Boone Dam Seepage Remediation

FINAL ENVIRONMENTAL ASSESSMENT

JANUARY 2016

TENNESSEE VALLEY AUTHORITY

This page intentionally left blank.

Document Type: EA-Administrative Record
Index Field: Final Environmental Assessment
Project Name: Boone Dam Seepage Remediation
Project Number: 2015- 15

Boone Dam Seepage Remediation

Final Environmental Assessment

January 2016

For Information Contact:

Matthew Higdon, NEPA Specialist
Tennessee Valley Authority
400 West Summit Hill Drive, WT 11D
Knoxville, Tennessee 37902-1499
Phone: 865-632-8051
Email: mshigdon@tva.gov

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 PROJECT LOCATION AND DESCRIPTION 1-1
1.2 BACKGROUND 1-7
1.2.1 Prior Related Activities and NEPA Compliance 1-7
1.3 PURPOSE AND NEED FOR ACTION 1-9
1.4 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT 1-9
1.5 SIMILAR AND CONNECTED ACTIONS 1-10
1.5.1 Related Actions to Address Near-Term Needs 1-10
1.5.2 Related Actions to Address Long-Term Needs 1-11
1.6 RELATED ENVIRONMENTAL REVIEWS 1-12
1.7 PUBLIC INVOLVEMENT 1-13

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES 2-1
2.1 NO ACTION – NO BOONE DAM REMEDIATION AND CONTINUE INTERIM OPERATIONS 2-1
2.2 PROPOSED ACTION – REMEDIATE BOONE DAM AND RETURN TO NORMAL OPERATIONS 2-2
2.2.1 Construction 2-2
2.2.2 Construction Support and Management of Excess Rock and Soil 2-5
2.2.3 Reservoir Drawdown and Interim Operations 2-6
2.2.4 Summary of TVA Commitments and Proposed Mitigation Measures 2-6
2.3 OTHER ALTERNATIVES EVALUATED, BUT DISMISSED FROM FURTHER CONSIDERATION 2-9
2.4 ENVIRONMENTAL RESOURCES CARRIED FORWARD 2-16
2.5 COMPARISON OF ALTERNATIVES 2-18
2.6 THE PREFERRED ALTERNATIVE 2-18

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES 3-1
3.1 BACKGROUND FOR ENVIRONMENTAL ANALYSIS 3-1
3.1.1 Boone Project Operations 3-1
3.1.1.1 Normal Operations (Prior to October 2014) 3-1
3.1.1.2 Normal Flood Control Operations 3-4
3.1.1.3 Interim Operations during Dam Remediation 3-5
3.1.1.4 Interim Flood Control Operations 3-6
3.1.2 General Characterization of Drawdown 3-6
3.2 GEOLOGIC RESOURCES 3-12
3.2.1 Affected Environment 3-12
3.2.2 Environmental Consequences 3-13
3.2.2.1 No Action Alternative 3-13
3.2.2.2 Proposed Action 3-14
3.3 WATER RESOURCES 3-15
3.3.1 Affected Environment 3-15
3.3.2 Environmental Consequences 3-24
3.3.2.1 No Action Alternative 3-24
3.3.2.2 Proposed Action 3-26
3.4 FLOODPLAINS AND FLOOD RISK 3-29
3.4.1 Affected Environment 3-29
3.4.2 Environmental Consequences 3-31
3.4.2.1 No Action Alternative 3-31
3.4.2.2 Proposed Action 3-32

3.5 WETLANDS 3-34
3.5.1 Affected Environment 3-34
3.5.2 Environmental Consequences 3-36
3.5.2.1 No Action Alternative 3-36
3.5.2.2 Proposed Action 3-39
3.6 TERRESTRIAL ECOLOGY 3-40
3.6.1 Affected Environment 3-40
3.6.2 Environmental Consequences 3-45
3.6.2.1 No Action Alternative 3-45
3.6.2.2 Proposed Action 3-46
3.7 AQUATIC ECOLOGY 3-48
3.7.1 Affected Environment 3-48
3.7.2 Environmental Consequences 3-53
3.7.2.1 No Action Alternative 3-53
3.7.2.2 Proposed Action 3-55
3.8 THREATENED AND ENDANGERED SPECIES 3-57
3.8.1 Affected Environment 3-57
3.8.2 Environmental Consequences 3-63
3.8.2.1 No Action Alternative 3-63
3.8.2.2 Proposed Action 3-64
3.9 HISTORIC AND CULTURAL RESOURCES 3-65
3.9.1 Affected Environment 3-65
3.9.2 Environmental Consequences 3-67
3.9.2.1 No Action Alternative 3-67
3.9.2.2 Proposed Action 3-68
3.10 AIR QUALITY 3-69
3.10.1 Affected Environment 3-69
3.10.2 Environmental Consequences 3-71
3.10.2.1 No Action Alternative 3-71
3.10.2.2 Proposed Action 3-71
3.11 SOCIOECONOMICS 3-72
3.11.1 Affected Environment 3-72
3.11.2 Environmental Consequences 3-83
3.11.2.1 No Action Alternative 3-87
3.11.2.2 Proposed Action 3-100
3.12 RECREATION 3-103
3.12.1 Affected Environment 3-104
3.12.2 Environmental Consequences 3-108
3.12.2.1 No Action Alternative 3-108
3.12.3 Proposed Action 3-110
3.13 VISUAL RESOURCES 3-111
3.13.1 Affected Environment 3-111
3.13.2 Environmental Consequences 3-115
3.13.2.1 No Action Alternative 3-115
3.13.2.2 Proposed Action 3-116
3.14 NOISE 3-117
3.14.1 Affected Environment 3-117
3.14.2 Environmental Consequences 3-118
3.14.2.1 No Action Alternative 3-118
3.14.2.2 Proposed Action 3-118
3.15 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY 3-120
3.15.1 Affected Environment 3-120
3.15.2 Environmental Consequences 3-122
3.15.2.1 No Action Alternative 3-122

3.15.2.2 Proposed Action 3-122
3.16 WASTE MANAGEMENT 3-124
3.16.1 Affected Environment 3-124
3.16.2 Environmental Consequences 3-125
3.16.2.1 No Action 3-125
3.16.2.2 Proposed Action 3-125
3.17 TRANSPORTATION 3-125
3.17.1 Affected Environment 3-126
3.17.2 Environmental Consequences 3-128
3.17.2.1 No Action 3-128
3.17.2.2 Proposed Action 3-129
3.18 LAND USE 3-130
3.18.1 Affected Environment 3-130
3.18.2 Environmental Consequences 3-132
3.18.2.1 No Action Alternative 3-132
3.18.2.2 Proposed Action 3-132

4.0 CUMULATIVE IMPACTS 4-1
4.1 POTENTIAL CUMULATIVE IMPACTS 4-3
4.1.1 Geologic Resources 4-3
4.1.2 Water Resources 4-4
4.1.3 Floodplains and Flood Risk 4-4
4.1.4 Wetlands 4-4
4.1.5 Terrestrial Ecology 4-4
4.1.6 Aquatic Ecology 4-5
4.1.7 Threatened and Endangered Species 4-5
4.1.8 Cultural and Historic Resources 4-5
4.1.9 Air Quality 4-6
4.1.10 Socioeconomics 4-6
4.1.11 Recreation 4-6
4.1.12 Visual Resources 4-7
4.1.13 Noise 4-7
4.1.14 Public and Occupational Health and Safety 4-8
4.1.15 Waste Management 4-8
4.1.16 Transportation 4-9
4.1.17 Land Use 4-9

5.0 LIST OF PREPARERS 5-1

6.0 ENVIRONMENTAL ASSESSMENT DISTRIBUTION LIST 6-1

7.0 REFERENCES 7-1

LIST OF APPENDICES

Appendix A: Responses to Comments Received on the Draft Environmental Assessment

LIST OF TABLES

Table 1-1: Site Preparation and Interim Risk Reduction Measures NEPA Compliance 1-7
Table 1-2: Related Actions to Address Near-Term Needs.....1-11
Table 2-1: Remediation Alternatives Evaluated but Dismissed from Further Consideration ..2-10
Table 2-2: Environmental Resource Areas with No, Negligible, or Temporary Impacts 2-17
Table 2-3: Comparison of Impacts of the No Action Alternative and the Proposed Action.....2-19
Table 3-1: Summary of Normal and Interim Operations for the Boone Project.....3-2
Table 3-2: Boone Dam Generation Units Capacities at a Tailwater Elevation of 1,265 Feet 3-4
Table 3-3: Distance and Slope from Normal Operations Summer Full Pool (1,382 feet) to Interim Operations Target Pool (1,352 feet).....3-7
Table 3-4: Distance and Slope from Normal Operations Winter Pool (1,362 feet) to Interim Operations Target Pool (1,352 feet).....3-7
Table 3-5: Surface Water Quality Data Collected by TVA at Boone Reservoir and Tailwater 3-20
Table 3-6: Background Water Quality Data Collected Near the Stone Tailrace Filter 3-23
Table 3-7: Sport Fishing Index (SFI) Scores and Spring Sportfish Survey at Boone Reservoir (2008).....3-50
Table 3-8: TVA's Spring Sportfish Survey at Boone Reservoir (2003–2008) 3-51
Table 3-9: TWRA Fish Stocking Rates for Three Key Sportfish Species in Boone Reservoir (2005–2014).....3-51
Table 3-10: TWRA Fish Stocking Rates for Three Key Sportfish Species in the Boone Dam Tailwater and upper FPH Reservoir (2005–2014).....3-52
Table 3-11: State or Federally Protected Plant Species Documented within 5 Miles of Boone Dam and Reservoir.....3-58
Table 3-12: Terrestrial Animal Species Potentially Occurring at Boone Dam and Reservoir .3-59
Table 3-13: Average Emissions for Sullivan and Washington Counties (2011).....3-70
Table 3-14: 2010 Population, Area, and Population Density in the Socioeconomics Analysis Area.....3-74
Table 3-15: Income, Unemployment, and Employment in the Socioeconomics Analysis Area ..3-74
Table 3-16: Value of Sales, Shipments, Receipts, Revenue, or Business for the Socioeconomics Analysis Area (2012 dollars [thousands]).....3-75
Table 3-17: Estimate of Total Annual Direct Economic Impact from a Change in User Days under Normal Reservoir Operations (2015 dollars [thousands]) 3-76
Table 3-18: Characteristics of Marinas within the Socioeconomics Analysis Area.....3-77

Table 3-19: Number and Value of Residential Properties on Boone Reservoir (2015 dollars)...3-80

Table 3-20: Minority Population in the Environmental Justice Study Area (2013).....3-83

Table 3-21: Low Income Percentage in the Environmental Justice Study Area (2013).....3-83

Table 3-22: Estimated Annual Economic Output and Community Impacts of the Proposed Action and No Action Alternatives (all dollars in 2015).....3-85

Table 3-23: Summary of Annual Changes in Estimated Economic Impacts of the Proposed Action and No Action Alternative Compared to Normal Operations.....3-86

Table 3-24: Annual Estimate of Change in Recreational User Days and Direct Economic Impacts under the No Action Alternative Compared to Normal Operations.....3-87

Table 3-25: Functionality of Boone Reservoir Marinas under the No Action Alternative (Percent Functional Compared to Normal Operations).....3-88

Table 3-26: Economic Impacts of Boone Dam Remediation-Related Construction from 2016 to 2022 (2015 dollars – millions).....3-102

Table 3-27: State and Local Government Revenue Impacts of Boone Dam Remediation-Related Construction from 2016 to 2022 (2015 dollars – millions).....3-103

Table 3-28: Developed Facilities and Associated Amenities on Boone Reservoir.....3-105

Table 3-29: Estimates of Developed Recreation User Days at Boone Reservoir under Normal Operations by Activity.....3-106

Table 3-30: Estimated Number of Developed Annual Recreational User Days by Category3-107

Table 3-31: Projected Number of Recreational User Days under the No Action Alternative 3-108

Table 3-32: Maximum Noise Levels at 50 feet for Common Construction Equipment.....3-119

Table 3-33: Existing Traffic Volumes in the Project Vicinity (2013 and 2014).....3-128

Table 4-1: Projects Identified for Consideration in the Cumulative Impacts Analysis.....4-2

Table 5-1: Environmental Assessment Project Team.....5-1

LIST OF FIGURES

Figure 1-1: General Project Location.....1-2

Figure 1-2: Conceptual Schematic of Stage 1 Construction of Seepage Barrier.....1-4

Figure 1-3: Conceptual Schematic of Stage 2 Construction of Seepage Barrier.....1-4

Figure 1-4: Conceptual Schematic of Stage 3 Construction of Seepage Barrier.....1-5

Figure 1-5: Conceptual Schematic of Completed Construction of Seepage Barrier.....1-5

Figure 1-6: Construction Areas at the Project Site.....1-6

Figure 2-1: Proposed Expansion of Construction Zone.....2-4

Figure 3-1: Boone Reservoir Operating Guides.....3-3

Figure 3-2: Boone Reservoir Drawdown Zones – Overview.....3-8

Figure 3-3: Boone Reservoir Drawdown Zones – Boone Reservoir.....3-9

Figure 3-4: Boone Reservoir Drawdown Zones – Watauga Arm 3-10
Figure 3-5: Boone Reservoir Drawdown Zones – South Holston Arm 3-11
Figure 3-6: Conceptual Illustration of Hydrogeologic Flow Regime beneath Boone Dam 3-17
Figure 3-7: Temperature and DO Profiles Measured during July 2013 and December 2014 3-21
Figure 3-8: Monthly Grab Sample Records of DO and Temperature Measured in the Boone Dam Tailwater Prior to Drawdown 3-22
Figure 3-9: Continuous DO and Temperature Measured at Tailwater Station TW-Float 1 Downstream of Boone Dam After Drawdown 3-24
Figure 3-10: Boone Dam FEMA FIRM Map 3-30
Figure 3-11: Socioeconomics Analysis Area – Sullivan and Washington Counties 3-73
Figure 3-12: Boone and Fort Patrick Henry Reservoir Recreation Sites 3-78
Figure 3-13: South Holston Reservoir Recreation Sites 3-79
Figure 3-14: Location of Residential Parcels Surrounding Boone Reservoir 3-82
Figure 3-15: Steep Slope Access Parcels 3-91
Figure 3-16: Gradual Slope Access Parcels 3-92
Figure 3-17: No Access Parcels 3-92
Figure 3-18: Example of Highest Density Parcels (dark red) with a 'No Access' Impact under the No Action Alternative 3-96
Figure 3-19: Example of Highest Density Parcels (dark red) with a 'Gradual Slope' Impact under the No Action Alternative 3-97
Figure 3-20: Example of High Density Parcels (dark red) with a 'Steep Slope' Impact under the No Action Alternative 3-98
Figure 3-21: Local Road Network, Traffic Counts, and Access Routes 3-127
Figure 3-22: Approximate Percent of Boone Reservoir Acreage by Land Use Zone 3-131

LIST OF PHOTOS

Photo 3-1: Growth of Weedy Species on Exposed Reservoir Bottom during the First Growing Season Following the Drawdown 3-37
Photo 3-2: Exposed Cave Opening below the Typical Summer Pool Level 3-64
Photo 3-3: Photograph of Steep Slope Access Parcel 3-94
Photo 3-4: Photograph Gradual Slope Access Parcel 3-94
Photo 3-5: Photograph of No Access Parcels 3-95
Photo 3-6: View of Forested Area at Boone Reservoir 3-113
Photo 3-7: View of Single-Family Residences and Boat Docks 3-113

Photo 3-8: View of Marina at Boone Reservoir 3-114
Photo 3-9: Aerial Photograph of Boone Dam and Hydroelectric Power Plant Facilities 3-114
Photo 3-10: Ongoing Construction Activities at Boone Dam 3-115

LIST OF ACRONYMS

Acronym	Definition
AADT	Average Annual Daily Traffic
AGC	automatic generation control
APE	Area of Potential Effect
AQCR	air quality control region
BMP	best management practices
CAA	Clean Air Act
CEC	Categorical Exclusion Checklist
CFR	Code of Federal Regulations
cfs	cubic feet/second
CO	carbon monoxide
dB	decibel
dBA	decibel A-weighted
DNL	day-night average sound level
DO	dissolved oxygen
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FICON	Federal Interagency Committee on Noise
FPH	Fort Patrick Henry
HABS	Historic American Building Survey
HAER	Historic American Engineering Record
HUC	Hydrologic Unit Code
HUD	Housing and Urban Development
IRRM	Interim Risk Reduction Measure
Leq[24]	equivalent sound level for 24 hours
MEL	Most Efficient Load
mgd	million gallons per day
mg/m^3	micrograms per cubic meter
mg/L	milligrams per liter
MSL	Maximum Sustainable Load
msl	mean sea level
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
O_3	ozone

LIST OF ACRONYMS CONTINUED

Acronym	Definition
OSHA	Occupational Safety and Health Administration
PA	Programmatic Agreement
Pb	lead
PCB	polychlorinated biphenyls
PM_{10}	particulate matter whose particles are greater than or equal to 10 micrometers
ppm	parts per million
REHP	Reservoir Ecological Health Program
RFAI	Reservoir Fisheries Assemblage Index
RLMP	Reservoir Land Management Plan
RM	river mile
ROS	Reservoir Operations Study
SFI	Sport Fishing Index
SH	State Highway
SHPO	State Historic Preservation Officer
SO_2	sulfur dioxide
SR	State Route
SWPPP	Stormwater Pollution Prevention Plan
TDEC	Tennessee Department of Environmental Conservation
TDOT	Tennessee Department of Transportation
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound

CHAPTER 1

1.0 INTRODUCTION

The Tennessee Valley Authority (TVA) was established by an act of Congress in 1933 to address a wide range of economic, environmental, and technological issues including delivery of low-cost electricity and management of natural resources. TVA operates the largest public power system in the United States, selling electricity to 155 municipal and cooperative distributors; 57 large industries and federal facilities; and more than 9 million people located across 80,000 square miles in most of the State of Tennessee and parts of the States of Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Virginia.

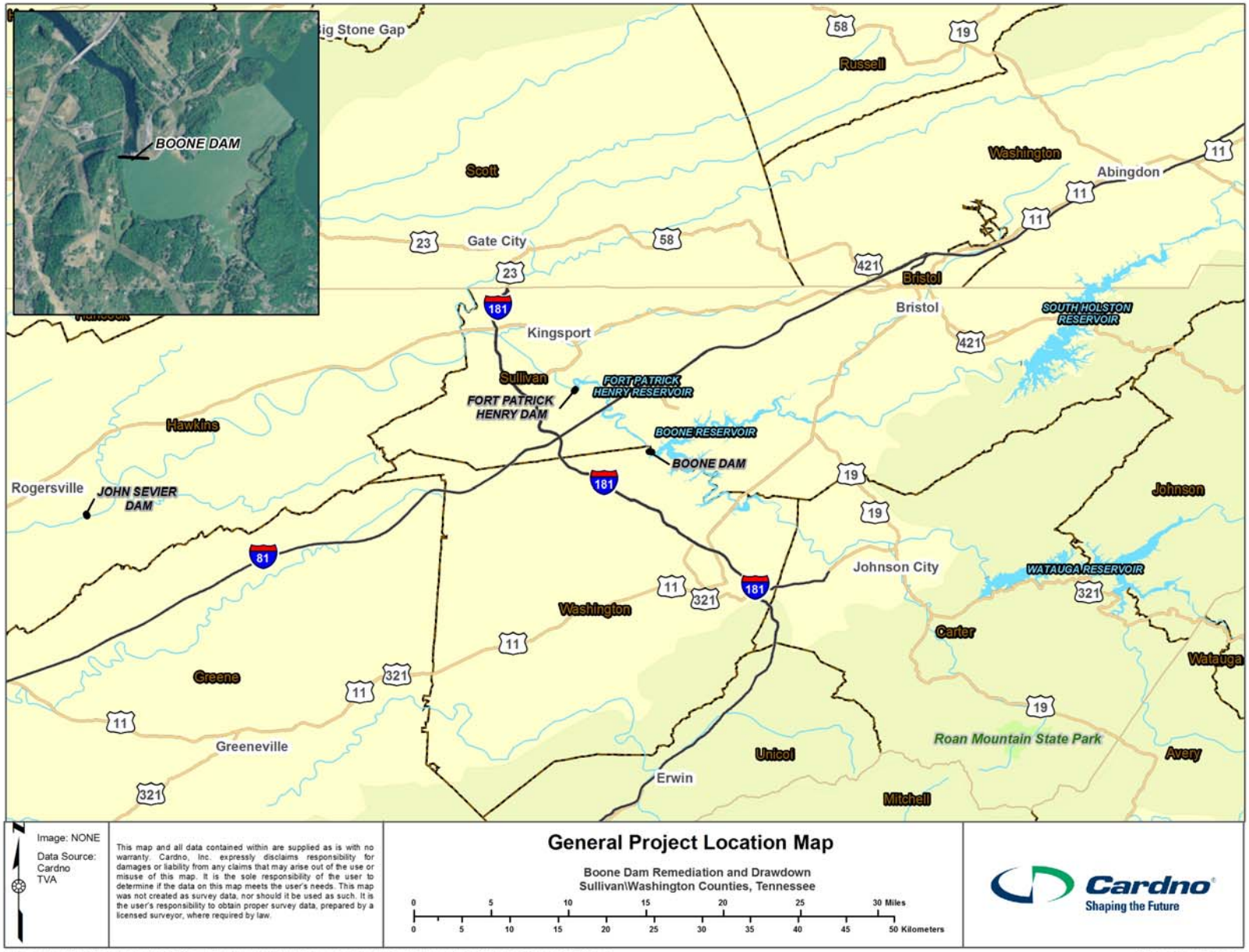
As stated in the TVA Act, TVA is to "improve the navigability and to provide for the flood control of the Tennessee River; to provide for reforestation and the proper use of marginal lands in the Tennessee Valley; to provide for agricultural and industrial development of said valley; [and] to provide for the national defense...". A fundamental part of this mission was the construction and operation of an integrated system of dams and reservoirs. As directed by the TVA Act, TVA uses this system to manage the water resources of the Tennessee River for the purposes of navigation, flood control, power production, and a wide range of other public benefits consistent with these purposes.

1.1 PROJECT LOCATION AND DESCRIPTION

TVA's Boone Dam is a multi-purpose dam on the South Fork Holston River, on the border between Sullivan and Washington Counties in Tennessee (Figure 1-1). Completed in 1952, the dam is 160 feet high and stretches 1,697 feet across the South Fork Holston River, impounding the 4,500-acre Boone Reservoir and providing a winter flood storage capacity of 81,580 acre-feet. In October 2014, a small sinkhole and seepage was discovered at the base of the dam that indicates a potential risk to the integrity of a section of the dam's earthen embankment. TVA responded to the discovery by taking immediate interim risk reduction measures (IRRMs) for the protection of public safety. These measures included repairing the small sinkhole, constructing a tailrace filter[1] to minimize further deterioration of the dam, closing the dam reservation (areas managed for the purpose of supporting operation and maintenance of the dam and associated infrastructure) to the public, installing a network of sensors to monitor the dam, and lowering the pool elevation to between 1,350 and 1,355 feet (roughly 10 feet below normal winter pool levels). As part of the IRRMs, TVA also began Interim Operations at Boone Dam that included lower reservoir levels, limited seasonal reservoir pool fluctuation, modified releases into the tailwater for hydropower generation, 24-hour inspection, and modified flood control operations. The change in operations was integral to the continued operation of the dam. TVA also promptly began a detailed study, described further in Chapter 2, of the cause of the seepage and potential alternatives for remediation of Boone Dam.

[1] A tailrace filter was installed at the seepage outlet point on the river bank. This consisted of graded layers of sand and stone aggregate designed to trap and filter suspended, eroded soils that were being lost with the seepage flows. To prevent scour, the berm was covered with large, grout-filled bags.

Figure 1-1: General Project Location



After extensive investigation, TVA has developed a proposal to remediate the seepage and has prepared this Environmental Assessment (EA) to consider its potential environmental impacts. The project involves remediating the seepage of water and sediment under Boone Dam by constructing a composite seepage barrier from the crest of the dam embankment downward into the foundation soils, weathered bedrock, and underlying bedrock beneath the dam. Construction of a composite seepage barrier would occur in stages, with the barrier consisting of an injected grout curtain and an excavated and filled concrete diaphragm wall (Figures 1-2 through 1-6). The composite seepage barrier would reduce movement of water through the dam's foundation and underlying bedrock, and would make the reoccurrence of seepage connection from the reservoir unlikely.

TVA proposes to first install a grout curtain into the dam's foundation soils, weathered bedrock, and underlying bedrock. Creation of the grouting curtain would entail drilling through the dam's earthen embankment into the foundation soils and epikarst[2] (in Stage 1) and bedrock (in Stage 2) to target the weathered rock and soil interface. Grout, which is commonly composed of various combinations of cement with sand, water, and other additives, would be injected under controlled pressures and flow rates into numerous holes drilled on multiple lines along the crest of the embankment (conceptually illustrated in Figures 1-2 and 1-3). Hardening after injection, the linear grouting injections would form a vertical curtain beneath and within the dam's embankment. In Stage 3, TVA would construct a concrete diaphragm wall along the same alignment as the grouting by excavating deep trenches into the dam's embankment into which concrete would be poured (conceptually illustrated in Figure 1-4). Finally, TVA would restore the dam's crest and return the reservoir to Normal Operations (conceptually illustrated in Figure 1-5).

Construction activities such as fencing, security, utility relocations, grading, access roadways, and other site improvements associated with this project would be primarily restricted to the Boone TVA reservation locations (Figure 1-6). The construction activity would include the current construction area previously approved for implementation of the IRRMs and additional construction areas adjacent or in close proximity to the current construction area. Fill materials from excavation would be hauled to one of two proposed Construction Support Areas on TVA land adjacent to or near the dam reservation (Construction Support Area 1, also referred to as the Earl Light Tract and Construction Support Area 2, also referred to as Tract 22R; see Figure 1-6). Under this proposal, TVA would maintain Interim Operations for the 5- to 7-year duration of the project. Typical reservoir elevations would be maintained between 1,350 and 1,355 foot mean sea level (msl) under this operations policy with temporary variations outside the range for special operations and flood control operations.

[2] The interval of soil and rock at the top of the karstic rock surface is termed "epikarst."

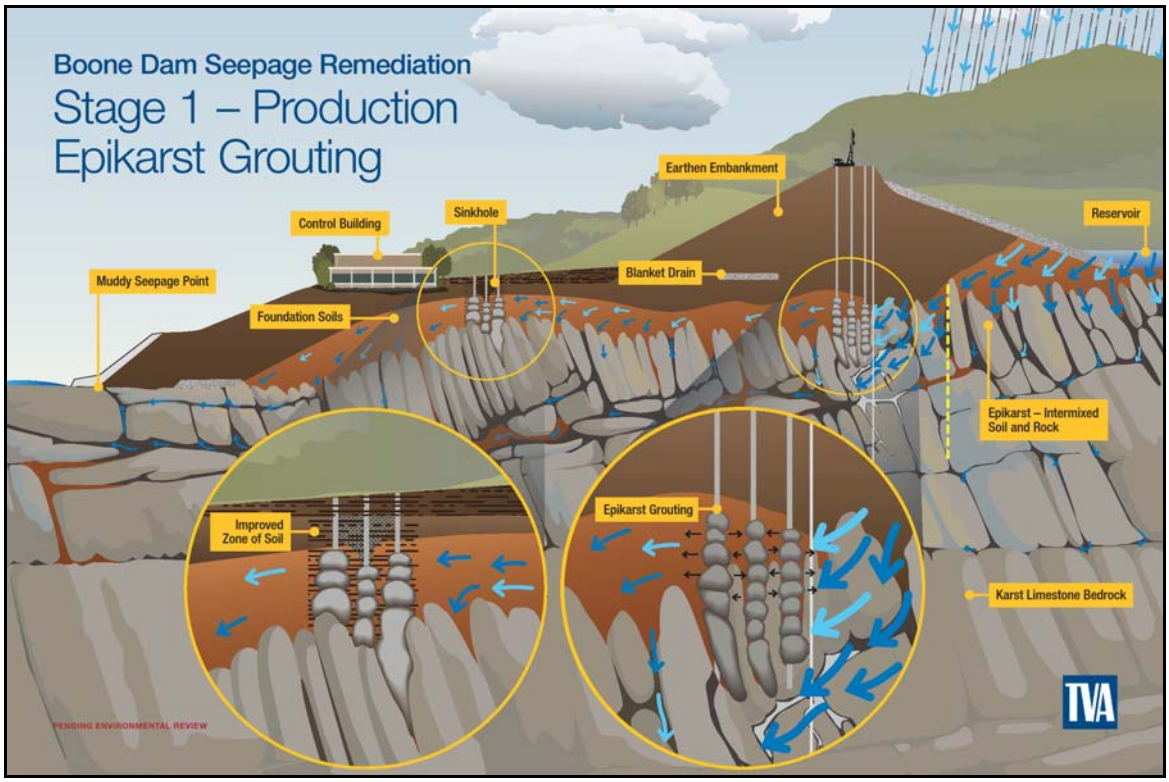


Figure 1-2: Conceptual Schematic of Stage 1 Construction of Seepage Barrier

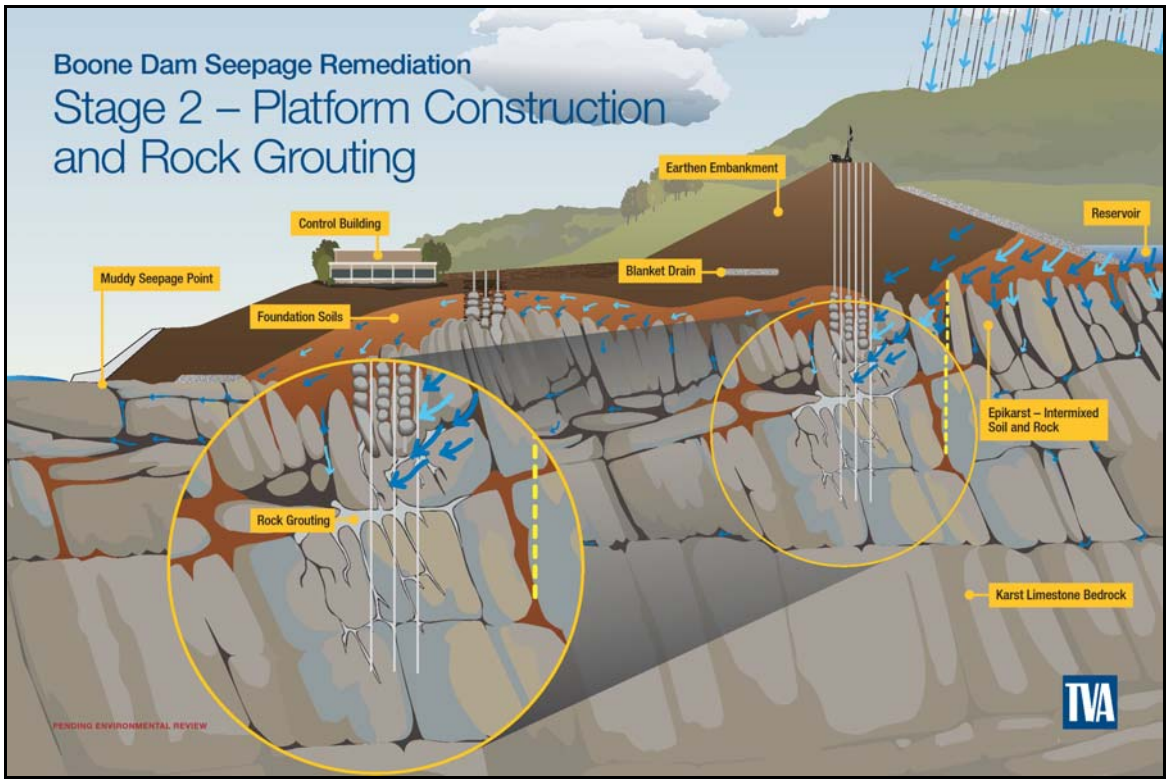


Figure 1-3: Conceptual Schematic of Stage 2 Construction of Seepage Barrier

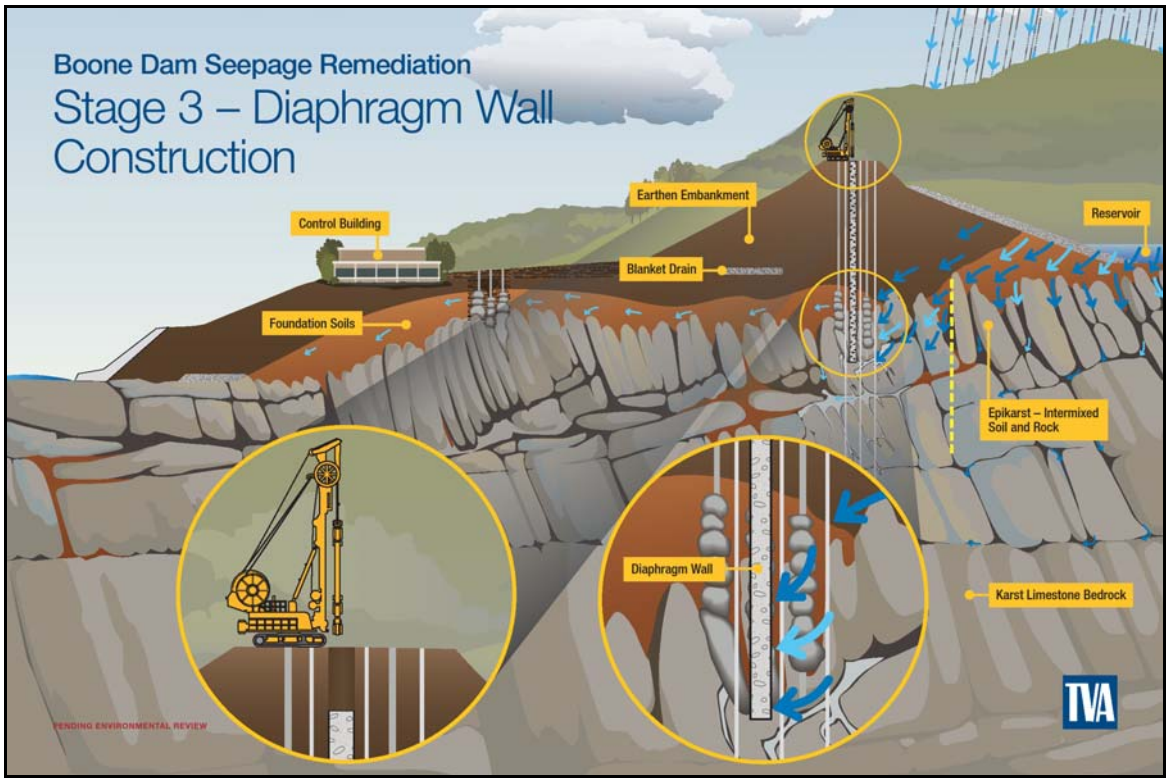


Figure 1-4: Conceptual Schematic of Stage 3 Construction of Seepage Barrier

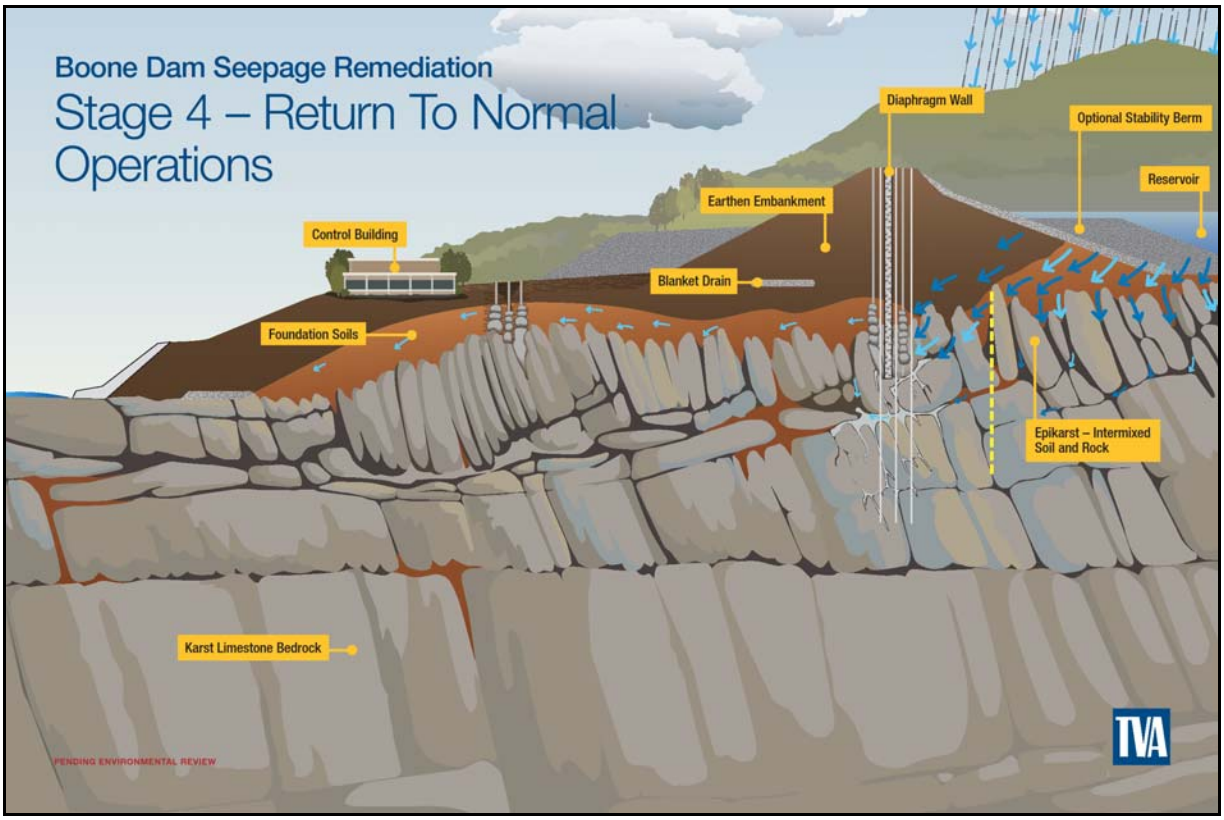
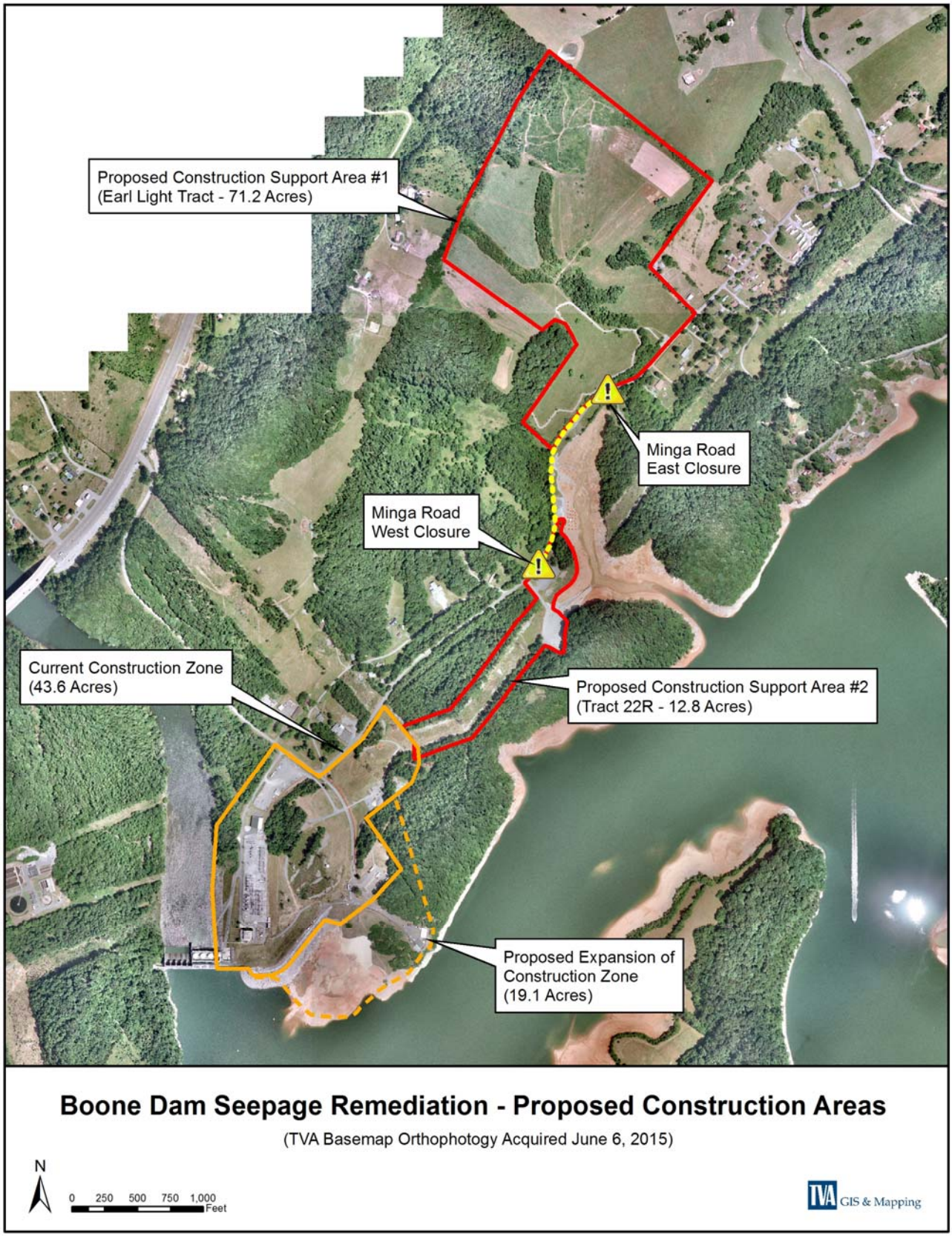


Figure 1-5: Conceptual Schematic of Completed Construction of Seepage Barrier

Figure 1-6: Construction Areas at the Project Site



1.2 BACKGROUND

On October 20, 2014, TVA engineers at the facility became aware of a small sinkhole at the base of the earthen embankment in a small parking lot adjacent to the facility's control building. The sinkhole was subsequently repaired. On October 26, 2014, inspectors discovered a small amount of water and sediment seeping from the riverbank below the dam near the location of the original sinkhole. Although seepage is not uncommon, seepage that carries sediment is. TVA conducted an urgent drawdown of the reservoir waters as a precaution to minimize threats to public safety and to allow engineers to inspect the dam's structure. TVA also closed areas at the dam to the public. TVA engineers began to investigate the cause of the seepage and to identify and design the necessary immediate and long-term measures to address the seepage.

1.2.1 Prior Related Activities and NEPA Compliance

TVA implemented a number of remedial activities as IRRMs upon learning of the seepage under the dam and began a number of site investigations and actions (see Table 1-1). Many of these remedial actions consisted of IRRMs or involved the preparation of the dam reservation for staging future remediation activities. Concurrently, TVA began to study long-term remedial alternatives for remediation and dam safety. The IRRMs (described further in this section) had independent utility.

Table 1-1: Site Preparation and Interim Risk Reduction Measures NEPA Compliance

Action	Status	Description
Installation of a stone tailrace filter	National Environmental Policy Act (NEPA) review completed in January 2015 in a Categorical Exclusion Checklist (CEC)	TVA installed a stone tailrace filter on the river bank at the seepage outlet point to minimize further deterioration of the dam. Some work took place below the high water line. In order to access the work location safely, a stone access road was installed along the bank. No trees were disturbed and the road will be removed upon completion of work. CEC was updated to include the construction of a breakwater structure in the tailrace[3] discharge in front of units 1, 2, and 3. Breakwater will act as a cofferdam to allow for access to seepage discharge point. Additional work included repair of the undermined portion of the draft tube outlet aprons and use of grout bags to armor the filter.
Initial site preparation and remedial activities	NEPA review completed in March 2015 in a CEC	TVA lowered the reservoir pool elevation to between approximately 1,350 and 1,355 feet (roughly 10 feet below winter pool levels) and exercised an emergency action plan. TVA assigned on-site inspectors to the dam for continuous surveillance. TVA prepared the area for the upcoming remediation activities by installing best management practices (BMPs); constructing laydown areas and haul roads; and installing security fencing, a control gate, temporary lighting, cameras, and an automated network of sensors to monitor pressures and movements that may occur within the dam. Minor grouting for structural support from within the control building parking lot at the site of the sinkhole also occurred. This grouting occurred adjacent to the control building, and between the control building and the powerhouse.

[3] Tailrace refers to the channel of water immediately below Boone Dam.

Table 1-1: Site Preparation and Interim Risk Reduction Measures NEPA Compliance

Action	Status	Description
		Grouting activities were preceded by test grouting in a smaller area of the parking lot to determine the most effective type of grouting method for the final remediation as well as to gain a better understanding of geological conditions below the earthen embankment. TVA continues to conduct test grouting to support design efforts and development of construction plans and technical specifications.
Installation of a new boat dock	NEPA review completed in May 2015 in a CEC	TVA installed a new boat dock in the forebay at Boone Dam, which is used to moor inspection boats for the duration of the project.
Drainage improvements and utility relocations	NEPA review completed in June 2015 in a CEC	TVA will implement drainage improvements and utility relocations that will involve re-grading the areas downstream of the dam (parking lot and areas adjacent to the control building and switchyard) to direct surface runoff away from the dam; modifying the existing storm-water collection system to develop a system separate from the internal drainage system within the dam; and constructing new stormwater outfalls. TVA also repaired or relocated existing utilities servicing the powerhouse and control building; abandoned and removed the existing potable water line along the groin of the dam; and installed a new line from the main entrance to the recreation area along the powerhouse access road to the control building. Existing underground electric lines will be relocated. TVA will demolish the existing parking lot east of the control building and re-grade this area. Finally, TVA installed a rock covered path down to the river bank in the project area to make accessing the river easier
Additional construction laydown areas	NEPA review completed in June 2015 in a CEC	TVA added one new construction laydown area.
Site improvement, office trailer installation, and additional parking areas	NEPA review completed in September 2015 in a CEC	TVA will implement the following improvements: construction of additional parking areas, installation of a proposed office trailer area, helipad, and construction of an alternative site access road. Additional office trailers and support connex boxes will also be erected on site and the existing restroom facility at the right abutment of the dam will be removed.
Investigative grouting and access modification	NEPA review completed in October 2015 in a CEC	TVA will conduct exploration grouting from the crest of the dam to collect information for design of the composite seepage barrier components. This exploration grouting consists of low mobility grouts and high mobility grouts to determine design depths for the composite seepage barrier and estimates of quantities, and requires lowering the earthen portion of the dam 10 vertical feet to create more surface area on which to perform the work. This measure is needed to improve the safety of those working on the dam's crest. *Note: the embankment height would remain at the lower height during the duration of the proposed seepage remediation project and would be returned to its original condition at the end of the project.*

Although these initial remediation activities were and are associated with Proposed Action described in this EA, TVA reviewed the activities in separate NEPA reviews, specifically in Categorical Exclusion Checklists (CEC). The CECs were completed so that site preparation and interim stabilization efforts could be initiated as soon as possible, given the uncertain nature and extent of the seepage from the dam. In addition, the CECs informed the design and development of construction plans for the various remediation alternative. Based on these environmental reviews, TVA has determined that the initial remediation actions would result in only minor temporary impacts at the Boone Dam reservation and facility. In addition, the cumulative effects of these actions are analyzed together with the Proposed Action in Chapter 4.

1.3 PURPOSE AND NEED FOR ACTION

The purpose of the project is to reduce the current risk to the public's safety and welfare posed by seepage flows eroding soils from under Boone Dam and reduce the potential erosion of the earthen embankment of Boone Dam. The project also would allow TVA to return the Boone Dam and Reservoir to normal operations in furtherance of TVA's statutory mission to manage the Tennessee River system, its tributaries, and its associated resources.

The need for the project arises from the ongoing seepage flows of water and sediment beneath the dam that with time would undermine the foundation of the embankment dam. If left unaddressed, continued internal erosion may lead to enlargement of the network of underground voids, at which time a large influx of water into the voids could rapidly accelerate erosion and eventually breach the dam. The project would remediate the seepage and allow TVA to continue normal operation of the dam for flood control, water supply, hydroelectric power, and recreation—both in the reservoir and in the dam's tailwater. Although dam failure is unlikely given the IRRM measures, the continued safety of the communities downstream of Boone Dam is TVA's paramount concern.

1.4 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT

Pursuant to NEPA and the Act's implementing regulations promulgated by the Council on Environmental Quality (40 Code of Federal Regulations [CFR] 1500–1508), federal agencies are required to evaluate the potential environmental impacts of any proposals for major federal actions. TVA prepared this EA to assess the potential consequences of TVA's Proposed Action on the environment and human health in accordance with NEPA and TVA's guidelines for implementing NEPA (TVA 1983).

Under NEPA, TVA considers the Proposed Action to consist of both construction of the composite seepage barrier at Boone Dam and the associated long-term drawdown of the reservoir. The scope of environmental consequences evaluated in this EA includes impacts related to construction of the proposed project and continued operation according to its current Interim Operations.

This EA describes the existing environment at the project site, analyzes potential environmental impacts associated with the Proposed Action and the No Action Alternative, and identifies and characterizes cumulative impacts that could result from the proposed project in relation to other ongoing or reasonably foreseeable proposed activities within the surrounding area of the project site.

For the purposes of this EA, the geographic area for the environmental analysis is defined as the Boone Dam and Reservoir; areas of Fort Patrick Henry (FPH) Dam and Reservoir affected by project operations (i.e., generation and flow releases) at Boone Dam, and the surrounding shoreline areas directly or indirectly affected by construction or changes in operation; and the nearby Construction Support Areas to be used for the placement of excavated soils, road construction, laydown areas, helipads, stockpile areas, office trailers, parking areas, work platform support services, and equipment and material staging areas. The socioeconomic analysis study area is larger, covering Washington and Sullivan Counties. This larger study area was used to ensure the analysis addresses the direct and indirect socioeconomic effects of the alternatives. The potential socioeconomic impacts were analyzed over the 5- to 7-year project duration for the Proposed Action and out to a 20-year horizon for both the Proposed Action and the No Action Alternative.

This EA consists of seven chapters discussing the project alternatives, environmental resources potentially affected, and analyses of impacts. The structure of the EA is outlined below:

- **Chapter 1.0:** Describes the purpose and need for the project, the decision to be made, related environmental reviews and consultation requirements, necessary permits or licenses, and the EA overview.
- **Chapter 2.0:** Describes the Action and No Action alternatives, provides a comparison of alternatives, and identifies the Preferred Alternative.
- **Chapter 3.0:** Discusses the affected environment and the potential direct and indirect impacts on these resource areas. Mitigation measures also are proposed, as appropriate.
- **Chapter 4.0:** Discusses cumulative impacts in relation to other ongoing or reasonably foreseeable proposed activities within the area surrounding the project site.
- **Chapters 5.0, 6.0, and 7.0:** Contain the list of preparers of this EA, the EA distribution list, and the literature cited in preparation of this EA, respectively.

1.5 SIMILAR AND CONNECTED ACTIONS

1.5.1 Related Actions to Address Near-Term Needs

As noted above, TVA is implementing a number of associated and related actions to address the near-term needs resulting from the reservoir drawdown. These actions were taken to address immediate reservoir access concerns and were reviewed before TVA determined that a long-term drawdown would be required to implement the long-term remediation project. The actions to address near-term needs are described in Table 1-2 and will be implemented prior to the decision on the Boone Dam remediation project.

Although these actions are also taken in response to the dam seepage and associated reservoir drawdown, TVA has reviewed and is reviewing these activities in separate NEPA documents (where applicable)—specifically CECs, to address independent and immediate reservoir access concerns.

Table 1-2: Related Actions to Address Near-Term Needs

Action	Status	Description
New Beach/ Recreation Area	NEPA review completed in September 2015 in a CEC	TVA is proposing to develop existing tracts of reservoir property adjacent to the Boone Dam reservation for temporary public recreation access to Boone Reservoir during the drawdown. The site is located on the right river bank of the South Fork Holston River, approximately 1/4 mile east of Boone Dam. The recreation site would include a boat ramp, a temporary public swimming/beach area, a parking area, security lighting, walking trails, and limited site access. Because accessing the proposed recreation area would require the public to cross a portion of the proposed Construction Support Area, TVA would implement safety and security measures to ensure the public's safety. Developing a new beach and recreation area is being considered as a measure to address reduced recreational access resulting from the temporary closure of the recreation facilities at Boone Dam and the reservoir drawdown.
Boat Ramp Extension at Pickens Bridge	NEPA review completed in September 2015 in a CEC	The boat ramp extension is located just south of the Pickens Bridge access area, on the left river bank of the Watauga River. The project includes a boat ramp extension, improved site access, an improved and expanded parking area, and roadway improvements. The project will provide public access to Boone Reservoir during the drawdown.
New Boat Ramp North of Devault Bridge	NEPA review completed in September 2015 in a CEC	The boat ramp is just north of Devault Bridge, on the right river bank of the South Fork Holston River. The project includes a boat ramp, site access, and a parking area. The project will provide public access to Boone Reservoir during the drawdown.
26a Permitting Allowances	Ongoing – permits recently issued, under review, and anticipated	TVA has offered to waive the fees associated with Section 26a permits to private property owners and marinas (e.g., ramps, stabilization, and rearranged slips) on Boone Reservoir.

1.5.2 Related Actions to Address Long-Term Needs

TVA is implementing other related actions to address long-term needs resulting from the reservoir drawdown. These actions are being taken to identify and mitigate impacts associated with the long-term reservoir drawdown.

TVA has launched a pilot program to provide loans to the Boone Reservoir marinas affected by the reservoir drawdown. The goal is to assist the marinas who need help to stay in business over the duration of the reservoir drawdown. In the program, the loans are at 0 percent interest until at least 12 months after the reservoir returns to normal operations. At that point, the loan

will be paid back over 15 years at 5.25 percent interest. The current total loan program is $550,000. TVA will determine later whether to offer additional amounts.

TVA is also considering taking action to address seepage of the right rim at the dam site. Data from instrumentation installed at the dam site have shown that groundwater flows under the dam embankment originate in the ridge to the east of the dam (in the right abutment or right rim of the project). Seepage from the right abutment area is recognized as a potential problem for the long-term performance of Boone Dam. However, more study is needed to characterize the problem, identify possible mitigations, and evaluate options. Many of the instruments needed to better understand the nature and areal extents of the problem were installed only recently. TVA will determine at a later date how to proceed to address this seepage, and will conduct additional environmental review if necessary.

1.6 RELATED ENVIRONMENTAL REVIEWS

In 2004, TVA completed a *Reservoir Operations Study* (ROS) and associated Programmatic Environmental Impact Statement (EIS) to review the policy that guides the day-to-day management of the Tennessee River and reservoir system. Consistent with the operating priorities established by the TVA Act, the reservoir operations policy sets the balance of trade-offs among competing uses of the water in the system. The policy directs how reservoir levels rise and fall, when changes in reservoir levels occur, and the amount of water flowing through the reservoir system at different times of the year. However, because TVA must respond to widely varying conditions in the operation of its reservoir system that are largely beyond TVA's control, its operations policy is a guideline that is implemented in a flexible manner. The ROS EIS (TVA 2004) was a programmatic review of TVA's operations throughout the Tennessee River Valley. It provides information about region-wide reservoir operations and data for specific reservoirs, including Boone Reservoir, as well as a description of potential environmental impacts related to TVA's operations of its reservoirs. The alternative selected based on the EIS changed the operation of Boone Dam by increasing the elevation of the winter pool level from 1,356 to 1,362 feet. This EA incorporates relevant information from the ROS EIS.

Management of TVA-managed reservoir lands currently are guided by the Boone Reservoir Land Management Plan (RLMP). The Boone RLMP was the result of a planning effort addressed by TVA in the *Northeastern Tributary Reservoirs Land Management Plan Final EIS* (TVA 2010); this Final EIS includes relevant information on the affected environment and potential environmental impacts of the Proposed Action, particularly relating to the long-term drawdown of Boone Reservoir. The Boone RLMP guides resource management and administration decisions on approximately 880 acres around Boone Reservoir that are publicly owned and managed by TVA (including approximately 84 acres of two tracts TVA proposes to use as Construction Support Areas). The Boone RLMP identifies the most suitable uses for 44 parcels of TVA-managed land by providing areas for Project Operations, Sensitive Resource Management, Natural Resource Conservation, Developed Recreation, and Shoreline Access. The 880 acres of TVA-managed public land account for approximately 23 miles of reservoir shoreline.

The Boone RLMP was developed consistent with implementation of TVA's Shoreline Management Policy (established in the TVA Shoreline Management Initiative EIS in 1998 [TVA 1998]). The Shoreline Management Policy establishes an overall management and environmental planning and review process, including preparation of individual RLMPs and procedures for implementing the Section 26a permitting program that affect and are affected by the reservoir operations policy.

1.7 PUBLIC INVOLVEMENT

During the scoping phase for this project, TVA hosted two open house-style public meetings to provide an opportunity for the public to learn more about the seepage at Boone Dam and TVA's proposed solution for remediating the seepage. The meetings were announced in local news media and were held in Johnson City, Tennessee at the Daniel Boone High School and the Millennium Centre on March 10, 2015, and July 30, 2015, respectively. Early in the process, TVA published a website dedicated to providing regular project updates to the public (available at http://www.tva.gov/boonedrawdown/). In early August, TVA invited the public to submit questions, comments, and input on the scope of the review and environmental issues that should be addressed during the environmental review. Comments received during these public meetings and through the web site were considered in the development of this EA.

As the project progresses, TVA will continue to hold regular meetings to update the public on the project status. TVA is committed to keeping the public informed and provides numerous opportunities for the public to receive project updates. Interested individuals also can receive a Boone Weekly Update newsletter by signing up on the project website and can follow the project on social media such as Facebook and Twitter.

TVA released the Draft EA on October 28, 2015 for public review and comment. TVA notified interested federally recognized Native American tribes, elected officials, and other stakeholders that the Draft EA was available for review and comment for a period ending November 30, 2015.. TVA also notified government agencies, including the Tennessee Department of Environmental Conservation (TDEC), Tennessee Wildlife Resources Agency (TWRA), the U.S. Army Corps of Engineers (USACE), and the U.S. Fish and Wildlife Service (USFWS). Printed copies of the Draft EA have been made available to the public at local libraries. Public notices were published in local newspapers, soliciting comments from other agencies, the general public, and any interested organizations. Refer to Chapter 6 of the Draft EA distribution list.

An electronic version of the document was posted on TVA's website, where TVA also provided contact information and directions on how to submit comments. The website also included a comment submittal form that could be used by the public to provide comments. . On November 5, 2015, TVA hosted a public meeting in Johnson City at Daniel Boone High School to inform the public of the findings of the environmental review and solicit comment on the Draft EA. The meetings were advertised in local newspapers, by press releases, via the weekly newsletter, and on the project website. TVA used an open-house format for the meeting. The meeting began with TVA personnel presenting a short overview of the NEPA process, the proposed action, and the findings of the EA. Attendees were invited to view informational poster exhibits and to speak with TVA specialists about their questions and concerns. Attendees were invited

to submit comments formally. Comment forms and boxes were provided and a court reporter was on hand to record attendees' verbal comments.

During the public review and comment period, TVA received comments from nine individuals (three anonymously) and TDEC. Comments received from the public and TVA's responses are provided in Appendix A.

CHAPTER 2

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

This chapter describes the No Action Alternative and the Proposed Action, and compares and contrasts their potential environmental impacts. Also described is the process by which Boone Dam remediation alternatives were developed and evaluated, and the rationale for selection of the Proposed Action.

Due to the complexity and urgency of the situation at Boone Dam, TVA has augmented its own team of dam safety engineers with nationally recognized experts in dam safety. Some of these experts serve to support TVA's staff and others serve as independent checks. In addition to these experts, TVA has engaged other owners of large dams, such as the USACE, and large private utilities that have dealt with similar seepage issues. Through review during multiple workshops, TVA's team of experts evaluated methods for repairing Boone Dam and identified a composite seepage barrier as the preferred method to remediate the problems at the dam, pending additional environmental review. TVA's evaluation of potential methods for repairing the dam is discussed further in Section 2.3.

The team of experts affirmed that the immediate IRRMs implemented by TVA were prudent and necessary responses to reduce the risk of dam failure. The primary risk reduction measure is restricting pool elevations. The lower reservoir water levels dramatically decrease pressure on the dam, which lowers the risk of further deterioration to the dam. Lower water levels also significantly decrease the amount of water that would flow downstream in the unlikely event of a breach. Therefore, the lowered pool elevations must continue until further remedial actions are completed.

2.1 NO ACTION – NO BOONE DAM REMEDIATION AND CONTINUE INTERIM OPERATIONS

Under the No Action Alternative, TVA would take none of the proposed actions. No composite seepage barrier would be constructed to address seepage flow of water beneath the dam and erosion would continue. TVA would not implement additional risk reduction measures beyond those identified in Section 1.2. TVA would continue to operate the reservoir under Interim Operations under the No Action Alternative.

Because of the continuing risk and potential impact to the public, this alternative is not considered reasonable. The No Action Alternative is analyzed in the EA to establish a baseline for analyzing the environmental impacts of proposed actions and to comply with applicable regulations.

With the IRRMs in place, the dam has a low probability of dam failure in the current configuration. However, without taking action, the risk of the eventual breaching of the dam would continue. In the event of such a failure, there could be loss of life; destruction of property (including downstream facilities); loss of delivery of critical services to communities such as electric service; and impacts to basic infrastructure such as roads and bridges. Economic

losses would be substantial. Downstream environmental resources in and along the river system also would be severely impacted. The severity and breadth of impacts would be influenced by a variety of factors, including how quickly a breach occurs and time of day. Portions of communities along the South Fork Holston River in Sullivan County, including Kingsport, and potentially Hawkins County would be impacted. Eventually, release waters would be contained within TVA's Cherokee Reservoir.

2.2 PROPOSED ACTION – REMEDIATE BOONE DAM AND RETURN TO NORMAL OPERATIONS

Under the Proposed Action, TVA would construct a composite seepage barrier at Boone Dam over a period of 5 to 7 years, during which time Interim Reservoir Operations would continue. Construction of the seepage barrier, which would begin in 2016, would require numerous support activities on the dam reservation and at nearby Construction Support Areas. After construction is substantially completed, the reservoir would return to Normal Operations.

The project area includes Boone Dam and Reservoir. Figure 1-1 shows the location of the Boone Dam project site. Figure 1-6 presents a map of the project location and the areas that would be affected by construction activities associated with the Proposed Action.

2.2.1 Construction

TVA would install a grout curtain into the dam's foundation soils, epikarst, and underlying bedrock and later would install a concrete diaphragm wall. Once complete, the curtain and concrete wall would form a linear, non-erodible feature to form a positive cutoff from the reservoir and dramatically reduce the potential for a seepage connection with the reservoir to reoccur.

During grouting activities, TVA proposes to mix and produce all of the grout that will be used during construction on site. Grout production would occur only during the phases of the project that include grouting activities (i.e., grout production and the use of associated equipment would not occur over the entire life of the project). The grout mixture generally would include water, Portland cement, bentonite clay (to improve stability and pressure filtration), superplasticizer (to reduce viscosity and cohesion of the grout), a viscosity modifier (if necessary), standard mason sand, and additional minor constituents common to grouting. The exact proportions and mixtures of these constituents are not known at this time and would be adaptive throughout the grouting process.

TVA would work with the selected construction contractor to identify the appropriate type of grout production equipment and determine the need for any associated infrastructure (e.g., water supply, access road, laydown area, waste water tanks). Generally, two types of grouting equipment and infrastructure are used for projects of this scale: one or more small and mobile mixing units, or a larger, stationary batch plant. Small mobile mixing units would likely be used for this project. However, because the volume of grout needed to install the seepage barrier will be significant, the smaller mobile mixing units may not be adequate to support this activity and an onsite batch plant may be required. If needed, a batch plant would be constructed within the

Construction Zone at the dam and would be removed after completion of the project. Typically, batch plants have a small footprint and are composed of stationary silos spaced so that trucks may drive and park between them. The plant would be built as close to the dam as possible, as space allows.

Stage 1 - Epikarst Production Grouting

Stage 1 would involve using low- mobility grouting to install a grout curtain into foundation soils and the epikarst beneath the dam (see Figure 1-2). Depending on the type of equipment used for the production of grouting during Stage 1, additional modifications to the crest may be necessary. Alternatively, it may be necessary to remove some of the asphalt during the initial grouting process. This decision would be made by TVA and the selected contractor prior to initiating activities.

Grout would be injected under controlled pressures and flow rates into numerous holes drilled in multiple lines along the crest of the embankment. The drill holes, spaced a few feet apart, would supply grout to the voids in the karst bedrock to depths potentially up to and greater than 300 feet below the crest of Boone Dam. Columns of grout would result during the process of the epikarst grouting as the drill rig is withdrawn in order to fill voids in the epikarst and displace soft soils. The size of the grout column will vary based on the adjacent geologic conditions.

Stage 2 - Bedrock Production Grouting

Stage 2 of grouting activities would involve the installation of a high-mobility grout curtain deeper into the bedrock (see Figure 1-3) and additional grouting support of the epikarst. Additional modification to the working platform would be needed to establish a wider working platform. The wider platform would be between 70 and 100 feet wide) and would be constructed by placing fill and supportive structures on the upstream and downstream sides of the dam.

The drill holes, spaced a few feet apart, would supply grout to the voids and fractures in the karst bedrock potentially up to and greater than 300 feet below the crest of Boone Dam. The objective is to fill the voids and thin fractures in the rock beneath the future diaphragm wall. TVA anticipates that each hole would be approximately 3 to 8 inches in diameter (drill diameter); the exact width of holes has not yet been determined and may vary depending on the technique of grouting or type of drill rig used.

The grout curtain would be formed as part of Stages 1 and 2 and would be an estimated 1,100 feet long, although the exact alignment is yet to be determined. These activities would be initiated in early 2016 and are expected to occur over the first 12 to 24 months of the project.

Stage 3 - Diaphragm Wall Construction

The third stage of the seepage barrier construction would be a concrete diaphragm wall. TVA would install the concrete wall component through the dam and epikarst, terminating in the underlying competent bedrock (see Figure 1-4). The wall would be constructed by excavating deep trenches into the dam's embankment, into which concrete would be placed. The wall

would reduce movement of water through the dam's foundation and epikarst. Construction of the wall may begin before grouting activities have concluded on other portions of the embankment.

Stage 4 - Crest Restoration

The final stage of the project potentially includes restoration of the crest, including possibly removing or covering a portion of the work platform (see example Figure 1-5). Additionally, rock and/or soil stability berms could be included on the upstream and/or downstream side of the dam as part of the seepage remediation; TVA will assess the effectiveness of the seepage barrier after it is installed to determine whether the berm is necessary and its configuration. If a berm is constructed, portions of the fill materials that were used to create the work platform on the dam's crest may be left in place as part of the berm, rather than be removed.

