federal, state, and local government sources or through private entities under a written agreement with such governmental entities. FirstNet has three primary sources of funding to carry out its mission: (1) up to $7 billion in cash funded by proceeds of incentive auctions authorized by the Act; (2) network user or subscriber fees; and (3) fees from covered leasing agreements that allow FirstNet to permit a secondary users to access network capacity on a secondary basis for non-public safety services only. The use of NPSBN capacity on a secondary basis for non-public safety services, including commercial services, by parties entering into a covered leasing agreement with FirstNet may also increase economic activity and generation of income for such party.

Direct spending of federal, state, and private sector funds to deploy and operate the NPSBN would likely represent new income to businesses that provide goods and services for the network, resulting in a positive impact. This direct impact would lead to indirect impacts (as directly impacted businesses purchase supporting goods and services) and induced impacts (as the employees of all affected businesses spend the wages they have earned). Because most FirstNet infrastructure investments would be dispersed across the nation, the business income and wages generated in any particular state or community would generally be small relative to the overall state or community economy, but measurable. Based on the significance criteria above, the business income and wage impacts would be considered positive and *less than significant* at the programmatic level. It is also highly unlikely that these impacts would lead to significant market shifts or other significant changes to local/regional economic structure.

Spending and income generation related to developing the NPSBN would also result in changes to public revenues. Property taxes may change as property values increase or decrease due to the installation of new infrastructure. General and selective sales taxes may change (most likely increase), reflecting expenditures during system development and maintenance. Public utility tax revenues may change. These taxes are a subcategory of selective sales taxes that includes taxes on providers of land and mobile telephone, telegraph, cable, and internet services (U.S. Census Bureau, 2006). These service providers may obtain new taxable revenues from operation of components of the public safety broadband network. In such cases, public utility tax revenues may increase, but they could also remain the same or decrease if providers are granted tax breaks in return for operating portions of the network. Individual and corporate income taxes may change as FirstNet infrastructure development and operation creates new taxable income for involved companies and workers.

FirstNet's partner(s) may be given the right to use excess NPSBN capacity commercially. This would result in additional economic activity and generation of income. In turn, this could have revenue implications for federal and state governments, through taxes on sales and on corporate income generated by commercial use of the network.

FirstNet may have an additional, non-revenue benefit to the public sector. The network is likely to create operational cost savings and increased productivity for public safety personnel.

Impacts to Employment

Private companies and government organizations that receive income from deploying and operating the NPSBN would use portions of that income to hire the employees they need to provide their support to the network. This generation of new employment could be a minor, direct, beneficial impact of expenditures on FirstNet. Additional, indirect employment increases would occur as additional businesses hire workers to provide supporting goods and services. For instance, FirstNet partner(s) and their subcontractors and vendors would need engineers and information technology professionals, project managers, construction workers, manufacturing workers, maintenance workers, and other technical and administrative staff. Further employment gains would occur as businesses throughout the economy benefit from consumer spending by wage-earners in direct and indirectly affected businesses.

For the most part, employment gains in any particular state or community would generally be measurable, but small relative to the overall state or community economy. This is because FirstNet infrastructure investments would be dispersed across the nation. Based on the significance criteria above, the employment impacts would be considered positive and *less than significant* at the programmatic level. However, even small employment gains are beneficial, and would be especially welcomed in areas that have high unemployment. As discussed in Affected Environment, unemployment rates (as shown by the unemployment rate map and selected economic indicators table) vary considerably across Tennessee. The average unemployment rate in 2014 was 6.7 percent, higher than the national rate of 6.2 percent. Counties with unemployment rates below the national average (that is, better employment performance) were located around Nashville, Murfreesboro, Columbia, Knoxville, and Cleveland, and in the south-central part of Tennessee (north of Huntsville, Alabama). Counties in the remainder of the state had unemployment rates above the national average, particularly in the western third of the state.

Large companies that win major contracts for deploying and operating the NPSBN may have concentrations of employees in some specific locations; for instance, engineers and other system designers may be located in one or a few specific offices. While such employment concentrations could be important to specific communities, these and other employment impacts would still not be significant based on the criteria in Table 14.2.9-1 because they would not constitute a "high level of job creation at the state or territory level."

Changes in Population Number or Composition

In general, changes in population numbers occur when employment increases or decreases to a degree that affects the decisions of workers on where they could find employment; that is, when workers and their families move to or leave an area because of employment opportunities or the lack thereof. As noted above, deployment and operation of the NPSBN is likely to generate new employment opportunities (directly and indirectly), but employment changes would not be large enough in any state to be considered significant at the programmatic level. Therefore, it is highly unlikely that the NPSBN would lead to significant changes in population numbers according to the significance criteria table above. Further, it is unlikely that the NPSBN would lead to any measurable changes in population numbers in any geographic areas, with the possible exception of cities where companies that win major NPSBN contracts establish centers for NPSBN deployment and operation activities. Smaller numbers of employees in any area would not produce measurable population changes because population is always in flux due to births, deaths, and in-migration and out-migration for other reasons.

Population composition refers to age, gender, race, ethnicity, and other characteristics of the individuals making up a population. Given the low potential for changes to population numbers, it is highly unlikely that the NPSBN would lead to any changes in population composition.

14.2.9.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could deploy various types of facilities or infrastructure. Almost all deployment activities would have socioeconomic impacts, because they represent economic activity that would result, for instance, in expenditures and generation of income. These effects are measurable by economists, even if very small, but their significance is determined by application of the criteria in Table 14.2.9-1. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts at the Programmatic Level

- Satellites and Other Technologies
    - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact socioeconomics, it is anticipated that this activity would have *no impact* on socioeconomic resources.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential impacts to socioeconomics for the Preferred Alternative would encompass a range of impacts that could result from deployment activities. The discussion below summarizes how the four types of socioeconomic impacts discussed above and listed again here apply to each type of deployment activity. For greater detail on the nature of these impacts, see the Description of Environmental Concerns section above.

- Impacts to Real Estate;
- Changes to Spending, Income, Industries, and Public Revenues;
- Impacts to Employment; and
- Changes in Population Number or Composition.

Positive impacts on property values would generally not result from one or a few particular activities, but instead would result from the totality of the new NPSBN infrastructure and operational systems that enable improved public safety services to currently underserved areas. Similarly, any change to population numbers in a few locations as discussed above would result from large contract awards and contractor decisions about employee locations, not from specific deployment activities. Therefore, these types of impacts are not included in the activity-focused discussions below.

- Wired Projects
    - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of fiber optic cable in existing conduit would have the following types of socioeconomic impacts:
        - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
        - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.
    - Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant on existing utility poles and other structures would have the following types of socioeconomic impacts:
        - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be

small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.
- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would be conducted electronically through existing infrastructure, and would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water, and associated onshore activities at existing or new facilities would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.
- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment through existing or new boxes or huts would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.
- New Build – Buried Fiber Optic Plant: New fiber optic cable installation usually requires construction activities and would have the following types of socioeconomic impacts:
    - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant*. at the programmatic level
    - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.

- o New Build – Aerial Fiber Optic Plant: Pole/structure installation would have the following types of socioeconomic impacts:
  - ▪ Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
  - ▪ Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.

- Wireless Projects
  - o New Wireless Communication Towers: Installation of new wireless towers and associated structures, such as generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads, or access roads would have the following types of socioeconomic impacts:
    - ▪ Impacts to Real Estate – As discussed above, communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013). Such impacts, if they occur, would be limited to a small area around each project and would generally be a small percentage reduction in property value; thus the impacts would be *less than significant* at the programmatic level.
    - ▪ Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
    - ▪ Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.
  - o Collocation on Existing Wireless Tower, Structure, or Building: Collocation would include mounting or installing equipment (such as antennas) on an existing facility would have the following types of socioeconomic impacts. While communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013), the impacts of existing wireless towers are presumably already factored into property values and would not be affected by the addition of new equipment.
    - ▪ Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
    - ▪ Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.
  - o Deployable Technologies: COWs, COLTs, and SOWs and aerial deployable technologies require storage, staging, and (for aerial deployables) launch/landing areas. Development of such areas, or enlargement of existing areas to accommodate FirstNet equipment, would have the following types of socioeconomic impacts:

        - Impacts to Real Estate – It is possible that development or enlargement of storage, staging, and launch/landing areas could have adverse impacts on nearby property values. This is because such facilities may have adverse aesthetic aspects (e.g., large areas of pavement and large numbers of parked vehicles), equipment maintenance activities at such facilities may generate noise and vibrations, and operational activities may generate traffic. Such factors could affect nearby property values. These impacts, if they occur, would occur within a limited distance of each site, and would be limited to a relatively small number of sites within the region and state. Therefore, these impacts would be *less than significant* at the programmatic level.
        - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
        - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.
- Satellites and Other Technologies
    - Satellite-Enabled Devices and Equipment: It is anticipated that the deployment of such devices and equipment would be similar to collocation of wireless equipment on existing wireless towers, structures, or buildings, and would have the following types of socioeconomic impacts:
        - Changes to Spending, Income, Industries, and Public Revenues – Materials and labor for these projects would represent new expenditures that would generate income, help support industries, and may generate public revenues. All such effects would be small in scale relative to the regional and state economy and of limited duration; their impacts would be *less than significant* at the programmatic level.
        - Impacts to Employment – Similarly, expenditures for these projects would generate temporarily a *less than significant* number of jobs regionally and statewide.

In general, the abovementioned activities would have *less than significant* beneficial socioeconomic impacts. The discussion above characterized the impacts of each type of activity. The socioeconomic impacts of all activities considered together would also be *less than significant* at the programmatic level. Even when considered together, the impacts would be very small relative to the total economic activity and property value of any region or the state. In addition, with the possible exception of property values, all deployment impacts would be limited to the construction phase. To the extent that certain activities could have adverse impacts to property values, those impacts are also expected to be *less than significant* at the programmatic level, as described above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of primarily of routine maintenance and inspection of fixed infrastructure. As with deployment activities, all operational activities would have socioeconomic impacts, because all represent economic activity. Public or private sector employees would conduct all operational activities, and therefore support employment and involve payment of wages. Even if these economic effects are a very small for each operational activity and not significant across the entire state, they are measurable socioeconomic impacts.

Potential socioeconomic impacts would primarily be beneficial, and generally of these types:

- Changes to Spending, Income, Industries, and Public Revenues – Operational activities would require expenditures, which then generate business income and employee wages, and may result in new public sector revenues such as taxes on sales and income. All such effects would be small in scale relative to the regional and state economy; their impacts would be *less than significant* at the programmatic level.
- Impacts to Employment – Public and private sector organizations responsible for operating the NPSBN would sustain existing employees and/or hire new employees to carry out operational activities. They would generate a *less than significant* number of jobs regionally and statewide.

The potential negative impacts on property values mentioned above for deployment of new wireless communication towers and deployable technology storage, staging, and launch/landing areas may also apply in the operations phase. The ongoing presence of such facilities has aesthetic and other effects that may reduce nearby property values, relative to values in the absence of such facilities. These impacts, if they occur, would be *less than significant* at the programmatic level as they would occur within a limited distance of each site, and would be limited to a relatively small number of sites within Tennessee. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.9.5. Alternatives Impact Assessment

The following section assesses potential impacts to socioeconomics associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to socioeconomics resulting from implementation of this Alternative could be as described below.

Deployment Impacts at the Programmatic Level

As explained above, all deployment activities represent economic activity and thus have socioeconomic impacts. These impacts would primarily be beneficial, such as generation of business income and employee wages, and creation or sustainment of jobs. The impacts would be small for each activity and therefore *less than significant* at the programmatic level.

Deployable technologies such as COWs, COLTs, and SOWs, along with aerial deployable technologies, would require storage, staging, and launch/landing areas. Development or enlargement of these facilities could have adverse impacts on nearby property values. The potential for such impacts is higher under this alternative than the Preferred Alternative because it is likely that these facilities would be implemented in greater numbers and over a larger geographic extent. These potential impacts are anticipated to be *less than significant* at the programmatic level as described above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts at the Programmatic Level

All operational activities represent economic activity and thus have socioeconomic impacts. These impacts would primarily be beneficial, and because they are small individually, overall impacts would be *less than significant* at the programmatic level.

The ongoing presence of facilities for housing and maintaining deployable technologies may have adverse aesthetic aspects (e.g., large areas of pavement and large numbers of parked vehicles) or other aspects (e.g., noise, vibrations, and traffic) that could negatively affect the value of surrounding properties. The potential for such impacts is higher under this alternative than the Preferred Alternative because it is likely that these facilities would be more numerous, present over a larger geographic extent, and used with greater frequency and duration. These impacts, if they occur, would be *less than significant* at the programmatic level as they would be limited to a relatively small number of sites within Tennessee. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed. Therefore, there would be no associated deployment or installation activities to deploy wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* at the programmatic level to socioeconomics from the No Action Alternative. Socioeconomic conditions would therefore be the same as those described in Section 14.1.9, Socioeconomics.

14.2.10. Environmental Justice

14.2.10.1. Introduction

This section describes potential impacts to environmental justice in Tennessee associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.10.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on environmental justice were evaluated using the significance criteria presented in Table 14.2.10-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with mitigation measures incorporated*, *less than significant*, or *no impact* at the programmatic level. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to environmental justice addressed in this section are presented as a range of possible impacts.

Table 14.2.10-1: Impact Significance Rating Criteria for Environmental Justice at the Programmatic Level

<table>
<tr><th rowspan="2">Type of Effect</th><th rowspan="2">Effect Characteristics</th><th colspan="4">Impact Level</th></tr>
<tr><th>Potentially Significant</th><th>Less than Significant with BMPs and Mitigation Measures Incorporated</th><th>Less than Significant</th><th>No Impact</th></tr>
<tr><td rowspan="3">Effects associated with other resource areas (e. g., human health and safety, cultural resources, socioeconomics) that have a disproportionately high and adverse impact on low-income populations and minority populations</td><td>Magnitude or Intensity</td><td>Direct and disproportionately high and adverse effects on environmental justice communities (as defined by EO 12898) that cannot be fully mitigated.</td><td rowspan="3">Effect that is potentially significant, but with mitigation is less than significant at the programmatic level.</td><td>Direct effects on environmental justice communities (as defined by EO 12898) that are not disproportionately high and adverse, and therefore do not require mitigation.</td><td>No direct effects on environmental justice communities, as defined by EO 12898.</td></tr>
<tr><td>Geographic Extent</td><td>Effects realized within counties at the Census Block Group level.</td><td>Effects realized within counties at the Census Block Group level, as opposed to throughout the state or territory.</td><td>Effects realized within counties at the Census Block Group level.</td></tr>
<tr><td>Duration or Frequency</td><td>Persists during the life of the project.</td><td>Persists for as long as the entire construction phase or a portion of the operations phase.</td><td>NA</td></tr>
</table>

NA = Not Applicable

14.2.10.3. Description of Environmental Concerns

Effects Associated with Other Resource Areas that have a Disproportionately High and Adverse Impact on Low-Income Populations and Minority Populations

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (Executive Office of the President, 1994), and guidance from CEQ, require federal agencies to evaluate potential human health and environmental effects on environmental justice populations. Specifically, "Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment." (CEQ, 1997) Thus, effects associated with other resource areas are of interest from an environmental justice perspective. This includes Human Health and Safety, Cultural Resources, Socioeconomics, Noise and Vibrations, Aesthetics and Visual Resources, and other resources.

Potential concerns noted in the impact analyses for these resources include dust, noise, vibrations, traffic, and other adverse impacts of construction activities. New wireless communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013). See Socioeconomics Environmental Consequences for additional discussion. The presence and operation of large storage, staging, and launch/landing areas for deployable technologies could raise environmental justice concerns as described below. American Indian tribes are considered environmental justice populations (CEQ, 1997); thus, impacts on tribal cultural resources (for instance, due to construction) could be a concern from an environmental justice perspective.

Impacts are considered environmental justice impacts only if they are *both* "adverse" and "disproportionately high" in their incidence on environmental justice populations relative to the general population (CEQ, 1997). The focus in environmental justice impact assessments is always, by definition, on *adverse effects*. However, telecommunications projects, such as those proposed by FirstNet, could have beneficial effects. These effects may include better provision of police, fire, and emergency medical services; improvements in property values; and the generation of jobs and income. These impacts are considered in the Socioeconomics Environmental Consequences (Section 14.2.9).

Construction impacts are localized, and property value impacts of wireless telecommunications projects rarely extend beyond 300 meters (984 feet) of a communications tower (Bond, Sims, & Dent, 2013). In addition, impacts related to deployment are of short duration. The potential for significant environmental justice impacts from the FirstNet deployment activities would be limited. Most, but not all, of the FirstNet operational activities have very limited potential for impacts as these activities are limited in scale and short in their duration.

Before FirstNet deploys projects, additional site-specific analyses to identify specific environmental justice populations and assess specific impacts on those populations may be necessary. Such analyses could tier-off the methodology and results of this PEIS. The areas shown in the environmental justice screening map of Affected Environment (Section 14.1.10.4) as having moderate potential or high potential for environmental justice populations would particularly warrant further screening. As discussed in Section 14.1.10.3, Environmental Setting: Minority and Low-Income Populations, Tennessee's population has mostly lower percentages of minorities than the region or the nation. The state's poverty rate is slightly lower than the region's rate and is higher than the nation's rate. Tennessee has a high proportion of areas with high potential for environmental justice populations. The distribution of these high potential areas is fairly even across the state, but slightly less prevalent in the central portion of the state surrounding the Nashville area. High potential areas occur both within and outside of the 10 largest population concentrations. The distribution of areas with moderate potential for environmental justice populations is also fairly even across the state. Further analysis using the data developed for the screening analysis in Section 14.1.10.4, Environmental Justice Screening Results, may be useful. In addition, USEPA's EJSCREEN tool and USEPA's lists of environmental justice grant and cooperative agreement recipients may help identify local environmental justice populations (USEPA, 2015f) (USEPA, 2016i).

Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work. Analysts could use the evaluation presented below under "Activities with the Potential to Have Impacts" as a starting point. Analysts should bear in mind that any such activities that are problematic based on the adverse impact criterion of environmental justice may also have beneficial impacts on those same environmental justice communities.

14.2.10.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could deploy various types of facilities or infrastructure. Depending on the physical nature and location of FirstNet facilities or infrastructure and the specific action, some activities would result in potential impacts to environmental justice communities and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level, in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* at the programmatic level to environmental justice communities under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of fiber optic cable in existing conduit would be through existing hand holes, pulling vaults, junction boxes, huts, and POP structures. Activities at these small entry points would be limited and temporary and thus are not likely to produce perceptible changes affecting any surrounding communities. Therefore, they would have *no impact* on environmental justice communities at the programmatic level.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting of dark fiber would be conducted electronically through existing infrastructure, and therefore would have *no impacts* to environmental justice. If physical access were required to light dark fiber, it would likely be through existing hand holes, pulling vaults, junction boxes, huts, and similar existing structures, with *no impact* on environmental justice communities at the programmatic level.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the deployment of such devices and equipment would not involve new ground disturbance, there would be no impacts to environmental justice communities at the programmatic level. Impacts associated with satellite-enabled devices requiring construction activities are addressed below.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact environmental justice at the programmatic level, it is anticipated that this activity would have *no impact* on environmental justice communities.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to environmental justice for the Preferred Alternative would encompass a range of impacts that could occur as a result of disturbance to communities from construction activities, such as noise, vibrations, dust, and traffic. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential impacts to environmental justice communities include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: New fiber optic cable installation usually requires construction activities such as trenching, plowing (including vibratory plowing), or directional boring, as well as construction of hand holes, pulling vaults, junction boxes, huts, and POP structures. These activities could temporarily generate noise, vibrations,

and dust, or disrupt traffic. If such impacts occur disproportionately to environmental justice communities, they would be considered environmental justice impacts.

- New Build – Aerial Fiber Optic Plant: Pole/structure installation could temporarily generate noise, vibrations,and dust, or disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would not impact environmental justice because there would be no ground disturbance or other impacts associated with this activity that would adversely impact communities. Associated onshore activities occurring at existing facilities such as staging of equipment and materials, or connection of cables, would be small in scale and temporary; thus, they would not impact environmental justice communities. Construction of new landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable could temporarily generate noise, vibrations, and dust, or disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts, there would be no adverse impacts on surrounding communities, and thus no potential for environmental justice impacts. Installation of optical transmission equipment or centralized transmission equipment requiring construction of new utility poles, hand holes, pulling vaults, junction boxes, huts, and POP structures could temporarily generate noise, vibrations, and dust, or disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures, such as generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads, or access roads requires construction activities that could temporarily generate noise, vibrations, and dust, or disrupt traffic. New communication towers sometimes have adverse impacts on nearby property values (Bond, Sims, & Dent, 2013). (See Socioeconomics Environmental Consequences for additional discussion.) If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would include mounting or installing equipment (such as antennas) on an existing facility. This activity would be small in scale, temporary, and highly unlikely to produce adverse human health or environmental impacts on the surrounding community. Thus, it would not impact environmental justice communities. If collocation requires construction for additional power units, structural hardening, and physical security measures, the construction activity could temporarily generate noise, vibrations, and dust and disrupt

traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

- o Deployable Technologies: COWs, COLTs, and SOWs and aerial deployable technologies require storage, staging, and (for aerial deployables) launch and landing areas. To the extent such areas require new construction, noise and dust could be temporarily generated, and traffic could be disrupted. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

In general, the impact from the abovementioned activities would be short-term and could potentially involve objectionable dust, noise, vibrations, traffic, or other localized impacts due to construction activities. In some cases, these effects and aesthetic effects could potentially impact property values, particularly from new towers. These impacts are expected to be *less than significant* at the programmatic level, but are problematic from an environmental justice perspective if they occur disproportionately in environmental justice communities. Since environmental justice impacts occur at the site-specific level, analyses of individual proposed projects would help determine potential impacts to specific environmental justice communities Furthermore, site-specific analysis could evaluate site conditions and the impacts of the type of deployment, and could satisfy requirements associated with any other permits or permissions necessary to perform the work. BMPs and mitigation measures may be required to address potential impacts to environmental justice communities at the site-specific level. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of primarily of routine maintenance and inspection of fixed infrastructure. It is anticipated that such activities would not result in environmental justice impacts, as the intensity of these activities would be low (low potential for objectionable effects such as noise, vibrations, and dust) and their duration would be very short. Routine maintenance and inspection would not adversely affect property values, for the same reasons. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment activities that involve construction.

Impacts are expected to be *less than significant* at the programmatic level given the short-term nature and limited geographic scope for individual activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.10.5. Alternatives Impact Assessment

The following section assesses potential impacts to environmental justice associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to environmental justice communities resulting from implementation of this alternative could be as described below.

Deployment Impacts

As explained above, deployable technologies such as COWs, COLTs, and SOWs, along with aerial deployable technologies, could require storage, staging, and launch/landing areas. To the extent such areas require new construction, noise, vibrations, and dust could be generated temporarily, and traffic could be disrupted. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts. *Impacts are expected to be less than significant* at the programmatic level because they would be temporary in nature. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

The ongoing presence of facilities for housing and maintaining deployable technologies may have adverse aesthetic aspects (e.g., large areas of pavement and large numbers of parked vehicles) that could negatively affect the value of surrounding properties. In addition, equipment maintenance activities at such facilities may temporarily generate noise, vibrations, and operational activities may generate traffic. These effects may be adverse in themselves, and may impact property values. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts. Impacts are expected to be *less than significant* at the programmatic level as operations are expected to be temporary in nature. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed. Therefore, there would be no associated construction or installation activities to deploy wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to environmental justice communities at the programmatic level as a result of the No Action

Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.10, Environmental Justice.

14.2.11. Cultural Resources

14.2.11.1. Introduction

This section describes potential impacts to cultural resources in Tennessee associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.11.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on cultural resources were evaluated using the significance criteria presented in Table 14.2.11-1. The categories of impacts are defined at the programmatic level as an *adverse effect; mitigated adverse effect; effect, but not adverse;* and *no effect*. These impact categories are comparable to those defined in *36 CFR § 800*, Secretary of Interior's Standards and Guidelines for Archaeology and Historic Preservation (NPS 1983), and the United States (U.S.) National Park Service's *National Register Bulletin: How to Apply the National Register Criteria for Evaluation* (NPS, 2002). Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to cultural resources addressed in this section are presented as a range of possible impacts.

Table 14.2.11-1: Effect Significance Rating Criteria for Cultural Resources at the Programmatic Level

Type of Effect	Effect Characteristics	Effect Level			
		Adverse Effect	Mitigated Adverse Effect[a]	Effect, but not Adverse	No Effect
Physical damage to and/or destruction of historic properties[b]	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties.	*Adverse effect* that has been procedurally mitigated through Section 106 process.	Effects to a non-contributing portion of a single or many historic properties.	No direct effects to historic properties.
	Geographic Extent	Direct effects Area of Potential Effect (APE).		Direct effects APE.	Direct effects APE.
	Duration or Frequency	Permanent direct effects to a contributing portion of a single or many historic properties.		Permanent direct effects to a non-contributing portion of a single or many historic properties.	No direct effects to historic properties.
Indirect effects to historic properties (i.e., visual, noise, vibration, atmospheric)	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties.	*Adverse effect* that has been procedurally mitigated through Section 106 process.	Effects to a contributing or non-contributing portion of a single or many historic properties.	No indirect effects to historic properties.
	Geographic Extent	Indirect effects APE.		Indirect effects APE.	Indirect effects APE.
	Duration or Frequency	Long-term or permanent indirect effects to a single or many historic properties.		Infrequent, temporary, or short- or long-term or permanent indirect effects to a single or many historic properties.	No indirect effects to historic properties.
Loss of character defining attributes of historic properties	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties.	*Adverse effect* that has been procedurally mitigated through Section 106 process.	Effects to a non-contributing portion of a single or many historic properties.	No direct or indirect effects to historic properties.
	Geographic Extent	Direct and/or indirect effects APE.		Direct and/or indirect effects APE.	Direct and/or indirect effects APE.

Type of Effect	Effect Characteristics	Effect Level			
		Adverse Effect	**Mitigated Adverse Effect**[a]	**Effect, but not Adverse**	**No Effect**
	Duration or Frequency	Long-term or permanent loss of character defining attributes of a single or many historic properties.		Infrequent, temporary, or short-term changes to character defining attributes of a single or many historic properties.	No direct or indirect effects to historic properties.
Loss of access to historic properties	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties.	*Adverse effect* that has been procedurally mitigated through Section 106 process.	Effects to a non-contributing portion of a single or many historic properties.	No segregation or loss of access to historic properties.
	Geographic Extent	Any area surrounding historic properties that would cause segregation or loss of access to a single or many historic properties.		Any area surrounding historic properties that could cause segregation or loss of access to a single or many historic properties.	No segregation or loss of access to historic properties.
	Duration or Frequency	Long-term or permanent segregation or loss of access to a single or many historic properties.		Infrequent, temporary, or short-term changes in access to a single or many historic properties.	No segregation or loss of access to historic properties.

NA = Not Applicable
[a] Whereas mitigation measures for other resources discussed in this PEIS may be developed to achieve an impact that is "*Less than Significant with Mitigation Measures Incorporated*," historic properties are considered to be "non-renewable resources," given their very nature. As such, any and all unavoidable *adverse effects* to historic properties, per Section 106 of the NHPA (as codified in 36 CFR Part 800.6), would require FirstNet to consult with the SHPO/THPO and other consulting parties, including American Indian tribes and Native Hawaiian organizations, to develop appropriate mitigation.
[b] Per NHPA, a "historic property" is defined as any district, archaeological site, building, structure, or object that is either listed or eligible for listing in the NRHP. Cultural resources present within a project's APE are not historic properties if they do not meet the eligibility requirements for listing in the NRHP. Sites of religious and/or cultural significance refer to areas of concern to American Indian tribes and other consulting parties that, in consultation with the respective party(ies), may or may not be eligible for listing in the NRHP. These sites may also be considered TCPs. Therefore, by definition, these significance criteria only apply to cultural resources that are historic properties, significant sites of religious and/or cultural significance, or TCPs. For the purposes of brevity, the term historic property is used here to refer to either historic properties, significant sites of religious and/or cultural significance, or TCPs.