Construction of the composite seepage barrier at the dam will require a variety of activities occurring on other portions of the dam reservation, in proximity to the dam embankment. TVA already has implemented a number of site preparation actions on the dam reservation, including constructing laydown areas, gravel parking areas, and haul roads; installing security fencing, a control gate, temporary lighting, and monitoring cameras; modifying water and utility lines in place; and installing a new water line along the road to the control building.

TVA proposes to expand the current Construction Zone at the dam site for greater areas on which to conduct these activities. As illustrated in Figure 2-1, areas of the dam reservation on the upstream side of the dam including the visitor center, beach, and picnic area would be included in the Construction Zone. Those areas have been closed, and numerous temporary office and storage buildings have been sited.

Figure 2-1: Proposed Expansion of Construction Zone

During construction activities, the project site would be an active construction zone requiring a wide-array of supporting activities (e.g., equipment mobilization, storage, and maintenance; grout and concrete mixing; washing; waste control; and soil removal). Generally, these activities would take place in the area north and east of the dam's embankment, though activities would occur throughout the expanded Construction Zone depicted in Figure 1-6.

2.2.2 Construction Support and Management of Excess Rock and Soil

Drilling and excavation for the composite seepage barrier will extract large quantities of soil and rock. The excavated soil and rock would be loaded at the site of extraction on the dam's crest and transported by truck to one of the two proposed Construction Support Areas near the dam reservation that are described below.

TVA proposes to use portions of two TVA tracts near the dam as areas to support various construction activities (Figure 1-6). Activities at the Construction Support Areas could include, but are not limited to, placement of clean fill, grading, security, access road construction, laydown areas, helipad landing areas, stockpile areas, trailers, parking areas, and equipment and material staging areas.

Construction Support Area 1 (also referred to as the Earl Light Tract) – is located along Minga Road, approximately 1 mile northeast of the dam, and would be accessed from Minga Road. The Construction Support Area would occupy up to 71.2 acres of the 118-acre parcel. TVA manages the property for conservation and, in the past, has partnered with the National Wild Turkey Federation, the Sierra Club, and the TWRA in managing the tract. A 54-acre portion of this parcel also is licensed for agricultural use as hay land. A portion of the tract was used as a borrow pit in the past. TVA proposes to primarily use the open fields or brushy portions of the tract. Some trees would be removed on the site, although, to the extent possible, TVA would avoid removal of trees. After completion of the project, TVA would revegetate and restore the area to its current recreation uses. Fill that is reused at this area would be graded to a natural appearance. TVA would reconstruct the recreation facilities at this tract as well.

Construction Support Area 2 (also referred to as Tract 22R) – is located adjacent to the dam reservation along an existing utility right-of-way. The Construction Support Area would occupy approximately 12.8 acres of the 53-acre parcel along the existing transmission right-of way. TVA would construct an access road up the right-of-way corridor from the Construction Zone at the dam to provide access to the area which would connect with Construction Support Area 1 via a proposed closure of a segment of Minga Road. An access road between the dam and the Construction Support Areas would minimize TVA's use of Minga Road. TVA proposes to primarily use the already cleared utility right-of-way, but may use limited portions of the adjacent forested areas for access. Two land depressions (land contours where materials were borrowed during past activities, including the construction of the dam) and one historic borrow pit used by TVA during construction of the dam within this site would be the primary locations for placement and storage of excavated soil and rock materials. After completion of the project, TVA would grade, revegetate, and restore the area to its current recreation uses. Fill that is

reused at this area would be graded to a natural appearance. TVA would reopen the existing Boone Dam boat ramp and parking lot for public use.

TVA proposes to close a small segment of Minga Road, located between the two Construction Support Areas, to the public during a portion of the project, potentially from 2 to 3 years. The closed portion of Minga Road would provide access to all construction areas. This temporary full road closure is intended to eliminate exposure of motorists to work areas and poor roadway conditions during construction, and to reduce exposure of workers to traffic activity. During full road closure, east and westbound traffic would be detoured—with a large turn-around area for motorists to safely turn their vehicles around, as well as adequate road signage of upcoming closure distances. This closure would allow project workers full access to roadway infrastructure in order to safely move construction materials between Construction Support Areas 1 and 2.

2.2.3 Reservoir Drawdown and Interim Operations

Under the Proposed Action, TVA would maintain the reservoir water levels of Boone Reservoir at its current level as part of Interim Operations for the 5- to 7-year duration of the project. To the extent possible, TVA would maintain the water level at the 1352.5 feet elevation. "Interim Operations" refers to the operations that TVA moved to after lowering the reservoir level and how the project would be operated through the period of dam remediation (refer to Section 3.1). TVA does not propose or foresee the need to lower the reservoir pool to lower levels during construction but may do so in the interest of public safety or for a brief period to support construction activities.

During construction, TVA may assess whether the embankment's stability is improved such that reservoir water levels may be raised prior to completion of the composite seepage barrier. Because this is unlikely to occur, however, TVA does not consider a shorter drawdown period as reasonably foreseeable. Temporary fluctuations above 1,355 feet may occur during special operations and to assist with extreme rain events.

2.2.4 Summary of TVA Commitments and Proposed Mitigation Measures

In addition to the requirements of any necessary permits, TVA would implement the following mitigation measures to avoid, minimize, or mitigate adverse impacts on the environment. All applicable permits would be acquired; therefore, associated permit-related mitigation measures and BMPs would be implemented to further minimize impacts.

Mitigation Measures Associated with Construction Activities

- TVA would return disturbed areas at the dam location and at the Construction Support Areas to their previous or improved condition and uses. Disturbed areas would be revegetated and regraded, and fill would be placed in areas that were previously disturbed in the past (e.g., borrow pit areas) to an improved condition.

- Appropriate BMPs for erosion control and stabilization of disturbed areas would be used; and construction activities would be conducted in a manner to ensure that waste materials are contained and that introduction of polluting materials into receiving waters is minimized.
- Appropriate construction BMPs would be used to reduce stormwater runoff. Mitigation measures and BMPs for soil erosion would be developed as part of the legally required Stormwater Pollution Prevention Plan (SWPPP). All erosion and sediment controls would be installed, placed, implemented, or constructed in accordance with the provisions of the Tennessee Erosion and Sediment Control Handbook.
- TVA would implement construction BMPs to address air emissions from open construction areas and unpaved roads. Areas would be sprayed with water as needed to reduce fugitive dust emissions.
- Proper management of hazardous materials/wastes would be conducted in accordance with established TVA procedures. TVA would comply with all TDEC regulations regarding disposal of waste materials.
- Fill materials (including sand, rock, and gravel) would be clean and free of contaminants.
- TVA will complete a Historic American Building Survey (HABS) and Historic American Engineering Record documentation for the Boone hydroelectric project to record the historic dam's features and architectural character, as part of consultation with the State Historic Preservation Officer (SHPO).
- TVA would attempt to limit deliveries of crushed stone, riprap, and other materials during normal operation hours. However, to meet construction completion milestones, this may not be possible.
- To reduce the potential noise impact, TVA would require the use of modern, well-maintained equipment and vehicles and will screen the equipment for noise emissions, when practicable.
- Berms would be constructed using the least amount of fill possible, while achieving project objectives. Where possible, materials and equipment subject to flood damage would not be stored below elevation 1385.0.
- To reduce potential visual impacts associated with lighting at the dam, TVA would position and adjust lighting as needed to reduce or minimize their visibility from nearby residences. TVA would work with private landowners to address concerns, to the extent practicable.
- Water quality near the construction and reservoir releases will be monitored to document temporary changes associated with construction and grouting activities and with the deep drawdown, maintenance of the deep drawdown, and refill of Boone Reservoir. Monitored water quality parameters include, but are not be limited to, pH, conductivity, dissolved oxygen (DO), temperature, and turbidity. During the project, if monitoring indicates a need—and if practicable given available water, dam safety constraints, minimum flow requirements, power system requirements, and downstream water supply needs, TVA will generate at Boone Dam with the objective of cooling the downstream trout fishery. TVA or contract

personnel will conduct routine visual inspections of waters to identify potential runoff or discharge issues.

- TVA will avoid or mitigate impacts on sensitive resources, including potential habitat for bat species. Potentially suitable summer roosting trees for Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*) were identified in sections of the current Construction Zone, one section of the proposed expansion of the Construction Zone, and two sections along the existing utility right-of-way of the proposed Construction Support Area 2. Areas identified as potentially suitable habitat for sensitive summer roosting bats would be avoided during activities. TVA will monitor these caves periodically to determine if listed bat species utilize these caves and will consult with USFWS under Section 7 of the Endangered Species Act should listed bat species be observed.

Mitigation Measures Associated with Impacts of the Reservoir Drawdown

In addition to activities that TVA has already initiated to address the impacts of the reservoir drawdown (e.g., increasing access to the reservoir), TVA proposes to implement a suite of activities to mitigate the impacts associated with the long-term drawdown of the reservoir, including the following:

- TVA proposes to implement a Vegetation Management Plan to manage the successional vegetation on much of the exposed reservoir bottom. TVA would work with private landowners to manage this growth with annual or periodic mowing or bushwhacking. When approved by the landowner, TVA would use mechanical means, including tractors with bush hog attachments, extendable hydraulic arms, and other equipment to ensure safety. Mowing may occur from small barges along the reservation where access may be too hazardous. Mowing vegetation on the exposed reservoir bottom would not be intended to eliminate the vegetation. Such vegetation may also be beneficial, by enhancing wildlife habitat, reducing erosion during the drawdown, and improving fish habitat after the reservoir is returned to normal water levels. TVA's two primary objectives are to remove tree species from the newly exposed reservoir bottom areas that normally do not establish due to season pool levels and to avoid having trees mature during the drawdown period to heights that would create navigation and public safety problems once the waters are returned to normal levels.
- In a portion of the drawdown area, TVA proposes to collaborate with TWRA and interested private landowners to plant or seed native and desirable vegetation. The primary objective is to enhance fish habitat when the reservoir returns to normal water levels, though the project will provide wildlife habitat and improve erosion control and aesthetics during the drawdown period. Between 400 and 500 acres would be identified, and planting would begin in February 2016. TVA estimates that seeding/planting activities would take up to 4 years to complete (about 100 acres annually).
- TVA would provide guidance to landowners to enhance revegetation along exposed reservoir bottom with appropriate native plant species.
- TVA would provide temporary stabilization of a significant archaeological site on TVA land by seeding the exposed reservoir bottom with grass or other vegetation to reduce erosion. TVA

would implement law enforcement patrols to prevent looting and vandalism to protect important archaeological sites. TVA also proposes to establish a volunteer monitoring program to obtain assistance from members of the public in monitoring previously recorded archaeological sites around the reservoir, and to conduct outreach to the public and to property owners adjacent to the reservoir about laws protecting archaeological sites on TVA-owned and private property.

- In consultation with SHPO, TVA would fund archaeological research and education within the reservoir.
- TVA would work closely with TWRA to mark any additional hazards in the reservoir that pose a threat to the health and safety of boaters. These buoys would be in addition to those placed by TVA in early 2015.

Immediate Mitigation Measures Being Implemented

The following activities were initiated in 2015 in order to address immediate impacts of the reservoir drawdown:

- TVA has implemented a program to assist marina owners on Boone Reservoir during the drawdown in the form of no or low interest loans (refer to Section 1.5.2).
- TVA has waived rental fees of marinas and permit fees for new requests from marinas (e.g., for ramps or seawalls).
- TVA placed hazard buoys at various sites around the reservoir to notify the public of safety and navigation concerns during the drawdown, and placed buoy lines above and below the dam.
- TVA has waived 26a application fees to eligible shoreline property owners and marina owners on Boone Reservoir seeking approvals under Section 26a of the TVA Act in order to provide reasonable access to the reservoir (refer to Table 1-2). To facilitate this access, TVA will approve variances for temporary docks/ramps to be placed along the exposed reservoir bottom that may exceed the maximum allowable footprint for a dock facility under TVA's Section 26a regulations.
- TVA will improve access to the reservoir by enhancing the only usable public boat launching ramp at Pickens Bridge and to add additional launch ramps on the South Fork Holston River (Devault Bridge). TVA also has proposed to install a boat launching ramp and a public beach/swim area on TVA-managed shoreline adjacent to the dam reservation on Tract 22R (refer to Table 1-2.)

2.3 OTHER ALTERNATIVES EVALUATED, BUT DISMISSED FROM FURTHER CONSIDERATION

TVA's engineers and external experts evaluated a wide range of alternatives for rehabilitating Boone Dam. During the internal review and challenge sessions, they evaluated options through a formal process using several considerations, including durability of the potential repair, time to

return to normal operation, impact on the public, risk for reoccurrence, environmental impacts, and costs to ratepayers.

The alternatives evaluated by the team of experts included the No Action Alternative and 14 possible concepts (including the Proposed Action) for rehabilitating the dam. Five of these alternative methods were determined to be viable; the remaining were determined not to be viable and were removed from further consideration. The five alternative methods were further evaluated using a Kepner-Tregoe Analysis[4] to determine the ability of each of the alternative methods to meet a set of objectives. The Kepner-Tregoe Analysis was selected as a reasonably objective methodology by which internal stakeholders could select a long-term remediation plan from the various methods.

Of the five alternatives evaluated in the Kepner-Tregoe Analysis, construction of a composite seepage barrier was selected for consideration as the Proposed Action. The primary factor in recommending a composite seepage barrier is that a positive cutoff from the reservoir is created from non-erodible material and therefore has a very low probability of a seepage connection with the reservoir reoccurring.

Alternatives considered by TVA engineers and external experts, but ultimately dismissed from further consideration, are listed in Table 2-1 along with the rationale for their dismissal.

Table 2-1: Remediation Alternatives Evaluated but Dismissed from Further Consideration

Remediation Alternative	Viable (Y/N)	Assessment
1. Remove the Dam	No	Boone Dam could be decommissioned and deconstructed and the dam and reservoir could be removed. While breaching and removing the dam would remove the flood risks to downstream areas of a dam failure, the dam's removal greatly increases the flood risk to downstream areas of typical flooding events. The Fort Patrick Henry reservoir provides limited flood storage, and it would be necessary to pass high flows to avoid overtopping the FPH Dam. High flows could cause flooding downstream of the Boone Dam location and result in impacts on safety, the destruction of property, and economic loss. Many critical residential, industrial, and commercial infrastructure are built on the floodplain below FPH Dam and would be affected by flows above 20,000 cubic feet per second, resulting in significant economic loss. The potential significant, negative impacts on the environment, flood control, power generating capacity, and the local economy would be unacceptable. This option would not achieve TVA's objective to return the Boone Dam and Reservoir to normal operations in furtherance of TVA's statutory mission to manage the Tennessee River system, its tributaries, and its associated resources.

[4] Kepner-Tregoe analysis refers to a process of weighing alternatives by listing and assigning a numerical weight to a series of values (noting that some may be absolute requirements), giving each alternative a numerical rating according to each value, and computing a numerical score for the alternative.

Table 2-1: Remediation Alternatives Evaluated but Dismissed from Further Consideration

Remediation Alternative	Viable (Y/N)	Assessment
2. Excavate and Build New Embankment	No	The existing embankment dam could be temporarily removed and then rebuilt along the same alignment. This would allow for excavation of the overburden soils to expose the bedrock surface, preparation of the karst foundation to contemporary standards, and construction of properly graded drainage features. The replacement structure could be designed and built so that seepage through the epikarst would be stopped and/or controlled so that it would not erode the base of the dam. However, construction would require removal of the dam for at least 1 to 2 years. For this time period, TVA would no longer control flooding and communities downstream would be at risk. The potential impacts on the environment, flood control, power generating capacity, and the local economy would be significant and unacceptable.
3. Widen the Crest with Large Downstream Berm	No	TVA could widen the existing earthen embankment dam by constructing a downstream berm, comprised of earth or rock fill. The berm would be sized so that a slope failure would not result in losing the pool. However, this alternative would not mitigate a key failure mode: seepage flows beginning at the tailrace could continue upstream and eventually connect to the reservoir and allow the reservoir to drain through the dam foundation. The long-term effectiveness of this alternative is questionable and, TVA has little confidence that the alternative would stop seepage flows occurring under the Boone Dam and would not achieve TVA's objective of returning Boone Dam and Reservoir operations to normal.
4. Upstream Seepage Blanket	No	A compacted clay blanket could be constructed along the upstream toe and on the reservoir bottom for some distance upstream into the reservoir. This option would likely lengthen the seepage path from the reservoir, resulting in lower average gradients and less seepage through the foundation. Although lowering the gradients might reduce the rate of erosion in the epikarst, it is unlikely that erosion would stop. More significantly, the seepage blanket would be subject to vertical seepage pressures and erosion into the epikarst, which would re-activate the failure modes. This potential makes this alternative unacceptable. The alternative is not likely to meet the project purpose and need of stopping seepage flows occurring under the Boone Dam. In addition, to construct the clay blanket, the pool would have to be temporarily lowered further, which would negatively impact the environment, flood control, power generating capacity, and the local economy. Such impacts during construction would be unacceptable.

Table 2-1: Remediation Alternatives Evaluated but Dismissed from Further Consideration

Remediation Alternative	Viable (Y/N)	Assessment
5. Tailrace Training Wall with Filtered Backfill	No	A reinforced concrete wall could be constructed along the tailrace channel immediately downstream of the concrete dam. The riprap and river bank would be excavated to expose the bedrock surface. The area behind the wall would be backfilled with filter sand and covered with riprap. The filter would be designed to trap and retain soil eroding from beneath the embankment dam. However, construction of a training wall in this location would be difficult. Because excavation bracing may be required, and a cofferdam would be needed in the tailrace, the filter would be located too far downstream to limit material movement under the dam. Moreover, it is likely that seepage and eroded soils exit at other locations (e.g., within the tailrace channel or along the river bank farther downstream) that would not be covered by a filter. It is unlikely that the tailrace training wall and filtered backfill would be sufficient to mitigate the seepage failure modes under the dam embankment. Thus, it is unlikely that this option would achieve TVA's purpose and need for the project.
6. Concrete and Sand Shaft Filter Wall at the Toe	No	A concrete and sand shaft filter wall could be constructed to attempt to cut off flows in the rock and epikarst zones at the downstream toe, and force all groundwater seepage through filter sand within the foundation soils. This would be accomplished by constructing alternating shafts of concrete and sand, and grouting of the deeper rock would be needed to stop seepage flows under the combination wall. This alternative would require unconventional and potentially difficult construction and achieving good confidence in the performance of this system would be difficult. In addition, there would be potential for the filter sands to be lost into voids within the epikarst adjacent to the wall, resulting in long-term deterioration of the filters. Thus, it is unlikely that this option would stop seepage flows occurring under the Boone Dam
7. Filtered Toe Drain by Horizontal Drilling and Rock Grouting	No	Under this alternative, a grout curtain would be installed but the key component would be a perforated pipe surrounded with filter sand along the toe of the dam. The pipe would be installed just upstream of a grout curtain, such that the foundation seepage would be captured by the drain pipe. The concept involves construction of the pipe and filter by horizontal directional drilling (i.e., a trench would not be used), with the pipe placed in rock near the bottom of the permeable epikarst zone. Groundwater seepage would be collected and filtered from beneath the dam. However, current directional drilling technologies are not capable of installing filter sand around a perforated pipe and building effective filter zones would be difficult where the pipe encounters voids in the epikarst. The filter sands could be lost into voids of the epikarst, resulting in long-term deterioration of the filters. Thus, it is unlikely that this option would meet the project purpose and need of stopping seepage flows occurring under the Boone Dam.

Table 2-1: Remediation Alternatives Evaluated but Dismissed from Further Consideration

Remediation Alternative	Viable (Y/N)	Assessment
8. Grout Cutoff along the Crest with Monitoring	Yes	The selection of this option as an effective long-term remediation was ultimately precluded by its failure to fully stop the internal erosion process if employed as a standalone measure. Once constructed and subjected to reservoir levels above the embankment toe for extended durations, pore pressures are anticipated to rise upstream of the constructed grout curtain. A steep hydraulic gradient is expected to develop in the vicinity of the newly-constructed grout curtain when the reservoir is placed into normal operations. The steep groundwater pressure gradient in the vicinity of the grout curtain would promote re-initiation of the internal erosion process, along seepage paths through “windows” in the grout curtain. In this sense, the discontinuous nature of the single-line grout curtain would promote re-initiation of the very failure mechanism that TVA is attempting to remediate. TVA determined that this option is capable of slowing progression of internal erosion in the short term but is very likely to allow re-initiation of the internal erosion process over the long-term. In addition, a high level of uncertainty exists regarding the duration over which the remediation may be effective, before internal erosion is re-initiated and progresses to a degree that decreases the safety of the dam to unacceptable levels.
9. Multiple Grout Curtains under Downstream Face	Yes	The redundancy of multiple alignments alleviates many concerns over the use of grout curtains to remediate the seepage problem. Once constructed and subjected to reservoir levels above the embankment toe for extended durations, pore water pressures would be anticipated to rise within the dam. However, the presence of multiple grout curtains would likely create a more uniform distribution of ground water pressures along the downstream slope of the dam. The gradients of these pressures should be significantly smaller than those associated with Option 8. The reduced pressure gradients would result in lower seepage pressures, which decrease the likelihood for re-initiation of the internal erosion process. Despite benefits for reducing the likelihood for re-initiation of internal erosion, this option would fail to remove the fundamental conditions associated with internal erosion at the site. Specifically, this option would fail to create a continuous barrier to groundwater flow within the epikarst zone. The lack of a continuous seepage barrier would permit pathways for internal erosion to continue after grouting is completed. These pathways may be lengthened in a way that would reduce the potential for re-initiation of the process, or would increase the time over which the process must act to cause a dam breach. However, the degree to which these beneficial effects occur is highly speculative. TVA determined that this option is capable of slowing progression of internal erosion over a time period commensurate with a typical dam design life. However, the concept fails to remove the underlying vulnerabilities that drive the process of internal erosion at Boone Dam.

Table 2-1: Remediation Alternatives Evaluated but Dismissed from Further Consideration

Remediation Alternative	Viable (Y/N)	Assessment
10. Cutoff Wall at the Toe with Downstream Berm	Yes	A concrete cutoff wall could be constructed along the downstream toe of the dam, with three lines of pressure grouting in the deeper rock beneath. The concrete cutoff wall could be constructed using a hydromill or similar technology; given the expected depth, it may be possible to build the wall using overlapping or secant shafts. The cutoff wall would be designed to stop seepage through the rock and overburden soils, which would result in significantly higher pressures backing up beneath the dam. A relatively shallow drain would be installed near the current ground surface to capture ground water that backs up behind the wall. However, an earthen or rockfill berm would be needed on the downstream face of the dam, to increase stability with the higher pore pressures in the foundation. A downstream wall would provide the same level of confidence for the seepage cutoff as for upstream alignments, but would require other measures to address stability related to pore pressure buildup. While there would be several advantages for a downstream alignment, this option would present significant construction and dam safety risks that are unacceptable. In addition, a cutoff wall structure along the toe of the dam would intersect the cable tunnel. Numerous buried utilities, including the grounding grid, would be affected. The tie-in to the concrete dam would be along the significantly battered, downstream face, and would require special consideration. Settlement due to construction of the stability berm, with associated impacts on the dam, existing utilities, and other infrastructure, would have to be anticipated and addressed. Construction sequencing would be critical to manage pore pressure buildup during construction. Dam safety risks associated with flood events during construction would require thorough planning. Construction of a composite cutoff wall, stability berm, and filtered drainage system along the embankment toe would address some of the concerns associated with groundwater flow from the right abutment area. However, additional mitigation would be needed to address groundwater flow from the right rim under the upstream face of the dam.
11. Cutoff Wall at the Toe with Trench Drain	No	A concrete cutoff wall could be constructed along the downstream toe of the dam, with grouting in the deeper rock beneath. The cutoff would be designed to stop seepage in the rock and overburden soils. Seepage coming through the dam foundation would be collected in a trench drain, consisting of a sand-filled trench with a perforated drain pipe. This option would attempt to capture and filter seepage from under the dam, without substantial changes to the piezometric levels. The concrete cutoff wall could be constructed using a hydromill or similar technology and, given the expected depth, it may be possible to build the wall using overlapping or secant shafts. The key component of this alternative is the trench drain, which could be built using specialty excavators that continually place backfill sand as the trench is cut. Unfortunately, these machines would not be able to cut through rock pinnacles or boulders along the alignment, which would significantly limit the depth of the trench and the effectiveness of the drainage system. In addition, there is a potential that the new seepage filter could erode into the karst foundation over time, further reducing the system's effectiveness. This option, therefore, is unlikely to achieve TVA's objective of stopping seepage flows occurring under the Boone Dam.

Table 2-1: Remediation Alternatives Evaluated but Dismissed from Further Consideration

Remediation Alternative	Viable (Y/N)	Assessment
12. Cutoff and Drainage Gallery in Braced Excavation at the Toe	No	Along the downstream toe of the dam, a drainage gallery would be constructed inside an open, braced excavation to rock, and a seepage cutoff would be achieved by backfilling the lower half of the excavation with concrete and the upper half with compacted clay. Grouting would be used to cut off seepage in the deeper rock. A graded filter would be constructed on the upstream side, as the excavation is backfilled. With an open excavation, a zoned filter could be manually constructed, which would allow much greater confidence in the quality and continuity of the filters. A drain pipe would be included at the bottom of the filter. The pipe would be connected to an accessible drainage gallery within the concrete cutoff, allowing for maintenance and monitoring of the seepage flows. This option attempts to capture and filter seepage from under the dam, without substantial changes to the piezometric levels. Construction of this design would be complex. The excavations would be relatively deep (up to 40 feet) and would require bracing. To avoid the potential for destabilizing the dam slope, the excavations would be completed in segments of limited length. Groundwater at the bottom of the excavations would also complicate construction. When completed, the filter sands could be lost into voids within the epikarst, resulting in long-term deterioration of the filter and the effectiveness of the system. This option is unlikely to achieve TVA's objective of stopping seepage flows occurring under the Boone Dam.
13. Grout Cutoff along the Crest with Maintenance Grouting	Yes	This alternative involves foundation grouting from the dam crest, with additional, periodic grouting to address anticipated erosion of this seepage barrier. This concept employs the same technologies as Option 8, and suffers from the same inherent vulnerabilities to re-initiation of internal erosion over the long term. This option presumes some reliable indicator of distress is available to evaluate the degree to which the initial grout curtain has deteriorated over time. TVA could not identify clear indicators for deterioration within the dam that would permit timely mitigation of future internal erosion. The consensus among TVA's engineering team is that no measure or collection of measures would be particularly reliable for this purpose, aside from obvious expressions of seepage similar to the one observed in October 2014. TVA determined that this option is capable of slowing progression of internal erosion in the short term, but would fail to remove the underlying vulnerabilities that drive internal erosion at Boone Dam. In addition, the concept relies upon poorly defined triggers to initiate subsequent cycles of grouting, while such grouting will be needed to maintain dam safety.

TVA also considered alternative locations for the reuse/storage of soils excavated from the dam site during construction. Initially, TVA examined the material that would be excavated from the dam and determined that the material is clean fill material (i.e., consisting of uncontaminated, inert material such as rock, dirt, stumps, pavement, concrete and rebar, and/or brick rubble). Because the materials can be used as clean fill material, TVA dismissed the option of disposing these materials as solid waste at a local landfill(s) as unwarranted and uneconomical. TVA also notes that the nearest landfill is more than 25 miles away and the volume of materials that TVA would dispose would likely strain the facility's capacity. Therefore, TVA searched for areas on which to place the clean fill material or where it could be used as fill. Key considerations were the areas' proximities to Boone Dam, availability and size of tracts, and costs. TVA considered

acquiring a number of small private properties within a few miles of the dam to store but the few properties available for sale were not large enough. Using portions of the reservoir shoreline adjacent to the dam to place fill was not considered because of the potential disturbance of the reservoir shoreline. Only the two proposed Construction Support Areas (Area 1 at the Earl Light Tract and Area 2 at the 22R Tract) were found by TVA to be reasonable and optimal because of their size, the low costs to TVA (i.e., no land acquisition was necessary), and their proximity to the dam (which would minimize environmental, economic, and safety impacts to the community).

2.4 ENVIRONMENTAL RESOURCES CARRIED FORWARD

Chapter 3 describes the affected environment and examines the potential environmental impacts of the Proposed Action and the No Action Alternative for the following resource areas:

- Geologic Resources
- Water Resources
- Floodplains and Flood Risk
- Wetlands
- Terrestrial Ecology (Vegetation and Wildlife)
- Aquatic Ecology
- Threatened and Endangered Species
- Historic and Cultural Resources
- Air Quality
- Socioeconomics
- Recreation
- Visual Resources
- Noise
- Public and Occupational Health and Safety
- Waste Management
- Transportation
- Land Use

The detailed analysis in Chapter 3 focuses on those resources with the potential to be affected by the Proposed Action. For the Proposed Action, TVA determined that there would be no impacts, or that potential impacts would be negligible or temporary, for the resources listed in Table 2-2. Therefore, TVA determined that detailed analysis was unnecessary for these resources, and they are not discussed further.

Table 2-2: Environmental Resource Areas with No, Negligible, or Temporary Impacts

Resource Area	No Action	Proposed Action
Prime Farmlands	Prime farmlands soils are located in some areas along the reservoir bottom exposed by the drawdown; however, these areas are not used as farmland and it is unlikely that they would be used for farmland in the future.	No prime farmland soils have been identified within the area of construction at the dam. Prime farmlands soils are located in some areas along the reservoir bottom exposed by the drawdown; however, these areas are not used as farmland and it is unlikely that they would be used for farmland during the time of the drawdown.
Hazardous Materials	No impacts are associated with hazardous materials.	During the proposed grouting activities, minor increases in on-site storage of hazardous materials such as fuels and lubricants may occur. BMPs such as secondary containment, waste minimization, and personnel training will be in place to minimize the possibility of spills and dictate appropriate measures in the event of a spill. The grouting materials are not considered hazardous to the public or the environment. Based on the small amounts of hazardous materials to be used, their temporary storage, and the BMPs to be implemented, impacts associated with hazardous materials were not considered further.
Climate Change	No impacts are associated with climate change.	No impacts related to climate change are anticipated to result from the proposed risk reduction measures. Concerning construction activities, operation of heavy equipment would be temporary and minor during project activities, and would not significantly increase greenhouse gases.
Natural Areas	Of the 10 Natural Areas existing within 5 miles of Boone Reservoir, only 2 areas - the Winged Deer Park and Austin Springs wetland - lie directly on the reservoir. Areas not on the reservoir would not be impacted. Winged Deer Park and Austin Springs wetland are addressed in the recreation and wetland sections of the EA, respectively.	No Natural Areas occur in the vicinity of the construction area at the dam. Natural Areas that are not directly on the reservoir would not be impacted. Winged Deer Park and Austin Springs wetland are Natural Areas that are addressed in the recreation and wetland sections of the EA, respectively.
Navigation	Other than personal recreational watercraft (addressed in Recreation), there is no commercial navigation on the reservoir or in the tailwater. No watercourses would be blocked or otherwise affected by the proposed project.	Other than personal recreational watercraft (addressed in Recreation), there is no commercial navigation on the reservoir or in the tailwater. No watercourses would be blocked or otherwise affected by the proposed project.

2.5 COMPARISON OF ALTERNATIVES

This EA evaluates the potential environmental effects that could result from implementing the No Action Alternative or the Proposed Action. The analysis of impacts in this EA is based on current and potential future conditions at Boone Dam and Reservoir, FPH Dam and Reservoir, and areas within the surrounding region.

Table 2-3 compares the impacts of the No Action Alternative and the Proposed Action. Although the No Action Alternative would not result in the construction impacts associated with the Proposed Action, it does not address the underlying purpose and need of this project. Under the No Action Alternative, seepage would continue and, over time, could result in the dam's failure. As stated in Section 2.1, although the risk of dam failure is low under Interim Operations and other IRRMs, taking no action to address the potential for such an occurrence is an unacceptable alternative to TVA.

2.6 THE PREFERRED ALTERNATIVE

TVA prefers the Proposed Action alternative. The No Action Alternative is not an acceptable alternative to TVA and is analyzed here only to comply with NEPA requirements.

Table 2-3: Comparison of Impacts of the No Action Alternative and the Proposed Action

Resource Area	Impacts from the No Action Alternative	Impacts from Proposed Action
Geologic Resources and Soils	Seepage and erosion under the dam's earthen embankment would continue long-term resulting in continued erosion under the dam; minor erosion and sedimentation of exposed reservoir bottom would continue, but would decline over time as the exposed areas become vegetated. TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species (see Section 2.2.4).	Minor erosion and sedimentation in the construction areas, which would be mitigated with erosion, sedimentation, and stormwater BMPs; localized adverse impacts on subsurface geology due to grouting; minor erosion and sedimentation of exposed reservoir bottom would continue, but would decline over time as the exposed areas become vegetated. The TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation of 400 to 500 acres of exposed reservoir bottom and TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species (see Section 2.2.4).
Water Resources	Surface and groundwater hydrology would remain largely unchanged because TVA operations would change little beyond the reduction of storage in Boone Reservoir; flows in the South Holston downstream of Boone Dam would be largely unaffected, but flows would fluctuate somewhat less; water supplies in the reservoir and downstream would not be adversely affected; at the upper end of Boone Reservoir, in the Watauga and South Fork Holston Rivers, areas of impoundment would revert to flowing water habitats. Water quality impacts would be minor; erosion and sedimentation of exposed reservoir bottom would increase reservoir turbidity at times, until revegetation occurs; water quality in Boone Reservoir and tailwater have not changed substantially due to Interim Operations, so limited changes in water quality are anticipated.	Surface and groundwater hydrology would remain largely unchanged during the 5- to 7-year drawdown, because TVA operations would change little beyond the reduction of storage in Boone Reservoir; flows in the South Holston downstream of Boone Dam would be largely unaffected, but flows would fluctuate somewhat less; water supplies in the reservoir and downstream would not be adversely affected; at the upper end of Boone Reservoir, in the Watauga and South Fork Holston Rivers, areas of impoundment would revert to flowing water habitats. Once the drawdown period is over, Normal Operations would resume and water resource conditions would return. Water quality impacts would be minor; erosion and sedimentation of exposed shoreline would increase reservoir turbidity at times, until revegetation occurs; water quality in Boone Reservoir and tailwater have not changed substantially due to Interim Operations, so limited changes in water quality are anticipated. TVA will monitor water quality near the construction and in reservoir releases to document temporary changes associated with construction and grouting activities and with the drawdown. Once the drawdown period is over, Normal Operations would resume and water resource conditions would return.

Table 2-3: Comparison of Impacts of the No Action Alternative and the Proposed Action

Resource Area	Impacts from the No Action Alternative	Impacts from Proposed Action
Floodplains and Flood Risk	The 100-year floodplain around Boone Reservoir would experience a lower likelihood of inundation; though the probability of inundation of these areas is already very low; downstream of Boone Dam, the frequency, duration, and extent of flooding events will remain largely unchanged because similar flood control operations would be in effect. Under the No Action Alternative, the operating range of Boone Reservoir would remain between 1350 and 1355 feet indefinitely. A permanent change in reservoir operations would result in a permanent change to the 100-year flood elevation upstream, downstream, and within Boone Reservoir.	The workbench on the crest of the dam needed for the dam remediation would encroach on a short part of the 100-year floodplain, but this would not affect the ability of Boone Dam to contribute to the reduction of downstream flooding. A small amount of flood control storage would be permanently lost due to placement of fill within the Flood Control Storage Zone. There would be no permanent loss of power storage. The 100-year floodplain around Boone Reservoir would experience a lower likelihood of inundation during the drawdown period. TVA's hydraulic models of the 100- and 500-year flood elevations downstream indicate that the frequency, duration, and extent of flooding events will remain largely unchanged from pre-drawdown conditions. Once the drawdown period is over, Normal Operations would resume and the probability of floodplain inundation conditions in the reservoir would return.
Wetlands	Minor to moderate impacts on wetlands caused by the loss of shoreline wetlands; new wetland types would be established in association with the new permanent shoreline at the lowered reservoir level. These changes would be slow to occur and would be permanent.	Minor to moderate impacts on wetlands caused by the loss of shoreline wetlands; new wetland types would be established in association with the new permanent shoreline at the lowered reservoir level. These changes would be slow to occur and would be temporary. After Normal Operations resume, the existing wetland areas and types would return over time.

Table 2-3: Comparison of Impacts of the No Action Alternative and the Proposed Action

Resource Area	Impacts from the No Action Alternative	Impacts from Proposed Action
Terrestrial Ecology (Vegetation and Wildlife)	Minor impacts on wildlife, primarily at the edges of the reservoir associated with wetlands and mudflats; new terrestrial and wetland vegetation would likely become established on newly exposed reservoir bottom; minor impacts on riparian vegetation that were previously dependent upon higher pool levels (spring/summer) may occur; the permanent drawdown increases the potential for invasive species to become established along exposed reservoir bottom. Over time, a new shoreline riparian area would be permanently established. TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species which would serve to enhance vegetative communities and improve wildlife habitat (see Section 2.2.4).	Due to reservoir drawdown, minor impacts on wildlife, primarily at the edges of the reservoir associated with wetlands and mudflats; new terrestrial and wetland vegetation would begin establishing on newly exposed reservoir bottom; minor impacts on riparian vegetation that were previously dependent upon higher pool levels (spring/summer) may occur; the 5- to 7-year drawdown increases the potential for invasive species to become established along exposed reservoir bottom. Over time, a new shoreline riparian area would establish, but with the return of Normal Operations, these areas would be inundated and vegetation and wildlife habitat would return to existing conditions over time. TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species which would serve to enhance vegetative communities and improve wildlife habitat (see Section 2.2.4). In addition, the TVA/TWRA Fishery Habitat Enhancement Project (see Section 2.2.4) would serve to enhance vegetative communities and improve wildlife habitat on 400 to 500 acres of exposed reservoir bottom during the drawdown.
Aquatic Ecology	With reservoir volume and surface area considerably reduced, the associated reduction in fish habitat and food sources will likely result in reduced populations over time; sport fish densities would increase in the short term, as may angler success for certain species; but over time fish carrying capacity would decline, leading to populations adjusting to the new reservoir size and productivity; over time, shoreline aquatic habitat would be reestablished at the new reservoir level and fish populations may respond positively, adjusting over time.	With reservoir volume and surface area considerably reduced during the 5- to 7-year drawdown, the associated reductions in fish habitat and food sources will likely result in reduced populations over time; sport fish densities would increase in the short term, as may angler success for certain species; but over time fish species carrying capacity would decline, leading to populations adjusting to the new reservoir size and productivity; over time, shoreline aquatic habitat would be reestablished at the new water level and fish populations may respond positively, adjusting over time; populations would rebound to existing levels over time, after normal water levels return. The TVA/TWRA Fishery Habitat Enhancement Project (see Section 2.2.4) would serve to enhance shoreline fish habitat on 400 to 500 acres of exposed reservoir bottom after normal pool levels return, which would benefit aquatic species and mitigate some of these effects. Vegetation established along the previously exposed reservoir bottom would not survive the inundation, but the remnant biomass would provide ample cover for young fish, as well as provide organic carbon and nutrients into the reservoir.

Table 2-3: Comparison of Impacts of the No Action Alternative and the Proposed Action

Resource Area	Impacts from the No Action Alternative	Impacts from Proposed Action
Threatened and Endangered Species	No adverse impacts. Potential positive impacts on some federally and state listed species due to formation of potentially suitable habitats resulting from the reservoir drawdown.	No adverse impacts. Potential positive impacts on some federally and state listed species due to formation of potentially suitable habitats resulting from the 5 to 7 year drawdown.
Cultural Resources	No adverse impacts to historic buildings and structures. Potential increase in looting and the accelerated erosion of archeological sites in the drawdown area, leading to the eventual loss of some sites and resources over time.	No adverse impacts to historic buildings and structures. Potential increase in looting and the accelerated erosion of archeological sites in the drawdown area during the 5 to 7 year drawdown.
Air Quality	No direct or indirect impacts.	Minor adverse impacts during construction resulting from construction emissions, dust and particulate matter air emissions resulting from operation of the on-site grout batch plant. TVA (or its contractor) would obtain any necessary permits and implement construction BMPs to address air emissions from open construction areas and unpaved roads. Areas would be sprayed with water as needed to reduce fugitive dust emissions.
Socioeconomics	Direct and indirect adverse impacts on the regional economy result from the reduced visitation days due to changes in access to the reservoir resulting from the long-term drawdown. Impacts will be felt in the form of reduced retail sales for recreation-related services, and potentially in reduced recreation-related jobs. In addition the long-term drawdown has potential to impact property values of reservoir-side property. Tax revenues from both changes in retail sales and property values may result. Impacts from a reduction in visitor days will be somewhat mitigated as TVA extends docks and increases accessibility.	Direct and indirect adverse impacts on the regional economy are the same under the Proposed Action for 5 to 7 years during the dam remediation. In addition to mitigating the impacts from reduced visitor days by improving access to the reservoir, TVA also plans to spend between $200 and $300 million repairing the dam. This construction activity will off-set some of the job losses, retail sales and tax revenue lost due to a reduction in visitors to the area. After the dam remediation period, property values and recreational visitors are expected to return to normal.

Table 2-3: Comparison of Impacts of the No Action Alternative and the Proposed Action

Resource Area	Impacts from the No Action Alternative	Impacts from Proposed Action
Recreation	Direct and indirect adverse impacts on recreation result from the reduced visitation days due to changes in access to the reservoir resulting from the long-term drawdown. Impacts are felt by both people visiting the reservoir, and those that live in reservoir-front property. Impacts from a reduction in visitor days will be somewhat mitigated as TVA extends docks and increases accessibility.	Direct and indirect adverse impacts on recreation are the same under the Proposed Action for 5 to 7 years during the dam remediation, mitigated in part by TVA's plans improve access. Recreation opportunities would be lost at the construction areas during construction but would be restored after project's completion. After the dam remediation period recreational visits are expected to return to normal.
Visual Resources	Direct and indirect adverse impacts on visual resources are primarily related to exposed reservoir bottom areas resulting from the long-term drawdown. Visual impacts would lessen over time as exposed areas are revegetated. TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species which would serve to enhance the reestablishment of appropriate vegetative communities and mitigate for visual impacts.	To reduce the potential visual impacts associated with construction lighting at the dam, TVA will position and adjust lighting as needed to reduce or minimize their visibility from nearby residences. Direct and indirect adverse visual impacts, primarily related to exposed reservoir bottom areas resulting from the long-term drawdown. Visual impacts would lessen over time as exposed areas are revegetated. The TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation on 400 to 500 acres of exposed reservoir bottom and TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species which would serve to enhance the reestablishment of appropriate vegetative communities and mitigate for visual impacts until normal reservoir levels return (see Section 2.2.4).
Noise	Minor reduction in noise levels associated with less recreational boating and because shoreline recreational users and land owners would be further from the water.	Minor adverse impacts during construction resulting from equipment and construction vehicles. Such impacts would be reduced in part by TVA requiring the use of modern, well-maintained equipment and vehicles, and screening the equipment for noise emissions, when practicable. Minor reduction in noise levels associated with less recreational boating during period of drawdown.

Table 2-3: Comparison of Impacts of the No Action Alternative and the Proposed Action

Resource Area	Impacts from the No Action Alternative	Impacts from Proposed Action
Public and Occupational Health and Safety	There would be adverse impacts on boater safety due to lower water levels exposing boating hazards for an indefinite period; over time the hazards would be well known and may be less likely to be hazardous. TVA has placed hazard buoys at various sites around the reservoir to notify the public of safety and navigation concerns during the drawdown, and placed buoy lines above and below the dam; TVA will work closely with TWRA to mark any additional hazards in the reservoir that pose a threat to the health and safety of boaters. Reduced access to boat ramps could make it difficult for emergency responders to launch. To improve access to the reservoir, TVA has proposed (and considered under other environmental reviews) to improve access to the reservoir by enhancing the only usable public boat launching ramp at Pickens Bridge and to add additional launch ramps on the South Fork Holston River (Devault Bridge).	There would be continued adverse impacts on boater safety due to lower water levels exposing boating hazards; over time the hazards would be well known and probably less likely to be hazardous. TVA has placed hazard buoys at various sites around the reservoir to notify the public of safety and navigation concerns during the drawdown, and placed buoy lines above and below the dam. TVA will work closely with TWRA to mark any additional hazards in the reservoir that pose a threat to the health and safety of boaters. Reduced access to boat ramps that could make it difficult for emergency responders to launch; to improve access to the reservoir, TVA has proposed (and considered under other environmental reviews) to improve access to the reservoir by enhancing the only usable public boat launching ramp at Pickens Bridge and to add an additional launch ramp on the South Fork Holston River (Devault Bridge). TVA's Vegetation Management Plan will aid in management of the successional vegetation on portions of the exposed reservoir bottom which will reduce navigation and public safety problems once the reservoir is returned to normal levels. Upon return to normal reservoir levels, public safety issues would return to pre-drawdown levels, after a period of adjustment.
Waste Management	No direct or indirect impacts.	Minor direct and indirect adverse impacts.
Transportation	Permanently reduced recreation trip traffic resulting from the reduction in recreational use.	Minor direct adverse impacts related to construction traffic and the temporary closure of a portion of Minga Road near the dam. Closure of Minga Road would result in a minor increase in travel time/distance for some residents along Minga Road and would also affect current school bus routes for the duration of the closure. TVA will attempt to limit deliveries of crushed stone, riprap, and other materials to usual business hours, approximately 10 hours per day to the extent practicable. Reduced recreation trip traffic resulting from the reduction in recreational use during the period of the drawdown.

Table 2-3: Comparison of Impacts of the No Action Alternative and the Proposed Action

Resource Area	Impacts from the No Action Alternative	Impacts from Proposed Action
Land Use	Land activities would not change, and no direct or indirect impacts on land use designations would result.	Temporary changes in activities within the Boone Dam Reservation during construction. Portions of two TVA tracts would be used temporarily inconsistently with the Boone RLMP. No long-term change in land use allocations or designation as a result of construction or the drawdown.

This page intentionally left blank.

CHAPTER 3

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the existing environmental, social, and economic conditions of the project site and the surrounding areas that might be affected if the Proposed Action or the No Action Alternative is implemented. The chapter also describes the potential environmental effects that could result from implementing the No Action Alternative and Proposed Action.

3.1 BACKGROUND FOR ENVIRONMENTAL ANALYSIS

This section describes the Normal Operations of the Boone Project (prior to the drawdown and other risk reduction measures) and the Interim Operations. Interim Operations are how the Boone Project would be operated for the 5- to 7-year period of the Boone Dam remediation (under the Proposed Action) or permanently (in the case of the No Action Alternative). This section also provides a summary of the changes in reservoir surface area (acreage) and the seasonal differences in the width and slope of the band of dewatered reservoir bottom area as a result of the drawdown. This background information is important for the environmental analysis in this EA.

3.1.1 Boone Project Operations

The Boone Project is a multi-purpose tributary project located on the South Fork of the Holston River in northeastern Tennessee. The dam impounds Boone Reservoir in Washington and Sullivan Counties, and its tailwater is part of the upper FPH Reservoir. Boone Reservoir is operated as a part of the TVA reservoir system to meet a number of purposes, including power production; flood control; recreation; and management of water supply, water quality, and aquatic habitat. Boone Dam operates as a hydroelectric facility that has three generating units with an average annual net dependable capacity of approximately 103 megawatts, under normal operations.

3.1.1.1 Normal Operations (Prior to October 2014)

Boone Project operations prior to October 2014 (Normal Operations) are summarized in Table 3-1 (which provides a summary of reservoir levels, turbine capacities, and typical hydroelectric generation flow releases) and in Figure 3-1, showing the Boone Project operating guides.[5] The upper two lines shown in Figure 3-1 are the normal reservoir level (elevation) guide curve and flood guide. These guides have been in place for decades at the Boone Project but were revised slightly as a result of the 2004 TVA ROS and Record of Decision (TVA 2004).

[5] TVA uses operating guides for each reservoir to make decisions about moving water through its dams. These guides are based on many decades of operating experience. They are built around the idea of allowing seasonal variations in the use of flood storage space.

Table 3-1: Summary of Normal and Interim Operations for the Boone Project

	Normal Operations (Prior to October 2014)	Interim Operations
Operating Mode	Power production; flood control; recreation; and management of water supply, water quality, and aquatic habitat	Power production; flood control; recreation; and management of water supply, water quality, and aquatic habitat
Reservoir Operating Levels	1,362 feet (normal winter) to 1,382 feet (normal summer)	Between 1,350 and 1,355 feet (Targeting 1,352.5 feet)
Seasonal Pool Fluctuation	20 feet	5 feet
Typical Flow Releases from Hydroelectric Generation	3,560[1] to 13,420 cubic feet/ second (cfs)[2]	3,510[3] to 8,180 cfs[4]
Flood Control Operations	Target 1,382 feet to not exceed 1,385 feet, using full turbine capacity and spill; FPH –11,000 cfs maximum flow within normal flood operations	Target 1,350 feet to not exceed 1,355 feet to extent possible, using full turbine capacity, sluice, and spill; FPH –11,000 cfs maximum flow within normal flood operations

[1] One unit most efficient load (MEL), best efficiency during winter pool (1,362 feet)
[2] Maximum turbine flow June 2004 through October 2014
[3] One unit MEL at 1,350 feet
[4] Two units maximum sustainable load (MSL), maximum capacity at 1,355 feet

As shown in Figure 3-1 and Table 3-1, Boone Reservoir has an annual pool variation of about 20 feet during normal years. Boone is operated in accordance with ROS with generally stable pool levels at about 1,382 feet during the summer season, from mid-May through Labor Day, during most years. In early September, the reservoir is lowered over a period of approximately 3 months to a level required to provide for seasonal flood storage – typically about 1,362 feet (Figure 3-1). During the spring, water levels are slowly raised to reach summer pool levels in May. Boone reservoir has a flood-storage capacity of 81,580 acre-feet at winter pool. Compared to other TVA multipurpose projects on major tributaries, Boone Reservoir has much less usable flood storage than most other projects.

During normal operations, Boone is operated for hydropower generation, downstream flows, and water quality. Upstream flows, including controlled releases from South Holston and Watauga Dams as well as unregulated flows from the Doe River and other minor tributaries, flow into Boone and act to raise its reservoir level. Three hydroelectric turbines, five spill gates, and one sluice gate can be used to release water downstream of the dam, although the sluice gates and spill gates are rarely used. The sluice gate does not generate electricity, and its use is typically limited for maintenance purposes. Spill gates are only used to pass flood flows in extreme hydrologic events, and have only been used operationally three times (in 1955, 1963, and 1984).

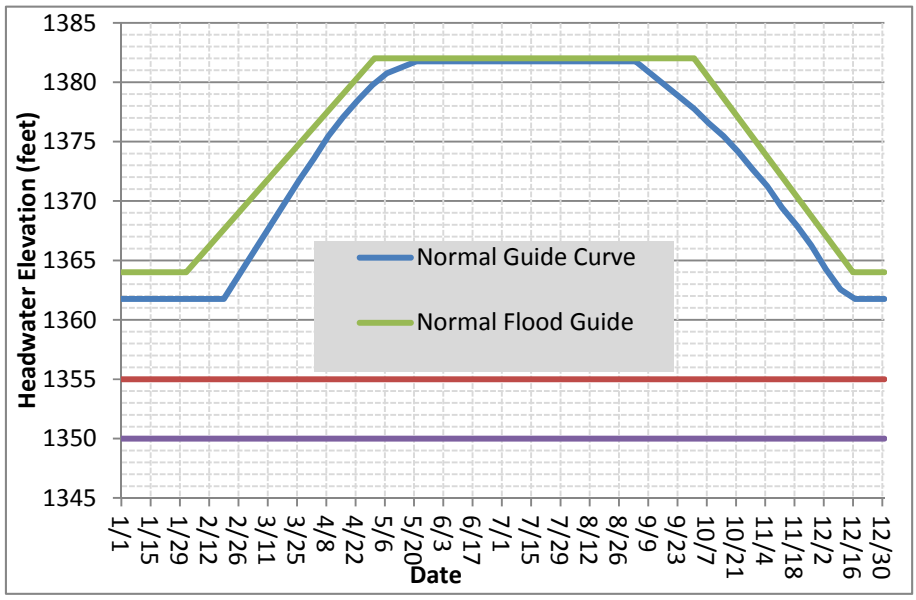


Figure 3-1: Boone Reservoir Operating Guides

Notes: Water elevations are expressed in feet above mean sea level. Flood-guide elevations show the amount of storage allocated for flood-damage reduction during different times of the year. The amount of storage varies with the potential flood threat. Flood-guide elevations are lowest from mid-December through January because winter storms are generally larger, occur more frequently, and produce more runoff. Flood-guide elevations increase between February and mid-May as the risk of flooding decreases. The reservoir elevation is highest from Memorial through Labor Day to support summer reservoir recreation. After Labor Day, TVA begins the unrestricted drawdown to winter flood-damage reduction levels.

Normal flow releases to downstream are released through the turbine (units) to generate electricity. The Boone powerhouse has three units with hydraulic capacities specified in Table 3-2. Boone's powerhouse is operated by automatic generation control (AGC) in a load-following or peaking mode. This means that Boone's units generally are operated remotely from TVA's System Operations Center (Hydro Dispatch Control Center) based on when power is most needed (e.g., at peak electrical demand periods). One, two, or three generators can be operated, resulting in a wide range of possible flows downstream and fluctuating flows during daily operations. Although the hydraulic capacities of the units are listed, the most efficient gate setting on the units for power generation will result in flow approximately 500 to 1,200 cubic feet per second (cfs) less than when operated at maximum hydraulic capacity (see Table 3-2).

Normally, Boone generates for several hours a day, often during the morning or evening when electrical power demand is greatest. One, two, or three units are used resulting in regular daily flow fluctuations during any given day or week from approximately 0 to 11,000 cfs. A minimum average daily flow of 400 cfs is maintained immediately downstream of Boone Dam. Boone is operated in part to meet the 800-cfs required minimum flow downstream of the FPH Project, which is required in part to meet water needs at the Eastman Chemical Company facility in

Kingsport, Tennessee. TVA typically maintains the water levels in FPH between 1,258 and 1,263 feet.

Table 3-2: Boone Dam Generation Units Capacities at a Tailwater Elevation of 1,265 Feet

		Unit #1 (cfs)	Unit #2 (cfs)	Unit#3 (cfs)
ROS summer 1,382 Headwater	Hydraulic capacity	4,777	4,755	4,749
	Most efficient operation	3,599	3,561	3,493
ROS winter 1,362 Headwater	Hydraulic capacity	4,295	4,299	4,272
	Most efficient operation	3,565	3,587	3,537
Interim 1,352 Headwater	Hydraulic capacity	*	4,023	4,002
	Most efficient operation		3,564	3,474

* Unit #1 not operable during remediation because the tailrace filter berm blocks the unit's outlet draft tubes.

3.1.1.2 Normal Flood Control Operations

The Boone and FPH Projects are operated in tandem during a flood control operation, with Boone providing the flood storage space but FPH releases being the key index of targeted discharges because it is located immediately upstream of Kingsport, Tennessee. During flood control operations, the Boone and FPH Projects are operated differently than typical tributary projects. This is because Boone flood storage is limited compared to the other tributary multi-purpose storage reservoirs, and FPH, 8-miles downstream, provides little additional storage. Although Boone provides some flood storage, FPH controls targeted discharges because it is located immediately upstream of Kingsport, Tennessee, a populated and industrial damage center.

When runoff-producing rainfall amounts occur in the Boone Basin and rainfall is expected to continue, FPH is scheduled to a one- or two-unit generating status – a discharge of 4,000 to 8,000 cfs. Boone discharges are adjusted to regulate the discharge out of FPH, taking into account that it may be desirable to gradually lower the pool at FPH to provide storage contingency if the heavy precipitation continues for enhanced spill operations at FPH and/or Boone if required. If rainfall continues, and the river forecast indicates that Boone is continuing to lose storage, it may be desirable to load the two units at FPH to maximum sustainable load (approximately 9,300 cfs) and—if conditions persist—to initiate spill at FPH up to an 11,000-cfs threshold.

Even with the above increases in discharge, it may not be possible to maintain FPH at 11,000 cfs without exceeding the top-of-gates level at Boone. When it is forecasted that the Boone top-of-gates elevation of 1,385 feet will be exceeded unless Boone Dam (and thus FPH) discharges are increased beyond minimum flood damage thresholds (i.e. 11,000-cfs), the River Forecast Center staff determines the minimum required discharges to regulate a 1,385 Boone Reservoir level and initiates water orders as necessary. At this point, the available storage essentially has been used up, and TVA's ability to further limit downstream flood damages is

limited. Typical flood recovery rates for Boone Reservoir vary from regulating FPH to operate within a discharge range of 8,000 to 11,000 cfs. This variation depends on the Boone pool elevation (which also may depend on flood recovery operations upstream at South Holston and Watauga Dams). Based on dam safety and erosion considerations, the recommended Boone Reservoir drawdown limit is 2 feet per day not to exceed 7 feet per week for 28 feet, and then 3 feet per week.

3.1.1.3 Interim Operations during Dam Remediation

Soon after the seepage was discovered at Boone in October 2014, TVA lowered the reservoir water levels to reduce the potential for dam failure for the protection of public safety. TVA has since implemented an interim operational policy to meet current Boone Dam safety objectives, including:

- Reducing headwater static loading condition (lowering the Boone Reservoir level);
- Maintaining constant Boone headwater/tailwater condition to extent possible (minimizing the elevation difference between the reservoir and the tailwater levels; and
- Supporting the passage of potential high-flow events (flood control operations).

Differences in Boone Project Operations Resulting from Interim Operations

- Water levels lowered to about 30 feet below Boone normal summer pool elevation and about 10 feet below its normal winter pool
- Reservoir seasonal fluctuation from approximately 20 feet reduced to 5 feet of continual fluctuation
- Fluctuations and levels of tailwater flows would be somewhat reduced due to restrictions on the number of turbines that can be operated
- Flows during flood control operations would not be substantially different during Interim Operations from Normal Operations.

As noted earlier, Interim Operations refers to the operations that TVA initiated after lowering the reservoir level to reduce risk of dam failure and how the project is anticipated to be operated through the period of dam remediation. Other operating measures to reduce the risk of dam failure include a new operating guide, flood control operations, and downstream releases for hydropower generation and other uses.

Under Interim Operations, the new objective for operating Boone Reservoir is to maintain stable headwater and tailwater conditions. TVA would maintain the current reservoir water levels, which is about 30 feet below normal summer pool elevation and about 10 feet below normal winter pool levels (see Figure 3-1) for the duration of the dam remediation project. This is referred to as the “headwater operating restriction” – maintaining the Boone Reservoir pool targeting an elevation of 1,352.5 feet (refer to Figure 3-1 and Table 3-1). This restriction has reduced the Boone Reservoir surface area acreage from approximately 4,369 acres at its normal summer pool (1,382 feet) to approximately 2,330 acres at the target elevation of 1,352 feet—a reduction of approximately 2,039 acres.

The headwater operating restriction also reduces potential usable storage in Boone Reservoir for flood operations by approximately 1,300 acre-feet during summer and 70,000 acre-feet

during winter. The restriction also lowers the operating head (the difference between the reservoir water level and the tailwater level) for hydropower generation, thus decreasing the amount of hydropower that can be generated by the units at Boone Dam. The surface area of Boone Reservoir would fluctuate between approximately 2,229 acres at 1,350 feet and approximately 2,437 acres at 1,355 feet.

Under Interim Operations, Boone would continue to be operated for hydropower generation, downstream flows, and water quality. Boone would continue to be operated remotely by AGC from TVA's System Operations Center based on when power is most needed. Unit #1 is currently offline because the tailrace filter berm blocks the outlet draft tubes.[6] Therefore, only Units #2 and #3 can be used. Tailwater restrictions however, dictate that Boone would be limited to operating a single generating unit to the extent possible, supplementing it with a second unit as needed to maintain headwater pool elevation. Tailwater elevation changes would be muted because operations would be limited to shifts from generating between no units and one unit or between one unit and two units, but not between no units and two units. The same amount of inflow generally would be coming from the upstream projects and through Boone on a daily basis. This means that the units would need to be operated for longer periods each day than during normal operations, all other things being equal. This would result in flows in the FPH downstream of Boone fluctuating within a more narrow range than under Normal Operations, and periods of generation being longer each day or occurring more often for two periods a day. Downstream of FPH, flows would tend to be more stable.

3.1.1.4 Interim Flood Control Operations

To reduce risk to the extent possible, Boone Reservoir has been lowered to the lowest pool elevation such that TVA River Management can regulate discharges during normal hydrological conditions and frequent (1- to 2-year flood) events. However, the operational headwater restriction would be exceeded during larger flood events.

Prior to and during heavy rainfall events, Boone Reservoir pool is and would be reduced to the lower range of the operating restriction (1,350 to 1,352 feet). During heavy rainfall events, outflow can be supplemented by a second unit, sluice gate, and spillway gates, as necessary. Operational policy upstream at South Holston and Watauga Dams was evaluated and deemed appropriate for interim conditions.

3.1.2 General Characterization of Drawdown

Drawdown of the reservoir pool to the Interim Operations target elevation of 1,352 feet results in a considerably wider band of exposed reservoir bottom between the normal full pool shoreline and the Interim Operations shoreline during the summer-fall period (at 1,382 feet). The width of this band varies with the location in the reservoir due to localized topography (Table 3-3; Figures 3-2 through 3-5).

[6] In a separate project, TVA is planning to construct a replacement filter that will provide longer-term protection against seepage. Completion of that work may allow Unit #1 to return to service before the dam remediation is complete.

During the May through August period, when the reservoir normally would be at full pool, the drawdown to 1,352 feet results in the edge of the water being on average about 192 feet from the normal shoreline. The change in the width of the band of land between normal winter pool level (1,362 feet) and the Interim Operations target elevation of 1,352 feet is much less (about 41 feet on average). Areas with extensive areas of dry land between the normal full pool shoreline generally are found at the upper end of the Watauga Arm and the South Holston Arm, as well as where smaller tributaries join the reservoir (Figures 3-2 through 3-5).

During the summer-fall period, the distance from the normal shoreline to the Interim Operations shoreline is on average about 192 feet, and the slope is about 16 percent. During the winter-spring period, the distance from the normal shoreline to the Interim Operations shoreline is on average about 41 feet, and the slope is about 24 percent.