14.2.11.3. Description of Environmental Concerns

Physical Damage to and/or Destruction of Historic Properties

One of the primary environmental concerns during deployment activities is damage to or destruction of historic and cultural resources. Deployment involving ground disturbance has the potential to damage or destroy archaeological sites, and the attachment of communications equipment to historic building and structures has the potential to cause damage to features that are historically significant.

Based on the impact significance criteria presented in Table 14.2.11-1, at the programmatic level, direct deployment impacts could have potentially *adverse effects* if FirstNet's deployment locations were in areas with moderate to high probabilities for archaeological deposits, within historic districts, or at historic properties. To the extent practicable, FirstNet would attempt to minimize activities in areas with archaeological deposits or within historic districts. However, given that archaeological sites and historic properties are present throughout Tennessee, some deployment activities may be in these same areas, in which case BMPs (see Chapter 16) would help avoid or minimize the potential impacts.

Indirect Effects to Historic Properties (i.e., visual, noise, vibration, atmospheric)

The potential for indirect effects to historic properties would be present during deployment of the proposed facilities/infrastructure and during trenching, grading, and/or foundation excavation activities. Indirect effects include the introduction of visual, noise, atmospheric, and/or vibration effects that diminish a property's historic integrity. The greatest likelihood of potentially *adverse effects* from indirect effects would be from the deployment of equipment in areas that would cause adverse visual effects to historic properties. To the extent practicable, FirstNet would attempt to minimize activities in areas within or adjacent to historic districts or properties.

Loss of Character Defining Attributes of Historic Properties

Deployment of FirstNet equipment has the potential to cause the loss of character defining attributes of historic properties; such attributes are the features of historic properties that define their NRHP eligibility. Examples of such impacts would be the loss of integrity of archaeological sites through ground disturbing activities, and direct impacts to historic buildings from equipment deployment that adversely alter historic architectural features. *Adverse effects* such as these could be avoided or minimized through BMPs and mitigation measures, as practicable and feasible (see Chapter 16).

Loss of Access to Historic Properties

The deployment of equipment requiring a secure area has the potential to cause the loss of access to historic properties. The highest potential for this type of significant impact would be from the deployment of equipment in secure areas that impact the access to sites of cultural importance to American Indians. It is anticipated that FirstNet would identify potential impacts to such areas by conducting research on particular areas and through the NHPA consultation process, and would minimize deployment activities that would cause such loss of access.

14.2.11.4. Potential Effects of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Effects

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to cultural resources, while others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level, in a range of *no effects* to potentially *adverse effects* depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Effect at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to cultural resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no effect* on cultural resources at the programmatic level since the activities that would be conducted at these small entry and exit points are not likely to produce impacts.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no effect* on cultural resources at the programmatic level. If required, and if done in existing huts with no ground disturbance, installation of new associated equipment would also have *no effect* oncultural resources because there would be no ground disturbance and no perceptible visual changes.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would have *no effect* on cultural resources because those activities would not require ground disturbance or create new perceptible visual effects.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch

vehicle would be very unlikely to impact cultural resources, it is anticipated that this activity would have *no effect* on cultural resources.

Activities with the Potential to Have Effects at the Programmatic Level

Potential deployment-related impacts to cultural resources as a result of implementation of the Preferred Alternative would encompass a range of effects that could occur as a result of ground disturbance activities, including destruction of cultural or historic artifacts. The types of infrastructure deployment activities that could be part of the Preferred Alternative and result in potential effects on cultural resources include the following:

- Wired Projects
    - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POP, huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to cultural resources. Soil disturbance and heavy equipment use associated with plowing, trenching, or directional boring as well as land/vegetation clearing, excavation activities, and landscape grading associated with construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in the disturbance of archaeological sites, and the associated structures could have visual effects on historic properties.
    - New Build – Aerial Fiber Optic Plant: Ground disturbance during the installation of new utility poles and the use of heavy equipment during the installation of new utility poles and hanging of cables could result in the disturbance of archaeological sites, and the associated structures could have visual effects on historic properties.
    - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water could impact cultural resources, as coastal areas, shorelines and creekbanks in Tennessee have the potential to contain prehistoric archaeological sites, as well as sites associated with the state's significant maritime history since European colonization, such as shipwrecks. Impacts to cultural resources could also potentially occur as result of the construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable. This could result in the disturbance of archaeological and historical sites (archaeological deposits are frequently associated with bodies of water), and the associated network structures could have visual effects on historic properties.
    - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no effect* on cultural resources. However, there could be potentially *adverse effects* on cultural resources if installation of transmission equipment required grading or other ground disturbance to install small boxes or huts, or access roads.. Ground disturbance could impact archaeological sites, and the associated structures could have visual effects on historic properties.
    - Collocation on Existing Aerial Fiber Optic Plant: Soil excavation and excavated material placement during the replacement of poles and structural hardening could result in direct and indirect effects to cultural resources, although any effects to access would be short-

term. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in direct and indirect effects to cultural resources.

- Wireless Projects
  - New Wireless Communication Towers: Deployment of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in impacts to historic properties. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the deployment of new wireless towers and associated structures or access roads, could result in the disturbance of archaeological sites. The deployment of new wireless communication towers and their associated structures could result in visual impacts to historic properties or the loss of access to historic properties.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower could result in impacts to historic properties. Ground disturbance activities could result in disturbance of archaeological sites, and the deployment of collocated equipment could result in visual impacts or physical damage to historic properties, especially in urban areas (such as Memphis and Nashville) that have larger numbers of historic buildings.
  - Deployable Technologies: Implementation of deployable technologies could result in potential impacts to cultural resources if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. In addition, impacts to historic properties could occur if the deployment is long-term, or if the deployment involves aerial technologies with the potential for visual or other indirect impacts.

In general, the abovementioned activities could potentially involve ground disturbance, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential effects on cultural resources associated with deployment could include physical damage to or destruction of historic properties, indirect effects including visual effects, the loss of access to historic properties, or the loss of character-defining features of historic properties. These activities could affect, but not adversely affect, cultural resources at the programmatic level as the potential *adverse effects* would be temporary and limited to the area near individual Proposed Action deployment site. Additionally, some equipment proposed to be installed on or near properties that are listed or eligible for listing on the NRHP could potentially be removed. Additionally, as appropriate, FirstNet would engage in consultation as required under Section 106 of the NHPA. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Effects

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major communications infrastructure replacement as part of ongoing system maintenance would result in effects similar to the abovementioned deployment effects. It is anticipated that there would be *no effect* to cultural resources at the programmatic level associated with routine inspections of the Preferred Alternative. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors, or if the acceptable load of the surface is exceeded, ground disturbance impacts on archaeological sites could result as explained above. These potential effects would be associated with ground disturbance or modifications of properties; however, due to the small-scale of expected activities, these actions could affect, but would not likely adversely affect, cultural resources at the programmatic level. In the event that maintenance and inspection activities occur off existing roads, FirstNet would engage in consultation as required under Section 106 of the NHPA. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.11.5. Alternatives Effect Assessment

The following section assesses potential effects oncultural resources associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential effects on cultural resources as a result of implementation of this Alternative could be as described below.

Deployment Effects

As explained above, implementation of deployable technologies could result in effects on cultural resources if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in effects on archaeological sites. These activities could affect, but not adversely affect, cultural resources at the programmatic level due to the limited amount of expected ground disturbing activities and the short term nature of deployment activities. However, in the event that land/vegetation clearing is required, FirstNet would engage in consultation as required under Section 106 of the NHPA. Chapter 16, BMPs and Mitigation Measures, provides a listing of

BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Effects

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the deployment impacts, it is anticipated that there would be effects, but no *adverse effects* to historic properties at the programmatic level associated with implementation/running of the deployable technology. No *adverse effects* would be expected to either site access or viewsheds due to the temporary nature of expected activities. As with the Preferred Alternative, it is anticipated that there would be *no effects* to cultural resources at the programmatic level associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors, effects on archaeological sites could occur; however, in the event that this is required, FirstNet would engage in consultation as required under Section 106 of the NHPA. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no effects* on cultural resources as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.11, Cultural Resources.

14.2.12. Air Quality

14.2.12.1. Introduction

This section describes potential impacts to Tennessee's air quality from deployment and operation of the Proposed Action and Alternatives. Mitigation measures, as defined through permitting and/or consultation with the appropriate resource agency, would be implemented as part of deployment and operation of the Proposed Action to help avoid or reduce potential impacts to air quality. Implementation of best management practices (BMPs), as practicable or feasible, could further reduce the potential for impacts. Both mitigation measures and BMPs are discussed in Chapter 16, BMPs and Mitigation Measures.

14.2.12.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on Tennessee's air quality were evaluated using the significance criteria presented in Table 14.2.12-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined at the programmatic level as *potentially significant, less than significant with mitigation measures incorporated, less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact. Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to Tennessee's air quality addressed in this section are presented as a range of possible impacts.

Table 14.2.12-1: Impact Significance Rating Criteria for Air Quality at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Increased air emissions	Magnitude or Intensity	Emissions would prevent progress toward meeting one or more NAAQS in nonattainment areas. Emissions in attainment or maintenance areas would cause an exceedance for any NAAQS. Emissions exceed one or more major source permitting thresholds. Projects do not conform to SIP.	Effect that is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	Negligible emissions would occur for any pollutant within an attainment area, but would not cause a NAAQS exceedance and would not trigger major source permitting.	Emission increases would be infrequent or absent, mostly immeasurable; projects conform to SIP.
	Geographic Extent/Context	NA		NA	NA
	Duration or Frequency	Permanent or long-term		Short term	Temporary

NA = Not Applicable

14.2.12.3. Description of Environmental Concerns

The Proposed Action has the potential to generate air pollutant emissions. These emissions could be above and beyond what is typically generated in a given area and may alter ambient air quality. Deployment activities may involve the use of vehicles, heavy equipment, and other equipment that could emit exhaust and create fugitive dust in localized areas. During operations, routine maintenance and other use of generators at tower facilities may emit exhaust for specific durations (maintenance) or unpredictable timeframes (if power is lost to a site, for example). Impacts are likely to be *less than significant* at the programmatic level due to the mobile nature of the sources and the temporary and short-term duration of deployment activities. Although unlikely, the emissions of criteria pollutants could impair the air quality of the region and potentially affect human health. Potential impacts to air quality from emissions may occur in areas where the current air quality exceeds, or has a history of exceeding, one or more NAAQS. Areas exist in Tennessee that are in maintenance or nonattainment for one or more criteria pollutants (see Section 14.1.12, Air Quality, and Figure 14.1.12-1). The majority of the counties in Tennessee are designated as nonattainment or maintenance areas for zero NAAQS pollutants. There are 17 counties within Tennessee designated as nonattainment or maintenance areas for one or more of the following NAAQS pollutants (Table 14.1.12-6): CO, lead, particulate matter (PM), SO_2, and ozone.

Based on the significance criteria presented in Table 14.2.12-1, air emission impacts would likely be *less than significant* at the programmatic level given the size and nature of the majority of the proposed deployment activities. The majority of FirstNet's deployment activities would not be located in sensitive areas nor would a large number of emission sources be deployed/operated long-term in the same area from fixed or mobile sources or construction activities. *Less than significant* emissions could occur at the programmatic level for any of the criteria pollutants within attainment areas in Tennessee; however, NAAQS exceedances are not anticipated. Given that nonattainment areas are present throughout Tennessee (Figure 14.1.12-1), and because infrastructure could be deployed in these areas, BMPs and mitigation measures (see Chapter 16, BMPs and Mitigation Measures) could help avoid or minimize potential air quality impacts. In addition, it is anticipated that any air pollution increase due to deployment would likely be short-term with pre-existing air quality levels generally achieved after some months (typically less than a year, and could be as short as a few hours or days for some activities such as pole construction).

14.2.12.4. Potential Impacts of the Preferred Alternative at the Programmatic Level

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction, deployment, and operation activities.

Potential Deployment and Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementing the Preferred Alternative could result in deploying various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to air quality and others would not. The potential impacts could range from *no impacts* to *less than significant* impacts at the programmatic level depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to air quality at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Activities associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit. Gaining access to the conduit and installing the cable may result in minor disturbance at entry and exit points; however, this activity would be temporary and infrequent, and is not expected to produce any perceptible changes in air emissions.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would require no construction and have no short- or long-term emissions to air quality because it would create no new sources of emissions.
- Satellites and Other Technologies
  - Satellite Enabled Devices and Equipment: The duration of construction activities associated with installing permanent equipment on existing structures would most likely be short-term. It is anticipated that insignificant concentrations of criteria pollutants would be emitted during installment of this equipment from the use of machinery. Deployment and operation of satellite-enabled devices and portable equipment are expected to have minimal to *no impact* at the programmatic level on ambient air quality concentrations.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact air quality resources, it is anticipated that this activity would have *no impact* on those resources at the programmatic level.

Activities with Potential Impacts to Have Impacts at the Programmatic Level

Construction, deployment, and operation activities related to the Preferred Alternative could impact air quality by generating various quantities of criteria and air pollutant emissions. It is expected that such impacts would be *less than significant* at the programmatic level due to the shorter duration and localized nature of the activities. The types of infrastructure deployment scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to air quality include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber as well as land/vegetation clearing, excavation activities, and landscape grading could result in fugitive dust and products of combustion from the use of vehicles and heavy equipment.
  - New Build – Aerial Fiber Optic Plant: The use of heavy equipment during the installation of new poles and hanging cables, as well as constructing access roads, POP huts, or other associated facilities to house plant equipment could result in products of combustion from the use of vehicles and machinery, as well as fugitive dust emissions from site preparation.
  - Collocation on Existing Aerial Fiber Optic Plant: Excavation equipment used during pole replacement, and other heavy equipment used for structural hardening or reinforcement, could result in products of combustion from the use of vehicles and heavy equipment, as well as fugitive dust from site preparation.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water could generate products of combustion from vessels used to lay the cable. In addition, the construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable could result in products of combustion and fugitive dust from heavy equipment used for grading, foundation excavation, or other ground disturbing activities.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Emissions associated with the installation of optical transmission or centralized transmission equipment would be limited to the short-term, temporary use of vehicle and construction equipment. Long-term impacts are unlikely, as the power requirements for optical networks are relatively low.
- Wireless Projects
  - New Wireless Communication Towers: Activities associated with installing new wireless towers and associated structures (e.g., generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in products of combustion. Operating vehicles and other heavy equipment, running generators while conducing excavation activities, and landscape grading to install new wireless towers and associated structures or access roads could result in products of combustion and fugitive dust.
  - Collocation on Existing Wireless Tower, Structure, or Building: Vehicles and equipment used to mount or install equipment, such as antennas or microwave dishes, on an existing tower could impact air quality. If the delivery of additional power units, structural hardening, and physical security measures required grading or excavation, then exhaust and fugitive dust from heavy equipment used for these activities could also result in increased air emissions.

- Deployable Technologies
  - The type of deployable technology used would dictate the types of air pollutants generated. For example, mobile equipment deployed via heavy trucks could generate products of combustion from the internal combustion engines associated with the vehicles and onboard generators. These units may also generate fugitive dust depending on the type of road traveled during deployment (i.e., paved versus unpaved roads). Aerial platforms (e.g., UASs or other aircraft) would generate pollutants during all phases of flight.

In general, the pollutants of concern from the abovementioned activities would be products of combustion from burning fossil fuels in internal combustion engines and fugitive dust from site preparation activities and vehicles traveling on unpaved road surfaces. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the construction impacts. These impacts are anticipated to be *less than significant* at the programmatic level due to the limited nature of the deployment. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major communications infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be *less than significant* impacts to air quality at the programmatic level associated with routine inspections of the Preferred Alternative due to the limited nature of the activity. If usage of heavy equipment as part of routine maintenance or inspections occurs off established access roads or corridors additional air quality impacts may occur; however, they would be *less than significant* at the programmatic level as they would still be limited in nature. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.12.5. Alternatives Impact Assessment

The following section assesses potential impacts to air quality associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific equipment associated with the

Deployable Technologies Alternative could include heavy trucks with onboard generators, aerial vehicles (e.g., UASs or other aircraft), and ground support vehicles and other equipment for aerial deployment. The stand-alone Deployable Technologies Alternative differs from the Preferred Alterative in the number of mobile and aerial vehicles likely to deploy, the distances traveled from storage locations, and the duration of deployment. The potential impacts to air quality are as follows:

Potential Deployment and Operation Impacts to Air Quality

Implementing deployable technologies could result in products of combustion from mobile equipment deployed via heavy trucks using internal combustion engines associated with the vehicles and onboard generators. While a single deployable vehicle may have an insignificant impact, multiple vehicles operating for longer periods, in close proximity, may have a greater cumulative impact, although this is expected to be *less than significant* at the programmatic level based on the defined significance criteria, since activities would be temporary and short-term. These vehicles may also produce fugitive dust if traveling on unpaved roads. Some staging or landing areas (depending on the type of technology) may require excavation, site preparation, and paving. Heavy equipment used for these activities could emit products of combustion as a result of burning fossil fuels in internal combustion engines. The deployment and operation of aerial technology is anticipated to generate pollutants during all phases of flight, except for balloons. The products of combustion from ground support vehicles, as well as the duration of ground support operations and travel between storage and deployment locations would dictate the concentrations and associated impacts. Additionally, routine maintenance and inspections of the deployable technologies are anticipated to be *less than significant* at the programmatic level, given that these activities are of low-intensity and short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, FirstNet would not deploy the NPSBN and there would be *no impact* to ambient air quality. By not deploying NPSBN, FirstNet would avoid generating emissions from construction, installation, or operation of wired, wireless, or deployable infrastructure or technologies; satellites; and other technologies.

14.2.13. Noise and Vibrations

14.2.13.1. Introduction

This section describes potential noise and vibration impacts from construction, deployment, and operation of the Proposed Action and Alternatives in Tennessee. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.13.2. Impact Assessment Methodology and Significance Criteria

The noise and vibration impacts of the Proposed Action were evaluated using the significance criteria presented in Table 14.2.13-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined, at the programmatic level, as *potentially significant, less than significant with mitigation measures incorporated, less than significant, or no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential noise and vibation impacts to Tennessee addressed in this section are presented as a range of possible impacts.

Table 14.2.13-1: Impact Significance Rating Criteria for Noise and Vibrations at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	Less than Significant with BMPs and Mitigation Measures Incorporated	Less than Significant	No Impact
Increased noise and vibration levels	Magnitude or Intensity	Noise levels would exceed typical noise levels from construction equipment and generators. Noise levels at noise sensitive receptors (such as residences, hotels/motels/inns, hospitals, and recreational areas) would exceed 55 dBA or specific state noise limits. Noise levels plus baseline noise levels would exceeds 10 dBA increase from baseline noise levels (i.e., louder). Project noise levels near noise receptors at National Parks would exceed 65 dBA.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Noise levels resulting from project activities would exceed natural sounds, but would not exceed typical noise levels from construction equipment or generators.	Natural sounds would prevail. Noise generated by the action (whether it be construction or operation) would be infrequent or absent, mostly immeasurable.
	Geographic Extent/Context	County or local.		County or local.	County or local.
	Duration or Frequency	Permanent or long-term.		Short term.	Temporary.

dBA = A-weighted decibel(s); VdB = vibration decibel(s)

14.2.13.3. Description of Environmental Concerns

Increased Noise and Vibration Levels

The Proposed Action has the potential to generate noise and vibrations during construction and operation of various equipment used for deployment. These noise and vibration levels could be above what is typically generated in a given area and may alter the ambient acoustical environment. If significant, the noise could cause impacts on residential areas, or other facilities that are sensitive to noise, such as churches, hospitals, or schools. The construction activities for deploying some of the various equipment evaluated under the Proposed Action could cause short-term impacts to nearby populations. However, it is likely that there would be less long-term effects from operational use of the proposed equipment (see Section 14.1.13, Noise).

Based on the significance criteria presented in Table 14.2.13-1, noise and vibration impacts at the programmatic level would likely be *less than significant* given the size and nature of the majority of the proposed deployment activities. The majority of FirstNet's deployment activities would not be located in sensitive areas nor would a large number of noise and vibration sources be deployed/operated long-term in the same area. Noise and vibration levels from deployment activities are not expected to exceed typical noise and vibration levels for short-term/temporary construction equipment or generators.

To the extent practicable, FirstNet would attempt to mitigate or minimize noise and vibration effects during construction or operation. BMPs and mitigation measures could help to limit impacts on nearby noise or vibration-sensitive receptors. However, given that much of the construction and operation of the Proposed Action would often occur in populated areas, FirstNet may not be able to completely avoid noise or vibration impacts.Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction, deployment, and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementing the Preferred Alternative could result in deploying various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential noise and vibration impacts and while others would not.

In addition, the same type of Proposed Action Infrastructure could result in a range *of no impacts* to *less than significant impacts* depending on the deployment scenario or site-specific conditions. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no noise impacts under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Noise and vibrations generated by equipment required to install fiber would be infrequent and of short duration, and is not expected to create perceptible impacts.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would require no construction or installation activities, and therefore would have no noise or vibration impacts.
- Satellites and Other Technologies
  - Satellite Enabled Devices and Equipment: The duration of construction activities associated with installing permanent equipment on existing structures would most likely be short-term. It is anticipated that insignificant levels of noise and vibrations would be emitted during installment of this equipment. Noise and vibrations caused by these construction and installation activities would be similar to other construction activities in the area, such as the installation of cell phone towers or other communication equipment. Deployment and operation of satellite-enabled devices and equipment are expected to have minimal to *no impact* on the noise or vibration-sensitive resources at the programmatic level.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it may include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact noise or vibration-sensitive resources, it is anticipated that this activity would have *no impact* at the programmatic level.

Activities with the Potential for Impacts at the Programmatic Level

Construction, deployment, and operation activities related to the Preferred Alternative could create noise impacts from either the construction or operation of the infrastructure. The types of infrastructure deployment scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to noise and vibration include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs , huts, or other associated facilities or hand-holes to access fiber as well as land/vegetation clearing, excavation activities, and landscape grading could result in high noise and vibration levels from the use of heavy equipment and machinery.
  - New Build – Aerial Fiber Optic Plant: The use of heavy equipment during the installation of new poles and hanging cables, as well as constructing access roads, POP huts, or other

associated facilities to house plant equipment would be short-term and could result in increased noise and vibration levels from the use of vehicles and machinery.
  - Collocation on Existing Aerial Fiber Optic Plant: Excavation equipment used during potential pole replacement, and other heavy equipment used for structural hardening or reinforcement, could result in temporary increase in noise and vibration levels from the use of heavy equipment and machinery.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Installation of new associated huts or equipment, if required, could result in short-term and temporarily higher noise and vibration levels if the activity required the use of heavy equipment for grading or other purposes.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water could generate noise if vessels are used to lay the cable. In addition, the construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable could result in short-term and temporarily increased noise and vibration levels to local residents and other noise and vibration-sensitive receptors from heavy equipment used for grading, foundation excavation, or other ground disturbing activities.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Noise and vibrations associated with the installation of optical transmission or centralized transmission equipment would be limited to the short-term, temporary use of vehicle and construction equipment. Long-term impacts are unlikely, as the noise emissions from optical networks are relatively low and vibration impacts would not occur. Heavy equipment used to grade and construct access roads could generate increased levels of noise and vibrations over baseline levels temporarily.
- Wireless Projects
  - New Wireless Communication Towers: Activities associated with installing new wireless towers and associated structures (e.g., generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in localized construction noise and vibrations. Operating vehicles, other heavy equipment, and generators would be used on a short-term basis and could increase noise and vibration levels.
  - Collocation on Existing Wireless Tower, Structure, or Building: Vehicles and equipment used to mount or install equipment, or to grade or excavate additional land on sites for installation of equipment, such as antennas or microwave dishes on an existing tower, could impact the local noise environment temporarily. Vibration impacts are expected to be negligible.
  - Deployable Technologies: The type of deployable technology used would dictate the types of noise generated. For example, mobile equipment deployed via heavy trucks could generate noise and vibrations from the internal combustion engines associated with the vehicles and onboard generators. Aerial platforms (e.g., UASs or other aircraft, except balloons) generate noise and vibrations during all phases of flight, including takeoff, landing, and flight operations over necessary areas that could impact local noise and vibration-sensitive resources.

In general, noise and vibrations from the abovementioned activities would be products of site preparation, installation, and construction activities, as well as additional construction vehicles traveling on nearby roads and localized generator use. These impacts are expected to be *less than significant* at the programmatic level due to the temporary duration of deployment activities. Additionally, pre-existing noise and vibration levels would be achieved after some months (typically less than a year but could be a few hours for linear activities such as pole construction). Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

Operation activities associated with the Preferred Alternative would be *less than significant* at the programmatic level and similar to several of the deployment activities related to routine maintenance and inspection of the facilities because of the temporary nature of the activities which would not create new permanent sources of noise or vibration. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that potential noise and vibration impacts would be similar to or less than those described for the deployment activities. If usage of vehicles or heavy equipment as part of routine maintenance or inspections or onsite generator use occurs, potential noise and vibration impacts could result as explained above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.13.4. Alternatives Impact Assessment

The following section assesses potential noise and vibration impacts associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific equipment associated with the Deployable Technologies Alternative would be heavy trucks with onboard generators, aerial vehicles (e.g., UASs or other aircraft), and ground support vehicles and equipment for aerial deployment. The stand-alone Deployable Technologies Alternative differs from the Preferred Alterative in the number of mobile and aerial vehicles likely to deploy, the distances traveled from storage locations and the duration of deployment. The potential noise and vibration impacts are as follows:

Deployment Impacts

Implementing deployable technologies could result in noise and vibrations from mobile equipment deployed via heavy trucks, including not only onboard generators, but also the vehicles themselves. While a single deployable vehicle may have an insignificant impact, multiple vehicles operating for longer periods, in close proximity, may increase localized noise levels. Several vehicles traveling together could also create short-term noise and vibration impacts on residences or other noise-sensitive receptors as they pass by. With the exception of balloons, the deployment of aerial technology is anticipated to generate noise and vibrations during all phases of flight. Aerial technologies would have the highest level of noise and vibration impact if they are required to fly above residential areas, areas with a high concentration of noise and vibration-sensitive receptors (i.e., schools or churches), or over national parks or other areas where there is an expectation of quiet and serenity on their way to their final destinations. Residences near deployment areas for aerial technologies (i.e., airports or smaller airfields) could also be affected during takeoff and landing operations. Additionally, routine maintenance and inspections of the deployable technologies are anticipated to be *less than significant* at the programmatic level, given that these activities are of low-intensity and short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

Operation activities associated with the Deployable Technologies Alternative would be similar to several of the deployment activities related to routine maintenance and inspection of the facilities. Operation of generators could also generate noise and vibrations in the area. However, deployable technologies could be deployed to areas with few existing facilities, so noise impacts could be minimal in those areas. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that potential noise and vibration impacts would be the same as those described for the deployment activities. If usage of vehicles or heavy equipment as part of routine maintenance or inspections occurs, potential noise and vibration impacts could result as explained above.

Operational impacts from aerial technologies would include repeated flyovers by UAS vehicles while they are needed in the area. This could generate *less than significant* short-term impacts at the programmatic level on any residential areas or other noise and vibration-sensitive receptors under the flight path of these vehicles. However, once these operations cease, noise and vibration levels would quickly return to baseline levels. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, FirstNet would not deploy the NPSBN and there would be *no impact* to ambient noise or vibrations. By not deploying the NPSBN, FirstNet would avoid generating noise from construction, installation, or operation of wired, wireless, deployable infrastructure or satellites and other technologies. Noise and vibrations would therefore be the same as described in Section 14.1.9, Noise.