Table 3-3: Distance and Slope from Normal Operations Summer Full Pool (1,382 feet) to Interim Operations Target Pool (1,352 feet)

Distance from Normal Full Pool Shoreline to Interim Operations Target Elevation Shoreline			Reservoir Bottom Slope between Normal Full Pool Shoreline to Interim Operations Target Elevation Shoreline
Mean	About 68% of shoreline areas are within this distance	Maximum	Mean
192 feet	400 feet	2,111 Feet	16%

Table 3-4: Distance and Slope from Normal Operations Winter Pool (1,362 feet) to Interim Operations Target Pool (1,352 feet)

Distance from Normal Full Pool Shoreline to Interim Operations Target Elevation Shoreline			Reservoir Bottom Slope Between Normal Full Pool Shoreline to Interim Operations Target Elevation Shoreline
Mean	About 68% of shoreline areas are within this distance	Maximum	Mean
41 feet	110 feet	867 feet	24%

Figure 3-2: Boone Reservoir Drawdown Zones – Overview

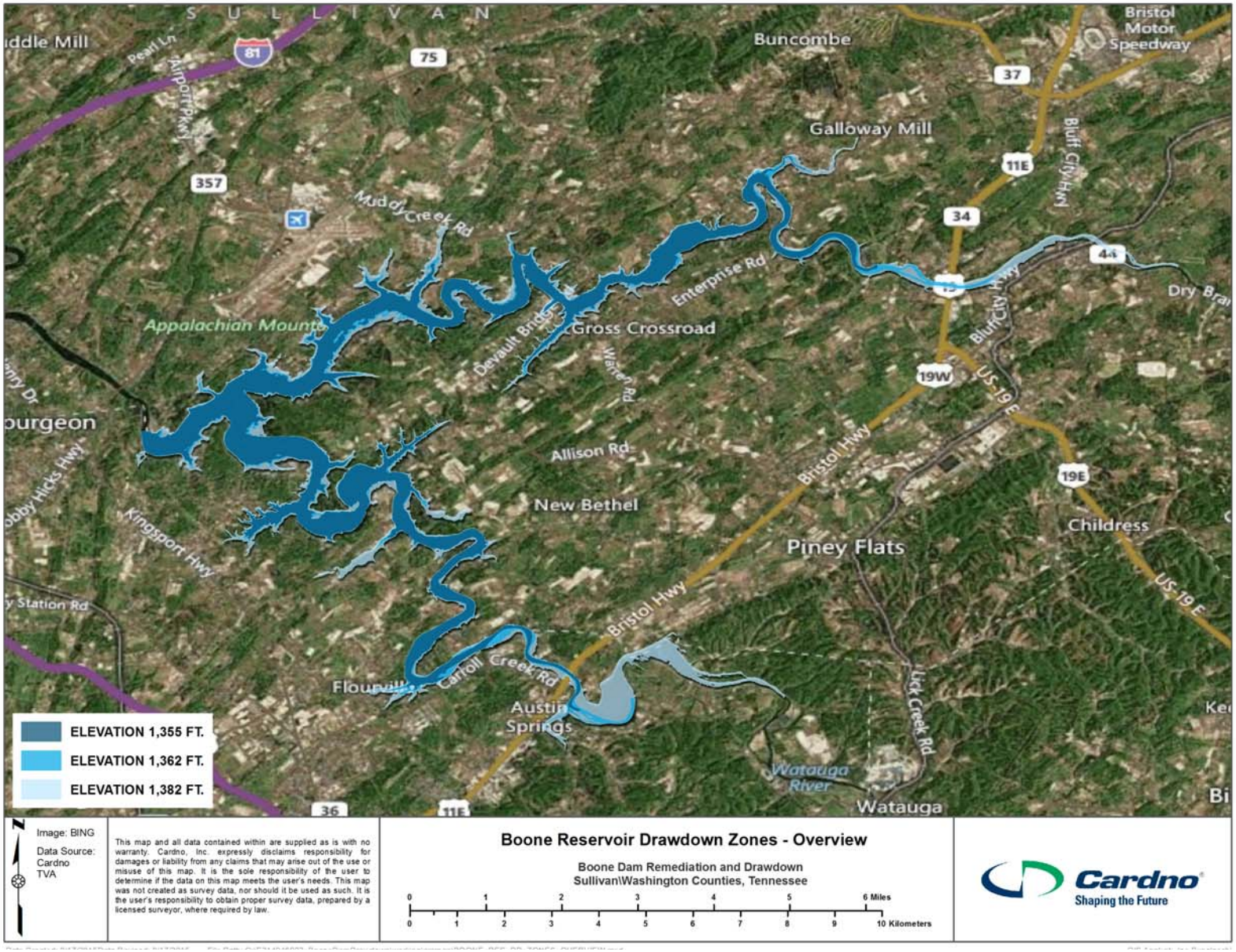


Figure 3-3: Boone Reservoir Drawdown Zones – Boone Reservoir

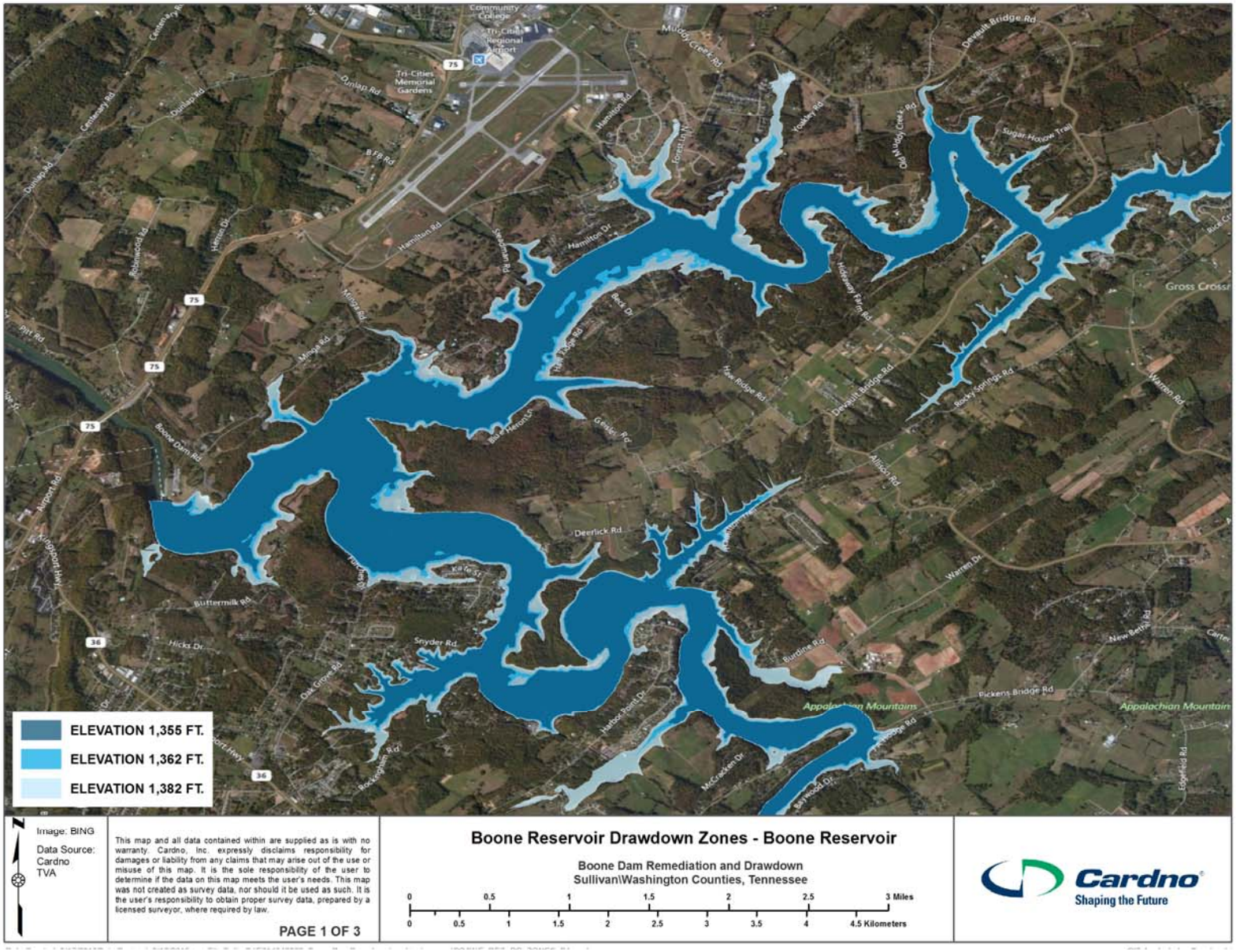


Figure 3-4: Boone Reservoir Drawdown Zones – Watauga Arm

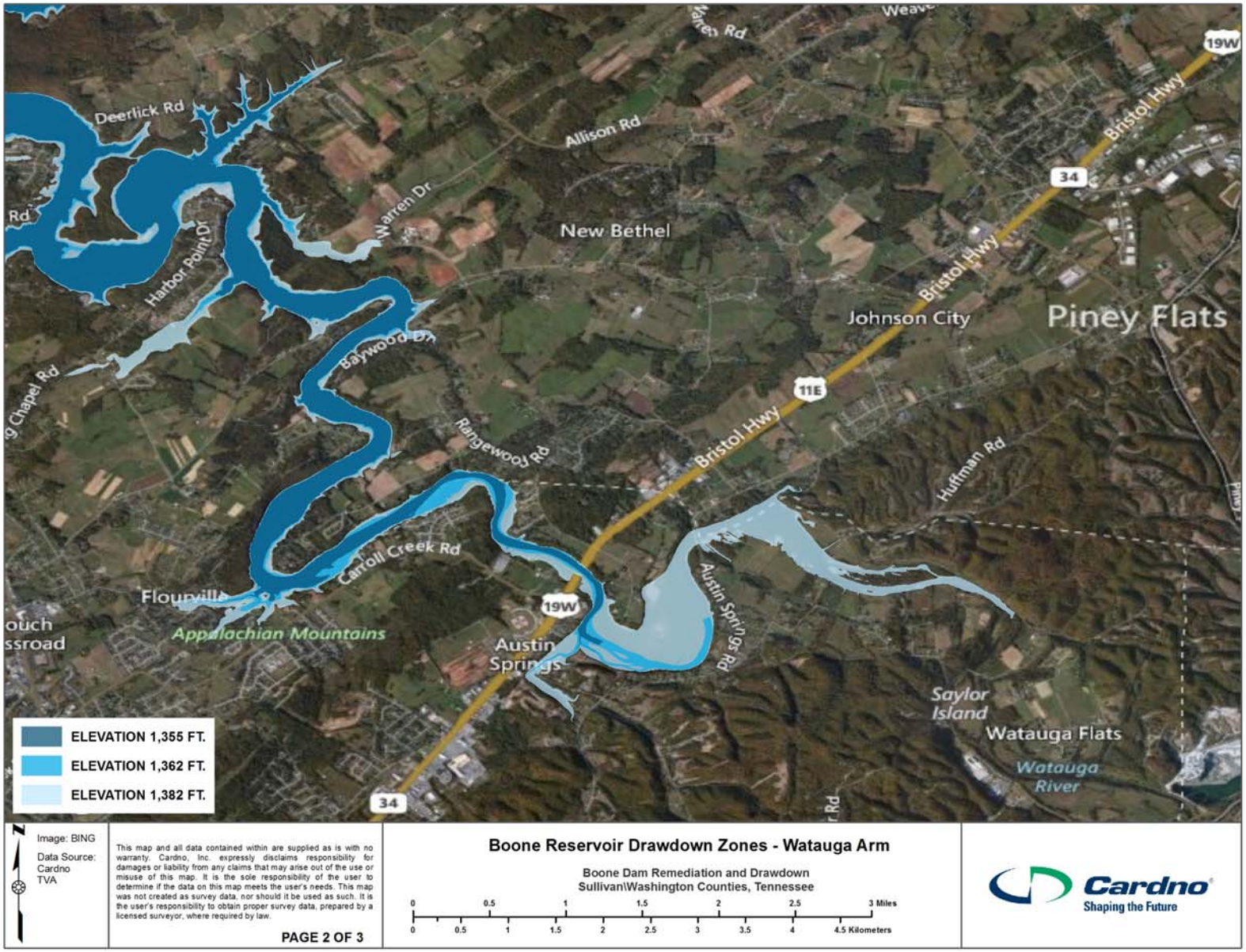
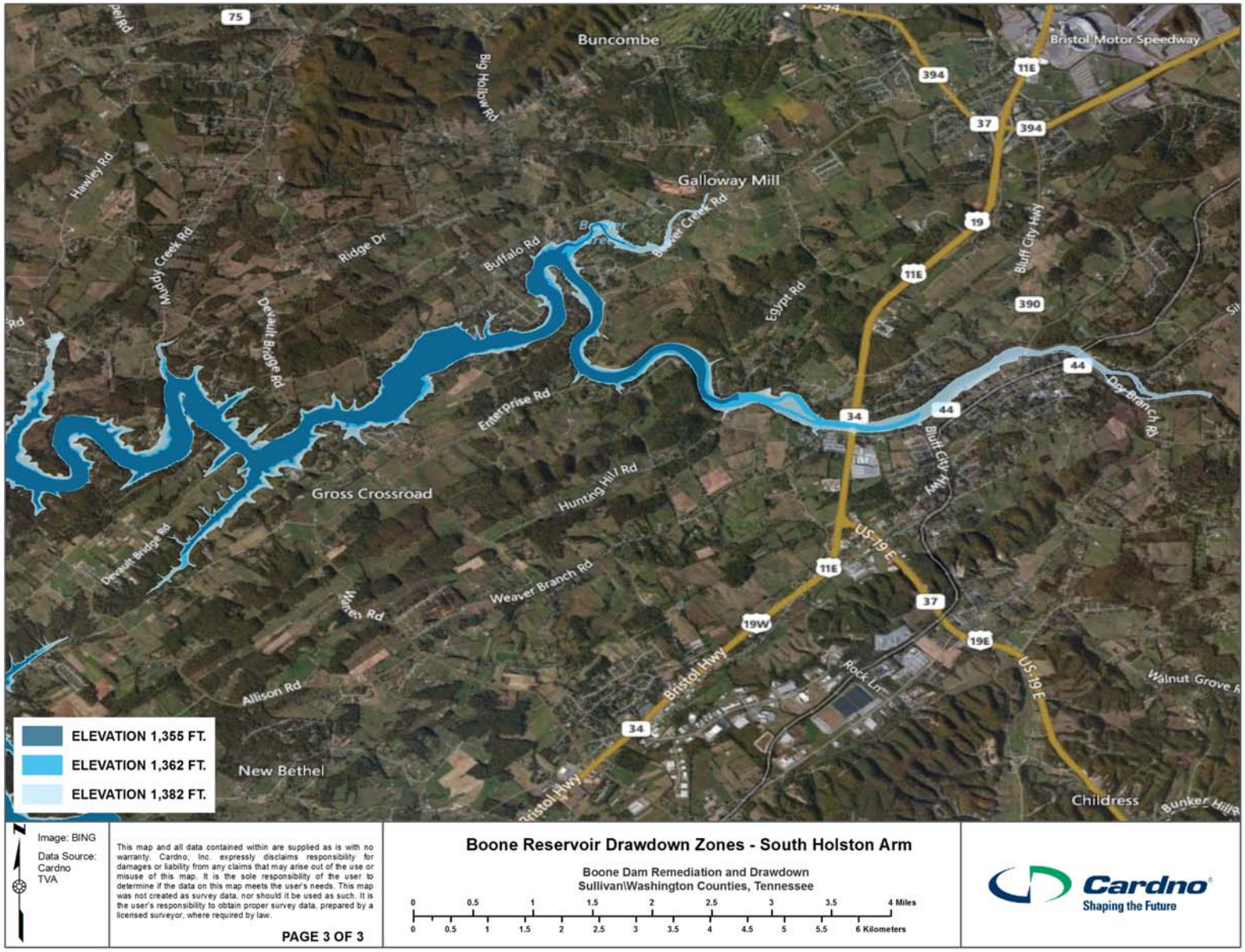


Figure 3-5: Boone Reservoir Drawdown Zones – South Holston Arm



3.2 GEOLOGIC RESOURCES

This section describes the existing geologic resources at the Boone Dam and Reservoir and the potential impacts on these resources associated with the No Action Alternative and the Proposed Action. Components of geologic resources that are analyzed include geology, paleontology, seismology, and soils.

3.2.1 Affected Environment

Geology

Boone Dam and Reservoir is located in the Valley and Ridge physiographic province of east Tennessee, which extends from New York southward through eastern Tennessee to the coastal plain of Alabama. The dominant geologic unit at the site is limestone belonging to the lower part of the Knox Group, locally known as the Conococheague Formation. The Conococheague is composed principally of a medium to dark gray, banded limestone. Its lower portion is characterized by a dense blue-gray sandy dolomite. Isolated zones of dolomite are found throughout the formation along with occasional nodules of black chert. The Conococheague is approximately equivalent in the geologic column to the Copper Ridge Formation of Upper Cambrian age. (TVA 1958)

Ample rainfall over this carbonate bedrock leads to the formation of karst topographical features with solution channels, caves, springs, and sinkholes. Rainwater, picking up carbon dioxide from the atmosphere, percolates slowly through soils, gathering further carbon dioxide, to form a weak carbonic acid that slowly dissolves the limestone and dolomite. Solution channels form—primarily upon fractures, faults, and planes—and slowly enlarge over time, forming underground stream channels and caves. Karst sinkholes may occur as the underlayment erodes away (U.S. Geological Survey [USGS] 2015c).

The risk of sinkhole activity at the Boone Dam reservation is equivalent to the karst risk anywhere else in this geologic setting and, thus, distress to TVA facilities at the dam is similar to what has existed for decades. TVA is currently measuring settlement at all major infrastructure located at Boone Dam and the immediate reservation and monitoring efforts will continue for the entire duration of the proposed project. While current technology in geotechnical engineering practice does not allow for accurate prediction of when and where sinkholes will occur, TVA is investigating whether its facilities at the dam are at risk from sinkholes. If the risk analysis identifies the potential for additional sinkholes, TVA will address these risks. Currently, redundancy measures and action plans are in place for the cable tunnel, control building, and switchyard. These plans will be updated as new information becomes available.

Paleontology

The temperate environment and shallow marine waters over the project site during the Cambrian period about 500 million years ago provided a rich environment for marine life. Marine organisms including stromatolites and trilobites thrived. Fossils of some of these Cambrian organisms help to date the formations (USGS 2015d).

The Gray Fossil Site, a unique zone abundant with Miocene fossils, is less than 7 miles southwest of Boone Dam. Possibly formed from a pond in a karst terrain sinkhole, the clays preserved a record of an ecosystem from 7 to 4.5 million years ago complete with plant and animal fossils. Findings include tapirs, frogs, and turtles along with Teleoceras (an extinct rhinoceros) and red panda skeletons. Only about 1 percent of the site has been explored, and future fossil recovery is expected to continue for a hundred years (ETSU 2015). It is unknown whether fossils are present within the proposed construction boundaries. However, most construction would occur on the dam embankment or other previously disturbed areas. The only place where excavation would occur is along the dam, which is made up of fill materials.

Seismology

Remnants of the plate tectonic activity that helped form the Valley and Ridge physiographic province with its folds and thrust faults continue to release energy through the Eastern Tennessee Seismic Zone. Extending from southwest Virginia to northeast Alabama, this seismic zone is one of the more active zones in the southeastern United States, with frequent shallow, mild quakes. The few historical earthquakes in the Eastern Tennessee Seismic Zone over the past century were primarily less than 4.5 in magnitude. Since 1973, 36 earthquakes ranging from a magnitude of 2.2 to 4.3 have occurred within 62 miles of the project site; six of these earthquakes were magnitude 4 or greater (USGS 2015e). The project site is located in a zone of moderate earthquake hazard, with only four earthquakes since 1973 of magnitude 2.2 or greater within a 31-mile radius of the site; in this smaller radius, quakes ranged from a magnitude of 2.4 to 3.3 (USGS 2015f).

Soils

The primary soils on the Boone Dam site and surrounding the Boone Reservoir banks are Talbott-Rock outcrop-Bradyville complex, Waynesboro loam, and the Collegedale-Etowah complex (United States Department of Agriculture, National Resource Conservation Service 2015). These soils generally are found on moderately steep and steeply sloping uplands that are underlain by limestone bedrock outcroppings. The soils can be characterized as well drained, with moderately slow permeability and with high to severe erosion potential.

3.2.2 Environmental Consequences

3.2.2.1 No Action Alternative

Under the No Action Alternative, the proposed remediation activities at Boone Dam would not occur. Therefore, no direct or indirect impacts on geologic or paleontological resources would result. Reservoir water levels would remain at Interim Operations levels (between 1,350 and 1,355 feet). Exposed soils on the banks of Boone Reservoir would continue to erode until vegetation stabilizes exposed banks. Over time, this erosion may slightly reduce the reservoir's storage capacity. TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species as a measure to mitigate erosion and sedimentation. Deterioration of the cutoff trench and seepage flows would continue to undermine the foundation of the embankment dam. If left unaddressed, continued internal erosion may lead to eventual breaching of the dam.

3.2.2.2 Proposed Action

Under the Proposed Action, minor direct impacts on geology and soil resources would be anticipated as a result of the remediation activities at the dam. As intended, the grouting and diaphragm wall installation activities would affect the subsurface geology and some paleontological resources in the immediate area affected by the grouting. These impacts would be negligible because access to and use of these resources are largely prevented because of their location under Boone Dam. Due to the previous disturbances associated with construction of Boone Dam, encountering paleontological resources is highly improbable during remediation activities.

Under the Proposed Action, Boone Reservoir would remain at Interim Operation levels (between 1,350 and 1,355 feet) through the 5- to 7-year period of dam remediation. Exposed soils on the banks of the reservoir would continue to erode through the period of dam remediation, but would decline over time as the exposed areas become vegetated. In addition, the TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation of portions of the exposed reservoir bottom. TVA would also provide guidance to landowners to enhance revegetation with appropriate native plant species. Upon completion of construction associated with the Proposed Action, Boone Reservoir would be returned to Normal Operations. Erosion of soils upstream of the dam during the period of remediation would be a temporary and minor direct impact of the Proposed Action.

During construction activities, impacts on surface soils would occur. Construction activities primarily would occur in areas that were disturbed during construction of the dam and during implementation of the IRRMs. Impacts on soils from these activities would be temporary and minor, and would be stabilized and/or revegetated upon completion of the dam remediation activities. Minor erosion and sedimentation in the construction areas would be mitigated with implementation of erosion, sedimentation, and stormwater BMPs.

Excavated soil and rock would be managed at one of two areas located near the dam reservation (see Figure 1-6). No impacts on geologic or paleontological resources are anticipated at the two Construction Support Areas, because these resources would be covered but not made permanently unavailable. The soils in these areas have been disturbed previously from borrow pit(s), transmission line clearance and maintenance, and/or agricultural activities. Addition of the placed materials would cause a permanent, minor, and local effect on site topography.

Hazards resulting from geological seismic conditions would be expected to be minor because the project site is in a relatively stable geologic setting and there is only a moderate probability for minor- to moderate-intensity seismic activity in the area. Because only four earthquakes greater than magnitude 2.2 have occurred within a 31-mile radius of the site since 1973 and the magnitude of these earthquakes ranged from only 2.4 to 3.3, the likelihood of a quake occurring and severely damaging the site is small.

3.3 WATER RESOURCES

This section provides an overview of existing water resources in the vicinity of the Boone Dam project and the potential impacts on these water resources associated with the No Action Alternative and the Proposed Action (Interim Operating Schedule). Specifically, this section evaluates groundwater and surface water resources related to the proposed Boone Dam remediation as they pertain to the construction areas, Boone Reservoir, and the immediate tailwater in the upper FPH Reservoir.

3.3.1 Affected Environment

General Setting

The Boone Project is located within two 8-digit Hydrologic Unit Code (HUC) watersheds: HUC 06010102 (South Fork Holston) and HUC 06010103 (Watauga). Boone Dam impounds portions of the South Fork Holston and Watauga Rivers. TVA operates two dams upstream of Boone Reservoir on the Watauga River. Boone Dam is approximately 30 miles downstream from South Holston Dam, 25 miles downstream from Wilbur Dam (Watauga River), and 10 miles upstream from FPH Dam.

Boone Reservoir is operated by TVA to meet a variety of purposes, including power production, flood control, recreation, water supply management, water quality, and aquatic habitat. These purposes are consistent with the designated uses assigned by the State of Tennessee for this portion of the South Fork Holston River, including domestic water supply, industrial water supply, fish and aquatic life, trout stream, recreation, livestock watering and wildlife, and irrigation (TDEC 2013a).

Hydrogeology

Boone Dam is within the Valley and Ridge physiographic province in eastern Tennessee. The tectonic setting of this province controls the occurrence, movement, availability, and quality of groundwater. Older rock units such as the Conasauga Group and the Rome Formation are thrust over younger units (the Chickamauga and Knox Groups). This forms repeating sequences of alternating permeable and less permeable hydrogeological units. Northeast-trending valleys and ridges and the associated channeling of major streams in these alternating valleys further localize groundwater movement. The area therefore is divided into a series of adjacent, isolated, shallow groundwater flow systems in which most of the groundwater movement takes place within 300 feet below the ground surface. Groundwater moves from the high levels along the ridges toward lower water levels adjacent to major streams flowing along the valleys. Most groundwater discharges directly to local springs or streams though some flows to more distant discharge points (Lloyd et al. 1995).

A rock unit with sufficient permeability to conduct groundwater and to allow economically significant quantities of water to be produced by man-made water wells and natural springs is known as an “aquifer.” To be productive, the aquifer must be permeable and porous and retain qualities that allow water to flow through it easily. The major aquifer in Sullivan and Washington Counties is the Valley and Ridge aquifer system. This aquifer system consists of a sequence of folded and faulted, northeast-trending Paleozoic sedimentary rocks that form a series of

alternating valleys and ridges that extend from Alabama and Georgia to New York (Lloyd et al. 1995).

Precipitation in the form of rain and snow falling directly on surface outcrops of the aquifer units provides the primary water recharge for the Valley and Ridge aquifer. Average annual precipitation in eastern Tennessee is approximately 80 inches. Average annual runoff in the area is 30 inches, a portion of which recharges the shallow aquifers. Annual groundwater recharge is estimated at 13 inches in Tennessee, where precipitation and ground permeability is high. The geology of the area dictates the occurrence, movement, availability, and quality of the groundwater. Generally, groundwater moves through fractures, bedding planes, and solution openings in the rocks; therefore, the direction of movement is dependent on the local geology (Lloyd et al. 1995).

Groundwater Flow

During excavation of the foundation, the original constructors of Boone Dam encountered highly irregular bedrock consisting in places of local pinnacles separated by 20- to 30-foot deep crevices. Near the surface of the bedrock and within these pinnacles, they encountered voids and soft muddy soils. To limit reservoir seepage underneath the dam during its original construction, a deep excavation called a “cutoff trench” was created to remove the voids and soft soils within the rock pinnacles and epikarst. Grout then was pumped into the underlying bedrock to create a grout curtain in order to limit the amount of water from the reservoir that could flow through the bedrock. Additionally, grout was pumped into the foundation soils and epikarst to fill any remaining voids beneath the embankment dam. Crews also compacted clay soils by hand into cavities and voids. While this foundation treatment was state of the practice in the 1950s and functioned well for over 60 years, it is now in need of remediation. Figure 3-6 provides a conceptual illustration of the hydrogeological flow regime under the dam.

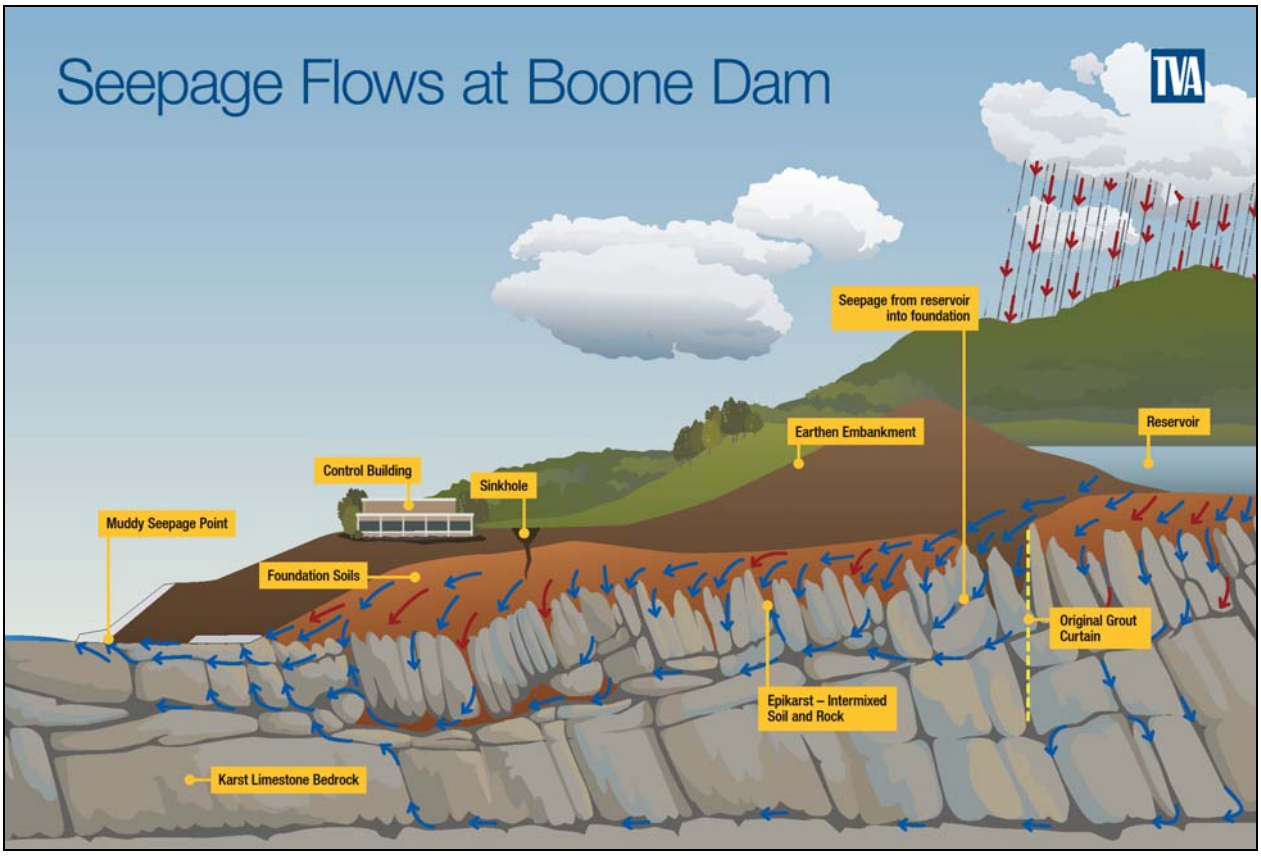


Figure 3-6: Conceptual Illustration of Hydrogeological Flow Regime beneath Boone Dam

Groundwater Supply

Lloyd et al. (1995) provides a summary of groundwater withdrawals from the Valley and Ridge aquifer system. In 1985, fresh groundwater withdrawals were estimated to be 82 million gallons per day (mgd). Public supply use accounted for about 31 mgd. Withdrawals for domestic and commercial use were about 19 mgd. Agricultural withdrawals from the Valley and Ridge aquifer system averaged about 12 mgd; industrial, mining, and thermoelectric power users withdrew about 20 mgd. As of 2000, withdrawals from the Valley and Ridge aquifer system totaled 267 mgd (Maupin and Barber 2005). This included 5.65 mgd for irrigation, 177 mgd for public supply and 83.9 mgd for self-supplied industrial purposes.

Groundwater usage estimates specifically in and around Boone Reservoir are much lower. Bohac and Koroa (2008) reported 0.14 mgd groundwater withdrawal from Boone Reservoir during 2005. This withdrawal was solely for irrigation purposes.

Groundwater Quality

The Valley and Ridge aquifer system was selected as a principal aquifer for study in the USGS's National Water Quality Assessment Program. A "principal aquifer" is a regionally extensive aquifer or aquifer system that has the potential of, or currently is, being used as a primary source of drinking water. Between 1993 and 2000, water quality samples were

collected from 550 domestic, monitoring, irrigation, and public-supply wells in the Piedmont, Blue Ridge, and Valley and Ridge aquifers as part of this program. Samples were analyzed for physical properties and multiple water quality constituents, including total dissolved solids, major inorganic ions, trace elements, radon, nutrients, dissolved organic carbon, pesticides, pesticide degradates, and volatile organic compounds (USGS 2015g).

Concentrations of dissolved solids increase with depth in the Valley and Ridge aquifer and are generally lowest in areas where the aquifer crops out and where it is buried only to shallow depths. Much of the region has groundwater with total dissolved concentrations of over 1,000 milligrams per liter (mg/L) at a depth of 500 feet (Lloyd et al. 1995). The geology of the region, principally the carbonate rock features, such as sinkholes make the aquifers particularly susceptible to contamination from the land surface. Crystalline rock and siliciclastic-rock aquifers frequently exceeded standards for contaminants with geologic sources such as radon, manganese, and arsenic; and carbonate-rock aquifers frequently exceeded standards for contaminants with human sources, most often nitrate and bacteria. The bedrock geology of the aquifer dictates the amounts of radon, arsenic and manganese in the groundwater (Lindsey et al. 2014).

Surface Water Supply

Boone Reservoir supports only one permitted water withdrawal. Bristol-Bluff City's water withdrawal was permitted by TVA in 1998, before TVA 26a permits included a maximum withdrawal volume. Bristol-Bluff City's application package to TVA states that the intake would support a new water treatment plant that was initially capable of treating 2.0 mgd and expandable to 3.0 in the future. The most recent withdrawal data from 2010 state reporting data show that Bristol-Bluff City withdrew an annual average of 0.85 mgd. TVA does not have minimum operating levels for this withdrawal. In addition, TVA does not guarantee any level of water quality or elevation, and the permittee is responsible for ensuring that the intake is low enough to stay underwater during droughts or drawdowns.

There are no TVA-permitted surface water intakes between Boone Dam and FPH Dam. However, Boone is operated in part to meet the 800-cfs required minimum flow downstream of FPH, which is required to meet the water supply needs at the Eastman Chemical Company facility in Kingsport, Tennessee.[7]

Surface Water Quality

The TDEC has established water quality standards and designated uses for streams and lakes across the state, and issues periodic reports on waterbodies not meeting these standards and uses. Generally, characteristics considered during the assessments are temperature, dissolved oxygen (DO), pH, nutrients, sedimentation, siltation, loss of habitat and contaminants. As part of this program, TDEC issues a list of impaired waters called the "303d list," referring to Section 303d of the federal Clean Water Act. Waterbodies are added to this list when they do not

[7] Bohac and Koroa (2004) reported that the Eastman Chemical Company's withdrawal from the FPH Reservoir in 2000 was 449 mgd.

support all designated uses because of water quality issues. TDEC classifies the South Fork Holston and Watauga Rivers in Boone Reservoir for domestic water supply, industrial water supply, fish and aquatic life, trout stream recreation, livestock watering and wildlife, and irrigation (TDEC 2013a).

The 2012 303d list included 87 impaired segments within the South Fork Holston watershed, including Boone Reservoir and the South Fork Holston River. Boone Reservoir also is listed for elevated concentrations of polychlorinated biphenyls (PCBs) and chlordane in the sediments. These levels have resulted in a fish consumption advisory for the reservoir (TDEC 2014). Other segments of the South Fork Holston River are listed due to elevated levels of mercury in fish or habitat loss due to stream flow alterations and thermal alterations. The elevated mercury levels are attributed to atmospheric deposition, while the stream flow alterations and thermal modifications are attributed to TVA reservoirs.

Surface Water Quality under Normal Operations

TVA has actively monitored temperature and DO, along with other key water quality parameters, at multiple stations throughout Boone Reservoir and tailwater for nearly 25 years. The resulting dataset represents a range of collection parameters, methods (grab vs. continuous), depths, and sampling frequencies (see Table 3-5).

Table 3-5: Surface Water Quality Data Collected by TVA at Boone Reservoir and Tailwater

Station	Zone	Period of Record	Collection Method	Data Stream	Comments
SFHRM 19.0	Forebay	Growing Season (April-December): 1991–2015	Grab	▪ Temperature ▪ pH ▪ Conductivity ▪ DO ▪ Secchi transparency ▪ Nutrients ▪ Chlorophyll	Variable depths: ranging from 1 to 86 feet
SFHRM 27.0	Mid-Reservoir (South Fork Arm)	Growing Season (April-December): 1991–2015	Grab	▪ Temperature ▪ pH ▪ Conductivity ▪ DO ▪ Secchi transparency ▪ Nutrients ▪ Chlorophyll	Variable depths: ranging from 1 to 86 feet
WRM 6.5	Mid-Reservoir (Watauga Arm)	Growing Season (April-December): 1991–2015	Grab	▪ Temperature ▪ pH ▪ Conductivity ▪ DO ▪ Secchi transparency ▪ Nutrients ▪ Chlorophyll	Variable depths: ranging from 1 to 86 feet
BOH 65	Forebay	April-August 2015	Continuous	▪ Temperature	Six discrete depths (feet): 10, 20, 30, 40, 50, and 65
BOH 75	Forebay	April-August 2015	Continuous	▪ Temperature	Six discrete depths (feet): 15, 25, 35, 45, 55, and 75
Boone Float 305	Forebay	March-June 2015	Continuous	▪ Temperature ▪ pH ▪ Conductivity ▪ DO ▪ Turbidity	Depths ranging from 7 to 9 feet
Boone Float 305	Forebay	June-September 2015	Continuous	▪ Temperature ▪ pH ▪ Conductivity ▪ DO ▪ Turbidity	Depths ranging from 64 to 69 feet
Taildeck	Tailwater	Growing Season (April-December): 1998–2015	Grab	▪ Temperature ▪ DO	Variable dates/times
TW-Float 1	Tailwater	April-September 2015	Continuous	▪ Temperature ▪ pH ▪ Conductivity ▪ DO ▪ Turbidity	Surface measurement at depths ranging from 0.2 to 2.5 feet
BOH-Downstream	Tailwater	September 2014 – September 2015	Continuous	▪ Temperature	Discrete depth: 3 feet

Although a man-made impoundment, Boone Reservoir behaves as a temperate lake with predictable patterns in certain water quality variables across seasons. During summer months, longer daylight hours and more direct solar radiation cause a warming of the near-surface waters. Since warm water is less dense than cold water, it floats on top of the cooler water. This causes the water to stratify into distinct layers based on temperature. A thermal boundary, termed the "thermocline," forms the border between these two layers. The depth and stability of the thermocline vary and are influenced by a range of factors, but generally this boundary is stable enough to prevent mixing of the warmer, near-surface layers (epiliminion) and the colder, deeper layers (hypolimnion).

This phenomenon dissipates during fall and winter, when days are shorter and prevailing air temperatures become cooler. During this period, the water column exhibits a more uniform temperature gradient from surface to bottom without stratification. Figure 3-7 displays a typical temperature and DO profile for Boone Dam during summer (stratified) and winter (non-stratified). Note that temperature ranges by more than 50 percent from surface to bottom in the summer graph, while DO ranges as high 14 mg/L near the thermocline to below 6 mg/L in the deeper waters.

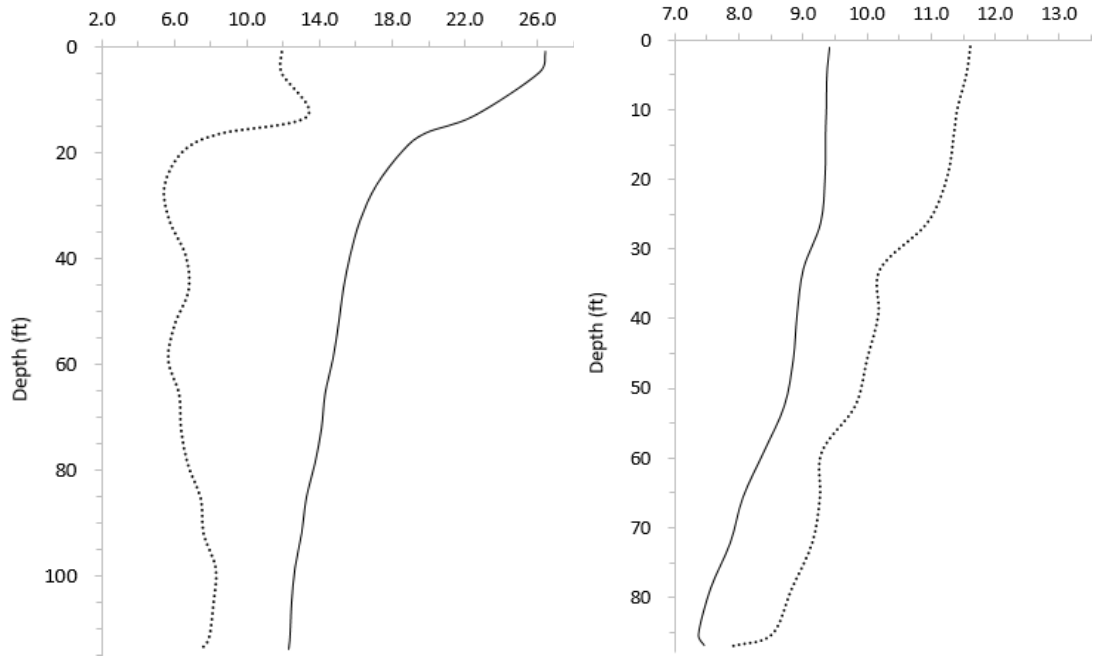


Figure 3-7: Temperature and DO Profiles Measured during July 2013 and December 2014

Notes: Temperature (^{o}C; solid line) and DO (mg/L; dashed line). July 2013 (left) and December 2014 (right). Measured from Boone Reservoir Forebay Station SFHRM 19.0.

The implication of summer stratification at Boone Reservoir is that DO in the hypolimnion gradually depletes due to the decomposition of organic matter in the sediments and from the water column. Without the ability to mix with the oxygen-rich surface waters, the hypolimnion can become low in oxygen (and at times anoxic [no DO]) and less or unsupportive of most aquatic life. Boone Dam releases water from the deeper hypolimnion to power the turbines.

Thus, during summer months, the water being released downstream may have lower than desired DO concentrations.

In a study of the TVA Reservoir Release Improvement Program, Higgins and Brock (1999) reported that DO concentrations in Boone Dam tailwater, on average, were below the target DO concentration (4 mg/L) for 46 days out of the year. The authors also estimated that the effects of low DO persisted for up to 10 river miles downstream from the dam before being sufficiently aerated by natural forces. This approximates the length of the FPH Reservoir.

To help mitigate these low-oxygen conditions, as part of TVA's Reservoir Release Improvement Program in the late 1990s, TVA installed auto-venting systems in the turbines at Boone Dam to improve the quality of water released from the dam. Aerating turbines use low-pressure areas to draw air into the turbine area as power is generated.

At Boone Dam, the turbine venting increases DO levels in the turbine discharge by about 0.7 mg/L, resulting in a near complete reduction of the DO deficit at Boone Dam and some improvement in the affected downstream reach (Higgins and Brock 1999). This is reflected in temperature and DO grab sample data collected at the Boone Dam tailwater during 1998 to 2014. Figure 3-8 represents monthly growing season (typically May through November) measurements recorded during this period. The historical grab sample data show a direct relationship between temperature and dam releases; discharge temperature rises during periods of no flow and declines during turbine generation.

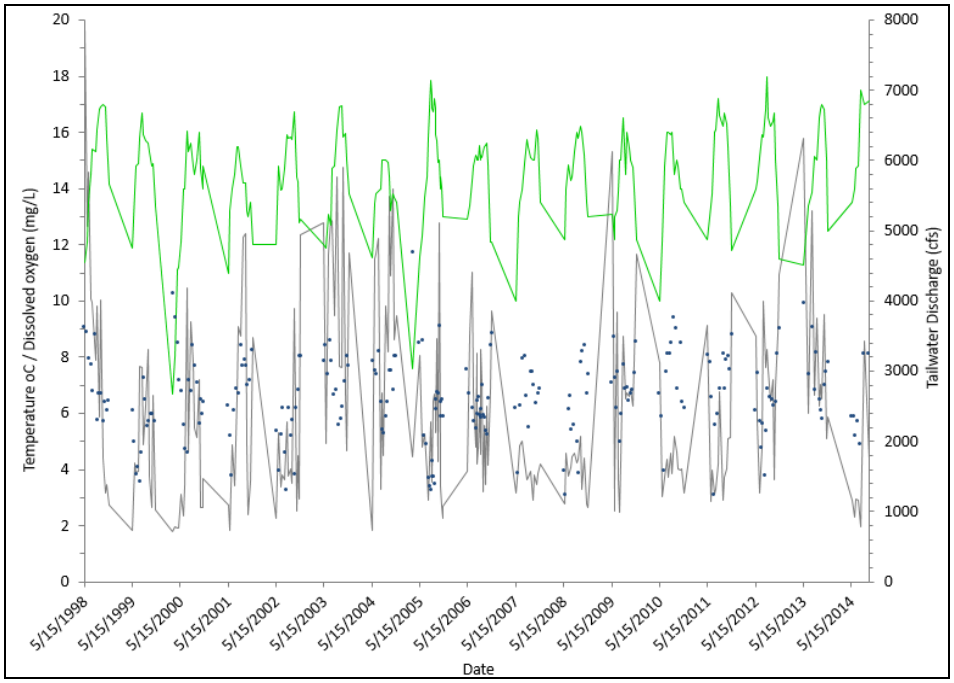


Figure 3-8: Monthly Grab Sample Records of DO and Temperature Measured in the Boone Dam Tailwater Prior to Drawdown

Notes: DO (blue dot) and Temperature (green line). Measured from April 1998 to November 2014. Data are plotted against tailwater discharge (gray line).

Dissolved oxygen shows a similar trend, although elevated DO also was recorded during periods of no discharge. This latter phenomenon is indicative of photosynthetic activity by phytoplankton and periphyton in the upper FPH Reservoir during periods of lower discharge at Boone Dam. Overall, DO ranged from 3.1 to 11.7 mg/L during this 16-year period. Only 16 of 236 grab sample records (approximately 7 percent) measured below 4.0 mg/L, which highlights the success of the turbine venting program.

Surface Water Quality under Interim Operations (Drawdown)

In response to the fall 2014 drawdown, TVA implemented continuous water quality monitoring in the reservoir and tailwater in order to better understand and predict surface water quality behavior during Interim Operations. Additional continuous monitoring below the dam is also being used to monitor water quality constituents such as pH, conductivity, and turbidity, which might signal grout seepage during the grouting process. Table 3-6 presents a summary of background data collected from this instrumentation.

Table 3-6: Background Water Quality Data Collected Near the Stone Tailrace Filter

Parameter	Units	Minimum	Median	Maximum	Count
pH	Standard units	6.79	8.28	9.57	33,663
Conductivity	µS/cm	164	223	299	33,663
Turbidity	Nephelometric turbidity units	3.6	547	580	2,487

Thermal stratification still occurs under Interim Operations, with temperature and DO dynamics in the reservoir behaving similarly to the Normal Operations period. However, reduced residence time in the reservoir may possibly interfere with the stability and duration of the stratification period. Any such abatement of summer stratification would alleviate the hypolimnetic oxygen deficit and possibly result in an indirect improvement to water quality within the reservoir and tailwater. However, a reduced residence time also might diminish coldwater storage within the reservoir's hypolimnion, which would result in warmer tailwater release during summer months. This would vary with seasonal and annual variation in precipitation, river flows, and weather conditions.

As under Normal Operations, the hypolimnetic water being released by the dam is prone to having depressed DO concentrations during the summer stratification period. Figure 3-9 displays continuous tailwater data measured from early April through early August 2015, from a continuous monitoring station positioned approximately 700 meters downstream from the dam.

A clear trend in warming temperature and declining DO is apparent during the warmest summer months of June and July; temperature has a direct effect on the amount of oxygen that can remain dissolved in water. Tailwater temperatures ranged from 13.2 to 20.6 ^{o}C during this period but at no point came close to the U.S. Environmental Protection Agency's (USEPA's) maximum weekly temperature for rainbow trout survival (24 ^{o}C) (USEPA 1977). The optimal temperature range for trout is from 10 to 15 ^{o}C (Piper et al. 1982).

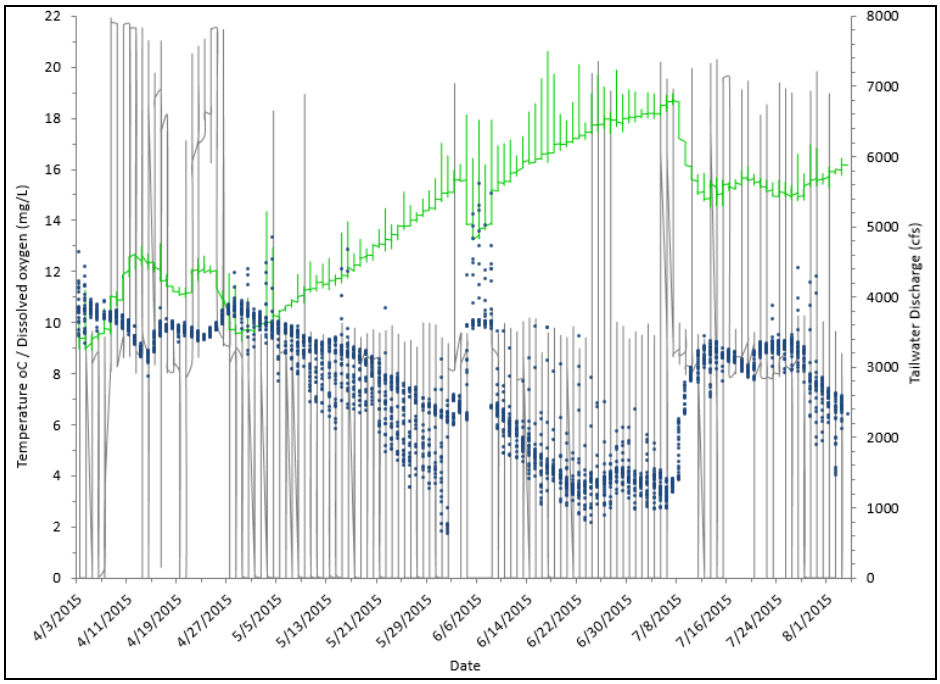


Figure 3-9: Continuous DO and Temperature Measured at Tailwater Station TW-Float 1 Downstream of Boone Dam After Drawdown

Notes: Continuous DO (blue dot) and temperature (green line). Measured from April 3 to August 4, 2015. Data are plotted against tailwater discharge (gray line).

During this same period, DO exhibited wide daily fluctuations in response to turbine generation but generally stayed within 5.7 mg/L (25th percentile) to 9.6 mg/L (75th percentile). Approximately 13 percent of the DO data collected during this period measured below 4 mg/L, a level that TVA has committed to meeting in its discharge at Boone Dam. This is a slightly higher percentage than recorded for grab sample data collected below the dam. However, it is important to note that the downstream location of this continuous monitoring station does not solely reflect the water being released from the dam but also reflects limnological processes occurring within the headwater reaches of the FPH Reservoir.

During periods of no generation, the headwaters of FPH Reservoir behave as a eutrophic lake, with phytoplankton activity having the greatest influence on near-surface DO concentrations. This is particularly evident in Figure 3-9 for the period between June 4 and June 8, 2015. No water was generated during this period, yet DO ranged as high 15.5 mg/L and at no point measured below 6.2 mg/L. Once turbine generation recommenced, the high DO water was flushed downstream, and DO concentrations stabilized in the 3- to 5-mg/L range.

3.3.2 Environmental Consequences

3.3.2.1 No Action Alternative

Water Supply

Under the No Action Alternative, the existing groundwater flow pathways and supply around

Boone Dam would not be altered from their current condition, so there would be no impacts on groundwater wells in the vicinity of the Boone Dam reservation. Permanent lowering of the reservoir pool elevation to 1,355 feet might result in a minor, localized lowering of the shallow water table around the reservoir. Shallow residential or agricultural groundwater wells near the shoreline of Boone Reservoir might be affected by this lowering, although TVA has not received any comments or complaints since the drawdown began in October 2014. Most residential or agricultural groundwater wells are likely deep enough so that impacts would not occur or would be minor.

As described in Section 3.1, the flow releases from Watauga and South Holston Dams, as well as flow through Boone Dam, under the No Action Alternative would remain largely unchanged from Normal Operations. Therefore, there would be little change in surface water availability from the rivers and within Boone Reservoir. No impacts are expected to the ability of Bristol-Bluff City to withdraw water at their intake.

The Eastman Chemical Company facility in Kingsport, Tennessee depends on water withdrawn from the South Fork Holston River downstream of FPH. By agreement with TVA River Operations, the FPH Project—supported by operations at Boone—TVA provides an 800-cfs required minimum flow downstream of the FPH Project. The minimum flow is required in part to meet water supply needs at the Eastman Chemical Company facility. This operation would continue under the No Action Alternative.

Groundwater Quality

Under the No Action Alternative, the proposed grouting would not occur and no impacts on groundwater quality are expected.

Surface Water Quality

Under the No Action Alternative, the proposed dam remediation would not occur and there would be no changes to the stormwater runoff character or patterns from construction activities. Minor adverse impacts on surface water may occur indirectly in the form of siltation as a result of continued groundwater seepage beneath the earthen dam into the Boone tailwater.

Interim Operations would continue, and surface water elevations within the reservoir would be permanently managed between approximately 1,350 and 1,355 feet. Much of the lower reservoir would remain deep enough to support summer stratification, although a reduced residence time likely would interfere with the stability and duration of the stratification period. Any such abatement of summer stratification would alleviate the hypolimnetic oxygen deficit and possibly result in an indirect improvement to water quality within the reservoir and tailwater. However, a reduced residence time also might diminish coldwater storage within the reservoir's hypolimnion, which would result in warmer tailwater release during summer months.

Despite the lower reservoir levels that would persist under the No Action Alternative, the amount of water flowing through Boone Reservoir would remain similar to that produced under Normal Operations. Boone Dam would be operated primarily as a run-of-the-river project; the inflowing water from the South Holston and Watauga Rivers, as well smaller tributaries and overland flow

during rain events, would be passed through the reservoir without being stored long term. Impacts on water quality under this flow regime are largely understood and are expected to be similar to past water quality conditions, as described in the Affected Environment section.

Soils along the exposed reservoir bottom would continue to erode until vegetation stabilizes the exposed areas. Erosion of exposed soils would contribute to increased reservoir turbidity at times of heavy rainfall. TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species to reduce erosion and sedimentation.

3.3.2.2 Proposed Action

Water Supply

Because the objective of the Proposed Action is to alter the local groundwater flow under the dam, by definition, groundwater flow in the immediate vicinity of the remediation activities would be altered locally. Seepage under the dam would be reduced, and groundwater flow would be expected to divert away from and around the seepage barrier. The exact change in the localized groundwater flow is not entirely predictable, but it is expected to decrease the groundwater elevation in the area immediately downstream from the dam embankment and possibly raise the groundwater elevation slightly to the north end of the dam. TVA would continue to monitor groundwater flow patterns in and around the earthen embankment to fully document any changes to groundwater flow.

As described in Section 3.1, the flow releases from Watauga and South Holston Dams, as well as flow through Boone Dam, would remain largely unchanged from Normal Operations. Therefore, there would be little change in surface water availability from the rivers and within Boone Reservoir. No impacts are expected to the ability of Bristol-Bluff City to withdraw water at their intake.

The changes in groundwater flow are expected to be localized, and no impacts on residential or agricultural wells are expected in the vicinity of the Boone Dam reservation.

Lowering of the reservoir pool elevation to between approximately 1,350 and 1,355 feet for 5 to 7 years may result in a minor, localized lowering of the shallow water table around the reservoir. Shallow residential or agricultural groundwater wells near the shoreline of Boone Reservoir might be affected by this lowering, although TVA has not received any comments or complaints since the drawdown began in October 2014. Most residential or agricultural groundwater wells are likely deep enough so that impacts would not occur or would be minor.

As noted above, the Eastman Chemical Company plant in Kingsport, Tennessee depends on water withdrawn from the South Fork Holston River downstream of FPH. Under the Proposed Action, TVA would continue to provide the required minimum flow downstream of the FPH Project to meet water supply needs at the Eastman Chemical Company facility.

Groundwater Quality

During remedial construction at Boone Dam, grout and cement would be injected into the local shallow groundwater aquifer. Constituents of the composite barrier generally may include

cement, water, bentonite, superplasticizer, viscosity modifier, and sand. Based on the Material Safety Data Sheet, most of these materials would be insoluble, would be inert after hardening, or would cause limited impacts on groundwater quality. However, some of the constituents have the potential to affect groundwater quality, including some potential for toxicity.

TVA is committed to monitoring and protection of water quality during construction, and would work with contractors to ensure that water quality is protected. TVA would monitor water quality upstream and downstream of the dam during the remediation project, using both water quality instrumentation and visual inspections. TVA would monitor and evaluate changes in pH and conductivity as an early warning system to indicate any potential grout seepage into the river. TVA would respond to grout seepage similar to requirements in the existing Environmental Response Plan, as stipulated in Underground Injection Control permit SUL-0000113. At a minimum, this would include a temporary cessation of grouting operations to allow for confirmation and evaluation of the seepage. Should grout seepage be confirmed, operations would remain halted while the grout dissipates.

Any hazardous materials (such as fuels and lubricants) stored onsite during construction would be stored appropriately in secondary containment, and site personnel would be trained in both spill prevention and response. Because of the small amounts of materials and implementation of BMPs, it is unlikely that groundwater would be affected by a spill of hazardous materials during construction.

Overall, potential impacts on water quality under the Proposed Action are possible but would be minor and localized.

Surface Water Quality

Under the Proposed Action, National Pollutant Discharge Elimination System (NPDES) permits would be obtained or updated to address stormwater management and treatment throughout the entire proposed construction area, including the current construction area at the dam, the proposed expansion of the construction area for widening of the dam crest, and the use of Tract 22R and the Earl Light Tract as Construction Support Areas. A range of BMPs would be implemented in accordance with the permit's SWPPP to mitigate the effects of surface water runoff from the construction area. The BMPs may include installation of silt fences, erosion eels, straw waddles, rock check dams, and concrete washout areas—as well as application of seeding and mulch to restore vegetation as construction activities within specific areas are completed. Any hazardous materials (such as fuels and lubricants) stored onsite during construction would be stored appropriately in secondary containment, and site personnel would be trained in both spill prevention and response.

Minor post-construction impacts on surface water also are possible. Changes to stormwater drainage patterns would result from the drainage upgrades onsite. Overall, however, on-site stormwater still would drain from both the embankment and the operations areas to the South Fork Holston River. Increases in the amount of impervious surface are expected. However, such changes would be small and would be localized to the dam crest and the parking lot. As

the parking lot is scheduled to be revegetated or graveled, the impervious surface onsite would be reduced, thereby potentially decreasing the total amount of stormwater runoff.

As described in Section 3.1, TVA has been closely monitoring water quality in the tailwater since April 2015, and these data provide a good picture of expected water quality during the 5- to 7-year period of drawdown. Water quality conditions in the reservoir and downstream of Boone Dam would be similar to those observed during Normal Operations, although the same flow through a reduced reservoir volume would decrease residence time and may reduce thermal stratification. This may have the effect of reducing the hypolimnetic oxygen deficit and may result in an indirect improvement to water quality within the reservoir and tailwater. However, a reduced residence time also might diminish cold water storage within the reservoir's hypolimnion, which would result in warmer tailwater release during summer months. The amount of these changes would depend on annual variation in precipitation, river flows, and weather conditions.

Soils along the exposed reservoir bottom would continue to erode through the period of the reservoir drawdown, but would decline over time as the exposed areas become vegetated. Erosion of exposed soils would contribute to increased reservoir turbidity at times until the exposed areas are stabilized with vegetation. The TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation of the portions of the exposed reservoir bottom and TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species. Upon completion of construction associated with the Proposed Action, Boone Reservoir would be returned to Normal Operations and erosion and sedimentation rates would be expected to return to pre-drawdown levels.

When the reservoir is returned to normal operations, vegetation that established in areas of the reservoir bottom during the drawdown will be inundated with water. The amount of newly established vegetation is expected to be considerable. As the vegetation is inundated, its decomposition may cause some reduction in DO concentrations in reservoir waters for a period, abating over time as the organic matter is depleted.

As described in Section 3.3.1, TVA actively monitors DO in Boone Reservoir and tailwater. Although DO conditions at Boone Reservoir have varied considerably from year to year and from site to site, portions of the lower water column have been observed to be hypoxic (less than 2-3 mg/L) at times during the warmer months, and the additional organic matter from inundated vegetation could cause these DO levels to be further depressed. The magnitude and duration of any changes in DO would depend on a number of factors, including the time of year reservoir filling is initiated, the rate at which the reservoir is filled, water temperatures, algal response to the nutrients released, river flows through the reservoir, and prevailing weather patterns. As described in Section 3.3.1, when DO levels are low, TVA uses a technique called turbine venting to improve DO levels in the river downstream of the dam. Additionally, if unusual DO conditions begin to develop in Boone Reservoir, TVA will assess the need to augment flows through the reservoir to help improve DO levels. As a result, TVA does not expect the inundation of vegetation to induce a change in DO that would have a measurable effect on aquatic life.

3.4 FLOODPLAINS AND FLOOD RISK

This section describes the existing floodplains at the Boone Dam project and the potential impacts on floodplains associated with the No Action Alternative and the Proposed Action. A floodplain is the relatively level land area along a stream or river that is subjected to periodic flooding. The area subject to a one-percent annual chance of flooding (100-year flood) in any given year is normally called the 100-year floodplain.

3.4.1 Affected Environment

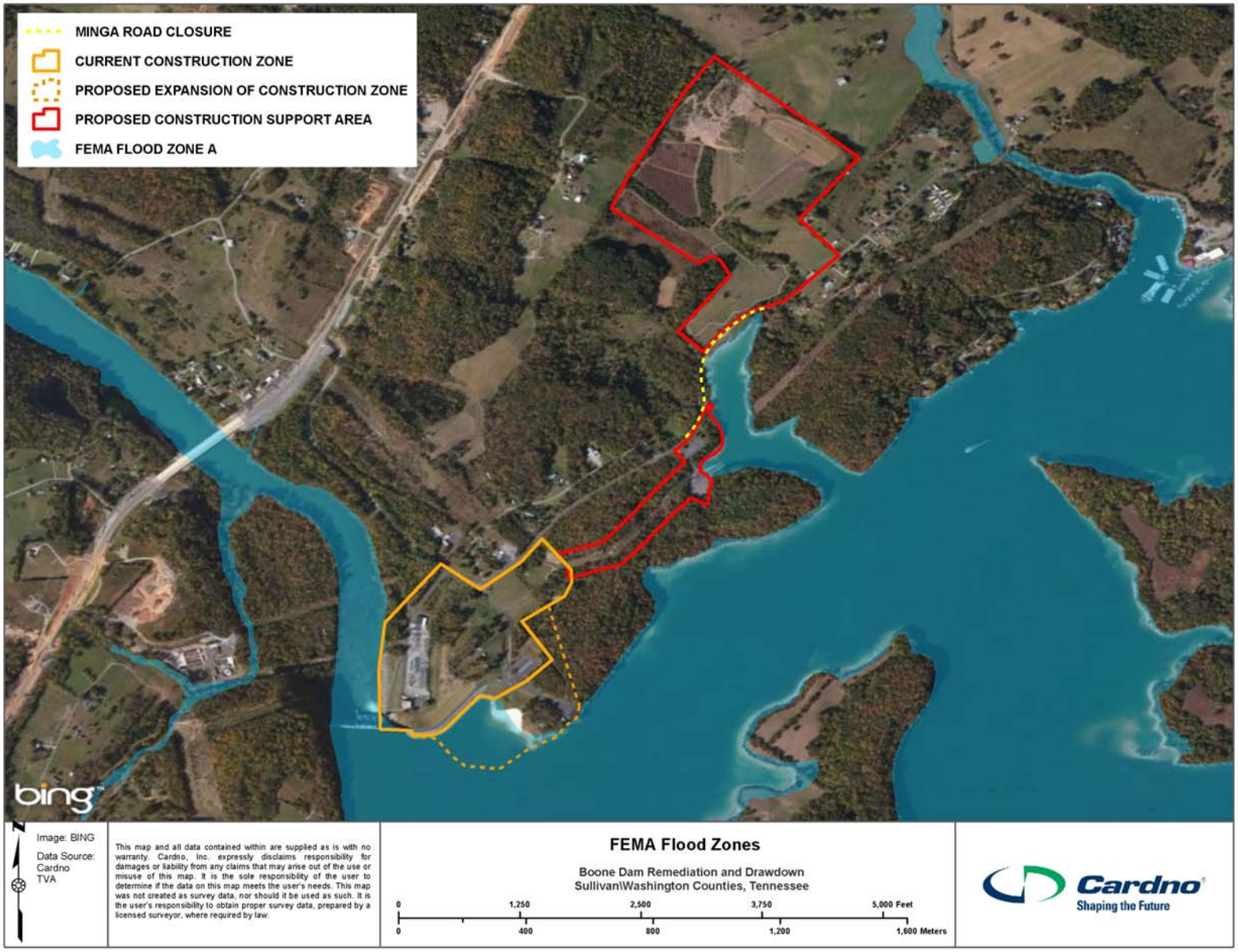
Construction Areas

Portions of the proposed expansion of construction zone would be located within the 100-year floodplain of the South Fork Holston River (Figure 3-10). The current Construction Zone is located between South Fork Holston River miles 18.3 and 19.5, and its boundary is outside the 100-year floodplain.

The proposed expansion of Construction Zone would be located between South Fork Holston River miles 18.6 and 19.4. The 100-year flood elevation would be 1385.0 from Boone Dam to South Fork Holston River Mile 19.4. All elevations are referenced to National Geodetic Vertical Datum 1929. The floodplain corresponding to these elevations is shown on Sullivan and Washington counties, Tennessee, Flood Insurance Rate Maps (FIRMs) as Zone A (Figure 3-10).

The proposed Construction Support Areas would be located outside the 100-year floodplain and above the 100-year flood elevation of South Fork Holston River, which would be consistent with EO 11988.

Figure 3-10: Boone Dam FEMA FIRM Map



Upstream Floodplain
All of Boone Reservoir exists within FEMA Flood Zone A (Figure 3-10), meaning that there is a one-percent chance of flooding annually (i.e., the 100-year flood). There are two main watercourses in Boone Reservoir: the South Fork Holston River and the Watauga River. Floodplain areas around the reservoir include (1) areas along the shoreline of the reservoir; and (2) headwater reaches of the reservoir near the upstream extent of the impounding effects of Boone Dam, along the South Holston and Watauga Rivers and other tributaries.

The 100-year flood elevations for the South Fork Holston River vary from 1,385.0 feet at Boone Dam to 1,403.3 feet msl at the upper end of TVA's land rights, at about river mile (RM) 36.3 (TVA 2010). The 100-year flood elevations for the Watauga River vary from 1,385.0 feet msl at the mouth (South Fork Holston River RM 19.9) to 1,402.7 feet msl at the upper end of TVA's land rights, at about RM 15.8. All msl measurements are referenced to National Geodetic Vertical Datum, 1929.

Downstream Floodplain
The area of potential effect downstream of Boone Dam consists of the South Fork Holston River from miles 8.2 to 18.6 (Fort Patrick Henry Dam to Boone Dam). The 100-year flood elevations vary from 1263.8 at South Fork Holston River Mile 8.2 (Fort Patrick Henry Dam) to 1271.8 at South Fork Holston River Mile 18.6 (Boone Dam).

3.4.2 Environmental Consequences

3.4.2.1 No Action Alternative

As a federal agency, TVA is subject to the requirements of EO 11988, Floodplain Management. The objective of EO 11988 is "…to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative" (United States Water Resources Council 1978). The EO is not intended to prohibit floodplain development in all cases, but rather to create a consistent government policy against such development under most circumstances. The EO requires that agencies avoid the 100-year floodplain unless there is no practicable alternative. The EO directs federal agencies to evaluate proposed development in the 100-year floodplain to ensure that the project is consistent with the requirements of the EO.

Construction Areas
Under the No Action Alternative, the proposed remediation activities at Boone Dam would not occur, resulting in no physical changes to the elevation in the operations area or on the downstream side of the dam. Therefore, there would be no impacts to the floodplain.

Upstream Floodplain
Under the No Action Alternative, Interim Operations would continue, and inundation of the 100-year floodplain would be less frequent than under Normal Operations. Impacts on natural and beneficial uses of the floodplain are expected to be minor and beneficial and are discussed for other resource areas (e.g., Terrestrial Resources, Recreation, Visual Resources, and Water

Resources). The No Action Alternative would result in a permanent change in operating policy and reservoir elevations at Boone Dam, which would require re-evaluation of the 100- and 500-year flood events between the upper reaches of Boone Reservoir to Fort Patrick Henry Dam, and potentially to John Sevier Detention Dam at Holston River Mile 106.2.

Downstream Floodplain

As described in Section 3.1, under the No Action Alternative, flows released downstream during flood operations would be very similar to flows under Normal Operations. Boone Dam would be operated following Interim Operations permanently. Boone Reservoir has been lowered to the minimal headwater elevation for normal operation of Boone Dam such that TVA River Management can regulate discharges during normal hydrological conditions and frequent (1- to 2-year) flood events.[8] Prior to and during heavy rainfall events, the Boone Reservoir pool is and would be reduced to the lower range of the operating restriction (1,350 to 1,352 feet). During heavy rainfall events, outflow would be supplemented by a second unit, sluice gate, and spillway gates, as necessary.

Results from hydraulic computer models indicate that the frequency, duration, and extent of flooding events would remain largely unchanged during Interim Operations; therefore, few or no impacts are expected to floodplain functions and values.

3.4.2.2 Proposed Action

Construction Areas

The current Construction Zone is outside the 100-year floodplain of the South Fork Holston River, which would be consistent with EO 11988. Therefore, there would be no impacts to floodplains or floodplain functions and values.

The proposed expansion of Construction Zone would be used for storage of equipment and materials only during construction activities associated with the rehabilitation project. No long-term development would occur within the expansion of Construction Zone. Where possible, materials and equipment subject to flood damage would be stored at or above elevation 1385.0.

Changes to the floodplain elevations and topography in the operations area and on the downstream side of the dam and embankment would be minor. No impacts on the floodplain are anticipated from proposed remediation activities. Surface drainage patterns may be slightly altered during construction activities but are not likely to affect the overall site drainage volumes or velocities.

In order to conduct exploration grouting at the dam's crest, TVA lowered the crest of the dam by 10 feet to establish a wider work platform. Under the Proposed Action, additional modification to the working platform/berm would be needed to establish a wider working platform. The wider platform would be between 70 and 100 feet wide) and would be constructed by placing fill and

[8] Ongoing investigations may further refine operational policy at upstream South Holston and Watauga Dams and downstream FPH Dam for unlikely but extreme flood events.

supportive structures on the upstream and downstream sides of the dam. Portions of this berm would be in the floodplain but should not affect the ability of the Boone Project to contribute to the management of flooding downstream of the dam. Portions of the berm would be within the 100-year floodplain. TVA has determined that there is no practicable alternative to locating the berm within the floodplain because the dam is within the floodplain and the equipment used during remediation must have direct access to the dam. Floodplain impacts would be temporary and minor and would be minimized by using the least amount of fill to construct the berm, and by removing the berm upon completion of the project and returning the embankment to its pre-construction condition. TVA would be required to obtain a permit for this action from the USACE.

After completion of the composite seepage barrier, TVA would assess the effectiveness of the seepage barrier and determine whether to construct permanent stability berms on the upstream and/or downstream side of the dam. TVA may determine that one or more permanent stability berms are necessary and berms or portions of berms constructed under the Proposed Action would be left in place. Additional berms may be constructed. These permanent berms would result in a negligible loss of flood control storage and would have a negligible impact on flooding and floodplain values and functions.