14.2.14. Climate Change

14.2.14.1. Introduction

This section describes potential impacts to climate and climate change-vulnerable resources in Tennessee associated with deployment and operation of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.14.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on climate and potential climate change impacts on the Proposed Action's installations and infrastructure were evaluated using the significance criteria presented in Table 14.2.14-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined, at the programmatic level, as *potentially significant, less than significant with mitigation measures incorporated, less than significant,* or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to climate and climate change-vulnerable resources addressed in this section are presented as a range of possible impacts.

CEQ requires the consideration of climate change from two perspectives. The first is the potential for impacts on climate change through GHG emissions resulting from the Proposed Action or alternatives. The second is related to the implications and possible effects of climate change on the environmental consequences of the Proposed Action or alternatives. This extends to the impacts of climate change on facilities and infrastructure that would be part of the Proposed Action or alternatives (CEQ, 2016).

In addition to the consideration of climate change's effects on environmental consequences, it also includes the impact that climate change may have on the projects themselves (CEQ, 2016). Projects located in areas that are vulnerable to the effects of climate change (e.g., sea level rise) may be at risk. Analysis of these risks through the NEPA process could provide useful information to the project planning to ensure these projects are resilient to the impacts of climate change.

Table 14.2.14-1: Impact Significance Rating Criteria for Climate Change at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Contribution to climate change through GHG emissions	Magnitude or Intensity	See discussion below in Section 14.2.14.5, Potential Impacts of the Preferred Alternative	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Only slight change observed.	No increase in greenhouse gas emissions or related changes to the climate as a result of project activities.
	Geographic Extent			Global impacts observed.	NA
	Duration or Frequency			Changes occur on a longer time scale. Changes cannot be reversed in the short term.	NA
Effect of climate change on FirstNet installations and infrastructure	Magnitude or Intensity	Climate change effects (such as sea level rise or temperature change) negatively impact FirstNet infrastructure.	Effect that is *potentially significant*, but with mitigation is *less than significant*.	Only slight change observed.	No measurable impact of climate change on FirstNet installations or infrastructure.
	Geographic Extent	Local and regional impacts observed.		Local and regional impacts observed.	NA
	Duration or Frequency	Long-term changes. Changes cannot be reversed in a short term.		Changes occur on a longer time scale. Changes cannot be reversed in the short term.	NA

NA = Not Applicable

14.2.14.3. Projected Future Climate

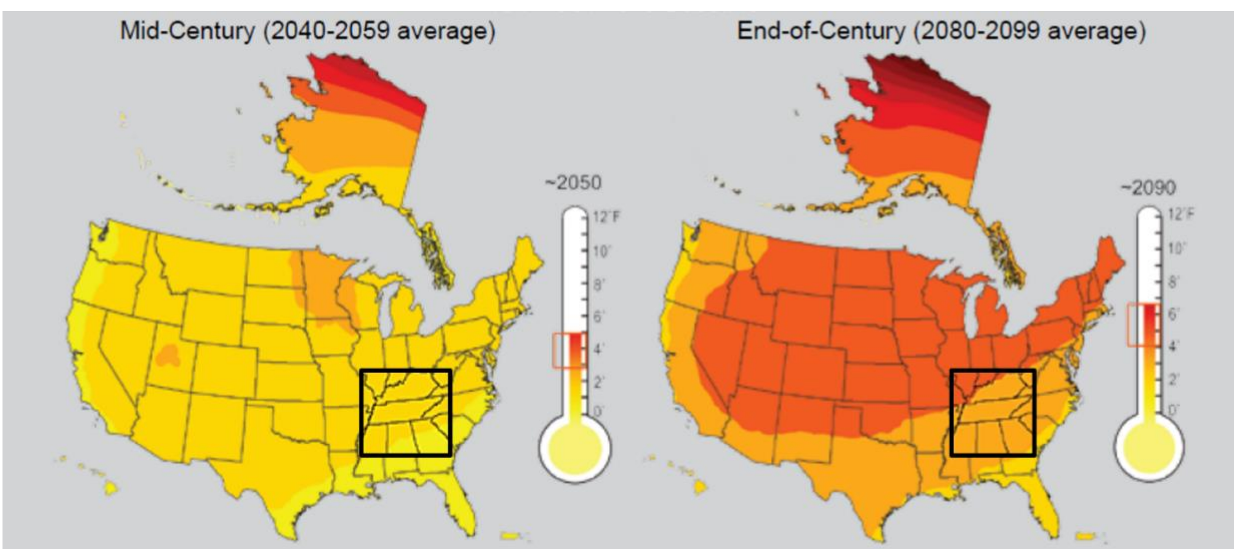
Climate model forecasts of future temperatures are highly dependent on emissions scenarios (low versus high), particularly in projections beyond 2050. There have been increasing numbers of days above 95 °F and nights above 75 °F, and decreasing numbers of extremely cold days since 1970 in the Southeast. Temperatures across this section of the United States are expected to increase during this century. Major consequences of warming include significant increases in the number of hot days, defined as 95 °F or above, and decreases in freezing events (USGCRP, 2014a).

Air Temperature

Figure 14.2.14-1 and Figure 14.2.14-2 illustrate the anticipated temperature changes for low and high GHG emission scenarios for Tennessee from a 1969 to 1971 baseline.

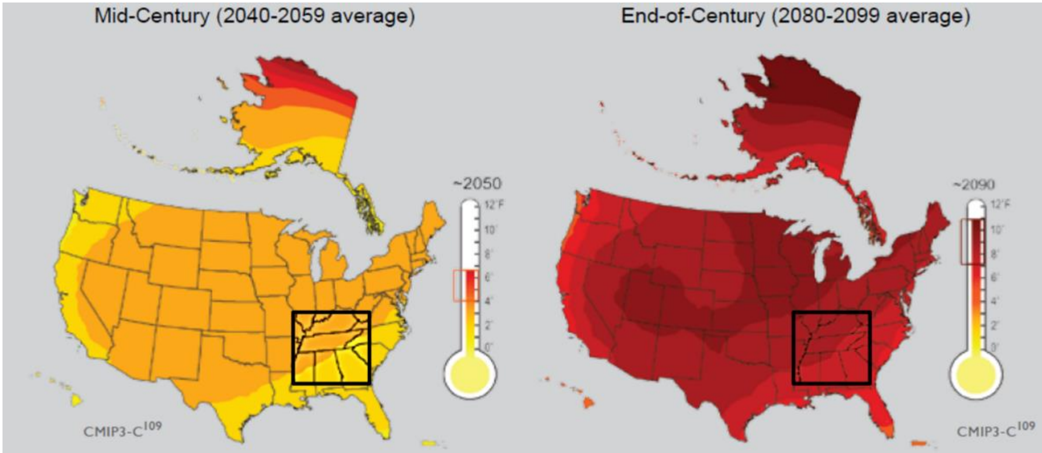
Cfa – Figure 14.2.14-1 shows that by mid-century (2040 to 2059), temperatures in Tennessee under a low emissions scenario would increase by approximately 4 °F, and by the end of the century (2080 to 2099) under a low emissions scenario temperatures in the entire state would increase by approximately 5 °F. (USGCRP, 2009)

Figure 14.2.14-2 shows that under a high emissions scenario for the period (2040 to 2059), temperatures would increase by approximately 5 °F for the majority of the state while a very small portion of the eastern portion of the state is expected to see temperature increases of 4 °F. Under a high emissions scenario for the period (2080 to 2099) in the Cfa region of Tennessee, temperatures would increase by approximately 9 °F in over half of the state while the eastern portion of the state is expected to have increases of 8 °F. (USGCRP, 2009)



Source: (USGCRP, 2009)

Figure 14.2.14-1: Tennessee Low Emission Scenario Projected Temperature Change



Source: (USGCRP, 2009)

Figure 14.2.14-2: Tennessee High Emission Scenario Projected Temperature Change

Precipitation

Predicting future precipitation patterns in the Southeast are much less certain that projections for temperature. The Southeast is located in the transition zone between projected wetter conditions to the north and drier conditions to the southwest, therefore, many of the model projections show only small changes relative to natural variations. However, many models do project drier conditions in the far southwest portion of the region and wetter conditions in the far northeast portion of the region. (USGCRP, 2014a)

Total seasonal snowfall has generally decreased in southern and some western areas although snow is melting earlier in the year and more precipitation is falling as rain versus snow. Overall snow cover has decreased in the Northern Hemisphere, due in part to higher temperatures that shorten the time snow spends on the ground. (USGCRP, 2014b)

In Tennessee, there is an expected increase of about 10 percent in the number of consecutive dry days under a low emissions scenarios by mid-century (2041 to 2070) as compared to the period (1971 to 2000). Under a high emissions scenario in the western portion of the state there is a projected increase of about 10 percent in the number of consecutive dry days and an increase of 20 percent in the eastern portion of the state. An increase in consecutive dry days could lead to drought. (USGCRP, 2014c)

Figure 14.2.14-3 and Figure 14.2.14-4 show predicted seasonal precipitation change for an approximate 30-year period of 2071 to 2099 compared to a 1970 to 1999 approximate 30-year baseline. Figure 14.2.14-3 show seasonal changes in a low emissions scenario, which assumes rapid reductions in emissions where rapid reductions means more than 70 percent cuts from current levels by 2050. (USGCRP, 2014c)

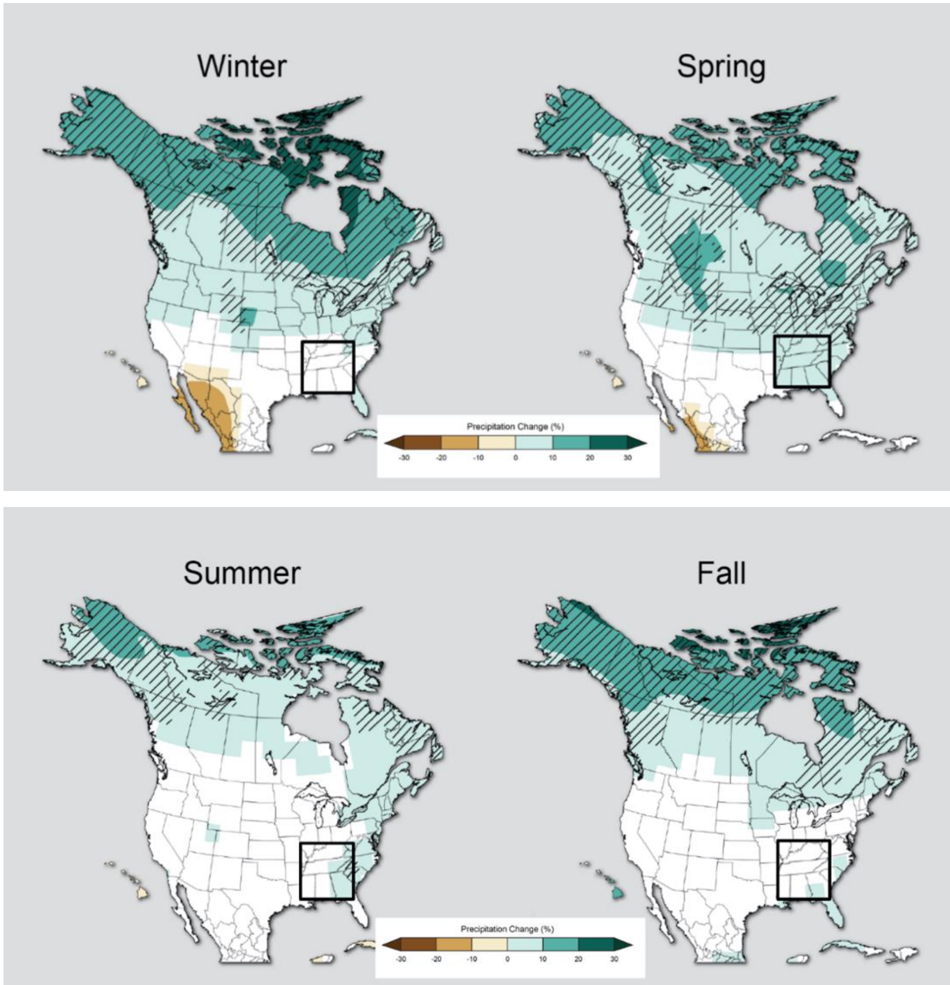
Figure 14.2.14-3 shows a high emissions scenario, which assumes continued increases in emissions, with associated large increases in warming and major precipitation changes. (Note: white areas in the figures indicate that the changes are not projected to be larger than could be expected from natural variability.) (USGCRP, 2014c)

Cfa – Figure 14.2.14-3 shows in a rapid emissions reduction low emissions scenario in the 30-year period for 2071 to 2099, precipitation would increase by 10 percent in spring and a small northeastern corner of the state is expected to have a 10 percent increase in winter precipitation. However, the majority of the state will have no changes in winter precipitation. Summer precipitation is anticipated to increase 10 percent in portions of the eastern region of the state while precipitation for the rest of the state is expected to remain constant. There are no expected changes to fall precipitation. (USGCRP, 2014c)

Figure 14.2.14-4 shows that if emissions continue to increase in the period 2071 to 2099, precipitation would increase by 10 percent in summer and fall in eastern portions of the state while the remainder of the state is not expected to have any changes in precipitation other than normal fluctuations due to natural variability. Winter precipitation could increase as much as 20 percent along the northern and northeastern border of Tennessee; however, the majority of the states is expected to have a 10 percent precipitation increase. In spring, precipitation in this scenario is expected to increase 10 percent. (USGCRP, 2014c)

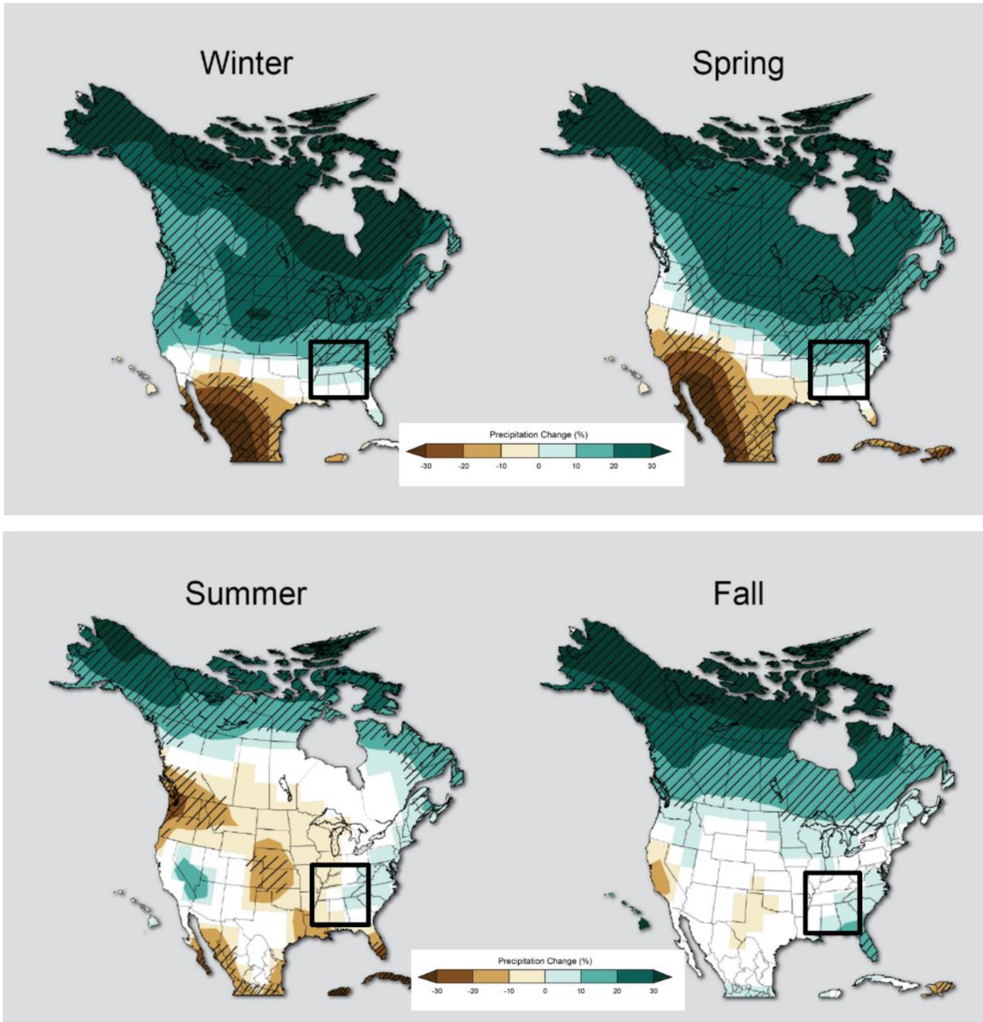
Severe Weather Events

It is difficult to forecast the impact of climate change on severe weather events such as winter storms and thunderstorms. Trends in thunderstorms are subject to greater uncertainties than trends in temperature and associated variables directly related to temperature such as sea level rise. Climate scientists are studying the influences of climate change on severe storms. Recent research has yielded insights into the connections between warming and factors that cause severe storms. For example, atmospheric instability and increases in wind speed with altitude link warming with tornadoes and thunderstorms. Additionally, research has found a link between warming and conditions favorable for severe thunderstorms. However, more research is required to make definitive links between severe weather events and climate change. (USGCRP, 2014b)



Source: (USGCRP, 2014c)

Figure 14.2.14-3: Predicted Seasonal Precipitation Change for 2071 to 2099 Compared to 1970 to 1999 Baseline in a Low Emissions Scenario



Source: (USGCRP, 2014c)

Figure 14.2.14-4: Predicted Seasonal Precipitation Change for 2071 to 2099 Compared to 1970 to 1999 Baseline in a High Emissions Scenario

14.2.14.4. Description of Environmental Concerns

Greenhouse Gas Emissions

Increases in GHG emissions have altered the global climate, leading to generalized temperature increases, weather disruption, increased droughts, and heatwaves, and may have potentially catastrophic long-term consequences for the environment. Although GHGs are not yet regulated by the federal government, many states have set various objectives related to reducing GHG emissions, particularly CO_2 emissions from fossil fuels.

Based on the impact significance criteria presented in Table 14.2.14-1, climate change impacts as a result of GHG emissions could be significant at the programmatic level and require a quantitative analysis if FirstNet's deployment of technology was responsible for increased emissions. The GHG emissions resulting from FirstNet activities fall into two categories: short-term and long-term. Short-term emissions could be associated with deployment activities (vehicles and other motorized construction equipment) and would have no long-term or permanent impact on GHG emissions or climate change. Long-term (both temporary and permanent) emission increases could result from operations, including the use of grid-provided electricity by FirstNet equipment such as transmitters and optical fiber, and from the temporary use of portable or onsite electric generators (a less efficient, more carbon-intensive source of electricity), during emergency situations when the electric grid was down, for example after a hurricane.

Climate Change

Climate change may increase project-related impacts by magnifying or otherwise altering impacts in other resources areas. For example climate change may impact air quality, water resource availability, and recreation. These effects would vary from state to state depending on the resources in question and their relationship to climate change. These impacts will be considered fully in Chapter 18, Cumulative Impacts. No BMPs will be described for this aspect of the resource.

In Tennessee, a warming climate is expected to change the tree species mix of ecologically and economically important species from elm-ash-cottonwood mix to oak-hickory-cottonwood, subject to larger infestations of southern pine beetle, and larger and more intense forest fires. These changes are expected to negatively impact forest species, while catastrophic fire as a "major change agent" for the decline of southeastern forests is expected to favor the spread of grasslands and associated animal and bird species. Warming fresh water temperatures in streams and other waterbodies are expected result in the decline of cold-water fish species such as brook trout, and increased heavy rains are expected to cause additional sedimentation, turbidity, and declines in water quality (TWRA, 2009). Extreme heat events are also anticipated to negatively impact public health both through the direct effect of heat on morbidity and mortality, and also through increased air pollution (USGCRP, 2014a).

Climate change impacts on FirstNet installations and infrastructure will vary from state to state, depending on the placement and vulnerability of the installations and infrastructure, and the impacts that climate change is anticipated to have in that particular location.

Winter and spring precipitation is projected to increase in Tennessee, and the frequency of heavy downpours is projected to continue to increase as the century progresses, which in turn may increase the potential for flash floods (USGCRP, 2014d). A large portion of Tennessee is expected to experience increases in extreme heat, especially in areas with a significant urban heat island (USGCRP, 2014d). Extended periods of extreme heat may place extended heavy demand on the grid and impede its operation and overwhelm the equipment needed to keep microwave and other transmitters cool (TVA, 2014).

Based on the impact significance criteria presented in Table 14.2.14-1, climate change effects on FirstNet installations and infrastructure would be significant if they negatively affected the operation of these facilities.

14.2.14.5. Potential Impacts of the Preferred Alternative

Greenhouse Gas Emissions

Given this assessment is programmatic and does not include any site-specific locations or deployment technology, it is impossible to determine the actual GHG emissions associated with any of the action alternatives. This information could only be captured once the site-specific information is determined. However, an assessment of potential impacts is provided in this section based on the potential emissions associated with the various activities that could occur as a result of the implementation of the Preferred in Tennessee, including deployment and operation activities.

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment and operation of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to GHG emissions, climate impacts in other resource areas, and FirstNet infrastructure and operations, and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level, in a range of *no impacts* to *less than significant impacts with BMPs and mitigation measures added* depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to climate change under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: There would be no short-term emissions associated with construction, as construction would not take place. The equipment required to blow or pull fiber through existing conduit would be used temporarily and infrequently, resulting in no perceptible generation of GHG emissions
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would require no construction and have no short- or long-term emissions. This would create no perceptible change in GHG emissions.

- Satellites and Other Technologies
  - Distribution of Satellite Enabled Devices and Equipment: The installation of satellite-enabled equipment on existing structures, or the use of portable satellite-enabled devices would not create any perceptible changes in GHG emissions because they would not create any new emissions sources.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. Therefore it is anticipated that there would be no GHG emissions or any climate change effects on the project because of these activities.

Activities with the Potential to Have Impacts at the Programmatic Level

The deployment and use of energy-consuming equipment as a result of the implementation of the Preferred Alternative would result in GHG emissions whose significance would vary depending on their power requirements, duration and intensity of use, and number. The types of infrastructure deployment scenarios that could be part of the Preferred Alternative and result in potential impacts to GHG emissions and climate change include the following:

- Wired Projects
  - New Build - Buried Fiber Optic Plant: This activity would include plowing (including vibratory plowing), trenching, and directional boring, and could involve construction of POPs, huts, or other facilities to house outside plant equipment or hand holes to access fiber. These activities could generate GHG emissions.
  - New Build Aerial Fiber Optic Plant: These projects would require construction equipment for installing or replacing new poles and hanging cables as well as excavation and grading for new or modified ROWs or easements. It could also include construction of POPs, huts, or other facilities to house outside plant equipment. These activities could generate GHG emissions.
  - Collocation on Existing Aerial Fiber Optic Plant: These projects would require equipment for replacement of existing wiring and poles. GHG emissions associated with these projects would arise from use of machinery and vehicles to complete these activities.
  - New Build – Submarine Fiber Optic Plant: The deployment of small work boats with engines similar to recreational vehicle engines may be required to transport and lay small wired cable. The emissions from these small marine sources would contribute to GHGs.
  - Installation of Optical Transmission or Centralized Transmission Equipment: The construction of small boxes or huts or other structures would require construction equipment, which could generate GHG emissions.
- Wireless Projects
  - New Wireless Tower Construction: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in short-term, temporary GHG emissions from vehicles and construction equipment. Long-term, permanent or temporary increases in GHG emissions would result from the electricity

requirements of the towers (both grid-provided and back-up), and would depend on their size, number, and the frequency and duration of their use.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on existing towers. There would be no short-term GHG emissions associated with construction, as it would not occur. Minor, short-term, temporary GHG emissions may result from any associated equipment used for installation, such as cranes or other equipment. Long-term, permanent or temporary increases in GHG emissions would result from the electricity requirements of the towers (both grid-provided and back-up), and would depend on their size, number, and the frequency and duration of their use.
- Deployable Technologies
  - COWs, COLTs, or SOWs: The long-term operations of these mobile systems have the potential to have GHG emission impacts if operated in large numbers over the long-term. However, this would be highly dependent on their size, number, and the frequency and duration of their use.
  - Emissions associated with the deployment and maintenance of a complete network solution of this type may be significant if large numbers of piloted or unmanned aircraft were used for a sustained period of time (i.e., months to years). Emissions would depend on the type of platforms used, their energy consumption, and the duration of the network's operation.

Potential climate change impacts associated with deployment activities as a result of implementation of the Preferred Alternative include increased GHG emissions. These emissions would arise from the combustion of fuel used by equipment during construction and operation. The total potential level of GHG emissions would be *less than significant*; although geographically large (all 50 states, five territories, and the District of Columbia) any one site would be limited in extent and emit minor levels of GHG emissions as explained in the analysis. Land use emissions occurring as a result of soil disturbance and loss of vegetation are expected to be *less than significant* at the programmatic level due to the limited and localized nature of deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Climate Change Impacts on FirstNet Infrastructure or Operations

Climate change effects on the Preferred Alternative could be *potentially significant to less than significant* at the programmatic level with BMPs and mitigation measures incorporated because climate change may potentially impact FirstNet installations or infrastructure during periods of extreme heat, severe storms, and other weather events. FirstNet installations should be evaluated in the design and planning phase through tiering to this analysis, in the context of their local geography and anticipated climate hazards to ensure they are properly hardened or there is sufficient redundancy to continue operations in a climate-affected environment. Mitigation measures could minimize or reduce the severity or magnitude of a potential impact resulting to the project, including adaptation, which refers to anticipating *adverse effects* of climate change and taking appropriate action to prevent and minimize the damage climate change effects could cause.

Climate change's anticipated impact on extreme weather events such as hurricanes or heat waves may increase the severity of the emergencies to which first responders are responding in vulnerable areas, and thus the extent and duration of their dependence on FirstNet resources. FirstNet would likely prepare to sustain these operations in areas experiencing climate and weather extremes through the design and planning process for individual locations and operations.

14.2.14.6. Alternatives Impact Assessment

The following section assesses potential impacts to climate associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration.

Deployment Impacts

As explained above, implementation of deployable technologies could involve use of fossil-fuel-powered vehicles, powered generators, and/or aerial platforms. There could be some emissions and soil and vegetation loss as a result of excavation and grading for staging and/or landing areas depending on the type of technology. GHG emissions are expected to be *less than significant* at the programmatic level based on the defined significance criteria, since activities would be temporary and short-term. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operations Impacts

Implementing land-based deployable technologies (COW, COLT, and SOW) could result in emissions from mobile equipment on heavy trucks using internal combustion engines associated with the vehicles and onboard generators. While a single deployable vehicle may have an insignificant impact, multiple vehicles operating for longer periods, in close proximity, may have a cumulative impact, although this impact is expected to be *less than significant* at the programmatic level due to the temporary nature of the operation of deployables. Some staging or landing areas (depending on the type of technology) may require excavation, site preparation, and paving. Heavy equipment used for these activities could produce emissions as a result of burning fossil fuels in internal combustion engines. The operation of aerial technology is anticipated to generate pollutants during all phases of flight, except for balloons. These activities are expected to be *less than significant* at the programmatic level due to the limited duration of deployment activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Additionally, routine maintenance and inspections of the deployable technologies are anticipated to be *less than significant*, given that these activities are of low-intensity and short duration.

Climate Change Impacts on FirstNet Deployable Infrastructure or Operations

Climate change effects have the most noticeable impacts over a long period of time. Climate change effects such as temperature, precipitation changes, and extreme weather during operations would be expected but could have little to *no impact* at the programmatic level on the deployed technology due to the temporary nature of deployment. However, if these technologies are deployed continuously (at the required location) for an extended period, climate change effects on deployables could be similar to the Proposed Action, as explained above. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure, or satellites and other technologies. Therefore, there would be *no impacts* to GHG emissions or climate as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.14, Climate Change.