Upstream Floodplain

Under the Proposed Action, Interim Operations would continue for 5 to 7 years, and the 100-year floodplain would experience less infrequent inundation than it would under Normal Operations during that period. Boone Reservoir would continue to be held between elevations 1350 and 1352 as part of Interim Operations. More storage within the reservoir would be available for flood waters; therefore temporary impacts would be beneficial. Upon completion of the rehabilitation project, operation of Boone Dam would resume in accordance with the ROS; therefore, there would be no permanent impacts to floodplains or floodplain values and functions within Boone Reservoir. Impacts on natural and beneficial uses of the floodplain are expected to be minor and are discussed in other resource areas (e.g., Terrestrial Resources, Recreation, Visual Resources, and Water Resources).

Additionally, TVA proposes to work with landowners to manage vegetation growth across the reservoir in the drawdown zone and eliminate the growth of small trees that might affect flood storage if otherwise left untreated.

Downstream Floodplain

As described in Section 3.1, under the Proposed Action, flows released downstream during flood operations are expected to be very similar to flows under Normal Operations. Boone Reservoir has been lowered to the lowest pool elevation such that TVA River Management can regulate discharges during normal hydrological conditions and frequent (1- to 2-year) flood events. Prior to and during heavy rainfall events, the Boone Reservoir pool is and would be reduced to the lower range of the operating restriction (1,350 to 1,352 feet). During heavy rainfall events, outflow can be supplemented by a second unit, sluice gate, and spillway gates as necessary.

TVA expects that the frequency, duration, and extent of flooding events would remain largely unchanged during Interim Operations; therefore, few or no impacts are expected to floodplain functions and values. After the remediation project, Normal Operations would resume in accordance with the ROS.

3.5 WETLANDS

This section describes the existing wetlands at the Boone Dam project and potential impacts on wetlands associated with the No Action Alternative and the Proposed Action.

3.5.1 Affected Environment

The Tennessee Water Quality Control Board defines wetlands as "areas that are inundated or saturated by surface or ground water 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" (TDEC 2013b). Wetlands form the transitional boundary between terrestrial and aquatic ecosystems; as such, they tend to be highly productive and biologically diverse ecosystems. They provide a multitude of ecological and public services, including flood control, reservoir shoreline stabilization, water quality protection, and habitat for fish and wildlife resources. A variety of wetland habitat types can be associated with an impounded river, many of which developed as a result of reservoir creation.

The presence and extent of wetland habitats at Boone Reservoir are greatly influenced by the shoreline and drawdown zone topography. Boone Reservoir has fewer and smaller wetlands than a natural floodplain or the larger TVA mainstem reservoirs due to the relatively steep shorelines and drawdown zones, the rolling to steep topography of adjacent lands, shoreline disturbance caused by wave action, and the lower predictability and shorter duration of summer pool levels.

Nevertheless, valuable wetland resources exist at Boone Reservoir. Based on estimates from the USFWS National Wetlands Inventory maps combined with data sets developed for TVA's 2004 ROS, Boone Reservoir has approximately 48 acres of wetland habitat. Much of this acreage exists in narrow bands along some shorelines and in the head of coves, where hydrologic and wave conditions are suitable for development of hydric vegetation important for establishing wetlands. Wetland extent within the Boone Dam reservation appears to be limited to a small wetland along the river below the dam, as well as shoreline vegetation that provides a riparian zone (National Wetlands Inventory, as cited by TVA 2010).

These areas of the reservoir-influenced wetlands seasonally provide shallow-water habitat for fish spawning and resting and foraging habitat for shorebirds; wading birds; resident and migrant waterfowl; and riparian- and wetland-inhabiting mammals, such as mink (*Neovison vison*), muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), and raccoon (*Procyon lotor*). The deeper portions of the reservoir provide deep-water habitat for resident and migrant waterfowl and other waterbirds.

Hodge Island located near the reservoir's headwaters on the Watauga River Arm is the largest wetland on Boone Reservoir; it includes a variety of mudflat, emergent, scrub/shrub, and forested wetland types. Many of these wetlands exist in scattered depressions created by historical mining activities. Hodge Island is part of the larger Austin Springs wetlands complex. This 186.8 acre complex provides important habitat for a myriad of terrestrial, aquatic, and avian wildlife and is of considerable regional significance. The Tennessee Ornithological Society has documented use of these wetlands as foraging/resting habitat or potential nesting habitat, by numerous species of listed birds—both migrant and resident-listed species (TVA 2010).

Following are descriptions of key wetland habitats and commonly occurring vegetation species in these wetlands.

Aquatic Beds

Aquatic beds exist within the littoral zone of the reservoir and are composed of submersed aquatic vegetation species such as fanwort (*Cabomba caroliniana*) and coontail (*Ceratophyllum demersum*), and obligate wetland species such as pickerel weed (*Pontedaria cordata*) and sagittaria (*Sagittaria* spp.) that require standing water to survive. These species perish within days or weeks after being exposed during reservoir drawdown. Depending on the bottom topography of the near-shore area, the exposed substrates may convert to mudflats or they may exist as dry, exposed reservoir bottom. Bare earth quickly colonizes with pioneer species, facultative wetlands plants, and upland grasses and forbs. These areas also are vulnerable to establishment of exotic, invasive plants.

The 2014 drawdown was more extensive than a typical annual drawdown, resulting in approximately 412 additional acres of exposed reservoir bottom compared with winter pool elevation under Normal Operations. The natural seed bank in these additional exposed areas is not as developed, if at all, compared with areas that typically grow annually.

Seasonally Exposed Mudflats

Seasonally exposed mudflats include areas of non-persistently vegetated and non-vegetated flats, as well as flats of other natural and artificial substrate types such as mixtures of sand, silt, cobble, and gravel (TVA 2004). These areas tend to be colonized by plant species such as least spike-rush (*Eleocharis acicularis*) that are especially adapted to the fluctuating water levels and capable of completing their life cycle between summer and winter pool elevations (Webb et al. 1988 and Amundsen 1994, as cited by Henry 2012). Mudflats are widely used throughout the Tennessee Valley by migrating waterfowl, wading birds, and other shoreline birds as resting and foraging habitat; although waterfowl activity at Boone Reservoir is less extensive than at other TVA impoundments (Henry 2012). Henry (2012) summarized shorebird counts that had been collected as part of a 5-year (2004 to 2009) multi-agency initiative across 10 TVA reservoirs. On average, seven individual shorebirds were observed per survey at Boone Reservoir. By comparison, observations at Wheeler and Douglas Reservoirs averaged 59 and 83 birds per survey, respectively.

Henry (2012) reported extensively on the formation dynamics of mudflats in TVA reservoirs. He found that the two primary variables affecting the development and availability of mudflats were

the rate of drawdown and the timing or seasonality of drawdown. Fast drawdown rates allow mudflats to dry quickly, constricting the invertebrate zone to the immediate reservoir edge and replacing moist-soil plants with nuisance species such as common cockleburr (*Xanthium strumarium*). In addition, the onset of soil compaction from desiccation can adversely affect plant establishment and shorebird foraging. As for timing of the drawdown, an early drawdown (August) creates habitat for shorebirds throughout migration and allows ample time for vegetative growth to mature and reproduce. Drawdowns initiated further into fall provide habitat for late migrants but do not allow seeds sufficient time to germinate or young plants sufficient time to grow before the onset of winter.

Emergent Wetlands

Emergent wetlands are areas of low-growing marshes and wet meadows that support a mix of wetland obligate and facultative plant species. Common emergent wetland species include cattail (*Typha* sp.), bullrush (*Scirpus* sp.), and American water willow (*Justicia americana*). At Boone Reservoir, these communities exist in narrow bands along some shorelines and in the heads of coves where hydrologic conditions are suitable for moist-site vegetation. Emergent wetlands also may be dispersed throughout the watershed surrounding Boone Reservoir at the base of hill slopes.

Scrub/Shrub Wetlands

Scrub/shrub and herbaceous communities also occur in floodplains, terraces, and other saturated to temporarily flooded riparian habitats. At Boone Reservoir, these communities exist in narrow bands along some shorelines and in the head of coves, where hydrologic conditions are suitable for moist-site vegetation. Representative shrub species found in these forests include such species as black willow, box elder (*Acer negundo*), buttonbush (*Cephalanthus occidentalis*), and green ash (*Fraxinus pennsylvanica*).

Forested Wetlands

Riparian forest communities are typical of most of TVA's tributary reservoirs, where upland forest types (e.g., hardwood, mixed deciduous-conifer forest) occur adjacent to reservoir shoreline. Because of the seasonal drawdowns, the reservoir has little, if any, influence on shoreline vegetation. Consequently, these forest communities occurring along Boone Reservoir shorelines are similar in species composition to upland forests found elsewhere in the watershed. This is also true for the herbaceous and shrub layers in these riparian communities. Riparian forests are further discussed in Section 3.6 (Affected Environment – Terrestrial Ecology).

3.5.2 Environmental Consequences

3.5.2.1 No Action Alternative

Under the No Action Alternative, the proposed remediation activities would not occur at Boone Dam; the reservoir pool elevation would be maintained at between 1,350 and 1,355 feet; and Interim Operations would continue, thereby reducing the acreage of surface water by half compared with the summer pool during Normal Operations. This equates to approximately

1,932 acres of permanently exposed reservoir bottom that otherwise would have been inundated for parts of the spring and summer each year. Much of this acreage now exists as exposed and drying reservoir bottom. These areas are particularly vulnerable to erosion (see Photo 3-1).

As part of mitigation measures, TVA would work with private landowners to protect vulnerable exposed reservoir bottom to the extent practical. TVA already has begun advising lakeshore residents on specific planting practices for spring 2016 that may reduce erosion while improving the overall ecology and aesthetics of the exposed reservoir bottom (TVA 2015a). TVA published recommendations in the September 15, 2015 Weekly Update Email Bulletin advising residents to sow annual rye grass (*Lolium multiflorum*) during fall 2015. This variety germinates quickly during cooler fall temperatures and would provide needed groundcover throughout the winter months. TVA further advised of a more long-term planting solution beginning in spring 2016 that involved planting any combination of the following types of native vegetation: switchgrass (*Panicum virgatum*), little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), cardinal flower (*Lobelia cardinalis*), coneflower (*Echinacea* sp.), sunflower (*Helianthus* sp.), or milkweed (*Asclepias* sp.). These varieties provide effective erosion control and would not create any navigational hazards when water levels return to Normal Operations. They are also ecologically beneficial, and an early establishment of native flora discourages infestation of exotics.

Photo 3-1: Growth of Weedy Species on Exposed Reservoir Bottom during the First Growing Season Following the Drawdown

Aquatic Beds

Under the No Action Alternative, previously established aquatic beds would not be supported by seasonal inundation. Instead, new aquatic bed habitat would form in areas where bottom topography, soil, and soil moisture are suitable along the exposed reservoir bottom.

An indirect benefit of the No Action Alternative would be the intra-annual stability of reservoir pool elevation. New aquatic beds would not be subjected to the annual cycle of winter drawdown, and the increased habitat stability might promote a more diverse plant and animal assemblage over time.

Seasonally Exposed Mudflats

Existing mudflats are exposed seasonally under Normal Operations. Under the No Action Alternative, these mudflats would be permanently exposed indefinitely. Seasonal inundation is a critical component of mudflat formation and habitat quality for migrating shorebirds (Henry 2012). The loss of seasonal flooding would result in the permanent transition of exposed mudflat areas to other habitat types, depending on the bank topography (e.g., scrub/shrub wetlands, upland pasture, and early-successional forest). Mudflat habitat may still be available under the No Action Alternative but would be limited to a narrow strip of habitat along the wetted perimeter of the reservoir.

Emergent Wetlands & Scrub/Shrub Wetlands

Under the No Action Alternative, previously established emergent and scrub/shrub wetlands along the lowered reservoir would result in the lack of seasonal water table and proximity to wetted shoreline to survive over time. New wetlands would form over time in narrow bands along the new shoreline areas and cove areas with standing water and/or saturated soils. An indirect benefit of the No Action Alternative would be the intra-annual stability of reservoir pool elevation. New wetlands would not be subjected to the annual cycle of winter drawdown, and the increased habitat stability might promote a more diverse plant and animal assemblage over time. However, this may take many years as development of the hydric soils necessary for diverse vegetation are established over long periods of time.

Under the No Action Alternative, the emergent wetland within Construction Support Area 1 (Earl Light Tract) would not require BMP protection to guard against stormwater runoff from soil storage areas and other construction-related activities.

Forested Wetlands

The No Action Alternative is expected to result in only indirect effects on forested wetlands. Permanent lowering of the reservoir pool elevation to 1,350 to 1,355 feet might lead to a localized lowering of the shallow water table around the reservoir, thus stressing plants and trees with shallow root systems. It is worth noting however, that the annual shoreline fluctuation under Normal Operations would produce similar stress on riparian communities on an annual cycle, and the plants within those areas likely have adapted to some degree to this annual disturbance.

3.5.2.2 Proposed Action

Under the Proposed Action, the reservoir pool elevation would be maintained at 1,350 to 1,355 feet. Interim Operations would continue for a period of 5 to 7 years. Following the project's completion, the reservoir pool elevation would be returned to 1,382 feet (summer pool) under Normal Operations. During the Interim Operations period, wetland communities, such as the Austin Springs complex, would be subjected to the same level of disturbance as described in Section 3.5.2.1 (No Action Alternative) except that the disturbance would be limited to a period of 5 to 7 years until refilling of the reservoir occurred following dam remediation.

Aquatic Beds

The Proposed Action is expected to result in a minor net effect on aquatic beds because while some may be dried out, others will be created over time. Aquatic bed habitats that existed prior to the reservoir drawdown would not be supported by the seasonal inundation that occurs under Normal Operations. New aquatic bed habitat would form in areas where the bottom topography and soil development are suitable. These beds would persist for the duration of the project until the reservoir is refilled following dam remediation. The aquatic beds established during Interim Operations then would revert back to reservoir bottom habitat after periodic inundation. Meanwhile, the littoral areas that once had supported aquatic beds prior to the drawdown would redevelop over the course of multiple growing seasons following a return to Normal Operations.

Seasonally Exposed Mudflats

Existing mudflats are exposed seasonally under Normal Operations. Under the Proposed Action, these mudflats would be exposed for a period of 5 to 7 years until dam remediation was completed. Seasonal inundation is a critical component of mudflat formation and habitat quality (Henry 2012). The temporary loss of seasonal flooding would result in the permanent transition of exposed mudflat areas to other habitat types, depending on the bank topography (e.g., scrub/shrub wetlands, upland pasture). Mudflat habitat still would be available under the Proposed Action but would be limited to a narrow strip of habitat along the wetted perimeter of the reservoir. Birds and other wildlife that had become accustomed to the greater availability of mudflats would continue to use the available habitat as before the Interim Operations period, or may bypass this reservoir and use mudflats in other nearby reservoirs.

An indirect benefit from the Proposed Action would be the boost to the reservoir's nutrient and carbon budget following reservoir refilling from decaying plant material that had colonized mudflat habitats during the Interim Operations. This pulse is expected to a temporary beneficial effect on aquatic food web productivity.

Emergent Wetlands and Scrub/Shrub Wetlands

The Proposed Action is expected to have no net adverse effect on emergent or scrub/shrub wetlands, but the location and condition of these habitats would change over time. Wetland habitats that existed prior to the reservoir drawdown would not be restored by seasonal inundation. Instead, new emergent and scrub/shrub habitats would form in areas where the bottom topography, soil, and soil moisture are suitable. These wetlands would develop over the 5- to 7-year project duration until the reservoir is refilled following dam remediation. These

wetlands then would be inundated and eventually revert to their existing reservoir bottom habitat types. Meanwhile, the shoreline and cove areas that once had supported aquatic beds prior to the drawdown would be expected to redevelop over the course of multiple growing seasons.

The Proposed Action is expected to have no effect on the emergent wetland located within the Earl Light Tract, as appropriate stormwater BMPs (e.g., silt fencing, socks) would be installed and maintained to guard against stormwater runoff from soil storage areas and other construction-related activities.

Forested Wetlands

The Proposed Action is expected to result in only indirect effects on forested wetlands. The sustained lowering of the reservoir pool elevation to between 1,350 and 1,355 feet might lead to a lowering of the water table rimming the reservoir, thus stressing plants and trees with shallow root systems. It is worth noting however, that the annual shoreline fluctuation under Normal Operations produces similar stress on riparian communities on an annual cycle, and the plants within those areas appear to have adapted to this repeated disturbance.

3.6 TERRESTRIAL ECOLOGY

This section summarizes the terrestrial habitats and ecology throughout the Boone Project area, which includes the proposed Construction Zone, Construction Support Areas, the reservoir and tailwater, and their shoreline and floodplain. It also describes potential impacts on terrestrial ecology associated with the No Action Alternative and the Proposed Action.

3.6.1 Affected Environment

Vegetative communities of the Ridge and Valley ecoregion can be grouped into two broad categories: lowland and upland. Lowland communities are those that are most likely to be influenced by changes in reservoir operations (e.g., bottomland hardwood forests, cove forests). Wetlands are specifically discussed in Section 3.5, Wetlands – Affected Environment. Upland communities include all other communities not immediately dependent on surface water features or surficial groundwater. These areas typically are situated at or above maximum summer pool levels. This section also includes a description of cave habitats which are common throughout east Tennessee and occur throughout the Boone Project area.

Construction Areas

As described in Chapter 2, TVA proposes to establish two construction support areas for activities including the storage and/or reuse of clean fill materials generated during drilling and excavation for the dam remediation. Construction Support Area 1 would be a 71.2-acre portion of a TVA-owned parcel commonly referred to as the Earl Light Tract. The tract is one of the largest TVA parcel on Boone Reservoir and contains a mix of upland and lowland forested areas, a gravel parking area, a recreational walking trail, native warm season grass stands, and open land maintained by a cooperative agriculture license. The parcel provides public opportunities for hiking and wildlife/bird viewing and is utilized by hunters. There are no known caves within the Earl Light Tract; however, there is an unnamed cave within a hardwood stand that borders to the parcel to the west.

The upland wooded portions have been grazed by cattle in the past and have little groundcover as a result (TVA 2010). Vegetative buffers have been established along the major drains throughout the lowland areas to enhance wildlife cover. The tract provides a variety of ecological communities for terrestrial species. In addition to the agricultural use, it is currently managed for dispersed recreation and natural resources. TVA proposes to primarily use the open upland fields on the tract. To the extent possible, TVA would avoid removal of trees on the site. TVA had identified a larger portion of the tract for use during construction but, after a group of potential bat roosting trees were identified, those areas were excluded by TVA from proposed Construction Support Area 1.

Construction Support Area 2 is a TVA-owned parcel commonly referred to as Tract 22R. Tract 22R has been heavily influenced by previous land use. Most of the parcel was used for agricultural practices prior to TVA management and has either reverted naturally to forest cover or was planted with pine (TVA 2010). The western portions of this parcel have been paved for two parking lots adjacent to the reservoir for access. A portion of the parcel also was used as a borrow pit/spoil disposal area during past construction projects for the dam reservation. Over one-third of the naturally reverted areas consist of upland hardwood vegetation dominated by locust (*Robinia* sp.), hickory (*Carya* spp.), elm (*Ulmus* spp.), and oaks (*Quercus* spp.). Other reverted forested stands consist of various mixtures of hardwoods, pine (*Pinus* spp.), and eastern red cedar. Scattered patches of planted shortleaf (*Pinus echinata*) and loblolly pine (*P. taeda*) occupy about 10 acres. The 12.8 acre section of Tract 22R that TVA proposes to use to support construction activities is along a transmission line that runs through the middle of the parcel, and a limited area in the adjacent forest. The transmission line portion of the tract is regularly maintained by mowing and tree/vegetation clearing. TVA most recently performed an environmental survey of the 12.8 acre area in September 2015. The biologists identified several stands of potential bat roosting trees in the forest areas along the edge of the proposed Construction Support Area. No other sensitive resources were identified within the 12.8 acre area.

Upland Habitats

Boone Reservoir is situated within the oak-hickory forest region of the Southern Appalachian Ridges and Valleys land resource area (USDA, Forest Service 1969). Two forest types, hardwood and mixed evergreen-deciduous, are common throughout the project area and together comprise 84 percent of the Boone Unit (TVA 2002).

Of TVA lands on Boone Reservoir, hardwood forest occupies a total of 297 acres and accounts for 59 percent of the total forested acreage (TVA 2010). Although hardwood is the major component of the Boone Unit lands, individual stands are small, ranging from less than an acre to 24 acres. About 102 acres of TVA lands is dominated by large sawtimber hardwood comprising upland, mixed, and cove types and dominated by yellow poplar (*Liriodendron tulipifera*), hickory, black oak (*Quercus velutina*), scarlet oak (*Quercus coccinea*),northern red oak (*Quercus rubra*), white ash (*Fraxinus americana*), and white oak (*Quercus alba*). Pole and small sawtimber stands occupy 146 acres of the total hardwood forest. Many of these stands are old fields that reverted naturally to hardwoods; the lower quality sites are occupied by black locust (*Robinia pseudoacacia*), hickory, elm, and oaks, while the more productive sites have

sugar maple (*Acer saccharum*) and yellow poplar. Extensive pine mortality from the southern pine beetle (*Dendroctonus frontalis*) in 2000 has facilitated the growth of approximately 74 acres of sapling and pole-size hardwood, which had existed as understory within the pine stands. These areas consist of scattered red maple (*Acer rubrum*), box elder (*Acer negundo*), black locust, yellow poplar, and various oak species. The remaining 49 acres of hardwood on TVA lands are in various-aged stands ranging from 20 to 90 years and comprise trees from pole to large sawtimber size. Most of these stands also resulted from natural reversion of old pastures.

A mixed evergreen-deciduous forest type occurs on the lower slopes, in narrow valleys, and along streams (TVA 2010). Dominant tree species include basswood (*Tilia americana*), American beech (*Fagus grandifolia*), black cherry (*Prunus serotina*), black locust, flowering dogwood (*Cornus florida*), Fraser's magnolia (*Magnolia fraseri*), eastern hemlock (*Tsuga canadensis*), yellow buckeye (*Aesculus flava*), red maple, sassafras (*Sassafras albidum*), sourwood (*Oxydendrum arboreum*), sweet gum (*Liquidambar styraciflua*), tulip poplar, umbrella magnolia (*Magnolia tripetala*), and white pine (*Pinus strobus*). Shrubs, vines, and herbs in this forest type include Christmas fern (*Polystichum acrostichoides*), cross vine (*Bignonia capreolata*), Dutchman's pipe (*Aristolochia* sp.), foamflower (*Tiarella* sp.), hydrangea (*Hydrangea* sp.), maidenhair fern (*Adiantum* sp.), maple-leaf viburnum (*Viburnum acerifolium*), muscadine grape (*Vitis rotundifolia*), rhododendron (*Rhododendron* sp.), Solomon's seal (*Polygonatum biflorum*), sweet shrub (*Calycanthus* sp.), Virginia creeper (*Parthenocissus quinquefolia*), wild ginger (*Asarum* sp.), and American witch hazel (*Hamamelis virginiana*).

Upland Wildlife

Southern Appalachian forests are one of the most biologically rich regions in North America for wildlife species (Simons et al. 1998). The oak-hickory-dominated forests that are common to the Ridge and Valley ecoregion and are prominent at Boone Reservoir provide habitat for a variety of mammals, birds, reptiles, and amphibians. Most species are regionally common.

Common mammal species present at Boone Reservoir include white-tailed deer (*Odocoileus virginianus*), raccoon, beaver, eastern chipmunk (*Tamias striatus*), stripped skunk (*Mephitis mephitis*), white-footed mouse (*Peromyscus leucopus*), southern flying squirrel (*Glaucomys volans*), and gray squirrel (*Sciurus carolinensis*) (TVA 2002, TVA 2010).

The oak-hickory-dominated forests that surround Boone Reservoir provide nesting habitat for a myriad of bird species, such as wild turkey (*Meleagris gallopavo*), whip-poor-will (*Antrostomus vociferus*), ruby-throated hummingbird (*Archilochus colubris*), red-eyed vireo (*Vireo olivaceus*), blue-headed vireo (*Vireo solitarius*), wood thrush (*Hylocichla mustelina*), gray catbird (*Dumetella carolinensis*), black-throated green warbler (*Setophaga virens*), black-and white warbler (*Mniotilta varia*), ovenbird (*Seiurus aurocapilla*), hooded warbler (*Setophaga citrina*), and scarlet tanager (*Piranga olivacea*). Notably, the Earl Light Tract, proposed for use by TVA as Construction Support Area 1, is well-known for the presence of wild turkey. The riparian zones along streams within these forests provide nesting habitat for additional species such as the Acadian flycatcher (*Empidonax virescens*), northern parula (*Setophaga americana*), and Louisiana waterthrush (*Parkesia motacilla*) (TVA 2002, TVA 2010).

Evergreen and mixed evergreen-deciduous forests also are common at Boone Reservoir and provide additional nesting habitat for species such as the pine warbler (*Setophaga pinus*), yellow-throated warbler (*Setophaga dominica*), great crested flycatcher (*Myiarchus crinitus*), and chuck-will's-widow (*Antrostomus carolinensis*). Birds that winter in this forest type include red-breasted nuthatch (*Sitta canadensis*), red crossbill (*Loxia curvirostra*), and pine siskin (*Spinus pinus*) (TVA 2002, TVA 2010).

Other common birds that may be found year-round at Boone Reservoir are the eastern phoebe (*Sayornis phoebe*), barn swallow (*Hirundo rustica*), tufted titmouse (*Parus bicolor*), eastern cardinal (*Cardinalis cardinalis*), American crow (*Corvus brachyrhynchos*), and large numbers of black vultures (*Coragyps atratus*) and turkey vultures (*Cathartes aura*) (TVA 2002, TVA 2010).

Forested bluffs and exposed limestone outcrops provided habitat for numerous species of woodland salamanders, such as slimy salamander (*Plethodon glutinosus*) and long-tailed salamander (*Eurycea longicauda*). Common reptiles included ground skink (*Scincella lateralis*), box turtle (*Terrapene carolina*), and northern water snake (*Nerodia sipedon*) (TVA 2002, TVA 2010).

Lowland Communities

Lowland communities include bottomland hardwood forests and wetland communities (e.g., scrub/shrub wetlands and exposed mudflats). These habitats are widespread along Boone Reservoir and may reflect seasonal patterns according to changes in their elevation and the duration, and timing of flooding during winter versus summer pool elevations during Normal Operations. Wetland habitats are more fully described in Section 3.5 (Affected Environment – Wetlands).

Bottomland hardwood forests occur in floodplains above and below the dam, as well as along terraces, natural levees, and back-lying sloughs. Dominant tree species found in these forests include black gum, red maple, river birch (*Betula nigra*), sycamore (*Platanus occidentalis*), sweet gum, tulip poplar, water oak (*Quercus nigra*), and willow oak (*Q. phellos*). Communities closer to water may support trees that are more adapted to wetter soils, such as bald cypress (*Taxodium distichum*), black gum (*Nyssa sylvatica*), black willow (*Salix nigra*), box elder (*Acer negundo*), cottonwood (*Populus deltoides*), and green ash (*Fraxinus pennsylvanica*), among others (TVA 2010).

Lowland Wildlife

Boone Reservoir provides habitat for shorebirds and waterfowl. Under Normal Operations, during annual reservoir drawdowns, approximately 108 acres of mudflats are exposed, providing important foraging and resting habitat for migrating shorebirds and waterfowl (Henry 2012; TVA 2004). Mudflats provide critical foraging and resting sites for shorebirds, especially sandpipers (small, long-distance migrants), as they migrate through the interior United States. Mudflats also provide nesting opportunities for ground-nesting species such as killdeer and common snipe. The timing and rate of seasonal drawdown significantly influence the suitability of habitat for waterbirds by affecting mudflat exposure, vegetation establishment, seed production, and invertebrate availability (Wirwa 2009 as cited by Henry 2012). At Boone, the

seasonal drawdown under Normal Operations typically begins in early September. Shorebirds typically begin migrating through the Tennessee River Valley in late July. Peak waterfowl abundance occurs during November (Wirwa 2009). The lowest reservoir levels are normally reached in December.

Other common birds that may be found year-round at Boone Reservoir include great blue heron, green heron (*Butorides striatus*), eastern phoebe, barn swallow, tufted titmouse, cardinal, American crow, a variety of migrating neotropical birds, and large numbers of black vultures and turkey vultures(TVA 2002, TVA 2010).

Several rookeries have also been documented along Boone Reservoir and its tailwater. One rookery, located downstream of Boone Dam near FPH Dam, was abandoned due to a great horned owl nesting nearby. Other rookeries which are presumed to still be active support great blue herons, yellow-crowned night herons (*Nyctanassa violacea*), and potentially other species (TVA 2015b).

Caves

The TVA natural heritage database lists 16 caves within a 3-mile radius of Boone Reservoir and tailwater (TVA 2015b). Many of the caves surrounding Boone Reservoir have not been explored and the extent of the caverns is unknown. Perhaps the most ecologically significant cave near Boone Reservoir is Morrell Cave located 0.5 miles from the reservoir east of Bluff City, Tennessee. The most recent survey of this cave conducted in 2002 reported approximately 10,000 bats, including the federally and state endangered gray bat (*Myotis grisescens*) (TVA 2015b). Other protected bat species that may occur at this and other proximal caves are discussed in Section 3.8 (Threatened and Endangered Species). Of the 16 known caves near Boone Reservoir, five occur along the rocky bluffs rimming the reservoir and are only exposed seasonally during the normal winter pool level under Normal Operations. These are unnamed and unexplored and their potential for hosting wildlife, including sensitive bat species, is unknown.

Invasive Species

According to the Federal Noxious Weed List of 2006 (USDA 2007), no known federal noxious weeds have been reported from the lands around Boone Reservoir. However, the Tennessee exotic plant pest list (Tennessee Exotic Plant Pest Council 2009), lists 15 (Rank 1) species that may occur along Boone Reservoir and, if present, would pose a severe threat to local plant communities because of their potential to spread rapidly and displace native vegetation. These plants include autumn olive (*Elaeagnus umbellata*), bush honeysuckle (*Lonicera* sp.), Chinese lespedeza (*Lespedeza cuneata*), Chinese privet (*Ligustrum sinense*), English ivy (*Hedera helix*), garlic mustard (*Alliaria petiolata*), Japanese honeysuckle (*Lonicera japonica*), Japanese stiltgrass (*Microstegium vimineum*), Johnson grass (*Sorghum halepense*), kudzu (*Pueraria montana* var. *lobata*), mimosa (*Albizia julibrissin*), multiflora rose (*Rosa multiflora*), Asian bittersweet (*Celastrus orbiculatus*), princess tree (*Paulownia tomentosa*), and tree of heaven (*Alianthus altissima*). Other nonnative species such as crown vetch (*Coronilla varia*), tall fescue (*Lolium arundinaceum*), wooly mullen (*Verbascum thapsis*), Queen Anne's lace (*Daucus carota*), periwinkle (*Vinca* spp,), and small carpet grass (*Arthraxon hispidus*) also may occur.

TVA conducts a variety of ongoing management activities to control invasive terrestrial plants. Through its Natural Areas Management Program, TVA has actively managed invasive terrestrial plants on lands known to contain rare plants or uncommon plant communities. Historically, invasive terrestrial plants were controlled mainly by hand removal, with limited herbicide application. Hand removal still is used, but herbicides are used to a greater extent now because more is known about this approach and more effective herbicides are available.

3.6.2 Environmental Consequences

3.6.2.1 No Action Alternative

Construction Areas
Under the No Action Alternative, the proposed remediation at Boone Dam would not occur, and no direct or indirect construction-related impacts on terrestrial habitats would occur.

Upland Communities
No direct impacts on the oak-hickory or mixed forests, or on the plant and animal species that they host, are expected under the No Action Alternative. Indirect effects are possible as the permanent lowering of the reservoir pool elevation might lead to a lowering of the water table rimming the reservoir, thus stressing plants and trees with shallow root systems. It is worth noting, however, that the annual shoreline fluctuation under Normal Operations would produce similar stresses on upland plant communities on an annual cycle, and the plants within those areas likely have adapted to this repeated disturbance.

Lowland Communities
Bottomland and cove forests may be adversely affected under the No Action Alternative as the permanently lower reservoir pool elevation would result in a permanent dewatering of some moist soil areas. The fate of these communities would be a gradual succession to more upland communities. Some birds, mammals, and amphibians/reptiles species dependent upon these habitats would become displaced as the quality of their lowland habitat decreases during the transition. The No Action Alternative is unlikely to affect established rookeries since known locations all occur downstream from Boone Dam where post-drawdown flows are expected to remain similar to the Normal Operations schedule.

Caves
The reservoir drawdown has exposed five cliff-side cave openings that are typically only exposed seasonally during the normal winter pool level under Normal Operations. Under the No Action Alternative, these caves would persist above water indefinitely and might possibly provide suitable roosting and/or hibernation refuge for sensitive bats. However, sensitive bat species such as the gray bat, Indiana bat, and northern long-eared bat, have very specific cave habitat requirements and it is unknown whether these unexplored caves would satisfy those requirements.

Invasive Species

Invasive plant species could become established on vulnerable exposed reservoir bottom. TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species which would serve to reduce the establishment of invasive plant species.

3.6.2.2 Proposed Action

Construction Areas

Under the Proposed Action, construction activities would take place within the Boone Dam reservation and the two Construction Support Areas. TVA would use the proposed Construction Support Areas to support construction activities, including storage of clean fill, road construction, creation of laydown areas and/or stockpile areas, utility relocation, security, communication upgrades, temporary positioning of trailers, creation of temporary parking areas, and equipment and material staging areas. At Construction Support Area 1, TVA primarily would use the open fields and would to the extent possible avoid the removal of trees, especially those within concentrated forest areas. After completion of the project, TVA would restore and revegetate the area and reestablish the area's current use for natural resource conservation.

At Construction Support Area 2, TVA primarily would use the already cleared utility right-of-way, as well as possibly a limited portion of the adjacent forested areas for access. Direct effects to some individuals that may be immobile during the time of construction/activities may occur, particularly if construction activities took place during breeding/nesting seasons. However, the actions are not likely to affect populations of species common to the area, as similar forested and herbaceous habitat exists in the surrounding landscape. Minor to moderate indirect adverse effects to wildlife would occur during use of these areas from displacement or disturbance. The constant disturbance of worker traffic and heavy equipment operation would be expected to disturb or displace most animals, ranging from large and small mammals to birds and reptiles/amphibians. Impacts would extend through the life of the project (5 to 7 years), after which TVA would restore and revegetate the area. It is expected that any displaced wildlife would return to the project area upon completion of actions.

Upland Communities and Wildlife

Other than those that may occur in construction areas, no direct impacts on the oak-hickory or mixed forests, or the plant and animal species that they host are expected under the Proposed Action. Indirect effects are possible during the Interim Operating period as the lowering of the reservoir pool elevation might lead to a lowering of the water table rimming the reservoir, thus stressing plants and trees with shallow root systems. It is worth noting however, that the annual shoreline fluctuation under Normal Operations would produce similar stresses on upland plant communities on an annual cycle, and the plants within those areas likely have adapted to this repeated disturbance. For this reason, refilling of the reservoir to summer pool following dam remediation is expected to result in minor impacts on the upland plant communities or the wildlife species that they host.

Lowland Communities and Wildlife

Bottomland and cove forests may be temporarily adversely affected under the Proposed Action

as the sustained lowering of the reservoir pool elevation to 1,335 feet would result in an extended dewatering of previously moist soil areas. Under the Proposed Action, the reservoir would be returned to summer pool elevation following the project duration. By this time, the lowland plant communities likely would be in state of transition as the more wetland obligate species would have been outcompeted by pioneering species and plants that are more tolerant of drier soil conditions. Birds, mammals, and amphibians/reptiles would become displaced as the quality of their lowland habitat decreased during this successional phase. Migrating shorebirds would no longer be able to use this habitat as stop-over grounds. The Proposed Action is unlikely to affect established rookeries since known locations all occur downstream from Boone Dam where post-drawdown hydrology is expected to remain similar to the Normal Operations schedule.

Caves

The reservoir drawdown has exposed five cliff-side cave openings that are typically only exposed seasonally during the normal winter pool level under Normal Operations. Under the Proposed Action, these caves would persist above water for the project duration, before being inundated following the dam remediation. It is unknown whether these exposed caves provide suitable habitat for sensitive bat species, as these species tend to have very specific habitat requirements with respect to size, temperature, etc. However, any bats that colonize these caves during the Interim Operations period would have ample time to displace as, after the completion of the project, the reservoir filling process occurs very gradually over the course of weeks and months. Exceptions might include non-volant (non-flying) juvenile bats and/or bats in torpor that are not fully awake or aware of their surroundings during winter. This topic is more succinctly addressed in Section 3.8 (Threatened and Endangered Species).

Invasive Species

Invasive plant species could become established on vulnerable exposed reservoir bottom. The TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation of the portions of the exposed reservoir bottom and TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species which would serve to reduce the establishment of invasive plant species.

TVA's proposed vegetation management plan, which will manage the successional vegetation on much of the exposed reservoir bottom with annual or periodic mowing or bushwacking, is not expected to adversely impact lowland communities and wildlife. Mowing vegetation on the exposed reservoir bottom would not be intended to eliminate the vegetation. Such vegetation may be beneficial, by enhancing wildlife habitat, reducing erosion during the drawdown, and improving fish habitat after the reservoir is returned to normal water levels.

Re-inundation of the reservoir following dam remediation would drown the new vegetative growth. That new growth would perish, and more wetland-tolerant plants gradually would recolonize the wetter areas.

3.7 AQUATIC ECOLOGY

This section summarizes the aquatic habitats and their ecology throughout the Boone Project area and the potential impacts on aquatic ecology associated with the No Action Alternative and the Proposed Action.

3.7.1 Affected Environment

Underwater topography in Boone Reservoir varies from moderately steep, with extensive areas of exposed bedrock near the river channel, to more gently sloping areas with shallower embayments and coves. Rock substrate is common throughout much of the reservoir, either in the form of rock outcrops, a mixture of rubble and cobble, or gravel along main channel shorelines. Cove substrate is typically soil and gravel with scattered cobble.

Aquatic habitat in the near-shore (littoral) zone is the most productive region of the reservoir. Many fish species rely on littoral habitats for spawning. The availability of submerged cover (e.g., submersed vegetation, rocks, logs, and brush) within the littoral zone is especially important and can influence year-class strength of key sportfish such as largemouth bass (*Micropterus salmoides*) (Sammons et al. 1999). Aquatic invertebrates and small fish in this area also serve as an important food source for other fish, birds, and mammals.

Shoreline land use can greatly influence the quality and productivity of the littoral habitat. For example, undeveloped shorelines often are accompanied by a wooded riparian zone and so fallen trees and brushy cover tend to be more widely present. A survey was conducted on Boone Reservoir in February 1997 to arrive at a modified Shoreline Aquatic Habitat Index score indicating the quality of aquatic habitat adjacent to the shoreline. Scoring parameters included riparian cover, aquatic habitat diversity, substrate, and bank stability as indicated by the extent of erosion. The average score at Boone was 12.9 (of a possible 20), which indicates generally "fair" shoreline habitat. Higher scores were seen in the quality of stable, diverse cover in the drawdown zone in most areas; problem areas were bank stability and a lack of good shoreline canopy in many areas.

The ecological health of Boone Reservoir has been monitored biennially since 1996 and annually prior to that, dating back to the early 1990s as part of TVA's Vital Signs Monitoring Program, now referred to as TVA's Reservoir Ecological Health Program (REHP). Monitoring takes place at three stations that include the forebay and two mid-reservoir regions, representing each of the South Holston and the Watauga River Arms of the impoundment. The REHP focuses on five ecological indicators: DO, chlorophyll-*a*, sediment quality, benthic macroinvertebrates, and fish assemblage. Each of these components is scored, and the 20- to 100-percent scoring range is divided into categories representing "good," "fair," or "poor" ecological health conditions.

Dissolved Oxygen

Dissolved oxygen concentrations vary considerably from year to year and from site to site but generally rate as poor at the forebay and South Fork Holston River stations and as good at the Watauga River mid-reservoir location. Prevailing weather patterns, changes in reservoir flows,

weather and related reservoir stratification and algal production are the major factor in these differences. Low DO in the hypolimnion at Boone Reservoir precludes most aquatic life, with the exception of tubificid worms which are tolerant of anoxic conditions (Dycus and Baker 2000). TVA has installed auto-venting turbines to add oxygen to the water as it is drawn from the hypolimnion at Boone Dam and passed downstream. (See additional discussion in Section 3.3.1 [Affected Environment – Water Resources].)

Chlorophyll a

Chlorophyll *a* is a pigment in phytoplankton cells that aids in photosynthesis. Its concentration in a water quality sample commonly is used as a surrogate for estimating phytoplankton biomass. High chlorophyll *a* concentrations indicate excessive algal growth, which often signals nutrient enrichment from anthropogenic sources. High chlorophyll *a* has been a common problem in Boone Reservoir, typically rating poor or at the low end of the fair range.

Sediment

Sediment quality generally rates as fair at all monitoring locations. Problems with metals and organic contaminants in the sediment have persisted over the years. Chlordane and PCBs have been present in the sediments at all monitoring locations, and elevated copper and sometimes zinc levels have been present at the Watauga River mid-reservoir site. These metals (arsenic, chromium, copper, and zinc) naturally occur in soils but also can originate from many sources. Their concentrations in sediments deposited in the reservoir are generally near suggested background concentrations (TVA 2015c). Other materials found in sediments (e.g., iron, manganese, sulfides, and ammonia) may be formed and mobilized in the deeper hypolimnetic waters of the reservoir when oxygen concentrations are low. These potential pollutants can adversely affect water supplies, recreation, and aquatic life.

Benthic Macroinvertebrates

Benthic macroinvertebrates indices generally rate as poor or at the low end of the fair range at all monitoring locations. This is most likely a factor of the anoxic conditions that develop and persist each summer during thermal stratification.

Fish Health

Fisheries monitoring for the REHP has traditionally occurred during the fall months of October and November. However, the reservoir drawdown during fall 2014 prompted TVA to conduct an additional summer monitoring event during June 2015. Monitoring occurs along established 300-meter transects, and fish are captured using boat electrofishing and sinking gill net techniques. From these data, TVA calculates a Reservoir Fisheries Assemblage Index (RFAI) score (McDonough and Hickman 1999). This index primarily is based on species diversity and composition and takes into account the relative abundances of species from various feeding guilds, tolerance thresholds, and condition (e.g., the presence of lesions, parasites, or abnormalities). As with the REHP, the RFAI scores are translated into a qualitative ranking of good, fair, or poor.

Compared to other storage reservoirs of similar physical characteristics in the Ridge and Valley ecoregion, the fish assemblage at the forebay and South Holston and Watauga River mid-

reservoir stations generally rate from poor to fair. Ratings are based primarily on fish species diversity and composition. Also considered in the rating is the percentage of the sample represented by omnivores and insectivores; the overall number of fish collected; and the occurrence of fish with anomalies such as diseases, lesions, parasites, and deformities. Overall, TVA has recorded 50 species of fish from Boone Reservoir, including hybrids, since monitoring began in 1991.

Reservoir Sport Fish and Prey Species

Boone Reservoir is a popular sport fishing destinations for local and regional anglers. Key sportfish include largemouth bass, smallmouth bass (*Micropterus dolomieu*), striped bass (*Morone saxatilis*), hybrid bass (*Morone chrysops* x *saxatilis*), black crappie (*Pomoxis nigromaculatus*), rainbow trout (*Oncorhynchus mykiss*), and brown trout (*Salmo trutta*). Other abundant sport fish species in Boone Reservoir include sunfish (*Lepomis* sp.), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), and walleye (*Stizostedion vitreum*). Collectively, these species account for nearly 80 percent of the fish sampled by TVA as part of the REHP. Perhaps as important to the sport fishery are the prey species required by these sport fish. Species such as gizzard shad (*Dorosoma cepedianum*), threadfin shad (*Dorosoma petenense*), and spotfin shiner (*Cyprinella spiloptera*) account for an additional 11 percent of recorded abundances within the reservoir.

In past years, TVA has directly measured the quality of the Boone Reservoir sport fishery through both the Spring Sportfish Surveys and the Sport Fishing Index (SFI). Both programs evaluated the fisheries based on population measures (the size and health of the individual fish, along with the number of fish present). The SFI, which was performed jointly with the TWRA, also included information on angler use and success (the number of anglers looking for a particular type of fish, and the number of that type that they actually catch). Table 3-7 compares Boone Reservoir SFI scores from 2008 against average SFI scores from other TVA-managed reservoirs in the region.

Table 3-7: Sport Fishing Index (SFI) Scores and Spring Sportfish Survey at Boone Reservoir (2008)

Fish Species	2008 Score	2008 Average across the TVA Region
Black basses (largemouth, smallmouth, spotted)	32	37
Black crappie	32	31
Largemouth bass	32	35
Smallmouth bass	37	31
Striped bass	40	35

Neither of these programs have been active since 2008, but previously collected data described Boone Reservoir as a top regional destination for striped bass, black crappie, and black bass

(largemouth and smallmouth). Table 3-8 lists results for TVA's spring sportfish survey during the period from 2003 to 2008.

Table 3-8: TVA's Spring Sportfish Survey at Boone Reservoir (2003–2008)

Parameter	2008	2007	2006	2005	2004	2003
Hours electrofished	12	12	12	12	12	12
Total number of black bass	526	378	343	271	213	217
Percent harvestable (over 10 inches)	83%	79%	79%	86%	88%	71%
Number of largemouth bass	405	272	254	186	154	161
Number of smallmouth bass	108	100	85	82	58	56
Number of spotted bass	13	6	4	3	1	0
Number of crappie	39	54	47	30	32	12
Number of white crappie	6	9	23	20	2	5
Number of black crappie	33	45	24	10	30	7
Electrofishing catch rate (per hour)	43.8	31.5	28.5	22.5	17.7	18
Average weight (pounds)	1.8	1.9	2.1	1.9	1.7	1.5
Largest black bass (pounds)	5.7	5.7	5.6	6	5.1	4.7
Disease/parasites	24%	12%	16%	3%	7%	28%
Number weighing more than 5 pounds	2	5	4	2	1	0
Number weighing more than 4 pounds	19	11	16	6	5	2
Number weighing more than 3 pounds	58	35	39	25	13	NA

The TWRA performs annual stocking of black crappie and hybrid and striped bass to increase populations and bolster angling success at Boone Reservoir. Table 3-9 displays annual stocking rates for these species over the past decade. In response to the reservoir drawdown, the TWRA plans to reduce the 2015 stocking rates by approximately half to prevent over-crowding of fish.

Table 3-9: TWRA Fish Stocking Rates for Three Key Sportfish Species in Boone Reservoir (2005–2014)

Year	Black Crappie	Hybrid Striped Bass	Striped Bass
2014	44,305	32,200	9,789
2013	62,997	25,502	22,545
2012	48,979	34,810	23,628
2011	47,258	32,574	25,355
2010	--	22,498	25,696
2009	31,186	27,994	48,482

Table 3-9: TWRA Fish Stocking Rates for Three Key Sportfish Species in Boone Reservoir (2005–2014)

Year	Black Crappie	Hybrid Striped Bass	Striped Bass
2008	22,992	26,489	47,720
2007	14,620	44,608	27,558
2006	--	12,376	25,445
2005	--	16,410	11,991

Tailwater Sportfish

The Boone Reservoir tailwater is one of the more productive trout fisheries in Tennessee. In September 2010, this fishery produced a state record rainbow trout (*Oncorhynchus mykiss*; 16 pounds, 15 ounces; Samsel 2010). Brown trout (*Salmo trutta*) and walleye (*Sander vitreus*) are also popular sportfish below the dam and generally stocked by TWRA on a regular cycle; see Table 3-10. Striped bass are also present as the result of downstream migration from Boone Reservoir, but typically in lower densities than occur above the dam (TWRA 2015a). Since the tailwater of Boone Dam is also the headwater of FPH Reservoir, warmwater fish species that are more typical to impounded waters (e.g., largemouth and smallmouth bass, black crappie) may also occur.

Table 3-10: TWRA Fish Stocking Rates for Three Key Sportfish Species in the Boone Dam Tailwater and upper FPH Reservoir (2005–2014)

Year	Rainbow Trout	Brown Trout	Walleye
2014	--	--	21,060
2013	8,217	--	7,860
2012	16,901	5,790	23,500
2011	9,037	5,804	2,142
2010	8,284	3,999	--
2009	8,010	5,014	--
2008	19,599	5,011	--
2007	16,438	--	--
2006	8,001	--	--
2005	2,982	--	--

The cold hypolimnetic water issued from Boone Dam makes this tailwater particularly suitable for cold water fish species which require not only cooler temperatures but also high DO). However, warmer temperatures and reduced DO may be unavoidable during the hot summer months. The optimal water temperatures for rainbow trout occur between 10 and 15°C, with death possibly occurring at sustained temperatures above 25°C (Piper et al. 1982; Raleigh et al.

1984). At no point in TVA's 2015 continuous tailwater monitoring have temperatures risen this high, and no fish kills have been documented below Boone Dam. However, sub-lethal stress is almost certainly occurring during the warmest summer months. Grizzle (1981) reported that bacterial infections of rainbow trout were most frequent in fish collected near a dam during a period of lowest DO concentration. A description of water quality dynamics in the Boone Dam tailwater is provided in Section 3.3 (Water Resources – Environmental Consequences).

Aquatic Invasive Animals

Seven invasive aquatic animal species pose a serious threat to aquatic communities in the TVA reservoir system: common carp (*Cyprinus carpio*), grass carp (*Ctenopharyndogon idella*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), rusty crayfish (*Orconectes rusticus*), Asiatic clam (*Corbicula fluminea*), and zebra mussel (*Dreissena polymorpha*). The Asiatic clam and zebra mussel are the most problematic of these species in the Tennessee River system, because these two species adhere to raw water intake systems at power plants and city water supplies.

The invasive aquatic species of greatest concern is the zebra mussel. Zebra mussels were first found about 25 years ago in the Tennessee River just upstream from Kentucky Dam, and the spread of zebra mussels has continued. In places where large numbers of zebra mussels occur, reservoir front property owners have been plagued by encrusted dock pilings and ladders, as well as sharp, foul-smelling shells littering beaches and shorelines. Boaters have experienced problems with increased drag and poor motor performance—the result of a buildup of mussels on hulls and internal engine parts. Intake pipes at water treatment and power plants have become clogged. Zebra mussels can form living blankets on the river and reservoir bottom, killing native mussels and reducing food supplies for young fish and other aquatic life.

TVA conducts an active program to monitor the populations of Asiatic clams and zebra mussels at power projects. When required, TVA uses chemical and warmwater treatments to control Asiatic clams and zebra mussels at generating facilities. TVA does not conduct management activities associated with the other invasive aquatic species.

Streams

TVA identified one intermittent stream feature on the Earl Light Tract, proposed for use as Construction Support Area 1. The stream is approximately 1,080 feet long, 2 to 4 feet wide, 1 to 3 feet deep, and appears to function as a wet weather conveyance.

3.7.2 Environmental Consequences

3.7.2.1 No Action Alternative

The No Action Alternative would result in minor to moderate direct and indirect effects to aquatic communities. The lower reservoir elevation would dewater the existing littoral habitat. Aquatic animals that rely on littoral habitat would be displaced to the new shoreline, which likely would not provide the same level of cover (e.g., submersed vegetation, woody debris) as the normal summer pool elevation shoreline. It is worth noting, however, that the annual shoreline fluctuation under Normal Operations would produce similar stresses on littoral communities on

an annual cycle, and the animals that use the Boone Reservoir littoral zone are likely to be more tolerant of this effect than aquatic communities that are not subjected to this type of repeated disturbance.

Indirectly, a positive effect of the No Action Alternative would be the seasonal and inter-annual stability of reservoir pool elevation. As discussed in Section 3.5 (Wetlands – Affected Environment), new littoral habitat would form in areas where the bottom topography is amenable along the exposed reservoir bottom. The newly developed littoral habitat would not be subjected to the annual cycle of winter drawdown. The resulting increase in habitat stability likely would promote a more diverse plant and animal assemblage over time.

Reservoir Sportfish and Prey Species

Under the No Action Alternative, population densities of popular sportfish (largemouth bass, striped bass, and black crappie) and their prey species (threadfin shad, gizzard shad, and spotfin shiner) would be expected to become greater following the drawdown, as the populations of these species would inhabit a smaller waterbody. In the short term, these greater densities likely would result in increased growth and condition of sportfish as foraging success increased. As prey species were depleted, growth and condition of sportfish would begin to decline, a process that may take from 2 to 3 years to manifest. The reduced growth and condition could translate to reduced fecundity, which in turn would produce depressed year classes for several consecutive years until the fisheries acclimated to the new habitat conditions (e.g., food availability, cover). Under the No Action Alternative, this rebalancing of the fisheries community eventually may stabilize, but population variability that already occurs under normal operation would continue.

The increased densities during the first 2 to 3 years following the drawdown also likely would translate into greater angler success. Because of increased harvest, it is possible that sport fishing pressure may accelerate depletion of the denser populations more quickly than by natural pressures alone. This is less likely to occur within the black bass fishery, as those anglers are expected to shift fishing pressure to other lakes. As one example, no black bass tournaments have been scheduled at Boone Reservoir since the fall 2014 drawdown. By contrast, striped bass fishing pressure is likely to stay the same or possibly increase because Boone Reservoir is the primary fishery for this species in the region.

The TWRA has indicated that they may reduce stocking of key sportfish (hybrid striped bass, striped bass, and black crappie) to half during the initial drawdown period. The intent is to avoid overcrowding an already increased sportfish density. Continued annual monitoring by TVA and TWRA during the 5 to 7 years following the drawdown would inform the TWRA's decision on how best to augment the stocking schedule moving forward.

Tailwater Sportfish

As described in Section 3.1, Boone Reservoir would operate as a run-of-the-river project for perpetuity under the No Action Alternative, and, the amount of water being released into the tailwater would remain similar to the Normal Operations release schedule. On average, about 2,000 to 2,500 cubic feet of water – or 15,000-18,700 gallons – flow through Boone Dam every

second (TVA 2015a). Some of this water comes from upstream on the South Holston and Watauga Rivers, and some flows directly into Boone Reservoir from numerous creeks and tributaries when it rains. As a result, the downstream tailwater fisheries, specifically rainbow and brown trout, should not be adversely affected by flow alternations under the No Action Alternative.

A description of downstream water quality effects under the No Action Alternative that may affect the tailwater sport fishery is provided in Section 3.3 (Water Resources – Environmental Consequences). Generally, warmer temperatures and reduced DO would occur in the tailwater during summer months, possibly with dry warm years producing more likelihood than others.

This could be temporarily stressful for coldwater fisheries (e.g., trout) that require cooler water temperatures and ample DO to survive. From an angling perspective, this would translate to lower fishing success. However, summer time stress is an annual occurrence at the Boone tailwater and most anglers are accustomed to the challenges of fishing in a stressed summer fishery. Ultimately, the flow releases through Boone Dam under the No Action Alternative would remain largely unchanged from Normal Operations, and fish habitat conditions below the dam would largely remain similar to previous years. The TWRA is expected to continue with the regular stocking of trout and walleye below Boone Dam under the No Action Alternative.

Streams
Under this alternative, no impacts would occur to the stream area on the 71.2-acre Earl Light Tract.

3.7.2.2 Proposed Action

The Proposed Action would result in direct and indirect effects to aquatic communities. The lower reservoir elevation during the Interim Operations period would dewater and dry existing littoral habitat. Aquatic animals that rely on this habitat would be displaced to the new shoreline, which may or may not offer the same level of cover (e.g., submersed vegetation, woody debris) as the normal pool elevation shoreline. It is worth noting, however, that the annual shoreline fluctuation under Normal Operations would produce similar stresses on littoral habitats on an annual cycle, and the animals that use the Boone Reservoir littoral zone are likely to be more tolerant of this effect than aquatic communities that are not faced with this repeated disturbance.

Under the Proposed Action, the reservoir would be inundated to full pool following the 5- to 7-year project duration. By this time, a new littoral zone is likely to have developed along the 1,335-foot elevation shoreline. The refilling process is gradual and would occur over the course of weeks and months. Aquatic beds would diminish as the depth of water would affect light penetration. However, aquatic animals accustomed to using submersed plants for food and cover would have ample colonization opportunities in the newly inundated areas, as these newly inundated areas would be heavily vegetated with grasses, forbs, and shrubs that grew during the drawdown period. The TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation of the portions of the exposed reservoir bottom and TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species. TVA's

proposed vegetation management plan, which will manage the successional vegetation on much of the exposed reservoir bottom with annual or periodic mowing or bushwhacking, is not expected to adversely impact aquatic habitats. Mowing vegetation on the exposed reservoir bottom would not be intended to eliminate the vegetation. Such vegetation may be beneficial, by enhancing wildlife habitat, reducing erosion during the drawdown, and improving fish habitat after the reservoir is returned to normal water levels.

Reservoir Sportfish and Prey Species

As explained under the No Action Alternative, population densities of popular sportfish (largemouth bass, striped bass, and black crappie) and their prey species (threadfin shad, gizzard shad, and spotfin shiner) are expected to become more dense following the drawdown as the populations of these species are condensed into a smaller waterbody. In the short term, these greater densities should result in increased growth and condition of sportfish as foraging success increases. As prey species deplete, growth and condition of sportfish would begin to decline, a process that may take from 2 to 3 years to manifest. This decline in growth and condition would likely result in reduced fecundity, which in turn could produce depressed year classes for several consecutive years until the fisheries acclimate to the new habitat conditions (e.g., food availability, cover).

The increased densities in the first 2 to 3 years following the drawdown also may translate into greater angler success. Because of the increased harvest, it is possible that sport fishing pressure may accelerate depletion of the denser populations more quickly than by natural pressures alone. This is less likely to occur within the black bass fishery as those anglers are expected to shift fishing pressure to other more accessible venues. As one example, no black bass tournaments have been scheduled at Boone Reservoir since the fall 2014 drawdown. By contrast, striped bass fishing pressure is likely to stay the same or possibly increase because Boone Reservoir is the only local fishery for this species.

During this time, the TWRA has indicated that they will continue to stock key sportfish (hybrid striped bass, striped bass, and black crappie), albeit at a rate of half of the typical stocking schedule. (Typical stocking schedules for 2005 through 2014 are provided in Table 3-9.) This reduced stocking is to avoid overcrowding of an already dense ecosystem. Continued annual monitoring by TVA and TWRA during the 5 to 7 years following the drawdown will inform the TWRA's decision on how best to manage the stocking schedule moving forward.

Under the Proposed Action, the reservoir would be inundated to normal seasonal pool levels following the 5- to 7-year project duration. By this time, the vast majority of exposed reservoir bottom following initial drawdown would be heavily vegetated. The types of vegetation would vary from warm season grasses and forbs to early successional shrubs and saplings. This vegetation would not survive the inundation and nutrients released by the decaying plant material and bottom soils provide a pulse of organic carbon and nutrients into the reservoir. This stimulus is expected to have a positive effect on food chain productivity and result in stronger year classes of aquatic animals. The remnant plant material would also provide ample cover for juvenile fish. This effect, combined with the increased carrying capacity of a larger waterbody would encourage growth and survival of young-of-year fish into the fishery. Many

studies have documented such a stimulus of young-of-year sportfish in response to raised water levels during spawning and/or growing seasons (Miranda et al. 1984, Aggus an Elliott 1975, Shirley and Andrews 1977). Fish from these initial post-flood year-classes would begin to reach harvestable size within two to three years following reservoir refilling and would continue to do so for several years until the stimulus effect diminished. Eventually, fish communities would stabilize according to food and cover availability, predator/prey ratios, and angling pressure.

Tailwater Sportfish

Under the Proposed Action, Boone Reservoir would be operated as a run-of-the-river project for a period of 5 to 7 years. As a result, the amount of water being released into the tailwater would remain similar to Normal Operations prior to drawdown. On average, about 2,000 to 2,500 cubic feet of water – or 15,000-18,700 gallons – flow through every second. Following dam remediation and subsequent refilling of the reservoir, this tailwater flow regime would return to Normal Operations.

A description of downstream water quality effects under the Proposed Action that may affect the tailwater sport fishery is provided in Section 3.3 (Water Resources – Environmental Consequences). Because the flow regime below the dam is expected to remain largely consistent with that experienced under Normal Operations, no significant impacts on the tailwater fishery are expected under the Proposed Action, beyond those that would typically occur under Normal Operations. Fish stress from high water temperatures and depressed DO still would be likely to occur during summer months. This likely would translate to lowered angler success during summer months as heat- or oxygen-stressed fish tend to be less active. A more complete description of the tailwater sport fishery under Interim Operations is stated in Section 3.7.2.1 (No Action Alternative – Tailwater Sportfish).

Streams

At Construction Support Area 1, TVA primarily would use the open fields and would to the extent possible avoid the removal of trees, especially those within concentrated forest areas. The intermittent stream feature within Construction Support Area 1 would be impacted while TVA uses this area. An application for a Section 404 of the Clean Water Act permit will be submitted after designs are constructed to minimize impacts such as a culvert, bridge, or other engineered measures. TVA would meet all state and federal wetland permit requirements, including the most recent guidelines published for Section 404 of the Clean Water Act. After completion of the project, TVA would restore and revegetate the area and reestablish the area's current use for natural resource conservation.

3.8 THREATENED AND ENDANGERED SPECIES

This section describes the special-status species at the Boone Dam project and potential impacts on these species associated with the No Action Alternative and the Proposed Action.

3.8.1 Affected Environment

TVA biologists and natural resource specialists used the TVA Natural Heritage database to assess the threatened and endangered species throughout the project area, which includes the

proposed construction areas, existing and proposed public recreation areas, soil storage location(s), and the Boone Reservoir and tailwater. The TVA Natural Heritage database was created to ensure that environmental compliance activities are conducted in a consistent manner across the TVA region and that these activities meet the requirements of NEPA and the Endangered Species Act (ESA). Database searches were based on the following criteria: (1) proximity to Boone Reservoir and Dam; (2) presence/absence; (3) element occurrence rank values; and (4) species or type of element present. Specific to proximity, plants were assessed within a 5-mile radius, aquatic species within 10 miles, and terrestrial species within 3 miles.

Plants

Field surveys and reviews of the TVA Natural Heritage database indicate the occurrence of seven state protected plant species within a 5-mile radius of Boone Reservoir and Dam (TVA 2015b). These species are presented in Table 3-11. No federally protected plant species are known to occur within this proximity.

Table 3-11: State or Federally Protected Plant Species Documented within 5 Miles of Boone Dam and Reservoir

Common Name	Scientific Name	Federal Status	State Status	State Rank
American barberry *	*Berberis canadensis*	--	SPCO	S2
American Fly-honeysuckle	*Lonicera canadensis*	--	LT	S1
Branching whitlow-grass	*Draba ramosissima*	--	SPCO	S2
Butternut	*Juglans cinerea*	--	LT	S3
Carolina pink	*Silene caroliniana ssp. pensylvanica*	--	LT	S1S2
Northern white cedar	*Thuja occidentalis*	--	SPCO	S3
Piratebush **	*Buckleya distichophylla*	--	LT	S2

Notes:
S2 – Very rare and imperiled within the state, 6 to 20 occurrences, some factor(s) making it vulnerable to extinction.
S3 – rare or uncommon in the state, from 21 to 100 occurrences.
S4 – Widespread, abundant, and apparently secure within the state, but with cause for long-term concern.
LE - Listed Endangered; LT - Listed Threatened
* - Historical record; last documented in 1934
** - Historical record; last documented in 1949

Two of these species, the American bayberry (*Berberis canadensis*) and piratebush (*Buckleya distichophylla*), are historic records dating back to before Boone Dam was constructed (TVA 2015b). American bayberry grows best on rocky slopes and was last observed by TVA in 1934 on a bluff near the Highway 37 Bridge crossing in the upper South Holston arm of the reservoir. Piratebush also prefers rocky slope habitats and was last recorded by TVA in 1949 on a bluff overlooking the Watauga River about three miles upstream from the confluence with the South Fork Holston River.

More recent records include three state-threatened species: Carolina pink (*Silene caroliniana ssp. pensylvanica*), American fly-honeysuckle (*Lonicera canadensis*), and butternut (*Juglans*

cinerea); as well as two species of special concern, northern white cedar (*Thuja occidentalis*) and branching whitlow grass (*Draba ramosissima*). These species are most often associated with rocky habitats or along wooded slopes, with all but butternut recorded at multiple locations within 5 miles of the reservoir (TVA 2015b).

Aquatic Animals

Field surveys and reviews of the TVA Natural Heritage database indicated that three state-listed aquatic species, the longhead darter (*Percina macrocephala*), tangerine darter (*Percina aurantiaca*), and Tennessee dace (*Chrosomus tennesseensis*), have been recorded near, but not within, Boone Reservoir. The longhead darter typically occurs in small- to medium-sized rivers with bedrock and boulder substrates (Etnier and Starnes 1993). The nearest record for this species is in the Doe River, several miles upstream of Boone Reservoir. Past TVA monitoring has extended to Watauga Flats Island (RM 15.1) on the Watauga River. This is considered the extreme headwater of the reservoir along the Watauga River. No longhead darters have been recorded by TVA at or downstream from this reach (TVA 2010).

The tangerine darter typically occurs in clearer portions of large- to moderate-sized headwater tributaries of the Tennessee River (Etnier and Starnes 1993), such as the Watauga River. One record is known from the Watauga River, upstream of Boone Reservoir. However, this record is historical, and the species has not been documented in this stretch of river in over 100 years (TVA 2010).

The Tennessee dace is restricted to small (6 feet wide or less) low-gradient streams. Several records are known from small tributaries to Boone Reservoir. The Tennessee dace potentially could occur on headwater parcels with small streams (TVA 2010).

Terrestrial Animals

Field surveys and reviews of the TVA Natural Heritage database indicated that one federally endangered species, one state threatened species, and two rare species identified by TDEC as in need of management occur within 3 miles of Boone Reservoir. These species are presented in bold font in Table 3-12. Additionally, there are five species that have not been documented by TVA but could possibly exist in the Boone Unit, including the federally listed Indiana bat and northern long-eared bat.

Table 3-12: Terrestrial Animal Species Potentially Occurring at Boone Dam and Reservoir

Common Name	Scientific Name	Federal Status	State Status	State Rank
Bald eagle	***Haliaeetus leucocephalus***	**--**	**In need of management**	**S3**
Barn owl	***Tyto alba***	**--**	**In need of management**	**S3**
Common raven	***Corvus corax***	**--**	**Threatened**	**S2**
Gray bat	***Myotis grisescens***	**LE**	**Endangered**	**S2**
Indiana bat	*Myotis sodalis*	LE	Endangered	S1

Table 3-12: Terrestrial Animal Species Potentially Occurring at Boone Dam and Reservoir

Common Name	Scientific Name	Federal Status	State Status	State Rank
Northern long-eared bat	*Myotis septentrionalis*	LT	No management status	S1S2
Least weasel	*Mustela nivalis*	--	No management status	S2
Southern bog lemming	*Synaptomys cooperi*	--	In need of management	S4
Southeastern shrew	*Sore longirostris*	--	In need of management	S4

Notes:
Bold font denotes that the species has been documented by TVA within 3 miles of Boone Reservoir
S1 – Extremely rare and critically imperiled in the state with five or fewer occurrences
S2 – Very rare and imperiled within the state, 6 to 20 occurrences, some factor(s) making it vulnerable to extinction.
S3 – rare or uncommon in the state, from 21 to 100 occurrences.
S4 – Widespread, abundant, and apparently secure within the state, but with cause for long-term concern.
LE - Listed Endangered; LT - Listed Threatened

Following are brief descriptions of these animals with respect to their distribution and behavioral ties to Boone Reservoir and tailwater.