14.2.15. Human Health and Safety

14.2.15.1. Introduction

This section describes potential impacts to human health and safety in Tennessee associated with deployment of the Proposed Action and Alternatives. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.15.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on human health and safety were evaluated using the significance criteria presented in Table 14.2.15-1. As described in Section 14.2, Environmental Consequences, the categories of impacts are defined, at the programmatic level, as *potentially significant*, *less than significant with mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact. Site-specific analysis may be required depending on the site conditions, the type of deployment, or any other permits or permissions necessary to perform the work.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to human health and safety addressed in this section are presented as a range of possible impacts.

Table 14.2.15-1: Impact Significance Rating Criteria for Human Health and Safety at the Programmatic Level

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Exposure to Worksite Occupational Hazards as a Result of Activities at Existing or New FirstNet Sites	Magnitude or Intensity	Exposure to concentrations of chemicals above occupational regulatory limits and time weighted averages (TWAs). A net increase in the amount of hazardous or toxic materials or wastes generated, handled, stored, used, or disposed of, resulting in unacceptable risk, exceedance of available waste disposal capacity and probable regulatory violations. Exposure to recognized workplace safety hazards (physical and chemical). Violations of various regulations including: OSHA, RCRA, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Toxic Substances Control Act (TSCA), EPCRA.	Effect is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	No exposure to chemicals above health-protective screening levels. Hazardous or toxic materials or wastes could be safely and adequately managed in accordance with all applicable regulations and policies, with limited exposures or risks. No exposure to unsafe working conditions or other workplace safety hazards.	No exposure to chemicals, unsafe working conditions, or other workplace safety hazards.
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a county or county-equivalent geographical extent, could extend to state/territory).		Impacts only at a local/neighborhood level, as opposed to throughout the state or territory.	NA
	Duration or Frequency	Occasional frequency during the life of the project.		Rare event.	NA

Type of Effect	Effect Characteristics	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
Exposure to Hazardous Materials, Hazardous Waste, and Mine Lands as a Result of FirstNet Site Selection and Site-Specific Land Disturbance Activities	Magnitude or Intensity	Exposure to concentrations of chemicals above regulatory limits, or USEPA chemical screening levels protective of the general public. A net increase in the amount of hazardous or toxic materials or wastes generated, handled, stored, used, or disposed of, resulting in unacceptable risk, exceedance of available waste disposal capacity and probable regulatory violations. Site contamination conditions could preclude development of sites for the proposed use. Violations of various regulations including: OSHA, RCRA, CERCLA, TSCA, EPCRA. Unstable ground and seismic shifting.	Effect is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	No exposure to chemicals above health-protective screening levels. Hazardous or toxic materials or wastes could be safely and adequately managed in accordance with all applicable regulations and policies, with limited exposures or risks. No exposure to unstable ground conditions or other workplace safety hazards.	No exposure to chemicals, unstable ground conditions, or other workplace safety hazards.
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a county or county-equivalent geographical extent, could extend to state/territory).		Impacts only at a local/neighborhood level, as opposed to throughout the state or territory.	NA
	Duration or Frequency	Occasional frequency during the life of the project.		Rare event.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Exposure to Hazardous Materials, Hazardous Waste, and Occupational Hazards as a Result of Natural And Manmade Disasters	Magnitude or Intensity	Exposure to concentrations of chemicals above regulatory limits, or USEPA chemical screening levels protective of the general public. Site contamination conditions could preclude development of sites for the proposed use. Physical and biologic hazards. Loss of medical, travel, and utility infrastructure.	Effect is *potentially significant*, but with mitigation is *less than significant* at the programmatic level.	No exposure to chemicals above health-protective screening levels. Hazardous or toxic materials or wastes could be safely and adequately managed in accordance with all applicable regulations and policies, with limited exposures or risks. No exposure to unsafe conditions. No loss of medical, travel, or utility infrastructure.	No exposure to chemicals, unsafe conditions, or other safety and exposure hazards.
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a county or county-equivalent geographical extent, could extend to state/territory).		Impacts only at a local/neighborhood level, as opposed to throughout the state or territory.	NA
	Duration or Frequency	Occasional frequency during the life of the project.		Rare event.	NA

NA = Not Applicable

14.2.15.3. Description of Environmental Concerns

Worksite Physical Hazards, Hazardous Materials, and Hazardous Waste

The human health and safety concern having the greatest likelihood to occur during FirstNet deployment activities is occupational injury to telecommunication workers. The nature of telecommunication work requires workers to execute job responsibilities that are inherently dangerous. Telecommunication work activities present physical and chemical hazards to workers. The physical hazards have the potential to cause acute injury, long-term disabilities, or in the most extreme incidents, death. Other occupational activities such as handling hazardous materials and hazardous waste often do not result in acute injuries, but may compound over multiple exposures, resulting in increased morbidity. Based on the impact significance criteria presented in Table 14.2.15-1, occupational injury impacts could be *potentially significant* if the FirstNet deployment locations require performing occupational activities that have the highest relative potential for physical injury and/or chemical exposure. Examples of activities that may present increased risk and higher potential for injury include working from heights (i.e., from towers and roof tops), ground-disturbing activities like trenching and excavating, confined space entry, operating heavy equipment, and the direct handling of hazardous materials and hazardous waste. Predominately, these hazards are limited to occupational workers, but may impact the general public if there are trespassers or if any physical of chemical hazard extends beyond the restricted access of FirstNet work sites.

To protect occupational workers, OSHA mandates that employers be required to protect their employees from occupational hazards that could result in injury. Depending on the source of the hazard and the site-specific work conditions, OSHA generally recommends the following hierarchy for protecting onsite workers (OSHA, 2017).

1. Engineering controls;
2. Work practice controls;
3. Administrative controls; and then
4. Personal protective equipment (PPE).

Engineering controls are often physical barriers that prevent access to a worksite, areas of a worksite, or from idle and operating equipment. Physical barriers take many forms like perimeter fences, trench boxes,[142] chain locks, bollards, storage containers (for storing equipment and chemicals), or signage and caution tape. Other forms of engineering controls could include machinery designed to manipulate the quality of the work environment, such as ventilation blowers. Whenever practical, engineering controls may result in the complete removal of the hazard from the work site, an example of which would be the transport and offsite disposal of hazardous waste or asbestos containing materials.

Work practice controls could be implemented as abiding by specific OSHA industry standards, such as the Confined Space Entry standard (29 CFR 1910.146) or thru the development of

[142] Trench boxes are framed metal structures inserted into open trenches to support trench faces, to protect workers from cave-ins and similar incidents (OSHA, 2015b).

employer specific workplace rules and operational practices (OSHA, 2017). To the extent practicable, FirstNet partner(s) would likely implement and abide by work practice controls through employee safety training and by developing site-specific health and safety plans (HASP). The HASPs would identify all potential hazardous materials and hazardous wastes, potential physical hazards, and applicable mitigation steps. Other components of a HASP identifying appropriate PPE for each task and the location of nearby medical facilities. Safety Data Sheets (SDS) describing the physical and chemical properties of hazardous materials used during FirstNet deployment and maintenance activities, as well as the physical and health hazards, routes of exposure, and precautions for safe handling and use would be kept and maintained at all FirstNet project sites. In addition to HASPs and SDSs, standard operating procedures (SOP) would be developed and implemented by FirstNet partner(s) for critical and/or repetitive tasks that require attention to detail, specialized knowledge, or clear step-wise directions to prevent worker injury and to ensure proper execution.

Administrative controls are employer-initiated methods to reduce the potential for injury and physical fatigue (OSHA, 2015c). Administrative controls may take the form of limiting the number of hours an employee is allowed to work per day, requiring daily safety meetings before starting work, utilizing the buddy system for dangerous tasks, and any other similar activity or process that is designed to identify and mitigate unnecessary exposure to hazards. When engineering controls, work practice controls, and administrative controls are not feasible or do not provide sufficient protection, employers must also provide appropriate PPE to their employees and ensure its proper use. PPE is the common term used to refer to the equipment worn by employees to minimize exposure to chemical and physical hazards. Examples of PPE include gloves, protective footwear, eye protection, protective hearing devices (earplugs, muffs), hard hats, fall protection, respirators, and full body suits. PPE is the last line of defense to prevent occupational injuries and exposure.

TNDLWD is authorized by OSHA to administer the state program that oversees employee safety in all state and local government and private sector workplaces. Tennessee OSHA (TOSHA) is an OSHA-approved “State Plan,” which has adopted all OSHA state and local government as well as private sector employment regulations, except for standards regarding toxic chemicals and handling (OSHA, 2015c). OSHA enforces occupational safety regulations at the state level by TNDLWD and at the federal level. The FirstNet Proposed Action and site work will not be performed by state or local employees. The involvement of state and local employees will be limited to emergency responders (e.g., police, fire, emergency medical transporters, etc.) and local government permitting authorities.

Hazardous Materials, Hazardous Waste, and Mine Lands

The presence of environmental contamination at FirstNet deployment sites has the potential to negatively impact health and safety of workers and the general public. Past or present contaminated media, such as soil and groundwater, may be present and become disturbed as a result of site activities. Mines may cause unstable surface and subsurface conditions because of underground shaft collapses or seismic shifting. Based on the impact significance criteria presented in Table 14.2.15-1, human health impacts could be significant if FirstNet deployment sites are near contaminated properties. Prior to the start of any FirstNet deployment project, potential site locations should be screened for known environmental contamination and/or mining activities using federal resources such as the USEPA Cleanups in My Community database and DOI's Abandoned Mine Lands inventory, through the TDEC, or through an equivalent commercial resource.

By screening sites for environmental contamination and reported environmental liabilities, the presence of historic contamination and unsafe ground conditions could be evaluated and may influence the site selection process. In general, the lower the density of environmental contamination, the more favorable the site will be for FirstNet deployment projects. If sites containing known environmental contamination are selected for proposed FirstNet deployment activities it may be necessary to implement additional controls (e.g., engineering, work practice, administrative, and/or PPE) to ensure workers, and the general public, are not unnecessarily exposed to the associated hazards. Additionally, for any proposed FirstNet deployment site, it is possible undocumented environmental contamination is present.

During FirstNet deployment activities, if any soil or groundwater is observed to be stained or emitting an unnatural odor, it may be an indication of environmental contamination. When such instances are encountered, it may be necessary to stop work until the anomaly is further assessed through record reviews or environmental sampling. Proposed FirstNet deployment would attempt to avoid known contaminated sites. However, in the event that FirstNet is unable to avoid a contaminated site, then site analysis and remediation would be required under RCRA, CERCLA, and applicable Tennessee state laws in order to protect workers and the general public from direct exposure or fugitive contamination.

Exposure assessments identify relevant site characteristics, temporal exposure parameters, and toxicity data to determine the likelihood of adverse health effects. More formally known as a human health risk assessment (HHRA), these studies provide mathematical justification for implementing controls at the site to protect human health. If the HHRA determines the potential for adverse health effects is too great TDEC may require FirstNet to perform environmental clean-up actions at the site to lower the existing levels of contamination. HHRAs help determine which level of PPE (i.e., Level D, Level C, Level B, or Level A) is necessary for a work activity. HHRAs take into account all exposure pathways: absorption, ingestion, inhalation, and injection. Therefore, specific protective measures (e.g., controls and PPE) that disrupt the exposure pathways could be identified, prioritized, and implemented.

Natural and Manmade Disasters

The impacts of natural and manmade disasters are likely to present unique health and safety hazards, as well as exacerbate pre-existing hazards, such as degrading occupational work conditions and disturbing existing environmental contamination. The unique hazards presented by natural and manmade disasters may include, fire, weather incidents (e.g., floods, tornadoes, hurricanes, etc.), earthquakes, vandalism, large- or small-scale chemical releases, utility disruption, community evacuations, or any other event that abruptly and drastically denudes the availability or quality of transportation infrastructure, utility infrastructure, medical infrastructure, and sanitation infrastructure. Additionally, such natural and manmade disasters could directly impact public safety communication infrastructure assets through damage or destruction.

Based on the impact significance criteria presented in Table 14.2.15-1, human health impacts could be significant if FirstNet deployment sites are located in areas that are directly impacted by natural and manmade disasters that could lead to exposure to hazardous wastes, hazardous materials, and occupational hazards. At the programmatic level, FirstNet's emphasis on public safety-grade communications infrastructure may result in a *less than significant* beneficial impact, as new infrastructure could be deployed with additional structural hardening, and existing infrastructure may also be hardened as appropriate and feasible, in an effort to reduce the possibility of infrastructure damage or destruction to some degree.

Potential mitigation measures for natural disasters is to be aware of current weather forecasts, forest fire activities, seismic activities, and other news worthy events that may indicate upcoming disaster conditions. Awareness provides time and opportunity to plan evacuation routes, to relocate critical equipment and parts, and to schedule appropriate work activities preceding and after the natural disaster. These mitigation steps reduce the presence of workers and dangerous work activities to reduce the potential for injury or death. Manmade disasters could be more difficult to anticipate due to the unexpected or accidental nature of the disaster. Though some manmade disasters are due to malicious intentions, many manmade disasters result from human error or equipment failure. The incidence of manmade disasters affecting FirstNet deployment sites would be difficult to predict and diminish because the source of such disasters is most likely to originate from sources independent of FirstNet activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.15.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and maintenance activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to human health and safety and others would not. In addition, and as explained in this section, the same type of Proposed Action Infrastructure could result, at the programmatic level, in a range of *no impacts* to *less than significant with mitigation*, depending on the deployment scenario or site-specific activities. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Activities Likely to Have No Impacts at the Programmatic Level

Of the types of facilities or infrastructure deployment scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to human health and safety at the programmatic level under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: the pulling or blowing of fiber optic cable would be performed through existing conduit. Use of mechanical equipment would be limited to pulley systems and blowers. Some locations with no existing power supply may require the use of electrical generators. Hazardous materials needed for this work would include fiber optical cable lubricants, mechanical oil/grease, and fuel for electrical generators although these materials are expected to be used infrequently and in small quantities. These activities are not likely to result in serious injury or chemical exposure, or surface disturbances since work would be limited to existing entry and exit points, would be temporary, and intermittent. It is anticipated that there would be *no impacts* at the programmatic level to human health and safety.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* at the programmatic level to human health and safety because there would be no ground disturbance or heavy equipment used.
- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact human health and safety resources, it is anticipated that this activity would have *no impact* at the programmatic level on those resources.