Bald Eagle

The bald eagle is one of the largest raptors in North America. Until recently, the species was protected under the ESA but was removed from the list in 2007 due to increasing populations nationwide. The species is still protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

Bald eagles typically nest in forested areas adjacent to large bodies of water. The species is an opportunistic forager known to predate on a variety of mammalian, avian, and reptilian species but fish tends to a favorite food item. The bald eagle has a range of foraging methods that include predation, scavenging (carrion), and pirating (stealing) food captured from other raptors such as osprey (Buehler 2010).

TVA observed a solitary bald eagle in flight at the upper reaches of Boone Reservoir (South Holston Arm) near the Enterprise Road Bridge crossing during August 2015. A nest was not observed.

Barn Owl

The barn owl is one of the world's most widespread birds and is seemingly ubiquitous year-round throughout North America (Elphick and Dunning 2002). However, populations of this species are declining in the eastern U.S. More than a dozen states, including Tennessee, have assigned this species to some level of conservation status in recent years (Dunn and Adler 2011). The owl tends to prefer open farmland for foraging and often is found nesting in barns or other remote structures. The occurrence of this species around Boone Reservoir likely is

associated with farmland within the Boone Reservoir watershed. Foraging habitat for this species also exists in the two proposed Construction Support Areas.

Common Raven

The common raven is known to occur in only 11 counties in eastern Tennessee, including Washington County, which borders Boone Reservoir to the south (TDEC 2015a). Populations of this species declined dramatically during the 19th and early 20th centuries due to a range of factors that included habitat loss, shooting, and poisoning. The species prefers hilly or mountainous areas, especially near cliffs. Ravens typically are found nesting on cliff ledges or in coniferous trees (Dunn and Adler 2011). Suitable nesting habitat for this species exists around Boone Reservoir on cliffs.

Gray Bat

The gray bat is widely distributed throughout cave systems of the southeastern United States; however, 90 percent of their known population occurs in fewer than a dozen cave systems. One known gray bat maternity cave is located approximately 0.5 mile from Boone Reservoir. No caves occupied by gray bats are known along Boone Reservoir (TVA 2010). However, 16 caves have been documented within three miles of Boone Reservoir, eleven of which are along, or immediately adjacent to the Reservoir.

Gray bats are insectivores and forage primarily over water and along lake and reservoir shorelines. Banding studies have indicated that gray bats prefer summer caves that have a feeding area (river or other reservoir of water) within 2 kilometers distance, although they have been known to fly as far as 12 miles from their colony to feed (Kentucky Bat Working Group 1990). Suitable foraging habitat for this species exists over Boone Reservoir.

Female gray bats give birth to a single offspring each year, during late May or early June (USFWS 2015). These offspring are weaned at 2 months old (Harriman and Shefferly 2003).

Indiana Bat

Indiana bats occupy caves during winter. During summer, they use areas of mature deciduous forest that have open mid-stories with an abundance of trees with exfoliating (i.e., loose or peeling) bark. Suitable roost trees include dead trees of several species and live trees such as shagbark hickory and white oak. The greatest threats to Indiana bats posed by forestry activities are disturbance of hibernating colonies in caves and destruction of summer roosting and foraging habitat (Hammond and Sweeney 1997). No winter hibernacula for Indiana bat are known near Boone Reservoir or within Washington or Sullivan Counties. However, potentially suitable summer roosting habitat for Indiana bat was identified alongside the right-of-way in the proposed Construction Support Area 2 and the proposed expansion of the Construction Zone. This habitat was identified as such due to the high number of suitable mature white oak and shagbark hickory trees, relatively open forest understory, and solar exposure.

Least Weasel

The least weasel is the smallest carnivore in North America and can be found in the middle and eastern regions of Tennessee. Least weasels can occur in a variety of habitats, ranging from

grasslands and brushy fields to marshy areas and other edge habitats. However, this species seems to prefer woodlands with rocky slopes. Least weasels occupy and build nests of grass, in old mole burrows or other holes in the ground (TWRA 2015b).

Least weasels most commonly prey on mice and other small mammals but also will forage on insects, lizards, and birds and their eggs (TWRA 2015b). Breeding typically occurs from spring through fall, with females capable of having two or more litters per year. Juvenile least weasels are considered weaned by 6 weeks of age. Suitable habitat for this species is present near Boone Reservoir and within the project construction areas.

Northern Long-Eared Bat

Northern long-eared bats spend the summer months in forested areas. They are acrobatic fliers and can fly and forage under the forest canopy and in relatively dense vegetative clutter. Maternity colonies of this species usually occur under sloughing bark of trees (Lacki and Schwierjohann 2001), although some use of bat boxes and human made structures like shutters have been documented (Broders and Forbes 2004). Little is known about northern long-eared bat hibernation. Though they do occur in caves during winter, they are rarely found in high numbers and are also believed to hibernate outside of caves and mines. Potentially suitable summer roosting habitat for northern long-eared bats was identified alongside the right-of-way in the proposed Construction Support Area 2 and the proposed expansion of the Construction Zone. This habitat was identified as such due to the high number of suitable mature white oak and shagbark hickory trees, relatively open forest understory, and solar exposure.

Southern Bog Lemming

The southern bog lemming occurs statewide; however, they are uncommon. Both the TWRA and TDEC consider them “in need of management.” This species can be found in lowland areas of moist, grassy fields or meadows, in swamps with thick vegetation, bogs, and damp woods (TWRA 2015c). The Southern bog lemming is known to forage on vegetation, fungi, and invertebrates (TWRA 2015c). The species typically breeds in spring and fall, although, it is capable of breeding any time of year. Nesting, feeding, resting, and food storage occurs within a system of underground tunnels. Suitable habitat for this species does not exist within the proposed construction areas but may occur along the reservoir shoreline in wetlands.

Southeastern Shrew

The southeastern shrew is distributed statewide; however they are uncommon. Both the TWRA and TDEC consider them “in need of management.” The species is an underground burrower that can be found in a variety of habitats, including bogs, marshes, swampy areas, areas of dense groundcover, and in wooded areas. They are mostly insectivores with much of their diet consisting of spiders, butterfly and moth larvae, slugs and snails, centipedes, and some vegetable matter (TWRA 2015d). The southeastern shrew breeds in mid spring (March) and sometimes again during summer. Females build nests made of leaf litter under decaying logs or inside the log (TWRA 2015d).

3.8.2 Environmental Consequences

3.8.2.1 No Action Alternative

Plants
The No Action Alternative is not expected to negatively affect federally or state-protected plants, since the prime habitat for these species, bluffs and wooded side slopes, will not be diminished as a result of the drawdown.

Aquatic Animals
The No Action Alternative is not expected to affect federally or state-protected aquatic fauna, as no protected aquatic species are known to occur within Boone Reservoir or its tailwater.

Terrestrial Animals
The No Action Alternative is not expected to affect the bald eagle, common barn owl, common raven, and least weasel. No suitable nesting habitat for bald eagle, common barn owl, or common raven would be impacted by the No Action Alternative. Any potential foraging habitat for these birds would remain undisturbed. Lower water levels allowing for vegetative growth around the water's edge and exposure of rocks may create additional habitat for least weasel. Some habitat for southern bog lemming and southeastern shrew would be removed as wetlands around the existing reservoir would no longer receive periodic flooding and would eventually dry out. Loss of this small amount of habitat is not expected to impact populations of these species however. This alternative is not expected to affect populations of southern bog lemming or southeastern shrew.

The reservoir drawdown has exposed five cliff-side cave openings that previously were submerged (see Photo 3-2). These cave openings are relatively common along the steep rocky shoreline along some areas of Boone Reservoir, with many becoming seasonally exposed every winter during the normal winter pool level under Normal Operations. Under the No Action Alternative, these caves would persist above water indefinitely and possibly may provide suitable roosting and/or hibernation refuge for gray bats, Indiana bats, and northern long-eared bats. Suitable summer roosting habitat for Indiana bat and northern long-eared bat would not be impacted by the no action alternative.

Photo 3-2: Exposed Cave Opening below the Typical Summer Pool Level

3.8.2.2 Proposed Action

Plants

The Proposed Action is not expected to negatively affect federally or state-protected plants. All known records of these species occur beyond the proposed construction areas. Also, the extended drawdown is not expected to diminish or significantly alter the prime habitat for these species, which includes bluffs and wooded side slopes.

Aquatic Animals

The Proposed Action is not expected to affect federally or state-protected aquatic fauna, as no protected aquatic species are known to occur within Boone Reservoir or its tailwater.

Terrestrial Animals

The Proposed Action is not expected to affect bald eagle, common barn owl, common raven, least weasel, southern bog lemming, and southeastern shrew. It is possible that lower fish densities in the reservoir during the first 1 to 2 years following refilling might reduce foraging success of bald eagles on fish, but eagles are opportunistic feeders that commonly predate or scavenge from terrestrial sources. As a result of the drawdown, exposure of rock, and drying of shoreline wetlands, least weasel, southern bog lemming, and southeastern shrews may migrate to lower elevations to the exposed rocky habitat (least weasel) or wet habitats along the existing shoreline (southern bog lemmings and southeastern shrews). These species would be displaced when reservoir levels return in 5 to 7 years. However this is not expected to impact populations of these species.

The reservoir drawdown has exposed a number of cliff-side cave openings that previously were submerged. These cave openings are relatively common along the steep rocky shoreline areas that occur at locations around Boone Reservoir, with many becoming seasonally exposed every winter during the lower headwater elevations targeted under a normal operating schedule. Under the Proposed Action, these caves would persist above water for the 5- to 7-year project duration, before being inundated following the dam remediation. Gray bats, Indiana bats, and northern long-eared bats each have very specific cave requirements, and it is unknown whether these exposed caves would satisfy any of those criteria. However, any bats that colonized these caves during the Interim Operations period would have ample time to displace as the reservoir filling process occurs very gradually over the course of weeks and months, after the completion of the project. Two exceptions would be non-volant (non-flying) juvenile gray bats and bats of all three species in torpor that are not fully awake or aware of their surroundings during winter. Gray bats give birth during late May or early June and are non-volant for approximately one month following birth. All three of these species of bat can be in torpor from November to March. TVA will monitor these caves periodically to determine if listed bat species utilize these caves and will consult with USFWS under Section 7 of the Endangered Species Act should listed bat species be observed.

Suitable summer roosting habitat for Indiana bat and northern long-eared bat was observed within the proposed Construction Support Area 2 and the proposed expansion of the Construction Zone. In early 2015, suitable habitat was also observed within the current Construction Zone and is not being impacted by ongoing activities. TVA has marked the suitable summer roosting habitat in these areas and would avoid any impacts to those trees. Therefore, there would be no impacts to potential summer roosting habitat for Indiana bat or northern long-eared bat in association with the proposed actions.

3.9 HISTORIC AND CULTURAL RESOURCES

3.9.1 Affected Environment

Cultural resources include prehistoric and historic archaeological sites, districts, buildings, structures, and objects, as well as locations of important historic events that lack material evidence of those events. Cultural resources that are listed, or considered eligible for listing, on the National Register of Historic Places (NRHP) are called historic properties. Cultural resources become historic properties when they possess both integrity and significance. A historic property's integrity is based on its location, design, setting, materials, workmanship, feeling, and association. The significance is established when historic properties meet at least one of the following criteria: (a) are associated with important historical events or are associated with the lives of significant historic persons; (b) embody distinctive characteristics of a type, period, or method of construction; (c) represent the work of a master, or have high artistic value; or (d) have yielded or may yield information important in history or prehistory.

Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies to consider the effects of their proposed undertakings on historic properties and provide the Advisory Council on Historic Preservation an opportunity to comment on those effects. TVA

determined that the proposed action is an undertaking for purposes of Section 106 compliance. Further, 36 CFR Part 800.3(a) requires agencies to consider whether the proposed undertaking is a type of activity that has the potential to cause effects on historic properties. If the undertaking is such an activity, then the agency must follow steps outlined in 36 CFR Part 800.4 through 800.13. These steps can be summarized as (1) involving the appropriate consulting parties; (2) defining the area of potential effects (APE); (3) identifying historic properties in the APE; (4) evaluating possible effects of the undertaking on historic properties in the APE; and (5) resolving adverse effects. At 36 CFR Part 800.16, APE is defined as the "geographic area or areas within which the undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist."

Different types of undertakings can have different types of effects. TVA anticipates the undertaking could have both direct physical effects and indirect visual effects to historic properties. TVA defined the APE to be the Current Construction Zone (43.6 acres); the Proposed Expansion of Construction Zone (19.1 Acres); the proposed Construction Support Area 1 (71.2 Acres); the proposed Construction Support Area 2 (12.8 Acres); those areas with a direct line of site within a ½-mile radius of the aforementioned construction areas; and the current reservoir "drawdown zone" between 1,382 feet (summer pool elevation) and 1,350 feet (extended drawdown elevation) (Figure 1-6).

Archaeological Sites

TVA has completed an archaeological inventory of the construction areas and identified no archaeological sites (Pietak and Holland 1998; Wampler 2015; Wells 2015a, 2015b). The 1/2-mile visual radius surrounding the construction areas did not warrant an archaeological survey since visually adverse effects to archaeological sites are not anticipated. Multiple archaeological surveys have been conducted within the current reservoir "drawdown zone" (Pietak and Holland 1998; Watkins 2014; S.D. Dean personal communication, 2014). The Pietak and Holland (1998) and Watkins (2014) surveys identified a total of 67 archaeological sites within the drawdown zone. Of those sites, TVA determined (in consultation with SHPO) that 31 are NRHP ineligible and 36 are potentially eligible. The Dean (2014) survey results will be documented as part of the PA. TVA estimates that 500 acres will require an archaeological survey to complete the inventory of the drawdown zone.

Historic Buildings and Structures

TVA conducted identification and evaluation efforts within the APE and identified one historic property named "The Boone Hydroelectric Project" (BHP) within the Current Construction Zone (Prybylski 2015). The Boone Hydroelectric Project is comprised of 10 contributing resources including the Boone Dam Hydroelectric Plant including the Powerhouse, Control Building, Visitors Overlook, Switch Yard, Water Storage Tank, Oil Purification/Storage Building, Recreation Area, and 2 Maintenance Buildings. As noted in Table 1-1, the dam's earthen embankment is being lowered by 10 feet to allow for initial exploratory grouting activities; because that portion of the embankment is not part of the original design of the dam, the alteration does not detract from the Boone Hydroelectric Project's historic integrity.

TVA identified 48 buildings within a ½-mile radius of the construction areas which are greater than 45 years of age. TVA determined that 42 buildings are not eligible for the NRHP, and the six remaining buildings may be eligible for the NRHP.

No historic buildings or structures were identified within the drawdown zone.

3.9.2 Environmental Consequences

Under both alternatives, due to the complexity of the undertaking, and pursuant to 36 CFR Part 800.14(b), TVA would execute a Programmatic Agreement (PA) with the Tennessee SHPO that stipulates how the anticipated adverse effects of the alternative would be resolved and establishes a process for phased identification, evaluation, and treatment of historic properties for unanticipated adverse effects.

3.9.2.1 No Action Alternative

Archaeological Sites

The No Action Alternative may adversely affect archaeological sites within the drawdown zone. Anticipated adverse effects include an increase in the frequency of artifact looting and the accelerated erosion of intact archaeological deposits and/or features. Over time, as the reservoir remains at the current levels indefinitely, looting and/or erosion may result in the total loss of some archaeological resources.

TVA would execute a PA pursuant to 36 CFR Part 800.14(b) allowing for phased identification and evaluation of archaeological sites within drawdown zone and stipulating a process for monitoring and mitigating adverse effects. TVA proposes to complete the archaeological inventory on the remaining approximately 500 acres of TVA land so that all sites in the APE can be identified. For all sites in the drawdown zone that TVA and SHPO agree are NRHP-eligible or potentially NRHP-eligible, under the No Action Alternative, TVA would implement the same avoidance measures as it would under the Proposed Action during the 5 to 7 year drawdown duration. TVA would:

- Increase TVA Police patrols on TVA land, with a focus on the NRHP-eligible and potentially eligible sites;
- Monitor eligible/potentially eligible archaeological sites on both TVA land and private property so that increases in looting frequency and/or accelerated erosion can be noted and appropriate actions can be taken; and
- Hydro-seed archaeological sites (for erosion control) where looting and/or erosion are found to be an adverse effect.

Since the TVA cannot feasibly prevent all instances of looting and erosion, the TVA would fund an academic institution's and/or Federally recognized Indian tribe's archaeological research at sites within the drawdown zone as the mitigation measure for this adverse effect.

Historic Buildings and Structures
The No Action Alternative is not expected to affect historic properties within the construction areas or within the ½-mile visual radius. TVA would determine whether it would be necessary to restore the height of the embankment (that is being lowered 10 feet for exploratory grouting); if deemed necessary, TVA would use in kind materials that would not detract from the dam's historic integrity.

3.9.2.2 Proposed Action

Archaeological Sites
The Proposed Action is not expected to affect archaeological sites within the construction areas due to the absence of NRHP-listed, eligible, or potentially eligible sites, or within the 1/2-mile visual radius because the visual parameters of archaeological sites are not normally considered when assessing their significance. During the 5 to 7 year drawdown, adverse effects may occur within the I-APE due to an increase in the frequency of artifact looting and the accelerated erosion of intact archaeological deposits and/or features, which could result in loss or harm to some resources. To address these effects, TVA would execute a PA with the SHPO pursuant to 36 CFR Part 800.14(b). Since the TVA cannot feasibly prevent all instances of looting and erosion, the TVA shall fund an academic institution's and/or Federally recognized Indian tribe's archaeological research at sites within the drawdown zone as the mitigation measure for this adverse effect.

TVA proposes to complete the archaeological inventory on the remaining ~500 acres of TVA land so that all sites in the APE can be identified. For all sites in the drawdown zone that TVA and SHPO agree are NRHP-eligible or potentially NRHP-eligible, TVA proposes to implement the following avoidance measures during the 5 to 7 year drawdown duration:

- Increase TVA Police patrols on TVA land, with a focus on the NRHP-eligible and potentially eligible sites;
- Monitor eligible/potentially eligible archaeological sites on both TVA land and private property so that increases in looting frequency and/or accelerated erosion can be noted and appropriate actions can be taken; and
- Hydro-seed archaeological sites (for erosion control) where looting and/or erosion are found to be an adverse effect.

TVA also proposes to establish a volunteer monitoring program to obtain assistance from members of the public in monitoring previously recorded archaeological sites around the reservoir, and to conduct outreach to the public and to property owners adjacent to the reservoir about laws protecting archaeological sites on TVA-owned and private property.

Historic Buildings and Structures
Within the construction areas, the undertaking will result in no visible change in the appearance of the dam and therefore will have no adverse effect. However, currently unforeseeable modifications to the undertaking may require immediate actions which preclude the steps

outlined in 36 CFR Part 800.4 through 800.13. Therefore, TVA will mitigate adverse effects to the "Boone Hydroelectric Project", including all ten contributing resources, by preparing documentation required for the HABS/Historic American Engineering Record (HAER) and submitting that documentation to the National Park Service. Although the crest of the earthen embankment that was lowered 10 feet would be restored after the seepage barrier is constructed, this alteration of the crest height would not be an adverse effect because that portion of the embankment is not original and thus, not historic.

The distance, topography, and vegetation of project activities will obstruct visual impacts of project activities to buildings which may be NRHP-eligible. Moreover the temporary nature of project activities will result in no permanent, adverse effects to these buildings. The Proposed Action is not expected to affect historic properties within the drawdown zone.

3.10 AIR QUALITY

This section provides an overview of the existing air quality at the proposed Boone Dam project site, and the potential impacts on air quality associated with the No Action Alternative and the Proposed Action.

3.10.1 Affected Environment

Air quality is measured by the concentration of various pollutants in the atmosphere, typically expressed in units of parts per million (ppm) or in units of micrograms per cubic meter (mg/m^3). Air quality is not only determined by the types and quantities of atmospheric pollutants but also by surface topography, size of the air basin, and prevailing meteorological conditions. Through its passage of the Clean Air Act of 1963 (CAA) and its amendments, Congress has mandated the protection and enhancement of our nation's air quality. The USEPA has established both primary and secondary National Ambient Air Quality Standards (NAAQS) for certain pollutants under the provisions of the CAA. Primary standards define levels of air quality necessary to protect public health with an adequate margin of safety. Secondary standards define levels of air quality necessary to protect the public welfare (i.e., soils, vegetation, and wildlife) from any known or anticipated adverse effects from a criteria air pollutant. NAAQS currently are established for six air pollutants (known as "criteria air pollutants"), including carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), and particulate matter equal to or less than 10 microns in aerodynamic diameter (PM_{10}). Although O_3 is considered a criteria air pollutant and is measurable in the atmosphere, it is not often considered as an air pollutant when calculating emissions because O_3 typically is not emitted directly from most emission sources. O_3 is formed in the atmosphere from its precursors, NO_2 and volatile organic compounds (VOCs), which are directly emitted from various emission sources. For this reason, NO_2 and VOCs are commonly reported in an air emissions inventory instead of O_3.

Regional Air Quality

The CAA requires each state to adopt regulatory requirements necessary to attain the NAAQS. The CAA also allows states to adopt air quality standards that are more stringent than the federal standards. The USEPA classifies the air quality within an air quality control region

(AQCR) according to whether or not the concentrations of criteria air pollutants in the atmosphere exceed primary or secondary NAAQS. All areas within each AQCR are assigned a designation of attainment or non-attainment for each criteria air pollutant. An attainment designation indicates that air quality within specific areas of an AQCR is as good as, or better than, NAAQS for individual criteria air pollutants or that the air quality is unclassified. Unclassified indicates that air quality within an area cannot be classified and therefore is treated as attainment. Non-attainment indicates that the concentration of an individual criteria air pollutant at a specific location exceeds primary or secondary NAAQS. Additionally, an AQCR may include locations such as national parks and wilderness areas, which are designated as Class I Areas. Such areas receive special protection under the CAA because of the importance of their air quality. Under these regulations, some national parks and wilderness areas are designated as Class I Areas and are specially protected. The nearest Class I Area is the Joyce Kilmer/Slickrock Wilderness, which is located approximately 50 miles southeast of the Boone Reservoir.

Tennessee also has state air quality standards. These standards were adopted by the state in 1985 as Section 68-25-105 Chapter 1200-3-3.01. Boone Reservoir is located in Washington and Sullivan Counties, Tennessee. Washington County is considered in attainment for NAAQS pollutants by the USEPA. Sullivan County is considered in non-attainment for lead and sulfur dioxide (USEPA 2015). The average emissions in these counties for 2011 are presented in Table 3-13.

Table 3-13: Average Emissions for Sullivan and Washington Counties (2011)

Pollutant	Emissions (tons per year) Sullivan County	Emissions (tons per year) Washington County
Carbon monoxide	37,716.02	19,255.55
Nitrogen oxides	16,011.86	3,817.42
PM_{10}	3,153.21	1,904.98
$PM_{2.5}$	1,364.87	512.63
Sulfur dioxide	22,227.51	85.90
Volatile organic compounds	17,197.51	8,332.66

Source: USEPA 2011

Regional Climate

Landforms and weather conditions determine the potential for the atmosphere to disperse emissions of air pollutants. The project site is located within the Ridge and Valley ecoregion of Tennessee, which occurs between the Blue Ridge Mountains and the Cumberland Plateau, and is a relatively low-lying area made up of roughly parallel ridges and valleys (Griffith et al. 1998). Landforms are mostly undulating valleys and rounded ridges and hills, with many caves and springs. The climate in the region of the project site is characterized by warm, humid summers with average temperatures around 75 degrees and cool winters with average temperatures around 35 degrees. Precipitation is highest from May through July (City-Data 2015).

Precipitation in nearby Bristol averages 41 inches per year (U.S. Climate Data 2015). Eastern Tennessee, including the area around the Town of Spurgeon, is vulnerable to tornados. Approximately 26 tornados occur, on average, throughout the state each year (NOAA 2013).

3.10.2 Environmental Consequences

3.10.2.1 No Action Alternative

Under the No Action Alternative, the proposed remediation at Boone Dam would not occur, reservoir water levels would be permanently left at Interim Operations Levels. Therefore, no project-related impacts on air quality would occur.

3.10.2.2 Proposed Action

Air quality impacts associated with the Proposed Action would occur from emissions in three areas during construction: the Construction Zone at the dam, along the transportation routes to the two proposed Construction Support Areas, and at the Construction Support Areas. Construction activities at the Construction Zone would create emissions from equipment and vehicles, personal vehicles, the fugitive dust mobilization associated with the remediation activities, and the on-site grout batch plant.

Within the Construction Zone, along the transportation routes to the proposed Construction Support Areas, and within the Construction Support Areas, fugitive emissions from vehicular traffic would consist mainly of particles that would be deposited near the roadways along the routes traversed. The proposed project would use construction equipment, trucks, and vehicles that would introduce a negligible amount of fossil fuel emissions into the environment.

The use of construction equipment would cause a minor temporary increase in pollutant emissions during construction. Combustion of gasoline and diesel fuels by internal combustion engines (haul trucks and off-road vehicles) would generate local emissions of PM, NO_2, CO, VOCs, and SO_2. The total amount of these emissions would be small and would result in negligible air quality impacts. The emissions associated with gasoline and diesel-powered vehicle and construction equipment are mandated by the USEPA to be mitigated and minimized (USEPA 2007); therefore, direct impacts on air quality associated with combustive engine emissions are expected to be minor.

The on-site grout batch plant would result in particulate matter air emissions resulting from grout production. Generally, two types of grouting equipment/infrastructure are utilized for grouting projects of this scale; either the construction contractor will utilize one or more small, mobile mixing units to mix and produce the grout, or the contractor will construct a larger, stationary batch plant for grout mixing and production. Based on similar seepage remediation projects that have occurred in the past by others, TVA anticipates that grout production will most likely be accomplished by utilizing small mobile mixing units for this project. Generally, small mobile mixing units are exempt from State of Tennessee air permitting requirements (TDEC Rule 1200-03-09-.04(4)(d)8) (TDEC 2015b) because they emit less than 0.1 pound per hour of particulate matter emissions. TVA will work with the construction contractor to provide specifications of the

mobile mixing units or a stationary batch plant operation and the associated emission levels. If the five ton per year limit is reached or a stationary concrete batch plant is required, the contractor will be responsible for obtaining the required State of Tennessee Minor Source Air permit. If all equipment and mixing plants emissions should exceed 100 tons of particulate matter an additional State of Tennessee Air permitting action may be required.

Dust particles emitted through activities at the Construction Zone, along the transportation routes to the proposed Construction Support Areas, and within the Construction Support Areas, would primarily be deposited very close to these areas and would not be expected to migrate outside of the close proximity to these areas. If necessary, dust and soils from construction areas, paved and unpaved roads would be mitigated using BMPs including wet suppression, sediment erosion controls, and other measures which would significantly reduce fugitive dust emissions. Therefore, direct impacts on air quality associated with dust and soils emissions are expected to be minor.

Air quality impacts from construction activities and transportation of materials to the proposed Construction Support Areas would be temporary and dependent on both man-made factors (e.g., the intensity of activity, control measures) and natural factors (e.g., wind speed, wind direction, soil moisture, localized landforms). However, even under unusually adverse conditions (i.e., thunderstorms, tornadoes, high wind events), these emissions would cause a minor and short-term impact on air quality and would not appreciably contribute to applicable ambient air quality standards. Overall, the direct air emissions impact of the Proposed Action would not be significant to local or regional air quality.

3.11 SOCIOECONOMICS

This section provides an overview of the existing social and economic conditions in the vicinity of Boone Reservoir and the potential effects that may occur under the No Action Alternative and the Proposed Action. Potential economic effects are both quantified and qualified. For effects that can be quantified both the direct economic impacts and the regional indirect impacts (sometimes referred to as “ripple effects”) on the economy are estimated, measured as changes in employment, income, and gross regional product. Many of the potential impacts are unique to each user (e.g., the change in the shoreline property owners’ enjoyment and use of their shorefront property) and not practicably quantified in which case the potential impact is qualified.

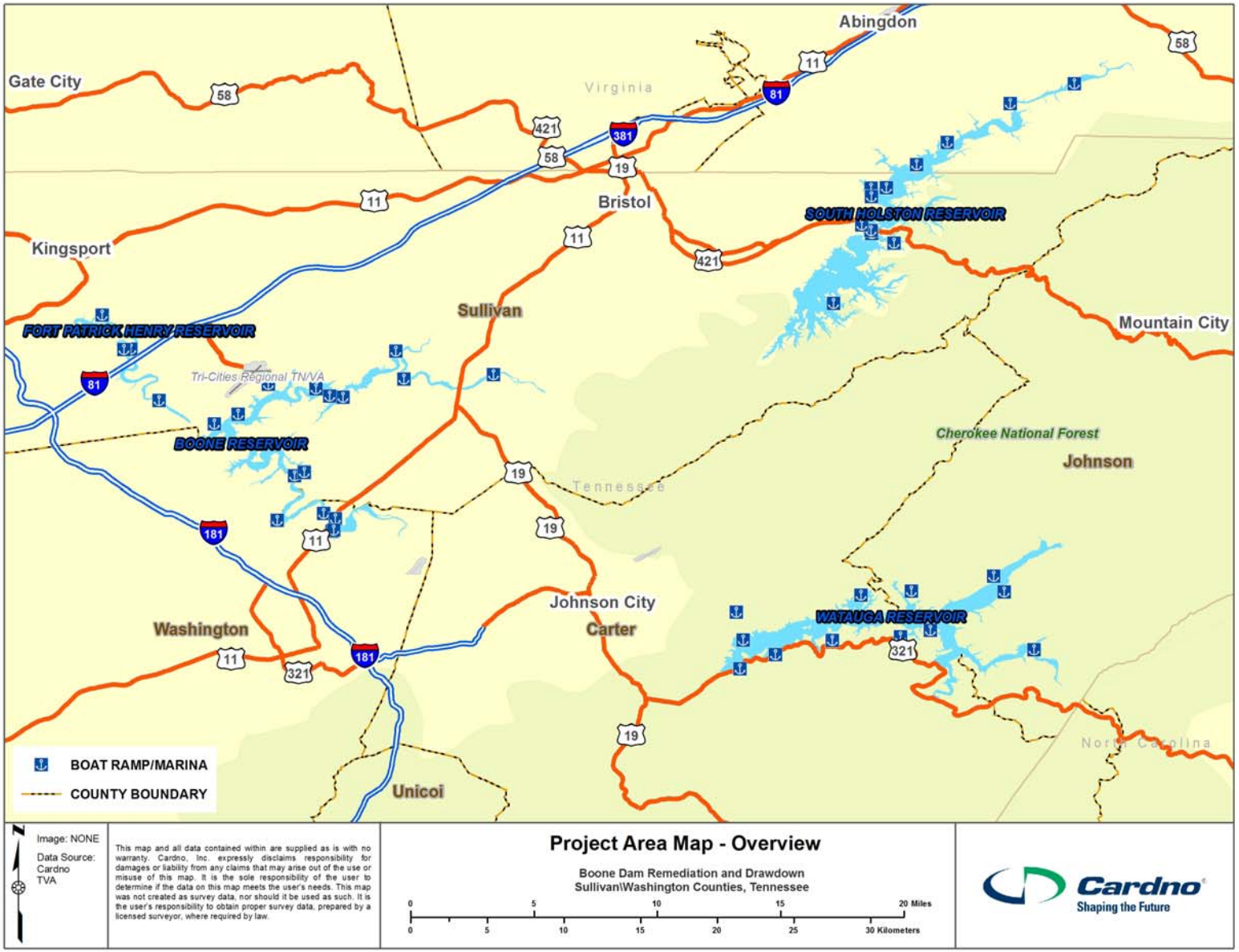
3.11.1 Affected Environment

This section provides an overview of the demographics of the analysis area as well as the existing conditions of the four categories of economic activity.

Overview

The geographic scope of the socioeconomics analysis area includes Sullivan and Washington Counties (Figure 3-11).

Figure 3-11: Socioeconomics Analysis Area – Sullivan and Washington Counties



Sullivan and Washington Counties are similar in population and density, and are two of the more populous counties in the state (Table 3-14). Out of a total of 95 counties in the state, Sullivan County is ranked 9th in population, and Washington County is ranked 11th in population. The total population estimate for the two-county analysis area is 279,802 people (Table 3-14). An estimated 156,823 of those people reside in Sullivan County (56 percent of the total analysis area) and 122,979 reside in Washington County (44 percent of the total analysis area).

Table 3-14: 2010 Population, Area, and Population Density in the Socioeconomics Analysis Area

Statistic	Tennessee	Sullivan County	Washington County	Total Analysis Area
Population	6,346,105	156,823	122,979	279,802
County rank (of 95 Counties)	N/A	9	11	N/A
Land area (square miles)	41,234.9	413.4	326.5	740.0
County rank (of 95 Counties)	N/A	56	69	N/A
Population density (per square mile)	153.9	379.4	376.7	378.1
County rank (of 95 Counties)	N/A	6	7	N/A

Source: U.S. Census Bureau 2015a.

While ranked relatively high in population, the two counties are relatively small in land area when compared to other counties in the state. Sullivan County is ranked 56th in land area, and Washington County is ranked 69th in land area. This makes the two counties more densely populated than the state average. Sullivan County is estimated to have 379.4 people per square mile and Washington County is estimated to have 376.7 people per square mile, compared to the state average of 153.9 people per square mile.

The median household income in both counties is slightly lower than the state median income (Table 3-15).The unemployment rates of both counties (5.9 percent) is nearly the same as the state rate (5.7 percent). Sullivan County's median income is $39,990, or 9.5 percent lower than state's median income of $43,697. Washington County's median income, higher than Sullivan County's at $41,361, is 5.3 percent lower than the state's median income.

Table 3-15: Income, Unemployment, and Employment in the Socioeconomics Analysis Area

Statistic	Tennessee	Sullivan County	Washington County
Median household Income, 2013 (1)	$43,697	$39,990	$41,361
Percent below poverty level, 2013 (2)	17.6%	18.4%	18.3%
Unemployment rate, August 2015 (2)	5.7%	5.9%	5.9%
Employment (full-time jobs), 2013	300,421	4,893	3,756

Sources:

(1) U.S. Census Bureau 2013 American Community Survey 5-year Estimates. 2015b

(2) Tennessee Department of Labor and Workforce Development 2015.

Table 3-16 shows the value of sales, shipments, receipts, revenue, or business (e.g., output) in 2012 dollars for the two-county analysis area compared to the state. Sullivan and Washington Counties comprise 2.0 percent and 1.0 percent of the state's value for all sectors, respectively.

Table 3-16: Value of Sales, Shipments, Receipts, Revenue, or Business for the Socioeconomics Analysis Area (2012 dollars [thousands])

Sector	NAICS Code (1)	Tennessee		Sullivan		Washington	
		2012	Percent of Regional Total	2012	Percent of Regional Total	2012	Percent of Regional Total
Utilities	22	Q		Q		Q	
Construction	23	$23,078.3	*4%*	$0	*0%*	$0	*0%*
Manufacturing	31-33	$139,960.5	*23%*	$6,361.4	*64%*	$1,503.7	*32%*
Wholesale Trade	42	$325,863.4	*54%*	$1,006.2	*10%*	$791.3	*17%*
Retail Trade	44-45	$91,641.6	*15%*	$2,222.7	*22%*	$2,011.5	*43%*
Real Estate and Rental and Leasing	53	$6,178.5	*1%*	$89.6	*1%*	$91.7	*2%*
Accommodation and food services	72	$12,499.0	*2%*	$286.4	*3%*	$278.5	*6%*
Regional Total	**NA**	**$599,221.2**	***100%***	**$9,966.2**	***100%***	**$4,676.9**	***100%***
Percent of State		***100%***		***2%***		***1%***	

Source: U.S. Census Bureau 2012

(1) The North American Industry Classification System is the standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy

The economic sectors most likely to be affected by the Boone Reservoir drawdown are the retail trade and accommodation and food services sectors. For both counties, those sectors comprise a larger percent of the total regional output when compared to the state total. Retail trade represents only 15.0 percent of the state's total output but accounts for 22.0 percent and 44.0 percent of the total output for Sullivan and Washington Counties, respectively. Where retail trade is ranked third as a percent of the state's total output, behind wholesale trade and manufacturing, it ranks first in Washington County and second in Sullivan County. Similarly, the accommodation and food services sector represents 2.0 percent of the state's total output but 3.0 percent and 6.0 percent of the total output for Sullivan and Washington Counties, respectively.

Recreation

The total annual direct economic impact of recreational users of Boone Reservoir (components of the Retail Trade and Accommodation and Food Services sectors listed in Table 3-16) is estimated to range between $484.4 and $771.7 thousand (Table 3-17). Direct economic impacts represent expenditures made by individuals recreating on and around Boone Reservoir.

The five main expenditure categories include lodging, food and beverages, transportation, boating, and other expenses. Estimates of the number of annual user days are described in Section 3.12 (Recreation). Estimates of the expenditure per person per user day are presented in Table 3-17.

Table 3-17: Estimate of Total Annual Direct Economic Impact from a Change in User Days under Normal Reservoir Operations (2015 dollars [thousands])

User Group	Annual User Days	Average Expenditure per Person per Day		Total Direct Economic Impact	
		Lower Bound	Upper Bound	Lower Bound	Upper bound
Out-of-area	27,913	$11.55	$21.59	$322.4	$609.7
Local/in-region and shoreline property owners	35,527	$4.56	$4.56	$162.0	$162.0
Total	**63,440**	**-**	**-**	**$484.4**	**$771.7**

Source: Murray, et.al. 2003; Schexnayder, et al. 2009a and 2009b; Stephens, Griffiin et al. 2007; Stephens, Didier et al. et.al, 2006a – 2006f.

For the purposes of estimating the economic contribution of Boone Reservoir, recreational users were split into the following user-group categories:

- "out-of-area" users who reside outside of the two-county area,
- "local" users who reside within Sullivan or Washington County
    - Local visitors to the area
    - Private users, or those who own shoreline property along the reservoir.

Categorizing users in this manner allows for the estimation and illustration of impacts on each user group, as well as the potential changes in recreation use patterns by these user groups that may result in different regional economic effects. For instance, users who reside outside of the two-county area are more likely to stay overnight and typically spend more money on trip-related items such as food, lodging, and transportation. Conversely, local users are more likely to make day trips and have lower overall trip-related expenditures.

Within the local user group, a subset of users who own private property along the shoreline of Boone reservoir will have additional annual recreation-related expenditures such as dock and boat maintenance, and private land fees.

Marina Businesses

Marinas offer important services to recreational users such as boat storage, launch ramps, fuel, maintenance, and boat sewage pumpout. In addition, they provide jobs throughout the region. Fifteen marinas are located within the two-county analysis area (Table 3-18). Seven of those marinas are located on Boone Reservoir. The remainder of the marinas in the two-county area are located at FPH Reservoir (Figure 3-12) or South Holston Reservoir (Figure 3-13).

Table 3-18: Characteristics of Marinas within the Socioeconomics Analysis Area

Reservoir	County	Marina	Floating Houses / Non-Navigable Houseboats[1]	Amenities					
				Wet Slips[2]	Dry Slips / Boat Repair[2,3]	Boat Ramps[3,4]	Boat Fuel[3,4]	Restaurant / Snack Bar[3,4]	Boat Ramp Parking Spaces[2]
Boone	Sullivan	Boone Reservoir Marina	3	100	Boat Repair	Yes	Yes	Yes	15
		Davis Marina	7	24	0	Yes	Yes	Yes	30
		Lakeview Marina	10	110	Dry Slips/Boat Repair	Yes	Yes	Yes	30
	Washington	Jay's Dock	54	150	0	Yes	Yes	Yes	10
		Serenity Cove Marina	7	60	0	Yes	Yes	Yes	25
		Sonny's Lakeside Marina	0	152	Dry Slips/Boat Repair	Yes	Yes	Yes	50
		Rockingham Marina	0	250	Boat Repair	Yes	Yes	Yes	40
Fort Patrick Henry	Sullivan	Warrior's Path State Park Marina	0	54	0	Yes	NA	NA	
South Holston	Sullivan	Jacob's Creek Recreation Area	0	1	0	No	No	No	
		Little Oak Mountain Recreation Area	0	1	0	Yes	No	No	15
		Friendship Dock	15	170	Dry Slips	Yes	Yes	No	0
		Lake View Dock	6	300	0	No	Yes	No	
		Laurel Marina and Yacht Club, Inc.	54	433	0	Yes	Yes	Yes	
		Painter Creek Dock	35	300	0	Yes	Yes	Yes	20
		Sullivan County Park	0	1	0	Yes	No	No	79

Sources: [1] TVA 2015c; [2] TVA 2014; [3] McNutt 2015; [4] TVA 2015d

Figure 3-12: Boone and Fort Patrick Henry Reservoir Recreation Sites

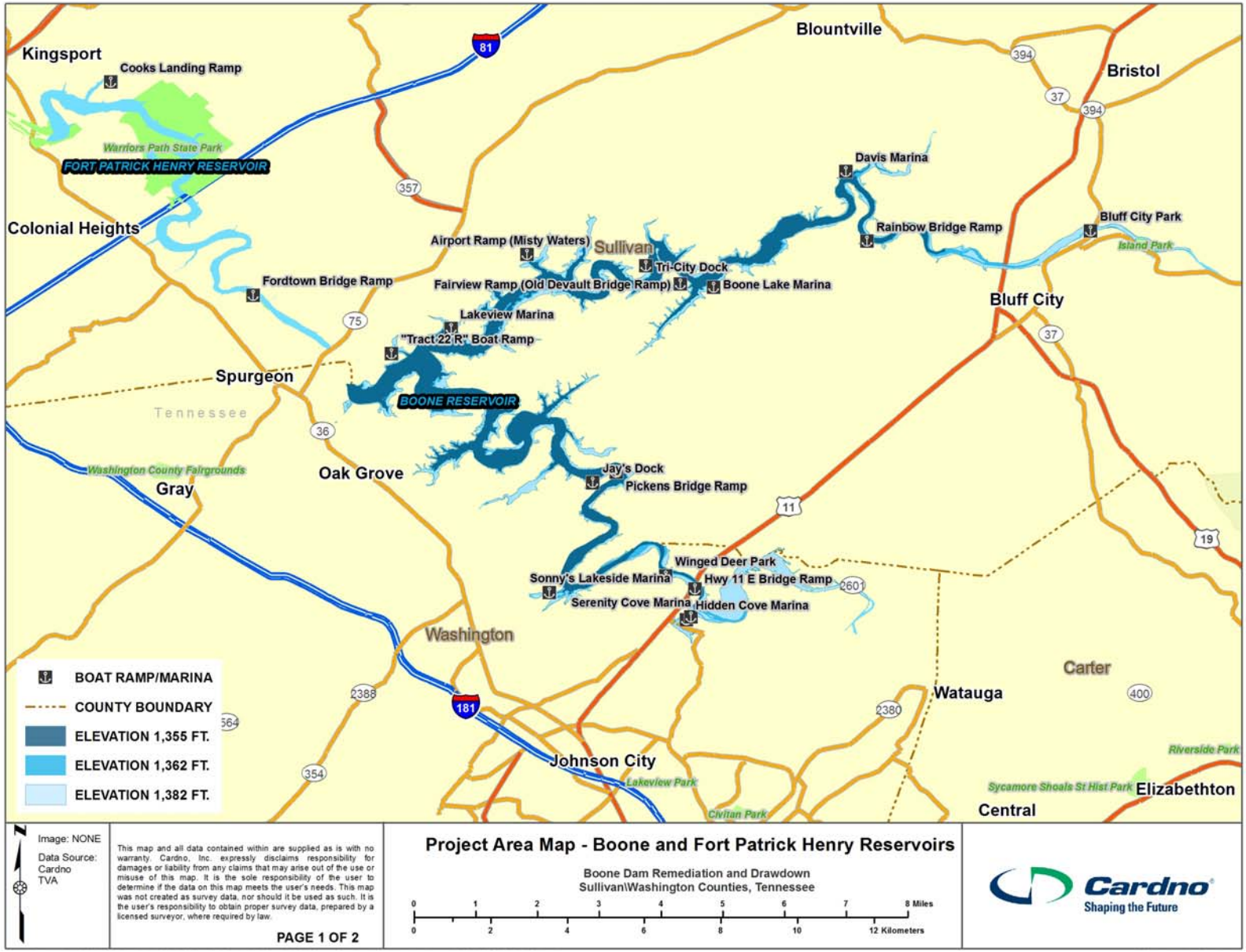
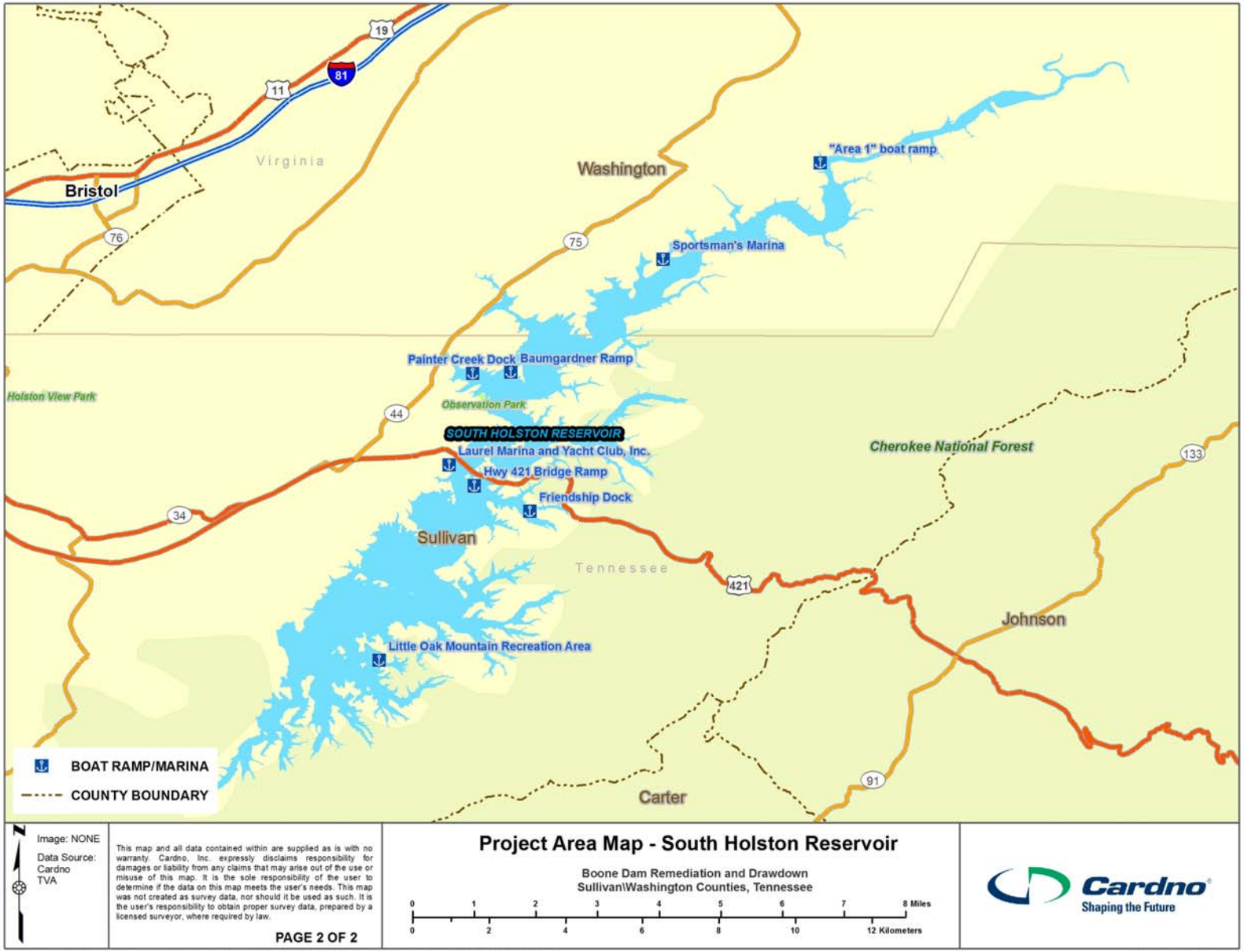


Figure 3-13: South Holston Reservoir Recreation Sites



The marinas located at FPH Reservoir and South Holston Reservoir offer a substitute location for recreation, which may lessen the economic impacts on recreation users under Interim Operations at Boone Reservoir and increase business at those reservoirs. However, the Boone Reservoir marina businesses are affected by the drawdown and as such are the focus of the following discussion.

Seven marinas operate along the shorelines of Boone Reservoir (Figure 3-12 and Table 3-18). In addition to traditional boating users, Boone Reservoir has an estimated 133 floating houses and nonnavigable houseboats (TVA 2015c). Many of these structures are moored within marina harbor limits. There are a total of 846 slip spaces on the water on the seven marinas and the marinas offer 200 total trailer parking spaces for users of their boat ramps. All of these amenities offer needed services for reservoir visitors. Slip rentals for boaters or floating houses/nonnavigable houseboat users and launch fees may also provide revenues for the marinas. Marinas also offer other services such as restaurants and general stores that can be used more generally by reservoir users and residents of the local community.

According to data from the 2012 U.S. Economic Census (U.S. Census Bureau 2012) and the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages (U.S. Bureau of Labor Statistics 2014), a marina in Tennessee employs an average of 8.3 people per year, pays out $172.8 thousand in total annual wages, and generates $734.7 thousand in revenue. Across the seven marinas on Boone Reservoir this represents a total of 57.9 employees, $1,210.0 thousand in wages, and $5,143.3 thousand in revenue per year.

In addition to marinas, other businesses surrounding the reservoir benefit from the scenic views or rely on the business of reservoir visitors. Retail businesses sell boating/fishing equipment to visitors using the reservoir, and local restaurants benefit from the influx of people in the area.

Property Values

Boone Reservoir is one of TVA's most densely developed reservoirs. Approximately 66 percent of the shoreline has been developed for residential use and another 16 percent is privately owned land that is available for development (TVA 2010). There are a total of 2,058 residential parcels surrounding the reservoir (Sullivan County GIS Tax Parcel Data, 2015 and Washington County GIS Tax Parcel Data, 2015) (see Table 3-19). Of these parcels 1,388 are developed or have at least one structure on them. The remaining 670 parcels are undeveloped, e.g. without buildings.

Table 3-19: Number and Value of Residential Properties on Boone Reservoir (2015 dollars)

County	Residential Parcels	Developed Residential Parcels	Undeveloped Residential Parcels	Average Sale Price Developed Residential Since 2010	Average Sale Price Undeveloped Residential Since 2010
Sullivan	1,327	807	520	$322,376	$141,245
Washington	731	581	150	$391,918	$209,433
Total	**2,058**	**1,388**	**670**	**$354,582**	**$158,292**

Source: Sullivan County GIS Tax Parcel Data 2015 and Washington County GIS Tax Parcel Data 2015.

Figure 3-14 shows the distribution of developed residential properties within the study area. The shaded areas on Figure 3-14 represent the average number of buildings per acre. The lower density areas are shaded yellow, representing relatively larger lots with fewer residential buildings (e.g. a 2-acre lot with one residential building would be shaded yellow). At the other end of the density spectrum, the areas shaded dark red represent relatively smaller lots for each residential building (e.g. between approximately 5 residences and 14 residences per acre). Figure 3-14 demonstrates the following:

- The developed residential shoreline (66 percent of the total shoreline) is not contiguous, rather it is located throughout the reservoir's shoreline.
- The majority of residential development is lower density
- Pockets of higher density development are located throughout the reservoir's shoreline.

The information presented in Figure 3-14 will be shown in greater detail in Environmental Consequences section below.

The property values on these parcels vary depending on a variety of factors. For example, the parcel's location on Boone Reservoir and its proximity to the water contributes to its value. Prices for parcels in sloughs or coves, with shallower water and less water access during winter months when the reservoir is drawn down even under Normal Operations, are generally lower than parcels that are located in deep-water on the main reservoir channel and that have water access year-round (Steuer 2015).

Between 2010 and 2015 the average sales price of developed waterfront parcels on Boone Reservoir was $322,376[9] (131 sales) and $391,918 in Washington County (113 sales) (Table 3-19). Undeveloped residential parcels surrounding the reservoir sold for an average of $141,245 in Sullivan County (57 sales) and $209,433 in Washington County (19 sales) during the same time period. Applying these values to all residential reservoir-front parcels on Boone Reservoir yields a total property value of roughly $592.7 million. Prices were adjusted to 2015 dollars.

Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs federal agencies to identify and address, as appropriate, any instances where programs, policies, or activities may create disproportionately high adverse health or environmental effects on minority or low-income populations. TVA is not subject to this executive order, but takes it into account as a matter of policy.

The percentage of minority populations in the two counties are well below the state percentage. The percent of minorities residing in Sullivan and Washington Counties are 6.0 and 9.0 percent, respectively, both lower than the 23.0 percent of minority populations residing in the state (Table 3-20).

[9] The average was calculated using data from the Sullivan and Washington County Tax Assessor's data for parcels sold from 2010 to 2015, where 'class' was 'residential' and 'Bldgs' was greater than one and sales price was not equal to zero.

Figure 3-14: Location of Residential Parcels Surrounding Boone Reservoir

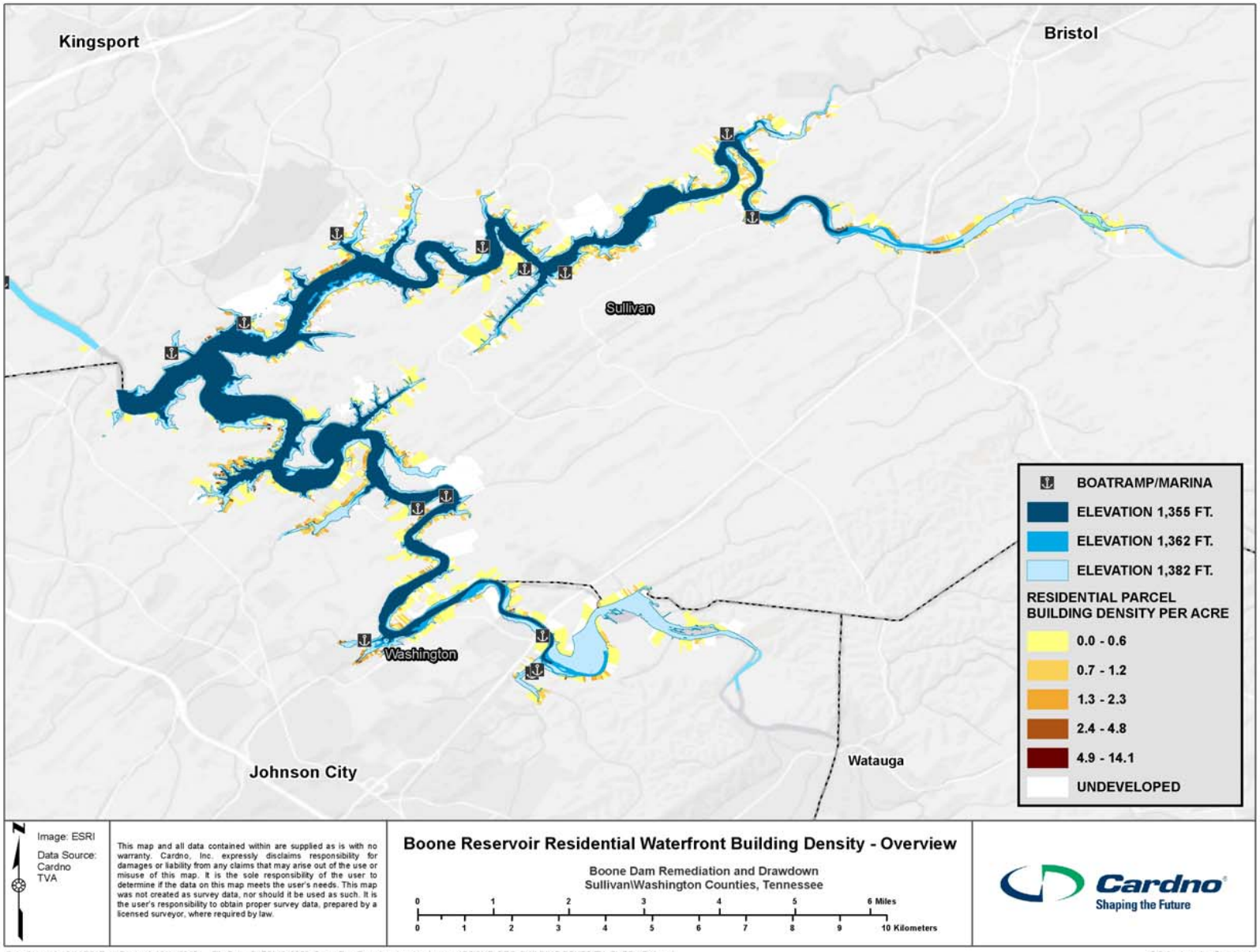


Table 3-20: Minority Population in the Environmental Justice Study Area (2013)

Geographic Region	Minority Percentage of Population
Tennessee	23%
Sullivan County	6%
Washington County	9%

Source: U.S. Census Bureau 2013

An estimated 18.3 percent of individuals in Sullivan and Washington Counties are living below the poverty line, slightly above the state percentage of 17.6 percent (Table 3-21).

Table 3-21: Low Income Percentage in the Environmental Justice Study Area (2013)

Geographic Region	Low Income Percentage of Population
Tennessee	17.6%
Sullivan County	18.3%
Washington County	18.3%

Source: U.S. Census Bureau 2013

3.11.2 Environmental Consequences

The estimated economic and social impacts of the No Action Alternative and the Proposed Action are summarized below and presented in detail in the sections that follow.

- Annual recreation spending under Interim Operations is estimated to decline between $870,000 to $1.8 million (Table 3-22). Under the No Action Alternative, these annual reductions in economic output would be permanent. Under the Proposed Action, these annual impacts persist throughout the 5- to 7-year dam remediation period, after which spending is estimated to return to normal. The two primary recreation impacts would be:
  - Decline in annual visitation of between 24 percent and 52 percent compared to estimated visitation under normal operations.
  - Reduction in property owners' spending on recreation-related items such as docks, boats and boat repair, etc. This reduction in property owners spending is somewhat offset by an increase in spending to adjust to the reduced pool elevation, including boat storage and maintenance of the exposed reservoir bottom.
- Shoreline property owners will be potentially impacted in two primary categories:
  - Property values. Under the No Action Alternative, if TVA took no action and the reservoir levels remained low indefinitely, property values are estimated to fall between 16.0 percent and 45.0 percent of 2015 values. Under the Proposed Action, property values are not expected to change appreciably. Despite the

significant impact on property owner's enjoyment and use of their shorefront (discussed in greater detail below), values are not expected to change. In general, a significant factor in the valuation of any property is uncertainty about the future condition of the property and/or the surrounding properties and neighborhood. Since TVA proposes to remediate the dam, any uncertainty about the future condition of the reservoir has been significantly reduced. If TVA were not taking prompt action to remediate the seepage issue and return to Normal Operations as quickly as possible, the uncertainty of the use of the shoreline would likely reduce property values. That is not to say that some owners selling their properties during the drawdown may receive offers for their property that are lower than would be offered during Normal Operations. However, in reviewing the real estate market around the reservoir, there are indications that the number of houses for sale is below seasonal averages, perhaps because owners do not want to sell during the remediation for fear of selling below market price under Normal Operations. The relatively low inventory of shoreline homes may be causing scarcity, keeping the prices near normal.

- Use and enjoyment of shoreline property. Undoubtedly shoreline property owners are facing 5 to 7 years of a significant reduction in the enjoyment of their shorefront property. The magnitude of the impact of the reservoir drawdown is unique to each property owner and is not quantifiable. For some homeowners, for example year-round residents in retirement, the impact may be more significant than, for example, some for whom the property is a second home in which they reside only part of the year.

- Marina businesses. Of the seven marinas on Boone Reservoir, only Rockingham Marina has maintained approximately the same surface water area as under Normal Operations. Three marinas—Davis Marina, Sonny's Lakeside Marina, and Serenity Cove Marina—have no marina surface water. The future of these marinas is highly uncertain. Furthermore, under the Proposed Action, the marina businesses may or may not return to pre-remediation operations. If marinas close, the ability to re-open will depend on several factors such as start-up capital.

- Construction industry. Under the No Action Alternative the construction spending on recreation access mitigation is estimated to contribute $1.1 million to the economy. Under the Proposed Action, the economic contribution of the dam remediation is estimated to be between $316.2 million and $474.3 million. See Table 3-22 below.

- Environmental justice communities. Within the two-county study area, the percent of low-income or minority population are similar to the percent of those communities in the state, so there are no environmental justice concerns.

Table 3-22: Estimated Annual Economic Output and Community Impacts of the Proposed Action and No Action Alternatives (all dollars in 2015)

Potential Impact	Unit of Measure	No Action	Proposed Action	
		Annual Impacts in Perpetuity	Annual Impacts during dam remediation	Post Dam Remediation
Recreational (annual dollars)	$ 000s	-$600.0 to -$1,800.0	-$600.0 to -$1,800.0	$0
Property Value	one-time % change from 2015	16% - 45%	0%	0%
Shoreline Property Owners Use of property (qualified)	Qualified	⊖	⊖	⊙
Marina Businesses (qualified)	Qualified	⊖	⊖	⊙ / ⊖
Construction on Dam Remediation	$ 000s	$1,117	$317,217 to $474,317	$0
Construction on Recreation Access Improvements	$ 000s	$1,117	$1,117	$0
Environmental Justice	$ 000s	$0	$0	$0

Source: Cardno.

⊖ Indicates a definitively negative impact to the user group that is unique to each user and not practicably quantified.

⊙ Indicates potential for a slight negative to neutral impact to the user group that is unique to each user and not practicably quantified.

For those estimated impacts that have been quantified, Table 3-23 summarizes the estimated change in jobs, labor income, output, and regional tax revenues, under the No Action Alternative and the Proposed Action. Under the No Action Alternative, the recreation sector is estimated to lose between 8 and 18 jobs, resulting in an estimated annual reduction in labor income between $300,000 and $600,000. Construction spending creates 7 jobs, but only in the short-term while construction is occurring to increase reservoir access. Under the No Action Alternative, property values are estimated to decline between $94.8 million (16.0 percent) and $264.9 million (44.7 percent) and regional annual tax revenues are estimated to decline between $31,400 and $98,400.

Under the Proposed Action, estimated economic losses in the recreation and marina sector occur only during the dam remediation (2016 to 2022) phase because recreation levels are assumed to return to normal after the dam is repaired and the reservoir water level returns to normal. The annual economic impact of spending in the construction industry is estimated to be between $50.7 million and $100.7 million, creating between 113 and 725 jobs and generating between $5.3 million and $33.9 million in labor income. Under the Proposed Action after the dam remediation construction period, 2022 and beyond, reservoir operations would return to Normal Operations, and the annual economic losses in the recreation and marina business

sectors would no longer occur, as business returns to pre-dam remediation levels. The regional economic gains in the construction sector would also no longer occur, as dam-remediation related construction concludes. Under the Proposed Action, property values are not expected to decrease appreciably.

Table 3-23: Summary of Annual Changes in Estimated Economic Impacts of the Proposed Action and No Action Alternative Compared to Normal Operations

Sectors	Jobs (Full-Time or Part-Time)		Labor Income ($ 000s)		Output ($ 000s)		Regional tax revenues ($ 000s)	
	Low	High	Low	High	Low	High	Low	High
No Action Alternative during Recreational Access Construction Phase								
Recreation and marina businesses	*(8.0)*	*(18.0)*	*($300.0)*	*($600.0)*	*($870.0)*	*($1,800.0)*	*($60.0)*	*($127.0)*
Dam remediation construction	0.0	0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Recreation access construction	7.0	7.0	$312.5	$312.5	$1,117.0	$1,117.0	$28.6	$28.6
Total	***(1.0)***	***(11.0)***	***$12.5***	***($287.5)***	***$247.0***	***($683.0)***	***($31.4)***	***($98.4)***
Proposed Action during Dam Remediation (2016-2022)								
Recreation and marina businesses	*(8.0)*	*(18.0)*	*($300.0)*	*($600.0)*	*($870.0)*	*($1,800.0)*	*($60.0)*	*($127.0)*
Dam remediation construction	113.0	725.0	$5,300.0	$33,900.0	$15,700.0	$100,700.0	$445.0	$2,900.0
Recreation access construction [(1)]	7.0	7.0	$312.5	$312.5	$1,117.0	$1,117.0	$28.6	$28.6
Total	**112.0**	**714.0**	**$5,613.5**	**$33,612.5**	**$15,947.0**	**$100,017.0**	**$468.6**	**$2,801.6**
Proposed Action after the Dam Remediation (beyond 2022)								
Recreation and marina businesses	0.0	0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Dam remediation construction	0.0	0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total	**0.0**	**0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**

[(1)] Construction on recreation access site development is estimated to be complete prior to 2022. *( )* = Negative.

3.11.2.1 No Action Alternative

Under the No Action Alternative, the reservoir levels would remain at the Interim Operations levels indefinitely. As a result, the output, labor income, and jobs supported by the recreation industry and marina business would be lower under the No Action Alternative compared to those same activities under Normal Operations. Additionally, property values would be lower than would be the case under Normal Operations.

Recreation

At a maximum, the total annual direct economic loss in the recreation and marina businesses sectors under the No Action Alternative is estimated to be between $158,300 and $397,200 annually, or between 21 and 52 percent lower than under Normal Operations (Table 3-24).

Table 3-24: Annual Estimate of Change in Recreational User Days and Direct Economic Impacts under the No Action Alternative Compared to Normal Operations

User Group	Normal Reservoir Operations		No Action				Difference between Normal Operations and No Action Alternative	
	Annual User Days	Direct Economic Impact [1]	Annual User Days [1]		Direct Economic Impact [2]		Direct Economic Impact [2]	
	(visitors)	($000s)	*Lower Bound* (visitors)	*Upper Bound* (visitors)	*Lower Bound* ($000s)	*Upper bound* ($000s)	*Lower Bound* ($000s)	*Upper bound* ($000s)
Out-of-area	27,913	$602.5	22,610	13,957	$488.0	$301.2	-$114.5	-$301.3
Shoreline property owners	9,237	$42.1	4,618	1,349	$21.1	$6.2	-$21.1	-$36.0
Subtotal	***37,150***	***$644.6***	***27,228***	***15,306***	***$509.1***	***$307.4***	***-$135.6***	***-$337.2***
Percent reduction from total normal reservoir operations							--21%	--52%
Local/in-region (not shoreline property owner)	26,289	$119.9	21,294	13,145	$97.1	$60.0	-$22.8	-$60.0
Total	**63,439**	**$764.5**	**48,522**	**28,451**	**$606.2**	**$367.3**	**-$158.4**	**-$397.2**
Percent reduction from normal reservoir operations							*-21%*	*-52%*

Notes:

[1] Different methods were used to estimate both an upper and lower bound change in annual user days to account for the uncertainty inherent in such estimates. Details about the methods are presented in the Section 3.12, Recreation that follows this section.

[2] Based on upper bound estimate of per person per day expenditures from Table 3-17

This impact in the region's recreation and marina business sector could be less, however, as it is possible that the amount spent by local or in-region users would remain in the two-county

analysis area, if recreational users continued to recreate at other local reservoirs, namely FPH and South Holston—both of which offer similar amenities. The extent to which this substitution occurred in the 2015 season is unknown. If Boone recreational users recreate at other local reservoirs, annual regional losses would consist only of the impacts on the out-of-area and shoreline property owner's users groups, between $135,500 and $337,200, or approximately 21 percent to 52 percent lower than under Normal Operations. See Section 3.12 (Recreation) for the estimate of the change in annual user days.

Marina Businesses

Under the No Action Alternative, Interim Operations continue indefinitely and impacts to Boone Reservoir marinas would be permanent. Under Interim Operations reservoir levels have dropped far enough on Boone Reservoir that most water based amenities at marinas can no longer be used and some marinas no longer have any access to water. Marinas that no longer have access to water would likely go out of business or be forced to relocate, if possible.

Although TVA is improving access in some areas, many boat ramps no longer extend to the water level, most wet slips and docks are not over water, and many fuel stations are no longer accessible from the water. Where boat ramps are no longer functional, the associated parking spaces are also no longer functional. All seven marinas at Boone Reservoir would be partially or fully affected by the lower water levels.

Table 3-25 presents estimates of the percent of functionality of each amenity at the Boone Reservoir marinas under the No Action Alternative in terms of both the physical constraints on the marinas and the expected reduction in visitation, presented in Section 3.12 (Recreation).

Table 3-25: Functionality of Boone Reservoir Marinas under the No Action Alternative (Percent Functional Compared to Normal Operations)

County	Marina	Approximate Marina Water Surface Area [1]	Amenities			
			Dry Slips and/or Boat Repair [1]	Boat Ramps [1]	Fuel [1]	Boat Ramp Parking Spaces [1]
Sullivan	Boone Reservoir Marina	38%	100%	0%*	0%	0%*
	Davis Marina	0%	N/A	0%*	N/A	0%*
	Lakeview Marina	23%	N/A	0%*	0%	0%
Washington	Jay's Dock	41%	N/A	0%*	0%**	0%
	Serenity Cove Marina	0%	N/A	0%	0%	0%
	Sonny's Lakeside Marina	0%	100%	0%	0%	0%
	Rockingham Marina	100%	100%	0%	100%	0%

Sources: [1] McNutt 2015; [2] Based on ranges of reduced visitation as presented in section 3.12, Recreation.
N/A = Amenity not provided. * = Marina plans to extend boat ramp. ** = Marina plans to relocate fuel station.

The Approximate Marina Water Surface Area represents the estimated surface acres occupied by the marina under Interim Operations relative to the surface acres occupied by the marina under Normal Operations (McNutt, 2015). The percent of remaining marina surface areas ranges between 0 percent (Davis Marina, Serenity Cover Marina and Sonny's Lakeside Marina) and 100 percent (Rockingham Marina). The average remaining surface are across all seven marinas is approximately 29 percent.

All marinas on the reservoir have lost the function of their boat ramps. Boone Lake Marina and Davis Marina have received permits to extend their ramps. Boat fueling stations also lost function at most marinas; however, Boone Lake Marina has a functional fueling station and Rockingham Marina has been able to restore the functionality of their fuel station. Davis Marina and Jay's Dock have expressed intentions of restoring their fueling facilities. Of the seven marinas, four (Boone Lake Marina, Davis Marina, Jay's Dock, and Rockingham Marina) have moved facilities to the new water line or are planning to extend their boat ramps. The three other marinas (Lakeview Marina, Serenity Cove Marina, and Sonny's Lakeside Marina) have either completely lost their water access or are now located too far from the water to readily relocate facilities.

Every marina has a restaurant/snack bar and a store. While there are no physical restrictions to impact the business of operating these restaurants and stores the reduced number of visitors likely would result in less business. The upper and lower bounds of the reduction in recreation user days presented in Section 3.12 (Recreation) is used to estimate average impact to marina restaurants and stores of between 46 percent and 79 percent.

Of the seven marinas on Boone Reservoir, four (Boone Lake Marina, Davis Marina, Jay's Dock, and Rockingham Marina) have moved facilities to the new water line or are planning to extend their boat ramps. The three other marinas (Lakeview Marina, Serenity Cove Marina, and Sonny's Lakeside Marina) have either completely lost their water access or are now located too far from the water to readily relocate facilities.

As discussed in Section 1.3, TVA has implemented several actions to address impacts on Boone Reservoir recreation sites. In the short term, the new beach/recreation area on TVA land adjacent to the Boone Dam reservation and the boat ramp projects at Pickens Bridge and north of Devault Bridge are expected to increase access and visitation to Boone Reservoir, which may increase marina business. The 26a permitting allowances will help reduce costs associated with marinas restoring functionality to amenities such as boat ramps and wet slips. In the long term, the Boone Pilot Marina Loans program described in Section 1.5 would help marinas absorb some of the additional costs associated with improving functionality and the loss in revenue associated with reduced visitation While these options may help Boone Reservoir marinas that are relatively close to the water line, other Boone Reservoir marinas would be too far from the water and, unless relocated, would not be able to remain in business under a permanent drawdown, representing a significant impact to these marinas.

As described further in Section 3.12 (Recreation), on a regional level, many of the lost visitor trips to Boone Reservoir would most likely stay in the study area by substituting to marinas at

South Holston Reservoir and FPH Reservoir. Because the marinas located at South Holston Reservoir and FPH Reservoir are not affected by the drawdown of Boone Reservoir, those marinas offer a substitute location for recreation. This substitution lowers the estimated regional economic impact on the marina industry as a whole, because decreased business on Boone Reservoir may result in increased business at marinas on South Holston and FPH.

Property Values

Under the No Action Alternative the drawdown of the reservoir would persist indefinitely. Parcels that have reservoir access under Normal Operations have their access impacted in various ways with lower water levels. Three general categories of impacts are shown in Figure 3-15 through Figure 3-20. The figures show parcel boundaries with an overlay of the reservoir levels at the normal summer pool elevation of 1,382 feet, the normal winter pool elevation of 1,362 feet, and the Interim Operations pool elevation of 1,355 feet. The three categories illustrated by the figures are Steep Slope Access (Figure 3-15 and Photo 3-3), Gradual Slope Access (Figure 3-16 and Photo 3-4), and No Access (Figure 3-17 and Photo 3-5).

Steep Slope Access (Figure 3-15)

For parcels with a relatively steep drawdown zone, the change in pool elevation makes little change in horizontal distance to the water. In other words, the reservoir is lower, and the exposed band of reservoir bottom is narrow. For these parcels, the impact of the reservoir drawdown may be low (see the light blue line in Figure 3-15). For many of these properties, however, water-access is more difficult than would be the case under normal summer pool levels (see Photo 3-3), even though the reservoir is still in contact with the parcel boundary.

Gradual Slope Access (Figure 3-16)

For parcels with moderately steep drawdown zone, the change in pool elevation makes more of a change in horizontal distance to the water and the exposed band of reservoir bottom is wider, although the edge of the reservoir is still in proximity or in contact with the property. Existing water-access features such as docks are out of the water. Property owners may choose to invest in extending or replacing docks to access the reservoir, depending on practicability.

No Access (Figure 3-17)

For parcels with a much flatter drawdown zone, the change in pool elevation makes a considerable change in horizontal distance to the water. The exposed band of reservoir bottom is much wider and the edge of the reservoir is not in proximity or in contact with the property. This results primarily for parcels located on sloughs or coves, with gently sloping drawdown zones and where there are extensive flats. The reservoir drawdown results in the reservoir receding away from the property and direct reservoir access is not possible, even with a dock extension. In this case the property may no longer be considered shorefront.

Figure 3-15: Steep Slope Access Parcels

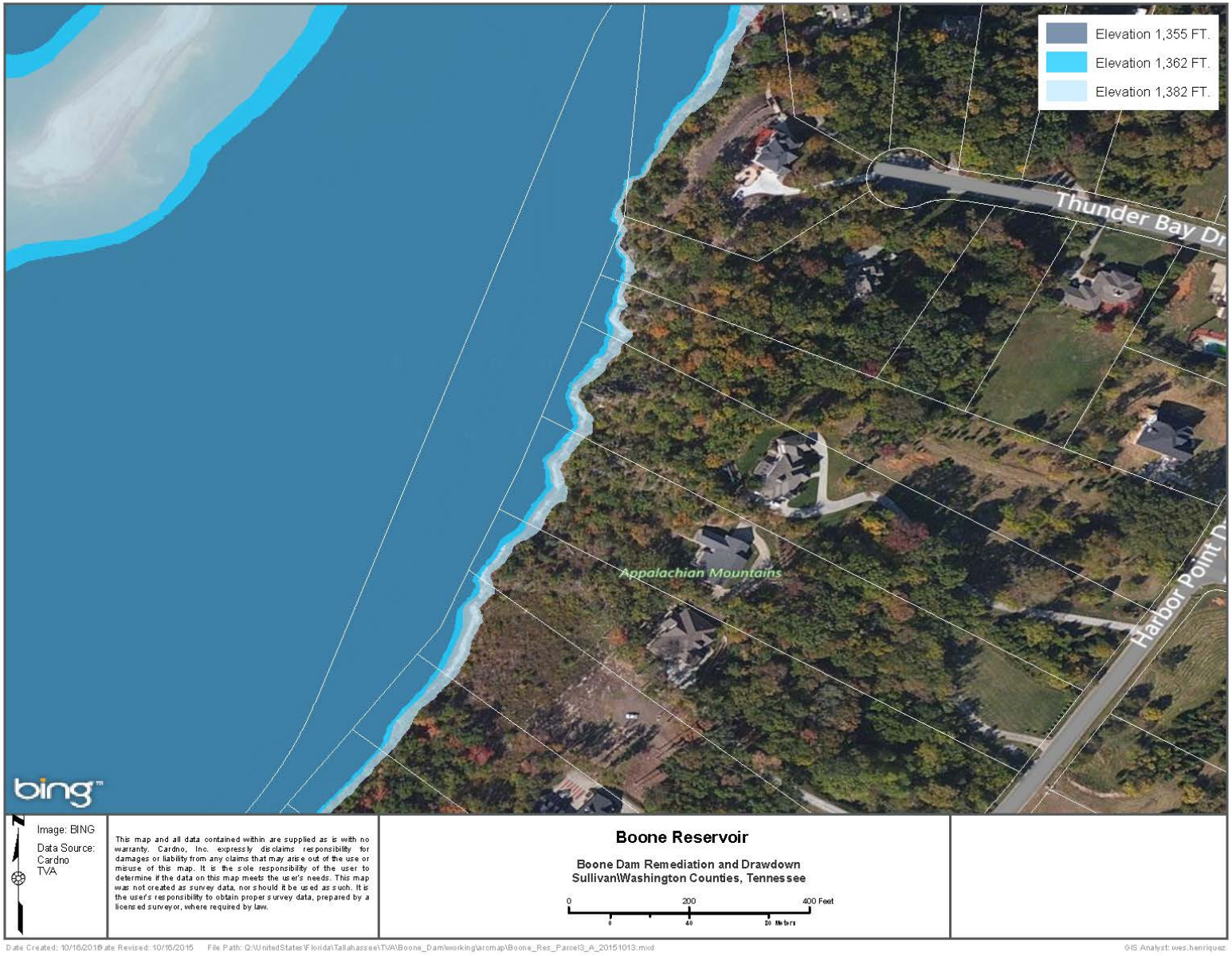


Figure 3-16: Gradual Slope Access Parcels

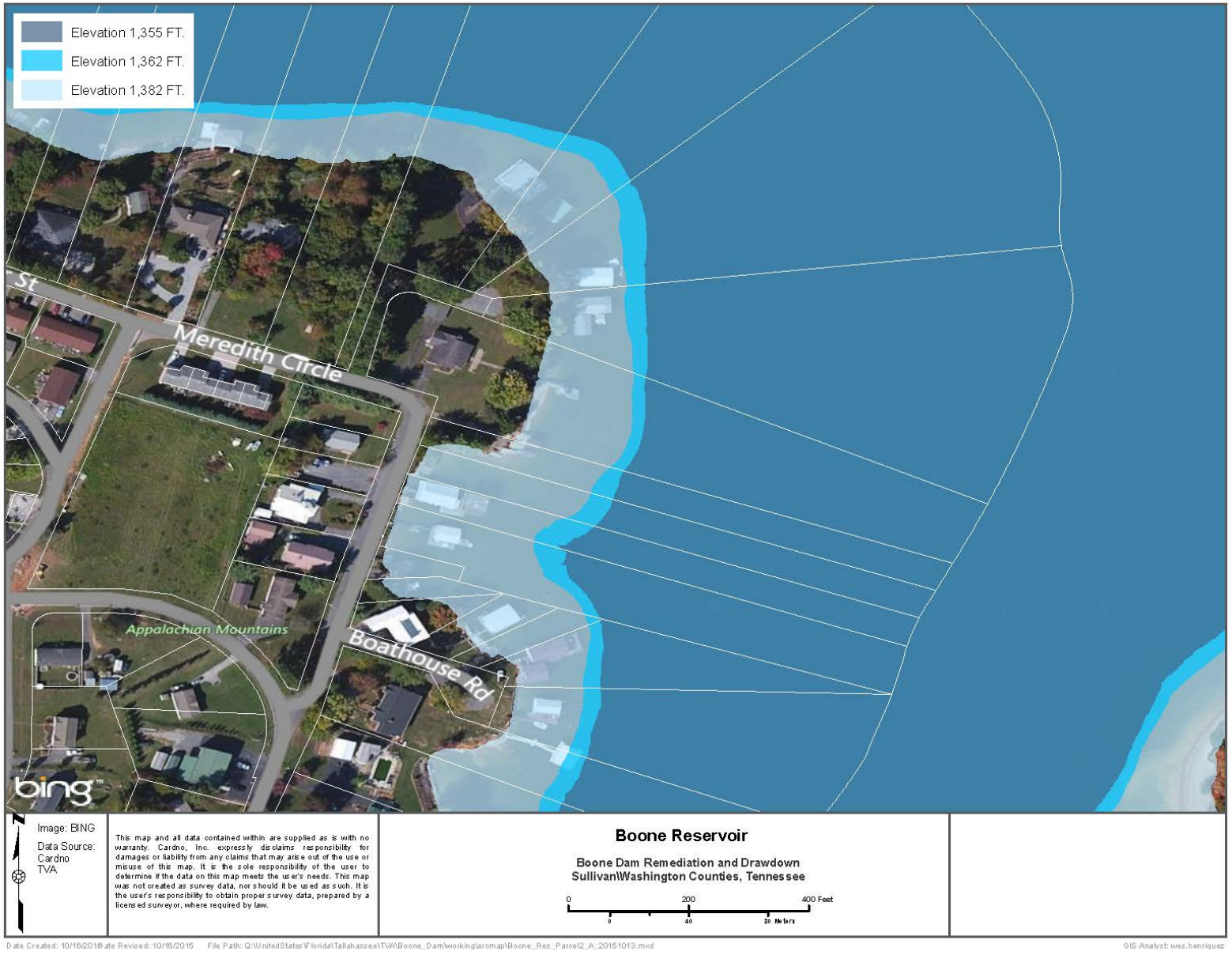


Figure 3-17: No Access Parcels

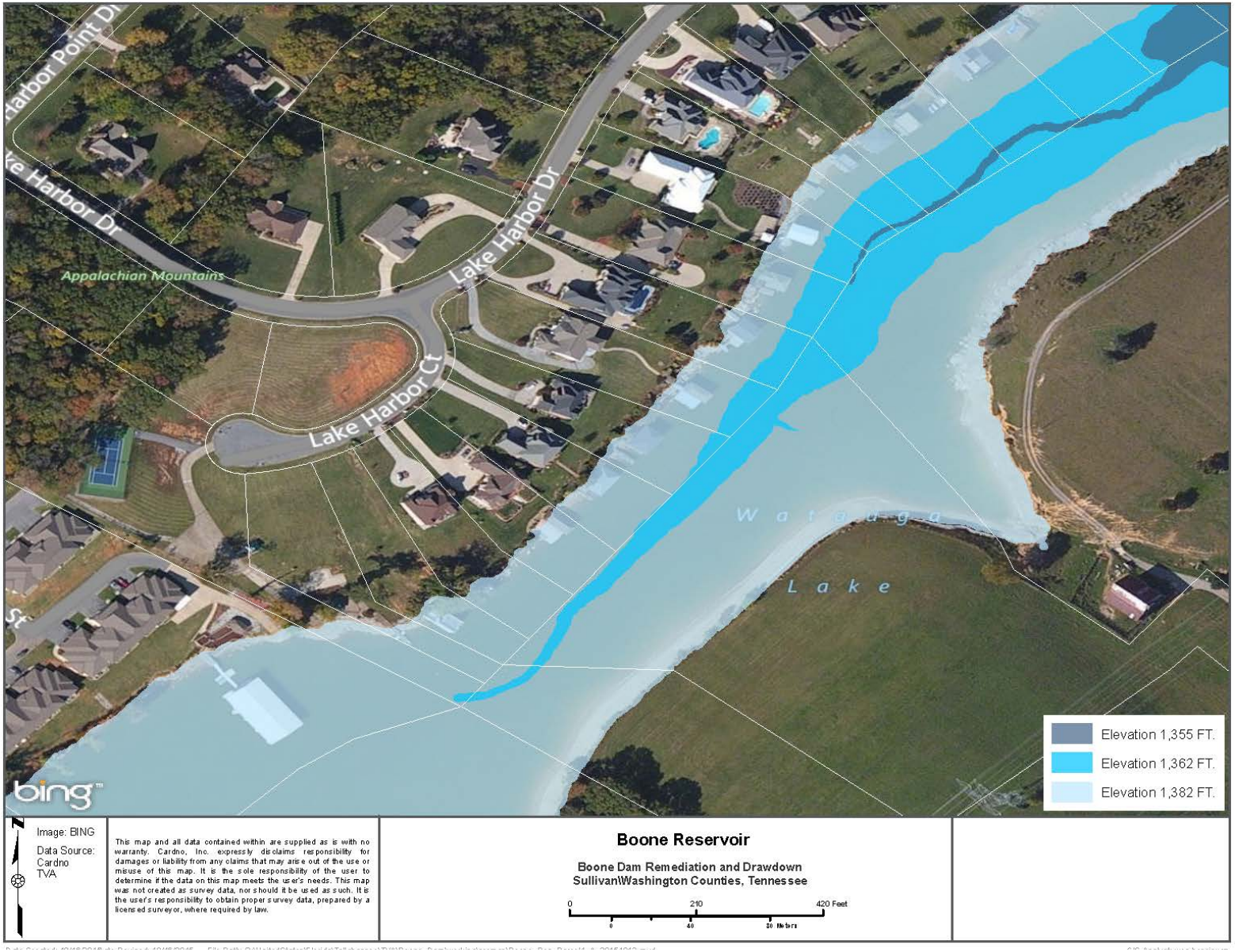


Photo 3-3: Photograph of Steep Slope Access Parcel

Photo 3-4: Photograph Gradual Slope Access Parcel

Photo 3-5: Photograph of No Access Parcels

To illustrate areas where the these three types of impacts occur where development is relatively dense, GIS parcel data from Sullivan and Washington counties (Sullivan County GIS Tax Parcel Data, 2015 and Washington County GIS Tax Parcel Data, 2015) was used to generate building density maps that show the number of buildings per acre on residential parcels surrounding the reservoir. These are layered with the reservoir at different elevations to show where the normal operation water line is compared to the drawdown water line. Example areas are shown in Figures 3-18 through 3-20.

To estimate the change in property value due to all of these impacts, TVA relied on data gathered while drafting the ROS (TVA 2004). As part of the ROS, data was gathered on the effects of different water levels on surrounding properties. From this, data models were developed on five reservoirs that associated a change in a property's distance to the reservoir with a change in the estimated value of the property. The GIS parcel data was used to generate an estimate of the change in horizontal distance from the edge of the parcel at the normal summer pool elevation to the edge of the pool under the drawdown elevations and an estimate of the change in horizontal distance from the edge of the parcel at the winter pool elevation to the edge of the pool under the drawdown elevations. Taking the average of these two distances gives an overall average change in distance of roughly 117 feet. Applying this change in distance to the coefficients generated in each of the five reservoir models from the ROS gave a range of 0.8 percent to 2.8 percent lost value on tributary reservoirs and a range of 16.0 percent to 44.7 percent on mainstem reservoirs.

Figure 3-18: Example of Highest Density Parcels (dark red) with a 'No Access' Impact under the No Action Alternative

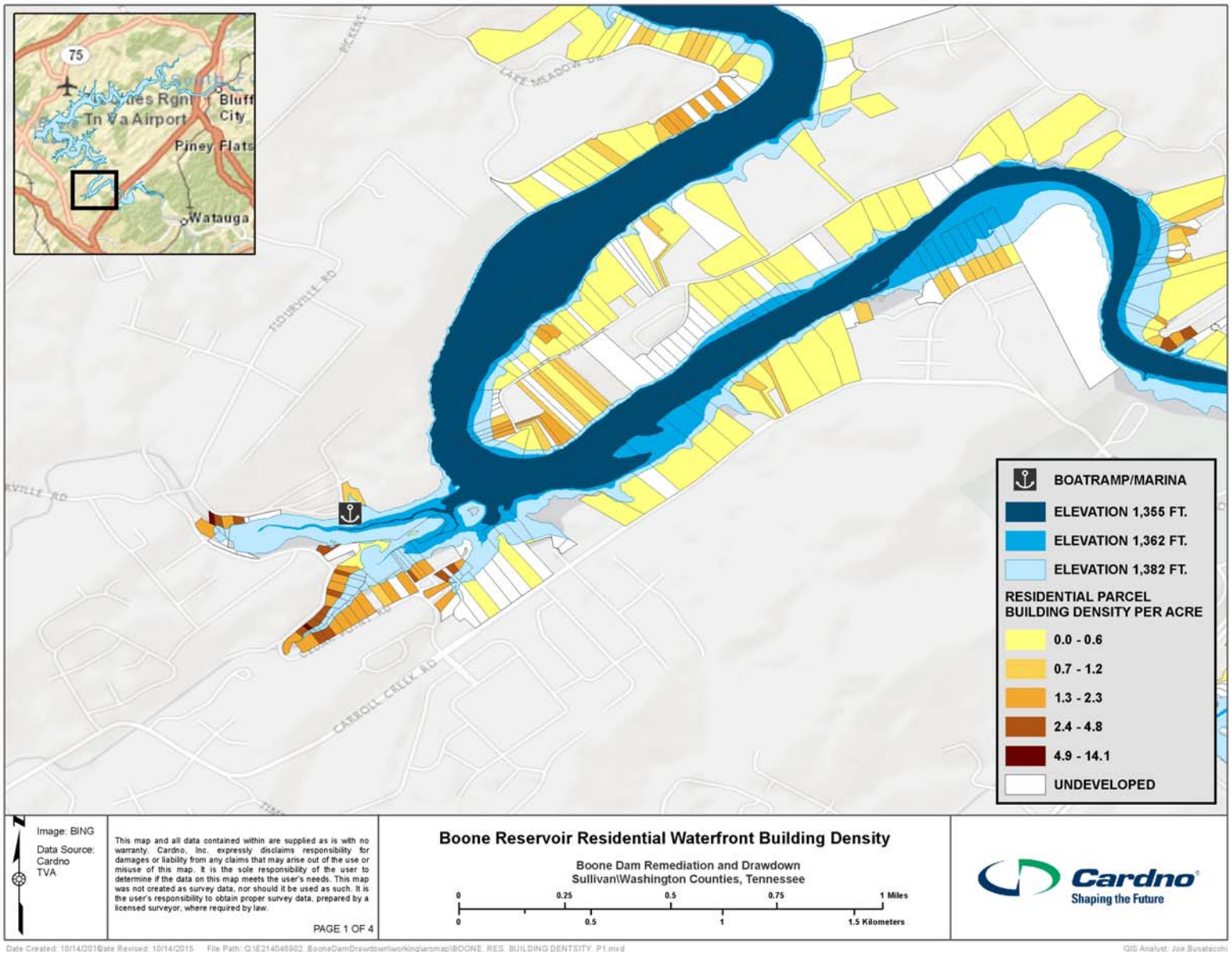


Figure 3-19: Example of Highest Density Parcels (dark red) with a 'Gradual Slope' Impact under the No Action Alternative

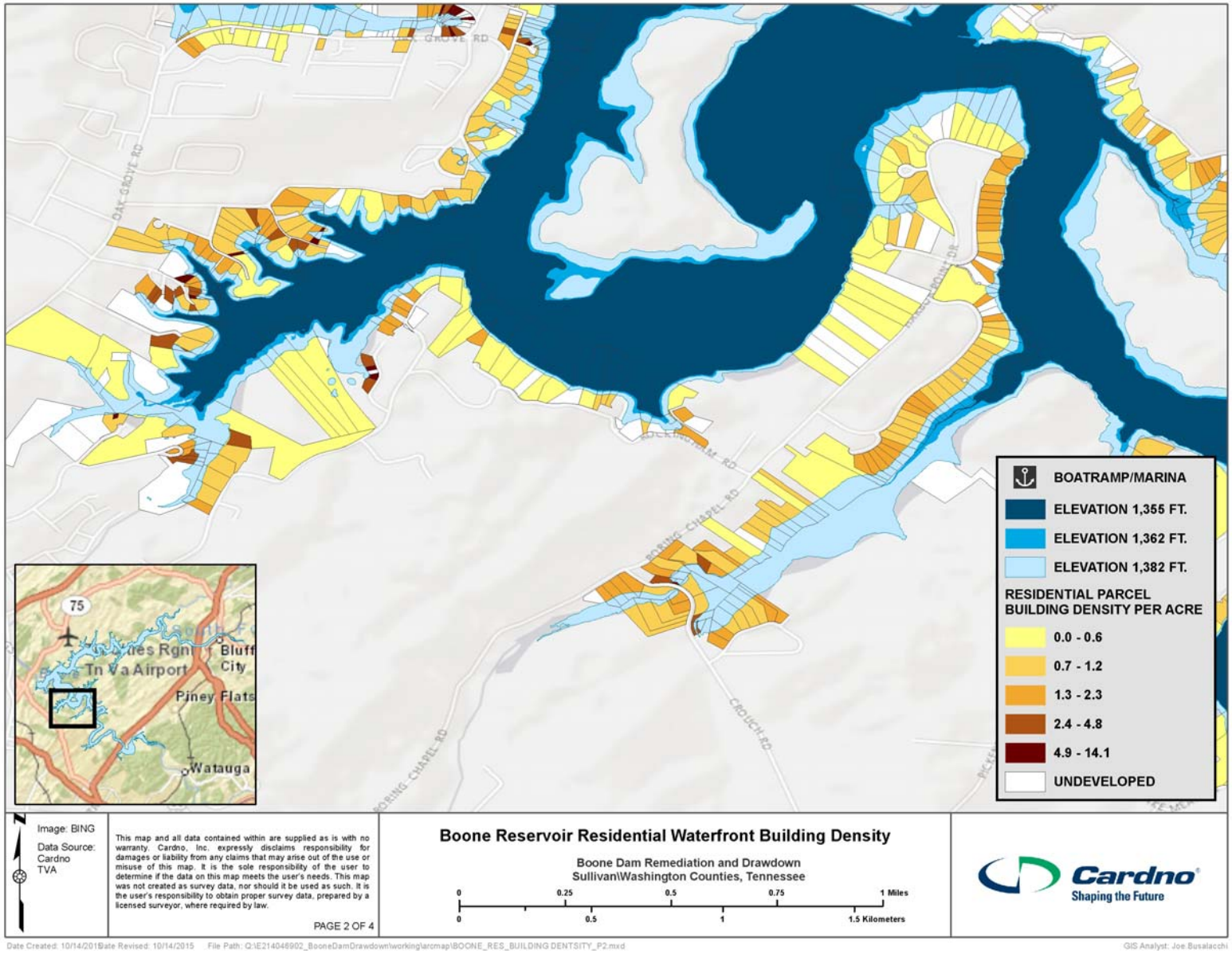
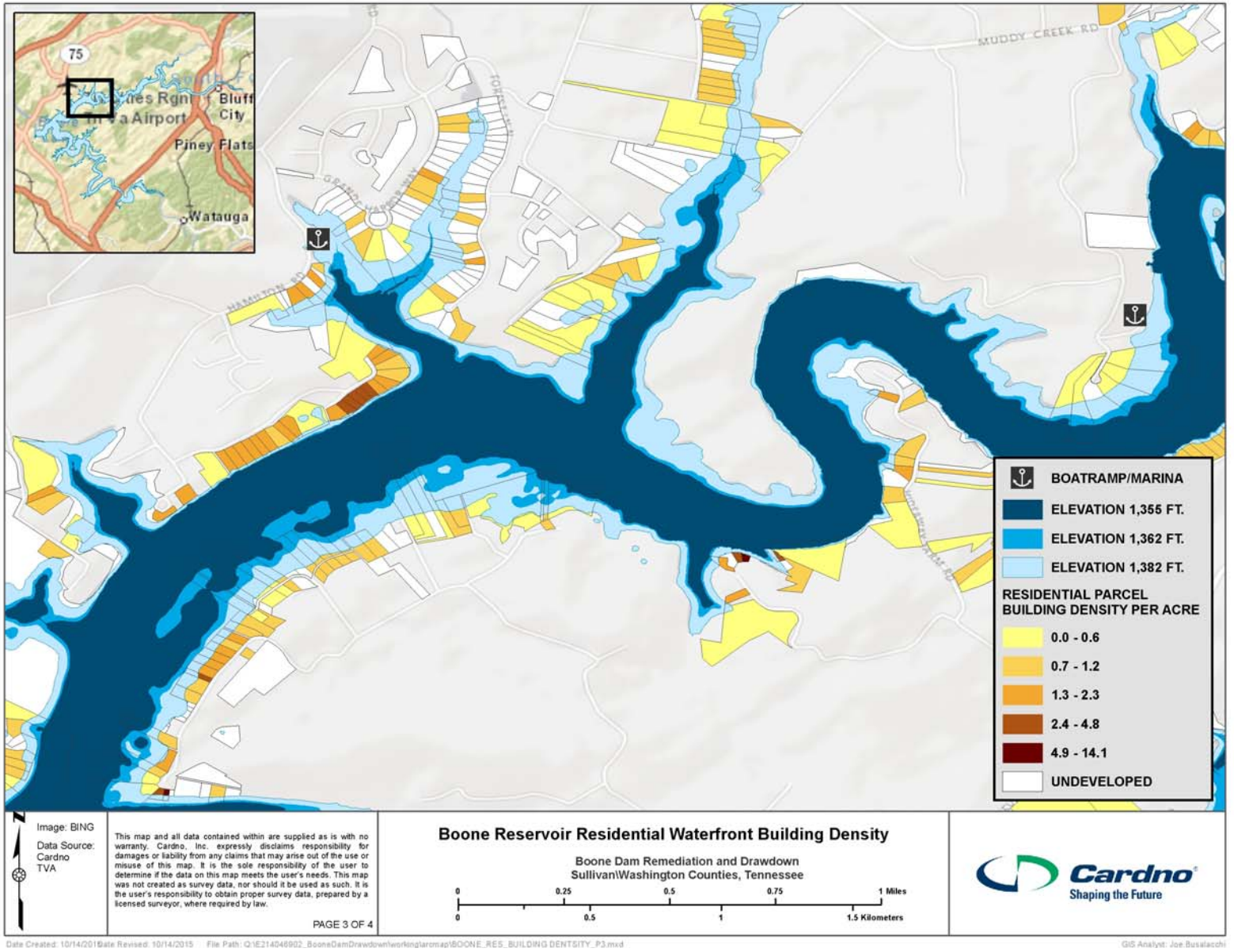


Figure 3-20: Example of High Density Parcels (dark red) with a 'Steep Slope' Impact under the No Action Alternative



It is important to note the difference between impacts on the mainstem reservoirs compared to the tributary reservoirs. The ROS models were looking at changes to seasonal flows. The tributary reservoirs showed less of an impact due to the fluctuating reservoir levels because they already experience variation in water levels and so adjustments have relatively small impact. On mainstem reservoirs water levels are generally kept more constant and therefore property values are more sensitive to what would be considered unexpected changes in distance to the water. In the instance of the Boone Reservoir drawdown, the increased distance to the water is an unexpected change, outside normal conditions. For this reason, even though Boone Reservoir is a tributary reservoir, it is appropriate to use the estimated property value reductions from the mainstem reservoir models. Using this range gives an estimated reduction in property value between 16.0 percent and 44.7 percent if TVA took no action and the reservoir levels remained low indefinitely. Further details on this estimate are contained in Cardno 2015.

Applying this range to the estimated total value of residential property along Boone Reservoir of $592.7 million, yields a loss of between $94.8 million and $264.9 million in property value under the No Action Alternative. Over time it is possible that investments to restore access and amenities on parcels would restore this lost value, however not all of the lost value could be recovered, specifically those properties in the 'No Access' category.

Construction

Under the No Action Alternative, the dam remediation-related construction activities would not occur; therefore, there would be no dam remediation-related economic impacts. There would be positive economic impacts from the construction that already has occurred and may continue to occur to mitigate the drawdown (i.e., funds to marina operators to lengthen existing docks)

Regional Economic Impacts (Indirect Economic Impacts)

Under the No Action Alternative, lower reservoir levels during Interim Operations may lead to reduced recreation-related spending in the two-county area. While reduced recreation-related spending at Boone Dam would likely be partially offset by increased spending at other recreation areas in the two-county region, an overall reduction in recreation-related spending within the two-county region would be anticipated. This reduced spending is anticipated to come from two sources: a reduction in visitors to the area and a reduction in recreation-related spending by private landowners who have residences bordering the reservoir, (e.g., private dock maintenance and new watercraft). The reduction in visitation may be offset somewhat by individuals that can substitute visits to FPH Reservoir and South Holston Reservoir, however as discussed in Section 3.12, Recreation, below, there is likely a reduction in overall recreation visitation in the two-county study area.

Reductions in recreation-related spending are estimated to lead to a reduction of between 8 and 18 jobs per year, a reduction of between $300,000 and $600,000 per year in labor income, and a reduction of between $870,000 and $1.8 million per year in economic output. Because Interim Operations would continue in perpetuity under the No Action Alternative, these negative economic impacts would continue for the foreseeable future.

Some economic benefits associated with construction of recreational access mitigation are anticipated. An estimated 7 jobs, $312,500 in labor income, and $1.117 million in economic output would be generated by these construction activities during 2016.

Regional Tax Revenues

Due to reductions in economic activity and property values under the No Action Alternative, it is anticipated that state and local tax revenues generated within the two-county area would decline. On an annual basis, an estimated decline of between $60,000 and $127,000 in state and local tax revenues associated with the reduction in recreation spending is anticipated. Because Interim Operations would continue in perpetuity under the No Action Alternative, these negative impacts on state and local tax revenues would continue for the foreseeable future.

Construction of recreational access mitigation is anticipated to generate increases in state and local tax revenues. An estimated $28,600 in state and local tax revenues would be generated by these construction activities during 2016.

Environmental Justice

Overall, disproportionate impacts on disadvantaged populations as a result of the No Action Alternative are unlikely because of the small size of the minority population and the relatively similar percentage of low-income individuals in the two-county area compared to the state.

3.11.2.2 Proposed Action

Under the Proposed Action, short-term economic impacts would be associated with Interim Operations and dam remediation-related construction expenditures. After the 5- to 7-year drawdown, economic conditions would return to prior levels within one season of completion of the dam remediation construction.

Recreation

Under the Proposed Action the adverse direct economic impacts to recreation would be limited to a 5- to 7-year period during dam remediation construction. TVA expects that annual economic impacts relating to recreation would be similar to those impacts described in the No Action Alternative but that the impacts would only extend through the life of the project (up to 7 years). After a period of adjustment, assumed to be one season, TVA expects that recreation would return to levels estimated under the normal operations.

Marina Businesses

Under the Proposed Action the adverse direct economic impacts to marina businesses would be similar to those impacts described in the No Action Alternative but limited to a 5- to 7- year period during dam remediation. Impacts would be partially offset by investments in extending docks and boat ramps where possible. TVA expects that annual economic impacts relating to marina businesses would extend through the life of the dam remediation construction. During the reservoir drawdown, TVA's loan program to marinas (described in Section 1.5.2) would assist marinas in absorbing some of the additional costs associated with improving functionality and/or the loss in revenue associated with reduced visitation. However, it is possible that the loss of revenue during the drawdown causes one or more marinas to cease operations. After

one season when the reservoir resumes Normal Operations, TVA expects that recreation would return to levels estimated under Normal Operations.

Property Values

Under the Proposed Action, property values of residential parcels are not expected to decline appreciably. However, in reviewing the real estate market around the reservoir, there are indications that the number of houses for sale is currently below seasonal averages, perhaps because owners do not want to sell during the remediation for fear of selling below market price under Normal Operations. The relatively low inventory of shoreline homes may be causing scarcity, keeping the prices near normal. Also, local real estate professionals have stated that prices are holding steady (Sweetman, 2015). According to Washington County Tax Assessor, 16 properties have been sold along the lake in 2015 and only four were sold below the assessed value. Although it is possible that property values may be depressed during the drawdown period, TVA expects that property values would rebound once the dam remediation is complete and the reservoir returns to Normal Operations. Any impact to property values, then, would be temporary.

During TVA's outreach efforts after the reservoir drawdown, some property owners have stated that the 5- to 7-year drawdown of the reservoir has prompted them to consider selling their property and relocating elsewhere and that they may be willing to accept a depressed price for their property due to the drawdown. If property owners choose to sell during the interim reservoir operations at a depressed price there are two socioeconomic impacts. The first economic impact is an adverse impact to the seller – accepting a reduced sales price. The second economic impact is a gain to the buyer – of acquiring a property with a reduced price. From a regional perspective, such a transaction would generally have no net economic impact, although the seller may suffer an adverse impact.

Many shoreline property owners have expressed that they are experiencing a significant reduction in the enjoyment of their property since the drawdown. These owners face up to 7 years of a drawdown. Some have expressed that the health of residents around the reservoir have been affected as well, with a decrease in recreation options on their property. One commenter expressed concern for the well-being of property owners during the remediation period. The magnitude of the impact of the reservoir drawdown is unique to each property owner and is not quantifiable. For some homeowners, for example, year-round residents in retirement, the impact may be more significant than those for whom the property is a second home wherein they reside only part of the year.

Construction

Under the Proposed Action, remediation-related construction activities would generate positive economic impacts in the two-county region. Direct construction spending on dam-remediation is estimated to be between $200 million and $300 million over the 5- to 7-year project period (TVA 2015e).

Regional Economic Impacts Related to Construction (Indirect Economic Impacts)

As shown in Table 3-26, indirect economic impacts in the two-county area related to

construction would begin in 2016 and increase until their peak between 2018 and 2020, consistent with the anticipated level of construction activity. After 2020, the anticipated level of construction activity and associated economic impacts would begin to decline until construction activities conclude in mid-2022. During the 2018 to 2020 period, initial estimates by TVA indicate that between 482 and 725 jobs may be generated on an annual basis, between $22.6 and $33.9 million in labor income may be generated annually, and between $67.2 and $100.7 million in economic output may be generated annually.

Table 3-26: Economic Impacts of Boone Dam Remediation-Related Construction from 2016 to 2022 (2015 dollars – millions)

	2016	2017	2018	2019	2020	2021	2022
Employment (jobs)	120 - 176	227 - 340	483 - 725	483 - 725	483 - 725	362 - 544	113 - 170
Labor income	$5.6 - $8.3	$10.6 - $15.9	$22.66 - $33.9	$22.66 - $33.9	$22.66 - $33.9	$16.9 - $25.4	$5.3 - $7.9
Economic output	$16.9 - $24.7	$31.5 - $47.2	$67.2 - $100.7	$67.2 - $100.7	$67.2 - $100.7	$50.4 - $75.6	$15.7 - $23.6

Source: Cardno 2015

While construction activities are occurring, Interim Reservoir Operations would be in place and recreation-related impacts would be similar to those identified under the No Action Alternative: a reduction of between 8 and 18 jobs, which equates to an annual reduction of between $300,000 and $600,000 in labor income and an annual reduction of between $870,000 and $1.8 million in economic output. Because Normal Operations would proceed once construction is completed under the Proposed Action, it is anticipated that these negative economic impacts associated with recreation would cease after 2022. Immediately after 2022, there may be a brief recovery period in visitor-related spending as visitors may be slow to return. This recovery period in visitor spending may be offset to some extent by a surge in private landowner expenditures related to private dock maintenance and new watercraft purchases, after years of reduced spending on these items.

Regional Tax Revenues

Under the Proposed Action, TVA estimates that construction activities would generate increases in state and local tax revenues in the two-county region. These impacts would occur during the 5- to 7-year construction period and are shown in Table 3-27. During the 2018 to 2020 period, when the anticipated level of construction activity would be the greatest, between $1.9 and $2.9 million in state and local tax revenues would be generated. In addition to state and local tax revenues associated with Boone Dam remediation related construction, approximately $28,600 in state and local tax revenues would be generated in 2016, related to recreational access mitigation construction activity. The estimated increases in state and local government revenues would cease after 2022, once construction is complete.

Table 3-27: State and Local Government Revenue Impacts of Boone Dam Remediation-Related Construction from 2016 to 2022 (2015 dollars – millions)

	2016	2017	2018	2019	2020	2021	2022
State and Local Government Revenues	$0.5 – $0.7	$0.9 – $1.3	$1.9 – $2.9	$1.9 – $2.9	$1.9 – $2.9	$1.4 – $2.1	$0.5 – $0.7

Source: Cardno 2015

While construction activities are occurring, Interim Operations of the reservoir would be in place and recreation-related impacts on state and local government revenues would be similar to those described under the No Action Alternative: an annual reduction of between $140,700 and $248,200 in state and local government revenues is estimated. Because Normal Operations would proceed once construction is completed under the Proposed Action, TVA estimates that these reductions in state and local tax revenues would cease after 2022 and return to levels consistent with Normal Operations over a period of a few years.

Environmental Justice

Overall, disproportionate impacts on disadvantaged populations as a result of the Proposed Action are unlikely because of the small size of the minority population and the relatively similar percentage of low-income individuals compared to the state percentage.

3.12 RECREATION

Providing accessible natural resources and recreational opportunities for the people of the Tennessee Valley is a key component of the TVA stewardship mission. Because of its relatively small size, proximity to three large cities (Bristol, Kingsport, and Johnson City), and increased residential development, Boone Reservoir has become one of the most intensively used reservoirs in the TVA system (TVA 2002). Including 8 miles of island shoreline, Boone Reservoir has 131 miles of shoreline, with 83 percent of the land designated for private development. Some farmland still exists around the reservoir but the majority of land has been developed with reservoir-front real estate properties and gated communities (TVA 2002).

Boone Reservoir provides a host of recreational activities, most of which include water-based activities such as fishing, boating, canoeing or kayaking, swimming, camping, and more. Boone Reservoir features several popular sportfish species such as striped bass, large and smallmouth bass, crappie, walleye, catfish, and trout, making it a popular destination for recreational anglers. It features approximately 18 developed recreation areas that collectively provide a variety of amenities. These sites are considered to be developed recreational sites because they are actively managed either by TVA or under contractual agreement to another government entity or commercial operator. Boone Reservoir also features 19 undeveloped parcels, providing opportunities for activities such as hunting, hiking and bird-watching.

Recreational opportunities at Boone Reservoir can be categorized into two types of use:

- Public recreation use—general public who use existing public access sites along the shoreline (including marinas, boat launches, and rental homes); and
- Private recreation use— shoreline property owners who have private access to the resource.

Public users consist of out-of-area visitors (visitors who reside in counties outside of the two counties that surround Boone Reservoir) and local visitors (visitors who reside in the two-county area surrounding Boone Reservoir). Private users are shoreline property owners along Boone Reservoir.

This review analyzes the potential impacts of the No Action Alternative and the Proposed Action on each user group because one group may be affected more severely than the other, and changes in recreation use patterns by these user groups may result in different regional impacts.

3.12.1 Affected Environment

Reservoir-based activities on Boone Reservoir include the following:

- Bank fishing (shore fishing);
- Motor boating, including fishing from a boat, pleasure boating, house boating, water skiing, and water tubing or towing;
- Canoeing and kayaking;
- Personal watercraft use;
- Swimming, including beach use;
- Other water-based activities, including sailing, rafting, diving, and hunting; and
- Non-water activities adjacent to the reservoir, including tent or vehicle camping, sightseeing, walking and hiking, biking, hunting, and picnicking.

People who take part in these activities at TVA reservoirs may do so at developed areas with modern facilities, such as campgrounds with electrical outlets, bathrooms, and showers, or even resorts with reservoir views (developed recreation). Alternatively, they may take advantage of undeveloped natural areas through activities such as camping, hiking or hunting (undeveloped recreation).

Developed Recreation

Developed facilities around Boone Reservoir provide a diverse opportunity for water-based recreation. Developed sites at Boone Reservoir include managed campsites, picnic facilities, beaches, facilities offering lodging, developed trails, fishing berms or piers, and visitor centers. Table 3-28 lists all of the developed facilities and the associated amenities located on Boone Reservoir.

Table 3-28: Developed Facilities and Associated Amenities on Boone Reservoir

Access Site	Type of Site	Amenities
Winged Deer Park	Community park, public boat ramp	Designated parking (72 spaces), paved boat launch, pier, picnic pavilion
11E Bridge	Public boat ramp	Paved boat launch, 26 parking spaces
Tract 22R Boat Ramp	Public boat ramp	Designated parking, paved boat launch, 52 parking spaces
Lakeview	Marina	Paved boat launch,150 wet slips, gas, 30 parking spaces
Boone Reservoir	Marina	Paved boat launch,100 wet slips, boat rental, gas, 15 parking spaces
Davis	Marina	Paved boat launch, 24 wet slips, 30 parking spaces
Rockingham Dock	Marina	Paved boat launch, 250 wet slips, boat rentals, showers, gas, 40 parking spaces
Jay's Dock	Marina	Paved boat launch,150 wet slips, gas, 10 parking spaces
Sonny's	Marina	152 wet slips, pontoon rentals, fueling station, 50 parking spaces
Serenity Cove	Marina	Paved boat launch, 60 wet slips, RV park, cabins, houseboat rentals, gas, 25 parking spaces
Tri-City Dock	Marina	None
Boone Dam Beach	Swimming beach	Designated parking, restrooms, courtesy pier, picnic pavilion
Lakeshore RV park	Camping (cabin, tent and RV)	Restrooms
Airport Ramp	Public boat ramp	Paved boat launch, 10 parking spaces
Bluff City Park	Community park, public boat ramp	Designated parking (43 spaces), paved boat launch, pier
Pickens Bridge Ramp	Public boat ramp	Paved boat launch, 38 parking spaces
Rainbow Bridge	Public boat ramp	Paved boat launch, 5 parking spaces
Fairview/Devault Bridge	Public boat ramp	Paved boat launch, 6 parking spaces

Source: TVA 2015d

The number of developed recreational user days at Boone was estimated using data from surveys taken by researchers at the University of Tennessee (UT) at 14 TVA reservoirs (Schexnayder et al. 2009a, 2009b; Stephens, Griffin et al. 2007; Stephens, Didier et al. 2006a-f). The reservoirs in the study included Blue Ridge, Chatuge, Cherokee, Douglas, Fontana, Fort Loudoun, Hiwassee, Kentucky, Melton Hill, Nickajack, Norris, Nottely, Parksville, and Wheeler. The surveys provided an estimate of visitors during the study period, using counts of people as they left various developed recreational sites around the reservoirs. To estimate visitation at Boone Reservoir, where no survey information was available, the estimates at the 14 reservoirs

were used to calculate an average number of visitors per shoreline mile. In addition to the counts of people leaving, the visitors were asked for information about their recreation. Among other questions, they were asked to estimate their average number of trips to the reservoir for each month of the year. Averages for each month and the averages for the study period were used to extrapolate an estimate of trips by month to Boone Reservoir.

Survey respondents were also asked to report their primary reason for visiting the reservoir. The percentage breakdown of their responses was multiplied to estimate recreation by activity, giving an estimate of just over 63,000 user days per year participating in water-based and shoreline recreation at Boone Reservoir (Table 3-29). As shown in the table, sixty-five percent of user days involve boating—fishing from a boat (32 percent), pleasure boating (28 percent) and waterskiing or tubing (5 percent).

Table 3-29: Estimates of Developed Recreation User Days at Boone Reservoir under Normal Operations by Activity

Recreation Activity	Annual User Days	Percent of Total	Cumulative Percent of Total
Fishing (boat)	20,152	32%	32%
Pleasure boating	17,611	28%	60%
Swimming/beach use	8,022	13%	72%
Waterskiing/tubing/other towing	3,482	5%	78%
Camping (at managed sites)	3,119	5%	83%
Fishing (shore)	2,566	4%	87%
Riding a personal watercraft	2,260	4%	90%
Other	1,926	3%	93%
Hiking/walking/jogging	1,649	3%	96%
Canoeing or kayaking	1,019	2%	97%
Bicycling	1,009	2%	99%
Sailing	209	0%	99%
Total	**63,024**	**100%**	**100%**

Source: TVA 2015c, Tables 3.3-2 and 3.3-5.

Undeveloped Recreation

The UT surveys used to estimate visitation were conducted at developed sites, enabling estimates for both developed shoreline visitation and water-based visitation at those facilities (Schexnayder et al. 2009a, 2009b; Stephens, Griffin et al. 2007; Stephens, Didier et al. 2006a-f). These estimates could not be used for the dispersed recreation occurring in undeveloped areas. Therefore, following the approach used in the Floating Houses Draft EIS (TVA 2015c), it is assumed that there are 20 undeveloped recreation visits per undeveloped land acre per

year.[10] The estimate of the total acreage of undeveloped land available for dispersed recreational activities was based on parcel data from the 2010 Boone RLMP. According to the RLMP, there are 19 undeveloped TVA parcels on Boone Reservoir that are available to support dispersed recreation activities. These tracts total approximately 592 acres, 284 acres are available by road and the remaining 308 acres are available only by boat. Regardless of the access type the estimate of 20 visits per acre per year is used to estimate undeveloped recreation. Therefore, the number of potential undeveloped user days is 592 acres multiplied by 20 visits per acre, for a total of 11,840 undeveloped user days.

Total Visitation

For the purposes of estimating the regional economic impact of visitors to Boone Reservoir, the total number of developed recreational user days was divided into the following categories: out-of-region visitors, local/in-region visitors, and shoreline property owners. To determine the share of user days attributed to each category, it was assumed that 56 percent of user days (average of survey results from 2006 to 2007 survey data) are attributed to people who have a local or seasonal home in a county that surrounds the reservoir (i.e., local/in-region users), giving 35,526 user days, while the remaining 44 percent are considered to be out-of-region user days (27,913).

Within the local/in-region user days, a subset of user days is attributable to shoreline property owners. To estimate the subset of user days attributed to shoreline property owners, the estimate of total local/in-region user days was multiplied by the average share of private users across 35 reservoirs from the ROS EIS (26 percent) (TVA 2004). This gives a total of 9,237 shoreline property user days, or 15 percent of the total developed recreational user days on Boone Reservoir. This figure is consistent with the findings in the ROS EIS (TVA 2004), where it was reported that private user days during the months of August, September, and October were approximately 10 percent of total recreational user days at Boone Reservoir.

Table 3-30: Estimated Number of Developed Annual Recreational User Days by Category

Category	Annual User Days	Percent of Total
Out-of-area	27,913	44%
Local/in-region (not shoreline property owner)	26,289	41%
Shoreline property owners	9,237	15%
Total	**63,439**	**100%**

Source: Cardno 2015

[10] The figure of 20 user days per undeveloped land acre was used in 2011 to estimate the economic benefits of the natural resource plan (TVA 2011). The estimate was calculated using data from actual visitation on USACE-managed lands and data on the proportion of people participating in dispersed recreational activities in the TVA region.

Table 3-30 shows the breakdown of user days by category. Out-of-area users account for 44 percent of total use. Local and in-region users account for another 41 percent. Shoreline property owners account for 15 percent of user days.

3.12.2 Environmental Consequences

3.12.2.1 No Action Alternative

Table 3-31 shows the estimated change in developed recreational user days under the No Action Alternative using both lower bound and upper bound assumptions.[11]

Table 3-31: Projected Number of Recreational User Days under the No Action Alternative

Alternative	Users	Current (2014)	No Action	Percent Reduction
No Action Alternative (Lower bound)	Out-of-area users	27,913	22,610	-19%
	Local users	26,289	21,294	-19%
	Shoreline property (private) users	9,237	4,618	-50%
	Total Developed Users	**63,439**	**48,522**	**-24%**
	Undeveloped Users	**11,840**	**10,656**	**-10%**
	Total	**74,863**	**59,178**	**-21%**
No Action Alternative (Upper bound)	Out-of-area users	27,913	13,957	-50%
	Local users	26,289	13,145	-50%
	Shoreline property (private) users	9,237	1,349	-85%
	Total Developed Users	**63,023**	**28,451**	**-55%**
	Undeveloped Users	**11,840**	**6,340**	**-48%**
	Total	**74,863**	**35,791**	**54%**

Source: Cardno 2015

The lower bound estimates utilize existing models and research performed by TVA in support of the ROS EIS (TVA 2005). One of the reservoir operations alternatives examined in the ROS (not the preferred alternative) maximized the production of summer hydropower and as such reduced the summer elevation of the reservoir immediately following Memorial Day rather than maintaining reservoir elevations to maximize recreation opportunities. The reservoir levels under the ROS's summer-hydropower alternative are not quite as low as under the Boone Dam interim operations but are significantly lower than elevations under the Boone Dam normal operations. Therefore, the estimated change in recreation under the ROS's summer-

[11] Assumptions used in the calculation of changes in user days are described in more detail in the Boone Dam Socioeconomic Analysis Report, Cardno (2015).

hydropower alternative was used as a proxy for the lower bound estimate of the change in recreation under the Boone Dam interim operations alternative. For private property owners at Boone Reservoir, the resulting change in recreational use was estimated to be a decline of 50 percent (TVA 2004). For all other public use types, it was estimated that recreational use would decline by 19 percent.

The upper bound estimates of the change in recreation use are based on a combination of different assumptions. First, the analysis revisits the calculations of user days for Boone Reservoir as described in the UT surveys described above (Schexnayder et al. 2009a, 2009b; Stephens, Griffin et al. 2007; Stephens, Didier et al. 2006a-f). Instead of using the average trips per month in each individual month to extrapolate an average number of user days for Boone Reservoir, the number of trips per month is held constant at 1.9, which is the average number of trips taken during winter months when the reservoir levels are lower. This results in a percent reduction of 44 percent, 25 percent and 85 percent respectively for out-of-area users, local users and shoreline property owners. This approach may tend to overestimate the change in use to a degree since there are other reasons outside of lower water levels (i.e. weather, etc.) that would decrease the number of trips during winter months.

The lower-bound estimate also considers the overall reduction in access to recreation sites as a way to quantify a decrease in developed recreational use at Boone Reservoir as a result of the drawdown. As indicated by adding up the parking spaces and wet slips listed in Table 3-28, there are approximately 452 parking spaces, and 922 wet slips at marinas and public boat launches on the reservoir. Public access to boat ramps is currently limited to the Pickens Bridge boat ramp. Currently, there are fewer than 100 parking spaces available for boat trailers which translates into a 78 percent capacity reduction in parking for boat trailers. Wetslips have decreased by approximately 50 percent and parking for swimming has decreased from approximately 100 sites to 19 temporary sites (Fouse 2015).

Some of this capacity loss in recreational sites may be offset by marinas extending ramps and TVA's plans to develop an existing tract of reservoir property on TVA land adjacent to Boone Dam that would include an extension of an existing boat ramp, a temporary public swimming/beach area, a parking area, and site access (as described in Section 1.5). Some of this capacity may be offset by access to recreation sites at nearby South Holston Reservoir, which is located within the study area, however it is reasonable to assume that total developed user days will decline significantly, the upper limit bounded closely by the overall reduction in the availability of facilities at Boone Reservoir's developed sites. Therefore, for the upper bound estimate, it is assumed that public user days (out-of-area and local users) will decline by up to 50 percent.

There are no recreational site substitutes for private property owners, and this analysis does not speculate whether private property owners will invest in features to maintain reservoir access. Therefore the upper bound reduction in recreation user days by private property owners is assumed to be 85 percent based on the calculations previously described (i.e. average number of trips during winter months is applied to all other months).

Table 3-31 illustrates how these assumptions in the percentage reductions affect the annual estimate of user days in the No Action column. Under the No Action Alternative the annual impacts would occur each year in the absence of dam repair. Ultimately this leads to a total percent reduction of developed recreational user days that ranges between 24 percent and 55 percent compared to recreation us under normal reservoir operations.

The estimate of lower bound impacts to undeveloped recreational users assumes impacts would be minimal as long as access to the undeveloped land that is accessible only by boat is not permanently restricted. In that case, impacts predominantly would be associated with the visual impact of the exposed reservoir bottom surrounding the periphery of the reservoir. Over time, these areas would revegetate to form the new land/water interface surrounding the reservoir. Therefore, for the purposes of determining a lower bound reduction, the analysis assumes a 10 percent reduction as a lower bound to acknowledge there may be some reduction in the number of user days due to the visual impacts

For the estimate of the upper bound of impacts it is assumed that all of the undeveloped land accessible by boat under normal operations is permanently inaccessible and that users who recreate on these lands would not be able to substitute their recreational experience to a site with road access. Eight parcels, totaling 284 acres (48 percent) of the total of 592 acres of undeveloped lands, are accessible by road while the remaining 308 acres are not accessible by road. Therefore the upper bound reduction in trips is also assumed to be 48 percent. This is an extreme upper bound since it assumes that these land acres are no longer available for recreational purposes and that users are not able to visit substitute sites.

Table 3-31 provides an estimate of the overall estimated change in recreational user days, including undeveloped recreational users. Once the change in undeveloped users is added in, the total estimated percent reduction in recreational user days under the No Action Alternative ranges from 21 to 54 percent.

Overall, impacts on recreational reservoir users under the No Action Alternative would be adverse.

3.12.3 Proposed Action

Under the Proposed Action, improvements to the Boone Dam and embankment would be implemented, and the existing reservoir drawdown water level under Interim Operations would continue for 5 to 7 years. The recreation site access plans, described above under the No Action Alternative, are planned and will mitigate the loss of access to the reservoir. Therefore, this analysis uses the same estimates of the projected annual number of user days under the No Action Alternative during Interim Operations and assumes that this level of recreational use remains until the completion of the dam remediation and return to normal reservoir operations. Once the project is completed, it is assumed that recreational use would return to the levels experienced during Normal Operations (i.e., post-construction) in approximately 1 year.

In addition to the adverse impacts that result from limited reservoir access, adverse and limited impacts would result from TVA's use of two TVA tracts as Construction Support Areas, whereon

TVA proposes to conduct numerous activities, including placement of clean fill materials generated during drilling and excavation for the dam remediation. Construction Support Area 1 (also known as the Earl Light Tract) is allocated as Zone 4 (Natural Resource Conservation) in the Boone RLMP. Up to 71.2 acres of the 118-acre parcel would be used. Dispersed recreation use on the parcel is primarily hunting, wildlife/bird viewing, and a constructed footpath/hiking, which allows users to walk through various successional stages of the forest community. Because TVA proposes to close the entire tract to use during construction activities, existing recreational opportunities would be lost during use of the parcel as a construction support area. After completion of the project, TVA proposes to restore the disturbed areas to a natural condition, to reconstruct the existing recreation facilities, and reopen the tract for public use. Impacts, thus, are anticipated to extend through the life of the project until those recreational opportunities are restored by TVA.

Construction Support Area 2 (also known as Tract 22R) is allocated in the Boone RLMP as Zone 6 (Developed Recreation). TVA proposes to use approximately 13 acres of the 53-acre parcel for construction support activities. TVA's Boone Dam boat ramp facility is located on the northeast portion of Tract 22R; the facility includes a paved boat ramp and parking lot, courtesy pier, and fishing access. These recreation facilities have been closed to the public by TVA as an interim measure in preparation for the remediation project. The majority of the activities at Area 2 would be located within an area of this parcel that primarily is an existing utility right-of-way with a transmission line, an area that is not typically utilized by the public for recreation. As noted in Table 1-2, TVA proposes to develop a recreation area and boat ramp on the eastern shoreline of Tract 22R to improve access and recreational opportunities on the reservoir. Though a portion of Tract 22R would not be available for recreation use during the life of the project, other recreational opportunities would be established on the tract. In addition, the 13 acres utilized to support construction activities would be revegetated and graded after the project and returned to recreational use. Therefore, impacts on recreational use of the site would be minor and temporary.

Overall, impacts on recreational reservoir users would be adverse, generally associated with limited reservoir access for boaters and people who primarily fish from a boat during the dam remediation construction period and visitors of public parks such as Winged Deer Park. However, in the short-term, anglers may experience an increase in the quality of their fishing experience because the lower reservoir levels will concentrate the fish in a smaller area, potentially increasing the average catch rate. But this benefit will likely diminish over a few years as fishing pressure depletes the stock until reservoir operations return to normal. At which time the new habitat provided by the re-vegetation of the previously submerged shoreline during the interim operations my boost fish population in the years the follow the construction.

3.13 VISUAL RESOURCES

This section describes the existing visual resources at the Boone Dam project and potential impacts on these resources associated with the No Action Alternative and the Proposed Action.

3.13.1 Affected Environment

Visual resources are the visual characteristics of a place and include both natural and man-made attributes. These attributes include the physical, biological, and cultural features seen in a landscape that contribute to its visual character and sense of place. Visual resources can have a large influence on aesthetics. Aesthetics is a measure of sentiment that an environment can induce in an observer. This involves the appearance of a view and its interaction with surrounding views and their individual components. Varied combinations of these features make the scenic resources of any portion of an area identifiable and unique. These impressions of the visual character can influence how the scenic resources of public lands are used, enjoyed, and protected.

The regional visual character of Boone Reservoir is predominantly rural, with ridges and valleys, a large waterbody (i.e., Boone Reservoir), agricultural fields, forested areas, and generally small towns and cities. Residential development is primarily single-family homes with yards and trees; many homes on Boone Reservoir include boat ramps and/or docks, which may be uncovered or covered with a single-story roof structure. The several towns in the vicinity of the Boone Reservoir include Spurgeon, Bluff City, Gray, Fordtown, and Holston—all of which are small and rural to suburban. Generally, these towns are located in the landscape of forested ridges and valleys and agricultural areas with fields used for crops.

Natural visual elements surrounding Boone Reservoir include islands, floodplains, and wetlands that are framed by high, wooded ridges. Shorelines include developed and undeveloped areas. The natural elements together with the communities and other cultural development provide a scenic, rural countryside. The waterbody itself of Boone Reservoir is the most distinct aesthetic feature of the visual landscape from the reservoir and throughout the area surrounding the reservoir from vantage points that include the reservoir. The horizontal surface of the water provides a visual balance and contrast to the wooded hillsides and residential areas that is satisfying and peaceful to most observers. Significant elevation changes along some stretches of shoreline provide a dramatic contrast to the surrounding reservoir and gently sloping countryside, particularly when they are viewed from background distances.

TVA implemented Interim Operations of Boone Reservoir in October 2014, which has reduced the water levels within the reservoir similar to levels during fall and winter associated with Normal Operations. This reduced water level has exposed soil and rock that is largely covered with water during summer under Normal Operations. Photos 3-6, 3-7, and 3-8 illustrate typical visual characteristics of the land and water level interface surrounding Boone Reservoir during Interim Operations.

Photo 3-6: View of Forested Area at Boone Reservoir

Photo 3-7: View of Single-Family Residences and Boat Docks

Photo 3-8: View of Marina at Boone Reservoir

The visual character of the Boone Dam itself is predominantly industrial (associated with the dam and hydroelectric infrastructure). Undeveloped land surrounds the dam in the periphery. Thus, this area combines natural elements (including rolling hills of forested areas) with industrial elements (including the hydroelectric power plant, overhead electrical transmission towers and wires, and the earthen dam), which creates a disjointed visual experience for the observer. Photo 3-9 illustrates the visual setting in the vicinity of Boone Dam in summer 2015.

Photo 3-9: Aerial Photograph of Boone Dam and Hydroelectric Power Plant Facilities

Currently, construction workers and various types of construction equipment, including drill rigs, are at Boone Dam conducting various evaluations for the dam remediation. Construction storage areas, the presence of construction workers and various types of construction equipment, and the use of construction vehicles increases the industrial visual sense of place in the immediate vicinity of the dam. Photo 3-10 provides an example of the visual resources associated with the ongoing construction activities at Boone Dam.

Photo 3-10: Ongoing Construction Activities at Boone Dam

3.13.2 Environmental Consequences

3.13.2.1 No Action Alternative

Under the No Action Alternative, the proposed remediation to Boone Dam would not be implemented; therefore, construction equipment, storage areas, and construction workers and construction-related equipment would not be present. The existing views in the vicinity of the dam would remain relatively unchanged and, upon the departure of construction equipment currently onsite, would be similar to what was present prior to initiation of the current activities associated with the geologic investigation.

The reservoir water levels under Interim Operations would continue and would be similar to reservoir water levels during winter that are associated with Normal Operations. This would permanently retain the lowered water level at Boone Reservoir and would continue to result in exposed soil and rock around the periphery of the reservoir. Over time, exposed areas that could support vegetation would be revegetated; however, areas that would not support vegetation would remain in an unvegetated state. TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species which would serve to mitigate for visual impacts until normal reservoir levels return. Impacts on visual resources would be long

term, moderate, adverse, and direct, but would tend to become less over time as the exposed reservoir bottom becomes mature vegetation.

3.13.2.2 Proposed Action

The presence of construction equipment, including drill rigs of various sizes and heights, would result in minor impacts on visual resources within the vicinity of Boone Dam for 5 to 7 years. Public access to Boone Dam is restricted, and this restriction would continue throughout the duration of construction activities. Upon completion of construction, equipment would be removed and the visual elements within the vicinity of the dam would return to what was present prior construction, as the composite seepage barrier is largely underground.