Activities with the Potential to Have Impacts at the Programmatic Level

Potential deployment-related impacts to human health and safety as a result of implementation of the Preferred Alternative would encompass a range of impacts that occur as a result of ground disturbance activities, construction activities, equipment upgrade activities, management of hazardous materials and/or hazardous waste, and site selection. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to human health and safety include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of POPs, huts, or other associated facilities or hand-holes to access fiber would require the use of heavy equipment and hazardous materials. The additional noise, vibrations, and activity at the site would require workers to demonstrate a high level of situational awareness. Failure to follow OSHA and industry controls could result in injuries. Excavation of soil at proposed sites known to contain environmental contamination has the potential to expose workers to harmful chemicals or releases that could impact the general public in the immediate vicinity.

Additionally, some of this work would likely be performed along road ROWs, increasing the potential for vehicle traffic to collide with site workers or equipment. If a proposed deployment activity involves the operation of heavy equipment, managing hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.

- New Build – Aerial Fiber Optic Plant: Installation of new poles and fiber optic lines could require excavation activities, working from heights, use of hazardous materials, and site locations in ROWs. Hazards associated with the site work include injury from heavy equipment, fall hazards, chemical hazards, and the potential for vehicle traffic to collide with site workers or equipment. Excavation of soil at proposed sites known to contain environmental contamination has the potential to expose workers to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.
- Collocation on Existing Aerial Fiber Optic Plant: Installation of overhead fiber optic lines would require work from height. In some instances, new poles would be installed requiring excavation activities with heavy equipment. Hazards associated with the site work include injury from heavy equipment, fall hazards, chemical hazards, and the potential for vehicle traffic to collide with site workers or equipment. Excavation of soil at proposed sites known to contain environmental contamination has the potential to expose workers to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water requires workers to operate over aquatic and/or marine environments, which presents opportunities for drowning. When working over water, exposure to sun, high or low temperatures, wind, and moisture could impact worker safety. Construction of landings and/or facilities on shores or the banks of waterbodies that accept the submarine cable would require site preparation, construction, and management of hazardous materials and hazardous waste. Excavation of soils or sediments at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.

- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of transmission equipment would require site preparation, construction activities, and management of hazardous materials and hazardous waste. Excavation of soils at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider.

- Wireless Projects
    - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads would require site preparation, construction activities, and management of hazardous materials and hazardous waste. Communication towers would be erected, requiring workers to perform their duties from heights sufficient to result in serious injury or death in the event of falling. Working from heights may also result in additional overhead hazards and falling objects. Excavation of soils at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.
    - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower. This would require workers to perform their duties from heights sufficient to result in serious injury or death in the event of falling. Working from heights may also result in additional overhead hazards and falling objects. Excavation of soils at proposed sites known to contain environmental contamination may result in workers being exposed to harmful chemicals or releases that could impact the general public in the immediate vicinity. If a proposed deployment activity involves the operation of heavy equipment, hazardous materials and hazardous waste management, or other site location challenges, there could be potential human health and safety impacts to consider. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions.

- Deployable Technologies
    - The use of deployable technologies could result in soil disturbance if land-based deployables are deployed on unpaved areas or if the implementation results in paving of previously unpaved surfaces. The use of heavy machinery presents the possibility for spills and soil and water contamination, and noise emissions and vibrations could potentially impact human health; and vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. Set-up of a cellular base station contained in a trailer with a large expandable antenna mast is not expected to result in impacts to human health and safety. However, due to the larger size of the deployable technology, site preparation or trailer stabilization may be required to ensure the self-contained unit is situated safely at the site. Additionally, the presence of a dedicated electrical generator would produce fumes, vibrations, and noise. The possibility of site work and the operation of a dedicated electrical generator have the potential for impacts to human health and safety. For a discussion of RF emissions, refer to Section 2.4, Radio Frequency Emissions. Use of aerial vehicles would not involve telecommunication site work. Prior to deployment and when not in use, the aerial vehicles would likely require preventive maintenance. Workers responsible for these activities may handle hazardous materials, not limited to fuel, solvents, and adhesives.
- Satellites and Other Technologies
    - Satellite-Enabled Devices and Equipment: The use of portable devices that utilize satellite technology would *not impact* human health and safety at the programmatic level because there is no construction activities or use of hazardous materials. The installation of permanent equipment on existing structures may require workers to operate from heights or in sensitive environments. As a result, the potential for falling, overhead hazards, and falling objects is greater and there is a potential to impact human health and safety.

In general, the abovementioned FirstNet activities could potentially involve site preparation work, construction activities, work in potentially harmful environments (road ROWs, work over water, and environmental contamination), management of hazardous materials and hazardous waste, and weather exposure. Potential impacts to human health and safety associated with deployment of the Proposed Project could include injury from site preparation and operating heavy equipment, construction activities, falling/overhead hazards/falling objects, exposure, and release of hazardous chemicals and hazardous waste, and release of historic contamination to the surrounding environment. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents, and injuries, noise and vibration exposure, and risk of infectious disease transmission would be *less than significant* at the programmatic level due to the small-scale of likely FirstNet activities that would be temporary and of short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned construction impacts. It is anticipated that there would be *less than significant* impacts to human health and safety at the programmatic level associated with routine inspections of the Preferred Alternative. Use of PPE or other mitigation measures could be necessary to adequately protect workers. If usage of heavy equipment is part of routine maintenance, the potential for impacts to human health and safety would also increase. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents and injuries, noise and vibration exposure, and risk of infectious disease transmission would be *less than significant* at the programmatic level due to the small-scale of likely FirstNet activities that would be temporary and of short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

14.2.15.5. Alternatives Impact Assessment

The following section assesses potential impacts to human health and safety associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable land-based infrastructure. There would be no collocation of equipment and minimal new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to human health and safety as a result of implementation of this Alternative could be as described below.

Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts to human health and safety at the programmatic level. The largest of the land-based deployable technologies may require site preparation work or stabilization work to ensure the self-contained trailers are stable. Heavy equipment may be necessary to complete the site preparation work. However, in general, the deployable technologies are small mobile units that could be transported as needed. While in operation, the units are parked and operate off electrical generators or existing electrical power sources. Connecting deployable technology to a power supply may present increased electrocution risk during the process of connecting power. If the power source is an electrical generator, then there would also likely be a need to manage fuel onsite. These activities could result in *less than significant* impacts to human health and safety at the programmatic level. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents and injuries, noise, and vibration exposure, and risk of infectious disease transmission would be *less than significant* at the programmatic level due to the small-scale of likely FirstNet activities that would be temporary and of short duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to human health and safety at the programmatic level associated with routine inspections of the Preferred Alternative. Use of PPE or other mitigation measures may be necessary to adequately protect workers. If usage of heavy equipment is part of routine maintenance, the potential for impacts to human health and safety would also increase. These impacts would be *less than significant* at the programmatic level because of the small-scale of likely FirstNet activities; activities associated would routine maintenance, inspection, and deployment of deployable technologies would be temporary and often of limited duration. Chapter 16, BMPs and Mitigation Measures, provides a listing of BMPs and mitigation measures that FirstNet and/or its partner(s) would require, as practicable or feasible, to avoid or minimize potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to human health and safety at the programmatic level as a result of the No Action Alternative. Environmental conditions would therefore be the same as those described in Section 14.1.15, Human Health and Safety.

ACRONYMS

Acronym	Definition
AAA	Agricultural Adjustment Act
AARC	Average Annual Rate of Change
ACHP	Advisory Council on Historic Preservation
ACS	American Community Survey
AGL	Above Ground Level
AIM	Aeronautical Information Manual
AIRFA	American Indian Religious Freedom Act
AML	Abandoned Mine Lands
APCO	Association of Public-Safety Communications Officials
APE	Area of Potential Effect
AQCR	Air Quality Control Region
ARPA	Archaeological Resources Protection Act
ASL	above sea level
ATC	Air Traffic Control
ATO	Air Traffic Organization
ATSDR	Agency for Toxic Substances and Disease Registry
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
BMP	Best Management Practice
BNA	Nashville International Airport
BNSF	Burlington Northern Santa Fe
BP	Birthplace
BTU	British thermal unit
C2	Control and Communication
CAA	Clean Air Act
CCC	Civilian Conservation Corps
CCR	Consumer Confidence Reports
CDC	Centers for Disease Control and Prevention
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Controlled Firing Area
CFR	Code of Federal Regulations
CGP	Construction General Permit
CH4	Methane
CHA	Chattanooga Metropolitan Airport
CIMC	Cleanups In My Community
CIO	Chief Information Officer
CO	Carbon Monoxide

Acronym	Definition
CO2	Carbon Dioxide
COLT	Cell on Light Truck
COW	Cell on Wheels
CRS	Community Rating System
CSC	Connecticut Siting Council
CWA	Clean Water Act
D.C.	District of Columbia
DHS	Department of Homeland Security
DOC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
EFH	Essential Fish Habitat
EIA	Energy Information Administration
EMS	Emergency Medical Services
EO	Executive Order
EPCRA	Emergency Planning and Community Right to Know Act
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FHWA	Federal Highway Administration
FL	Flight Level
FLM	Federal Land Manager
FR	Federal Register
FSDO	Flight Standards District Office
FSS	Flight Service Station
FWC	Florida Fish and Wildlife Conservation Commission
GADNR	Georgia Department of Natural Resources
GAO	Government Accountability Office
GHG	Greenhouse Gas
GPO	Government Publishing Office
GWP	Global Warming Potential
HAP	Hazardous Air Pollutants
HASP	Health and Safety Plans
HHRA	Human Health Risk Assessment
IBA	Important Bird Area
IFR	Instrument Flight Rules

Acronym	Definition
IPCC	Intergovernmental Panel on Climate Change
ITU	International Telecommunication Union
LBS	Locations-Based Services
LLC	Limited Liability Company
LMR	Land Mobile Radio
LRR	Land Resource Regions
LTE	Long Term Evolution
MBTA	Migratory Bird Treaty Act
MEM	Memphis International Airport
MHI	Median Household Income
MHz	Megahertz
MLRA	Major Land Resource Areas
MMT	Million Metric Tons
MOA	Military Operation Area
MSL	Mean Sea Level
MT	Metric Ton
MTR	Military Training Route
MYA	Million Years Ago
N2O	Nitrous Oxide
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAICS	North American Industry Classification System
NAS	National Airspace System
NASAO	National Association of State Aviation Officials
NCDC	National Climatic Data Center
NCED	National Conservation Easement Database
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NHA	National Heritage Area
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NM	Nautical Miles
NMSZ	New Madrid Seismic Zone
NNL	National Natural Landmarks
NO2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notices to Airmen
NOX	Nitrogen Oxides

Acronym	Definition
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service
NPSBN	Nationwide Public Safety Broadband Network
NRC	National Response Center
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSA	National Security Area
NTFI	National Task Force on Interoperability
NTIA	National Telecommunications and Information Administration
NWI	National Wetlands Inventory
NWP	Nationwide Permit
NWR	National Wildlife Refuge
NWS	National Weather Service
OE/AAA	Obstruction Evaluation and Airport Airspace Analysis
OHV	Off-Highway Vehicle
ONRW	Outstanding National Resource Waters
OSHA	Occupational Safety and Health Administration
OSMRE	Office of Surface Mining and Reclamation and Enforcement
OTR	Ozone Transport Region
PAB	Palustrine aquatic bed
PEIS	Programmatic Environmental Impact Statement
PEM	Palustrine emergent
PFO	Palustrine forested
PGA	Peak Ground Acceleration
PM	Particulate Matter
POP	Point of Presence
POTW	publicly owned treatment works
PPE	Personal Protective Equipment
PSAP	Public Safety Answering Point
PSCR	Public Safety Communications Research
PSD	Prevention of Significant Deterioration
PSS	Palustrine scrub-shrub
PUB	Palustrine unconsolidated bottom
RCRA	Resource Conservation and Recovery Act
RF	Radio Frequency
ROW	Right-of-way
RTA	Regional Transportation Authority
SAA	Sense and Avoid
SAIPE	Small Area Income and Poverty Estimates

Acronym	Definition
SASP	State Aviation System Plan
SCEC	State Climate Extremes Committee
SDS	Safety Data Sheets
SDWA	Safe Drinking Water Act
SGCN	Species of Greatest Conservation Need
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SO2	Sulfur Dioxide
SOC	Standard Occupational Classification
SOP	Standard Operating Procedure
SOW	Site on Wheels
SOX	Sulfur Oxides
SPL	Sound Pressure Level
STATSGO2	State Soil Geographic
SUA	Special Use Airspace
SWAP	State Wildlife Action Plan
SWPPP	Stormwater Pollution Prevention Plan
T.C.A.	Tennessee Code Annotated
TACN	Tennessee Advanced Communications Network
TAR	Tennessee Administrative Register
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment and Conservation
TDOC	Tennessee Department of Corrections
TDTD	Tennessee Department of Tourist Development
TEMA	Tennessee Emergency Management Agency
TFR	Temporary Flight Restriction
THP	Tennessee Highway Patrol
TNDLWD	Tennessee Department of Labor and Workforce Development
TNDOH	Tennessee Department of Health
TOSHA	Tennessee Occupational Safety and Health Administration
TPY	Tons per year
TRA	Tennessee Regulatory Authority
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TVA	Tennessee Valley Authority
TVRCS	Tennessee Valley Regional Communications System
TWA	Time Weighted Average
TWRA	Tennessee Wildlife Resources Agency
TYS	McGhee Tyson Airport
U.S.	United States

Acronym	Definition
U.S.C.	U.S. Code
UA	Unmanned Aircraft
UAS	Unmanned Aerial Systems
UHF	Ultra High Frequency
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
UVA	University of Virginia
VDGIF	Virginia Department of Game and Inland Fisheries
VFR	Visual Flight Rules
VHF	Very High Frequency
VOC	Volatile Organic Compound
WCS	Wetlands Classification Standard
WONDER	Centers for Disease Control and Prevention Wide-ranging Online Data for Epidemiologic Research
WWII	World War II
XP	Experimental Population

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