Because of the drawdown of water in the reservoir, the existing view of exposed rock and soil surrounding the periphery of reservoir would continue until completion of the proposed remediation (5 to 7 years after the initiation of the Proposed Action), when TVA would allow water levels to return to Normal Operations levels. During the timespan of the drawdown, areas of exposed soil and rock would revegetate where possible. The TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation of the portions of the exposed reservoir bottom. In addition, TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species. Reestablishment of appropriate vegetative communities would serve to mitigate for visual impacts until normal reservoir levels return. TVA's proposed vegetation management plan, which would allow TVA to manage the successional vegetation on much of the exposed reservoir bottom with annual or periodic mowing or bushwhacking, is not expected to adversely impact visual resources. Mowing vegetation on the exposed reservoir bottom would not be intended to eliminate the vegetation. Such vegetation may be beneficial, by enhancing wildlife habitat, reducing erosion during the drawdown, and improving fish habitat after the reservoir is returned to normal water levels. Impacts on visual resources would be more significant during summer, when the difference between the existing lowered water level and the Normal Operations summer full-pool water level would be most evident to residents and recreational users. During fall and winter, the visual difference between the existing water level and the Normal Operations water level would not be as substantial because these water levels are similar. Visual resource impacts on recreational users or individuals observing Boone Dam would be minor, as these observations could be made only from a distance given the restricted access in the vicinity of the dam.

Adverse visual impacts could occur on roads in the vicinity of the project site from trucks and other heavy machinery travelling on the local roadway network. Large machinery traveling these roads could result in a visual disturbance to other drivers and residents. However, this disturbance would be momentary and present only as the vehicle passes the observer. To reduce potential visual impacts associated with construction lighting at the dam, TVA would position and adjust light sources as needed to reduce or minimize their visibility from nearby residences. Therefore, these adverse impacts on visual resources are considered minor and temporary.

Overall, long-term, minor to moderate, adverse visual impacts would be associated with the Proposed Action. The proposed construction activity would result in a minor impact on visual

resources at Boone Dam given the existing industrial nature of the dam and hydroelectric power plant. Historically, water levels on Boone Reservoir have been lowered during fall and winter; the Proposed Action would retain water levels year-round similar to the historical winter water level operation of the reservoir. Visual impacts would tend to become less over time as the exposed reservoir bottom becomes mature vegetation.

3.14 NOISE

This section provides an overview of the existing ambient sound environment at the proposed Boone Dam project site and the potential impacts on the ambient sound environment associated with the No Action Alternative and the Proposed Action.

3.14.1 Affected Environment

Noise and sound can directly or indirectly affect health, enjoyment, and well-being. High levels of noise can cause hearing loss, interfere with communication, disturb concentration, and cause stress. Moderate and low levels of noise can disturb sleep and annoy sensitive receptors. Typically, “noise” is defined as unwanted sound, which can be based on objective effects (e.g., hearing loss, damage to structures) or subjective judgments (e.g., community or individual annoyance). Sound is usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the dB scale is referred to as the sound level.

Environmental noise regulations, ordinances, guidelines, and other criteria are established for two reasons: (1) to protect existing residents from the potential impact of new noise sources; and (2) to protect new residents from existing noise sources. The environmental noise guidelines from USEPA (USEPA 1974) address the first reason. Guidelines from the U.S. Department of Housing and Urban Development (HUD 1983) concentrate on the second reason. The USEPA recommends an equivalent day-night average sound level (DNL) of 55 A-weighted decibels (dBA) to protect the health and well-being of the public with an adequate margin of safety. Generally, TVA uses the USEPA guideline of 55 dBA DNL at the nearest residence and 65 dBA at the property line in industrial areas, when no resident is nearby. In addition, TVA uses the Federal Interagency Committee on Noise (FICON 1992) recommendation that a 3-dB increase indicates possible impact, requiring further analysis when the existing DNL is 65 dBA or less.

Exposure to high noise and sound levels can cause hearing loss. The Occupational Safety and Health Administration (OSHA) regulates noise exposure in the workplace. Similarly, the USEPA gives guidance for exposure to environmental noise. The USEPA recommends an average annual exposure limit of 70 dBA equivalent sound level for 24 hours (Leq[24]) over 40 years to prevent hearing loss. The OSHA exposure standard is 90 dBA for 8-hour exposure (OSHA 1984).

Communication interference begins at background noise levels much lower than levels that can cause hearing loss. Sentence intelligibility is one method of determining communication interference when background or intruding noise is broad spectrum. This is usually the case

when there are multiple noise sources. Disturbance noise can either disturb or aid concentration depending on its characteristics. Even moderate levels of intruding noise can be distracting if it they are sporadic, have a dominant frequency, or are identified with an undesirable source.

Ambient noise surrounding Boone Reservoir consists mainly of mild industrial (i.e., hydroelectric power operations, including sluice release and activities in the immediate vicinity of the dam), moderate vehicle use on the local road network, intermittent aircraft noise associated with flight arrivals and departures at the nearby Tri-Cities Regional Airport, personal watercraft use associated with powered boats, rural and community noises (i.e., children playing, outdoor lawn equipment), and natural sounds (e.g. wind, wildlife, and similar sounds). Generally, noise levels in these types of areas range from 45 to 55 dBA. Overall, the area surrounding Boone Reservoir is primarily rural residential, agricultural, suburban, and undeveloped land.

Construction activities under the Proposed Action would occur within the immediate limits of Boone Dam and on haul routes using the local road network to deliver construction materials and to travel from Boone Dam to and from the proposed Construction Support Areas. Numerous residences and one sensitive receptor (e.g., schools, churches, hospitals) are within 1 mile of Boone Dam. A church located on Old Minga Road northeast of the dam. A few residences are across from the dam or along the shoreline within the dam's vicinity. There are numerous residences adjacent to or in the vicinity of the proposed Construction Support Areas along Minga Road and Old Minga Road.

3.14.2 Environmental Consequences

3.14.2.1 No Action Alternative

Under the No Action Alternative, the proposed remediation at Boone Dam would not occur and no project-related impacts on the ambient sound environment would occur. The reservoir water levels under Interim Operations would remain and would be similar to fall and winter reservoir water levels associated with Normal Operations. This would reduce the surface area of the reservoir year-round and the intensity of recreational boating, as well as increase the distance between motorized watercraft and the shoreline, which would reduce noise levels associated with motorized watercraft.

3.14.2.2 Proposed Action

Increased noise associated with the Proposed Action would occur at several areas within the reservoir and would transpire with varying timeframes. The first area that would be affected by noise impacts is at the dam and Construction Support Areas, where all construction activities associated with the Proposed Action would occur. Noise sources during construction would be associated with drilling through the dam's earthen embankment, equipment usage associated with injecting the grout into these drill holes, heavy equipment usage to remove portions of the dam where drilling and grout injection would occur, grading and using trucks to remove and haul soils and other materials for transport to construction support areas, and using heavy equipment

to construct the concrete diaphragm wall. Noise levels have increased at the dam because of the various construction activities underway to prepare the dam for remediation activities.

Under the Proposed Action, it is anticipated that noise levels would be elevated further during implementation of the Proposed Action relative to the current noise levels at the dam. Noise levels associated with the remediation activities would periodically increase or decrease in intensity as construction activities vary.

Typical construction equipment and associated noise levels are described in Table 3-32. Construction noise would cause temporary and short-term adverse impacts on the ambient sound environment in the vicinity of the dam. Access to the reservoir and the use of personal watercraft in the immediate vicinity of the dam have been restricted by TVA's placement of buoys around the dam; this restriction would continue for the duration of the Proposed Action.

Table 3-32: Maximum Noise Levels at 50 feet for Common Construction Equipment

Equipment Type	Maximum Noise Level at 50 feet (dBA)
Air compressor	80
Auger drill	85
Backhoe	80
Boring jack power unit	80
Compactor (ground)	80
Concrete truck	85
Crane – boom truck	85

Source: USDOT 2006

TVA anticipates that the construction and activities associated with implementing the Proposed Action would occur throughout the week. Activities may occur on weekend days and within nighttime hours if TVA and its contractors determine that work is necessary to meet time-critical construction activities. TVA and its contractors have discretion to establish the start, end, and duration of work days.

Generally, the distance from the dam or Construction Support Areas to residences and other noise receptors would typically reduce the minor and temporary adverse impacts on noise levels in the area. The expanse of the reservoir, fencing, and associated forest and land coverage would serve as a buffer to most residences throughout the extent of the construction areas. Residents directly across the reservoir from the dam or near Construction Support Areas are most likely to experience adverse noise impacts. Residents near the proposed Construction Support Areas, who are currently less likely to experience noise impacts from current activities at the dam because of the distance from the site, would in some cases experience noise impacts for the first time under the Proposed Action, Generally, impacts on individuals visiting the areas surrounding the reservoir would be minimal.

The project also would result in increased noise impacts from heavy trucks driving along the haul route(s) to the two Construction Support Areas located along the local road network. TVA anticipates that materials would be transported in approximately 30 round-trips per day over the expected 5- to 7-year duration of the Proposed Action. The increase to the existing noise levels that residents near these two areas currently experience from truck traffic would be periodic and minor.

To reduce potential noise impacts, TVA would require the use of modern, well-maintained equipment and vehicles and would screen the equipment for noise emissions, when practicable. TVA also would seek to reduce the sound levels using various mitigation methods such as shielding, mufflers, dampners, aprons, or other measures when feasible.

Finally, noise impacts may occur under the Proposed Action along the reservoir and along the shoreline. The current reservoir water level under Interim Operations would remain and would be similar to water levels under Normal Operations during fall and winter. This would reduce the surface area of the reservoir year-round and the intensity of recreational boating, as well as increase the distance between motorized watercraft and the shoreline—all of which would reduce noise levels associated with motorized watercraft. TVA's plan to manage vegetation growth in the drawdown zone by periodically bushwacking or mowing would also generate localized and temporary noise when those activities are conducted around the reservoir.

Upon completion of construction activities under the Proposed Action, noise levels associated with these activities would cease and the ambient sound environment is expected to return to pre-construction levels. Therefore, the Proposed Action would not affect noise levels after the 5- to 7-year remediation project is complete. After the project, noise associated with existing hydropower electric power generation at Boone Dam, maintenance activity, and vehicular noise from visitors would be the primary sources of ongoing noise.

Overall, the No Action and the Proposed Action would result in minor, temporary adverse or beneficial impacts on the ambient noise environment for those residents living in proximity to the project sites during construction, and negligible impacts in association with operations.

3.15 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

This section provides an overview of existing public and occupational (worker) health and safety with regard to the Boone Dam facility and the potential impacts on public health and safety associated with the No Action Alternative and the Proposed Action. Public health and safety topics include emergency response and preparedness to ensure that project construction and operations do not pose a threat to public health and safety, as well as public safety considerations during Interim Operation of Boone Reservoir. Occupational health and safety issues include worker safety in compliance with the OSHA standards.

3.15.1 Affected Environment

A variety of federal safety regulations and requirements apply to all TVA facilities, lands, and projects. These include the following:

- Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S. Code [USC], 9601 et seq.);
- Superfund Amendments and Reauthorization Act Public Law 99-499 (100 Stats. 1613);
- Resource Conservation and Recovery Act (42 USC, 6901 et seq.);
- Clean Water Act (33 USC, 1251 et seq.), which includes requirements for Spill Prevention Control and Countermeasures Plans;
- Hazardous Material Transportation Act (49 USC, 59 et seq.);
- Toxic Substances Control Act (15 USC, 2601 et seq.);
- Federal Regulations on Hazardous Waste Management (40 CFR, Parts 260-279);
- Chemical Accident Prevention Provisions (40 CFR, Part 68);
- Emergency Planning and Community Right-to-Know Act of 1986 (42 USC, 16 et seq.); and
- OSHA standards (Occupational Safety and Health Act of 1970) (29 CFR).

Public emergency services in the area include various medical centers, a regional hospital, law enforcement services, and fire protection services. Health care institutions include the Holston Valley Medical Center and the Indian Path Medical Center located in Kingsport, Tennessee, approximately 5 miles north of Boone Reservoir. Others include the Johnson City Medical Center and the Franklin Woods Community Hospital, located in Johnson City, approximately 10 miles south of Boone Reservoir. Law enforcement services are provided to the area by the Washington County Sherriff's Office in Johnson City, the Sullivan County Sherriff's Office in Blountville, and the city police departments of Johnson City and Kingsport. TVA also provides police security for the dam and on the reservoir. TVA police patrol on the reservoir includes general boater safety outreach and boater behavior near the dam.

Fire departments are provided to the area by the Gray Volunteer Fire Department and fire stations in Colonial Heights, Kingsport, and Johnson City. Additionally, the Tennessee Emergency Management Agency is available to provide assistance by reaching out for mutual aid from local jurisdictions, Tennessee agencies and departments, and the federal government for assistance in the event of disasters and emergencies.

Upon TVA's observations in October 2014 that conditions indicated a potential risk to the integrity of a section of the dam, TVA released water from Boone Reservoir to the current drawdown condition. In coordination with a team of dam safety engineers, TVA implemented a number of IRRMs to reduce the risk of dam failure. In addition to lowering the reservoir water level, TVA has engaged local and state emergency management agencies, instituted actions to reinforce downstream facilities to minimize potential risks associated with dam failure, and installed buoy markers and barricade floats on Boone Reservoir and in the tailwater area (downstream of the dam) to designate areas of potential hazards to recreational users.

3.15.2 Environmental Consequences

3.15.2.1 No Action Alternative

Under the No Action Alternative, the proposed remediation activities at Boone Dam would not occur. Therefore, no additional occupational health and safety impacts on the workers would be associated with the proposed construction activities.

The reservoir water levels under Interim Operations would continue and would be similar to reservoir water levels during fall and winter associated with Normal Operations. This would reduce the surface area of Boone Reservoir year-round and change patterns of recreational boating use. The lowered water level likely would expose some subsurface and/or surface hazards that were not a problem at higher water levels. These hazards could include tree trunks, boulders, unusually shallow areas, and other objects that have accumulated at the bottom of the reservoir. While these hazards could negatively affect recreational public safety in the near term, this negative impact would diminish over time as boaters become aware of the location and nature of these hazards.

The buoy markers and barricade floats deployed by TVA on Boone Reservoir and in the tailwater area (downstream of the dam) to designate areas of potential hazards to recreational users would remain. TVA would work closely with TWRA to mark any additional hazards in the reservoir that pose a threat to the health and safety of boaters. Emergency responder access may be delayed until existing boat ramps/launches are extended, and new boat ramps/launches are constructed, to the current reduced water level. Impacts on public safety under the No Action Alternative would be moderate and would continue to diminish as boaters become accustomed to the hazards preset at the lower water level and emergency access is improved.

3.15.2.2 Proposed Action

Construction activities associated with the Proposed Action would expose workers to hazards associated with most large construction projects, including falls, heavy equipment accidents, and trenching accidents. Additionally, due to the proximity of the proposed construction areas to Boone Reservoir, there is the possibility that falling into the water could lead to injury or death. Finally, construction activities would be close to energized electrical transmission lines and equipment associated with the hydroelectric power plant, which could result in various degrees of electrocutions or burns to workers who would come into contact with these objects. Environmental hazards of construction projects include working in extreme temperatures (primarily heat stress) and potential exposures to biological hazards such as mosquitoes, ticks, poisonous spiders, and venomous snakes.

TVA would require the construction contractors to emphasize safety, to follow all OSHA and other federal and state regulations with respect to worker safety, and to comply with all applicable health and safety procedures. As construction work has known hazards, standard practice is for contractors to establish and maintain health and safety plans in compliance with OSHA regulations. Such health and safety plans emphasize implementation of BMPs for site safety management to minimize potential risks to workers. Based on the nature of the proposed

construction activities and their proximity to water and the hydroelectric power plant, the risk of potential temporary minor negative impacts related to occupational health and safety are increased but could be mitigated through implementation of a rigorous site health and safety plan.

Under the Proposed Action, the reservoir water levels under Interim Operations, which would be similar to fall and winter reservoir water levels under Normal Operations, would remain for the 5- to 7-year duration of the project. The lowered water level reduces the water column of the reservoir and may result in subsurface or surface hazards that were not present prior to the reservoir drawdown. While these hazards could negatively affect recreational public safety in the near term, this negative impact would diminish over time as boaters become aware of the location and nature of these hazards.

TVA-deployed buoy markers and barricade floats on Boone Reservoir and in the tailwater area would remain during the duration of the dam remediation. TVA would work closely with TWRA to mark any additional hazards in the reservoir that pose a threat to the health and safety of boaters. Emergency responder access may be delayed until existing boat ramps/launches are extended, and new boat ramps/launches are constructed, to the current reduced reservoir level. Public safety impacts associated with the drawdown period of the Proposed Action would be moderate and would diminish with increased boater knowledge of water hazards and as infrastructure improvements were made to improve emergency responder access to the reservoir. Upon completion of the Proposed Action, the reservoir water level would be raised to Normal Operations, and impacts on these hazards would be eliminated due to the increased depth of the reservoir water column. Public safety impacts would revert to those observed prior to initiation of Interim Operations.

Upon completion of the Proposed Action, the reservoir water level would be raised to Normal Operations and vegetation that has established along the exposed reservoir bottom will be inundated. TVA's vegetation management plan would aid in management of the successional vegetation on much of the exposed reservoir bottom. Vegetative growth would be managed with annual or periodic mowing or bushwhacking, as requested by property owners. TVA's two primary objectives are to remove tree species from the newly exposed reservoir bottom areas that normally do not establish due to season pool levels and to avoid having trees mature during the drawdown period to heights that would create navigation and public safety problems once the waters are returned to normal levels.

Potential public and occupational health and safety hazards could result from the flow of construction traffic along the public roadways. Although the proposed number of trucks is not anticipated to significantly affect traffic in the region, the presence of these trucks on the local roadway network throughout the duration of the Proposed Action could negatively affect the traveling public and workers operating project-related trucks and vehicles. Similarly, public knowledge of the haul routes and clearly marked signage along the haul routes would increase public awareness of the trucks using the roadway network throughout the duration of the construction activities.

Overall, implementation of the Proposed Action would result in minor impacts on public and occupational health and safety.

3.16 WASTE MANAGEMENT

This section describes existing solid waste management at the proposed Boone Dam project site and the potential impacts on solid waste management associated with the No Action Alternative and the Proposed Action.

Solid waste may include a variety of components normally generated from construction activities, including biodegradable waste (i.e., food and kitchen waste), recyclable materials (i.e., paper, glass, metals, certain plastics), and inert materials (e.g., construction waste, dirt, rocks). Sources of solid waste include construction activities, construction equipment and maintenance, commercial and industrial facilities, and households and the generation of discarded items such as scrap metal, appliances, and furniture. Generally, solid waste is managed by reduction, reuse, recycling, and disposal in landfills.

3.16.1 Affected Environment

Boone Reservoir is located on the border between Sullivan and Washington Counties in Tennessee and near the cities of Boring and Spurgeon in Sullivan and Washington Counties, respectively. Solid waste generated in Sullivan County is managed by the cities of Kingsport and Bristol government offices (Sullivan County Government 2015), while solid waste generated in Washington County is managed by the Washington County government offices (Washington County Government 2015a). Two Class III landfills are within the geographic region of Boone Reservoir. The Kingsport Demolition Landfill is a Class III demolition landfill that accepts waste streams including brick or block, rock, soil, asphalt, concrete, and building materials (e.g., sheet rock, lumber) (City of Kingsport 2015; TDEC 2015c). The Bristol Demolition Landfill is a Class III demolition landfill that accepts waste streams including non-household waste and construction materials (TDEC 2015c). In addition, the Iris Glen Environmental Center, located in Johnson City, accepts waste including asbestos-friable, asbestos-non-friable, construction and demolition debris, drum management-solids, industrial and special waste, and municipal solid waste (Waste Management 2015). The Eco Safe Landfill, managed by Advanced Disposal and located in Blountville, also accepts a variety of waste streams including municipal solid waste, construction and demolition wastes, yard waste, and contaminated soil (Advanced Disposal 2015).

In addition to landfill capacity in the vicinity of Boone Reservoir, three recycling centers are located in Sullivan County (Sullivan County Government 2015) and five in Washington County (Washington County Government 2015b). Combined, these recycling centers process mixed paper, aluminum, used oil, glass, plastic, cardboard, appliances and electronics, batteries, copper, brass, steel, iron, antifreeze, and paint (Washington County Government 2015b).

3.16.2 Environmental Consequences

3.16.2.1 No Action

Under the No Action Alternative, the proposed remediation at Boone Dam would not occur and no project-related impacts on solid waste management would occur. Therefore, existing waste management conditions likely would remain as they are at present.

3.16.2.2 Proposed Action

Construction associated with the Proposed Action would generate several nonhazardous solid waste streams. Soils, rock, concrete, and other clean fill materials would be removed and used at the two Construction Support Areas. Continuation of the current Interim Operations water levels at Boone Reservoir would not affect solid waste management.

In addition to removal, disposal, and storage of these materials, the Proposed Action would include injection of low-mobility and high-mobility grouts into the epikarst and bedrock below the dam. The low-mobility grouts would consist of variable mixtures of water, pea gravel, sand, cement, natural silts, and fly ash while the high-mobility grouts would consist of variable mixtures of water, sand, cement, fly ash, welan gum, superplasticizers, and stabilizers, or other admixtures. TVA would require its contractors to submit Material Safety Data Sheets for these grout mixture components for approval. Geological analysis of the bedrock and epikarst underlying the dam is currently underway; therefore, the anticipated volume of grouts and grout waste is currently unknown as the grout would fill voids within the geologic formations underneath the dam. BMPs such as secondary containment for oils/lubricants/fuels, on-site spill containment and remediation supplies, and recurring personnel training would be implemented throughout the duration of the construction to minimize the possibility of spills and to dictate appropriate measures in the event of a spill.

Overall, adverse direct and indirect impacts on solid waste management would be minor and temporary because of the nonhazardous nature of materials (i.e., rock and soil) and construction material waste streams (i.e., cement and grouting materials) associated with the Proposed Action. Implementation of BMPs and employee/construction contractor training for spill avoidance and spill response/clean-up as a component of the construction work plan would further reduce adverse impacts on solid waste management associated with the Proposed Action.

3.17 TRANSPORTATION

This section describes an overview of the regional transportation infrastructure (i.e., the roadway network) at Boone Dam and Reservoir and discusses the potential impacts on these transportation resources associated with the No Action Alternative and the Proposed Action.

3.17.1 Affected Environment

Access to Boone Dam is available from two intersections with State Route (SR) 75, near the town of Spurgeon (Figure 3-21).

The shortest route to access Boone Dam is the intersection of Boone Dam Road, a two-lane road, and SR 75. This route, approximately 0.6 miles from SR 75 to Boone Dam, is located approximately 1.1 miles northeast of the intersection of SR 75 and SR 36. SR 75 is a four-lane road with a continuous center turn lane that is oriented in a southwest-to-northeast direction; SR 36 is a four-lane road that is oriented in a northwest-to-southeast direction. The entrance to Boone Dam Road that is available from SR 27 is served by this continuous turn lane. SR 36 provides access to Interstate-81 at an intersection approximately 4.6 miles from the intersection of Boone Dam Road and SR 75. A longer access route to the Boone Dam is available at the intersection of SR 75 and Hamilton Mill Road, approximately 1.3 miles northeast of the intersection at SR 75 and Boone Dam Road. This route is approximately 3.2 miles in length and uses Hamilton Mill Road, a two lane road, for approximately 0.3 mile to the intersection at Minga Road, a two lane road, for approximately 1.6 miles. This route also passes through several residential areas while the shorter route, via Boone Dam Road, does not pass through residential areas. Figure 3-21 provides an overview of the roadway network and the two access routes to Boone Dam.

Existing traffic volumes for 2013 and 2014 were determined using average annual daily traffic (AADT) counts measured at exiting Tennessee Department of Transportation (TDOT) stations (TDOT 2015a) on SR 75, SR 36, and Interstate 81 in the vicinity of Boone Dam. The AADT counts represent the total volume of vehicle traffic of a highway or road for a year divided by 365 days. They are a useful and simple measurement of how busy the road is. Table 3-33 presents these historical traffic volumes to provide existing vehicle usage on the local road network that could be used in conjunction with the Proposed Action. The AADT data provided in Table 3-33 are also presented in Figure 3-21 for a graphic representation of existing traffic volumes on the localized roadway network.

Figure 3-21: Local Road Network, Traffic Counts, and Access Routes

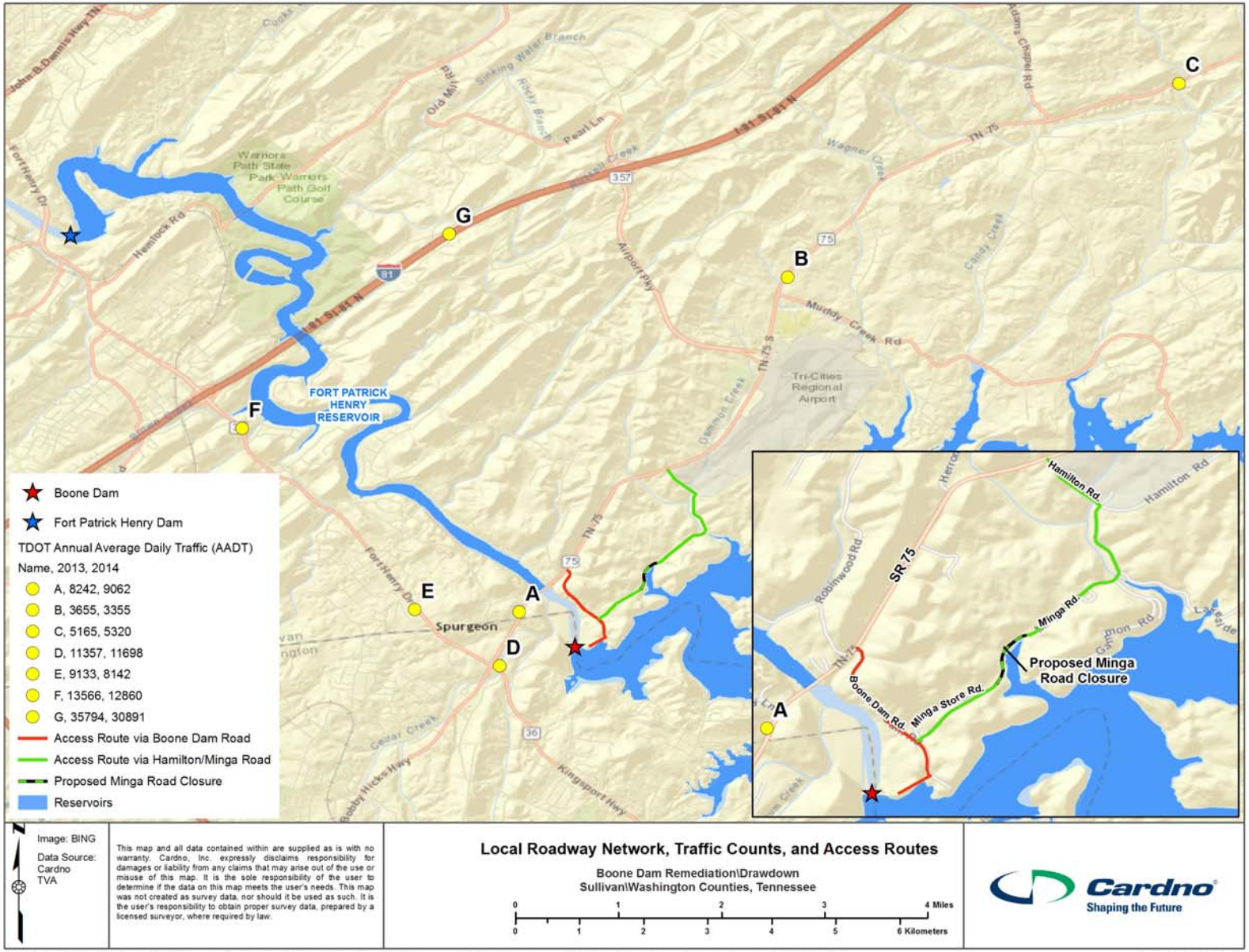


Table 3-33: Existing Traffic Volumes in the Project Vicinity (2013 and 2014)

Road	Location of TDOT AADT Measurement	TDOT Annual Average Daily Traffic		Marker Number Shown in Figure 3-21
		Calendar Year 2014	Calendar Year 2013	
SR 75	East of intersection at SR 36; 0.5 mile northwest of Boone Dam	9,062	8,242	A
SR 75	Northeast of Tri-Cities Airport; 4 miles northeast of Boone Dam	3,355	3,655	B
SR 75	Southwest of Tri-Cities Airport; 7.3 miles northeast of Boone Dam	5,320	5,165	C
SR 75 and SR 36 intersection	0.6 mile southwest of Boone Dam	11,698	11,357	D
SR 36	0.8 mile northwest of intersection at SR 75; 1.2 mile northwest of Boone Dam	8,142	9,133	E
SR 36	0.4 mile southeast of interchange at Interstate 81; 4.1 miles northwest of Boone Dam	12,860	13,566	F
Interstate 81	2.5 miles northeast of interchange at SR 36; 7 miles south of Boone Dam	30,891	35,794	G

Source: TDOT 2015a

3.17.2 Environmental Consequences

3.17.2.1 No Action

Under the No Action Alternative, the proposed modifications to Boone Dam would not be constructed and haul routes would not be used. Therefore, no construction-related impacts on transportation resources would result.

Under the No Action Alternative, the reservoir water levels would remain at Interim Operations levels (between 1,350 and 1,355 feet). The existing drawdown condition has resulted in reduced access to and use of recreational facilities (e.g., marinas, boat ramps/launches) throughout Boone Reservoir. As a component of the existing risk reduction plan for Boone Dam, TVA closed the Boone Dam Recreation Area, which consists of a beach and swimming area, a boat ramp, and picnic areas adjacent to Boone Dam. Because of these closures, recreation-related traffic on the local roadway network likely has diminished. TVA anticipates relocating the Boone Dam Recreation Area east of its current position. When it re-opens, the traffic volume on access roads is anticipated to resume. Additionally, it is expected that access to the lowered water level would be improved over time (e.g., extending boat ramps, modifying recreational areas near the water) and recreation-related traffic would resume.

Overall, minor and temporary direct impacts on traffic volumes could occur under the No Action Alternative.

3.17.2.2 Proposed Action

TVA anticipates that an average of approximately 50 workers would be present on a daily basis throughout the 5- to 7-year lifespan of the Proposed Action. All construction activity would occur within the immediate vicinity of Boone Dam. All construction workers, most construction deliveries, and construction equipment would access the proposed construction site at the dam from Boone Dam Road at SR 75. Typically, construction activities would occur from dawn to dusk during business days; therefore, construction worker traffic entering and leaving the site would increase traffic volume at the intersection of SR 75 and SR 36 as well as at the entrance of Boone Dam Road at SR 75. This could result in localized congestion at these intersections that would adversely affect traffic at times when workers are entering and leaving the Boone Dam project site. TVA would attempt to limit deliveries of crushed stone, riprap, and other materials to usual business hours, approximately 10 hours per day, to the extent practicable. Left-hand turning movements from SR 75 southbound to Boone Dam Road are not anticipated to substantially affect traffic as SR 75 recently was widened to include a dedicated left-turn lane to Boone Dam Road. The additional vehicles associated with the anticipated 50 workers at the Boone Dam project site would result in moderate impacts on SR 75 and SR 36 in the immediate vicinity of Boone Dam. Therefore, it is anticipated that the additional traffic associated with workers on the site would constitute only a minor adverse impact on local traffic conditions.

In order to use two parcels on Minga Road and adjacent to the Boone Dam reservation as Construction Support Areas, TVA proposes that a small segment of Minga Road (see Figures 1-6 and 3-21) would be closed to the public for an estimated 2 to 4 years during construction, most likely beginning in 2016. This road closure would restrict motorists from the construction areas and relieve local motorists from impacts associated with construction traffic, including the exposure of motorists to work areas and poor roadway conditions during construction, and to reduce exposure of workers to traffic activity.

The closure on Minga Road would not result in any residential driveway access closures. During the road closure, road signage would be erected to alert motorists about upcoming closure distances, and a turnaround area would be constructed at the terminus of the temporary road closure to allow vehicles to safely turn their vehicles. When access is no longer needed for construction, the closed portion of Minga Road would be repaired to pre-closure condition and would be re-opened to the public. The proposed closure of Minga Road would eliminate the use of construction vehicles on the residential portion of the road and would result in minor impacts on residential traffic using Minga Road.

Residents along Minga Road that would be most affected by closure of the portion of the road currently have an approximately 1.5-mile drive from their residences to the intersection of Boone Dam Road and SR 75. When the road closure is in effect, these same residents would have an approximately 2.4-mile drive (via Minga Drive to Hamilton Road) to the same intersection along SR 75. This small detour would result in only minor impacts on residential traffic in the

immediate area. The closure would also affect current school bus routes along Minga Road for the duration of the closure.

Under the Proposed Action, the reservoir water levels would remain at Interim Operations levels for the 5- to 7-year project duration. The continued drawdown and the temporary closure of the TVA Boone Dam Recreation Area would limit recreation-related traffic until these facilities were modified or re-opened. Recreation-related traffic is anticipated to return to the levels before Interim Operations began when the Boone Reservoir water level is raised.

The Proposed Action would result in localized minor impacts on traffic volumes at access points to the Boone Dam construction area and at the proposed Construction Support Areas. The addition of trucks onto the roadway network associated with the haul routes would not be an appreciable addition to the traffic volumes observed on the roadway network. Overall, direct impacts on transportation resources associated with implementation of the Proposed Action are anticipated to be minor.

3.18 LAND USE

This section provides an overview of the existing land use in the vicinity of the Boone Dam project and lands adjacent to Boone Reservoir, and the potential impacts on land use associated with the No Action Alternative and the Proposed Action.

3.18.1 Affected Environment

Boone Reservoir has approximately 131 miles of shoreline, of which the majority is privately owned, flowage easement land. The remaining lands are owned and managed by TVA, owned by TVA and jointly managed, or TVA-owned shoreline access.

Approximately 66 percent of the Boone Reservoir shoreline is residential. The Watauga Arm of the reservoir includes a higher concentration of urban residential development on the southern shore in Washington County, Tennessee. This area includes one developed TVA area at the dam reservation, four commercial docks, a city park, and three public access areas. Several large parcels of rural land on the northern shoreline of the Watauga Arm are active dairy and beef cattle farms. Most of the TVA-owned land lies in this segment of the reservoir.

The South Fork Holston River Arm is primarily privately owned land, with moderate urban residential development interspersed with several farms, primarily beef cattle. There are four commercial docks, a city park, and five public access areas.

The Boone Dam reservation contains several buildings associated with power production from Boone Reservoir, the dam, the control building, the powerhouse, the switchyard, and the regional hydropower production maintenance building, as well as power transmission lines. Additional facilities located on the reservation are the Boone Dam Visitors Center, a picnic area, a beach area with public restrooms, a firing range for the TVA police, maintenance facilities, and the Water Management Field Engineering Base.

TVA's current reservoir land planning process allocates land to seven land use allocation zones (Figure 3-22). Land use allocations were determined by TVA with consideration of the social, economic, and environmental conditions around the reservoir using a land use management process that included public involvement (TVA 2010). Figure 3-22depicts the composition of Boone Reservoir lands allocated to each land use zone. Zone 1 (Non-TVA Shoreland) accounts for the largest portion of land on Boone Reservoir, followed by (in descending order) Zone 4 (Natural Resource Conservation), Zone 2 (Project Operations), Zone 3 (Sensitive Resource Management), Zone 6 (Developed Recreation), and Zone 7 (Shoreline Access). No Zone 5 (Industrial Lands) are present on Boone Reservoir.

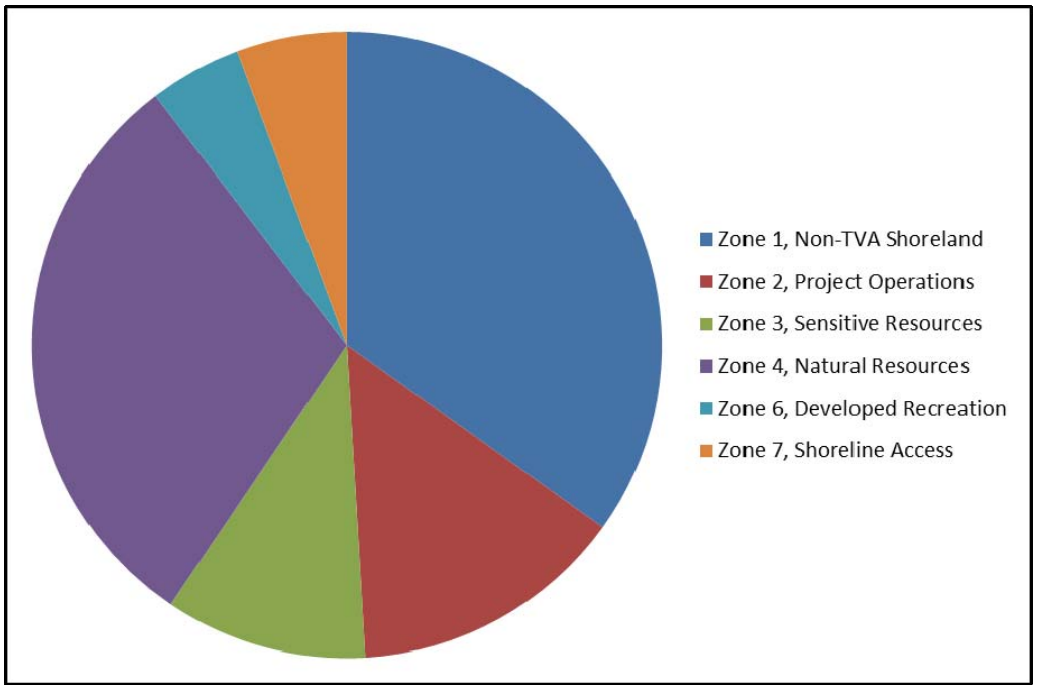


Figure 3-22: Approximate Percent of Boone Reservoir Acreage by Land Use Zone

As described in Chapter 2, TVA intends to establish two Construction Support Areas for reuse and/or stockpiling of clean rock, soil, and fill materials generated during drilling and excavation for the dam remediation. Construction Support Area 1 (also known as the Earl Light Tract) is allocated as Zone 4 (Natural Resource Conservation) and would occupy 71.2 acres of the 118-acre parcel. The tract is currently managed by TVA for dispersed public recreation and natural resources. A 54-acre portion of this parcel also is licensed for agricultural use as hay land. The parcel was allocated to Zone 4 (Natural Resource Conservation) to reflect its capability to provide a diversity of ecological communities and recreation opportunities. The majority of the activities at Area 1 would be located within areas that are maintained primarily as open fields and previously were used as a borrow pit during construction of Boone Dam.

Construction Support Area 2 (also known as Tract 22R) is allocated as Zone 6 (Developed Recreation) and would occupy 12.8 acres of the 53-acre parcel. The larger parcel that this site is a part of consists primarily of forested areas, and a small area is mowed grass. The parcel

was allocated to Zone 6 (Developed Recreation) to reflect current recreation uses, including a paved boat ramp and parking lot, courtesy pier, and fishing access. The majority of the activities at Construction Support Area 2 would be located within an area of this parcel that primarily is an existing utility right-of-way with a transmission line.

3.18.2 Environmental Consequences

3.18.2.1 No Action Alternative

Under the No Action Alternative, the proposed remediation at Boone Dam would not occur, reservoir water levels would be permanently left at Interim Operations levels, and Interim Operations would continue. Therefore, land activities would not change, and no direct or indirect construction-related impacts on land use designations would result. The existing land use at Boone Dam and the surrounding construction areas are expected to remain classified and operated as Project Operations lands consisting of existing operational facilities and undeveloped areas.

Although the Interim Operations water levels would result in exposed reservoir bottom, the existing land use zones on Boone Reservoir would not change.[12] It is anticipated that these lands would remain shoreline property maintained primarily as residential and undeveloped areas. It is possible that some landowners may build structures down to the current water levels; however, this would not result in a change in the current land use as it would remain shoreline property.

3.18.2.2 Proposed Action

Under the Proposed Action, activities within the Boone Dam reservation would change during the dam remediation process, but land use allocations or designation would not change as a result of the construction. The construction laydown areas are a part of the Boone Dam reservation that is used for project operations purposes. The existing land use at Boone Dam and the surrounding construction areas are expected to remain as Project Operations.

Land use at TVA's proposed Construction Support Areas would be directly affected during the project, as portions of these tracts would be managed in a manner that is not consistent with their current zone allocations. After the completion of the project, Construction Support Area 1, currently allocated as Zone 4 (Natural Resource Conservation), would again be managed for natural resource conservation. Similarly, Construction Support Area 2, currently allocated as Zone 3 (Developed Recreational), would be managed for developed recreation. Implementing the Proposed Action does not change TVA's zone designations for these areas because the proposed uses are temporary. TVA would return disturbed areas at the dam location and at the two Construction Support Areas to their previous uses. Disturbed areas would be revegetated with native or noninvasive plant species, and TVA would regrade and restore areas that previously were disturbed (e.g., borrow pit areas) to an improved condition.

[12] Designated land use changes may occur in the future as part of TVA's standard land management planning process.

Under the Proposed Action, reservoir water levels would be left at the Interim Operations levels and Interim Operations would continue. Following Boone Dam remediation, water levels under Normal Operations would resume.

Although the current operating water levels would result in exposed reservoir bottom, the existing land use zones on Boone Reservoir would not change. It is anticipated that these lands would remain shoreline property maintained primarily as residential and undeveloped areas. Land use activities may change, as it is possible that some landowners may build temporary structures down to the current water levels and develop other temporary uses on the exposed reservoir bottom areas. These activities would not result in a change in the current land use designation. Following completion of dam remediation activities, water levels would be returned to Normal Operation levels, and areas of exposed reservoir bottom would return to seasonally-inundated shoreline.

This page intentionally left blank.

CHAPTER 4

4.0 CUMULATIVE IMPACTS

Cumulative impacts on the environment results from the incremental impact of the action when added to the impacts of other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (Council on Environmental Quality Regulations, Section 1508.7). This section evaluates the potential cumulative impacts of the project alternatives together with other past, present, and reasonably foreseeable future actions. The potential cumulative impacts are described in each resource area below; they vary by resource area, but not all resources have the potential for cumulative impacts.

Cumulative effects are examined within the geographic area of the Boone project over the 5- to 7-year project duration. For the purposes of this evaluation, the geographic scope is limited to the area over which the impacts from the Proposed Action may overlap with or interact with impacts from other past, present, and reasonably foreseeable future actions.

To identify other past, present, and reasonably foreseeable future actions, TVA sought information on specific projects, developments, or activities with impacts that could overlap with those of the No Action Alternative and the Proposed Action. TVA identified these actions by examining TVA's internal records and the following publically available resources:

- Local and regional news sources;
- Town of Spurgeon and Johnson City government website records, including planning commission meetings, city meeting minutes, and public notices;
- The TDOT website; and
- Sullivan and Washington Counties Chamber of Commerce websites and meeting minutes.

In addition to the projects identified in Section 1.5 (Similar and Connected Actions) and in Table 1-2 and Section 1.5.2, TVA identified six past, present, and reasonably foreseeable future actions within the geographic area of the project for consideration in the cumulative impacts analysis. Table 4-1 identifies the locations, timeframes, and general scope of these additional identified projects.

Prior related activities identified in Table 1-1 included various site preparation activities and IRRMs. These actions are recent past and ongoing actions occurring over the same area as the Proposed Action and were evaluated under separate NEPA reviews, specifically CECs. These actions would result in only minor temporary impacts within the same area as the construction associated with the Proposed Action and would not contribute to cumulative impacts in the area of the project.

Table 4-1: Projects Identified for Consideration in the Cumulative Impacts Analysis

Project	Location	Status	Description
Floating Houses Policy Review	Twenty-nine reservoirs in the Tennessee River watershed, including Boone and FPH Reservoirs	Under NEPA review (Draft EIS published in June 2015)	TVA is considering how to respond to increased mooring of floating houses on its reservoirs and is evaluating a set of five policy alternatives, in addition to the No Action Alternative. The identified alternatives include grandfathering existing floating houses (permitting them to remain on the reservoirs), removal after a 30-year sunset period, and immediate removal.
SR 126 (Memorial Boulevard) Corridor Improvement Project	Nearest point approximately 4 miles northwest of Boone Dam	Final EIS approved in November 2014; Federal Highway Administration Record of Decision issued in April 2015; Notice of Final Federal Agency Action issued in July 2015.	The TDOT, in cooperation with the Federal Highway Administration, is proposing to improve SR 126 between the City of Kingsport and Interstate-81. The project will provide a safe, efficient route for local traffic between the City of Kingsport and Interstate-81.
TDOT upgrade of SH 75 interchange bridge over I-26	Approximately 3 miles south of Boone Dam	Construction ongoing	The TDOT is upgrading the SH 75 interchange bridge over I-26. Current activities have necessitated nightly lane closures and brief rolling roadblocks in this area. Traffic congestion during peak travel times is likely in this area.
TDOT upgrade on SR 36 between SR 354 and SR 75	Nearest point approximately 0.75 mile south of Boone Dam	Construction ongoing	The TDOT is upgrading SR 36 between SR 354 and SR 75. Intermittent lane closures and temporary detours are expected as a result of this work.
TDOT upgrade on SR 34 between SR 44 and Bristol City Limits	Approximately 8.5 miles northeast of Boone Dam; crosses South Fork Holston River	Construction ongoing	The TDOT is upgrading SR 34 between SR 44 and Bristol City limits. Intermittent lane closures and temporary detours are expected as a result of this work.
TDOT upgrade on US 11E/SR 34 at US 19E/SR 37	Approximately 8.5 miles northeast of Boone Dam and 0.75 mile south of South Fork Holston River	Construction ongoing	The TDOT is upgrading US 11E/SR 34 at US 19E/SR 37. Intermittent lane closures and temporary detours are expected as a result of this work.

Sources: TDOT 2015b, 2015c; TVA 2015c and TVA internal records

4.1 POTENTIAL CUMULATIVE IMPACTS

No direct or indirect cumulative impacts are expected to result related to prime farmlands, hazardous materials, climate change, or navigation. This is because there were no direct impacts of the alternatives on these resource areas or because no interactive effects are expected from the projects previously identified in this EA (Table 1-2 and Section 1.5.2) and the additional projects identified in Table 4-1.

Potential cumulative impacts were determined primarily to be associated with geologic resources, water resources, terrestrial ecology, aquatic ecology, air quality, socioeconomics, recreation, visual resources, noise, public and occupational health and safety, waste management, and transportation. The Proposed Action also could affect floodplains, wetlands, threatened and endangered species, cultural and historic resources, and land use; but these effects would be minor and are not anticipated to contribute to cumulative impacts when considered with the impacts of the projects previously identified in this EA (Tables 1-2 and Section 1.5.2) and the additional projects identified in Table 4-1.

Implementation of the project alternatives is not expected to result in any more than minor adverse cumulative effects to any resources. Each of the subsequent resource area sections discusses cumulative impacts on those resources.

4.1.1 Geologic Resources

The dam remediation activities associated with the Proposed Action would not result in cumulative impacts on geology in the area. Projects identified for consideration in this cumulative impacts analysis would not involve activities that would affect geologic resources.

Erosion and sedimentation related to soil disturbance during construction activities and along the exposed reservoir bottom during the period of the drawdown associated with the Proposed Action and No Action Alternative could contribute to a minor cumulative impact with erosion and sedimentation resulting from construction of the new beach/recreation area and boat ramp extensions along the shoreline of Boone Reservoir. However, cumulative impacts would be limited to the period of overlapping construction. In addition, TVA would mitigate potential impacts by implementing BMPs to control erosion and sedimentation during construction of the projects, and the TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation of the portions of the exposed reservoir bottom. TVA would also provide guidance to landowners to enhance revegetation along the exposed reservoir bottom with appropriate native plant species. The TDOT projects identified in Table 4-1 are not anticipated to contribute to cumulative erosion and sedimentation impacts because of their minor nature. The TVA Floating Houses Policy Review does not involve ground disturbance and would not contribute to cumulative erosion and sedimentation impacts.

Implementation of the project alternatives is expected to result in only minor and temporary adverse cumulative impacts on geology and soils.

4.1.2 Water Resources

The remediation activities associated with the Proposed Action, considered together with other projects (Tables 1-2 and 4-1) would result in minor cumulative impacts on water resources in the area. Erosion and sedimentation related to soil disturbance during construction and along the exposed reservoir bottom during the period of the drawdown associated with the Proposed Action and the No Action Alternative could result in a minor cumulative impact on surface water with the erosion and sedimentation resulting from construction of the new beach/recreation area, boat ramp extensions along the shoreline of Boone Reservoir, and road construction in the local watershed (Tables 1-2 and 4-1). However, cumulative impacts would be limited to the period of overlapping construction. TVA would mitigate potential impacts by implementing BMPs to control erosion and sedimentation during construction of the projects, and the TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation of the portions of the exposed reservoir bottom. TVA would also provide guidance to landowners to enhance revegetation along the exposed reservoir bottom with appropriate native plant species.

No cumulative impacts on groundwater flows, quality, or supply are expected as a result of the Proposed Action or the No Action Alternative and the projects identified for consideration in this cumulative impacts analysis. Implementation of the project alternatives would result in only minor and temporary adverse cumulative impacts on surface water resources.

4.1.3 Floodplains and Flood Risk

Neither the Proposed Action nor the No Action Alternative would contribute to cumulative impacts on floodplains. Adverse impacts on floodplains are not expected as a result of the projects identified for consideration in this cumulative impacts analysis, because none were found that would have an impact on floodplains; therefore, no potential for cumulative impacts exist.

4.1.4 Wetlands

Neither the Proposed Action nor the No Action Alternative would contribute to cumulative impacts on wetlands because the impacts are minor and temporary and would consist mostly of changes in the location and types of wetland resources. Adverse impacts on wetlands are not expected as a result of the Proposed Action or the projects identified for consideration in this cumulative impacts analysis (Tables 1-2 and 4-1), therefore no potential for cumulative impacts exist

4.1.5 Terrestrial Ecology

The dam remediation activities associated with the Proposed Action, considered together with other projects (Tables 1-2 and 4-1) would result in a minor way to cumulative impacts on terrestrial ecology in the area. Each of the projects identified for consideration in this cumulative impacts analysis, with the exception of the TVA Floating Houses Policy Review project, involve construction activities that would contribute in varying degrees to impacts on terrestrial ecology. Impacts resulting from the construction under the Proposed Action and construction of the new

beach/recreation area and boat ramp extensions (Table 1-2) along the shoreline of Boone Reservoir would have the greatest potential for cumulative impacts as these projects involve disturbance of vegetation and disruption of wildlife in the area of construction. However, cumulative impacts are expected to be minor, localized, and limited to the period of overlapping construction. In addition, appropriate BMPs would be installed and maintained to protect water quality in emergent plant communities and shoreline habitat, and implementation of the TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance vegetative communities and improve wildlife habitat during the drawdown. TVA would also provide guidance to landowners to enhance revegetation along the exposed reservoir bottom with appropriate native plant species.

4.1.6 Aquatic Ecology

The remediation activities associated with the Proposed Action, considered together with other projects (Tables 1-2 and 4-1) would result no more than minor cumulative impacts on aquatic ecology in the area. Erosion and sedimentation related to soil disturbance during construction and along the exposed reservoir bottom during the period of the drawdown associated with the Proposed Action and the No Action Alternative, and erosion and sedimentation resulting from construction of the new beach/recreation area and boat ramp extensions along the shoreline of Boone Reservoir could cause a minor cumulative impact on aquatic species. However, the minor cumulative impacts on aquatic habitats would be temporary, and TVA would mitigate potential impacts by implementing BMPs to control erosion and sedimentation during construction of the projects. In addition, the TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance shoreline fish habitat after normal pool levels return, which would benefit aquatic species and mitigate some of the effects. Vegetation established along the previously exposed reservoir bottom would not survive the inundation, but the remnant biomass would provide ample cover for young fish, as well as provide organic carbon and nutrients into the reservoir.

4.1.7 Threatened and Endangered Species

Neither the Proposed Action nor the No Action Alternative would contribute to cumulative impacts on threatened and endangered species. Adverse impacts on threatened and endangered species are not expected as a result of the Proposed Action or the projects identified for consideration in this cumulative impacts analysis; therefore, no potential for cumulative impacts exist.

4.1.8 Cultural and Historic Resources

Neither the Proposed Action nor the No Action Alternative would contribute to cumulative impacts on historic buildings and structures. Adverse impacts on these resources are not expected as a result of the Proposed Action or from the projects identified for consideration in this cumulative impacts analysis (Tables 1-2 and 4-1). In the reservoir drawdown area, adverse effects to archaeological resources may result from looting of artifacts or accelerated erosion of intact archeological deposit and/or features. Projects identified for consideration in this cumulative impacts analysis, with the exception of the TVA Floating Houses Policy Review

project, involve construction activities which have potential to affect archaeological resources. However, TVA and other agencies would avoid or mitigate those impacts in accordance with applicable law.

4.1.9 Air Quality

The remediation activities associated with the Proposed Action, together with other projects such as road improvements (Table 4-1) would result in minor cumulative impacts on air quality in the area. Each of the projects identified for consideration in this cumulative impacts analysis, with the exception of the TVA Floating Houses Policy Review, would involve construction activities that would generate construction air emissions and fugitive dust in the area.

Although Sullivan County is designated as non-attainment due to lead and sulfur dioxide (USEPA 2015), the Tennessee State Implementation Plan sets forth standards, controls, and monitoring requirements for addressing compliance with the NAAQS. In addition, it is not expected that the emissions during construction of the project would be a significant source of $SO_{2,}$ and therefore would not appreciably contribute to applicable ambient air quality standards.

It is anticipated that air emissions and dust resulting during the period of construction for the Proposed Action and the projects identified for consideration in this cumulative impacts analysis would be localized, minor, and temporary. TVA would implement construction BMPs to address air emissions from open construction areas and unpaved roads. Areas would be sprayed with water as needed to reduce fugitive dust emissions.

4.1.10 Socioeconomics

The actions, identified in Table 1-2, to increase access to Boone Reservoir under the interim reservoir operations, would contribute to positive cumulative impacts. Increasing reservoir access reduces the adverse socioeconomic impacts associated with limited reservoir access and the associated reduction in spending on recreation-based activities. Whether recreation-based spending comes from visitors to the reservoir, or from reservoir-front property owners, both user groups are adversely affected when reservoir access is limited. The planned boat ramp extensions and new beach and recreation area would partially mitigate adverse impacts to visitor's use of the reservoir. TVA's offer to waive the Section 26a permitting allowances would partially mitigate effects to both marina owners/operators and private shoreline property owners who seek to invest in construction projects to improve reservoir access.

4.1.11 Recreation

The drawdown of Boone Reservoir has an adverse impact recreation due to reduce access and a smaller reservoir available for recreation, however, the related activities identified in Table 1-2 would offset the effect by increasing access to Boone Reservoir at the reduced reservoir elevation. Therefore, these actions together yield a smaller adverse cumulative impact on recreational access and use.

TVA's offer to waive the Section 26a permitting allowances would partially mitigate effects to both marina owners/operators and private shoreline property owners who seek to invest in construction projects to improve reservoir access.

4.1.12 Visual Resources

The combined construction at Boone Dam and construction of the new beach/recreation area could produce minor and temporary adverse impacts on visual resources. Cumulative impacts on visual resources would be localized to certain views from the reservoir and shoreline, and would be limited to the period of overlapping construction. In addition, public access to the Boone Dam Reservation currently is restricted, which limits visibility of the site from the area immediately around the dam. This restriction would continue throughout the duration of construction. Construction activities would be most apparent to boaters using the reservoir; however, cumulative impacts would be minor as observations of the construction at Boone Dam could be made only from a distance because of the restricted access in the vicinity of the dam.

The exposed reservoir bottom during the period of the drawdown together with the new beach/recreation area and boat ramp extensions along the shoreline of Boone Reservoir could cause minor cumulative impacts on visual resources in the immediate vicinity of the reservoir. However, cumulative impacts would be localized and temporary. In addition, visual impacts resulting from the drawdown would tend to become less over time as vegetation grows and matures along the exposed reservoir bottom. Implementation of the TVA/TWRA Fishery Habitat Enhancement Project would serve to enhance revegetation of the portions of the exposed reservoir bottom and TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species which would serve to enhance the reestablishment of appropriate vegetative communities and mitigate for visual impacts until normal reservoir levels return.

Although the Proposed Action and No Action Alternative would contribute to cumulative adverse visual impacts these impacts would result in only minor and temporary adverse cumulative impacts on visual resources. No other projects were identified that would affect the viewshed of the project.

4.1.13 Noise

Noise generated during construction of the project, combined with noise resulting from construction of the new beach/recreation area that would be nearby, could cause a minor cumulative impact. TVA would partially mitigate these impacts by requiring the use of modern, well-maintained equipment and vehicles, and by screening the equipment for noise emissions, and implementing some noise reducing mitigations such as sound screens or comparable measures when practicable. Because cumulative impacts would be limited to the period of overlapping construction, they would be temporary. Cumulative impacts also would be localized and minor, and would likely result in only minor and temporary adverse cumulative impacts. Other projects identified in Table 4-1 are located too far away from the area of construction to contribute to elevated noise levels.

4.1.14 Public and Occupational Health and Safety

The remediation activities associated with the Proposed Action could contribute to minor cumulative public health and safety impacts. Cumulative health and safety hazards could result from the flow of construction traffic generated during construction of the project combined with construction of the new beach/recreation area. Signage and increased public awareness of construction travel routes would minimize potential cumulative impacts.

Cumulative health and safety hazards also could result from the reservoir drawdown associated with the Proposed Action and No Action Alternative and the changes to TVA's Floating Houses Policy proposed in the Floating Houses Policy Review EIS. Under the Proposed Action and the No Action Alternative, the lowered water level reduces the water column of the reservoir, which may result in subsurface and surface hazards that were not present prior to the reservoir drawdown. TVA has placed hazard buoys at various sites around the reservoir to notify the public of safety and navigation concerns during the drawdown, and has placed buoy lines above and below the dam, which would reduce the potential for reservoir users to be exposed to the noise at the Boone Dam construction site TVA would work closely with TWRA to mark any additional hazards in the reservoir that pose a threat to the health and safety of boaters.

Public safety impacts associated with the drawdown would be minor to moderate and would diminish with increased boater knowledge of water hazards and as infrastructure was improved to facilitate emergency responder access to the reservoir. The potential cumulative impacts of the changes associated with drawdown, when combined with a potential change in the Floating Houses Policy, would vary depending on the policy selected. However, a potential change to the Floating Houses Policy is being considered to address direct and indirect impacts on public safety such as improper mooring and anchoring practices that create recreational boating hazards, lack of structural integrity, fire hazards, and unsafe electrical systems (TVA 2015c). Regardless of the policy selected, there would be a beneficial cumulative impact on public health and safety, which would offset potential minor adverse cumulative impacts during the drawdown period. Although these conditions and their impacts are somewhat unique to floating houses and nonnavigable houseboats on TVA reservoirs, minor cumulative public safety impacts could occur during the period of the reservoir drawdown. However, the 5- to 7-year drawdown period does provide an opportunity to more easily perform any needed upgrades to floating houses or removal of houses that may be required under the selected Floating Houses Policy.

Although the Proposed Action and the No Action Alternative would contribute to cumulative adverse impacts related to health and safety hazards, these impacts would be minor and temporary.

4.1.15 Waste Management

The Proposed Action would not contribute to cumulative impacts related to waste generation or management in the vicinity of the project. The waste generation and management associated with the dam remediation would not interact with waste management for other identified

projects, and would not affect the waste disposal capacity of the other projects considered in this cumulative impacts analysis. Implementation of BMPs and employee/construction contractor training for spill avoidance and spill response and clean-up would reduce the minor adverse impacts on waste generation and management in the project area.

4.1.16 Transportation

The Proposed Action would result in minor, adverse cumulative impacts on transportation in the vicinity of the project. These impacts could result from temporary road closures, the flow of construction traffic during the overlapping period of remediation construction and construction of the new beach/recreation area, combined with the TDOT projects involving upgrades of the SH 75 interchange bridge over I-26 and SR 36 between SR 354 and SR 75. However, the impacts from these projects would be localized and would not appreciably add to the traffic volumes observed on the roadway network in the project vicinity. In the event that adverse impacts on traffic should occur, TVA would mitigate these impacts (e.g., by scheduling deliveries during non-peak travel hours or by staggering worker shift times).

4.1.17 Land Use

The remediation activities associated with the Proposed Action and No Action Alternative would not contribute to cumulative impacts on land use in the area of the project. The Proposed Action would result in changes in activities within the Boone Dam reservation during construction, but TVA land use allocations and designations would not change as a result of construction. Although the Proposed Action and No Action Alternative involve maintaining reservoir water levels at Interim Operations levels until project completion (Proposed Action) or long term (No Action Alternative), resulting in exposed reservoir bottom, the existing land use zones on Boone Reservoir would not change.

Land use at TVA's two proposed Construction Support Areas would be affected during construction. Following construction, TVA intends to return these areas to a condition compatible with the existing land use designations for the areas. TVA intends to return disturbed areas at the dam location and at the Construction Support Areas to their previous uses. Most of the disturbed areas would be revegetated with native or noninvasive plant species. In addition, TVA would grade and restore areas that previously were disturbed (e.g., borrow pit areas) to an improved condition. Therefore, no cumulative impacts on land use are expected.

This page intentionally left blank.

CHAPTER 5

5.0 LIST OF PREPARERS

Table 5-1 summarizes the expertise and contribution made to the EA by the Project Team.

Table 5-1: Environmental Assessment Project Team

Name/Education	Experience	Project Role
TVA		
Tyler F. Baker *M.S., Ecology; B.S., Wildlife and Fisheries Science*	26 years in aquatic resources monitoring and assessment	Water Quality
John T. Baxter *M.S. and B.S., Zoology*	24 years in protected aquatic species monitoring, habitat assessment, and recovery; 13 years in environmental	Aquatic ecology, threatened and endangered species
Nicole Berger *M.S., Engineering Management; B.S., Civil/Environmental*	14 years in river forecasting; 1 year in navigation	Navigation
Adam J. Dattilo *M.S., Forestry; B.S., Natural Resource Conservation Management*	15 years in ecological restoration and plant ecology; 8 years in botany	Threatened and Endangered Species, Ecological Resources
Patricia Bernard Ezzell *M.A., History with an emphasis in Historic Preservation;* *B.A., Honors History*	27 years in history, historic preservation, and cultural resource management; 12 years in tribal relations	Tribal outreach
Jerry G. Fouse *M.B.A.; B.S., Forestry and Wildlife*	41 years in natural resources, recreation planning and economic development	Recreation
Elizabeth B. Hamrick *M.S., Wildlife,* *B.S. Biology*	8 years in biological surveys and environmental reviews	Threatened and Endangered Species (terrestrial animals), Ecological Resources (wildlife)
Andrew Henderson *M.S., Fisheries Biology (Conservation); B.S., Fisheries Biology*	10 years in aquatic monitoring, rare aquatic species surveys	Ecological Resources (aquatic ecology); Threatened and Endangered Species (aquatic species)
Matthew Higdon *M.S., Environmental Planning* *B.A. History*	12 years in natural resources planning and NEPA compliance	NEPA Compliance and Document Preparation

Table 5-1: Environmental Assessment Project Team

Name/Education	Experience	Project Role
Samuel W. Hixson *M.S., Environmental Engineering*	32 years environmental engineering experience, NPDES and RCRA permitting, water quality, solid waste, groundwater monitoring, and environmental compliance	Solid and Hazardous Wastes
Tim L. Keeling *B.S., Computer Science*	38 years in application and database design	Heritage viewer, Data quality
Robert Marker *B.S. Recreation Resources Management*	45 years in recreation planning and management	Recreation
Keil Neff *Ph.D., Civil Engineering, Water Resources; Professional Engineer; M.S., Environmental Engineering; B.S., Engineering Science and Anthropology*	10 years in water resources engineering; 3 years in environmental and cultural resources management	River Operations
Jeffery T. Ogden, P.E. *B.S., Civil Engineering, M.B.A.*	2 years in NEPA compliance	NEPA Compliance
Kim Pilarski-Hall *M.S., Geography, Minor Ecology*	20 years in wetlands assessment and delineation	Wetlands, Natural Areas
Matthew Reed *M.S., Wildlife and Fisheries Science*	2 years in fisheries work and biological consulting	Aquatic Ecological Resources
R. Lesley Rogers *B.A. Environmental Studies & Biology*	14 Yrs. Environmental Multi Media Compliance	Environmental and Technical Review
Amos Smith *B.S., Geology*	32 years in solid and hazardous waste management	Solid and Hazardous Waste
Clint P. Smith *M.S., Wildlife and Fisheries Science*	7 years in wildlife ecology and conservation	Terrestrial Zoology Resources
Edward W. Wells III *M.A. and B.S., Anthropology*	13 years in Cultural Resource Management	Cultural Resources
Carrie C. Williamson, PE, CFM *M.S. and B.S., Civil Engineering; Professional Engineer*	2 years in Floodplains and Flood Risk; 3 years in River Forecasting; 11 years in Compliance Monitoring	Floodplains and Flood Risk

Table 5-1: Environmental Assessment Project Team

Name/Education	Experience	Project Role
Cardno		
Rachel Bell, PMP *B.S., Environmental Science*	10 years in natural resources planning and NEPA compliance, including project management and biological and environmental studies and analysis.	EA Project Manager, Land Use
Paul Leonard *M.S., Fisheries Science/Statistics* *B.S., Aquatic Science/Biology*	30 years in project management, regulated river systems, impact assessment, permitting, and NEPA compliance	EA Technical Advisor and Reviewer
Bruce Hart *M.S., Biology* *B.S., Microbiology*	24 years in environmental planning, environmental impact assessment and permitting, and environmental compliance program management	Visual Resources, Noise Air Quality, Waste Management, Public Health and Safety, and Transportation
Jason Dickey *M.S., Limnology* *B.S., Wildlife & Fisheries Science*	15 years in the assessment of freshwater ecosystems with focus on CWA compliance and permitting, and protected species management.	Water Resources, Floodplains, Wetlands, T&E Species, and Terrestrial and Aquatic Habitat
David Kelly, P.G. *B.S., Geoscience*	18 years in geologic and hydrogeologic investigations, water supply planning and alternatives analysis	Geologic Resources and Soils
Susan Burke *B.S., Business Administration/Finance* *M.S., Agricultural and Resource Economics* *Ph.D., Agricultural and Resource Economics*	14 years in economics and water resources planning and NEPA compliance, including project management and regional economic impact analysis.	Socioeconomics and Recreation

This page intentionally left blank.

CHAPTER 6

6.0 ENVIRONMENTAL ASSESSMENT DISTRIBUTION LIST

Following is a list of the agencies, organizations, and persons who have received copies of the Draft EA or notices of its availability with instructions on how to access the Draft EA on the TVA webpage.

Federal Agencies and Offices

- U.S. Department of Agriculture, Natural Resource Conservation Service
- U.S. Department of Agriculture, Forest Service (Cherokee National Forest)
- U.S. Department of Army, Corps of Engineers
- U.S. Fish and Wildlife Service

Federally Recognized Tribes

- Absentee Shawnee Tribe of Oklahoma
- Cherokee Nation
- Eastern Band of Cherokee Indians
- Eastern Shawnee Tribe of Oklahoma
- Shawnee Tribe
- United Keetoowah Band of Cherokee Indians in Oklahoma

State Agencies

- Tennessee Department of Agriculture, Division of Forestry
- Tennessee Department of Economic and Community Development
- Tennessee Wildlife Resources Agency
- Tennessee Department of Environment and Conservation
- Tennessee Division of Archaeology
- Tennessee Emergency Management Agency
- Tennessee Historical Commission
- Warrior's Path State Park

Local Agencies

- Appalachian RC&D Council
- Boone Lake Association
- Boone Watershed Partnership
- Carter County, Mayor
- Hawkins County, Mayor
- Johnson City Chamber of Commerce

- Kingsport Chamber of Commerce
- Mayor of Johnson City
- Mayor of Kingsport
- Sullivan County, Mayor
- Washington County, Mayor
- Washington County Chamber of Commerce

Organizations

- Boone Lake Association
- Boone Watershed Partnership
- Ducks Unlimited
- First Tennessee Development District
- National Wild Turkey Federation
- Sierra Club (Watauga Group)
- Sullivan County Soil Conservation District
- Tennessee Wildlife Federation
- Tennessee Ornithological Society (Elizabethton, Lee and Lois Herndon Chapter)
- Trout Unlimited
- Washington County Soil Conservation District

Individuals

TVA notified over 900 individuals who have requested to receive regular email updates regarding the remediation of the dam.

Area Public Libraries

- Johnson City Public Library
- Kingsport Public Library
- Sullivan County Public Library (Blountville)

CHAPTER 7

7.0 REFERENCES

Advanced Disposal. 2015. Eco Safe Landfill. Accessed 9/2/15 at: http://www.advanceddisposal.com/tn/blountville/eco-safe-landfill

Aggus, L. R. and Elliot, G.V. 1975. Effects of Cover and Food on Year-Class Strength of Largemouth Bass. Black bass biology and management. National Symposium on the Biology and Management of the Centrarchid Basses, Tulsa, Oklahoma, February 3-6, 1975. Eds. R.H. Stroud and H.Clepper.

Amundsen, C. C. 1994. Reservoir riparian zone characteristics in the Upper Tennessee River Valley. Water, Air and Soil Pollution. 77:460–593.

Benson, E., J. Hansen, A. Schwartz, and G. Smersh. 1998. Pricing residential amenities: The value of a view, J. Real Estate Financial. Econ., 16, 55–73.

Bohac, C.E. and Koroa, M.C. 2004. Tennessee Valley Supply Inventory & Needs Analysis. Report by Tennessee Valley Authority.

Bohac, C.E. and Koroa, M.C. 2008. Tennessee Valley Supply Inventory & Needs Analysis. Report by Tennessee Valley Authority.

Broders, H. G. and G. J. Forbes. 2004. Interspecific and Intersexual Variation in Roost-site Selection of Northern Long-eared and Little Brown Bats in the Greater Fundy National Park Ecosystem. Journal of Wildlife Management 68(3):602-610.

Buehler, D. A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). *In* The Birds of North America, No. 564 (A. Poole and F. Gill, eds.). Birds of North America Online. Accessed 10/21/15 at http://bna.birds.cornell.edu/bna/species/506/articles/introduction#_ga=1.210272797.960238937.1442247654

Cardno. 2015, In Preparation. Boone Dam Socioeconomic Analysis Report.

City-Data. 2015. Spurgeon, Tennessee. Accessed 9/2/15 at: http://www.city-data.com/city/Spurgeon-Tennessee.html

City of Kingsport. 2015. Public Works Department. Accessed 3/30/15e at: http://publicworks.kingsporttn.gov/streets-sanitation/landfill

Dean, S.D. (2014). Personal communication with Edward Williams Wells III.

Dunn, Jon Lloyd, and Jonathan K. Alderfer. *National Geographic field guide to the birds of North America*. National Geographic Books, 2011.

Dycus, D. L., and T. F. Baker. 2000. Aquatic Ecological Health Determinations for TVA Reservoirs—1999. Tennessee Valley Authority, Water Management, Clean Water Initiative, Chattanooga, Tennessee.

Elphick, Chris, and John Barnard Dunning, eds. 2002. *The Sibley Guide to Bird Life & Behavior*. New York: Alfred A. Knopf, 2001.

Etnier, D.A. and W.C. Starnes. 1993. The Fishes of Tennessee. Knoxville: University of Tennessee Press.

Executive Order 11988 – Floodplain Management., May 1977 (42 CFR 26951). Accessed 10/21/15 at: http://www.archives.gov/federal-register/codification/executive-order/11988.html.

Federal Interagency Committee on Noise (FICON) 1992. Federal Interagency Committee on Noise, Federal Agency Review of SelectedAirport Noise Analysis Issues, 1992

Fouse, Jerry, 2015. Edits provided on the draft EA provided to Matthew Higdon, TVA, and forwarded to Rachel Bell, Cardno. Dated 9/9/2015

Griffith, G. E., J. M. Omernik, and S. Azevedo. 1998. Ecoregions of Tennessee. Reston, Virginia.: U.S. Geological Survey

Grizzle, J. M. (1981). Effects of hypolimnetic discharge on fish health below a reservoir. *Transactions of the American Fisheries Society*, *110*(1), 29-43.

Gunnison, D., J. M. Brannon, R. L. Chen, I. Smith, and T. C. Sturgis. 1984. "Richard B. Russell Dam and Reservoir: Potential Water Quality Effects of Initial Filling and Decomposition of Vegetation." Miscellaneous Paper E-84-2, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Hammond and Sweeney. 1997. Threatened and Endangered Species in the Forests of Tennessee - A Guide to Assist with Forestry Activities. A Cooperative Publication of Champion International Corporation, National Fish and Wildlife Foundation, U.S. Fish and Wildlife Service, Tennessee Department of Environment and Conservation, Tennessee Wildlife Resources Agency, and Tennessee Conservation League. 134 pp.

Hamour, A. WJHL News. 2015. Concerns over property values emerge after TVA's Boone Dam announcement. Accessed on 9/23/2015 at http://wjhl.com/2015/07/31/concerns-over-property-values-emerge-after-tvas-boone-dam-announcement/

Harriman, V. and N. Shefferly. 2014. "Myotis grisescens" (On-line), Animal Diversity Web. Accessed 9/12/15 at http://animaldiversity.org/accounts/Myotis_grisescens/

Henry, Travis, H. 2012. Results of the Tennessee River Valley Shorebird Initiative. Accessed 9/12/15 at http://pbadupws.nrc.gov/docs/ML1328/ML13289A213.pdf

Higgins, John M., and W. Gary Brock. 1999. Overview of reservoir release improvements at 20 TVA dams. Journal of energy engineering 125.1: 1-17.

Kentucky Bat Working Group, 1999. "Gray Bat" (On-line). Accessed 9/15/15 at http://www.biology.eku.edu/bats/graybat.htm.

Lacki, M. J., and J. H. Schwierjohann. 2001. Day-Roost Characteristics of Northern Bats in Mixed Mesophytic Forest. Journal of Wildlife Management. Volume 65 (3): 482-488.

Lindsey, Bruce D. Tammy M. Zimmerman, Melinda J. Chapman, Charles A. Cravotta III, and Zoltan Szabo. 2014. Water Quality in the Principal Aquifers of the Piedmont, Blue Ridge, and Valley and Ridge Regions, Eastern United States, 1993–2009. Accessed 10/21/15 at: http://pubs.usgs.gov/circ/1354/pdf/circ1354.pdf

Lloyd, Jr., Orville B. Lyke, William L. (United States Geological Service [USGS]). 1995. Ground Water Atlas of The United States Illinois, Indiana, Kentucky, Ohio, Tennessee. Accessed 10/21/15 at: http://pubs.usgs.gov/ha/ha730/ch_k/K-text4.html

Marker, Robert, 2015. Personal e-mail communication dated 10/15/2015 to Matthew Higdon, TVA forwarded to Susan Burke, Cardno.

Maupin, Molly A. and Nancy L. Barber. 2005. Estimated Withdrawals from Principal Aquifers in the United States, 2000. Accessed on 4/27/15 at: http://pubs.usgs.gov/circ/2005/1279/pdf/circ1279.pdf

McDonough, T. A. and G. D. Hickman. 1999. "Reservoir Fish Assemblage Index Development - A Tool for Assessing Ecological Health in Tennessee Valley Authority Impoundment," in Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities, 523-540. Edited by T. Simon. Washington, D.C.: CRC Press.

Miranda, L.E., Shelton, W.L., and Bryce, T.D. 1984. Effects of Water Level Manipulation on Abundance, Mortality, and Growth of Young-of-Year Largemouth Bass in West Point Reservoir, Alabama-Georgia. North American Journal of Fisheries Management. 4: 314 – 320.

Muller, N. Z. 2009. Using hedonic property models to value public water bodies: An analysis of specification issues, Water Resources. Res., 45, W01401, doi:10.1029/2008WR007281.

Murray, M. N., Barbour, K., Hill, B., & Stewart, S. (2003). *Economic Effects of TVA Lake Management Policy in East Tennessee.* Knoxville: The Center for Business and Economic Research at the University of Tennessee. Accessed 10/21/15 at: http://cber.utk.edu/lakeres/HUD0.pdf

National Oceanic and Atmospheric Administration (NOAA). 2013. US Tornado Climatology. Accessed 9/2/15 at: http://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology

Occupation Safety and Health Administration (OSHA) 1984. Occupation Safety and Health Administration, Occupational Noise Exposure, 29 CFR 1910.95, 1984.

Pietak, Lynne Marie and Jeffrey L. Holland (1998). Phase I Archaeological Survey of Boone Lake, Sullivan and Washington Counties, Tennessee. Report on file at the Tennessee Valley Authority Cultural Resources Library, Knoxville, Tennessee.

Piper, R. G., McElwain, I.B., Orme, L.E., McCraren, J.P., Fowler, L.G., and Leonard, J.R. 1982. Fish hatchery management. United States Department of the Interior. Fish and Wildlife Service.

Prybylski, Matthew (2015). Historic Resources Survey of the Tennessee Valley Authority Boone Dam Hydroelectric Plant and Boone Reservoir Facility Sullivan and Washington Counties, Tennessee. Report on file at the Tennessee Valley Authority Cultural Resources Library, Knoxville, Tennessee.

Raleigh, R.F., T Hickman, R.C. Solomon, and P.C. Nelson. 1984. Habitat suitability information: Rainbow trout. US Fish and Wildl. Serv. USFWS/OBS-82/10.60. 64pp.

Sammons, S. M., Dorsey, L. G., Bettoli, P. W., & Fiss, F. C. 1999. Effects of reservoir hydrology on reproduction by largemouth bass and spotted bass in Normandy Reservoir, Tennessee. North American Journal of Fisheries Management, 19(1), 78-88.

Samsel, J. 2010. Tennessee's Overlooked Trout Fishery. Game and Fish Magazine. (On-Line). Accessed on 9/1/2015 at: http://www.gameandfishmag.com/fishing/fishing_trout-fishing_tn_aa055003a/

Schexnayder, S., B. Stephens, et al. 2009a. Recreation Use on Nickajack Reservoir. University of Tennessee Agriculture Institute. Knoxville, Tennessee.

Schexnayder, S., B. Stephens, et al. 2009b. Recreation Use on Wheeler Reservoir. University of Tennessee Agriculture Institute. Knoxville, Tennessee.

Shirley, K.E. and Andrews, A.K. 1977. Growth, Reproduction, and Mortality of Largemouth Bass during the First Year of Life in Lake Carl Blackwell, Oklahoma. Transactions of the American Fisheries Society. 106: 590-595.

Simons, T. R., K. N. Rabenold, D. A. Buehler, J. Collazo, and K. E. Franzreb. 1998. The Role of Indicator Species: Neotropical Migrant Songbirds. In Ecosystem Management for Sustainability: Principles and Practices Illustrated by a Regional Biosphere Cooperative. Ed. J. Peine. Lewis Publications. Boca Raton, Florida.

Stephens, B., A. Griffin, et al. 2007. Recreation Use on Cherokee Reservoir. University of Tennessee Agriculture Institute. Knoxville, Tennessee.

Stephens, B., L. Didier, et al. 2006a. Recreation Use on Douglas Reservoir. University of Tennessee Agriculture Institute. Knoxville, Tennessee.

Stephens, B., L. Didier, et al. 2006b. Recreation Use on Fort Loudoun Reservoir. University of Tennessee Agriculture Institute. Knoxville, Tennessee.

Stephens, B., L. Didier, et al. 2006c. Recreation Use on Kentucky Reservoir. University of Tennessee Agriculture Institute. Knoxville, Tennessee.

Stephens, B., L. Didier, et al. 2006d. Recreation Use on Melton Hill Reservoir. University of Tennessee Agriculture Institute. Knoxville, Tennessee.

Stephens, B., L. Didier, et al. 2006e. Recreation Use on Mountain Group Reservoir. University of Tennessee Agriculture Institute. Knoxville, Tennessee.

Stephens, B., L. Didier, et al. 2006f. Recreation Use on Norris Reservoir. University of Tennessee Agriculture Institute. Knoxville, Tennessee.

Steuer, N. 2015. E-mail communication dated February 2, 2015 between Norman Steuer, Manager Real Property Transactions, TVA and Frank Edmondson, TVA. Forwarded to Susan Burke, Cardno from Matthew Higdon, TVA on 8/20/2015

Sullivan County Government. 2015. Solid Waste Department. Accessed 9/02/15 at: http://sullivancountytn.gov/node/34

Sullivan County GIS Tax Parcel data (acquired March 2015). State of Tennessee.

Sweetman, C. 2015. Concern over Boone Lake property values, reported by WCYB on line, Accessed 10/10/2015 at http://www.wcyb.com/news/concern-over-boone-lake-property-values/34475548

Tennessee Department of Environmental Conservation (TDEC). 2013a. Chapter 0400-40-04, Use Classifications for Surface Waters (On-Line). Accessed on 9/15/15 at http://share.tn.gov/sos/rules/0400/0400-40/0400-40.htm

TDEC. 2013b. Chapter 0400-40-07 Aquatic Resource Alteration. Rules of the TDEC Division of Water Resources Water Pollution Control. (On-Line) Accessed 9/18/15 at http://share.tn.gov/sos/rules/0400/0400-40/0400-40-07.20131216.pdf

TDEC. 2014. Final Version 2012 303(d) List. Accessed 10/21/15 at: http://www.tn.gov/environment/water/docs/wpc/2012-final-303d-list.pdf

TDEC. 2015a. Online Services Portal: Rare Species By County. (On-line). Accessed 9/2/15 at http://environment-online.state.tn.us:8080/pls/enf_reports/f?p=9014:3:2460269094081

TDEC. 2015b. TDEC Rule 1200-03-09-.04(4)(d)8), Construction and Operating Permits, Exemptions. Accessed 9/25/15 at: http://share.tn.gov/sos/rules/1200/1200-03/1200-03-09.20150630.pdf

TDEC. 2015c. Solid Waste Management Permits. Accessed 9/02/15 at: http://environment-online.state.tn.us:8080/pls/enf_reports/f?p=19035:34001:7290182738166

Tennessee Department of Labor and Workforce Development, 2015. Accessed 10/18/15 at: http://www.tn.gov/assets/entities/labor/attachments/LaborAUG2015.pdf.

Tennessee Department of Transportation (TDOT). 2015a. Tennessee Department of Transportation Traffic History. Accessed 8/11/15 at: https://www.tdot.tn.gov/APPLICATIONS/traffichistory

TDOT. 2015b. East Tennessee Construction Report for August 20-26, 2015. Accessed 8/25/15 at: https://www.tn.gov/tdot/news/17214

TDOT. 2015c. SR 126 Memorial Boulevard. Accessed 8/27/2015 at: https://www.tn.gov/tdot/article/sr-126-memorial-boulevard.

Tennessee Exotic Pest Plant Council, 2009. TN-EPPC Invasive Exotic Pest Plants in Tennessee, December 2009 (2nd Edition). Accessed 10/21/15 at: http://s3.amazonaws.com/tneppc2/uploads/619/original/tn-eppc-plant-list-ww-w09-final-1.pdf

Tennessee Valley Authority (TVA). 1958. A Comprehensive Report on the Planning, Design, Construction, Initial Operations and Costs of Four Hydro Projects in the Holston River Basin (Watauga, South Holston, Boone, and Fort Patrick Henry). TVA, Technical Report No. 14. Governmental Printing Office, Washington, DC.

TVA. 1983. Tennessee Valley Authority Instruction IX Environmental Review – Procedures for Compliance with the National Environmental Policy Act. 15 pgs. April 28. Accessed 10/21/15 at: https://www.tva.com/Environment/Environmental-Stewardship/Environmental-Reviews/NEPA-at-TVA

TVA. 1998. TVA Shoreline Management Initiative Final Environmental Impact Statement. Accessed 10/21/2015 at: https://www.tva.com/Environment/Environmental-Stewardship/Environmental-Reviews/Shoreline-Management-Policy

TVA. 2002. Resource Management Plan and Final Environmental Assessment: Boone Management Unit.

TVA. 2004. Reservoir Operations Study Final Programmatic Environmental Impact Statement. Knoxville, Tennessee. Accessed 10/21/15 at: https://www.tva.com/Environment/Environmental-Stewardship/Environmental-Reviews.

TVA. 2010. Northeastern Tributary Reservoirs Land Management Plan Final Environmental Impact Statement. Accessed 10/21/15 at: https://www.tva.com/Environment/Environmental-Stewardship/Environmental-Reviews.

TVA. 2011. Natural Resource Plan. Accessed 10/21/15 at: https://www.tva.com/Environment/Environmental-Stewardship/Environmental-Reviews

TVA. 2014. TVA Database Information. October 27, 2014. RecAreasFacilities_Oct 27.xlsx.

TVA. 2015a. Boone Dam Weekly Update - Volume 1, No. 13. Accessed 10/21/15 at: http://www.tva.gov/boonedrawdown/weekly_update.htm

TVA. 2015b. Natural Heritage Database, data query performed by TVA for Threatened and Endangered Species, Wetland occurrence, and Cave locations.

TVA. 2015c. Floating Houses Policy Review EIS. Accessed 10/21/15 at: https://www.tva.com/Environment/Shoreline-Construction/Floating-Houses.

TVA. 2015d. Recreation Area Matrix. Natural Resources and Real Property Sources. Rec_Boone_Matrixw_SHolston_Watauga.xlsx. August 31, 2015.

TVA. 2015e. Boone Dam Press Release, July 30, 2015. Accessed 10/21/15 at: https://www.tva.com/Newsroom/Press-Releases/TVA-Proposes-Solution-for-Boone-Dam-Seepage

Tennessee Wildlife Resources Agency (TWRA). 2015a. Fort Patrick Henry Reservoir – General Information. Accessed 10/21/15 at: http://www.tnfish.org/ReservoirLakeInformation_TWRA/TWRA_FortPatrickHenryReservoirInformation.htm

TWRA. 2015b. “Least Weasel” Tennessee Watchable Wildlife. (On-Line) Accessed 9/15/15 at: http://www.tnwatchablewildlife.org/

TWRA. 2015c. “Southeastern Bog Lemming” Tennessee Watchable Wildlife. (On-Line) Accessed 9/15/15 at: http://www.tnwatchablewildlife.org/

TWRA. 2015d. “Southeastern Shrew” Tennessee Watchable Wildlife. (On-Line) Accessed 9/15/15 at: http://www.tnwatchablewildlife.org/

U.S. Fish and Wildlife Service. 2015. “Gray Bats Fact Sheet” (On-Line). Accessed 9/7/15 at: http://www.fws.gov/midwest/endangered/mammals/grbat_fc.html

U.S. Army Corps of Engineers (USACE). 2014. Engineering and Design, Safety of Dams – Policy and Procedures. Accessed 9/1/15 at: http://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_1110-2-1156.pdf

U.S. Bureau of Labor Statistics. 2014. Quarterly Census of Employment and Wages. 2014 Annual Averages.

U.S. Census Bureau. 2012. American FactFinder. All sectors: Geographic Area Series: Economy-Wide Key Statistics:

U.S. Census Bureau. 2013. American Fact Finder. 2009–2013 American Community Survey.

U.S. Census Bureau. 2015a. American FactFinder Population, Housing units, Area and Density: 2010 - State and County/County Equivalent.

U.S. Census Bureau. 2015b. Income: U.S. Census Bureau. Employment: U.S. Census Bureau, American Fact Finder, State and Local Government Employment and Payroll Data: March 2013. 2013 Annual Survey of Public Employment & Payroll

U.S. Climate Data. 2015. Temperature - Precipitation - Sunshine – Snowfall. Bristol, Tennessee. Accessed 9/2/15 at: http://www.usclimatedata.com/climate/bristol/tennessee/united-states/ustn0055

U.S Department of Agriculture, National Resource Conservation Service. 1994. Soil Survey of Sullivan County, Tennessee. Accessed 10/21/15 at: http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/tennessee/TN163/0/sullivan.pdf

USDA. 2007. *Invasive and Noxious Weeds.* (On-Line) Accessed 9/19/15 at: http://plants.usda.gov/java/noxious?rptType=State&statefips=47

USDA, Forest Service. 1969. *A Forest Atlas of the South*. Southern Forest Experiment Station, New Orleans, Louisiana, Southeastern Forest Experiment Station, Asheville, North Carolina. 27 pp.

USDA,NRCS. 2015. Web Soil Survey. Accessed 10/21/15 at: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

U.S. Department of Housing and Urban Development (HUD) 1983. United States Department of Housing and Urban Development, Noise Assessment Guidelines, HUD-PDR-735, 1983

U.S. Department of Transportation (USDOT) 2006. United States Department of Transportation, Federal Highway Administration, Roadway Construction Noise Model User's Guide, FHWA-HEP-05-054 DOT-VNTSC-FHWA-05-01, 2006

U.S. Environmental Protection Agency (USEPA) 1974. United States Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, Pub. 550/9-74-004, Washington, DC, 1974

USEPA. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. EPA-600/3-77-061

USEPA. 2007. Control of Hazardous Air Pollutants from Mobile Sources, Federal Register Volume 27, Number 37, February 26, 2007

USEPA. 2011. The 2011 National Emissions Inventory. Accessed 9/2/15 at: http://www.epa.gov/ttn/chief/net/2011inventory.html

USEPA. 2015. Current Nonattainment Counties for All Criteria Pollutants. Accessed 9/2/15 at: http://www.epa.gov/oaqps001/greenbk/ancl.html

U.S. Fish and Wildlife Service (USFWS). 2015. Gray Bats Fact Sheet (On-Line). Accessed 9/7/15 at: http://www.fws.gov/midwest/endangered/mammals/grbat_fc.html

U.S. Geological Survey. USGS. 2015a. Mineral Resources On-Line Spatial Data. Tennessee Geology. Accessed 4/15/15 at: http://mrdata.usgs.gov/sgmc/tn.html

USGS. 2015b. Mineral Resources On-Line Spatial Data. Tennessee Geology. Geologic Units in Sullivan County, Tennessee. Accessed 4/16/15 at: http://mrdata.usgs.gov/geology/state/fips-unit.php?code=f47163

USGS. 2015c. USGS Groundwater Information. Karst and the USGS. Accessed 4/17/15 at: http://water.usgs.gov/ogw/karst/index

USGS. 2015d. The Paleontology Portal. Accessed 4/14/15 at: http://www.paleoportal.org/index.php

USGS. 2015e. Earthquake Hazards Program. Search Earthquake Archives. Accessed 4/12/15 at: http://earthquake.usgs.gov/earthquakes/search/?region=Tennessee

USGS. 2015f. Earthquake Hazards Program. Tennessee. 2014 Seismic Hazard Map. Accessed 4/12/15 at: http://earthquake.usgs.gov/earthquakes/states/tennessee/hazards.php

USGS. 2015g. National Water-Quality Assessment Program. Water Quality in the Piedmont – Blue Ridge and Valley and Ridge Aquifers. Accessed 4/12/15 at: http://water.usgs.gov/nawqa/studies/praq/piedvr/PBVRCallingCard.pdf

U.S. Water Resources Council. 1978. Floodplain Management Guidelines for Implementing EO 11988, 43 CFR 6030, February 10, 1978. Washington, DC.

Wampler, Marc (2015). Phase I Archaeological Survey of Five Tracts for Boone Dam Staging Areas, Sullivan County, Tennessee. Report on file at the Tennessee Valley Authority Cultural Resources Library, Knoxville, Tennessee.

Washington County Government. 2015a. Solid Waste Department. Accessed 9/2/12 at: http://www.washingtoncountytn.org/departments/solid_waste

Washington County Government. 2015b. Recycling. Accessed 9/2/15 at: http://www.washingtoncountytn.org/departments/solid_waste/recycling

Washington County Tax Parcel GIS data (acquired March 2015). State of Tennessee.

Waste Management. 2015. Accessed 9/2/15 at: http://www.wm.com/find-a-facility.jsp#/?address=Bristol%2C%20TN%2C%20United%20States%20usa&radius=80500

Watkins, Joel H. (2014). A Cultural Resources Shoreline Survey and Erosion Monitoring of Boone Reservoir, Sullivan and Washington Counties, Tennessee. Report on file at the Tennessee Valley Authority Cultural Resources Library, Knoxville, Tennessee.

Webb, D. H., W. M. Dennis, and A. L. Bates. 1988. An analysis of the plant community of mudflats of TVA mainstem reservoirs. Pp. 177-198 In: Proceedings of the first annual symposium on the natural history of lower Cumberland and Tennessee River valleys (D. H. Snyder, ed.). The Center for Field Biology of Land Between the Lakes, Austin Peay State University, Clarksville, TN.

Wells III, Edward William (2015a). Archival Research and Archaeological Reconnaissance for the TVA Boone Hydro Seepage Mitigation, Sullivan County, Tennessee. Report on file at the Tennessee Valley Authority Cultural Resources Library, Knoxville, Tennessee.

Wells III, Edward William (2015b). Cultural Resources Reconnaissance of the Boone Hydro Plant Laydown Area #2, Sullivan County, Tennessee. Report on file at the Tennessee Valley Authority Cultural Resources Library, Knoxville, Tennessee.

Wirwa, Drew W. 2009. Waterbird use and food resource response to drawdown of Kentucky Reservoir. Thesis, University of Tennessee, Knoxville, Tennessee, USA. Cited by Henry 2012.

This page intentionally left blank.

APPENDIX A

RESPONSES TO COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL ASSESSMENT

This page intentionally left blank

Appendix A
Responses to Comments Received on the Draft Environmental Assessment

A.1 Introduction

TVA made available to the public and stakeholders the Draft Environmental Assessment (EA) of the Boone Dam Seepage Remediation Project on the TVA project website on October 28, 2015 (https://tva.com/Newsroom/Boone-Dam-Project). This appendix describes the process by which public and interagency comments were submitted, reviewed, organized, and evaluated for response, as well as how the EA was revised in response to the comments.

A.2 Comments Received

The release of the Draft EA on October 28, 2015, initiated a public comment period that ended on November 30, 2015. A public meeting was held on November 5, 2015, in Johnson City, Tennessee. Comments were submitted to TVA during the public meeting, as well as online through the TVA project website. At the end of the comment period TVA had received a total of 10 individual submittals, nine from private citizens (three anonymously) and one from the Tennessee Department of Environmental Conservation (TDEC). Each comment submission was cataloged with a unique comment document number.

TVA reviewed the 10 submittals and identified 31 individual comments. These comments and TVA's responses are included in a table in Section A.4 below.

A.3 The Comment-Response Process

As noted above, each statement, letter or message submitted to TVA could contain one or more specific comments. The individual comments were identified in the following manner:

- Each submittal was reviewed to identify individual substantive comments pertaining to the Draft EA.
- The individual comments were assigned a unique comment number within the body of the submittal, the first number identifying the submittal number and the second the individual comment (e.g. comment 5-1 was the 5th comment submittal and the 1st comment in the submittal). This process resulted in 31 individual comments.

Responses were developed by TVA based on the nature of the comments. General comments voicing an opinion or preference were noted and included in Table A-1; these comments did not require changes to the EA. When TVA changed or revised the EA based on the comment, it is noted in Table A-1. Responses were then compiled into the master comment-response table (Table A-1).

A.4 Responses to Individual Comments Received on the Draft EA

Please see table below.

Table A-1. Public Comments and TVA Responses

ID	Name	Comments	Response
1-1	Anonymous 1	I just read over the EA of Boone Reservoir/Dam remediation. My particular interest(s) was/were the options TVA considered for repair of the earthen embankment. The part where you considered removing the embankment and rebuilding it stuck out to me. I realize the impact it would potentially pose to do such a thing, but I'm afraid you didn't consider this as an alternative: Since you said it showed quite the risk of flood damage to have the river flowing freely for a couple years while you rebuilt the embankment, it would make sense to still consider this as it is still very early in the remediation. You have 3 major tributaries coming into Boone Lake- South Fork Holston, Watauga, and Beaver Creek (although not a major tributary, it still counts for a lot of the runoff). You have dams built upstream on each of these (South Holston, Watauga, and Beaver Creek dams). I know there is no permanent reservoir behind Beaver Creek, but it is there to serve the purpose of an auxiliary dam to prevent flooding since Beaver Creek has a long history of doing so. My idea is to hold the Holston and Watauga reservoirs at an appropriate elevation to be used as flood storage for the duration of the reconstruction of the Boone Dam embankment. Both reservoirs are plenty deep enough to not have an impact on navigation and/or recreation. And in the event of a flash flood, those two reservoirs could hold back all the water you want, while you could close the gates at Beaver Creek in the event of a flash flood on that water way. I have no idea on the costs of this idea, but it	As described in Section 2.3 of the Draft EA, TVA engineers and external experts evaluated numerous remediation alternatives that were dismissed from detailed analysis in the Draft EA. Your comment apparently regards Remediation Alternative #2, listed on page 2-11, involving the excavation (removal) and construction of a new earthen embankment at Boone Dam. As noted in your comment, under this alternative TVA would no longer control flooding for at least 1 to 2 years and communities downstream would be at risk, which is unacceptable to TVA. Under this scenario, South Holston and Watauga Reservoirs would be unlikely to adequately protect communities downstream from flooding during this time period because large inflows would continue from local stream systems, including the Doe River, into Boone Reservoir. There are approximately 670 square miles of land (of the 1,840 square mile basin) from which waters flow unregulated into the Boone Reservoir. During localized, extreme weather events, the flood risk to downstream communities would be great. In addition, the removal of the earthen embankment under this scenario would likely require TVA to lower the water levels to nearly the natural river channel elevations. At those levels, it would be unlikely that TVA could manage water flow within the existing outlets of the dam (beneath the concrete portion of the dam) because only one sluice gate would be available to TVA. For these reasons, such an alternative would not be viable.

ID	Name	Comments	Response
		can't be far off from the costs of the Proposed Action. I don't disagree with the Proposed Action you are taking, however, I feel there is a more efficient way of going about this. And it will tie up less time and have the reservoir back to normal levels in less than half the time.	
2-1	Anonymous 2	Concern about the four municipal wastewater outfalls into Boone. Over time, with less water, the reservoir will become a cesspool for sewage.	TVA addressed impacts to water quality in Section 3.3.2 of the Draft EA. Water quality conditions in the reservoir and downstream of Boone Dam would be similar to those observed during Normal Operations. Because the same flow through a reduced reservoir volume would decrease residence time (the average length of time water remains in the reservoir), there may be an indirect improvement to water quality within the reservoir during the drawdown.
2-2	Anonymous 2	Anonymous 2 is concerned about DO levels after reservoir levels returned to normal levels. Once all the vegetation that has grown during the drawdown period is inundated by the reservoir waters, the commenter believes their decay will result in extreme dissolved oxygen levels and fish will die.	When the reservoir is returned to normal operations, vegetation that established in areas of the reservoir bottom during the drawdown will be inundated with water. Despite TVA's Vegetation Management Plan (described in the EA) and landowner vegetation management during the dam remediation period, the amount of newly established vegetation is expected to be considerable and the organic matter would, as it is inundated and decomposes, add biological oxygen demand (BOD) and nutrients to the reservoir. This would likely cause some reduction in dissolved oxygen (DO) concentrations in the reservoir water for a period, reducing over time as the organic matter is depleted. The extent to which BOD would be added and DO levels lowered would depend on a number of factors, including time of year reservoir filling is initiated, water temperature, algal

ID	Name	Comments	Response
			response to nutrients, river flows through the reservoir, DO in inflowing waters, and prevailing weather patterns. As described in Section 3.3 of the EA, the lower levels of the reservoir are hypoxic (lower than fully saturated DO levels given the water temperature), and the additional BOD may cause these DO levels to be further depressed. This effect would likely be experienced for several months after the vegetation is inundated. As described in Section 3.3, TVA actively monitors the DO in the reservoir and downstream. When DO levels are low, TVA uses a technique called turbine venting to improve DO levels in the dam tailwaters. If BOD loading were to cause DO levels to decline more frequently or for longer periods, TVA could operate its turbine venting more frequently to help mitigate the lower DO levels. Additionally, if unusual DO conditions begin to develop in Boone Reservoir, TVA will assess the need to augment flows through the reservoir to help improve DO levels. TVA does not expect that the changes in DO in the Boone Reservoir would result in fish kills or DO levels that would have a measureable effect on the fish community of the reservoir. In response to this comment, TVA has revised the discussion in the Surface Water Quality section of Section 3.3.3.2 to include this information.
3-1	Kathy Sullivan	My only comment has to do with the possibility of seven years for completion of this project. The Hoover dam took five years to complete and the new expansion for of the Panama Canal will take seven years. How is it that this project will take so long? During the original dam construction of the TVA, sixteen dams were built in eleven	The basis for TVA's estimated timeline is not influenced by annual construction budgets and expenditures. As described above, TVA came to its estimate that the project will take 5 to 7 years based on several considerations. The first and foremost of these is safety. TVA must account for the safety of its workers when determining how quickly to conduct this complex

ID	Name	Comments	Response
		years! Five to seven years to repair an existing dam, I'm sorry but I believe something is wrong with this picture.	work and implement these very complicated construction activities. Our estimate includes the planning and design period of the project, including extensive investigation to characterize the nature and extent of the seepage issues, consultation and design evaluations with dam safety and engineering experts, completing environmental and permitting requirements, and mobilizing the resources for construction. TVA is on schedule to complete this phase of the project within 18 months, whereas the same level of planning and design on other similar remediation projects have taken at least 3 years. The complex nature of the proposed remediation action is also a determining factor. As described in Chapter 2 of the EA, the remediation project requires extensive grouting and the construction of a concrete wall deep into the earthen embankment of the dam. Grouting will require drilling hundreds of separate holes deep into the underlying bedrock. Limited working space atop the earthen embankment puts restrictions on how many drilling and grouting rigs can work simultaneously. Constructing a linear wall into the earthen embankment is also complicated and great care must be taken to ensure that the embankment remains stable during construction. In estimating the timeline, TVA consulted with other agencies that have completed similar projects and benchmarked those projects (including some lasting more than 10 years) to determine a realistic proposed project timeline.
4-1	William	Length of Time 5-7 yr for “safety” - how and why explain one very important very important economic factor	As described in Section 3.11 (Socioeconomics) of the EA, property values are only estimated to decline if TVA took no

ID	Name	Comments	Response
	Morrell	overlooked. Depressed property values being sold causes lower real property taxable values. County and City tax revenue drops of ~ 45% on an unknown portion of the area. Any recover of visitor or resident use of the lake would not be 'brief' (exactly what is meant in years?) planning and saving long term is what was required to live on or use the lake. In the economic evaluation - no factor given for effect on residents of loss of enjoyment and hydro-exercise swimming, skiing, floating - factors which directly or indirectly affect mental well-being and physical health of property owners and visitors to the lake. Many of which have long planned for those benefits in their mid and last years of life. [Therefore] increase in health costs to residents.	action and the reservoir levels remained low indefinitely, which is the No Action Alternative. A decline in property values would also drive down property tax revenues, which has been noted in the text of TVA's Final EA. As explained in Section 3.11, property values are not expected to decline under the Proposed Action Alternative. It is anticipated that normal market conditions would occur within one year of completing the dam remediation and returning the reservoir to Normal Operations. Because of the unique nature of the issue, lowering the pool elevation of a reservoir with a relatively high percent of shoreline development, there are no examples to refer to that would suggest what the recovery period might be. The assumption that the recovery would occur within the first year is based in part on the fact that, under Normal Operations, more than half of the estimated visitors are shoreline property owners or local/in-region users, who would likely be eager to return to the reservoir as soon as Normal Operations resume. TVA acknowledges that the drawdown of the reservoir has affected how shoreline property owners use and enjoy the reservoir and their property. Shoreline property owners are facing 5 to 7 years of a significant reduction in the enjoyment of their shorefront property. The magnitude of the impact of the reservoir drawdown is unique to each property owner and is not quantifiable. For some homeowners, for example year-round residents in retirement, the impact may be more significant than, for example, some for whom the property is a second home.

ID	Name	Comments	Response
4-2	William Morrell	As part of TVA's mission and goals. Health.	TVA shares your concern for public health and considered a range of health issues in the Draft EA, including public and occupational health and safety, water quality, air quality, and potential contamination from waste materials. TVA also considered the enjoyment and use of the reservoirs through the assessment of visual resources, noise, and recreational use.
4-3	William Morrell	You must distinguish between the "exist forever TVA properties" and the "not here forever" humans involved and include both - and you haven't.	TVA has interpreted this comment to mean the EA should include a description of the potential impact that the 5- to 7-year reservoir drawdown would have on the community, in particular shoreline property owners. Undoubtedly shoreline property owners are facing 5 to 7 years of a significant reduction in the enjoyment of their shorefront property. The magnitude of the impact of the reservoir draw down is unique to each property owner and is not quantifiable. For some homeowners, for example year-round residents in retirement, the impact may be more significant than, for example, some for whom the property is a second home. Nonetheless, TVA acknowledges the impact the dam remediation will have on the community.
5-1	Steve Carter	TVA should raise the water for a time period to allow the public to retrieve stranded boats. This would be fair because TVA did not provide proper notification to property owners that the October 2014 drawdown was going to be long-term. The risk of having the water up for a short duration would be minimal compared to the difficulties people are experiencing with having their boats stranded potentially for 5-7 years.	For safety purposes, TVA intends to keep the reservoir waters at lower levels. During the course of the project, however, project engineers would evaluate the potential of raising the water based on a review of the conditions of the embankment. In 2015, many in the community requested that TVA temporarily raise the water levels so that shoreline property owners may remove their boats. Unfortunately, TVA needs to maintain the lower water levels to reduce the hydrostatic pressure on the dam and the volume of water that would be released in the unlikely event of a dam failure. The continued drawdown of the reservoir is the safest and most prudent

ID	Name	Comments	Response
			measure to reduce risk to those downstream of the dam.
6-1	Anonymous 3	Anonymous 3 expressed concern about the increased boat traffic in other places due to the Boone drawdown.	There are three reservoirs (Fort Patrick Henry, Watauga and South Holston) within approximately 25 miles of Boone Reservoir which offer public users with similar recreational experiences in terms of site access and site quality without drastically increasing the cost of accessing the substitute site. Fort Patrick Henry has three boat ramps, one marina and one picnic facility; Watauga Reservoir has ten boat ramps, eight marinas, swimming areas, fishing piers, hiking trails, camping and lodging and serves as a reasonable substitute for visitors to Boone Dam; and South Holston also has eight boat ramps, 10 marinas, swimming areas, fishing piers, hiking trails and camp sites. TVA categorizes all three reservoirs as low use (TVA, ROS) and does not anticipate that over-crowding will be an issue should Boone users choose to substitute any of the other three reservoirs.
6-2	Anonymous 3	Anonymous 3 also expressed concern about the increased erosion and requirements for replacement of rip rap and other structures.	TVA's Draft EA addressed the increased potential for erosion and sedimentation resulting from construction activities at the dam and from the exposed reservoir bottom. In addition, TVA, in coordination with the TWRA, would implement a Fishery Habitat Enhancement Project that would serve to enhance revegetation of 400 to 500 acres of exposed reservoir bottom and TVA would provide guidance to landowners to enhance revegetation with appropriate native plant species. These mitigation measures are described in Section 2.2.4 of TVA's EA. For more information about permitting requirements

ID	Name	Comments	Response
			associated with placement of riprap and installation of structures, please visit TVA's Boone Repair webpage or call TVA's Gray office at (423) 467-3801.
7-1	TDEC Division of Natural Areas	TDEC'S Division of Natural Areas (DNA) has reviewed the Draft EA and comments that, provided that Best Management Practices are in place during the project, the proposed action is not expected to negatively affect federally or state-protected plants. Based on information in the rare species database, DNA does not anticipate adverse impacts upon rare, threatened, and endangered plant species or critical habitat.	As described in Section 2.2.4 TVA's Draft EA, appropriate Best Management Practices will be implemented throughout the duration of the project.
7-2	TDEC Division of Water Resources	DWR supports the approach TVA is taking for the mitigation of the Boone Dam and notes that it is its currently working with TVA on the mitigation project and will continue to do so.	TVA will continue to work with the Tennessee Division of Water Resources on mitigation measures to be implemented for the project.
7-3	TDEC Division of Water Resources	Under section 2.2.2 "Construction Support, Construction Support Area 2," DWR recommends that TVA clarify whether or not the mentioned depressions are sinkholes and if there are other sinkholes in the area that will receive fill. If so, DWR recommends that TVA notify TDEC's Underground Injection Control (UIC) Program before filling operations commence.[3] [3] TVA will also need to be in contact with the UIC Program on the grouting plan, mixtures, and locations and on the up	The land depressions mentioned in Section 2.22 "Construction Support, Construction Support Area 2," of TVA's Draft EA are not sinkholes. The depressions are simply land contours where materials were borrowed during past activities, including the construction of the dam. To TVA's current knowledge, there are no other sinkholes in this area that would be impacted by TVA's construction activities. TVA will continue to coordinate with TDEC regarding its existing UIC permit for the exploratory grouting and sinkhole remediation activities. Under the Proposed Action, TVA would

ID	Name	Comments	Response
		and down stream monitoring during grouting operations.	also coordinate with TDEC to modify the existing UIC permit to incorporate proposed grouting activities associated with the construction of the seepage barrier, once TVA completes a more precise design of the barrier.
7-4	TDEC Division of Water Resources	DWR comments that the City of Bristol Bluff City withdraws water from this area and recommends that TVA be in contact with the city, if it has not done so already, regarding its proposed actions.	TVA has been in contact with these community leaders and will continue to communicate and coordinate with local governments throughout the remediation project.
8-1	Ricky Dingus	I was just wondering wouldn't it be cheaper and faster to just build a new dam?	Removing the current dam and rebuilding a new dam was an alternative that TVA dismissed early when it initially identified alternative remediation actions for several reasons. Critical to TVA's decision not to pursue such a remedy was the loss of flood control capabilities that would occur during an extended period of time while the dam would be reconstructed. The potential impacts to local communities from an extreme flooding event during the period with no flood control could be significant (as noted above in the response to Comment 1-1). The potential for such impacts is unacceptable to TVA. In addition, TVA estimates that such an alternative would require a similar or greater amount of time as the proposed action; removal of the dam would likely take one to three years, with construction of a new dam requiring at least several additional years. As explained in Table 2-1 in the EA, TVA did consider excavating the existing earthen embankment dam and building a new embankment but determined that undertaking this alternative would also require the temporary loss of flood control which would imperil communities downstream.

ID	Name	Comments	Response
8-2	Ricky Dingus	And also what is your goal to replace the game fish while the lake is low? Also i think you need to build more places to fish on the bank of the lake for those people who don't have excess to a boat, i would like to see this done while the lake is down. Thanks for your time.	Anglers may experience an increase in the quality of their fishing experience because the lower reservoir levels will concentrate the fish in a smaller area, potentially increasing the average catch rate. This benefit will likely diminish over a few years as fishing pressure depletes the stock until reservoir operations return to normal. As stated in Section 3.7 of TVA's EA, the TWRA performs annual stocking of game fish to increase populations and bolster angling success at Boone Reservoir. However, in response to the reservoir drawdown, the TWRA may reduce the 2015 stocking rates by approximately half with the intent to avoid overcrowding an already increased sportfish density (due to the reduced reservoir area). Continued annual monitoring by TVA and TWRA during the 5 to 7 years following the drawdown would inform the TWRA's decision on how best to augment the stocking schedule moving forward. At this time TVA does not propose to develop additional shoreline fishing access during the drawdown period. As a part of its ongoing land management planning, TVA continues to identify properties that may be developed for public recreational use. TVA will take this comment into consideration for future recreational development on Boone Reservoir.
9-1	Mark Joseph	The seepage problem is not justified with appropriate reference to specific detailed Engineering Reports, that are available for review as part of the EA to serve as a technical basis for the severity of the problem and need for repair. Without the detailed engineering reports, the EA does not support the serious and immediate nature of the condition of the dam or earthen embankment. The EA also	As is standard practice for official TVA documents that may contain business or other sensitive information, your request for Boone engineering reports has been forwarded to TVA's Freedom of Information Act office for a response. TVA believes it has provided sufficient details in the EA document by which the condition of Boone Dam and the various alternatives for correcting that condition can be fairly assessed.

ID	Name	Comments	Response
		makes claims that are not supported by an appropriate study of the seepage and the affect lake levels have on the seepage. It is assumed that the seepage is in need of immediate repair and that the repair must be performed with lake levels maintained at low levels throughout the repair interval. There has been no 'Evaluation' of the seepage with and without full pool levels. The current level of detail in the EA does not justify spending $300,000,000 over 5 to 7 years as the preferred or best option. The reported level of seepage and seriousness of the problem should be defined in detailed engineering reports that are referenced as part of the report. These reports should be available for review as part of the EA. This is the justification for performing the repair.	TVA determined soon after discovering the sinkhole and seepage at Boone Dam that it was necessary to draw down the reservoir for the safety of communities downstream and its employees on site. While sinkholes are not uncommon especially in a karst region, a sinkhole, seepage, and soil discharges at the toe of a dam is unusual and indicates the potential internal erosion beneath the dam. The internal erosion process underneath the dam was confirmed by TVA in the ongoing investigation. Internal erosion is one of the leading causes of dam failures worldwide and the drawdown was an immediate measure to reduce the risk of a dam failure while TVA investigated the extent of the seepage issues. TVA's proposal to continue Interim Operations (keeping water levels at approximately 1,350 to 1,355 feet) for the remainder of the project is a prudent measure to reduce the risk of dam failure. At higher reservoir water levels, the rate of seepage flows would increase due to confirmed connections between the reservoir and the downstream side of the dam. At this time, the risks associated with increasing hydrostatic pressure on the earthen embankment in order to raise the water levels to normal pool levels are unacceptable.
9-2	Mark Joseph	The seepage has not been quantified and a determination in relation to lake level has not been studied. The lake level was at winter pool level when the seepage was discovered (section 1.2). The level of seepage is not quantified at current and normal winter pool level, which are the only conditions that have been observed to date. It is not clear that the seepage has stopped at the current lower level, or	As stated in the EA and in previous responses above, the seepage of the Boone Dam is a valid cause for concern and TVA determined it was necessary to investigate the extent to which erosion beneath the dam is occurring. At this time, TVA does not consider it to be prudent nor an acceptable risk to raise the reservoir water levels higher in order to study how the level of seepage may increase as reservoir levels increase.

ID	Name	Comments	Response
		that it is significantly affected by higher lake levels This should be investigated thoroughly and consideration given to interval repairs during winter pool levels, or continued repair with normal summer lake levels. It is also not clear that 'seepage' cannot be safely monitored and reasonably responded to without fear of catastrophic failure. The EA seems to indicate that any level of seepage is cause for alarm and that increased seepage could cause a catastrophic event that would endanger the safety of the dam. There is no evidence that controlled monitoring and adjustment of dam flow and lake level would not adequately remediate an increase in seepage. The discussion in section 1.3 is totally unsupported with evidence or technical data. These claims need specific data to warrant the actions defined. Further study and data is needed to warrant a firm determination of repair, required lake levels, and estimated completion period.	TVA has confirmed through testing that connections through the dam's foundation exist and that the seepage was of quantities and velocities sufficient to erode soils in the foundation. The reservoir water level was near elevation 1,375 feet when the sinkhole and muddy seepage was first observed. After observing the continuing muddy seepage, TVA issued notice that the reservoir would be drawn down to winter pool (1,362 feet) at an accelerated rate. When the muddy seepage was observed to continue at the winter pool elevation, TVA decided to continue lowering the reservoir to the current operations range. The muddy discharge was observed to be reduced as the reservoir level was lowered. Rather than raising the water levels for an extended period of time to conduct such an investigation, TVA proposes to begin construction of the proposed seepage barrier in early 2016. In addition to presenting an unacceptable risk, undergoing additional study of this type would likely delay the remediation of the seepage. TVA continues to monitor the conditions at the dam, which allows TVA to assess the effectiveness of the IRRMs.
9-3	Mark Joseph	The EA does not discuss any history of dam inspections or observed or non-observed seepage. Is this the first time the dam has been inspected for seepage, or the first time seepage has been observed? What has been observed in past years at the site? What is the history of dam inspections at this site? Is seepage monitored at other sites? Is seepage at other sites significantly affected by lake level? What is it specifically that supports the	TVA has a robust dam safety program with comprehensive inspections and monitoring of all 49 TVA dams. In addition to regular maintenance, 'health checks' are performed routinely on TVA dams to thoroughly analyze their conditions. The monitoring and assessment programs quickly identify any potential issues in their earliest stages, which allows TVA to take corrective action quickly, effectively and safely. TVA personnel trained to identify dam safety issues were the first to

ID	Name	Comments	Response
		seriousness of this seepage condition?	discover the issues at Boone Dam in October 2014. Before the discovery of the sinkhole and seepage, past inspections of the dam have shown that Boone Dam is structurally sound. Wet areas have appeared on the downstream face of the dam intermittently over the years. However, this is the first time TVA has observed muddy discharge from the river bank indicating that erosion of the foundation soils could be occurring. Seepage has been observed at other dams in the region in the recent past, including TVA's Tim Ford, Bear Creek, and Little Bear Creek Dams. In addition, the U.S. Army Corps of Engineers' Wolf Creek Dam had similar issues. At these dams the source of the seepage was identified and successfully remediated. Because of the region's karst geology, sinkholes in the area near the dam are not uncommon. However, when TVA observed the sinkhole at Boone Dam in October 2014, its location on the base of the dam's earthen embankment was cause for concern. TVA's concern was compounded six days later when seepage and sediment discharges were observed seeping into the river at the toe of the dam. The sinkhole, seepage, and muddy discharges are classic signs of an embankment dam with active piping and internal erosion, which create voids within the dam and/or its foundation under the action of flowing groundwater. Because internal erosion is one of the leading causes of dam failures worldwide, TVA determined that it was prudent to implement a number of immediate measures in late 2014 to reduce the risk of dam failure, including lowering the reservoir's water levels to reduce

ID	Name	Comments	Response
			the hydrostatic pressure on the earthen embankment.
9-4	Mark Joseph	The repair and length of time to perform have both been determined by TVA, however, the details of how the repair is tied to the 5 to 7 year estimate is not provided. The repair and schedule should be based on a high priority to return levels to safe and full dam use conditions, not on a 'budgeted' expenditure limit each year. What is the 5 to 7 year estimate based on? Clearly if yearly expenditures were increased along with resources, a shorter repair period would be achievable. The basis for taking 5 to 7 years is not at all clear, and it appears to be based on a budgeted yearly expenditure limit. The repair should clearly be based on a repair schedule that returns the lake to normal levels and safety as soon as possible.	As explained above in TVA's response to Comment 3-1, the basis for TVA's estimated timeline is not influenced by annual construction budgets and expenditures. TVA came to its estimate that the project will take 5 to 7 years based on several considerations. The first and foremost of these is safety. TVA must account for the safety of its workers when determining how quickly to conduct this complex work and implement these very complicated construction activities. Our estimate includes the planning and design period of the project, including extensive investigation to characterize the nature and extent of the seepage issues, consultation and design evaluations with dam safety and engineering experts, completing environmental and permitting requirements, and mobilizing the resources for construction. TVA is on schedule to complete this phase of the project within 18 months, whereas the same level of planning and design on other similar remediation projects have taken at least 3 years. The complex nature of the proposed remediation action is also a determining factor. As described in Chapter 2 of the EA, the remediation project requires extensive grouting and the construction of a concrete wall deep into the earthen embankment of the dam. Grouting will require drilling hundreds of separate holes deep into the underlying bedrock. Limited working space atop the earthen embankment puts restrictions on how many drilling and grouting rigs can work

ID	Name	Comments	Response
			simultaneously. Constructing a linear wall into the earthen embankment is also complicated and great care must be taken to ensure that the embankment remains stable during construction. In estimating the timeline, TVA consulted with other agencies that have completed similar projects and benchmarked those projects (including some lasting more than 10 years) to determine a realistic proposed project timeline.
9-5	Mark Joseph	Although the EA states that an Independent evaluation of the problem was performed, the detailed report is not referenced or available for review as part of the EA. Again, the expense of $300,000,000 over 5 to 7 years needs to be justified by an independent engineering report that is referenced and available for review as part of the EA. The expertise and independence of the 'Independent' firm should be clearly stated, along with fully documented expertise and experience with this type of problem. The independent firms report should include documentation to support the serious nature of the problem and also the proposed repair.	As stated in the EA, due to the complexity and urgency of the situation at Boone Dam, TVA augmented its own team of dam safety engineers with nationally recognized experts in dam safety. Some of these experts serve to support TVA's staff and others serve as independent "checks" to provide advice and valuable perspective. In addition to these experts, TVA has engaged other owners of large dams, such as the USACE, and large private utilities that have dealt with similar seepage issues. Through review during multiple workshops, TVA's team of experts and independent advisors evaluated methods for repairing Boone Dam and identified a composite seepage barrier as the preferred method to remediate the problems at the dam, pending additional environmental review.
9-6	Mark Joseph	In addition to the independent repair determination, an independent firm should follow the course of the repair with reporting authority directly to the TVA Board. The Independent firm should concentrate on safety and economic impact to the area. The main objective should be return to normal lake levels as soon as possible, as this is the safest and least impact option. The return to normal levels will accomplish both the safety of boaters and least	TVA dam safety professionals and the team of independent dam safety experts are working closely with TVA leadership to inform and advise the TVA Board of Directors. TVA does not agree that it would be safer to elevate water levels at this time. TVA did not consider a remediation alternative which would include maintaining Normal Operations of Boone Reservoir during remediation activities because an

ID	Name	Comments	Response
		risk for dam safety. By concentrating on the quickest return to normal levels, the firm would accomplish both objectives of safety and least economic impact.	alternative that would include higher water levels during remediation activities is not reasonable due to the increased risk associated with greater hydrostatic pressure on the dam. In addition, in the event of a dam failure, higher water levels in the reservoir would increase the volume of water moving downstream. While many businesses and individuals in the community are impacted economically by the drawdown and the lower reservoir levels affect boater safety (both of which are issues discussed in the EA), TVA must weigh consideration of those impacts with the potential for severe impacts to those downstream. The potential economic impacts and risk to public safety associated with a dam failure would be significant, with homes, businesses and recreational areas flooded and thousands of lives placed in danger. It is for these reasons that we must maintain lower reservoir levels while we safely correct the seepage problem. The continued drawdown of the reservoir is prudent and safe at this time.
9-7	Mark Joseph	The determination of the preferred/best repair option is not technically justified, and it is not clear who within TVA determined the repair method. Again this should be supported by a detailed engineering report as part of the EA, with documented expertise of the authors provided. The options also do not appropriately consider the interim long term safety and economic impact of the proposed 5 to 7 year repair period. There should be several options that look at less economic impact, return to 'safe' levels sooner, and the need for concern with normal levels and determined affect on seepage. There is not adequate	As noted in the EA, due to the complexity and urgency of the situation at Boone Dam, TVA augmented its own team of dam safety engineers with nationally recognized experts in dam safety. Some of these experts serve to support TVA's staff and others serve as independent checks. In addition to these experts, TVA has engaged other owners of large dams, such as the USACE, and large private utilities that have dealt with similar seepage issues. Through review during multiple workshops, TVA's team of experts and independent advisors evaluated methods for repairing Boone Dam and identified a composite seepage barrier as the preferred method to

ID	Name	Comments	Response
		support for the estimated 5 to 7 years to complete the repair. Why does it take 5 to 7 years to complete this repair. Why are there not other repairs or other options with shorter repair periods?	remediate the problems at the dam, pending additional environmental review. Also noted in the EA are the other remediation actions that this team considered but determined to be not viable or potentially ineffective. Economic and public safety impacts were important considerations in reviewing these other remediation actions, including the potential impacts to communities associated with the temporary loss of flood control (which would occur under a number of alternatives) and the potential that the action is ineffective and TVA would have to reinitiate another timely and costly remediation proposal.
9-8	Mark Joseph	There should be an option for making repairs while the lake is returned to a level that is more amenable to safety and less economic impact. This would be the safest and least economic impact option. It is also the least cost option. The lake bottom would not have a chance to grow as quickly if it was alternated with higher water levels, the revenue cost to the city and county from loss of taxes would be much less, in addition to the obvious return of Marina's and private property to normal values. The 'seepage' issue was discovered with lake levels at the winter level, it is not clear that the water level will significantly affect the seepage or the repairs. Interval repair or repair during the higher water levels is a viable option and has the least impact on safety and the economy. This option should be fully investigated and considered.	Please see the response to Comment 9-6 above regarding TVA's consideration of public safety and economic impacts.

ID	Name	Comments	Response
9-9	Mark Joseph	The economic impact as cost to the area businesses and residents is not totaled accurately so that the cost per year can be weighed against repair options that shorten the time interval to 'return to normal lake levels'. The cost of each economic impact should be estimated for each year, and totaled to provide the yearly cost of not returning the lake level during the May to September time interval.	Please note that Table 3-24 in Section 3.11 (Socioeconomics) of TVA's Draft EA does report the annual costs of the No Action Alternative and the Proposed Action Alternative by impact area.
9-10	Mark Joseph	Also, there is no compensation provided for the private property owners. The determination to provide relief for the Marinas without consideration for property owners is totally without merit. The average property owner that sells during this period is likely to lose 20 to 25% of the property value, as sales will be down and value will also be down. Job transfers that require sale of the property can have significant impact on private citizens. The loss to property owners should be accounted for with some form of compensation similar to the Marinas.	TVA does not have plans to compensate private property owners. TVA is committed to fixing the earthen embankment as quickly and safely as possible. Please note that Section 3.11 (Socioeconomics) of TVA's Draft EA explains that property values are not expected to decline appreciably during the 5 to 7 year drawdown period under the Proposed Action. To date, real estate professionals have not seen appreciable declines in home prices. In general, a significant factor in the valuation of any property is uncertainty about the future condition of the property and/or the surrounding properties and neighborhood. Since TVA proposes to remediate the dam, any uncertainty about the future condition of the reservoir has been significantly reduced. If there were uncertainty about the future management of the reservoir, economic theory suggest that prices would respond more to uncertainty, than a temporary period of reduced enjoyment.
9-11	Mark Joseph	Lake bed tree and vegetation removal – The yearly cost to remove trees and other disruptive vegetation from the lake bed that would pose a safety issue for the return to normal pool levels needs to be determined accurately as a yearly cost. This could be a significant cost and needs to be determined accurately.	Please note that Section 2.2.4 of TVA's Draft EA includes a description of TVA's proposal to implement a Vegetation Management Plan to manage the successional vegetation on much of the exposed reservoir bottom. TVA would work with private landowners to manage this growth with annual or periodic mowing or bushwhacking. When approved by the

ID	Name	Comments	Response
			landowner, TVA would use mechanical means, including tractors with bush hog attachments, extendable hydraulic arms, and other equipment to ensure safety. TVA's two primary objectives are to remove tree species from the newly exposed reservoir bottom areas that normally do not establish due to season pool levels and to avoid having trees mature during the drawdown period to heights that would create navigation and public safety problems once the waters are returned to normal levels. Because TVA is offering to manage this potential problem for the shoreline property owners, the costs were not included as an impact to property owners. Based on this comment, the EA's socioeconomic discussion (Section 3.11.2) has been revised to acknowledge that property owners may incur costs to manage vegetation over the remediation period.
9-12	Mark Joseph	The cost to the landowners, both developed and undeveloped, needs to be determined accurately by an appraiser based on actual sales data in the area. Lake front property sales, compared to the same type of property for non-lake front property is readily available for determination of lake front compared to non-lake front. The properties that would normally be considered lake front for normal lake levels would not sell for 'lake front', they would be comparable to the non-lake front properties. The loss of value should be a percentage so that it can also be applied to the loss of revenue by the city and county tax authority. The loss of tax revenue to the city and county should be accurately defined and justified.	Please refer to TVA's response to comment 9-10 above.

ID	Name	Comments	Response
9-13	Mark Joseph	Section 1.5.2 provides specific action to address loss of revenue to area Marinas. The singling out of Marinas to be addressed and not private property owners is not warranted. The loss of property value and ability to sell lakefront property during the repair period should be addressed, as the affect on property owners is very significant. The option of filling and monitoring the lake during the summer months would provide relief for both Marinas and property owners. If this option is determined not viable based on specific data, the repair period should be minimized and compensation provided equally to property owners as provided with Marinas.	Please refer to TVA's response to comment 9-10 above.
9-14	Mark Joseph	The safety of the current lake level, and increased boating traffic with planned improvements has not been adequately studied or evaluated. The narrowness of the lake in several areas will not allow for more than two boats to pass safely by each other without encroaching on potential obstructions close to the shoreline. There are no new rules or buoys that I have seen. If TVA is considering the current lake levels to be safe for boating, then they should clearly state that they are responsible and accountable for safety during the drawdown period, and will be liable for any accidents due in part or in full to the lower lake levels. Accidents due to hitting unmarked obstructions or shallow water during this period would fall under this responsibility. Likewise, the narrowness of the lake should also be considered a significant hazard to boaters. The current conditions are questionable as far as hazards, and in addition TVA has a plan to encourage higher usage of the lake during the repair period by building additional ramps	To address this comment it is important to understand that TVA projects recreational boater use of the reservoir will decline during the 5- to 7-year duration of the project. To address immediate reservoir access concerns resulting from the drawdown, TVA is implementing reservoir access improvement projects as described in Section 1.5.1 of the EA. Although the planned reservoir access improvement projects may partially offset limited reservoir accessibility over the 5- to 7-year duration of the project, they will only increase boater accessibility and are not anticipated to offset the overall predicted decline in recreational boater use. TVA's analysis of recreational impacts during Interim Operations indicates that a significant decline in the recreational boater use of the reservoir will likely occur until the project is completed and Normal Operations is resumed (refer to Section 3.12.2 of the EA). TVA recognizes that the drawdown water levels over the 5- to 7-year duration of the project would reduce the surface area of

ID	Name	Comments	Response
		and other improvements. Again, TVA should be clearly accountable for safety during this period and determine specific hazards, buoy markings, and speed limit or passing rules as appropriate. The safety of boaters during this period is very questionable and the return to normal lake levels should be of utmost priority.	Boone Reservoir year-round and change patterns of recreational boating use. The reservoir water levels under Interim Operations during the 5- to 7-year period would be quite similar to fall and winter reservoir water levels under Normal Operations, levels to which many boaters who use Boone Reservoir are accustomed during the fall and winter. TVA recognizes that the somewhat lower water levels under Interim Operations likely would expose some additional subsurface and/or surface hazards that are not a problem at higher water levels. While these hazards could adversely affect recreational public safety in the near term, this negative impact would diminish over time as boaters become aware of the location and nature of these hazards. TVA has mitigation measures in place to reduce these impacts such as buoy markers, barricade floats, and signs, and will continue to mark any additional hazards in the reservoir that pose a threat to the health and safety of boaters (refer to Section 2.2.4 of the EA). In addition, TVA has provided boater safety guidance on the project website (https://www.tva.com/Newsroom/Boone-Dam-Project) that should be followed to reduce boating hazards during the drawdown period.
9-15	Mark Joseph	The details provided in Table 1-2 need careful consideration of the potential affect increased boat traffic on the lake will have on boating safety. Current lake levels are not safe in comparison to normal summer levels with increased boat traffic. Improvements that increase boating traffic will have an adverse effect on safety. Specific mitigating measures and precautions are warranted.	Please refer to the response for Comment 9-14 above.

ID	Name	Comments	Response
10-1	Kenneth Wagner	After serious consternation, I've decided that I must make my feelings known about the total lack of responsible action on the part of the administration of the TVA and their failure to notify persons living on Boone Lake that the water level in the lake was to be dropped for an extended period of time (5 - 7 years) without giving any semblance of notice to residents having boats suspended, in some cases 31' above what was the bed of Boone Lake behind their residence - as is my case. I am certainly in agreement with the environmental assessment and agree wholeheartedly that something must be done to protect life and property. What I am hard pressed to understand, especially after hearing the news report from last week, which indicated that TVA knew of the hazards associated with the seepage discovered in the earthen part of Boone Lake Dam, is why the community was not timely notified of such a major issue. For them to have known anywhere from eight months to one year that this problem existed and their absolute failure to notify residents that they should take precautions to get their watercraft out of their boat houses and into the water before it reached levels that would not allow their retrieval. This negligence on the part of the TVA has cost numerous people considerable amounts of money in their attempts to try to rectify the wrong that was committed upon them by the irresponsible actions of the TVA. Having said that, I am curious to know how many, if any, TVA employees find themselves in the same posture that I and numerous others find ourselves in because of the aforementioned. Certainly it would have been wise on the part of the TVA administration, whether they knew or merely suspected that the damage to the dam was to	When TVA became aware of the seepage at the dam in late October 2014, it took immediate action to address the potential risk of dam failure. Discovering a sinkhole and then, days later, seepage and muddy discharges at the toe of the dam was cause for concern. The decision to lower water levels to below the normal winter pool was made soon after discovering these issues and out of concern for the health and safety of people in communities downstream as well as TVA employees working at the site. For safety purposes, TVA intends to keep the reservoir waters at lower levels during the course of the project. However, project engineers would evaluate the potential of raising the water based on a review of the conditions of the embankment which may improve as progress is made to complete the seepage barrier. Many in the community have expressed frustration that they cannot access and move their boats and have requested that TVA temporarily raise the water levels so that boats may be removed. Unfortunately, TVA needs to maintain the lower water levels to reduce the hydrostatic pressure on the dam and the volume of water that would be released in the event of a dam failure. The continued drawdown of the reservoir is the safe and prudent thing to do to maintain the stability of the dam. TVA recognizes that this drawdown has greatly impacted shoreline property owners. TVA continues to evaluate the issue of stranded boats. There continues to be no simple resolution to this issue, as the variety of different boat sizes and their locations prevents a single solution. TVA is considering how best to address that situation

ID	Name	Comments	Response
		cause such severe consequences for the community, for them to at least let us know that there was potential for such egregious action to be taken with no warning at all; 30 days, one week, two days or even one hour to get our boats out. There has be nothing more than irresponsible action on the part of the decision makers in this circumstance. To the contrary, the decision makers in this situation have shown a total disregard for their responsibility to notify the community. As such, what if any action is the TVA administrative personnel going to take to facilitate rectifying the wrong that has been done to affected community members?	and will post any updates on the Boone Repair website (https://www.tva.com/Newsroom/Boone-Dam-Project).

This page intentionally left blank.